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Build your own in under 30 minutes p42

POWERHOUSE PCs FROM £999

Eight heavyweight systems do battle p74

WINDOWS REGISTRY

The hacker's guide

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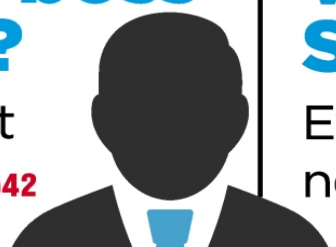
What can your boss see about you?

Private messages aren't as secure as you think p42



Windows 10 Spring Update

Everything you need to know p50

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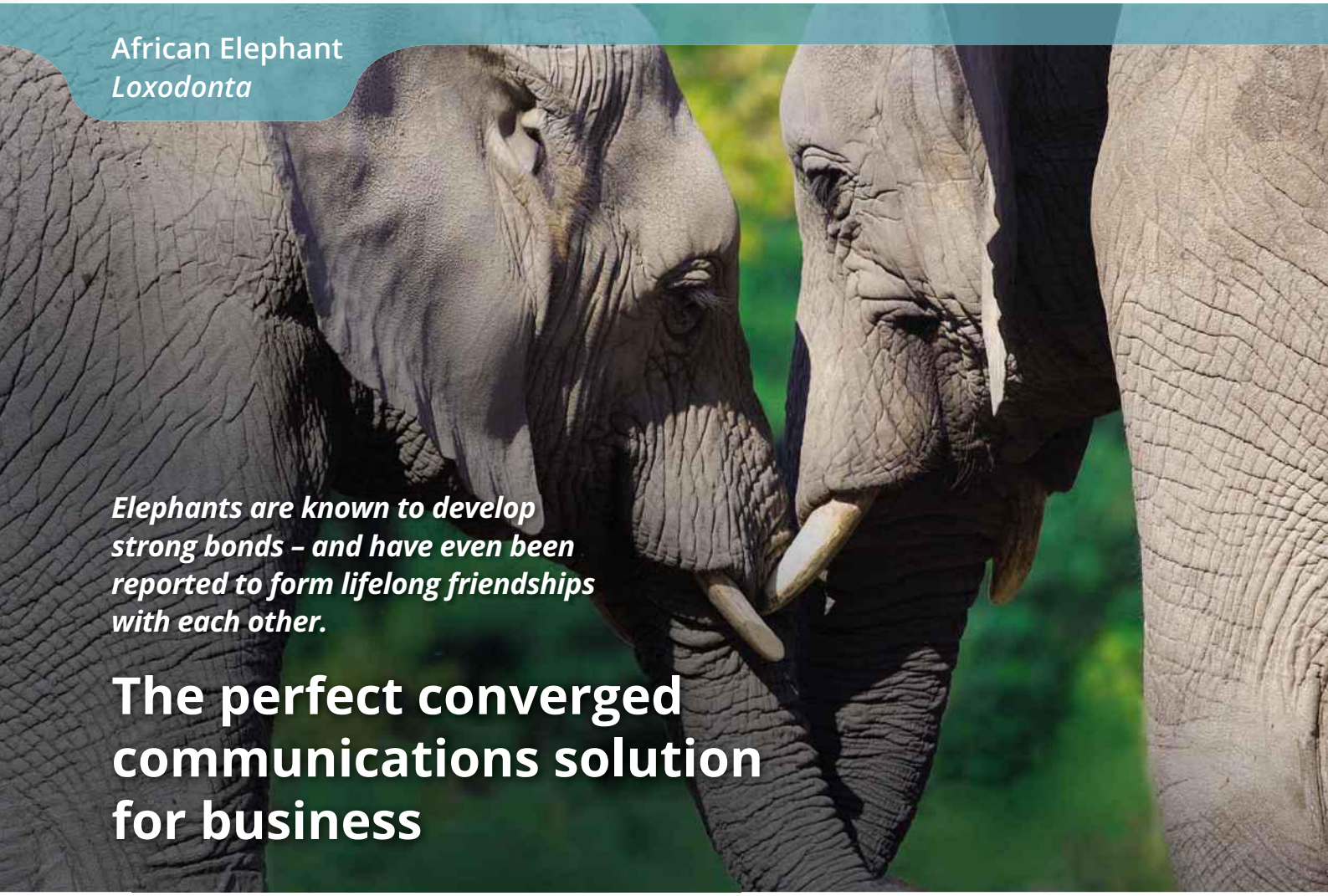

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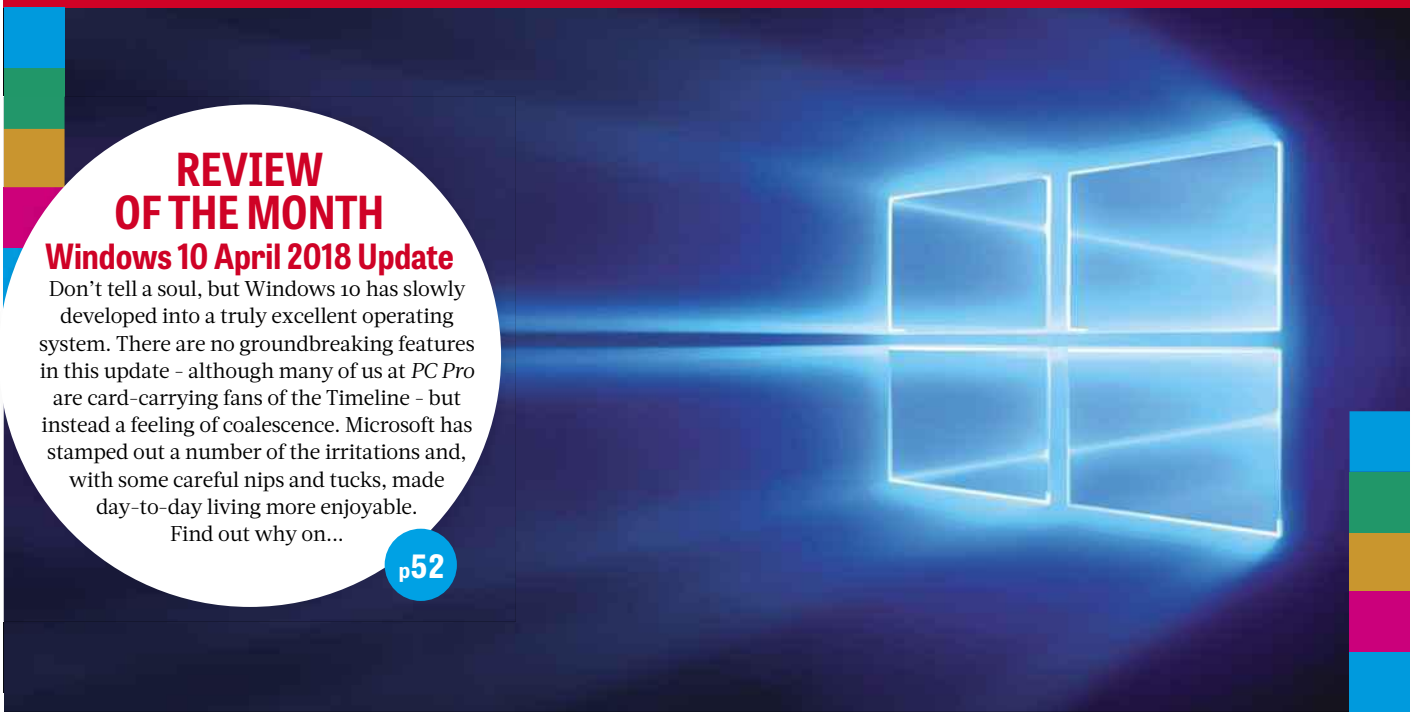
HIGHLIGHTS THIS MONTH

Full contents overleaf

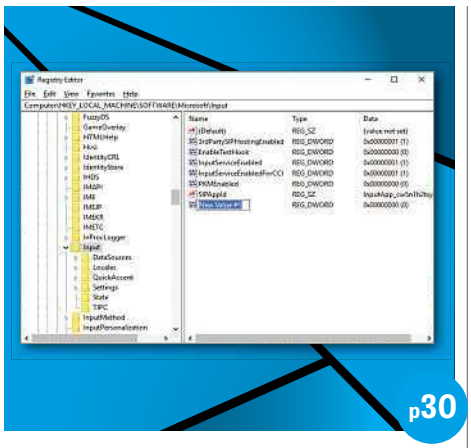


REVIEW OF THE MONTH

Windows 10 April 2018 Update

Don't tell a soul, but Windows 10 has slowly developed into a truly excellent operating system. There are no groundbreaking features in this update – although many of us at *PC Pro* are card-carrying fans of the Timeline – but instead a feeling of coalescence. Microsoft has stamped out a number of the irritations and, with some careful nips and tucks, made day-to-day living more enjoyable. Find out why on...

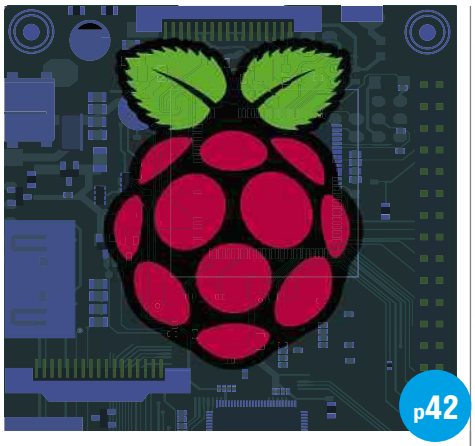
p52



p30

TIP OF THE MONTH

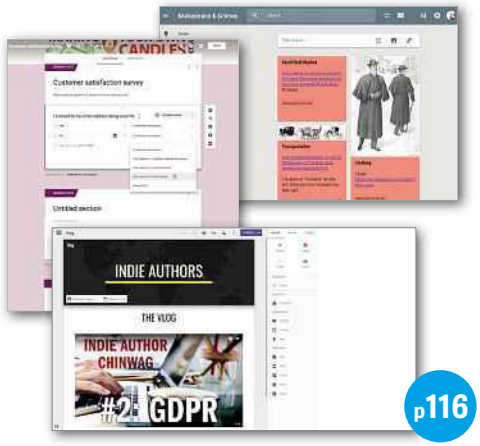
Or perhaps we should say tips of the month instead, because our main feature – on "hacking" the Windows Registry – is packed with the blighters. It's time to take deep-level control of what you see and how Windows behaves.



p42

PROJECT OF THE MONTH

The Raspberry Pi is a gift that just keeps on giving, with its latest iteration costing around £30 and offering more than enough power to create your own home server or even host your own website. Nik Rawlinson provides step-by-step advice.



p116

GOOGLE FREEBIES OF THE MONTH

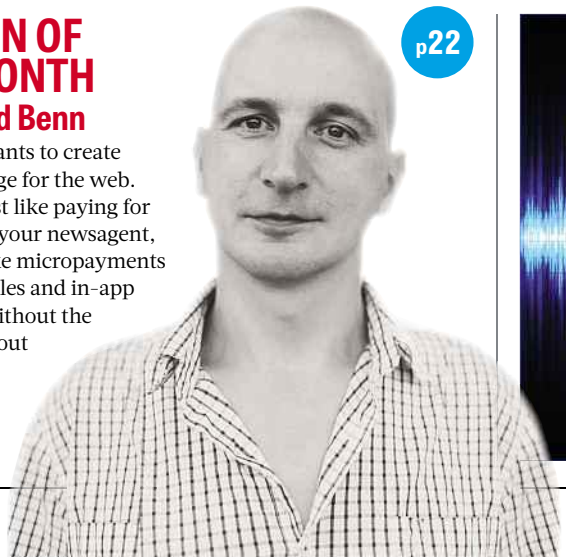
Kevin Partner returns with his verdict on three Google tools that don't get the airtime they deserve but could both save you money and provide valuable insight. Discover what they are on p116.

PERSON OF THE MONTH

p22

Meinhard Benn

Meinhard wants to create pocket change for the web. Why? So, just like paying for the paper at your newsagent, you can make micropayments for web articles and in-app purchases without the hassle. Find out what makes SatoshiPay different from p22.

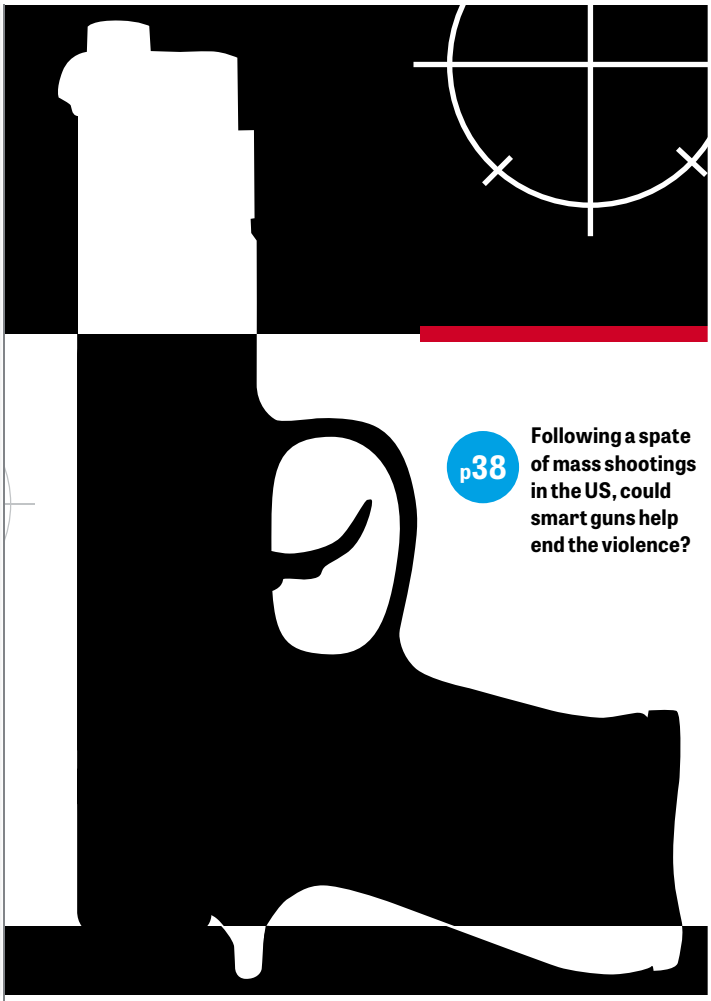


THE LABS IN ONE NUMBER

p74

64GHz

We're cheating, but that's what you get if you times the number of threads by the overclocked processor power inside two of our stunning PCs this month. They're quite fast.



p38 Following a spate of mass shootings in the US, could smart guns help end the violence?

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It's time to take full control of Windows: Darien Graham-Smith demystifies the Registry and shares a treasure trove of handy hacks.

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Guns are out of control in the US. Could smart weapons succeed where politicians have failed? Davey Winder finds out.

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We meet the entrepreneur who is using blockchain technology to crack the tricky micropayments market and help web publishers sell their content to consumers.

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BRIEFING

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Confusion over what the GDPR rules actually mean could lead to further waves of re-consent requests from companies.

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A screen-centric HP ultraportable, a futuristic Hub from Microsoft and the first 10nm Intel CPU.

13 Amazon's face scanner raises doubts over Echo
The tech giant's reputation is at risk over government surveillance deals.

14 Firms go to war on 'right to repair'
As new laws are proposed to let consumers repair their own tech, manufacturers redouble their efforts to prevent it, Stewart Mitchell discovers.

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p70 **Will Motorola reclaim its place as king of the budget handsets with the Moto G6?**

REVIEWS THIS MONTH

POWER HOUSE PCs

p74 **Which of these eight supercharged systems is right for you?**

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THE NETWORK

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Editor's letter

If you can't beat 'em, go do something else

AS THE THERMOMETER tipped over 30°C in the shade, my regular conference combo of jeans and jacket was proving overkill. But this is the problem of a work trip abroad: you're there for the briefest of times, you're normally in a mad hurry to pack, and you anticipate spending most of your time in an air-conditioned conference centre.

Instead, I was wandering the sun-scorched New York streets in search of interesting tech and gaudy souvenirs – although I spent almost as much time people-watching. Aside from the tourists, everyone in New York is locked in their own world, cocooned by earphones. Most frequently, the faintly ridiculous Apple AirPods, which at least Londoners have had the good sense to ignore.

Indeed, it's aptly named the Big Apple. The brand's dominance was obvious, from the laptops people used in Starbucks to the phones in their hands and the huge Apple store at the top of Fifth Avenue. I didn't visit it this year, being unwilling to traipse to the top of the street, but I did pop into Microsoft's flagship store a bit further down.

It's the first time I've visited this shop, although back in 2012 I spent several hundred dollars on a Surface RT at a pop-up Microsoft store that was essentially its proof-of-concept predecessor. Despite the six-year gap, and the sweeping corporate changes of Satya Nadella, I'm not convinced Microsoft has moved on. In my view, it's slipped further into a battle against Apple that it will never win.

The moment you step through the doors, it's embarrassingly obvious the company has scoured Apple's shop looking for tips. The floor is flooded with helpers, but where Apple sales assistants have an almost cloying desire to help you, the Microsoft assistants seem more interested in chatting with one another. That's perhaps a difference in status: you probably don't boast about working in the Microsoft store in the same way you do for Apple.

That's a shame. A couple of hours earlier, I'd been watching Acer CEO Jason Chen announce a super-slim 15in laptop that weighs under 1kg. While this has the disadvantage of not actually existing yet – the laptop shown on stage wasn't even a working prototype, just a mock-up – it looks like an incredible piece of engineering. It also adds to the rich diversity of Windows laptops you can buy. Even in this issue, we've got a 13.3in Asus laptop (*see p58*), the glamorous HP Spectre 13 (*p60*) and a 14in business ultraportable from the same company (*p63*). (I'll gloss over the fact that two of those three laptops have an uncanny resemblance to MacBooks.)

Want greater diversity? Fine. How about desktop PCs? In fact, the biggest portion of Chen's announcements revolved around gaming: Acer's first mechanical keyboard will accompany rucksacks, giant desk mats and a fleet of new gaming PCs of all sizes. This is an area of absolute dominance for Windows systems, as shown by the eight daunting systems we put to the test on p74.

My message to Microsoft? Forget Apple. It's not the competition. You'll never lure the people with AirPods in their ears and iPhone Xes in their pockets. Instead, concentrate on your strengths: the diversity of your partners; the flexibility of your OS, as underlined by our feature on tweaking the Registry on p30; your long-standing business credentials. Leave the anodised aluminium and slick stores to Apple.

Tim Danton
Editor-in-chief

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Darien Graham-Smith
Ever wondered how to get the most from the Windows Registry? We asked Darien to go explore, and he came back with over 20 hacks. See p30

Kevin Partner
Long-time contributor Kevin makes a welcome return to our pages with three underrated Google tools, along with tips on how to use them. See p116

Davey Winder
Davey for president? Sadly, it will never happen, which is a shame as – with the help of experts – he puts together a convincing case for smart guns from p38

Nik Rawlinson
The Raspberry Pi has plenty of rivals – see p113 – but we love its latest incarnation. Find out how to turn it into a home server from p42

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We review the OnePlus 6, which undercuts premium phones by £300, on p68. But it's still £469. How much do you think is reasonable to spend on a smartphone?

"After my Nexus 6P died, I panic-bought a £150 Moto G5S before a trip, and it's been so good that I don't see the point in spending hundreds anymore."

"As you'll be using it constantly, spend as much as you want – for me, I want to spend as little as possible and go on holiday instead. Enjoy your iPhone X, I'll be in Paris."

"Under £400. Either by picking a price breakthrough (for example, the OnePlus 5) or by going for last year's refurbs."

"It depends on how you plan to use it. In the home, a lot of these devices get handed down within families, so it makes sense to buy something that will last. A business will need a strong element of platform standardisation for remote management, app deployment and so on. That might push them to doing larger waves of updates, but less frequently."

"Every year when the new flagship phones arrive I say, 'I can't imagine paying that much for a phone'. And then, a few months later, I usually do. Whether that's reasonable or not I can't answer..."

"I'd say under £250 is reasonable (off contract). However, my current phone is a Galaxy S8+ (pre-ordered, on contract), which will have cost the business £1,056 by the end of contract. So, erm..."

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Briefing

Background and analysis on all the important news stories

No end to GDPR email hell

Confusion over GDPR rules could see ongoing waves of re-consent requests

THE BARRAGE OF GDPR emails looks set to continue, despite the regulation's drive to reduce inbox clutter.

In the run-up to the General Data Protection Regulation (GDPR) coming into effect at the end of May, people were overwhelmed with emails asking them to re-consent to ensure companies could continue to send them marketing emails.

"Don't lose your discounts – let us stay in touch," was a common refrain, but according to experts, companies that sent these messages and failed to get a response could still follow up with further requests or continue with marketing messages regardless.

"I expect what we'll really see is a lot of companies come grovelling in the next few weeks saying: 'Actually, we asked you to re-consent – sorry about that – we're just going to send you email unless you object'," said Neil Brown of internet specialist law firm decoded:Legal.

Companies could either rely on previous consent or keep trying to gain re-consent through fear of losing many of the contacts in their databases. "What we will certainly have seen is a load of companies that have completely mucked up their marketing base," said Brown. "If you ask 100 people to re-consent, how many people are actually going to bother to do that? 10%?"

Now that companies have asked for permission to continue sending messages and received no response, they may have to continue to make contact to rebuild bridges, even if such approaches are illegal in themselves. "They'll be sending pleading emails with spurious justification for the rest of the year," said Tim Turner of data protection training specialist 2040 Training.

Last-minute rush

Re-consent rates are expected to be low, but, according to Turner, charities and other organisations that sent requests out before the late rush fared better than companies that waited until the last minute. "The RNLI did a long process of getting opt-in consent and ended up with half a million people (which is great) but it was a slow, considered process done when no-one else was doing the same thing," said Turner.

ABOVE Think you've seen the last of pleading GDPR emails cluttering up your inbox? Think again

"I think organisations joining in this current frenzy will be hit by a wave of indifference. I expect uptake to be very low. When it's done, the result will be shrunken databases and no legal method to send marketing to many people."

The irony for many companies is that they may not have needed to send any messages out in the first place. "The law around the consent for sending marketing email hasn't really changed since 2003," said Brown. "Most companies should have had consent already."

Companies would have either had a soft opt-in gathered during online transactions, or full consent, meaning it's possible that many of the companies sending messages either

didn't have proper consent in the first place or misunderstood the complicated new regulations.

"What you're seeing in a lot of cases is that companies either simply weren't complying beforehand or they've been given shoddy advice. Once one company started sending requests everyone joined the bandwagon," Brown said.

Some companies may have been unsure if their consent was sufficient, Brown said, while others may not have retained proof of when and how consent was gathered.

No permission to beg for permission

The situation is even more confused because the very act of sending messages asking to be allowed to send messages could breach data regulations – so hundreds of companies could face censure.

"It may not be appropriate to seek fresh consent if you are unsure how you collected the contact information in the first place, and the consent would not have met the standard under our existing Data Protection Act," Steve Wood, deputy information commissioner, said in a blog post.

In fact, the Information Commissioner's Office (ICO) has previously issued fines to companies

> "Companies either simply weren't complying beforehand or they've been given shoddy advice"

for requesting permission – last year, for example, it hit airline Flybe and car giant Honda with penalties. The ICO said at the time that "Flybe sent 3.3 million emails to people who had told them they didn't want to receive marketing emails from the firm", while Honda Motor Europe "had sent 289,790 emails aiming to clarify certain customers' choices for receiving marketing".

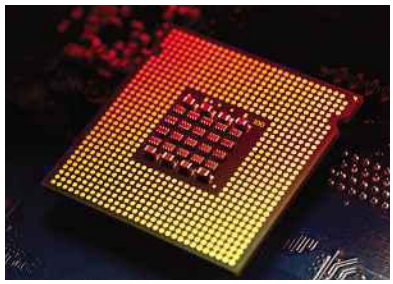
"Both companies sent emails asking for consent to future marketing and in doing so they broke the law," said Steve Eckersley, ICO head of enforcement. "Sending emails to determine whether people want to receive marketing without the right consent is still marketing, and it is against the law."

The body said it wasn't currently investigating any companies over their GDPR actions, but that doesn't mean it won't take action in future. Firms in breach of the regulations face fines of up to €20 million or 4% of their annual turnover (if greater).

Five stories not to miss

1 Chip flaws strike again

Security researchers at Google and Microsoft have uncovered a fourth flavour of a processor flaw similar to Spectre and Meltdown that could be exploited by scripts within software such as JavaScript. The newly discovered speculative execution vulnerability (CVE-2018-3639) could be used to sniff data by malicious software or anyone logged into systems using many modern Intel, AMD, ARM and IBM processors.



2 Researchers warn of major router malware threat

Researchers from Cisco's Talos labs have uncovered a possibly state-level malware targeting home and small office routers, claiming it was already installed on 500,000 devices. Primarily targeting Ukraine, the researchers say VPNFilter has been spotted in 54 countries and that it can steal website credentials, kill infected devices and "has the potential of cutting off internet access for hundreds of thousands of victims worldwide".

3 Windows Update downbeat

Windows 10 users were warned to delay the April 2018 Update (*see p52*) that caused a double whammy of problems and sparked system crashes. Incompatibility with Intel and Toshiba SSDs was blamed for the first issue and Microsoft stopped sending updates to configurations with known issues, saying a fix should be ready by June. The firm was investigating a further issue that caused users to lose access to their desktops.

4 Last chance in fight to block online snooping

The ongoing fight from Privacy International over the way the UK spy agencies access data and use general warrants to hack computers is heading to the final court of appeal in December. The fight dates back to 2014 and a complaint to the Investigatory Power Tribunal, but the rights group has been granted a final chance to redress what it calls excessive powers at the Supreme Court.

5 Social networks anger MPs

UK officials are pushing ahead with plans to fine social media companies for slow removal of abusive content, having lost patience when only four of 14 networks turned up to requested meetings. Previous plans had involved "working with companies" on voluntary programmes, but the lack of impetus from the industry means politicians are pushing for regulation.

Unveiled

The key details of this month's hot hardware releases

HP EliteBook x360 1030 G3

HP has updated its Elite and Envy ranges, with the most interesting features appearing in the business-centric HP EliteBook x360 1030 G3.

Featuring four form-factor modes, the lightweight convertible is aimed at professionals who work in a range of light conditions, with the EliteBook x360 1030 G3 offering several different screen options.

The five available 13.3in touchscreens all feature Gorilla Glass 4, but there are key differences that set them apart. The flagship option is a glossy 4K Ultra HD (3,840 x 2,160) screen with a respectable brightness of 500cd/m², but more interesting for anyone that works outdoors is the anti-glare 1,920 x 1,080 option that throws out 700cd/m².

The brighter displays feature HP's Sure View privacy system, which enables users to switch the screen from being visible to a wide audience to allowing only the user directly in front of the screen to see its contents (*see our review of the EliteBook 840 G5, which also includes this technology, on p63*).Two more run-of-the-mill 400cd/m² Full HD displays – one of which is anti-glare – complete the display options.

The EliteBook x360 1030 is also the first device to feature HP's Sure Recover with Embedded Reimaging, which stores a software system image in embedded memory, so that data can be recovered even if the hard drive is wiped.

For those prone to misplacing pens and styluses, there's another feature that might appeal: the stylus sends alerts to the device if the accessory strays too far from home.

LEFT The EliteBook x360 1030 G3's Gorilla Glass screen will appeal to anyone who works outdoors

KEY DIGITS AND DETAILS

Availability From June
Price From $1,499
Processor Core i5-8250U or i7-8650U
Memory 16GB LPDDR3-2133 SDRAM
Storage SSDs from 128GB up to 2TB
Weight 1.25 kg

Microsoft Surface Hub 2

Microsoft has unveiled the Surface Hub 2, an upgrade to its collaborative conference room display that looks like it's straight out of the incident room of a futuristic police drama.

The original Hub shipped some 5,000 units, and with prices topping out at $21,999 for the 84in version, this is a high-margin business for Microsoft.

The updated Hub 2 is based on a 4K+, 50.5in multitouch display with a 3:2 aspect ratio. 4K cameras in the display – as well as far-field mic arrays – are intended to provide a more inclusive feel for videoconferencing participants, but the big draw for larger firms may be the ability to tile up to four displays for a wider working space.

ABOVE It may look like something from *Minority Report*, but the Surface Hub 2's videoconferencing potential will appeal to big firms

Microsoft says multiple people will be able to authenticate on the same Surface Hub 2 workspace, allowing them to simultaneously access their documents and notes.

KEY DIGITS AND DETAILS

Availability 2019
Price To be announced
Screen Rotatable 50.5in, 4K+ resolution

Lenovo IdeaPad 330 with 10nm CPU

The Lenovo IdeaPad 330 might not look like the vanguard of laptop innovation, but it includes the first offering from Intel's long-awaited 10nm production line.

Intel thought it would have processors built on 10nm silicon as long ago as 2015, but the date for the Cannon Lake processors has been pushed back multiple times.

Yields are not yet sufficient for widespread rollout, but the Core i3-8121U that powers this IdeaPad 330 still marks an important moment in Intel's roadmap. The Core i3-8121U is an 8th generation low-end chip running on 15W, with two cores, four threads and a basic clock speed of 2.2GHz, which boosts up to 3.2GHz.

The Cannon Lake processor supports two new kinds of memory – LPDDR4 and LPDDR4X – which should reduce power consumption.But Intel remained coy on whether the processor will later feature integrated graphics, which is commonplace on its low-end chips. Instead, this first outing for Cannon Lake ships with AMD Radeon graphics.

ABOVE The Lenovo IdeaPad 330 is the first laptop to ship with a 10nm Core i3-8121U processor

KEY DIGITS AND DETAILS

Price From $449, with 4GB RAM/500GB hard disk
Availability Now, in China
CPU Intel Core i3-8121U
GPU AMD Radeon RX 540 2GB
Display 15.6in, 1,366 x 768
Memory 4GB or 8GB, DDR4-2133/2400
Storage 500GB or 1TB hard disk, 128GB or 256GB SSD
Weight 2.1 kg

Amazon's face scanner raises doubts over Echo

Company's reputation at risk over government surveillance

ABOVE Do you really want face-recognition technology in your home?

AMAZON'S PRESENCE IN the smart home has been called into question after it emerged the company was working with police forces and governments to provide face recognition.

Rights groups have questioned the desirability of having camera-equipped devices such as the Echo Show and Echo Spot in the home when the company is developing such technologies for the state.

The American Civil Liberties Union (ACLU) has launched a campaign trying to get Amazon to rein in its Rekognition tool, which is run through the company's Amazon Web Services arm. "With Rekognition, a government can now build a system to automate the identification and tracking of anyone," said the ACLU. "If police body cameras, for example, were outfitted with facial recognition, devices intended for officer transparency and accountability would further transform into surveillance machines aimed at the public."

The ACLU discovered that several US states and police forces were already customers of a service that launched in late 2017 and has recently undergone an upgrade. "You can now perform real-time face searches against collections with tens of millions of faces," Amazon claimed in its marketing documents, adding that images featuring up to 100 people can be run through the system.

While security services may welcome the ability to identify a face in the crowd, the ACLU certainly does not. "With this technology, police would be able to determine who attends protests.

"Amazon has publicly opposed secretive government surveillance," the organisation said. "But actions speak louder than words, and Amazon's efforts to deploy this technology run counter to its proclaimed values and risk harm to the company's customers."

The unwanted publicity comes at a time when Amazon is trying to sell always-listening Alexa smart devices, with one of its difficulties being that some consumers are wary of eavesdropping. "You can market the technologies as being as benign as you like, but essentially they are surveillance technologies and then you come out explicitly providing surveillance tools," said Millie Graham Wood, a solicitor at rights group Privacy International.

"You've let Amazon into your home because of the way it's marketed and you don't think about the speaker always listening to you and then you look at what else it's doing and it's creepy. The idea that Amazon is there primarily for the consumer is not really true any more."

Amazon declined to comment on whether there were any UK customers for Rekognition, but the British police services have been trialling their own tools and have amassed an image database of 19 million UK residents. Such a dataset, coupled with Amazon's know-how, could be a powerful weapon, and one that legislation has yet to address.

"There's no oversight and there's no legal basis for its use," said Graham.

AI can't save NHS without safeguards

ABOVE While AI can help in scan analysis, questions remain over data safeguards

ARTIFICIAL INTELLIGENCE COULD save thousands of lives a years, according to Prime Minister Theresa May, but experts warn that will require a significant improvement in the way patient data is handled.

In a speech promoting technology and science, May said the UK would invest and "use data, artificial intelligence and innovation to transform the prevention, early diagnosis and treatment of diseases like cancer, diabetes, heart disease and dementia by 2030".

However, the speech made no mention of specific investment and gave no indication of how the process would safeguard patient data. Given recent history, experts say, this is a matter of some concern.

"The use of AI in healthcare offers huge potential, but there has to be a much better conversation with patients about how and why data is used, and how confidentiality is protected," said Nicola Perrin, head of Understanding Patient Data, an industry/public sector collaboration set up to study the potential of AI in healthcare.

The plans come less than a year after UK officials found that the Royal Free hospital in London had wrongly given 1.6 million patient records to DeepMind, a London-based Google company building AI tools. Among the chief concerns from watchdogs was that patients didn't consent to their health data being used in the trials.

Any future plans would need to take into consideration how patients could be informed and how to persuade the public of the value of using their data to improve NHS performance. "Innovation and privacy can go hand in hand," said Perrin. "We have to learn the lessons from previous examples, including from DeepMind and the Royal Free. Most importantly, there has to be transparency and meaningful engagement with patients, from the very beginning."

Tech firms go to war on 'right to repair'

As new laws are proposed to let consumers repair their own tech purchases, manufacturers redouble their efforts to prevent it, finds Stewart Mitchell

Lay down your screwdrivers. That's the message from the tech industry, despite efforts on both sides of the Atlantic to make it easier for consumers to repair their own kit.

With lawmakers threatening to legislate a right to repair, the tech firms are fighting a rearguard action. And they're fighting dirty.

Apple, for example, is suing independent repair shops that import spare parts to repair customers' iPhones. Meanwhile, sources tell us the company is increasingly stamping its logo onto internal cables and devices to make it easier to spot refurbished parts and punish offenders.

LG, on the other hand, is attempting to block a right to repair on the grounds that independent engineers don't have the "extensive background checks" and "drugs screening" that its own staff are subject to.

Is this the behaviour of an increasingly desperate industry fighting its last stand, or will it continue to make repairs nigh on impossible?

Fixing the fixers

Environmental campaigners say manufacturers make it intentionally difficult for individuals and independent repair shops to find parts, and are designing devices in a way that makes repairs impractical.

"Apple and Microsoft are good examples, and they also happen to be two of the biggest players in the market," said Mauro Anastasio, resource efficiency spokesperson for the European Environmental Bureau (EEB), an umbrella body for 140 environmental groups.

"They actively discourage repair in a number of ways, like not making spare parts available and issuing software updates that aren't compatible with older models. They make key components impossible to replace and will not provide repair information."

According to Anastasio, "when a company makes a product that's difficult to repair, consumers are more likely to buy a new one when it breaks. That's a fact."

"Whether it's a motivation or not, only the companies can tell," he said.

Batteries that are impossible to replace are a prime case of designing kit that's designed to fail within a finite period. "It's crazy," said Kyle Wiens, founder of iFixit, which provides information and tools to aid with repairs. "If you buy a laptop it should last longer than a 500-cycle battery. It's guaranteed to fail in everything. Any other failure is accident or wear and tear, but the battery always goes. It's a consumable like tyres on a car and you wouldn't buy a car where you can't change the tyres."

Sealed batteries are increasingly common in both smartphones and laptops and, although manufacturers sometimes offer their own replacement services, the price means it's often more economic to replace than repair.

The process of making repair easier isn't limited to batteries, though. "Across the board, the parts are not supplied in any official way to third-party repairers," said Ugo Vallauri, co-founder of the Restart Project, which runs workshops in London and other cities, where consumers can take defunct hardware and try to repair it themselves under the watchful eye of experienced engineers. "The manufacturers are not trying to encourage repairs and instead are trying to control everything and reduce the chances that people will repair."

iFixit's Wiens agrees. "In order to repair something, you have to have a product that can be repaired, then you have

Painful decisions

Repair costs mean consumers often have to think long and hard whether to replace a cracked screen or depleted battery, or upgrade the entire device.

Microsoft's Surface Pro 3 is at an age where a battery replacement might be required, but the company explains on its website that "your Surface will be replaced with a refurbished Surface (repair usually costs more than sending a replacement)." The cost listed on the site for out-of-warranty repairs is £492.

Even going to a third party – which Microsoft cautions against – can be eye-wateringly expensive because of the way the device is designed. "The LCD screens on the Surface Pro 3s are very delicate and there is a greater than 50% chance that the screen will crack during the repair process," explains device

fixer Repairaphone. The cost of the battery replacement is £149, but the company quotes £210 in case the screen is broken.

iPhone repair costs are equally hard to swallow. The £156-to-£336 range for a screen replacement on an iPhone 6 Plus is steep enough to make many consider replacing the phone outright.

to have parts information and know-how to do the repairs," he said. "On the other side you have Apple, which is systematically trying to lock down every aspect of the system that it possibly can."

Apple declined to comment directly on this story, but a spokesperson pointed out that the company prioritised ease of use and stability over ease of repair. If users were able to replace batteries, the company said, it could damage seals and allow water to get into its devices.

Jailed for repairing?

The difficulties facing repair and recycling companies trying to prolong the life of tech is perhaps best summed up by a legal case in which a recycling company's founder was recently sentenced to 15 months in jail for counterfeiting Microsoft restore discs (*read Nicole Kobie's view on p25*).

Eric Lundgren built up a US recycling company and said he was trying to improve the opportunities for repair shops to breathe life into old machines, which already had a licensed version of Windows installed. He believed that, because the software could be downloaded by users with an original product code, it could also be distributed as a disc. The judge disagreed and put a value of $25 on each disc, which is the price that Microsoft would have charged a repair shop for a fresh install.

Microsoft refused to comment directly on the case, pointing out that the prosecution was brought by the US Department of Justice and not the company itself. It pointed us towards a company blog post in which Microsoft's communications chief Frank Shaw wrote: "Lundgren established an elaborate counterfeit supply chain in China" and that he "went to great lengths to mislead people."

Lundgren disputes Microsoft's stance and believes the company has mounted a character assassination to protect its own image. "Frank Shaw has been given the task to slander my purpose, my good name and muddy the waters for the topic at hand," he told *PC Pro*.

Lundgren says that charging small repair companies for an operating system that's already been paid for once is unlikely to keep hardware from landfill. "Microsoft built this Registered Refurbisher Program to double-charge customers," Lundgren claims.

"Specifically, it wants to charge you for a licence multiple times on the same computer. This would eliminate the ability to refurbish most of the lower-end laptops and PCs in the world as it is simply not economically feasible for older, functional computers." Microsoft says the programmes it runs see millions of PCs recycled.

iFixit's Wiens says the case highlights how manufacturers have all the power. "What you see when you step back from this is a system that's stacked in favour of the manufacturers," said Wiens. "They have the lawyers, they have the customs, the copyright and the trademarks are theirs, and these poor repair shops are being strangled by the system."

ABOVE Some campaigners believe tech firms intentionally make it difficult for users to repair their kit

The legal fightback

The brighter news for consumers is that lawmakers in Europe and America are also growing weary of the tech firms' reluctance to repair. In the US, for example, "right to repair bills" proposed in 17 states would require electronics companies to sell spares and tools to the public and would ban "software locks" that restrict repairs. The European Parliament, meanwhile, has already recommended a right to repair regulation and Brussels officials are currently assessing the results of a public consultation on the topic.

The tech companies are already manning the barricades against such legislation. Apple, for instance, recently lost a court case in Norway when it tried to stop an independent repair shop from fixing iPhones with recycled spare parts bought from Hong Kong. It has, however, succeeded with similar suits in New York.

> "What you see when you step back from this is a system that's stacked in favour of the manufacturers"

Others are citing questionable safety concerns. LG, for example, sent a letter to state officials laying out objections to the right to repair laws, with claims that allowing independent companies to make repairs was a danger to consumers.

"Technician certification generally requires extensive background checks as well as drug screening, as well as technical and safety training," LG's US communications director John Taylor told lawmakers in the letter. "If manufacturers are required to make their technical information public knowledge, they no longer have the ability to address whether the technicians who are entering the homes of consumers have completed the necessary technical, safety and security checks."

Asked whether this attitude amounted to little more than scaremongering to convince regulators to maintain the status quo, LG went on the defensive. "We're not going to get into a debate with naysayers," Taylor told *PC Pro*. "Our primary goal is taking the best care of LG's consumers. A big part of that is assuring that authorised technicians (who have undergone background checks) are the ones that service LG products in consumers' homes."

The A-List

The best products on the market, as picked by our editors

PC PRO A-LIST

PREMIUM LAPTOPS

Dell XPS 13 9370

Ultraportable from £1,249

from dell.co.uk

This 2018 update to the all-dominant Dell XPS 13 keeps tweaks to the minimum: slimmer bezels, eighth-generation Intel Core processors and the promise of even longer battery life are the most important benefits. Just keep in mind that Dell has embraced USB-C ports at the expense of the old-fashioned Type-A variety. **REVIEW Issue 284, p54**

ALTERNATIVES

Microsoft Surface Book 2
A unique and versatile laptop with a screen that detaches to become a tablet – the £1,830 version is our pick of the bunch. **From £1,034 from microsoft.com/store**
REVIEW Issue 281, p48

Lenovo Yoga 920
An ultra-thin convertible from Lenovo that not only looks the part, and has supreme power, but also lasted for a very impressive 12 hours in *PC Pro*'s battery tests. **£1,079 from lenovo.com**
REVIEW Issue 281, p51

Scan 3XS LG17 Carbon Extreme
A brilliant 17in, 4K laptop for demanding gamers, with a desktop Core i7-8700 chip, 16GB of RAM and GeForce GTX 1080 graphics. **£2,580 from scan.co.uk/3xs**
REVIEW Issue 283, p57

SMARTPHONES

NEW ENTRY

OnePlus 6

Android, 64GB, £469

from oneplus.net

The OnePlus 6 is terrible news for Huawei, Samsung and Sony, because it begs one simple question: why on earth would anyone pay over £700 for a flagship phone when they can get something that's almost as good for two-thirds of the price? Yes, it lacks IP-certified waterproofing and there's no optical zoom on the camera, but this phone is gorgeous, fast and takes rather nice photos, too. **REVIEW Issue 286, p68**

ALTERNATIVES

Apple iPhone 7
Despite the launch of the iPhone 8 and iPhone X, the iPhone 7 retains its place as the best-value Apple phone. **32GB, £549 from apple.com/uk**
REVIEW Issue 266, p54

Honor 9 Lite
A huge 18:9 display and stylish design give this budget phone a high-end look. There's even room for a dual-camera setup on the front. **£200 from store.hihonor.com/uk**
REVIEW Issue 283, p70

Samsung Galaxy S8
A stunning phone, complete with a great camera, long battery life and chart-topping speed. **64GB, £609 from samsung.com/uk**
REVIEW Issue 273, p74

TABLETS

Apple iPad

9.7in tablet from £319

from apple.com/uk

While we criticise Apple – and quite rightly – for its failure to deliver a new design on this thick-bezelled basic iPad, we can't quibble about its value for money. With support for the Pencil, it's now also a viable alternative to the iPad Pro. **REVIEW Issue 285, p48**

ALTERNATIVES

Apple iPad Pro 10.5
With the Pencil and Smart Keyboard, the Pro is pricey but – for mobile workers – it's definitely worth it. **64GB, £619 from apple.com/uk**
REVIEW Issue 278, p89

Amazon Fire HD 10
A top-quality tablet for the price, with a 10.1in IPS display and solid turn of pace. Only the cameras disappoint. **32GB, £120 from pcpro.link/279hd10**
REVIEW Issue 279, p71

Huawei MediaPad M5 Pro
This stylish Android tablet comes with a stylus, 64GB of storage and plenty of power. **4G, €499 from huawei.com**
REVIEW Issue 284, p70

EVERYDAY LAPTOPS

Asus ZenBook UX410UA

Stunning 14in budget laptop, £675

from pcpro.link/280zenbook

It was always going to take something special to kick the Asus UX330 off the A-List – and it's no surprise that Asus was the one to do it, with the UX410UA having the looks and feel of a much more expensive machine. Consider upgrading to the more expensive version with 8GB of RAM and a 256GB SSD, though. **REVIEW Issue 280, p68**

ALTERNATIVES

NEW ENTRY

HP Chromebook 13 G1
A stylish and high-quality laptop, but with Chrome OS, not Windows. It's fast, has all-day battery life and won't look out of place in a boardroom. **£480 from pcpro.link/271hpc**
REVIEW Issue 271, p54

Asus ZenBook 13
A brilliant 13.3in ultraportable, which packs an excellent specification into a slender 1.12kg frame – including Nvidia graphics. **£1,100 inc VAT from johnlewis.com**
REVIEW Issue 286, p58

Asus ZenBook UX330UA
A superb 13in laptop with a top quality screen, but the spec we tested is now off sale. An updated version (FB276T) is on sale but we haven't tested it. **£650 from box.co.uk**
REVIEW Issue 266, p62

ENTHUSIAST PCs

NEW ENTRY

CCL Reaper GT

AMD Ryzen 2 PC, £1,499

from cclonline.com

In a world of big black boxes, the Reaper GT's all-white finish stands proud. As you'd expect, it includes some cracking components (an AMD Ryzen 2700, 16GB of RAM, a 250GB SSD and 8GB GTX 1080 graphics) with watercooling for good measure. A brilliant high-end PC. **REVIEW Issue 286, p80**

Palicomp Intel i7 Nebula

NEW ENTRY

Palicomp goes a different route to CCL, with an i7-8700K overclocked to 4GHz and two RAID0-optimised SSDs to accompany its GeForce 1080 graphics. The final result is a stupidly quick machine – and it includes a light show to match. **£1,650 from palicomp.co.uk**
REVIEW Issue 286, p84

Alienware Area-51 Threadripper Edition

We tested the ridiculous £5,299 version, with dual GeForce GTX 1080 Ti graphics cards, but if that's overkill – and you still want the latest Threadripper processors – you'll find the Area 51 an excellent choice. **From £2,149 from dell.co.uk**
REVIEW Issue 281, p56

WORKSTATIONS

Scan 3XS WI6000 Viz

Core i9-7980XE workstation, £4,650

from scan.co.uk

An overclocked Core i9-7980XE processor, together with 64GB of 3GHz DDR memory and Nvidia's Quadro P4000 graphics, ensured this was a great all-rounder. With a 2TB hard disk and 500GB SSD, it's a brilliant showcase for Intel's top-end CPU. **REVIEW Issue 281, p84**

Apple iMac Pro

There are no major design changes, but the new iMac Pro's internal components are a very different matter. Apple creates a compelling workstation with an octa-core Xeon processor, AMD Radeon Pro Vega 56 graphics and 32GB of ECC memory. **From £4,899 from apple.com**
REVIEW Issue 284, p50

PC Specialist Apollo X02

PC Specialist provides a terrific-value alternative with this system based on Intel's eight-core Core i7-7820X. Overclocked to 4.6GHz, with support from 32GB of 3GHz RAM and Nvidia Quadro P4000 graphics, it proved a solid performer in modelling tasks. **£2,500 from pcspecialist.co.uk**
REVIEW Issue 281, p83

MONITORS

Eizo FlexScan EV2450

1080p display, £305

from pcpro.link/263eizo

A great-value 24in IPS display that offers more colour-accurate images than you've any right to expect at this price – and a reassuring five-year warranty, too. **REVIEW Issue 263, p72**

ViewSonic VP3268-4K

NEW ENTRY

It's true you can buy 32in 4K monitors for around £500, but we think it's worth spending the extra money on this ViewSonic. In return, you get superb colour accuracy and terrific all-round quality. **£895 from pcpro.link/286view REVIEW Issue 286, p65**

Philips 276E7QDAB

The obvious sacrifice you make for a 27in IPS panel at this price is resolution – it's 1,920 x 1,080 – but it offers good all-round image quality and looks attractive on the desk thanks to a slimline design. **£198 from alza.co.uk**
REVIEW Issue 272, p75

ENTHUSIAST/SMB NAS DRIVES

Synology DS918+

Four-bay NAS, £490

from laptopsdirect.co.uk

While all of Synology's NAS drives share the same great OS, with all the attendant apps, the DS918+ stole top spot in our Labs due to its horsepower, the four available drives and the sheer number of roles it can perform. **REVIEW Issue 284, p81**

Qnap TS-453Be-4G

Qnap markets the TS-453Be at businesses rather than home users – although, in our opinion, it's equally at home in both situations. It's straightforward to use and a very solid performer, as well as being extremely versatile. **£515 from pcpro.link/284qnap**
REVIEW Issue 284, p80

WD My Cloud EX4100

If you're looking for a solid, speedy NAS – particularly for a small office – then take note of the affordable WD My Cloud EX4100. Despite that reasonable price, it includes four bays, and its mid-range specification can handle office duties well. **£303 from pcpro.link/284wd1**
REVIEW Issue 284, p83

WIRELESS NETWORKING

Zyxel Multy X

Mesh networking, £250

from pcpro.link/282multy

Not the smallest nodes, but that's for a reason: each one crams in a dedicated 4x4 antenna array for the backhaul alongside separate 2x2 arrays for connected clients. The result? Lighting-fast Wi-Fi and impressively wide coverage for a reasonable price.
REVIEW Issue 282, p85

BT Whole Home Wi-Fi

The best-value mesh networking system around thanks to a price drop from £300 to £170. For that, you get three discs and fast, stable speeds throughout your home. Perfect for medium-sized houses, and it can now be expanded with extra discs. **£170 from shop.bt.com**
REVIEW Issue 282, p81

TP-Link Archer VR2800

A terrific value router that beams a powerful signal throughout a medium-sized home. Add strong parental controls and two handy USB 3 ports, and it's our top choice for people who don't want to go the mesh route. **£190 from box.co.uk**
REVIEW Issue 274, p85

WORKGROUP PRINTERS

Xerox VersaLink C600DN

Colour laser, £779 exc VAT

from printerland.co.uk

The C600DN hit 53ppm speeds in our tests, managing 50ppm double-sided, and produced great results even on cheap 75gsm paper. Low running costs of 1.1p mono and 6.4p colour only add to its attractions. **REVIEW Issue 283, p98**

Brother HL-L9310CDW

If you can't quite afford the Xerox VersaLink C600DN, consider this good-value rival from Brother. This colour laser provides great output quality, low running costs (1.1p/7.8p) and speeds of up to 32ppm, as well as plenty of security features. **£441 exc VAT from printerbase.co.uk**
REVIEW Issue 283, p94

Kyocera Ecosys M5526cdw

Low running costs and easy maintenance are the key factors here, with 1.3p per mono page and 9p for colour. Print quality is great too, even if you're kept waiting a little longer for 600dpi prints. **£381 from printerland.co.uk**
REVIEW Issue 279, p101

HOME OFFICE PRINTERS

Brother MFC-J5330DW

All-in-one inkjet, £120

from pcpro.link/273bro

A high-quality and versatile printer – it can even print in A3 – with a tempting price, and it won't cost the earth to run. Provided you have space for it, it's a great choice for home and small office use. **REVIEW Issue 273, p84**

Epson EcoTank ET-4750

If you do lots of printing then this EcoTank is almost certainly going to save you money, with enough ink supplied to last 14,000 black pages and 11,200 in colour. And, unlike previous EcoTank printers, the image quality is pretty good, too. **£352 from pcpro.link/282epson**
REVIEW Issue 282, p62

Oki C332dn

If you're looking for a budget-priced A4 colour laser printer, stop your search: you won't find one for less than this network-ready desktop model. With 30ppm mono and 26ppm colour speeds, only high running costs (2p mono/11.4p colour) count against it. **£143 from okidirect.co.uk**
REVIEW Issue 283, p97

VIDEOCONFERENCING

Polycom RealPresence Trio 8800 Collaboration Kit

Full VC kit, £1,417 exc VAT

from pcpro.link/275poly

This kit provides everything for a small business, with no need to hook it up to a laptop or mobile. It's flexible when it comes to positioning and won't be beaten for features or audio quality. **REVIEW Issue 275, p98**

Lifesize Icon 450 and Phone HD

The price is steep, but this complete VC solution makes high-quality videoconferencing a walk in the park – it's impressively easy to deploy and use, while the audio quality delivered by the four built-in mics was top notch. **£3,462 exc VAT from uk.insight.com**
REVIEW Issue 275, p96

Logitech ConferenceCam Connect

If you need a portable solution for smaller rooms, this sleek device can be set up in seconds. Despite its size, it can't be faulted for quality and the price is right, too. **£250 exc VAT from pcpro.link/275log**
REVIEW Issue 275, p97

BUSINESS WI-FI

NEW ENTRY

DrayTek Vigor 2862Lac

Secure router, £354 exc VAT

from netxl.com

This 802.11ac router is loaded with potential, from bolstered security to a 3G/4G SIM card slot to expansive VPN options. There's almost nothing a business could ask for that it doesn't do, making it an easy choice for any switched-on SME. **REVIEW Issue 286, p100**

WatchGuard AP420

Not cheap, but SMBs wanting enterprise-class wireless security and central management will find it money well spent. The cloud portal is one of the best we've seen, performance is great and WatchGuard's WIPS delivers smart wireless security. **£649 exc VAT from broadbandbuyer.co.uk**
REVIEW Issue 281, p97

Cape Networks Wireless Sensor

The perfect wireless monitoring solution for SMBs thanks to a superbly designed cloud portal, packed with information, for a very tempting price. A huge range of network and service monitor features also impress. **£650 exc VAT from irisnetworks.com**
REVIEW Issue 279, p104

SCANNERS

Xerox DocuMate 6440

USB scanner, £395 exc VAT

from printerbase.co.uk

A brilliant choice for heavy workloads, the DocuMate 6440 hit speeds of nearly 70ppm in our tests. It also has a large ADF and versatile software.
REVIEW Issue 278, p98

Brother ADS-3000N

Aimed at mid-sized workgroups, the ADS-3000N is a solid deal: it supports both USB and Gigabit Ethernet network connections, while offering 50ppm scan speeds, a robust 5,000-page daily duty cycle and a generous software package. **£384 exc VAT from pcpro.link/278ads**
REVIEW Issue 278, p94

Plustek SmartOffice PL4080

Looking for a flatbed scanner? The PL4080 fits the bill nicely, combining a fast 40ppm duplex ADF with an A4 flatbed scanner. With Plustek's intuitive DocAction software thrown in, it's a great buy. **£348 exc VAT from grooves-inc.co.uk**
REVIEW Issue 278, p97

DOMAINS | MAIL | HOSTING | eCOMMERCE | SERVERS

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SECURITY SOFTWARE

Bitdefender Internet Security 2018

A stellar selection of extras including ransomware protection, along with rock-solid antivirus protection, makes this our top choice for 2018. **3 devices, 1yr, £30 from bitdefender.co.uk** REVIEW **Issue 279, p85**

Avast Free Antivirus

We recommend dumping Windows Defender, but if you don't want to spend a penny then Avast's superb protection makes it the best choice. Just ignore the inevitable, relentless upsell. **Free from avast.com** REVIEW **Issue 279, p84**

Kaspersky Internet Security 2018

The best choice for power users and tinkerers, with little different from last year's offering – but with so many features already, that's fine by us. **3 devices, 1yr, £21 from pcpro.link/279kas** REVIEW **Issue 279, p86**

PRODUCTIVITY SOFTWARE

Microsoft Office 2016

We'll be honest: there's very little here for anyone upgrading from Office 2013. However, this is still the best office suite for professionals. **Home & Student, £58 from pcpro.link/254off** REVIEW **Issue 254, p62**

Google G Suite

Not a fully-featured alternative to Office, but it has enough core features to cover most people's needs, with extra tools available via add-ons. And it's brilliant for collaboration. **Free from docs.google.com** REVIEW **Issue 284, p35**

Scrivener

A brilliant package for serious writers: not only a word processor, but a tool that helps you organise your ideas and manage the process of composition from start to finish. Expensive, but a trial is available. **£32 from literatureandlatte.com** REVIEW **alphr.com**

CREATIVITY SOFTWARE

Adobe Creative Cloud

Adobe entrenches its position as an indispensable resource for creative professionals, with useful upgrades to the core print-orientated apps such as Photoshop, and exciting new additions for digital designers, too. **Complete plan, £50/mth from adobe.com/uk** REVIEW **Issue 268, p72**

Serif Affinity Photo

Don't be fooled by the low price: this is a serious rival to Adobe Photoshop in terms of features, even if it does require a hefty system to make it fly. Even professionals should give it a look. **£49 from affinity.serif.com** REVIEW **Issue 271, p72**

CyberLink PowerDirector 16 Ultra

An excellent tool for 360 video production and also a fine choice for normal video, with powerful plugins that boost it yet further. Not cheap but worth it. **£80 from pcpro.link/278cyb** REVIEW **Issue 278, p73**

RACK SERVERS

Broadberry CyberServe Xeon SP1-208S

It may only have a single CPU socket, but this is a big rack server with a Xeon Silver lining. It's a good option for SMBs, with plenty of room to grow and the ability to keep costs down by choosing your own storage devices. **£1,995 exc VAT from broadberry.co.uk** REVIEW **Issue 284, p94**

Lenovo ThinkSystem SR550

This is an affordable entry point to the world of Xeon Scalable processing. The design allows you to start small and expand as your needs grow, while the server management features are top-class. **£1,858 exc VAT from lenovo.com** REVIEW **Issue 284, p98**

PEDESTAL SERVERS

Fujitsu Server Primergy TX1320 M3

Fujitsu's smallest ever tower server, the TX1320 M3 will immediately appeal to space-poor SMBs. Despite including a 3GHz Xeon E3-1220 v6 processor and two 1TB cold-swap hard disks, it has a price to match its compact dimensions – and includes plenty of business-friendly features. As reviewed, **£593 exc VAT from lambda-tek.com** REVIEW **Issue 277, p97**

Dell PowerEdge T130

The T130 packs a lot into its compact chassis and won't disturb you even in a small office, with our audio tests measuring a noise level of only 37.9dB. Storage features are basic, but there's room to grow – a fine first server. **£399 exc VAT from dell.co.uk** REVIEW **Issue 265, p98**

SECURITY

WatchGuard Firebox T15

The Firebox T15 offers the toughest gateway security measures at a pocket-friendly price. It's seems to have every angle covered: the Total Security Suite subscription enables web content filtering, application controls, anti-spam, gateway antivirus, network discovery, IPS and reputation-enabled defence. **Appliance with 1yr Total Security Suite, £429 exc VAT from watchguard-online.co.uk** REVIEW **Issue 285, p100**

Panda Adaptive Defense 360

A clever cloud security solution packed with features and priced right for SMBs. It's easy to deploy and its smart detection and response service hardens malware protection. 25 seats, 1yr subscription, **£1,214 exc VAT from pandasecurity.com** REVIEW **Issue 273, p101**

NAS APPLIANCES

Qnap TS-1277

Thought AMD's Ryzen processors were for consumer PCs only? Qnap clearly doesn't, as evidenced by the eight-core 3GHz Ryzen 7 1700 inside this blisteringly fast NAS appliance. The TS-1277 raced through our performance tests, but impressed just as much for deployment, data protection features and cloud backup. **Diskless, £2,514 exc VAT from span.com** REVIEW **Issue 283, p101**

Broadberry CyberStore 224S-WSS

The perfect platform for Windows Storage Server 2016 Standard, the CyberStore offers 24 hot-swap SFF drive bays at a great price. It also provides huge expansion potential, with seven PCI-E slots. **£5,445 exc VAT from broadberry.co.uk** REVIEW **Issue 274, p100**

BACKUP NEW ENTRY

Veritas Backup Exec 20

If you want total control over your data protection, Backup Exec 20 is the perfect choice. It's easy to use, yet provides a superb breadth of features, and the price is within reach of even the smallest business. **£370 per TB exc VAT from span.com** REVIEW **Issue 286, p98**

Backup Everything Business NEW ENTRY

The name makes quite a claim, but it supports Windows, Linux, Mac, VMware, Hyper-V, Exchange and more. Add a price that undercuts Backup Exec, and it's a tempting alternative. **£10 per month for 100GB exc VAT from backupeverything.co.uk** REVIEW **Issue 286, p94**

VOIP SERVICES

3CX Phone System 15.5

There's no getting away from it: 3CX Phone System is a very impressive bit of software. It's a breeze to deploy, has a great range of features, and if you're looking to host your own IP PBX then you can't go wrong. You can even get 3CX to host it in the cloud for free for a year. **8 SC Standard, £266 exc VAT (first year free) from 3cx.com** REVIEW **Issue 285, p94**

RingCentral Office

This cloud-based VoIP service has a great set of call-handling features. SMEs that want an easier alternative to an on-site IP PBX will find RingCentral delivers an affordable and powerful service. **From £7.99 per month exc VAT from ringcentral.co.uk** REVIEW **Issue 285, p97**

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*TÜV Rheinland tested toner cartridges from three third-party toner brands on KYOCERA FS-C5250DN printers in March-July 2012, following the international ISO/IEC 19798 standards and measured criteria.

KYOCERA
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Profile

BACKGROUND INFO ON INNOVATIVE BRITISH COMPANIES

SatoshiPay

We meet the entrepreneur who's using blockchain technology to crack the tricky micropayments market

KEY FACTS

SatoshiPay is a blockchain-based micropayments company that seeks to help web publishers sell their content to consumers

LOCATION
Berlin, but the company is registered in London

FOUNDED 2014

EMPLOYEES 10

WEBSITE
satoshipay.io

If I had a fiver for every company who tried to convince me they'd cracked the problem of micropayments over the years... well, I wouldn't be writing a story about another one.

SatoshiPay's Meinhard Benn says his company has created the "pocket change" of the internet. And if you've nodded knowingly at the first part of the company's name, you'll know by now that he's using cryptocurrency to do it.

The Satoshi is the smallest unit of Bitcoin, the crypto equivalent of a cent or a penny, and named after Bitcoin's shadowy founder Satoshi Nakamoto. However, SatoshiPay has recently dropped Bitcoin in favour of a different cryptocurrency. We find out why and discover how the company believes it will prosper in a micropayments market where so many others have failed.

Catching the bubble

Benn became interested in Bitcoin early on. "I started mining Bitcoin in 2011, so very early," he told us. "I thought this is very interesting, let's keep an eye on this space. And in 2013 it took off in terms of Bitcoin hitting $1,000. I thought I would use this momentum to start a company."

By the end of 2014 he'd launched SatoshiPay as a generic Bitcoin payments processor, similar to what companies such as BitPay are doing now. "We quickly realised there's no differentiation and Bitcoin as a payment method is not taking off – we need a bit of a niche here," he said. "We picked the niche of nanopayments or micropayments. For the first use case of those small payments we picked publishing, or micropayments for content, because that's something very tangible."

LEFT SatoshiPay founder Meinhard Benn started mining Bitcoin way back in 2011

The SatoshiPay offering is simple. Want to charge users to download a piece of content, watch a video or read an article? Then they need to drop a few credits (or "lumens") from their cryptocurrency wallet to the publisher to access the content. SatoshiPay takes a 10% flat fee on each transaction and the publisher can have the money from the transaction in their account in as little as five minutes.

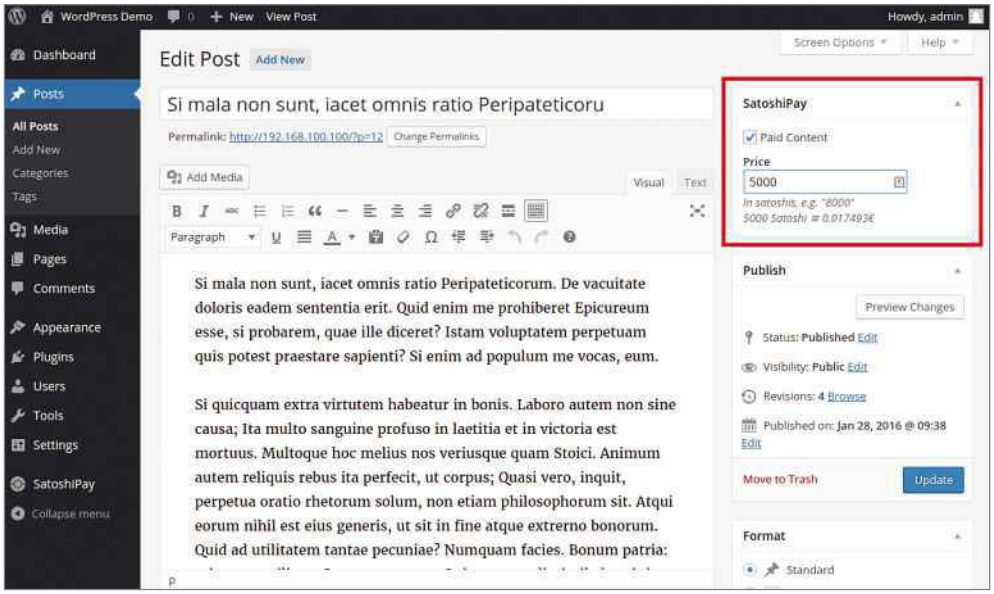
Benn says that the SatoshiPay technology is "very different" to any micropayments system that has gone – and, let's be frank, failed – before. "We use blockchain technology and different security models. We don't have a centralised storage of accounts. We have decentralised storage of accounts, meaning each user of the service has full control over their fund from their web browser. We don't hold the funds, we just negotiate transactions directly to the publishers. So, there's a real peer-to-peer element to it."

What's more, and in what some might regard as an eyebrow-raising security lapse, there's no login or passwords protecting the users' wallets. "[The wallet is] tied to the profile in the browser that you're using," explained Benn. "There is a mechanism to sync to different devices, similar to WhatsApp. But to sync to the other device you don't log in, you can scan a QR code. Logins will be optional later, but the idea was to remove all the friction points that consumers have in starting to use a service like ours. There's nothing in the way between you and the publisher."

In that case, how do you prevent thieves or your kids (some might regard them as the same thing) hopping onto your computer and making unauthorised payments? Benn says it's no less secure than emptying the coins in your jeans pockets of an evening. "Having a pre-paid account means the maximum you can spend is only what's available in your wallet," he said. "It behaves like pocket change in that way. If you have pocket change on the table, people can take that and go shopping with it."

Bye bye Bitcoin

Ironically, the soaring value of Bitcoin that piqued Benn's interest in the cryptocurrency in the first place is now what's driven SatoshiPay to seek alternatives. Bitcoin has, of course, soared well beyond the $1,000 mark that prompted Benn to back the horse in the first place. But the currency's recent volatility and booming popularity



ABOVE To make the payment process as smooth as possible, there are currently no passwords – just scan a QR code to purchase or top up

ABOVE RIGHT The SatoshiPay plugin for WordPress doesn't require any extra software and allows users to charge visitors to view a post

has made it impractical for a micropayments provider.

Bitcoin became "slow and expensive", according to Benn, and the transaction costs were proving prohibitive for a service where you might only be handing over a few pence at a time. Instead, the company moved to the Stellar blockchain. While the Bitcoin community was discussing how to make a scalable system, Stellar "went ahead and just did it", according to Benn, resulting in a system that can handle 1,000 transactions per second, with the transactions settled within five seconds. The costs, meanwhile, are just one ten-thousandth of a cent – "almost free transactions".

Making micropayments stick

Irrespective of which technology is used to power the service, many have tried to make micropayments stick, but none have succeeded – at least not when it comes to reading or watching web content. Why does Benn believe SatoshiPay will be any different? "Ease of use" is one factor he highlights. "[Online] payments have come a long way in the past 20 years. We were always lacking a decent, light payments technology. Now we have it."

> "Psychology in payment works that way. It's easier if you have a sort of Monopoly money that you feel freer to spend"

What's more, consumers are now more willing to make small transactions online. Look at the games in the top ten of the app stores, and almost all of them will have their own virtual currency for buying in-game trinkets or extra content. For millennials, it's the equivalent of handing over a pound coin for a newspaper in WHSmith.

Indeed, that's why SatoshiPay transactions are currently made in "lumens" instead of, say, euros or pounds. "Essentially, you are freed from the individual transaction cost," Benn said. "You decide ahead of time – you say, okay, I'm investing five euros in this system – and that's your purchase decision made.

"Psychology in payment works that way. It's easier if you have this sort of Monopoly money that you feel freer to spend and you don't have your debit card the entire time. This point system, we believe, will make it easier for people to spend."

SatoshiPay is also experimenting with a new token system, where one content token will equate to one euro cent, making it easier for people to understand the true cost of what they're buying. Benn is perhaps too polite to say it, but I suspect that's designed to appeal to old farts like me, who like to know the value of every transaction.

Getting the publishers on board

No matter how simple the system is or what label it applies to its virtual currency, it won't take off unless publishers offer consumers the chance to buy their content using SatoshiPay. Benn told us he "had one big publisher in the UK," but at the time of our interview he couldn't disclose who that was.

A recently launched lumens "giveaway" on the company's website listed several sites where you could spend your currency, but none were close to being household names. A handpan musician, a cryptocurrency news site and a Croatian blogger were on the list of "smaller websites" currently supporting SatoshiPay.

"We are in talks with at least another five [publishers] in the UK and also in Germany," Benn insists. "We are talking to major news outlets, including one of the biggest in Europe. We are talking to the technical division of these guys at the moment."

One potential roadblock for SatoshiPay is the app stores. Companies such as Google and Apple want in-app payments driven through their own payment systems, making it difficult for SatoshiPay to crack the lucrative and proven games market. "There is a bit of an issue with in-app payments," Benn admits. "The app stores have quite strict regulations around that. They of course want to sell their own in-app payments and if you try and get around that… it's a bit more complicated." (*See "Why you could soon be paying for the web", p124.*)

Investors clearly have faith that SatoshiPay will eventually find a large audience. The company is now preparing for its fourth round of funding, having attracted €1 million of investment from venture capitalists in January last year. Still, it's not the big cheques that are going to make or break SatoshiPay. It's that 10% cut from millions of tiny transaction that it's banking on. If you've just paid 20 lumens to read this article on a website, you'll know it has succeeded. **BARRY COLLINS**

What about you?

Do you work for a British technology company that could be profiled in *PC Pro*? If so, get in touch: profile@pcpro.co.uk

Viewpoints

PC Pro readers and experts give their views on the world of technology

Email isn't dying – it's about to show its true value

Instant messaging may be all the rage, but the advent of GDPR highlights the strengths of email

Darien Graham-Smith is *PC Pro*'s associate editor, and if GDPR applies to tweets, he's in trouble with numerous celebrities.
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It was a bright, cold morning in 1995, and the clocks were striking eleven. *Some Might Say* was playing on the radio, and I'd just sat down at my computer desk with a cup of coffee. I opened my telnet client as usual, and connected to the university email service to see what my friends were up to that day. And there it was: my first piece of spam.

It's hard to fully describe the feelings that swirled inside me. This was the only internet account I had ever known, and it was more than just an inbox to me – it was the locus of my identity. Even in person, friends addressed me unironically by my user ID, "deg20". Now, my online home was being invaded. I fired off a furious response – and, of course, it bounced straight back. There was no way to undo the violation. No way to prevent it happening again. My inbox was no longer my own.

I won't ever forget that feeling – but equally, I couldn't end my love affair with email. I carried on checking my messages ten times a day until I graduated; then I got my first office job, and went up to 20.

It was an easy addiction, because everyone else loved email too. At first the incoming messages were mostly personal – my newly employed friends and I spent days on end firing emails back and forth among ourselves, costing our employers thousands in wasted revenue.

Then the private sector got in on the act. Before long, it seemed like every time I bought a book online, connected to a social network or logged onto a Wi-Fi hotspot, I'd find myself added to another mailing list. Some of the messages were useful, detailing train times, confirming access codes and so on. Most weren't. Services such as **unroll.me** sprung up to deal with the deluge; Gmail started tagging messages as "Promotions" and "Updates" to help me cope, but even so I started to open my inbox with trepidation.

It didn't help that email was becoming ubiquitous within the various offices I worked at. In retrospect, it's obvious why: a quick email is far less intrusive than picking up the phone. At the same time, it sneakily buys you some free time – because they're not going to respond right away – and establishes a written record of what was said should you later need to cover your arse.

Before long, email overload had become a genuine problem – and it was clear that something had to give. Back in 2012, this very magazine published a major investigation by our man Stewart Mitchell entitled "The Death of Email", concluding that with more than 90 trillion messages being sent a year, and some employees spending as much as 20 hours a week just fielding emails, the whole thing was becoming untenable.

> **"Right now, for the first time in more than two decades, I'm starting to feel that my inbox is genuinely my own"**

Looking back, I have to say that the feature was quite prescient – take a bow, Stewart. Email didn't die, obviously, but it's no longer the only game in town. Today my work conversations take place over Slack, while personal stuff goes on WhatsApp. I still check my email account, but it's no longer a priority; if there's something in there that I actually need to read and respond to, it's fifty-fifty whether I'll even spot it amongst the chaff.

This month, of course, brought a particular deluge ahead of the arrival of the new data protection regulations. Seemingly every business I've ever so much as walked past on the street popped up in my inbox, begging for permission to bombard me with emails in a GDPR-compliant way. In many cases these were companies I'd already instructed not to contact me, so the messages were themselves in breach of the old regulations. But since those were self-evidently toothless, I can't really blame the marketers for taking a final punt.

At any rate, I have given consent to precisely zero of these chancers – and it's a surprisingly empowering feeling. It remains to be seen how effective GDPR will be in the long run, but right now, for the first time in more than two decades, I'm starting to feel that my inbox is genuinely my own.

The question now is whether all of this is too late to rehabilitate email. When almost all of my online interaction takes place on instant messaging services, does it even matter what lands in my inbox? When I mentioned the subject of this column to Tim Danton – a conversation that, naturally, we had over Slack – he agreed that email feels "very old-fashioned". Indeed, there's something tragic about the way Google has been touting new features in Gmail, such as snoozing messages and sending self-deleting emails with expiration dates. They're not bad ideas, but now? Email? In 2018?

And yet I won't be closing my Gmail account any time soon. Because, once the chit-chat has migrated away, and the mailing-list spam has been shut off, what's left? I'll tell you what: all those informational messages, detailing what time my flight to Copenhagen departs, and confirming my hotel booking at the other end. Email may no longer be the intensely personal thing it once was, but if you can cut through the rubbish it still makes a great online filing cabinet, accessible from anywhere, and instantly searchable. It's years since I last felt the need to file a paper document in my physical box file, and I can't imagine why I would ever need to again.

I'm sure this sort of evolution isn't what the lawmakers had in mind when drafting the GDPR, but part of the beauty of technology is in finding ways to make the best of it. For years I've been readying myself for the death of email, but I suspect it's about to take on a new lease of life.

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Google: um, hang up on the idea of being "human", okay?

Attempting to con people into thinking they're talking to a human is Google's dumbest idea yet

Barry Collins is the co-editor of bigtechquestion.com. As anyone who's listened to the *PC Pro* podcast will testify, no computer will ever talk like him.
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How do you know it's me writing this column and not some terrifyingly literate algorithm? It's not as if AI hasn't already branched into journalism. Go to any financial news website and the vast majority of the stories about earnings reports will have been written without any human intervention. Sure, the style is dryer than a Jacob's cracker, but the algorithm doesn't call in sick, need a pension or drink heroic quantities of tea on the company's tab.

You know this column is written by me because no algorithm could write similes as weak as the one in the last sentence. There's something quintessentially human about my prose. It's grammatically imperfect, hackneyed, full of all the flaws that only a 40-year-old dragged up through an Essex comprehensive could get away with.

But the video I've just watched (**bit.ly/286talk**) makes me wonder whether the day when it's hard to distinguish between humans and AI isn't that far away, after all. The video in question is Google's demo of Duplex, the company's voice-assisted butler. Want to book an appointment at your hairdresser's between 4 and 6pm next Friday? There's no need to phone Flavio any more – just tell Google when you want the appointment and it will ring on your behalf.

The chilling part of Google's demo is the way its voice assistant imitates a human. Not only does it respond convincingly to the questions posed by the person answering the phone – even when the conversation veers off track – but its speech is full of the umms and ahhs that normally distinguish a human caller from the automated voice bots. Google is trying to con the caller into thinking they're talking to a real human being.

You can understand why Google's done that. We've all grown so sick of automated calls from "lawyers" who have heard we've been in a car accident that our knee-jerk response to an automated call is to hang up. But at a time when trust in tech companies is at an all-time low, conning people into thinking they're dealing with a real person is a spectacularly dumb idea that could well kill Duplex before it's even been launched.

To be fair, Google seems to be wrestling with the ethics. In a faintly contradictory blog post, it says "transparency is key" to the service's success, while in the same paragraph claiming that the "technology is built to sound natural, to make the conversation experience comfortable".

I don't know about you, but I'm more comfortable when people are being honest with me. I'd have no problem with Google Duplex ringing me up to book one of my photography courses on a customer's behalf if it declared it was an automated service from the get-go. I'd be less inclined to complete the booking if I wasn't sure it was Google calling, if it was something that sounded eerily like a human being but isn't. Because no matter how good Google makes Duplex, there will always be little tells that you're dealing with a computer. The unnatural pauses; the refusal of the tech to speak over you like a human would; the absence of empathy, humour or local dialect.

There are practical issues too. When someone rings to book one of my courses, we talk about what camera they've got, how much photographic experience they have, whether they know the meeting place next to Brighton's West Pier. Duplex isn't going to know all this stuff. In much the same way, it will be flummoxed when Flavio's Saturday girl asks if you want a blow dry or whether you're okay to have your roots touched up by Gina because Flavio is on holiday in Tenerife (you can't deny my hairdresser clichés are top drawer).

But what really bites me about Google Duplex is how over-engineered the solution to this problem is. The sample conversations that Google provided are all about basic booking transactions: an appointment at the hairdresser's, a reservation at a restaurant, enquiring about the opening hours of a store. None of these should require a telephone conversation in the first place, let alone one where Google has to pretend to be a human.

I've got a Google Assistant on my desk and on my phone. If I tell it to book me a table at Pizza Express for 1pm tomorrow, it should be able to ferret into Pizza Express's booking system, check availability, and either book me in or tell me it's full. This isn't ground-breaking – almost every ticket booking or restaurant chain website lets you do this. What we need is standardised automatic booking systems, and who's in a better position to implement one than Google?

> **"No matter how good Google makes Duplex, there will always be little tells that you're dealing with a computer"**

When I can ask Google to find me the best deal on a restaurant on a quiet Monday night and it can come back with eight suggestions of places with spaces, then you've got a technology that solves a problem for me as a consumer and for the business owner. We've no need for Duplex's duplicity. We just need something simple.

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Disc inferno: a Windows licence to print money

How a free version of Windows can land you in jail – if you print 28,000 copies of it, that is

Nicole Kobie is *PC Pro*'s Futures editor. She keeps her kit as long as possible, for environmental reasons – not because she's incredibly cheap. Nope, not that.
@njkobie

The difference between software and a software licence isn't something most of us concern ourselves with – Windows comes installed on our laptops, and that's the end of it. But for people who run their business's IT or refurbish old machines, it's a fine line that can be very costly.

Just ask Eric Lundgren. He has plenty of time to mull the distinction, as he's been jailed for 15 months over this key distinction. He's a tech entrepreneur who's focused on e-waste and recycling – a problem that sees Americans chuck out 3.4 million tons of devices each year. Recycling is key to battling that waste and, when it comes to computers, that often means extending their usable lifespans by refurbishment.

Rebuilding a PC means you need to reinstall Windows. If you have the original install disc or licence key, you're set, as you can download a fresh copy of Windows for free directly from Microsoft . If you don't have a licence, registered refurbishment companies can buy a licensed copy for $25.

Despite such offers from Microsoft, Lundgren clearly thought there was a market for restore discs that didn't include a licence. He bought a shipment of 28,000 dodgy Microsoft restore discs in counterfeit Dell packaging and sold them on to computer refurbishers in Florida. Then, one day, armed federal agents kicked in his door at 5am, he

told *The Verge*. He wasn't actually at home, but he hopped on a flight to face the music.

Lundgren pleaded guilty, but he doesn't think he cost the company any money. His argument is that the restore software on the discs has no value: if you're restoring your Windows-running PC, you can download that software for free online from Microsoft – but the software must be validated with a licence key. Lundgren says he redistributed and sold the software, but not a licence to go with it.

Microsoft has its own version of events. Frank X Shaw, Microsoft's vice president for communications, blogged that "Microsoft's role in the case and the facts themselves are being misrepresented". Stressing that the US government targeted Lundgren without any involvement from the Redmond giant, Shaw pointed to an email used in court that showed Lundgren intended to profit from the sales and tried to make the "counterfeit software look like genuine software", telling partners to pass it off as genuine Dell discs to "less discerning customers" in case tech-savvy sorts spotted the difference.

Microsoft also points out that efforts such as Lundgren's are unnecessary: thousands of refurbishers are signed up to its programme to get a fresh version of Windows for $25.

What did the court think? The prison sentence answers that, with an appeals board noting that Lundgren was distributing to refurbishers, and the use of the Dell logo didn't help him.

It all seems a lot of hard work to save $25 or to avoid a download. Why would anyone buy a dodgy disc when they can download the content for free? There are a few reasons, albeit with good retorts. How do you download an OS when your computer is kaput? (Ask a friend.) How do you make a restore disc when you don't have a DVD burner? (USB is an option.) Plenty of people, faced with such hurdles and unarmed with any tech skills, simply turn to a repair shop – or to tech-savvy friends. Perhaps alongside coding in schools, they should teach PC maintenance.

Now that Microsoft is done defensively blogging that it's not to blame for the harsh sentence, it should sit back and reconsider if there's a better route to take here, making it so easy to refurb a PC that no-one turns to dodgy discs or less than reputable repair shops. Whether or not Microsoft lost hundreds of thousands of dollars in sales because of Lundgren is up for debate, but there's no question too many useful PCs are being dumped in landfill. That's the real battle we should all be fighting.

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Hello, my name is Dick and I am not a photographer

Flickr's sale to SmugMug is all about the money, so why are we still sharing photos?

Dick Pountain is editorial fellow at *PC Pro* and would be delighted if you viewed his creations at flickr.com/photos/dick_pountain. It won't cost you a penny.

The casual dropping of the "e" was a bravado touch (and I don't imagine it had anything to do with Oulipo), but when I joined in 2006 I still found Flickr rather an odd name, simply because for we Brits a "flick" is a motion picture rather than a still. Okay, Flickr did later admit video content, but it's very much a platform for still photography. And it's not half so odd a name as SmugMug.

SmugMug is the US firm that, back in April, bought Flickr from its previous owner Yahoo. It recently emailed me with an assurance that my Flickr account would remain unchanged for the foreseeable future, but also to invite me to try its own offering (which, to my surprise was founded in 2002, two years before Flickr).

Regular readers may recall that I'm a dedicated Flickr user, with 1,856 photos and other graphics displayed there. I have to confess that my dedication has been, er, flickering somewhat over the past year or two, because getting pictures seen on Flickr feels increasingly like a chore. The reason is simply the site's success: it currently hosts over ten billion pictures, and has 75 million users who upload as many as 25 million more pictures per day. There are more Flickr users than UK residents, so getting a picture seen is much like stepping out into the street and waving it above your head.

> **"I realised that I'm not actually a photographer at all, just someone who employs a digital camera and software to make images"**

Flickr's organising principle is the photostream: your pictures get displayed in strict chronological order, so only the most recent, the head of the stream, are broadcast to your followers. Each picture becomes progressively less visible as time passes. Flickr's Groups are the way around this: there are over ten million of these, created by users on specific themes. I'm in 221 of them, from birds, flowers and water to surrealism, abstract art and the disturbing. Putting a picture into groups gets it far more views than leaving it on your photostream for people to find. Unfortunately, due to that torrent of fresh content, many groups impose restrictions – for example, only one or two pictures per day – and many also demand that you comment on some number of other people's pictures for each of yours posted (to discourage spamming and careless use).

I like to make picture sequences that need to be seen together, but to get enough attention on Flickr I need to post them into at least 20 groups, most of which will only permit one or two a day, and require up to three comments. Hence it can take several days to post them all, and half an hour each day to add the comments.

It's becoming a chore, so I often put a sequence into a Facebook album instead, with just one on Flickr. But Facebook is an awkward platform for pictures, so I decided to check out SmugMug's 14-day free trial.

SmugMug is all about selling your pictures (which I wouldn't mind doing). Instead of a photostream, you get a customisable website that looks highly professional, with its own URL for potential customers. You pay for these services, with a monthly fee that rises with the promotional features you require, while 15% of any sale goes to SmugMug. At $4, the Basic plan is twice what I now pay on Flickr, while the Power ($6), Portfolio ($16) and Business ($30) plans would need to sell a lot of pics for me to break even.

It was viewing the sample sites that made up my mind. Most showed portraits, family pictures or postcard scenes, like those high-street photography shops you still see in many small towns. I realised that I'm not actually a photographer at all, just someone who employs a digital camera and computer software to make images. I don't aim at perfection, I don't enter competitions and I don't share the dominant aesthetic on Flickr which is for over-saturated, over-sharpened photos that whack you in the eye.

My favourite among the famous photographers is Saul Leiter, who worked for *Vogue* but, for his own pleasure, preferred the out-of-focus, the eccentrically framed, the sudden splash of highly emotional colour. I heavily process my pictures to make them look more like paintings, I fiddle with fractal images in Sumo Paint for hours until something catches my eye, usually through colour as much as form. What pleases me is unlikely to be what would sell. Posting to Flickr is a chore, but then so is stretching a canvas. It's art, innit.

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Bloodsport by Timothy Poulton - Shoot The Frame Affinity Photo Contest Winning Entry

AFFINITY

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Readers' comments

Your views and feedback from email and the web

Unfair criticism?

I felt you missed the point of the Gemini PDA in your review (*see issue 285, p58*). You kept either comparing it to, or referring to it as, a phone. The Gemini is neither a smartphone nor a laptop but an entirely new class of device. The same mistake was made when Microsoft released the first Surface Pro. It wasn't a tablet, but that is what everyone compared it to.

As such, I feel that many of the criticisms levelled against it don't take into account that owners will be using it for everything from blogging and writing reports to monitoring data centres. These aren't tasks you can perform on a smartphone, and you can't fit a laptop in your pocket for them either.

While the Gemini PDA isn't perfect, for a first-generation device from a British startup I feel it's up there with the best in terms of overall quality. I'm thoroughly looking forward to seeing what Planet Computers does next. Oh, and the good news: I happen to know that a full manual will be available for the device by the time it goes on general sale this summer. **Mike Halsey**

needs.more.work?

I was fascinated by your profile of what3words (*see issue 285, p22*) [which has assigned three unique words to every 3 x 3m square on the planet to make them easy to locate]. I thought I would test it using Google Maps. First, I cleared my browser history then typed "g" into the search box and was offered Google Maps, which I selected. In that box I typed "dennis p" and was offered "Dennis Publishing, Alfred Place, London", which I selected.

Repeating the exercise, I had to type "what3" before being offered what3words. I selected that and then selected the what3words map. I then entered "levels.grin.bonus" and located the same place. Impressive, except that the first example required 11 keystrokes and the second, 24.

As a further test, I entered "31,wc1e7dp" into Google Maps, which increased my keystrokes to 13 and it gave me the same building but a different brand, in this case Buyacar. And therein lies the problem: what3words gives you a geolocation in two dimensions, as does a building number and a postcode, but neither is a complete address. You could post something to "31, WC1E 7DP, UK" from anywhere in the world with a good chance of it reaching its destination – and you may be able to do the same eventually using "levels.grin.bonus".

The former conveys so much more information to a human. "UK" locates the country and a little local knowledge says central London. The latter tells you nothing helpful and is prone to the slightest error: for example "level.grin.bonus" is in California, "levels.grins.bonus" is in Alaska, "levels.grin.bonuses" is in New South Wales and "levels.grins.bonuses" is in South Australia. I understand that similar three-word addresses are deliberately geo-diverse, but that is only useful if intelligence intervenes to avoid errors. Multi-occupancy buildings, such as tower blocks, are going to need much more information.

I wish the company well, but fear they have many hurdles to overcome to make it a useful competitor to postcodes in urban areas. (As an aside, I was amused to find that the code for my front door ends in "enter", and for my back door it ends in "exit".) **Andy Cole**

Barry Collins replies: For sure, what3words has a long way to go if it's to become anywhere near as universal as a postcode. But speaking as someone who lives outside of London and routinely spends ages lost in Sussex villages, trying to find the place the satnav's postcode lookup insists are HERE, I very much welcome any effort to make addressing more accurate. Besides, who doesn't want to work at "nasal.defends.glare" (the Dennis Publishing address)?

ABOVE what3words aims to revolutionise geolocation, but is it really better than a traditional postcode?

> **"While the Gemini PDA isn't perfect, for a first-gen device from a UK startup, I feel it's up there with the best"**

Talk to your vendor

I read your article on document management (*see issue 285, p102*) with interest, as I run an IT consultancy specialising in data capture and workflow. Eddie Ginja recommended that "businesses should identify exactly what the business need is", which is good advice, but he goes on to recommend creating a list of requirements, what you want it to do and how much you want to spend; this is the point at which I would also urge engaging with likely vendors.

All too often, we vendors are given soulless lists of requirements and asked to put a tick against the ones we can do. If we tick the right boxes and it progresses, more often than not we find the list of features was created without any real understanding of what technology can offer or how

Star letter

At our rural home, about three miles from the closest green cabinet, we have just-bearable 5Mbits/sec internet. There's no mobile service, even though we're only four miles from a Vodafone 4G mast (at least Vodafone works through its Sure Signal box).

I read your VoIP buyer's guide (*see issue 285, p92*) that mentioned BT's proposal to discontinue its wired landline service and move everybody to VoIP by 2025. The wired BT landline is, therefore, a must-have. It's also the only phone service that works during our all-too-frequent power outages. We have to keep an old handset close by. Without it, we wouldn't have access to emergency services. Nigel Algar

***PC Pro* replies:** You raise a good point. Traditional handsets require no more power than resides in the network, which certainly isn't true of any VoIP application. We can only hope that, should the switch go ahead, people in your situation will see their connectivity options greatly improved over the next seven years – for both broadband and 4G.

Our star letter writer wins a copy of Serif Affinity Photo. Five years in the making, it provides sophisticated image-editing tools and a meticulous focus on workflow.


Document management: well, d'oh!

best it can be used to meet the business objectives.

That's a shame, as it's that guidance that companies such as ours provide. Engaging with vendors gives customers the opportunity to plan a better solution and allows vendors to prove their worth even before money has changed hands. **Alan Ingram**

> "We vendors are given soulless lists of requirements and asked to put a tick against the ones we can do"

Touching Base

Your comparative review of LibreOffice in the June 2018 issue of *PC Pro* (*see issue 284, p30*) failed to mention its database known as Base (a free rival to Microsoft's Access). Let me fill the gap.

According to Libre's own website for Base, anyone who wants to make changes to Base must do it themselves – which means that effectively it's completely unsupported.

In fact, two serious bugs in Base that I reported to the OpenOffice Organisation long ago, before it split into the Libre and Apache versions, remain uncorrected in LibreOffice. The Apache version has fixed one of the bugs; the other remains unfixed but doubtless has a low priority since I offered the pre-split developers an effective workaround.

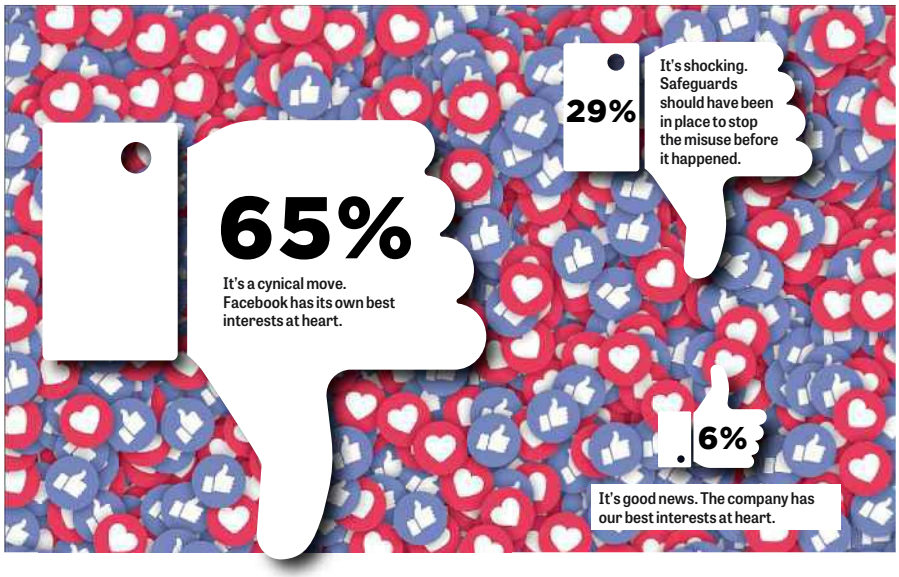
I wish both Apache and Libre would put more effort into fixing bugs and less into adding "features" that only a decreasing minority will want to use. **John White**

OCR in Office

Office has a hidden optical character recognition (OCR) engine in OneNote. Upload an image or add a screengrab and OneNote will recognise it automatically. The text can be copied to the clipboard and is fully searchable inside the application. **N Blake**

Readers' poll

In wake of the news that Facebook had suspended 200 apps for potentially misusing data, we asked you what its motivations might be. The results were clear:



In response to our survey, Vladimir Lungo commented: "I live in a developing country and as such I haven't really paid much attention to what Facebook does with my data... What's the point of protecting your data anyway? The government and other webpages all store some of what you do, and really, does it affect you? Does it matter if they know something you do?"

Adam, on the other hand, explains how he "deleted all posts, tags and Like history and now only keep the single most recent post on there. My personal info is now all made up as well."

John Delaney was just as bullish. "I would never sign up to be spied on and milked by Facebook even if they paid me."

> "They're only doing it because they've been caught out. I haven't changed my social media habits: I'm expecting the companies will change their modus operandi" **Tony C**

> "If an app wants permission to do something I ask 'Why?' and, if they don't or can't give a good reason, they don't get it" **John Chapman**

> "I made use of all the security and sharing preferences before the recent news. Sadly, most are not even vaguely interested" **Adam**

> "I deleted Facebook and I am considering doing the same with Twitter and Instagram. Life is better without Facebook" **Nick**

Join the debate

Join the growing *PC Pro* community on Facebook at facebook.com/pcpro

Get the latest news and updates by following us @pcpro

Email us at letters@pcpro.co.uk

WINDOWS REGISTRY

THE HACKER'S GUIDE

It's time to take full control of Windows: Darien Graham-Smith demystifies the Registry and shares a treasure trove of handy hacks

The Windows Registry is a bit like the engine in your car. You know it's there, and broadly speaking you know what it does. But few of us fully understand its inner workings, and even when things go wrong, we'd probably be hesitant to dive in and start trying to make fixes and adjustments. In fact, it's a good bet that most *PC Pro* readers would be more comfortable tinkering with an internal combustion engine than getting hands-on with the Registry.

There's no need to be intimidated, though. The Registry is fundamentally quite a simple thing, and while some of its contents are best left untouched, there are plenty of useful tweaks and adjustments you can make as long as you have a little knowledge of what you're doing.

What is the Registry?

The Registry has been part of Windows since 1992, when it made its debut in Windows 3.1. Simply put, it's an internal database storing settings for Windows and applications. Some of those settings are very technical, and aren't intended for humans to edit, or indeed understand; others are quite straightforward, and can be safely tweaked.

On disk, the Registry is made up of several different files, dotted around different locations. These are known as "hives" (supposedly an insider joke, to do with the developer's aversion to bees). Four of these hives live in C:\Windows\System32\config, under the names SAM, SECURITY, SOFTWARE and SYSTEM. These contain machine-wide settings.

Additionally, for every registered Windows user, there's a hive called NTUSER.DAT file that contains information about their identity, personal settings and so forth. You'll find your own copy sitting in your user folder, although you'll have to enable "Hidden items" in Windows Explorer to see it.

While it may be useful to know the locations of these hives, once you open the Registry Editor, you'll see that the database is internally structured as a virtual tree that doesn't directly correspond to the arrangement of the on-disk hives. From here on, we'll focus on that tree structure, since that's how Registry locations are normally described – but if, in the future, you come across a reference to the hive files themselves, you'll know what they are.

How is the Registry structured?

At its highest level, the Registry is split into five sections:

HKEY_CLASSES_ROOT – Contains technical information that enables applications to exchange information with one another

HKEY_CURRENT_USER – Contains personal settings for the currently logged-in user

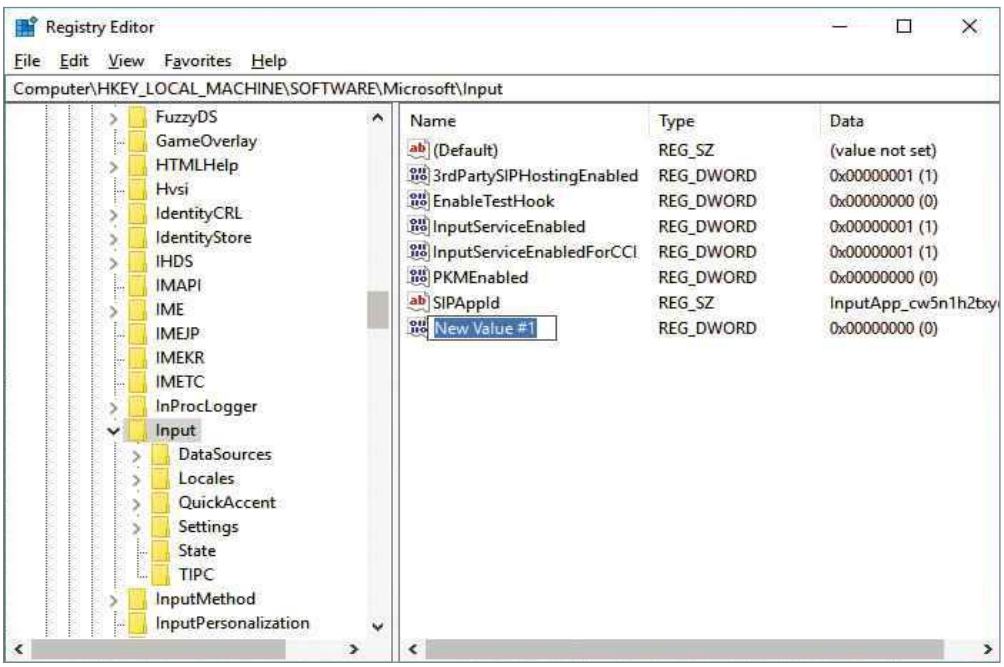
HKEY_LOCAL_MACHINE – Contains system-wide settings that apply regardless of who's logged in

HKEY_USERS – Stores the personal settings of all registered users, including special system accounts that are used for administrative tasks

HKEY_CURRENT_CONFIG – Contains information about which hardware and drivers are installed and running at the moment

Unhelpfully, these sections are also often referred to as hives, although they don't perfectly correspond to the hive files on your hard disk. However, Since their names are a bit of a mouthful, they're commonly abbreviated to HKCR, HKCU, HKLM, HKU and HKCC.

There's no need to be intimidated, though – the Registry is fundamentally quite a simple thing



BELOW Create a new Registry value by right-clicking in an empty area of the right-hand pane

As we've mentioned, the Registry has a tree structure. If you launch the Registry Editor and click on the arrow next to HKEY_CURRENT_USER (or double-click on its name), you'll see about a dozen items – Registry keys – appear below it, mostly with meaningful names such as Network, Printers, Software and so on. Some of these keys will themselves have arrows, indicating that you can open them up to reveal further nested keys.

You'll notice that the structure of the Registry looks a lot like a familiar tree of folders and files, and nested keys are addressed in a similar way, using backslashes to indicate their paths. What's more, while Registry keys can contain subkeys, they can also store values: for example, click once on HKCU\Console and you will see a big long list of values appear in the right-hand pane. You might like to think of these values as analogous to data files inside a folder; in this case, each "file" contains data specifying something about the appearance and behaviour of a command prompt window.

Why might I want to edit the Registry directly?

The Registry isn't really designed for users to tinker with. When the likes of you and me want to configure our Windows settings, we're expected to

use the friendly graphical interfaces built into Windows, such as the PC Settings app or the Device Manager. These bits of software then access and update the Registry behind the scenes.

However, using the Registry Editor, you can access options that aren't available via the user-friendly apps: for example, as you'll see below, you can customise context menus, and modify which icons appear in Explorer. Sometimes these options have been hidden away because they're too complex to bother users with. Sometimes they're just waiting for Microsoft to implement a front-end: in the original release of Windows 10, you had to edit the Registry to activate "Dark Mode", to disable Aero Snap or to make the Recycle Bin appear in This PC, but now these options are all available in the PC Settings app.

Inside the Registry, the settings themselves are stored in a few different formats. The most common is the DWORD – a "double word", which is jargon for a 32-bit number – but the Registry can also store binary code, text strings and various other types of data. If you look in the right-hand pane of the Registry Editor, you'll see the "Type" column shows what sort of data each value is. Strings are abbreviated as SZ" – short for String-Zero, because the text is terminated with a zero-value byte.

You can edit these values in the Registry Editor, by double-clicking on the name of one and typing in new data. You can also create new keys and values from the context menu that appears when you right-click on an existing key (or anywhere in the right-hand pane). If you're creating a new value, make sure you set the correct data type, or Windows is likely to ignore it; if you're editing a value within a Registry key, you won't be allowed to enter a value that isn't of the right type.

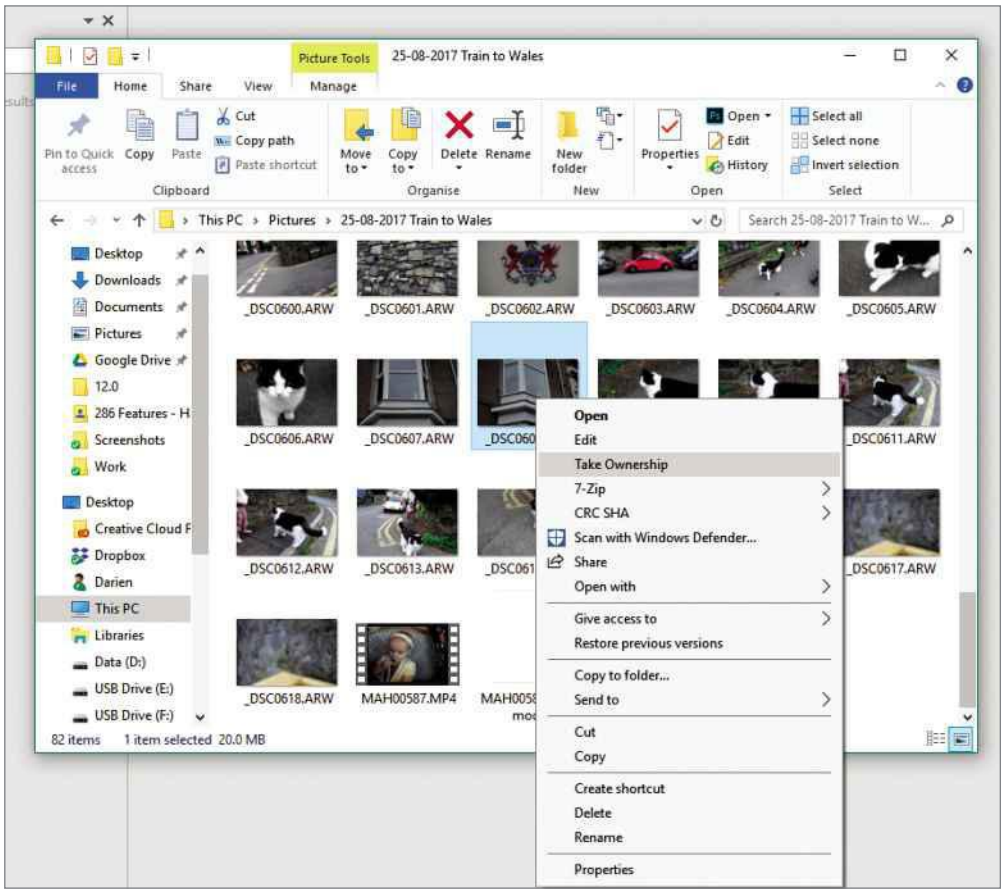
Is it safe to edit the Registry?

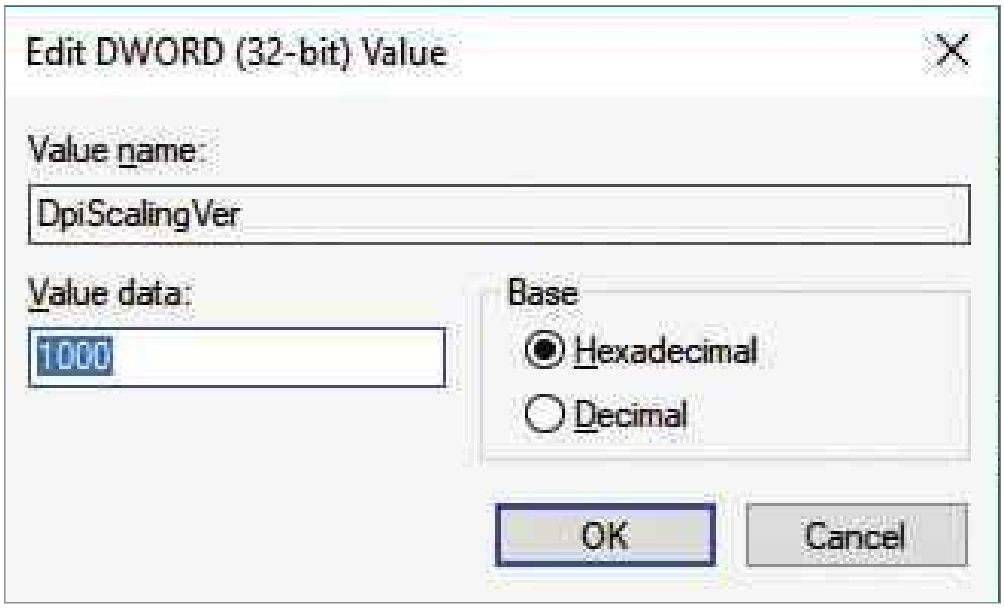
There are keys and values in the Registry that could, if deleted, cause applications to stop working properly, or prevent Windows from booting. However, if you're browsing around HKCU and HKLM, you'll see a lot of values with fairly self-explanatory names, and to be honest if you want to experiment with changing them, the danger is minimal.

We've a few caveats, though. First, some changes will only take effect when you restart Explorer, or sign out, or restart Windows completely. So even if a change doesn't immediately appear to do anything, it could reveal its effect later on.

Second, if you do make a silly mistake, there's no easy way to undo Registry edits. Before you delete or edit a value, it's a good idea to back it up by right-clicking on the key in the Registry Editor and selecting Export. This will save a backup file (with a REG) extension containing all the data within that key; if you repent of your changes, you can just double-click on the REG file to import the old settings. To back up the entire Registry, click on Computer at the top of the tree and select Export.

If you mess up the settings in HKCU, you can also go and look in HKU\.DEFAULT – this contains many default settings that are applied for new users, so you may be able to copy values from here to restore your own account to default behaviour.





TOP By tweaking the Registry you can add a time-saving "Take Ownership" option to the Explorer context menu

ABOVE The most common file format in the Registry is DWORD, or "double word", which is Microsoft jargon for a 32-bit number

Is it safe to use Registry-tweaking tools?

There are many freely downloadable, third-party apps out there that offer

an easy way to apply Registry hacks, and customise Windows in other ways. If you're nervous about getting hands-on with the Registry then such a tool might suit you nicely. However, these programs have to contend with the fact that Windows is a moving target, and tricks that work in one version might not work in the next. The hacks we recommend below have all been tested on the latest edition of Windows 10, and most will work on older releases, too.

Be more sceptical of tools that claim to find and fix Registry errors. These apps usually focus on removing references to applications and resources that have been deleted. They won't do you any harm, but it's unlikely that they'll fix any serious problems, and they almost certainly won't be able to help you out if you have manually changed a setting you shouldn't have.

It's a similar story with Registry compacting tools. It's true that the Registry takes up space on your hard disk, and parts of it are cached in RAM, so clearing out superfluous data will give you more free disk space, and more available memory. However, by modern standards the hive files are very modestly sized – typically less than 200MB on a single-user system – so compacting them is unlikely to make a noticeable difference.

Time to get hacking

You should now have a good idea of what the Registry is, how it's structured and how you can tweak it with minimal risk. Below you'll find a selection of our favourite hacks to try out for yourself – it's not just cosmetic stuff, but tweaks that can really improve your productivity, with an emphasis on the Windows desktop and Explorer.

If you want to go searching for further Registry tweaks, there's no shortage of pointers online – for example, you'll find settings to change the scaling and spacing of the icons on your desktop, adjust the appearance of window borders and play with many other visual defaults. Be aware, though, that a lot of the information you'll find will be obsolete, or may not work in the expected way. People have been posting Registry tweaks for as long as the internet's been around, and many of them no longer fully apply to Windows 10.

Finally, we're obliged to point out that the tweaks on the following pages are offered for information only, and we can't be held responsible for anything that happens as a result of your using them. Back up your Registry before you start, or test them in a virtual machine before deploying them on your desktop.

HACKER TIPS

Make your taskbar translucent

The April Update brings subtle transparency effects to the Windows desktop, but the taskbar remains fairly opaque. If you want to make it more see-through, navigate to:

HKLM\SOFTWARE\Microsoft\Windows\CurrentVersion\Explorer\Advanced

Within this key, you should create a new DWORD value called "UseOLEDTaskbarTransparency" and set it to 1. This means that, when you next restart, the taskbar will be much more lightly tinted.

Add seconds to your taskbar clock

If you like to know the precise time, you can update the clock at the bottom-right of the Windows desktop to show seconds, rather than the default hour-and-minute display. The key you need to update is:

HKCU\SOFTWARE\Microsoft\Windows\CurrentVersion\Explorer\Advanced

Create a new DWORD value called "ShowSecondsInSystemClock" and set it to 1 to enable the seconds display in the taskbar clock.

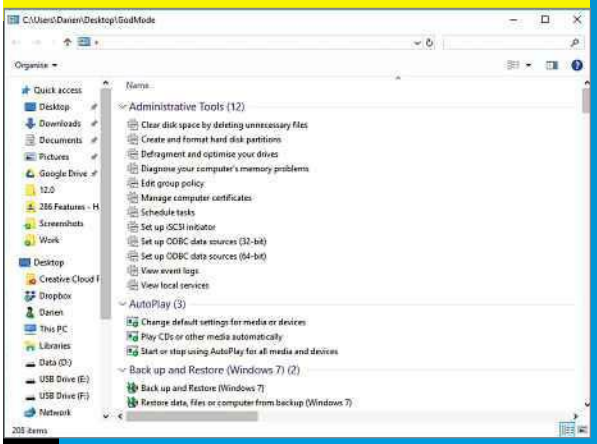
Make taskbar buttons bring the last active window to the front

If you have more than one window open in an application – for instance, two Word documents – then clicking on the taskbar icon will open a thumbnail for each, allowing you to click on either one to bring it to the fore. However, if you prefer, you can tweak this behaviour so that clicking takes you straight back to whichever window was last active. As with the previous Registry tweak, the key you need to edit is:

If you do make a silly mistake, there's no easy way to undo Registry edits so it's a good idea to back up

"God Mode"

This isn't strictly a Registry hack, and to be honest the name very much oversells it. Still, this trick conveniently exposes the complete range of Control Panel settings in a flat, searchable interface. To enable it, all you have to do is create a folder on your desktop called "GodMode.{ED7BA470-8E54-465E-825C-99712043E01C}" (if the presumption offends you, you can change the first bit to whatever you like). Then double-click to open it, and browse the settings and configuration options to your heart's content.



Open Explorer at whatever directory you choose

By default, the Windows 10 Explorer opens up on the Quick Access view. In the original release of Windows 10, there was no official way to change this, and hackers quickly sought out ways of tweaking the Registry to make it show a different folder when opened. Recent editions of Windows 10 now give you the option of always opening Explorer at This PC instead (it's the top option in the File Explorer Options dialog).

However, if you want it to open at some other folder, a bit of hackery is still required. First, create a shortcut to the folder you want to be your default location – and rename that shortcut "File Explorer". Then, enter this address into the location bar of an Explorer window:

%APPDATA%\Microsoft\Internet Explorer\Quick Launch\User Pinned\TaskBar

You'll see a link here to File Explorer. Overwrite it with your new shortcut and hey presto – now, when you click on the File Explorer icon on the Taskbar, Explorer will open at your desired location.

Unfortunately, there's no way we know of to change the default location that comes up when you open an Explorer window by pressing Win+E – but what you can do is open the Properties of your new shortcut, click on the Shortcut tab and assign a new keyboard shortcut (such as Ctrl+Alt+E) to directly open your chosen folder.

HKCU\SOFTWARE\Microsoft\Windows\CurrentVersion\Explorer\Advanced

Create a new DWORD called "LastActiveClick" and set it to 1. You can still access the thumbnails of other windows by hovering the mouse pointer over the application's taskbar icon.

Adjust the duration of menu animations

When you right-click on an item in the Windows Explorer, the menus (and submenus) take a moment to "fade in". You can shorten this delay by changing a value within this Registry key:

HKCU\Control Panel\Desktop

The value you want is called "MenuShowDelay"; the default is 400 milliseconds, but you're free to reduce it (or raise it if you wish). You can also choose to make windows pop up, rather than fading in, by opening the Settings app, searching for the toggle labelled "Show animations in Windows", and flipping the switch. Be warned, though – having submenus appear instantaneously is actually quite distracting!

Disable Aero Shake

Windows' "Aero Shake" function kicks in when you pick up a window by its title bar and use the mouse to literally shake it from side to side: all other windows are automatically minimised, leaving you to focus on the one you're holding. It's a quick and easy way to hide clutter, but it's not all that useful – and if you like to jiggle your mouse around it can be triggered by accident. To turn it off, navigate to:

HKCU\Software\Policies\Microsoft\Windows

Once there, create a new subkey called Explorer, and then, within that new key, create a DWORD called "NoWindowMinimizingShortcuts". Set its value to 1, restart Explorer, and Shake is gone.

Shut down Windows more quickly

When you shut down or restart Windows, the operating system instructs all running processes to terminate. Sometimes, though, a program won't do that – and it might be for a good reason, such as an open "save file" dialog that needs your attention. Often, though, the cause is just a badly written program that doesn't close down promptly like it should. If you don't like waiting, you can tell Windows to forcibly kill all processes when it's time to restart. To do so, navigate to:

HKCU\USER\Control Panel\Desktop

Create a new DWORD value called "AutoEndTasks", set it to 1 and those annoying "this app is preventing shutdown" messages should be a thing of the past. Just make sure you've saved your data before you tell Windows to reboot.

Remove graphics driver shortcuts from desktop context menu

If your PC has a discrete graphics card, you'll notice that when you right-click on the desktop, a shortcut to your graphics driver appears at the top of the context menu. Don't want it there? Then kill it. The key you're looking for will be one of these two, depending on whether your GPU is from AMD or Nvidia:

HKCR\Directory\Background\shellex\ContextMenuHandlers\ACE

HKCR\Directory\Background\shellex\ContextMenuHandlers\NvCplDesktopContext

Just delete these keys and reboot to remove the unwanted menu entries. (You may want to back up the keys first in case you later change your mind – or, you can always get them back by reinstalling the drivers.)

Hide unwanted drives from This PC

By default, the Windows 10 File Explorer shows all local and network drives that have letters assigned to them. If you want, you can hide any of these drives from This PC – while still leaving them accessible by typing their paths into the location bar. To do so, navigate to this key:

HKCU\Software\Microsoft\Windows\CurrentVersion\Policies\Explorer

Next, create a new DWORD value named "NoDrives". Now comes the slightly difficult bit: Windows uses a 26-bit binary code to record which drives should be hidden, with each bit representing a letter from Z: to A:. So if, for example you wanted to hide drives A:, B:, D: and E:, the value would be 00000000000000000000 0011011. Unfortunately, NoDrives

isn't itself a binary value, so you will have to enter the code in either decimal or hexadecimal format: in this case, the decimal equivalent is 27.

Add "Command Prompt here" to the Explorer context menu

In previous versions of Windows, you could hold down Shift while right-clicking on a folder to see the handy option to "Open Command Prompt here". In Windows 10 that's changed to "Open Powershell window here". If you want to get the old-school Command Prompt option back, the key to edit is:

HKCR\Directory\Background\shell\cmd

Look for a DWORD value called "HideBasedOnVelocityId"; to restore the old menu option, rename it to "ShowBasedOnVelocityId". Unfortunately this isn't as simple as it sounds, as by default you don't have permission to edit this value.

To gain access, right-click on the "cmd" key, select Permissions and then click Advanced. At the top of the window that opens you should see that this key is owned by TrustedInstaller. Click the Change link next to this name to open the "Select user or group" dialog. Type in your username, then click OK to close this window, and again to close the Advanced Security Settings window.

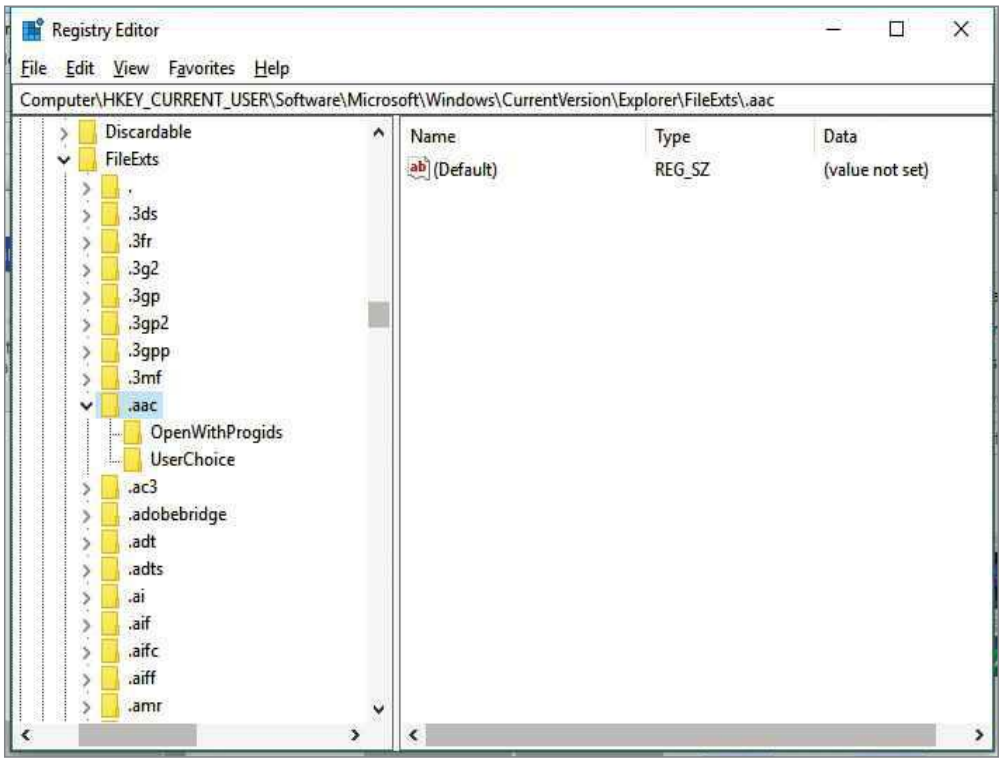
Finally, once you're back in the "Permissions for cmd" window, select the Adminstrators group, tick the "Allow" box next to "Full Control" and click OK. You can now change the name of the value – phew!

Hide "Open PowerShell window here" from the Explorer context menu

Having done the above, you might prefer to hide the old PowerShell menu item. The key you need to edit is right next to the one we were just editing, at:

HKCR\Directory\Background\shell\Powershell

As you might be able to guess, you can hide the menu item in question by changing this value from "ShowBasedOnVelocityId" to "HideBasedOnVelocityId". However, since this key is also protected, you will need to go through the exact same rigmarole as above to gain access – but by now you should be an old hand at that.



ABOVE You can change which program opens a particular file type in the extensions folder of the Registry Editor

Add "Take Ownership" shortcut to the Explorer context menu

As we've just seen, permissions in Windows can be a drag if you want to get hands-on with certain system functions. Adding an Explorer shortcut can make it a lot easier to take ownership of specific files (although, sadly, it doesn't work for Registry keys). To add in a shortcut, navigate to:

HCR*\shell

Now create a new subkey within this key called "runas", and double-click the "(Default)" value that is automatically created for the new key. Change its value to "Take Ownership". Once that's done, create a new String value within the runas key called "NoWorkingDirectory" and leave its value unset.

If you don't like waiting, you can tell Windows to forcibly kill all processes when it's time to restart

The next step in the process is to create a new subkey within "runas" called "command", and again edit the "(Default)" value. However, this time, you will need to enter the following value:

cmd.exe /c takeown /f \"%1\" && icacls \"%1\" /grant administrators:F

Finally, we need to create a new string value inside this key called "IsolatedCommand"; set its value to the same CMD.EXE string as above. The change should take effect immediately: when you right-click on a file, you will now see the option to take ownership of it, without having to delve into Windows' security settings.

Make "Take Ownership" work with folders too

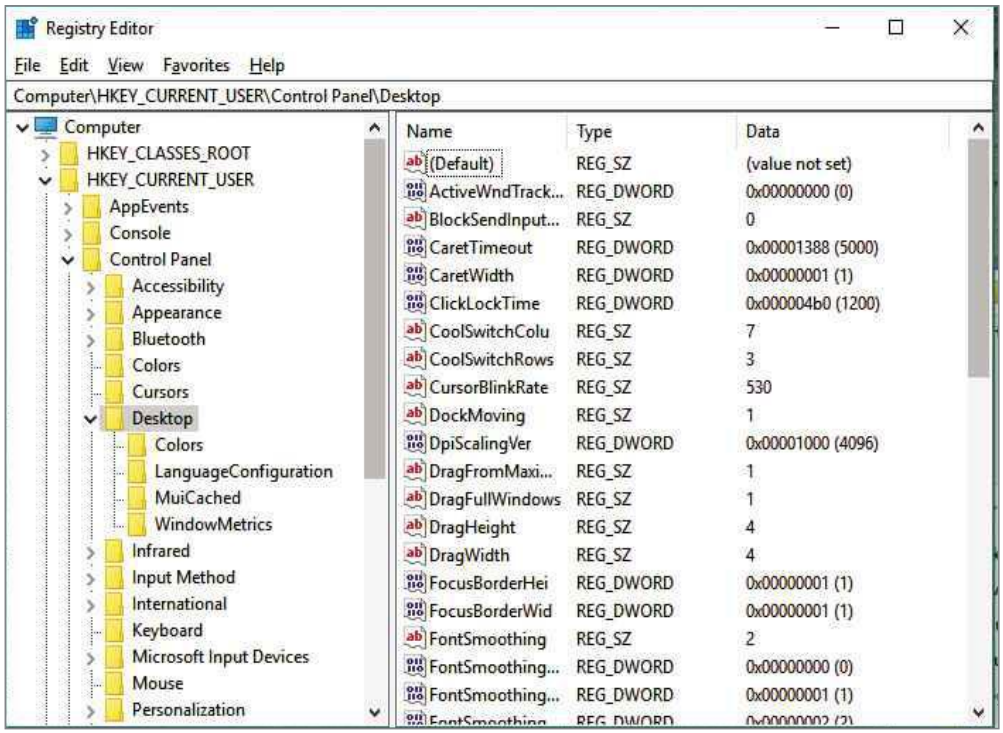
The above hack works on files, but not on entire folders. To make it work recursively on folders – which means you can easily take possession of hundreds of files at once – you should navigate to:

HCR\Directory\shell

Follow the same instructions as before: create a new "runas" key, change its default value to "Take Ownership" and create a new "NoWorkingDirectory" string value. Then again, create a subkey called "command" and edit the "(Default)" value. This time, though, the command is:

cmd.exe /c takeown /f \"%1\" /r /d y && icacls \"%1\" /grant administrators:F /t

Once more, you should copy the command above into a new string value called IsolatedCommand within the "command" subkey – and you're finished.



ABOVE Desktop Registry tweaks include shutting Windows down more quickly and adjusting the duration of menu animations

Clean up the "Open With" context menu

When you right-click on a file and select "Open With", you'll see a selection of programs that have registered themselves as handlers for that particular filetype. To remove a particular application from this list, browse to:

HKCU\SOFTWARE\Microsoft\Windows\CurrentVersion\Explorer\FileExts

Here you'll find a long list of all the different file extensions that are registered on your PC. Scroll down to the one you want to edit and then expand it to reveal a subkey called "OpenWithList". Here you'll see all the registered handlers; delete any key to remove it from the context menu.

If you want to add programs to this list, it's safest not to try to do it through the Registry: instead, right-click on the file in Explorer, select "Open With", and then pick "Choose another app…" at the bottom of the list. Select the application you want and henceforth, it will be added to your context menu.

Add "Copy To…" and "Move To…" context menus

Move files around a lot? There's no need to be dragging icons this way and that, or messing around with Ctrl+C and Ctrl+V. By editing the Registry, you can create contextual menu items that let you copy and move items with a single click. Start by navigating to:

HCR\AllFilesystemObjects\shellex\ContextMenuHandlers

You'll see that there's already a subkey here called SendTo. Create a new one and call it "Copy To". Then, edit its "(Default)" value and set it to "{C2FBB630-2971-11D1-A18C-00C04FD75D13}" (including the curly brackets, but not the quotation marks"). Now when you right-click on a file or folder, you'll see a new menu item entitled "Copy to folder…" which lets you directly specify a destination.

To create a "Move To" menu item, do exactly the same thing, but call the key "Move To" (obviously) and set its default value to "{C2FBB631-2971-11D1-A18C-00C04FD75D13}".

Remove "3D Objects" from This PC

Explorer's This PC view shows quick links to personal folders in its upper pane, including Documents, Downloads and Music. Recent Windows 10 updates have added another folder named "3D Objects". It's a fair to say that very few people will actually need this – but there's no obvious way to stop it cluttering up your workspace. Fortunately, you can get rid of it very easily. Just navigate to:

HKLM\SOFTWARE\Microsoft\Windows\CurrentVersion\Explorer\MyComputer\NameSpace

Then, look for a subkey called "{0DB7E03F-FC29-4DC6-9020-FF41B59E513A}". It's very likely that this will be the only one beginning with a zero, but double-check that you've definitely got the right one. Once you're sure you have, delete it. Refresh your Explorer windows and you will see that the useless shortcut is gone.

In the Registry, you can create contextual menu items that let you copy and move items with a click

Remove OneDrive from Explorer

OneDrive isn't quite as useless as the "3D Objects" folder, but it's not necessarily something you're going to use every day – and similarly, it can't be removed from Explorer using normal methods, unless you completely uninstall it. To get rid of the persistent shortcut in the navigation pane, first browse to HKCR\CLSID and scroll down the very long list of class identifiers until you find "{018D5C66-4533-4307-9B53-224DE2ED1FE6}". Within this key, edit the value called "System.IsPinnedToNameSpaceTree", and change it from 1 to 0. If you're running on 64-bit Windows, make the same change at:

HKCR\Software\Classes\WOW6432Node\CLSID

Finally, browse to:

HKEY_CURRENT_USER\Software\Microsoft\Windows\CurrentVersion\Explorer\Desktop\NameSpace

Within this key you'll see a subkey with the same long hexadecimal name we referred to above (starting {018D5C66…). Delete this too and, after a reboot, that pointless shortcut will be gone. If you still want to access your OneDrive folder, you can access it by typing "OneDrive" into the location bar, and create a shortcut to it wherever you like.

Remove "Shortcut to…"

When you create a shortcut to a file, Windows helpfully appends " – Shortcut" to the filename. This is a little superfluous, since there's already a little arrow icon in the corner that tells you it's a shortcut. To change this behaviour, you should navigate to:

HKCU\USER\SOFTWARE\Microsoft\Windows\CurrentVersion\Explorer

Now create a new binary value named "link" and set it to 00 00 00 00. When you next reboot your PC, your shortcuts should come out with the same names as the originals.

Remove arrow overlays for shortcuts

If you really want your shortcuts to look like regular files, you can get rid of the arrow overlays. To do this, navigate to:

HKLM\SOFTWARE\Microsoft\Windows\CurrentVersion\Explorer

Create a new subkey called "Shell Icons" and create a new string value within it called "29" (yes, really). Set this to "%windir%\System32\shell32.dll,-50". Restart Windows and the arrows will be gone.

Make "Do this for all items" the default when copying files

It's a small thing, but when you're copying a folder full files, it's annoying when Windows keeps stopping to ask what it should do about conflicts and other issues. So you might be happy to learn that there's a Registry setting you can tweak to automatically tick the "Do this for all items" box. You still have to tell Windows what to do, but now it's a single click. You'll find the key at:

HKCU\Software\Microsoft\Windows\CurrentVersion\Explorer\OperationStatusManager

Simply edit the "Confirmation CheckBoxDoForAll" value, changing it from 0 to 1.

Use strictly alphabetical file sorting

Windows Explorer tries to show you files in an intuitive order, so FILE_10 comes after FILE_9. But perhaps your filenames aren't sequential, and you would prefer to see them in strict alphabetical order? The key you need to edit is:

HKLM\Software\Microsoft\Windows\Currentversion\Policies\Explorer

Create a new DWORD value called "NoStrCmpLogical" and set it to 1. Next time you open an Explorer window, FILE_10 will be sorted ahead of FILE_9 (and indeed FILE_2).

Disable automatic driver updates

Windows 10's ability to automatically download and install drivers makes it a cinch to set up, compared to earlier versions of the OS. More problematic is the way it also automatically installs updates as they become available – even though these may contain unwanted feature changes or even bugs. To keep your drivers stable, navigate to:

HKLM\SOFTWARE\Policies\Microsoft\Windows

Create a subkey called WindowsUpdate and then within it create a new DWORD value called "ExcludeWUDriversInQualityUpdate". Set it to 1 and restart your PC; while Windows Update continues to automatically download security updates, it should now leave your device drivers alone.

Change your owner and organisation name

When you originally installed Windows, it may have asked you for a name and organisation. Many applications will use this information as the defaults for registration and other metadata. This is fine as far as it goes –but there's no official way to ever update this information once you've provided it. Happily, it's straightforward to do with a quick Registry tweak. The keys you want are located at:

HKLM\Software\Microsoft\Windows NT\CurrentVersion

The values are called "RegisteredOrganization" and "RegisteredOwner" – feel free to change them to whatever you want.

Enable Verbose booting

The Windows 10 boot screen may be tasteful,with its cyan logo on a plain black background – but it's entirely uninformative if something goes wrong. Technical users may therefore prefer to see a Linux-style log of exactly what's going on during the boot process. To enable "verbose" mode, browse to:

HKEY_LOCAL_MACHINE\SOFTWARE\Microsoft\Windows\CurrentVersion\Policies\System

Create a new DWORD value called "VerboseStatus" and give it a value of 1. Once that's done, prepare for a deluge of technical information next time you start up Windows...

Cancel Windows Update

If you go searching online, you'll find numerous Registry tweaks that claim to prevent Windows from automatically rebooting after a new update has been downloaded. But these don't work on the latest version of Windows 10.

The good news is that they're less necessary than they once were: Windows is much less pushy than it was, and you can now nominate a set time for the system to reboot. But if you absolutely don't want the OS to ever restart on its own, the best solution we've found is to set up a scheduled task that periodically cancels any pending reboot jobs.

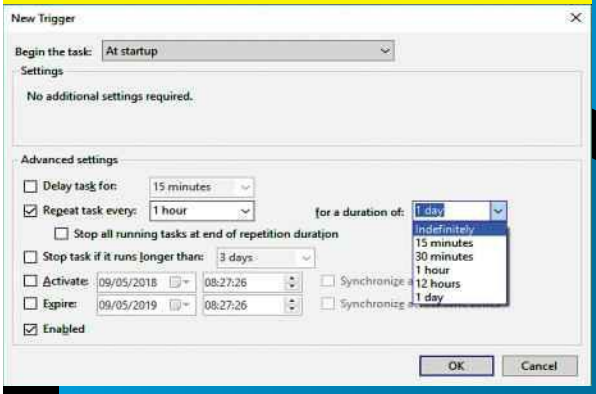
To do this, open the Task Scheduler and click on "Create Task..." The window that opens will have several tabs: on the first ("General"), tick "Run with highest privileges". On the Triggers tab, use the dropdown to set your task to run at startup, and tick to have it repeat every hour; set the duration to "indefinitely" and click OK.

Next, in the Actions tab, click "New..." and in the "Program/script" enter "powershell". In the "add arguments" field, type:

-command Disable-ScheduledTask \Microsoft\Windows\UpdateOrchestrator\Reboot

Click OK to finish creating your Action. Next, click onto the Conditions tab and untick "Stop if the computer switches to battery power". And finally, on the Settings tab, untick "Stop the task if it runs longer than..."

Click OK for a final time and the job's finished. In the future, your new task will activate hourly and cancel any pending reboots.



ARE SMART GUNS THE SILVER BULLET?

Guns are out of control in the US. Could smart weapons succeed where politicians have failed? Davey Winder investigates

BELOW To operate the semi-automatic Armatix iP1, the matching wristwatch has to be within ten inches of the gun

Students took to the streets to demand tighter gun controls following the Florida Parkland shooting. The president's response? Give guns to teachers.

Assuming that arming teachers isn't the solution, maybe the answer sits with technology. Could smarter guns be the solution?

Mass shootings in the US have become frighteningly common. The one that took place on 14 February at the Marjory Stoneman Douglas High School in Parkland, Florida claimed 17 lives and saw 17 more wounded. Yet mass shootings account for a tiny fraction of the total number of gun-related deaths. By the end of May, the Gun Violence Archive (**gunviolencearchive.org**) reported a total of 5,736 verified gun-related deaths in the US already this year. These statistics don't include the estimated 22,000 suicides by shooting in the US annually but do include some 675 "unintentional shootings". The number of children aged up to 17 either killed or injured in the same period was 1,298.

According to the Pulitzer Prize-winning fact-checkers PolitiFact, the true scale of the problem is almost incomprehensible. It calculates that between the start of the American Revolutionary War in 1775 up until 2015, there had been 1,396,733 cumulative deaths on the battlefield. Gun-related deaths in the US since 1968, when Robert F. Kennedy was assassinated, tallied up to a staggering 1,516,863 in only 47 years. That figure also includes suicides, accidents and law-enforcement interventions, as well as homicides, but it's still a population the size of Birmingham and Glasgow combined wiped out by bullets.

If people and politicians aren't smart enough to deal with the problem themselves, is there a way to control gun deaths by making the weapons smarter instead?

REAL-LIFE LAWGIVER

The notion of a high-tech weapon that can both identify the user and disable the firing mechanism for anyone but the verified owner is nothing new. Think of the Lawgiver from *Judge Dredd* (a movie yours truly was in when the 1995 remake was produced). Yet such a gun isn't constrained to the realms of fiction; the Magna-Trigger device that prevents firing unless a magnetic ring is worn predates *Judge Dredd*, having first appeared in 1974. In 1998, Colt came up with the Z40, which used a radio-frequency wristband to enable firing and, in 2011, Smith & Wesson inked a deal with the US government to fund smart gun technology. So why have you never heard of these weapons? Because NRA members and Second Amendment activists boycotted both companies and almost drove them into bankruptcy. Both the Z40 and the promise of research were dropped.

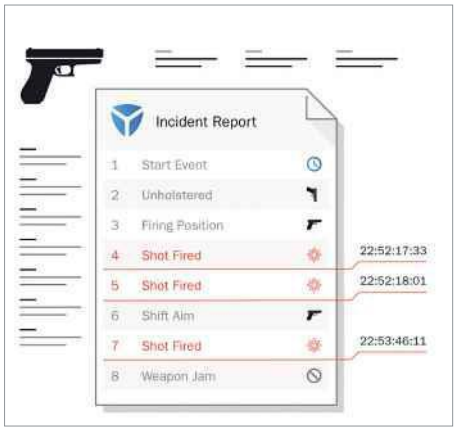
The NRA insists it doesn't currently, and never has, opposed such developments, but it does oppose government mandates over what weapons citizens can use. Mandates such as a law passed in New Jersey in 2002 that requires all gun shops in the state to only sell smart guns within a three-year window from when the first smart gun is sold, anywhere in the country. Those earlier boycotts, the motivational muscle of the NRA and a real fear of going out of business have meant that no gun shop has yet had the courage to do so. Some have thought about it, such as the owner of Engage Armament in Maryland who

announced he was going to stock the Armatix iP1 in 2014. He received death threats and faced a well-organised boycott if he continued. Needless to say, he dropped the idea.

HACKING FIREARMS

But what of the Armatix iP1 itself? How does this advance the smart gun? It takes the ideas from the Magna-Trigger device of the seventies, and more recent smart "trigger guard" add-ons such as the Identilock fingerprint reader, and builds them into the handgun. The iP1 requires the owner to wear a smartwatch that pairs with the gun – if both watch and weapon are within 10in of each other, the gun can fire.

However, a hacker called "Plore" was able to demonstrate serious flaws in the protection. He first managed to extend the unlock pairing range by building transmitter relays, having worked out the signal wavelengths being used and then blocked the handset remotely. The most damning exploit, though, was when Plore was seen in a video bypassing the lock mechanism entirely simply by placing a stack of cheap neodymium magnets on the right part of the gun and leaving the £1,000 smart weapon with, when the biometric scanner fails to recognise the user and repeated attempts are required to gain access. "Consider a scenario where your fingerprint reader does not align in a rushed grip, or a sweaty palm creating a negative reading in the heat of a gunfight," warned Graeme Park of Mason Advisory and a former major in the military. When it comes to the old usability versus security argument, usability can't be impacted in the firearms sector.



ABOVE Yardarm's forensic Blackbox system records key details such as when the gun was unholstered, aimed and fired

RIGHT SOLUTION, WRONG PROBLEM?

Maybe, then, we're looking for a smart solution to the wrong problem? Mass shootings are unlikely to be prevented by the type of gun control a smart weapon can provide. Not least as the overwhelming majority are perpetrated by the registered owner of the gun. And then there's the problem of the millions of "dumb" guns in existence. It's doubtful that the weapons already in the underground system could be eliminated within our lifetimes, or the generation still to come, even if only smart guns could be legally sold as from today.

So where does smart tech fit into gun control in any meaningful way? Margot Hirsch, president of the Smart Tech Challenges Foundation believes that almost all accidental shootings and teen suicides could be prevented by smart guns. Margot says that of the 2,600 youth suicides using guns each year in the US, 70% use a family member's firearm. With one in three American households owning at least one gun, it's perhaps surprising these figures aren't even higher.

Margot also reveals that 80% of the 250,000 guns stolen each year are never recovered, which simply feeds the underworld. "If law enforcement officers carried firearms personalised for their use, we wouldn't see guns stolen out of officer's cars being used in killings."

Indeed, law enforcement is the one area where smart tech is being applied to firearms. Not in identifying the user, as such, but rather in determining the location and usage of weapons. One outfit that has made great strides in this sector is Yardarm, which builds products and services that don't interfere with the mechanical function of the weapon, but do reveal where and when a weapon is drawn and fired.

Jim Schaff, vice-president at Yardarm, explains that by using a combination of gun-and holster-aware sensors, alongside a cloud platform, law enforcement can identify all motion-related firearm activity. "Primary use cases include real-time alerts to dispatch, so if an officer in the field uses their weapon then dispatch can send backup

"BACKDOORS MIGHT BYPASS THE FINGERPRINT RECOGNITION PROCESS ALTOGETHER"

looking pretty dumb. Of course, in a real home invasion the intruder wouldn't know the owner had such a gun and wouldn't come prepared with tech kit to disable it. A savvy family member wanting to kill themselves, or others, might have more success.

What about the fingerprint readers? If they're reliable enough to stop unauthorised access to your phone, why can't they work on guns too? Matt Lewis, research director at the NCC Group, isn't convinced this is necessarily secure enough either. "Fingerprint spoofing is rife," Lewis explained, "with many public sources explaining how this can be done." That opens the potential for such weapons to be fired without the knowledge of the owner, leaving them in the frame for the shooting.

Then there are exploits in the software used in the fingerprint enrolment process. "Software vulnerabilities, or the addition of backdoors, might bypass the fingerprint recognition process altogether," he warned. That's not to mention the false negatives that every smartphone user will be familiar

BELOW The Identilock can only be opened with a fingerprint from a maximum of three users

immediately," Schaff said, "even if the officer is unable to call for help on the radio."

Yardarm can also activate the Engage body-worn camera system so that all critical evidence during a shooting is captured. The Blackbox firearm forensic system records all weapon telemetry such as holster state, discharge time, magazine insertion, three-axis motion data, weapon jams and so on.

LOCK DOWN THE LOCATION

One young technologist, 17-year-old Chloe Green, is developing similar location-aware tech for firearms that she hopes might prevent mass shootings. The gUNarmed project revolves around a location-aware gun magazine that uses GPS data to jam the mechanism if someone tries to fire the weapon in a location where it's not permitted. By moving the smarts from the person using the gun to the place the gun is being used, Chloe hopes to prevent the kind of tragedies that unfold in schools and government buildings, shopping centres, airports and so on. As well as locking the magazine, gUNarmed can also alert law enforcement to the presence of the would-be shooter. It doesn't require the purchase of a new gun as it's an add-on, but it does require the support of the gun-owning population. As we've seen, that certainly can't be taken for granted.

And so, we come full circle to the real problem with smart guns. There are areas of the gun control debate where smart guns are playing a part – they're just not the areas that most people would have hoped for.

It beggars belief that technology is unable to play a much broader role and can't make firearms safer for both the legal owner and potential victim alike. It leads me to the conclusion that the real problem is that there simply is no appetite for developing such technology within Silicon Valley or the venture capital outfits that fund it. Where is the Elon Musk, Jeff Bezos or Bill Gates of smart gun technology?

Is it merely that nobody wants to be associated with the firearms market, even if that association led directly to fewer suicides, fewer accidental shootings and ultimately a safer society for all? Or is "the market" waiting for the power of the gun lobby to subside?

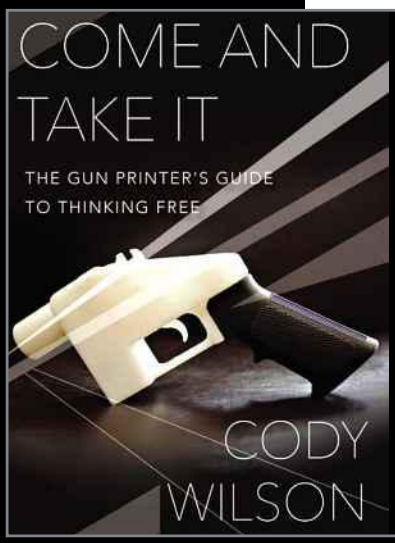
Until the path to market becomes a lot clearer and less congested, with the picket lines dismantled and distribution channels allowed to respond to technological advance, it's unlikely much will change. Apart from the victim statistics that will continue to rise week by week, year on year...

3D-PRINTED FIREARMS

One area where technology has caused a stir within both the gun-owning population and law enforcement is 3D printing. The dark web is well known for selling firearms as well as drugs, and you can now add 3D files for printing firearms to that shameful list.

And while buying a "real" gun on the dark web will cost around $1,000 according to the most recent research, a CAD file to enable the 3D printing of one will set you back as little as $12.

Of course, the chances are high that it would explode if you tried to fire it. Using polylactic acid (PLA) plastics wouldn't work as the material is so soft that parts would deform or break upon firing, at best preventing a successful shot and possibly injuring the would-be shooter. Harder acrylonitrile, butadiene and styrene (ABS) polymers would likely deliver better results, but even so the forces involved in firing a single shot would likely render the weapon incapable of firing a second time.



Hybrid 3D printed guns using a combination of plastic printed parts and off-the-shelf metal components, or even industrial 3D metal printers, are both alternatives. Both suffer the same drawbacks of being much costlier than just buying a gun, unless the real value is in avoiding legal ownership. Even then, the idea that a criminal organisation would go to the expense and complexity of producing some kind of gun-printing factory is unlikely when buying them ready-made on the black market is easier.

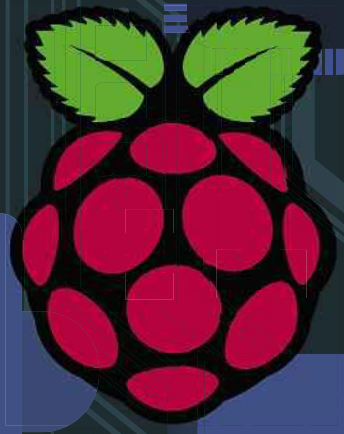
But that's today – come tomorrow, who knows where the technology will take us? Yesterday, relatively speaking, technology took us to the first functional 3D-printed gun, known as the Liberator. This one-shot weapon was designed by a "crypto-anarchist" called Cody Wilson in 2013 and caused a media frenzy when his open-source gunsmithery Defense Distributed (defdist.org) made the files available for download.

That it was downloaded more than 100,000 times in the first 48 hours was probably enough for the US government to get involved and persuade the organisation to remove the plans. Not that you can print a fully functional gun using a 3D printer anyway, not even in the case of the Liberator; it still requires a metal firing pin and real bullets to actually fire.

Interest in the gun wasn't restricted to the US, which was only second in the "most downloaded" list of countries: Spain topped the list, and the UK was fifth. Maybe this led the Home Office to introduce stricter controls on 3D printed firearms, and firearm components, that year. Since then it has been illegal to create, buy or sell such 3D items in the UK.

Build a RASPBERRY Pi HOME SERVER in 30 minutes

Want to stream your music, create Dropbox-like storage or even host your own website? Nik Rawlinson provides step-by-step advice on doing precisely that



The ideal home server is quiet, reliable and light on power – just like the Raspberry Pi. Better yet, the Raspberry Pi is cheap. The board itself costs less than £40 and the Raspbian operating system is free. If you have an old monitor, keyboard and mouse going begging, you can usually power it using a regular USB power supply, so all you need to add is a microSD card to boot from.

Over the next four pages, we'll show you how you can turn a regular Raspberry Pi into a fully-fledged home server for photos, storage and media streaming – in half an hour or less. We're using the new Raspberry Pi 3 Model B+, but the instructions are the same if you're using one of its predecessors. The benefit of the Pi 3 B+, if you haven't yet bought one, is that it has a faster processor and runs cooler. It can still manage with a passive heatsink (around £3) or, in many cases, no heatsink at all, allowing you to keep the server under your TV without being disturbed by constantly running fans.

Initial installation

You can find clear and detailed instructions for setting up a factory-fresh Pi at raspberrypi.org/documentation/setup. The board can run several different operating systems, but we're using Raspbian for the main server functions. We would recommend doing the same if you want to follow along. As the Pi boots from microSD, there's nothing to prevent you installing several different operating systems – including Debian, Ubuntu and OSMC – on separate cards and swapping them as appropriate.

Open Source Media Center (OSMC) is the system that underpins Kodi, so if you want to use your Pi as a streaming device, it's a simple matter of installing this using New Out Of Box Software (NOOBS), the regular installer for setting up a Raspberry Pi. It is, quite literally, a two-click operation, meaning we won't cover it here. Instead, we're going to focus on making your Raspberry Pi accessible remotely and installing ownCloud to create a self-hosted Dropbox-like file and media sharing server.

1 Install Apache

Open the Raspbian Preferences menu and pick Add/Remove Software. This interface greatly simplifies the task of downloading and installing apps without having to use the command line. Search for "apache2" and select Apache HTTP Server from the results. Click Apply to download and install it. You'll need to enter your super user password. If you've left all of the defaults as they are, the super user's username is "pi" and the password is "raspberry".

2 Notice the dependencies

Installation should take less than a minute, although the exact time will depend on your broadband and Wi-Fi configuration. Once that's complete, you'll notice that Raspbian has also installed two further packages containing modules and common files. These are required by the server, so don't uncheck them or you'll run into problems.

3 Test your server

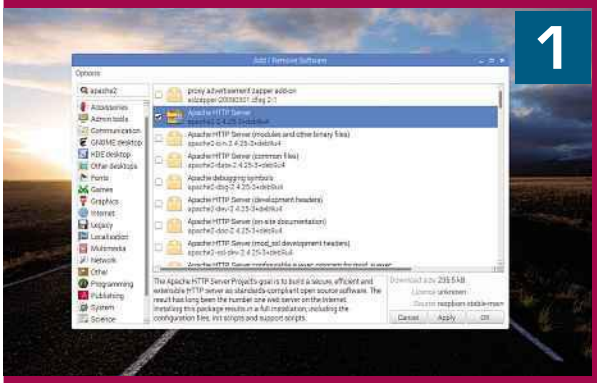
Step 3 is… technically there is no step 3 if all you want to do is set up a web server. Apache is installed and running, as you'll see if you point your Pi's browser at **http://localhost/**. You can also access it from other machines on your local network using its IP address. You can find this by opening a terminal window and typing **sudo ifconfig**. Check the "inet" value for the interface through which it's connected to your network. In our case, that's "wlano" – the Pi's Wi-Fi interface.

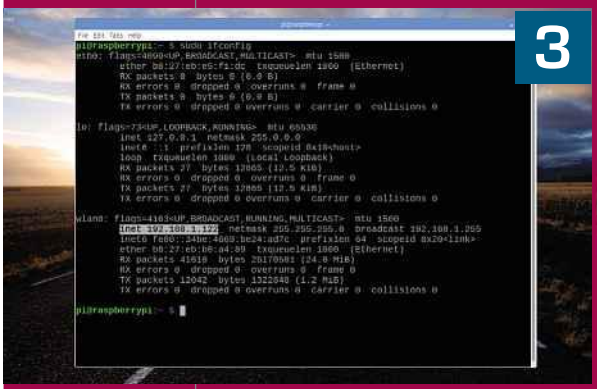
4 Set permissions

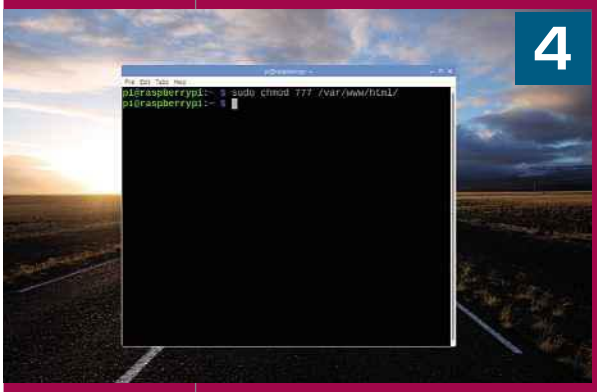
If you want to create a regular HTML site, without PHP or a database, save your HTML files to "/var/www/html/". At the moment, it contains just an INDEX.HTML file, which you'll need to replace or overwrite to make your changes. Before you can do that, though, you need to change the folder's permissions. Open a terminal window and type **sudo chmod 777 /var/www/html/**, which grants read and write permissions to all users.

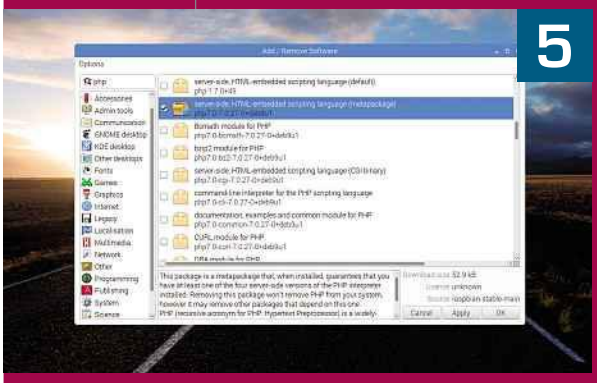
5 Install PHP

So far, our web server is functional but basic. If we're going to run an application such as ownCloud, we need to add PHP. Again, this can be done through the Raspbian UI. Return to the Add/Remove Software app and search for PHP. Select and install "server-side, HTML-embedded scripting language (metapackage)". This appeared second in the list of









results for us. You'll need to provide your username and password again to proceed.

6 Install MariaDB

Our server now has a modicum of intelligence, but running ownCloud requires a database to keep track of which files we've shared and where they are. In this case, we're going to use MySQL/MariaDB, which we'll install from the command prompt by opening a Terminal window and typing **sudo apt-get install mysql-server python-mysqldb**. It should only take a few seconds to complete.

7 Provide a password

We now need to set up a user account. You can create as many as you want but, in this case, we're going to create the root user with the command **sudo mysql -u root -p**. Once you hit Return, it will ask you to provide a password. However, this won't be shown onscreen as you type it, so be careful to enter it correctly. Once you've provided the password that you want to use, hit Return again to continue.

8 Authorise your account

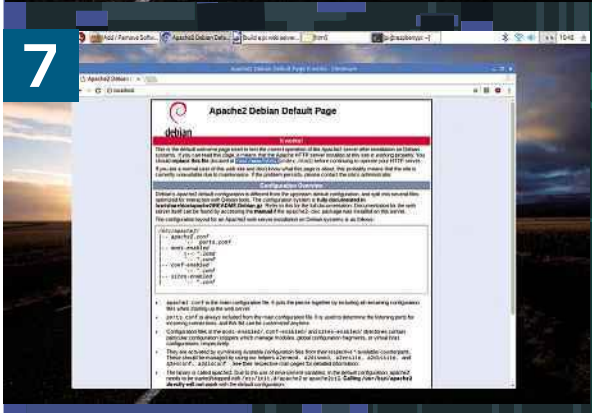
With the user set up, we need to give it permission to actually manipulate the server. Without that permission, it won't be possible to create, delete and amend databases, tables or their content. While still in the MySQL/MariaDB environment, type "GRANT ALL PRIVILEGES ON mydb.* to 'root'@'localhost' IDENTIFIED BY 'xxx';" (without the double quotes, but with the single quotes, and replacing xxx with the password you used in step 8). Press Return.

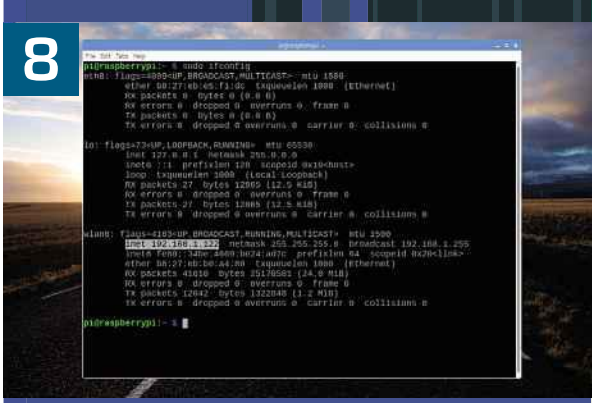
9 Install phpMyAdmin

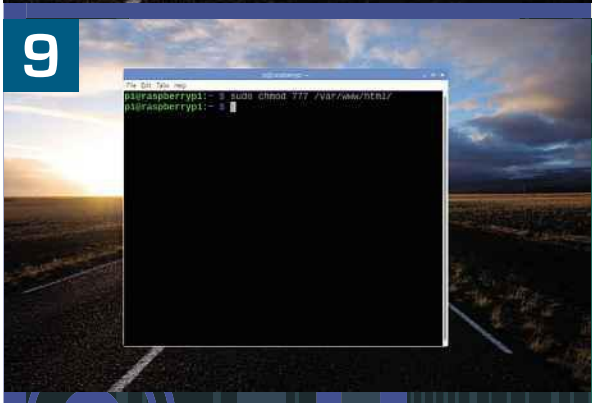
We now need to set up the database itself, which we can do through phpMyAdmin. Point your browser at **phpmyadmin.net** and download the latest build. Extract the files and place them in the root of your web server (the folder "/var/www/html/"). You then need to associate phpMyAdmin with Apache, so open a terminal window and type **sudo nano /etc/apache2/apache2.conf**.

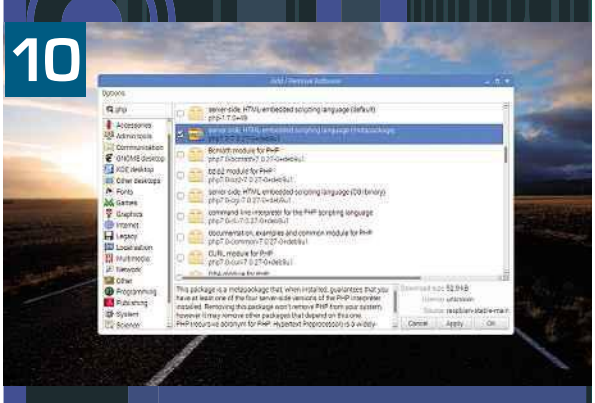
10 Save and restart

Scroll to the bottom of the configuration file and add "Include /etc/phpmyadmin/apache.conf" on its own line, without the quotation marks. Save the file by pressing Ctrl+O, then quit Nano with Ctrl+X. Restart the web server with the command **/etc/int.d/apache2 restart**. You can now log in to phpMyAdmin by pointing your browser at **http://localhost/phpmyadmin/** and using the credentials specified in step 8.









11 Create a new database

We've almost finished configuring the database server and can soon move on to installing our content management system. First, though, we need to create a database for its contents. We'll do that by clicking New in the phpMyAdmin sidebar and providing a name in the "Create database" field. We're going to install ownCloud, so we've chosen "owncloud", but if this is taken you can use anything else.

12 Forward web traffic

The instructions for this and the next step are device-specific. We're using a Plusnet Hub, which is a rebranded BT unit and shares the same layout. Whichever router you're using, look for a Port Forwarding setting, which may be in an advanced section. Once you find it, set HTTP traffic to arrive at your Pi. On the Plusnet/BT router, you can select the Pi from a list of clients on the network. Certain routers may require the Pi's IP address instead.

13 Set up the IP updater

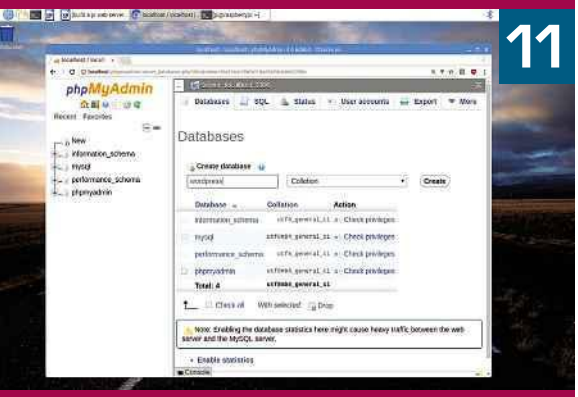
We're going to use No-IP's free forwarding service at **noip.com**. Having provided the details it needs to set up the free account, and chosen a hostname, we'll follow its own comprehensive instructions for installing the update client on our Pi (**noip.com/support/knowledgebase/install-ip-duc-onto-raspberry-pi**). This monitors our network's external IP address and updates the No-IP servers when it spots a change. That means any traffic landing on our dynamic address forwards to our local network, at which point the router redirects it to the Pi.

14 Download and install ownCloud

Point your browser at **owncloud.org/download**, scroll down to the Download TAR button in the Tarball section, right-click and copy the address. Open a new terminal window and type **wget**, before pressing Ctrl+Shift+V to paste the address you copied from the openCloud site. Hit Return to download the package and make a note of the resulting filename.

15 Relocate and unpack your files

When the download completes, move the file to the "/var/www/html" folder by typing **copy mv <filename> /var/www/html/**. Navigate to the HTML folder (**cd /var/www/html**) and unpack the archive with **sudo tar xfj <filename>**.



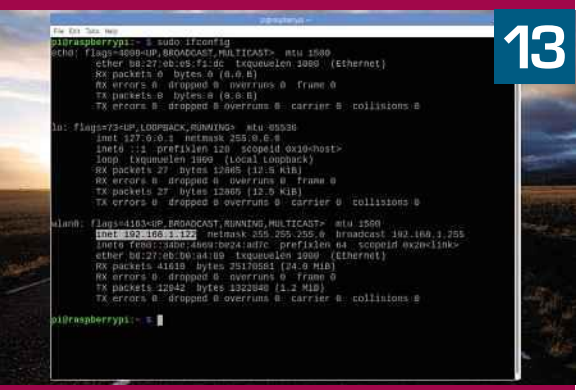
This creates an ownCloud folder with the unpacked files. Copy them to the root of the server with **sudo mv /var/www/html/owncloud/* /var/www/html/**.

16 Create your account

OwnCloud is installed. Now you need to set it up. Start by giving Apache permission to access the ownCloud files by typing **sudo chown -R www-data /var/www/html/** then restart the server to implement the change by typing **sudo service apache2 restart**. Now point your browser at "<IP address>/owncloud" and fill in the details.

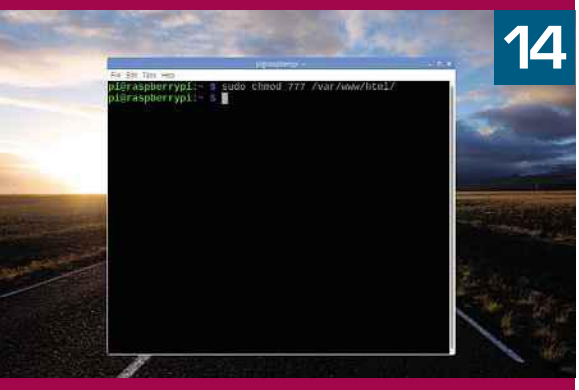
17 Log in for the first time

OwnCloud will take a few seconds to build its configuration file, then return you to the login prompt. Enter the username and password you specified earlier. Once inside, click your name on the top bar and pick Settings, then set a recovery email in the first section of the first page. This is also the page you'll return to when you need to change your password.



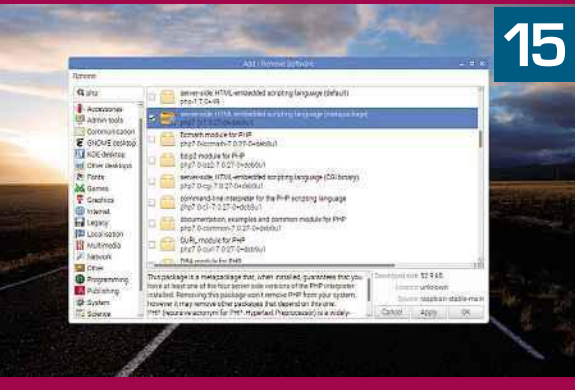
18 Connect via WebDAV

Our server is running properly, so let's connect remotely. OwnCloud has a built in WebDAV server, which we'll use to connect from Windows. Download any WebDAV client from the Microsoft Store and use your Pi's IP address and the username and password to log in. You can now manage your files and photos from any local PC or access the server via the browser using the Pi's IP address.



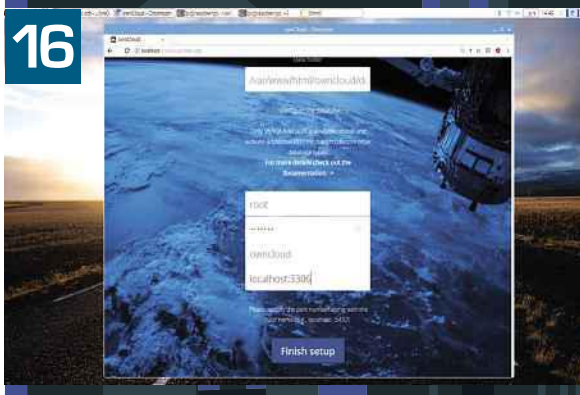
19 Try – and fail – a remote connection

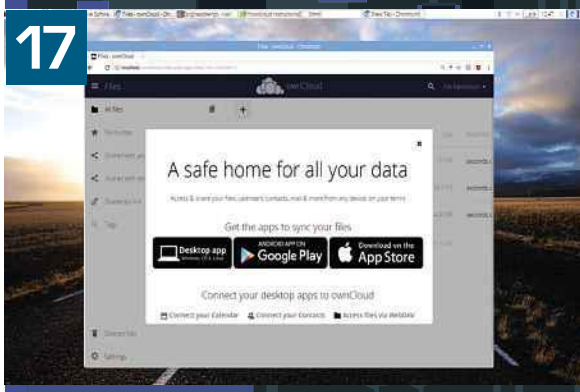
The IP address won't work externally as it sits behind your DHCP server, so to connect remotely you'll need to use the dynamic domain name that you set up earlier. In our case, that's "pcpro.hopto.org" but, as you can see from the screenshot to the right, typing that in throws up an error. As the domain hasn't been permitted, ownCloud blocks it.

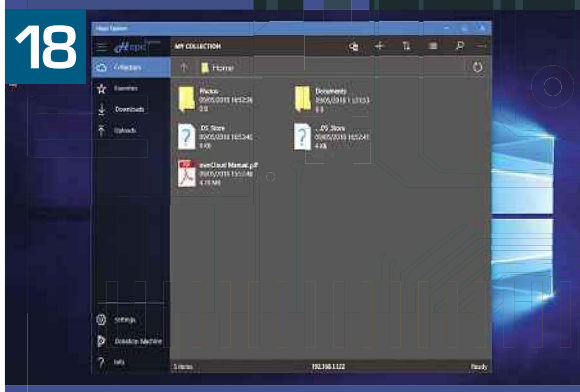


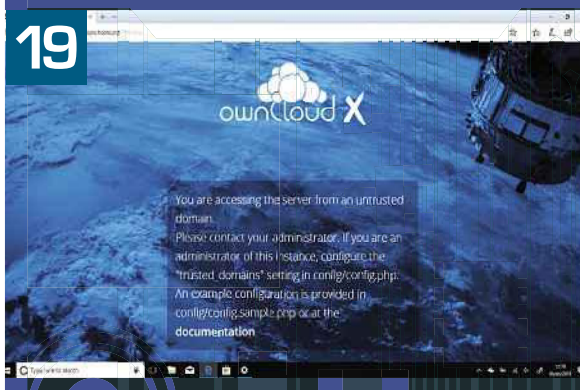
20 Fix the remote connection issue

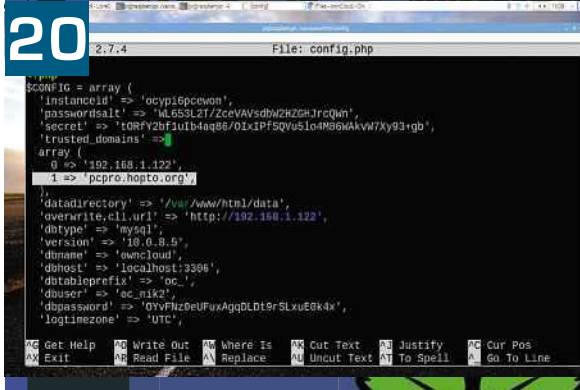
Back on the Raspberry Pi, we type **sudo nano /var/www/html/config/config.php** and add **pcpro.hopto.org** (swap this for your own dynamic URL) in the trusted servers section of the configuration file. We then use Ctrl+O to write the amendment to disk and Ctrl+X to exit the Nano editor. If we return to Windows and try accessing the server using the dynamic domain name, it now works perfectly. Job done!





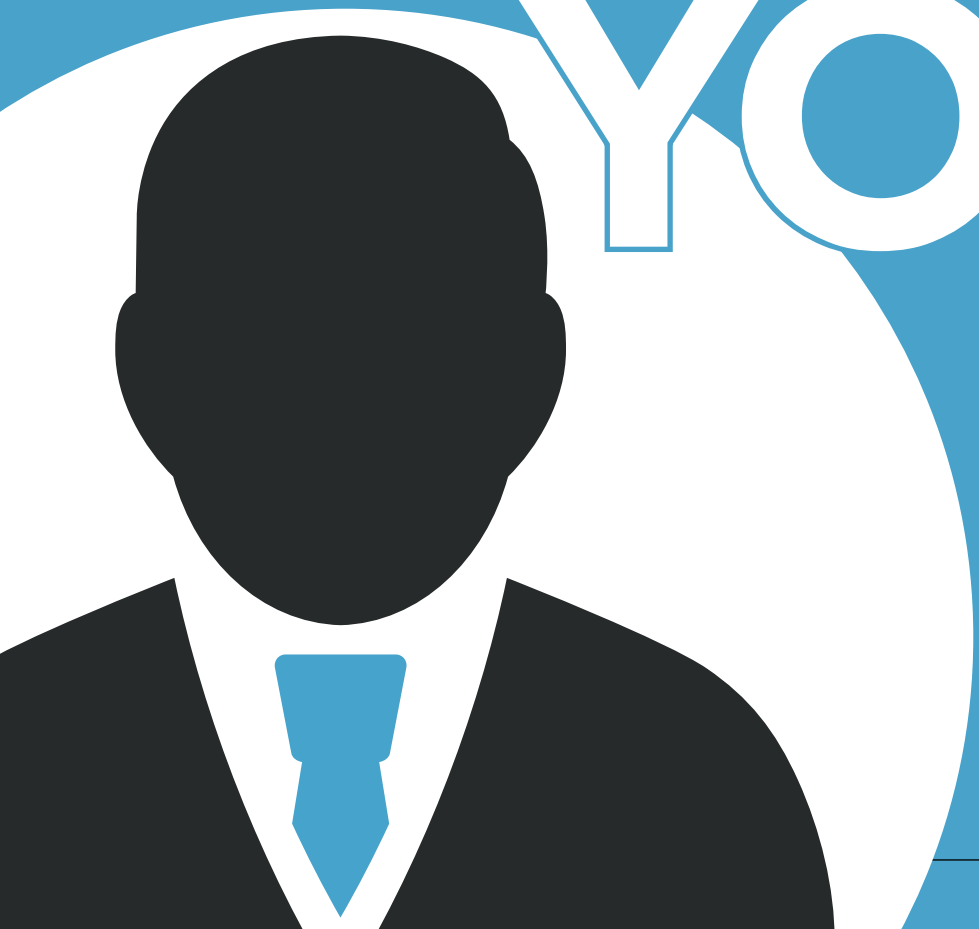






WHAT DOES YOUR BOSS KNOW ABOUT YOU?

Think your private messages on work systems are safe? Think again. Barry Collins explores what your boss can see on Slack, G Suite and Office 365



Take a good look through your employment contract. Chances are that, tucked somewhere within, you'll find a clause letting your company monitor your electronic communications. But now that most of our communications live in the cloud, what can your company see?

Has the ability of your boss to snoop on your private messages been diminished now that the content doesn't sit on the company's own servers? Or is it easier than ever to scour private conversations that take place on 'work' systems?

Here, we dive deep into the admin panels of three of the most used business communications platforms to give you an insight into the communications monitoring tools available to IT admins. You may be shocked to discover what your boss can see.

SLACK

Slack has largely replaced email for internal communications within many companies. But, while most employees will be aware that their email can be read by their employer – a condition normally stated in contracts of employment – what about their Slack messages? Especially those posted in private Slack channels?

The extent to which your boss can read your Slack messages will depend on their appetite to pay for the service.

Slack has infiltrated many organisations from the ground up, with many teams still using the free tier – especially if it's not officially supported by the IT department. (In many small organisations, there's no such thing as an IT department in the first place.)

On the free tier, teams only have access to their past 10,000 messages. The rest are bundled into an unreachable archive, which Slack doesn't delete, because it uses access to the archive as a carrot to induce companies to subscribe.

Admins can search and export content from any public Slack channels, even on the Free tier. Public channels are all those listed under Channels in the Slack interface that don't have a padlock next to their name (the indicator of a private channel only open to selected users).

On the Free and Standard tiers, it's not ordinarily possible for Slack admins to search for direct messages between team members, unless they themselves were privy to the conversation in the first place. Direct messages can be sent between two or more employees, and effectively act as private channels.

Free and Standard tier admins might not be able to see direct messages, but they can still tell if there's a lot of private chatter going on. Slack analytics display a graph that shows the percentage of daily communication in public, private and direct messaging channels. If the boss can see a high percentage of chatter in direct messages, that might encourage them to probe further.

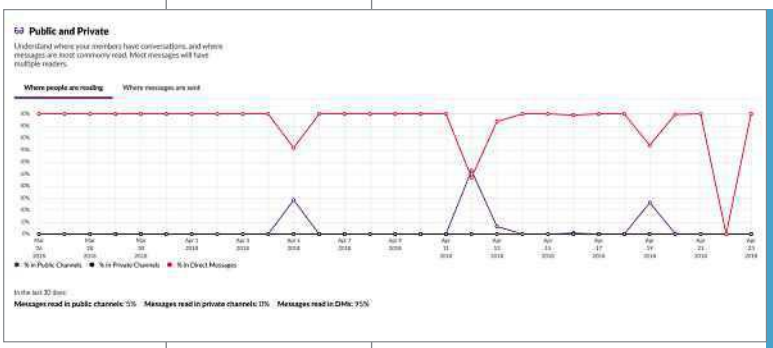
If Free and Standard tier admins do want to access private conversations between employees, they would have to apply directly to Slack. Slack says it "will reject applications, unless Workspace Owners show in each instance (a) valid legal process, or (b) consent of members, or (c) a requirement or right under applicable laws in order to export data".

If your company pays for one of Slack's Plus or Enterprise plans, however, the ball game changes. Paid subscribers can perform what's known as a Corporate Export, which Slack describes as "a self-serve export tool that permits a Workspace Owner to export content from private channels and direct/group messages as needed and permitted by law".

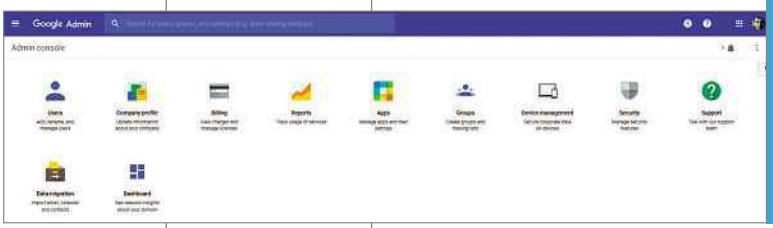
While Slack once again insists that the Workplace Owner must "ensure that (a) appropriate employment agreements and corporate policies have been implemented, and (b) all use of Corporate Export is permitted under applicable law", note that key phrase "self-serve tool". There's nothing in practice that prevents IT admins or managers exporting and skimming through private messages. Such conversations are exported as JSON files, with conversations in the following format:

```
{
"type": "message",
"channel": "a123456789",
"user": "u1234565789",
"text": "Hello world",
"ts": 1234567.123456"
}
```

That means it would be the work of moments to do a keyword search for a particular name or phrase, and identifying the person behind a user ID wouldn't be difficult.



BELOW Slack administrators are given a graph that breaks down the percentage of daily messages in public, private and direct channels



ABOVE In the most basic G Suite plan, admins can't read your emails, but they can search the logs to see who you're emailing and the subject line

So how do you know if the boss is exporting your private conversations? Under its old Compliance Report system, Slack used to notify users if there was a chance their private messages could be read.

Now you have to go to **slack.com/account/team**, log in and read the notification at the bottom, which reveals the type of data that can be exported from your company's Slack account. If private messages are listed, it might be better to use WhatsApp or some other private channel to plot the overthrow of your manager…

There is one potential saviour for Slack plotters. Paid-for Slack accounts can allow users to set their own private channel and direct message retention policies. This means you can click the settings cog in any private or DM channel and have the messages routinely purged in as little as 24 hours. This is a permanent deletion and means the message won't be retrievable by admins. However, admins need to explicitly switch on this option – it's not on by default. If your company is the kind of employer to go poking around your private messages, it's hardly likely to switch this on in the first place.

GMAIL

It may come as a surprise to people who work for companies using Google as their email provider that employers can't routinely read emails – at least, not on the most basic G Suite plan.

G Suite Basic admins can search email logs, to see what their users are receiving and sending, and even narrow down those searches to specific recipients, senders or subject lines. If a company wanted to show that Employee A had been harassing Employee B by barraging them with email, for example, the audit logs could be used as evidence.

What those audit logs don't show is the content of messages. That doesn't mean that G Suite admins have no way of searching through employees' inboxes, as Google's support staff cheerfully explained to me when I asked for a way to search employees' emails from the admin console.

"Barry to answer your question, you can reset users' passwords… and then you'll be able to access users' inboxes," support desk Daniel said. This, of course, will lock the employee out of their inbox, so if you've ever found your work Gmail mailbox password has been mysteriously reset, you might wonder what the IT admins have been up to.

Once they have access to your inbox, admins can also set themselves up as a "delegate", allowing them to read any messages sent to or by you. But you'd be able to see who's been afforded delegate access in your Gmail settings – if you ever bothered to look.

Those companies on the more expensive G Suite Business and Enterprise accounts need not resort to such underhand measures. These tiers get access to Google Vault, which archives all the email accounts in the firm's domain on Google's servers.

Crucially, this lets the company search the content of email by keyword – and not only email, but Drive files, Hangout chats and Google Groups messages, too. As Google's support files helpfully explain: "When you open an email or chat message, the thread's entire conversation is displayed. For very long threads, only the most recent 100 messages are included in the preview. You can't preview earlier messages from the thread. However, all messages that match your search criteria are included when you export."

Even the criminals' favourite technique of saving messages in Drafts so that they can't be intercepted on their way to recipients is thwarted by Google Vault. Indeed, the help files suggest that you have to specifically exclude drafts from a search if you don't want those results to be returned.

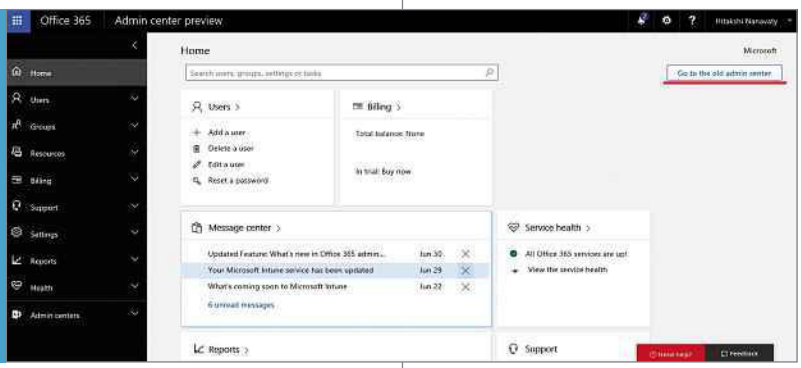
OFFICE 365

Office 365 admins have much the same ability to plough through employees' email as G Suite overlords.

Office 365 doesn't even force you to pay for the higher tier products before handing businesses the ability to search through employees' emails. It's a standard part of the Office 365 Business admin centre.

Usage reports let admins see when users are accessing their mailbox, OneDrive, SharePoint or Skype services, although these reports merely highlight the frequency with which they're being used, not the nature of those communications.

To look for specific keywords in mailboxes, admins can run a content search in the Office 365 Security & Compliance Center. As with the Google Vault, this not only covers email, but SharePoint Online and OneDrive for Business sites, Skype for Business conversations, Microsoft Teams and Office 365 Groups.



LEFT In Office 365, admins can monitor when you access your mailbox and can also search the whole company for specific keywords

Admins can search specific inboxes or the entire company, and as Microsoft's help files explain: "After you run a search you can preview the results, get keyword statistics for one or more searches, bulk-edit content searches, and export the results to a local computer."

Office 365 lets admins perform relatively complex searches, so they can drill down to very specific pieces of information. "You can specify keywords, message properties such as sent and received dates, or document properties such as file names or the date that a document was last changed," Microsoft states. "You can use more complex queries that use a Boolean operator, such as AND, OR, NOT, NEAR, or ONEAR. You can also search for sensitive information… in documents, or search for documents that have been shared externally."

Microsoft's search results even deliver detailed statistics. Say you've searched the company's mailboxes for a particular keyword: the search results can be sorted to show the mailboxes with the greatest number of hits at the top, for example. Big Brother has never had it so good.

WHAT DOES THE LAW PERMIT?

While there are few technical barriers in the way of employers monitoring messages, what about the legal barriers? Are they allowed to look for whatever they want provided you're using a work account?

Companies are legally permitted to monitor communications provided that the surveillance is business-related, that the equipment (or service) is being provided for work purposes, and that the company made "all reasonable efforts" to inform you that your communications may be monitored. But your firm doesn't have to tell you when it plans to search your inbox, just that it might do so at some point. This is normally covered off with a clause in the employment contract.

Firms also don't need to seek your permission to monitor communications if they can show that they were doing so to

- **check that work procedures or standards are being met**
- **prevent or detect crime, or is in the interests of national security**
- **check for unauthorised use of comms systems, such as personal email or internet use**
- **maintain the system (eg virus checking)**

To give an example of how communications can be lawfully monitored, take the case of the Essex police officer who was dismissed in December last year after he was caught using his work email to drum up work for his side business as a photographer. He was also found to have used the police email address to try to get out of two parking tickets.

Last November, a primary school teacher in Walsall was sacked after he admitted to using school equipment to send personal emails "of a sexual nature". The teacher had apparently ignored previous warnings not to send personal emails from work computers but had ignored them. The matter was reported to the police, but he wasn't found to have done anything illegal and has been allowed to remain in the teaching profession.

But the European Courts seem to suggest that dismissal for such an offence may not be warranted. Last September, the European Court of Human Rights backed Romanian Bogdan Barbulescu, who was sacked in 2007 for exchanging messages about his sexual health with his fiancée from his professional Yahoo Messenger account, which was being monitored by his employer.

The ECHR ruled that an employer "cannot reduce private social life in the workplace to zero. Respect for private life and for the privacy of correspondence continues to exist, even if these may be restricted in so far as necessary."

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- Parental advisor
- File encryption
- Anti-theft protection

Android protection

- On-install app scanning
- Full speed and low-battery impact
- Web security
- Privacy advisor
- Anti-theft protection

macOS protection

- Cross-platform antivirus protection (don't spread threats)
- Adware blocker
- Time Machine protection
- Anti-phishing tools
- Secure online shopping
- Ultra-fast automatic protection

3CX HACKS

How to create private online meetings

Give your online meetings a professional aura by making them personal – and allowing employees to add a unique invite on their business cards

It doesn't matter if you're a one-man band or IT director of a 10,000-seat enterprise: you want all your business meetings to appear professional. While you can't pretend your offices are in The Shard in real life, when it comes to online meetings there are several ways to ensure everyone involved comes away with a positive view of you and your company.

That means presenting a slick, professional image from the moment you send the invitation until you sign off. In an ideal situation, you'd be sitting in a conference room, croissants at the ready, with no chance of interruption. But real life isn't like that. Often, the only time you can make a call is when you're at home; as we'll see, that doesn't mean you should sacrifice professionalism.

Private rooms

One way to stay professional is to emphasise privacy. 3CX includes the concept of private rooms, where it's clear that you're in a one-to-one conversation. This lets you have all the benefits of a professional videoconferencing system – sharing desktops, recording options, video calling – but with the knowledge that it's just the two of you talking.

Want someone else to join the meeting? No problem. Whether it's during the call or before it, inviting other people to join the meeting is a simple task.

Click2Meet

Another way to stay professional? Make the whole experience feel tailored to your company, not an off-the-shelf option. For example, one of many benefits of 3CX Phone System is that it offers a personal Click2Meet option. And it's free, too. Everyone you add to your 3CX system will be given their own Click2Meet URL that they can personalise. That means, if Kate Jenkins works for your company Acme, she can edit her URL to read **acme.3cx.net/join/katejenkins**.

Kate could then add that link to her business cards and email signature. If anyone wanted to request a meeting, they would simply enter that URL (*see "How to set up a private online meeting" opposite*).

Your caller doesn't need to install any software. As 3CX uses WebRTC, so long as they're using Firefox, Chrome or Opera, they'll be able to log straight into the call.

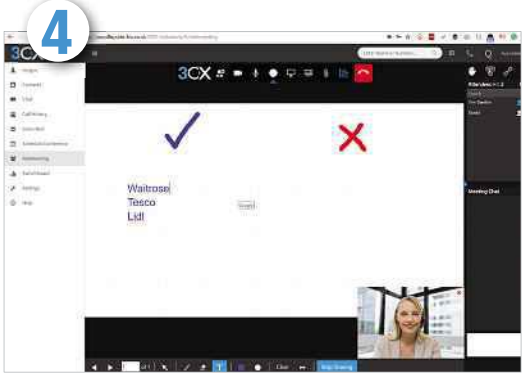
RIGHT As the admin dashboard indicates, 3CX is a serious tool with plenty of power and features when you need them

How to set up a Click2Meet meeting

Let's assume you've already arranged the time to have your meeting. All you need to do is log into the 3CX web client and click WebMeeting. The meeting will start automatically.

Your caller enters the address into Opera, Chrome or Firefox. They will be prompted to enter their name and confirm usage of microphone and webcam.

At this point, your caller will see a lovely image of you, so it probably makes sense to check that your location – and indeed you – look suitably professional before you begin.



You're ready to go. You can share screens, switch the webcam on or off, send chat messages and draw on a whiteboard – collaboration has never been easier.

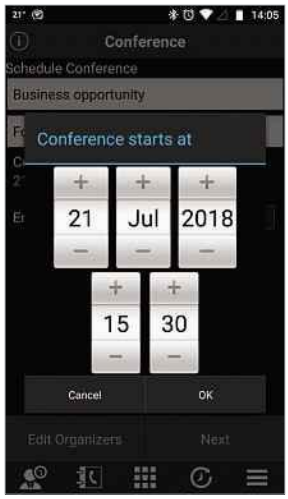
Scheduling meetings

It's also possible to schedule a meeting, complete with an invitation that slots into people's chosen calendar. They click accept and the calendar entry will pop up at the appropriate time, with a unique link and sign-in code.

Inviting colleagues is a simple matter of starting to type their name and clicking Add. For external people, all you need is an email address.

Once the meeting starts, you can share your screen, take remote control of someone else's system (they will need to download the 3CX Remote Control Extension and give their consent) and share documents. These are automatically put into a shared documents repository, but you can stop sharing if you wish.

A final useful feature (which is also available in Click2Meet meetings) is the whiteboard. Obvious usages include brainstorming, collaborating on ideas and online classrooms. And, as with Click2Meet, you can easily add more people by email or create a link that can be shared on social media.



LEFT **It's easy to schedule a meeting date for the future – just pick a time and send the invite**

Beyond VoIP

So far, so easy, but don't let this simplicity fool you: 3CX offers tools that go way beyond what consumer VoIP services provide. A better comparison is with the enterprise communication tools that used to cost tens of thousands of pounds.

For example, install 3CX across your business and you will add presence information to people's contacts. That's obviously useful for remote employees, but also allows people to set "do not disturb" statuses.

A built-in chat tool makes it easy to instant-message someone: you don't need to install a third-party messaging service – simply send text-based messages and links in a familiar chat interface, whether people are using a Mac, Windows, iOS or Android device.

If you're still receiving faxes, get them forwarded to an inbox as a PDF. And there's no need to mess around with pressing a series of digits on your phone to listen to voicemails: they're converted to audio files and emailed to the relevant person.

3 WAYS YOU CAN HOOK UP IN 3CX

Direct phone call
It's as simple as 123 – or whatever you want the extensions to be. This translates into a direct dial number and, whenever someone calls, they'll be put straight through – whether that's to the person at their desk or using the phone app when out of the office.

Click2Meet
As we've already seen, it's straightforward to personalise a Click2Meet email that your employees can share on their business cards. You also have all the conferencing tools to play with – including video, shared screens, remote control and call recording.

Video conference calls
Want to set up a group call? No problem. In fact, you have all the tools you need to host a webinar, all without participants having to download any additional software. People can even join in on iOS and Android phones by downloading the 3CX WebMeeting app.

Download 3CX FREE at www.3cx.com

Windows 10

April 2018 Update

Don't expect epic new features, but this is an entirely positive upgrade that makes Windows 10 less annoying

PRICE Free **for existing Windows 10 users from windowsupdate.microsoft.com**

The latest major update to Windows 10 – the fifth since its original release in 2015 – is here. Clearly Microsoft continues to take seriously its promise that Windows 10 will be a constantly evolving platform, with new free features coming along at regular intervals.

The official name "April 2018 Update" doesn't make any grand claims, but it's more unambiguous than some of the airy previous names such as the "Anniversary Update" and the "Creators Update". It wouldn't be Microsoft if there wasn't a small catch, though: while Microsoft did make the update available on 30 April 2018, the nature of Windows Update means the vast majority of users didn't get the opportunity to upgrade until well into May.

The other nature of Windows Update means that you may have been covertly upgraded to the new version by now. So which features are worth exploring? And which should be ignored?

Timeline

The big new feature in the April 2018 Update is Timeline. If that sounds familiar, it's because it was originally supposed to be in the Fall Creators Update, released last October, but was held back for final polishing.

You access Timeline by pressing Win+Tab, or clicking its icon – which replaces the old Task View icon next to the Search bar. Either way, you'll be greeted with a full-screen calendar view showing the applications and documents you've been using

today, yesterday and in the more distant past. Click on one and Windows will reopen that document, ready for you to resume work.

It seems like a great idea: when I sit down at my computer, my mind goes to the project I want to work on, rather than the application I need to open. And the implementation is slick, with nice big thumbnails and previews of recently accessed files (including Office 365 files that you've opened on other devices).

It remains to be seen whether Timeline will be a game-changer, however. At the very least, it will take some getting used to: personally, it feels jarring when an interface takes me completely out of the desktop – remember Windows 8, anyone?

Right now, there's also the issue that not all applications work with Timeline: developers will have to update their applications to make them compatible. Currently, I can hop back into editing yesterday's Word document, but the audio projects I've been working on in PreSonus Studio One don't show up.

There's also the small fact that an increasing proportion of my day's work is done in a web browser. Timeline has a good bash at guessing which pages you might want to go back to, but it didn't manage to capture a complete record of the various Google Docs I'd been editing. Still, there's no reason why that can't be addressed in the future.

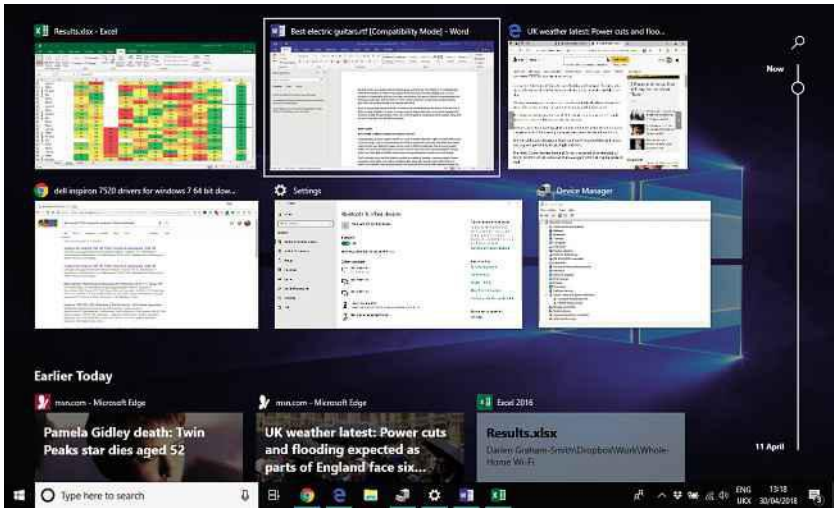
Productivity enhancements

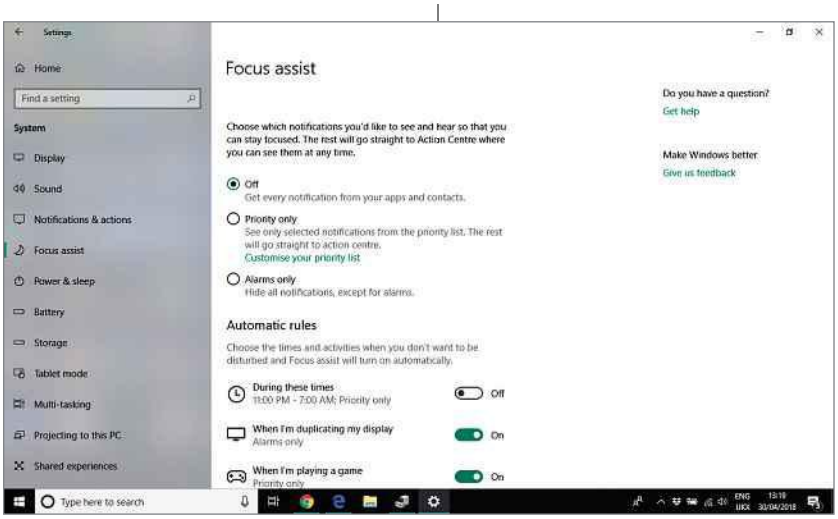
Focus assist may sound like a feature you'd get on a camera, but it's an enhancement of Windows 10's Quiet Hours tool. You can now engage Focus assist whenever you need to get a bit of work done, or set it to come on automatically between certain times, or when you're mirroring your screen or playing games.

When Focus assist is active, notifications will be temporarily silenced – although you can still nominate priority individuals whose communications will get through. And when you turn off Focus assist, you'll get a summary of all the notifications that were suppressed.

It's not a bad idea: the only problem is that, while it can stop emails and Slack notifications from popping up on my desktop, it can't do anything to stop the same alerts popping up on my Android phone. If Microsoft had managed to make a success of Windows 10 Mobile, and had built the integrated platform it originally envisioned, Focus assist might have been much more powerful. But the company has had to settle for using the Cortana app for Android and iOS as a bridge between the desktop and mobile worlds. Perhaps the Android app will be updated to integrate with Focus Assist; I suspect that will be impossible on iOS.

It's a similar situation with Nearby sharing, a new feature that lets you beam files directly to and from compatible Windows 10 clients. It's a pretty obvious copy of Apple's AirDrop, but there's no shame in that: it's an easy way to quickly move the odd file from a desktop to a laptop. Once again, what's lacking is support for mobile devices – which is disappointing, because the awkwardness of getting files from your smartphone onto your PC is surely a more general frustration.





A final interesting feature is a new hands-free dictation mode. Press Win+H and... well, for most of us, probably nothing will happen. But if you're running the US English edition of Windows, it will pop up a dictation window that lets you talk directly into applications instead of typing.

The technology will no doubt come to the UK soon enough but, again, I wonder whether it's really going to be useful. Voice control is great for barking short orders at Alexa, but when it comes to anything longer, composing out loud is actually pretty challenging – and that's assuming you don't have to worry about background noise or easily disturbed colleagues.

Appearance and Settings

You might not immediately notice it, but Windows 10 brings subtle changes to the appearance of the desktop. The concept is called Fluent Design, and what it most visibly means is that some windows become slightly translucent, so you can see soft hints of the colours and content beneath them. New design guidelines promote the use of lighting and depth effects to help convey the relationships between controls. Bluntly put, it's a step away from the flat, featureless Windows 8 style, and back towards the shinier Windows 7 Aero way of doing things – a move I wholeheartedly applaud.

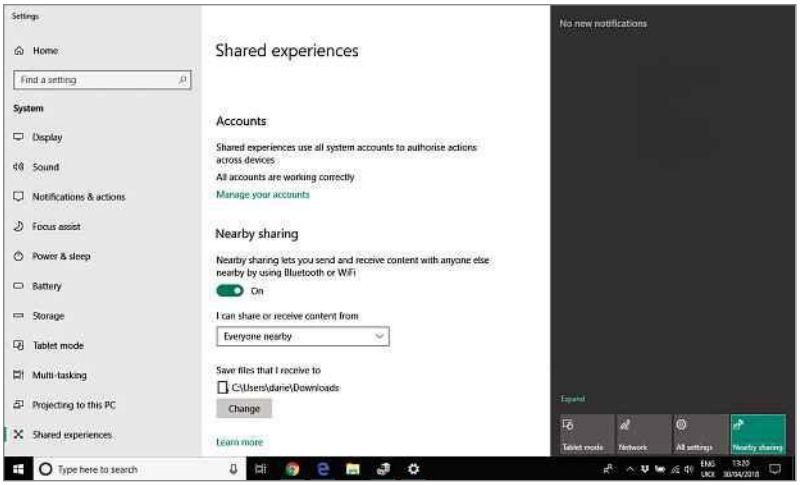
TOP The new Timeline feature allows you to quickly hop back into a recently accessed file, but it only works with certain applications

ABOVE Easily distracted? When active, Focus assist mutes notifications for a period of time

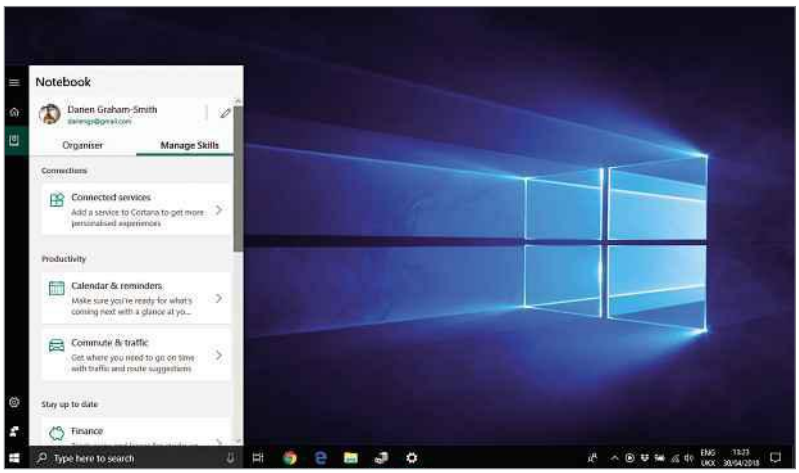
"The concept is called Fluent Design, and what it most visibly means is that some windows become slightly translucent"

The visual revamp is particularly noticeable in the Settings app, which is finally starting to look and feel like a mature and coherent successor to the Control Panel. The various pages now have a tasteful two-tone design, with a grey sidebar, and more features that were previously scattered about the OS have now been migrated into the app's various pages. These include Sound settings, the Disk Cleanup tool, the Startup Items manager, font options and new per-app graphics options. These allow owners of dual-GPU systems to specify which programs should make use of the dedicated graphics chip and which should always use CPU graphics.

There's one page you'll look for in vain, though: the HomeGroup feature has finally been removed from



LEFT Nearby sharing owes a lot to Apple's AirDrop, but it's a simple way of pinging a file from a desktop PC to a laptop



LEFT The Cortana Notebook page has been given a lick of paint, making it easier to manage connected services

Windows. That feels like a shame, as there are surely more households than ever wanting a straightforward way to share files across their home networks. But perhaps it had become an anachronism in these days when the devices on those networks are as likely to be running Android or Chrome OS as Windows.

Cortana and Edge

I haven't heard of anyone seriously using either Cortana or Edge for more than experimental purposes, but they're core parts of Windows 10, and they certainly haven't been forgotten in the latest update.

For example, Cortana's Notebook page has been revamped: you can now switch between the Organiser tab, which shows your immediate lists and reminders, and the Manage Skills tab, which offers quick links to connected services, your calendar and more.

The Edge browser, meanwhile, gains support for so-called Progressive Web Apps (PWAs). Basically, these are apps that run in the browser but behave more or less like native programs, and don't necessarily need an always-on internet connection. Microsoft sees these as a big up-and-coming deal, and it's also going to start hosting them in the Windows Store alongside UWP apps – although part of the point of PWAs is that they should run on any platform, and in any compatible browser.

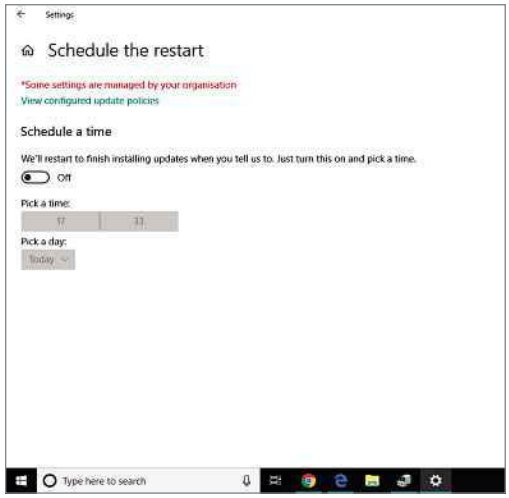
Edge continues to catch up with other established browsers with the addition of automatic form-filling capabilities, and the ability to mute tabs that insist on playing unprompted audio. There's also a welcome Clutter-Free printing option that saves paper by skipping over ads. It would have been nice if Edge had been given these features when Windows 10 first came along three years ago, but they're here now.

Windows Update update

Lastly, it's worth mentioning that this latest Windows update updates Windows Update. Or, to put that another way, the April 2018 Update brings some changes to the way that Windows 10 downloads and installs updates.

For a start, Microsoft has noted users' frustration with the way that updates seem to appear at unpredictable times, and the pushy way in which the OS then tries to force you to update. As of the April 2018 Update, you'll see an icon in the system tray advising you when there's an update ready to be installed – another welcome throwback to Windows 7 – and if you're not ready to deploy it there and then, you can now nominate a specific time for installation. Much more civilised.

Even better, Microsoft has worked to ensure that when a major update comes down the line, much more of the installation can take place in the background while the operating system is still up and running. So when you next go to restart your PC and find that there are updates pending, the interruption should only last a few minutes before you're back at the desktop.



BELOW Microsoft has listened to frustrated users and you can now nominate a convenient time for an update

Spring clean verdict

As well as the major features discussed above, the April 2018 Update brings a sprinkling of small enhancements to Windows 10: these include bandwidth controls for Windows Update, and a new Diagnostic Data Viewer tool that allows you to check what's being sent back to Microsoft. Users of Windows 10 Pro also gain access to Windows Defender Application Guard – a feature previously only included with the Enterprise edition, which effectively runs the Edge browser in a virtual machine to provide extra protection against online exploits.

"The April 2018 Update is another step on a journey through which Windows just keeps getting better and better"

For most of us, though, what we'll mostly notice about the April 2018 Update is its slightly slicker looks, the more comprehensive Settings app and – hopefully – the fact that Windows Update is no longer quite so intrusive.

Those are all positives – yet, it must be said, there's not much here to warm the heart. Perhaps Timeline or the new dictation functions will revolutionise the way you work, but I suspect that they will find minority appeal at best. Perhaps it was smart of Microsoft not to give this update a more presumptuous name.

Still, the April 2018 Update is another step on a journey through which Windows just keeps getting better and better – and every improvement and innovation so far has been completely free. What's not to like? **DARIEN GRAHAM-SMITH**

How we test

Laptops and PCs

We run our own benchmarks on every Windows and macOS system we test. These are based around image editing, video editing and multitasking (where we run the video editing benchmark while simultaneously playing back a 4K video). At the bottom of each laptop and PC review you'll find the system's score in each of these tests, plus an Overall score.

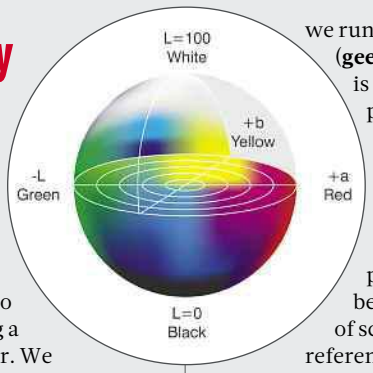
If a laptop scores 70, say, then it's 30% slower than our reference system – a PC with a Core i7-4670K and 8GB of RAM. If it scores 160, then it's 60% faster.

We test laptop battery life by playing back a full-screen video until the battery runs out. We set the screen brightness to 170cd/m², or as close as we can get using its settings, and switch to Flight mode.

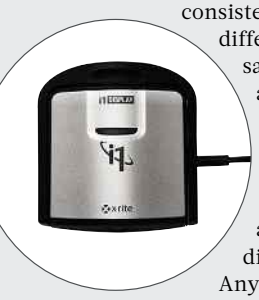
ABOVE We put PCs and laptops through intensive benchmarks and test laptops for battery life

Screen quality

In each laptop, phone, tablet and monitor review you will see our conclusions about the screen quality. Some of this will be subjective, but we also test each screen using a Display i1 Colorimeter. We measure for maximum brightness, colour accuracy and consistency – there may be a difference in brightness, say, from the middle and the edges of the panel.



We also measure Delta E, which gives a guide as to how accurately the panel displays a colour. Anything under 1 is excellent and likely to be difficult for the human eye to distinguish; 1-2 is still strong; above this suggests a panel that you shouldn't trust for colour-accurate photo editing.



LEFT & FAR LEFT To measure a screen's sRGB gamut coverage and Delta E, we use a Display i1 Colorimeter

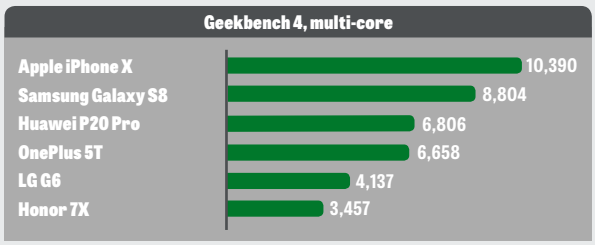
Phones and tablets

We run a selection of publicly available benchmarks on all the phones and tablets we test. First, we run Geekbench 4 (**geekbench.com**). This is a good test of the processor and memory in particular, and includes both a test for single-core and multi-core performance. See below for a selection of scores to provide a reference of what's good... and what's not so good.

We also run the graphics-intensive GFXBench (**gfxbench.com**) to see how well the phones and tablets are likely to perform in games.

As with laptops, we test smartphone and tablet battery life by playing back a full-screen video until the battery runs out. We set the screen brightness to 170cd/m², or as close as we can get using its settings.

BELOW We play back a video, setting the screen to 170cd/m², until the battery runs out to test battery life



What our awards mean

Recommended
This, quite simply, is a product we would recommend you buy – if it meets your needs.

A-List
The best buy in its category right now. The product will also feature on our A-List, starting on p16, updated each month.

Labs Winner
Each month we run a group test, or Labs. This product has managed to beat all others to top position.

The pcpro.link

Throughout the magazine you'll see pcpro.link shortcuts. Enter these into the address bar of your browser and it will take you to a particular page, which will either be too long or awkward for us to publish or will take you to the precise shop from which to buy. If it's Amazon, note that we have an affiliate deal in place so we will receive a commission from each sale. This will never affect our verdict of a product, and if another reputable vendor is selling the product cheaper then we will use them instead.

Prices will vary

Prices we publish are correct on the day we publish, but we often see prices change – especially on sites such as Amazon. However, we do work with British PC retailers to ensure the prices we quote for their systems are correct. If the price isn't being honoured, contact us via letters@pcpro.co.uk.

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Asus ZenBook 13 UX331UN-EG009T

Slender design, impressive performance and accurate stereo speakers make this 13.3in laptop a cracking buy

SCORE ★★★★½

PRICE £917 (£1,100 inc VAT)
from johnlewis.com

While the royal blue finish of the ZenBook 13 may not be familiar on these pages, the fundamental design certainly is. This is the 2018 iteration of the ZenBook UX330UA, which ruled supreme on the A-List for over a year. While the external design hasn't changed, Asus achieves a minor miracle inside by squeezing in Nvidia's discrete GeForce MX150 graphics chip. That's quite an achievement given the ZenBook's slender 13.9mm frame.

With such a slim design, you might expect a limited number of ports – yet that's anything but the truth. Asus has squeezed in two USB 3 Type-A ports, one USB-C (USB 3.1 Gen 2), HDMI, microSD and a 3.5mm jack. Unlike the Dell XPS 13, Huawei Matebook X Pro, HP Spectre 13 and Apple's 13.3in MacBook Pro, there's nothing missing. And as for wireless connectivity, there's dual-band 802.11ac Wi-Fi (2x2) and Bluetooth 4.2. Bravo, Asus.

The party doesn't stop there. There's a blisteringly quick fingerprint sensor at the bottom right-hand corner of the keyboard for sign-in, which is aided by the integration of Windows Hello. Naturally, there's a webcam, too.

Weighing only 1.12kg, it's easy to lug around with one hand (although, if you're sensitive to such things, you might want to don a pair of gloves before getting too close – the glossy lid attracts a lot of fingerprints). Finally, a set of Harman Kardon-tuned stereo speakers sit underneath the laptop. I found that setting the laptop to Music mode through the preinstalled AudioWizard app resulted in the best audio quality. The speakers are loud enough to fill a small room and sound surprisingly accurate.

BELOW The ZenBook 13 is a featherweight at 1.12kg, making it easy to carry around

Mixed ergonomics

The ZenBook 13's trackpad is superb. The palm rejection works flawlessly, and I liked the fact that you can left-click anywhere on the pad – except, of course, the designated right-click area at the bottom right-hand side. Its accompanying keyboard is similarly refined. It's fully backlit with white LEDs and, as the keys have 1.4mm of travel, there's plenty of feel and feedback – you can touch type on the laptop at full speed and with a minimum of noise.

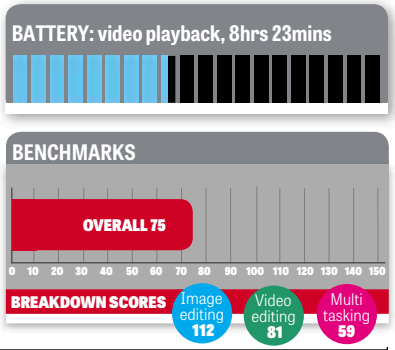
ABOVE The keyboard is fully backlit and there's enough travel for fast and quiet touch typing

The laptop has a 13.3in Full HD matte display with a 16:9 aspect ratio. The thin 6.86mm bezels ensure that the display takes centre stage, but when tested with our X-Rite i1Display Pro calibrator, its IPS panel proved a letdown. The panel only covers 84.5% of the sRGB colour spectrum, which, in comparison to high-end rivals that typically achieve between 90% and 96%, means colours appear dull.

ABOVE Unfortunately, the ZenBook's 13.3in Full HD matte display lags behind those of its close competitors

With an average Delta E of 3.64 and maximum of 9.85, it's not the most colour-accurate of screens either. It's miles behind the Huawei MateBook X Pro's Delta E figures of 1.27 and 2.53, and inferior to the Dell XPS 13, which achieved 2.49 and 7.95 in the same test. Arguably its biggest shortcoming is brightness. With a peak brightness of only 314cd/m², it's quite dim, especially in bright light conditions. Here, the Dell XPS 13 manages 454cd/m² and the Huawei Matebook X Pro 488cd/m².

There are no such issues with contrast, with the Asus' panel delivering a ratio of 1,117:1. However, even here it lags behind those two rivals from Huawei and Dell, both of which achieve contrast ratios of over 1,500:1. In general use, that won't make much of a difference, but a



higher contrast level does help when watching moody films.

Turn of speed

Performance is strong across the board. The UX331UN-EG009T we test here includes a 1.6GHz quad-core Intel Core i5-8250U processor that turbo boosts to 3.4GHz when required. Even with 8GB of RAM – 16GB seems a more apt partner to Intel's chip – it whipped up a score of 75 in *PC Pro*'s benchmarks. That's only one point behind the Huawei Matebook X Pro, which included the faster Intel Core i7-8550U, but significantly behind the Dell XPS 13, which scored 104.

While I haven't tested the ZenBook 13 with a Core i7-8550U, I'm quietly confident that it will be closer to the Dell's score than the Huawei's. The reason? While the Huawei's cooling mechanism struggled to keep the Core i7 chip cool under heavy load, the Asus' cooling is great for a slim machine: it gets to around 90°C across all four cores under full load. The fans can be heard at this point, but they aren't obnoxious.

LEFT Unlike certain rivals, Asus has crammed the full gamut of ports into the slim 13.9mm frame

In Geekbench 4, the Asus ZenBook 13 managed a single-core score of 4,178 and a multi-core score of 14,253. That's very impressive, given that Dell's Core i7 XPS 13 hit scores of 4,744 and 15,047.

Only the 256GB SATA3 SSD lets the side down: it scored 476MB/sec read and 369MB/sec write speeds in the AS SSD sequential benchmark. That's deeply ordinary compared to the Dell XPS 13's 512GB NVMe SSD, which managed a blazing 2,224MB/sec and 444MB/sec in the same tests. That said, in general use, you aren't going to notice the difference.

Where you will is gaming. The Asus' discrete Nvidia GeForce MX150 GPU helped pull away convincingly in the gaming benchmarks. In the GFXBench Car Chase benchmark, the Asus managed an impressive onscreen score of 54fps. By comparison, the Dell XPS 13, which relies on Intel's UHD Graphics 620, achieved only 31.9fps.

ABOVE The ZenBook 13's glossy royal blue lid might look stylish, but be aware that it picks up fingerprints very easily

At 8hrs 23mins in our strenuous battery benchmark, the ZenBook 13 will last around a day or so – as long as you keep the screen brightness below 50%. And even if you do run dry, the fast-charging feature replenishes 60% of the battery's capacity in only 50 minutes.

"The discrete graphics chip puts the ZenBook 13 in another league compared to its competition, while its design, connectivity and speed make it a great all-round machine"

It's not perfect by any means – a faster SSD, 16GB of RAM and an improved display are top of my wish list – but the Asus ZenBook 13 still packs plenty of appeal. The discrete graphics chip puts it in another league compared to its closest competition, while its design, sheer amount of connectivity and turn of speed make it a great all-round machine. In short, the Asus ZenBook 13 is the best value 13.3in laptop you can buy.

CHRISTOPHER MINASIANS

SPECIFICATIONS

Quad-core 1.6GHz Intel Core i5-8250U processor • Nvidia GeForce MX150 graphics • 1,920 x 1,080 display • 256GB SATA3 M.2 SSD • 8GB 2,133MHz LPDDR3 RAM • 2x2 MIMO 802.11ac Wi-Fi • Bluetooth 4.2 • USB-C 3.1 • 2 x USB 3 • HDMI • microSD slot • Windows 10 Home • 310 x 216 x 13.9mm (WDH) • 1.12kg • 50Wh lithium-polymer battery • 2yr RTB warranty (via John Lewis)

HP Spectre 13 (2018)

A classy laptop that's packed with the latest technology, but battery life is beyond disappointing

SCORE ★★★★☆

PRICE £1,165 (£1,399 inc VAT)
from hp.com/uk

When it first went on sale in mid-2016, HP's Spectre 13 nailed the perfect balance of looks, weight and speed. This 2018 update doubles down on the formula. Despite the ultra-skinny chassis, it comes equipped with Intel's latest Core i7 processor and a touch-enabled 4K display, as well as an all-new ceramic white and silver paint job.

Not only does it look gorgeous, but the carbon fibre and aluminium chassis feels sturdy, too. This is despite the Spectre's lithe dimensions, which have to be seen to be believed. At a mere 10.4mm with the lid closed, it's half the girth of the Dell XPS 13 (*see issue 285, p64*) and even makes the 14.6mm-thick Huawei MateBook X Pro (*see issue 284, p57*) look obese. At 1.1kg, it also weighs 100g less than the Dell and 200g less than the MateBook.

What do you sacrifice? Connectivity. There are no old-style USB Type-A ports, with three USB-C ports at the rear instead. But two of these support Thunderbolt 3, and HP bundles a USB-C-to-Type-A adapter and a handy USB-C-to-HDMI dongle.

There's no need to connect a keyboard – typing is a pleasure, with the amount of feedback as good as you'll get from any ultraportable. Its glass-topped touchpad is equally impressive and, while it's a little short, my only complaint is that the click action is on the heavy side.

The Gorilla Glass-covered 13.3in 3,840 x 2,160 IPS display is wonderful. Our X-rite i1 Display Pro colorimeter reported sRGB colour gamut coverage of 95.6% and, at maximum brightness, the HP Spectre 13 reaches 351cd/m², which makes the display usable in all but direct sunlight.

Colour accuracy could be better, with an average Delta E of 2.71 and maximum of 6.07 (lower is better), with the Huawei MateBook X Pro's Delta E figures of 1.27 and 2.53 putting this ultraportable to shame. The Spectre's contrast ratio of 1,497:1 is superb, however, which helps images look punchy onscreen.

The Bang & Olufsen-branded speaker array at the top of the keyboard is also laudable, producing clear and crisp audio with plenty of volume. With a device this small, you often get rattle and buzz from the chassis when the volume is cranked up to full, but that isn't the case here.

HP packs a surprising amount of power, with Intel's quad-core Core i7-8550U processor inside both configurations of the Spectre 13. It was paired with 8GB of LPDDR3 RAM in our review unit, but can be upped to 16GB in the top-end configuration. This pushed it to an overall score of 63 in our benchmarks, which is a stonking 46% improvement over the 2016 model. That said, the Dell XPS 13 – with the same processor and 16GB of RAM – scored 104.

Some of that difference is due to the extra memory, but it's also down to thermal throttling. It's certainly not due to the Samsung-made 512GB NVMe PCIe M.2 SSD, which produced sequential read and write speeds of 1,253MB/sec and 1,037MB/sec in the AS SSD benchmark. That's not the fastest around, but it won't hold you back in daily tasks.

With Intel UHD Graphics 620 on board, the Spectre 13 is a capable gaming machine. I got a slick 55fps out of *Dirt: Showdown* running at 720p with High settings; bumping the resolution up to 1080p still produced a playable 30fps average. The base of the Spectre 13 did get toasty when pushed to such limits, but never uncomfortably so.

Alas, the laptop trips at the final hurdle. It lasted a woeful 4hrs 52mins in our video playback test. I often failed to eke a full day's use out of it on a single charge, no matter how conservative I was with applications. The XPS 13 lasted 10hrs 58mins. Is that enough to damn the Spectre? Not quite, but it tarnishes its appeal.

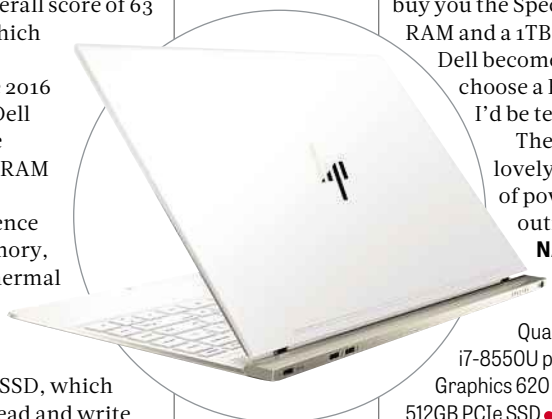
ABOVE The HP Spectre's 13.3in 3,840 x 2,160 IPS display is stunning and covers 95.6% of the sRGB colour gamut

"With a device this small, you often get rattle and buzz from the chassis when the volume is cranked up, but that isn't the case here"

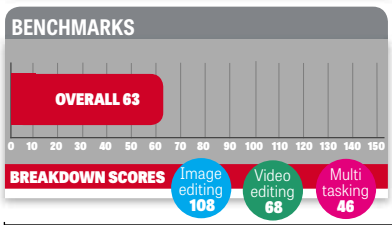
Where it strikes back is the price: at £1,399 for this 8GB RAM/512GB SSD configuration, the closest Dell – with a 4K touchscreen, 16GB of RAM and a 512GB SSD – costs £1,699, albeit with an on-site warranty to the HP's return-to-base offering. That could buy you the Spectre 13 with 16GB of RAM and a 1TB SSD. Then again, the Dell becomes cheaper if you choose a Full HD screen, which I'd be tempted to do.

The HP Spectre 13 is a lovely laptop with bags of power, but it's not an outright winner.

NATHAN SPENDELOW



ABOVE The super-thin carbon fibre and aluminium chassis looks gorgeous – and is easy to lug around



SPECIFICATIONS

Quad-core 1.8GHz Intel Core i7-8550U processor • Intel UHD Graphics 620 • 3,840 x 2,160 display • 512GB PCIe SSD • 8GB 2,133MHz LPDDR3 RAM • 2x2 MIMO 802.11ac Wi-Fi • Bluetooth 4.2 • 2 x Thunderbolt 3 • USB-C 3.1 • 43.7Wh lithium-ion battery • Windows 10 Home • 308 x 224 x 10.4mm (WDH) • 1.11kg • 1yr RTB warranty • ceramic white finish: code af002na

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 [1]Independent third-party research by Coleman Parkes Research, commissioned by Xerox, The State of SMB Document Management, September 2016

HP EliteBook 840 G5

A great choice for security-conscious companies, with the best feature being a screen privacy mode

SCORE ★★★★½

PRICE £1,374 (£1,649 inc VAT)
from hp.com/uk

If your business puts security at the top of your wishlist when it comes to laptops, the HP EliteBook 840 G5 should be on your radar. Although, judging by all the security features this machine boasts, it's probably got a secret anti-radar protective coating. Not content with the usual defensive layers of smart card reader, infrared webcam and fingerprint reader, HP goes one step beyond: press F2 on this machine and the screen switches to privacy mode. You can still view the display face-on, albeit dimmed, but those to your left and right see a grey blur.

Then there's HP's combination Sure Start Gen4 feature. While it may sound like a government-sponsored house-buying scheme, it's actually an added layer of protection for your BIOS. If malware targets this and makes a change, Sure Start will revert to the latest "good" version and notify both the user and the IT team. Clever.

All this would be for nought if the laptop was a lemon, but it's a solid business laptop. I stop short of calling it stylish, with a business-like silver finish and – compared to the Dell XPS 13 (*see the A-List on p16*) – a porky base. I measured it at 13.1mm thick and, even though the lid is slim, this laptop's total thickness of 19.1mm is nothing to boast about anymore. If 1.59kg sounds heavy, note that our review sample had a touchscreen, which adds around 100g.

In HP's defence, that weight is partly due to the 14in panel on show here, compared to the 13.3in XPS 13, and the aluminium chassis feels suitably sturdy and rugged. HP weakens such arguments by including big bezels, though. The 8mm-wide side bezels look okay, but the one at the bottom is almost a full inch and the top bezel not much better at 20mm. These make the 14in screen feel smaller than it is.

ABOVE It might not be the best-looking or lightest laptop, but you get an excellent screen and keyboard

The screen itself is great. Its star feature is the ability to hit a blazing 625cd/m² for use outdoors, while a Delta E of 2.15, contrast ratio of 1,071:1 and sRGB gamut coverage of 91.7% are all fine scores for a laptop. I have few complaints about the keyboard either. It would have been nice to have a little more travel in the keys, but that's just me being fussy. The only thing that stops me being more fulsome in my praise is that the touchpad is too far to the left, so I had to adjust the position of my palm when typing or it would nudge the position of the cursor.

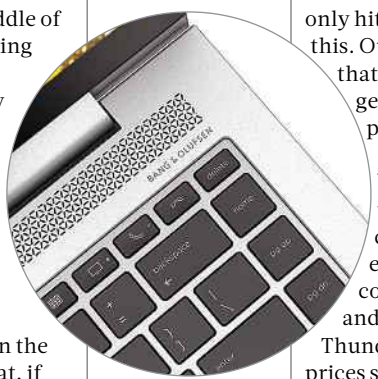
HP includes a few nice features to make up for this minor annoyance. One is the trackpoint in the middle of the keyboard, with accompanying mouse buttons below the spacebar, which come in handy in cramped conditions. It's also curious to see dial and hang-up buttons at the top-right of the keyboard. This highlights HP's aim to make this a conferencing-friendly laptop, with the promise of "crystal clear collaboration", thanks to a third microphone on the outside of the lid. The idea is that, if other people are taking part in your call, this third mic will help pick up their voices; if it's just background noise, the laptop will block the sound.

HP promises up to 14 hours of battery life from the EliteBook 840, but our video-rundown tests suggest you'll be lucky to reach this. With the screen brightness set to 170cd/m² and Flight mode on, it lasted for 6hrs 30mins. You'll want to carry the 355g power supply when travelling, but at least you won't need any adapters. Along with two USB 3.1 ports, there is a Thunderbolt 3 port, full-size HDMI output and an Ethernet slot.

Yet more options come via HP's existing side-mounted docking stations – which are still compatible – and the upcoming Thunderbolt Dock G2, which can power a pair of 4K displays. This laptop has the potential to be a workhorse, too, thanks to Intel's eighth-generation Core processors and, in future models, optional Radeon GPUs.

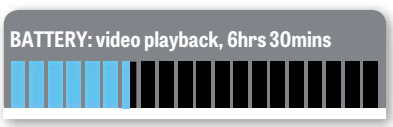
"In privacy mode, you can still view the display face-on, albeit dimmed, but those to your left and right see a grey blur"

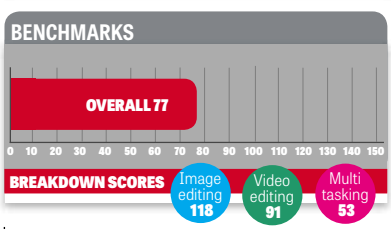
We tested the a high-end model (code 3JX09EA-ABB) that included the popular quad-core Core i7-8550U processor with 16GB of RAM and a fast 512GB PCIe SSD. This combination was potent enough to push the Dell XPS 13 over 100 in our benchmarks, but for reasons I can only speculate on – most likely thermal throttling – it only hit 77. I'm not too concerned by this. Our benchmarks are stress tests that last over half an hour, and in general use I doubt that many people will notice a slowdown.



ABOVE HP includes physical dial and hang-up buttons for quickly making and ending calls

While I wouldn't rush out to buy the EliteBook 840 G5, there's much to like here: the conferencing features; the extra levels of privacy; the convenience of built-in Ethernet and HDMI ports to accompany Thunderbolt 3. This versatility, and prices starting at £1,099 inc VAT on HP's website, make the EliteBook an attractive option for security-sensitive businesses. **TIM DANTON**





SPECIFICATIONS

Quad-core 1.8GHz Intel Core i7-8550U processor • Intel UHD Graphics 620 • 1,920 x 1,080 touchscreen display • 512GB PCIe SSD • 16GB 2,400MHz DDR4 RAM • 2x2 MIMO 802.11ac Wi-Fi • Bluetooth 4.2 • Thunderbolt 3 • 2 x USB 3.1 • HDMI 1.4b • RJ-45 Ethernet port • microSDXC slot • Windows 10 Home • 302 x 199 x 15mm (WDH) • 1.59kg • 3yr limited warranty

Oculus Go

Untethered from a PC and without the shackles of a mobile phone, Oculus Go is VR at its most accessible

SCORE ★★★★★

PRICE 32GB, £166 (£199 inc VAT)
from oculus.com

One argument why VR has never hit the big leagues is the hassle: people don't want the faff of setting up cables and trackers, while smartphone add-ons such as the Samsung Gear VR are awkward. Oculus Go solves this by bundling everything into one device.

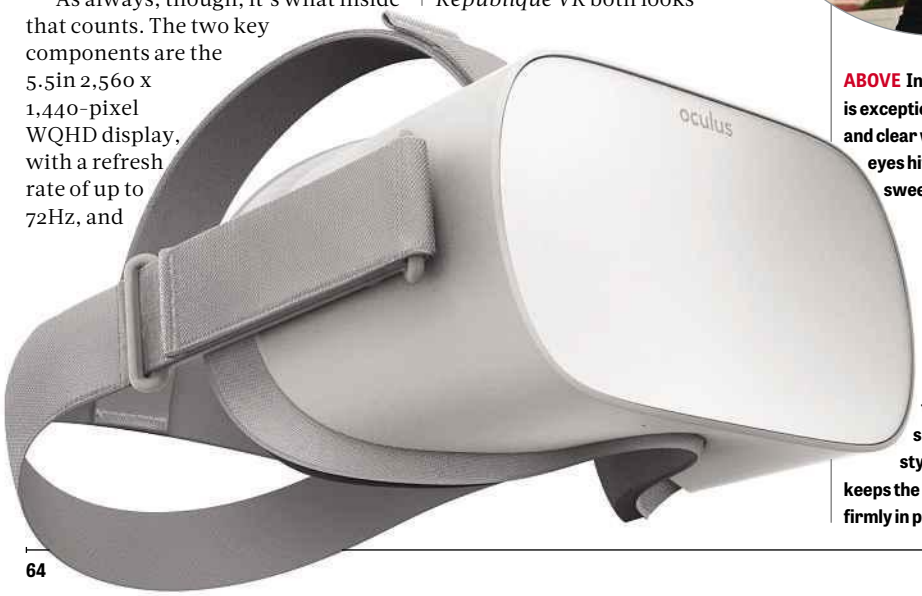
Gone is the Oculus Rift's fabric-wrapped shell, with an understated matte plastic casing in its place. Oculus trades the Rift's built-in headphones and hard, baseball cap-style headband for a soft-strapped design more akin to ski goggles, with audio integrated into the headset itself. A power button and volume rocker sit on the top of the headset, with a headphone jack and micro-USB charging slot on the left side. Everything has been designed to feel sleek and integrated.

Oculus upgrades the eye surround with a more comfortable and breathable lining, and there's an optional insert that makes it easier to wear with glasses. The remote control is now just a touchpad button and trigger, plus two small "back" and "Home" buttons for menu navigation. It's dinky, fits comfortably in your hand and feels more robust than both the Daydream View and Gear VR's remotes (you can tether a gamepad to the headset via Bluetooth if you'd rather have a pad-based experience).

As always, though, it's what inside that counts. The two key components are the 5.5in 2,560 x 1,440-pixel WQHD display, with a refresh rate of up to 72Hz, and Qualcomm's Snapdragon 821 SoC. That's a lesser combination than a Galaxy S9 in a Gear VR headset, but the Oculus Go is a dedicated VR device. This is most notable in the clarity of its VR experiences: everything is brilliantly crisp and clear when your eyes hit the lens' generous sweet spot. Even when your vision strays to the edges, the Go's fast-switch LCD screen helps to reduce ghosting and the screen-door effect you see when individual pixels become clearly visible.

The most impressive aspect of the Oculus Go hardware, however, is its audio capabilities. Instead of a speaker simply pumping sound out into a room, Oculus Go utilises built-in directional speakers that do a great job of making everything sound like it's playing in your head. For games that utilise 3D audio, it's a fantastic experience – and, unlike with earphones, you aren't closed off from the outside world.

Oculus Go taps into the same catalogue as Samsung's Gear VR, as both devices run on the same Oculus-developed system. However, the simplicity of Oculus Go's controller and its improved optics mean it's much more enjoyable to use. Something as immersive as *République VR* both looks gorgeous and feels slick to play, and diving into a home-theatre-sized Netflix session while lying in bed never gets dull.



LEFT A two-band ski goggle-style strap keeps the Oculus Go firmly in place

ABOVE The pint-sized remote has a trigger, touchpad and two buttons for navigation

PC PRO RECOMMENDED

"Oculus Go utilises built-in directional speakers that do a great job of making everything sound like it's playing in your head"

ABOVE In use, the Go is exceptionally crisp and clear when your eyes hit the lens' sweet spot

Other experiences, such as Oculus Rooms, which lets you "hang out" with friends in VR, point to the social aspects of virtual reality and highlight the potential benefits of more Oculus Go-like devices coming to market. Even donning a headset at breakfast to watch VR news reports is an entertaining glimpse into what the future could hold, despite it feeling a little jarring now.

As Oculus Go doesn't require anything but the headset to function – at least once you've set up everything via a companion app – it could also be used as a useful educational tool both in and out of the classroom. In a similar way to how Gear VR has been used to transport kids to the depths of the ocean, into space or back in time, Oculus Go could do the same at a far lower price.

I'm not saying the Go is perfect. The battery lasts for around two to two-and-a-half hours, depending on what you're doing and, as it lacks USB-C, it takes a few hours to charge back up again. Also note you can't expand on the 32GB or 64GB of inbuilt storage, so it makes sense to spend the extra £50 for the latter version.

Even so, £199 for the 32GB Go and £249 for the 64GB model is a huge step down from the £120-plus-phone price of the Samsung Gear VR. If you've been curious about virtual reality but put off until now, this is an excellent first step into the world.

VAUGHN HIGHFIELD

SPECIFICATIONS

5.5in 2,560 x 1,440 LCD screen • Qualcomm Snapdragon 821 processor • 3GB RAM • 32GB/64GB storage • Bluetooth • Wi-Fi • handheld controller • 190 x 105 x 115mm (WDH) • 467g

ViewSonic VP3268-4K

Brilliant colour accuracy when you need it and a versatile 32in monitor when you don't – a great buy

SCORE ★★★★★

PRICE £746 (£895 inc VAT)
from pcpro.link/286view

When you can buy a 32in, 4K monitor for less than £500, you might wonder how ViewSonic has the audacity to charge £895 for the VP3268-4K. The answer is accuracy. Or, to be more accurate about its accuracy, that it offers a pre-calibrated IPS display that – ViewSonic claims – can reproduce 100% of the sRGB spectrum.

I was keen to put such boasts to the test. On switching it from the default to sRGB mode, the most obvious change isn't a sudden improvement in colour accuracy but that the VP3268-4K goes from being a bright screen to something much dimmer. That's because the panel's sRGB calibration was performed at 120cd/m² and, if you change the brightness, your results will change. Once you select sRGB mode, you're locked to 120cd/m².

It performed magnificently in our tests. I measured an average Delta E of 0.51, which edges towards perfection and over-delivers on ViewSonic's promise of a Delta E of less than two. Its gamma tracking and uniformity proved terrific as well – it typically deviated by less than 5% brightness, with only the corners going up to 8%. The sole black mark was when our calibrator reported that it could only display 93.8% of the sRGB gamut, not the 100% ViewSonic claims. I'm not overly concerned by this. The more important figure is that low Delta E.

While 120cd/m² is fine, I prefer a brighter screen. The VP3268-4K reached 357cd/m² at its peak, so it seems a shame not to take advantage. Luckily, the OSD allows you to jump quickly between colour modes and I spent most of my time in the Standard Color setting. Even with this on, and brightness boosted to 170cd/m², colour accuracy is strong. Average Delta E increased to 1.52, and the gamma tracking grew worse, but our colorimeter reported that it could cover 98.4% of the sRGB gamut.

All this fiddling with the controls highlights one of this monitor's weak points: its OSD controls. There's no rotary button, so you have to flick left and right through the main headings – such as input select, viewing mode and colour adjustments – then select which one you want, then scroll down using a different button, then select the precise option you want to change, and then change it. It's awkward. The only consolation is that ViewSonic provides a simpler set of controls for main shortcuts, such as controlling brightness.

There are some unusual options tucked away, too. With four inputs – two HDMI, one DisplayPort and one mini-DisplayPort – you can split the screen four ways and view all of them at once. ViewSonic builds in a generous four-port USB port, plus an audio in and audio out if the built-in speaker doesn't offer quite enough power for you. It can't match the quality of dedicated speakers, but it was great for Skype calls and surprisingly effective when watching films.

The monitor also includes an HDR mode. This isn't certified for content creation as I saw on the Asus ProArt PA32C (*see issue 285, p61*), but if you want to watch HDR films rather than make them, it's an excellent inclusion. It's fine for occasional gaming, too. Don't be put off by that 14ms response time because a pixel overdrive setting tucked away in the OSD reduces the minimal ghosting.

And I have more plus points to end on. First is the slimness of the bezels, which add to the display's already svelte style.

Second the flexibility, with a pivot mode, 130mm of height adjustment and a well-designed base that makes it easy to swivel the screen 60° each way. Third, the fact that ViewSonic calibrates the screen for Rec 709, SMPTE-C and EBI colour spaces (for video editors), not only sRGB. Moreover, you don't need to live with the factory calibration: using ViewSonic's Colorbration software, it also supports hardware calibration using the popular x1-iDisplay Pro.

While the ViewSonic doesn't have all the HDR features of the Asus ProArt PA32UC, or the high-end auto calibration of Eizo's ColorEdge CG277, it's a great option due to the level of quality it offers for the price. You'll have to invest in a £100 hardware calibrator to make sure it stays accurate, but even then the price is below £1,000. With rivals costing almost twice that, it's a bargain if you need the accuracy on offer. **TIM DANTON**

ABOVE The slim bezels around the screen add to the overall svelte design

PC PRO RECOMMENDED

"The ViewSonic VP3268-4K performed magnificently. I measured an average Delta E of 0.51, which edges towards perfection"

LEFT The ViewSonic's well-designed base makes swivelling the screen 60° each way an easy task

SPECIFICATIONS

31.5in 3,840 x 2,160 IPS panel • 8-bit panel • 14-bit look-up table • 4K at 60Hz • 14ms response time • DisplayPort 1.2 • miniDisplayPort • 2 x HDMI 2 (with HDCP 2.2) • USB hub (4 x USB 3 ports) • hardware calibration • PiP/PbP • 2 x 5W speakers • -5° to 21° tilt • pivot • 120° swivel • 130mm height adjustment • 714 x 265 x 506-636mm (WDH) • 10.3kg • 3yr limited warranty inc backlight

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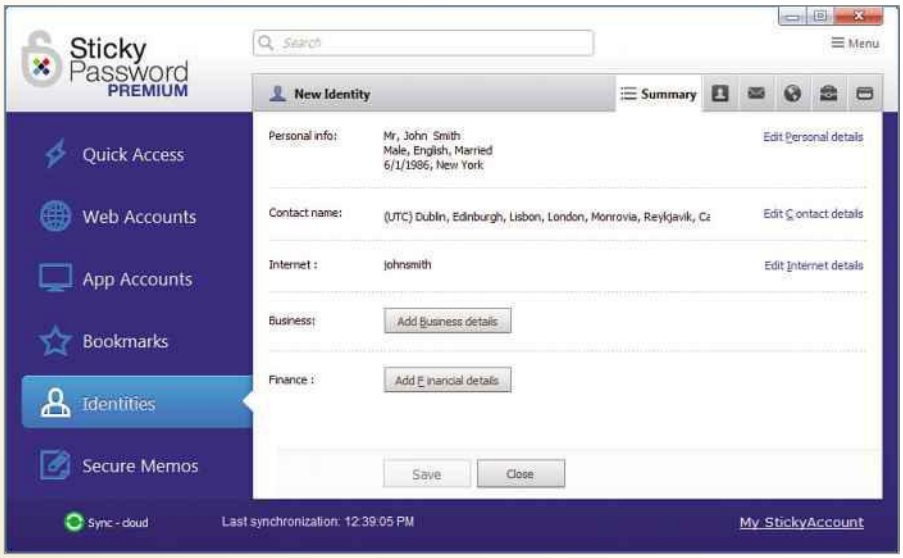
Sticky Password works with a range of applications including Firefox and Thunderbird, and passwords that you've stored elsewhere can be imported with just a few mouse clicks. In all, Sticky Password isn't only a useful time-saver – it's also a very effective security tool.



REQUIRES Windows XP or later; 50MB hard drive space; online registration

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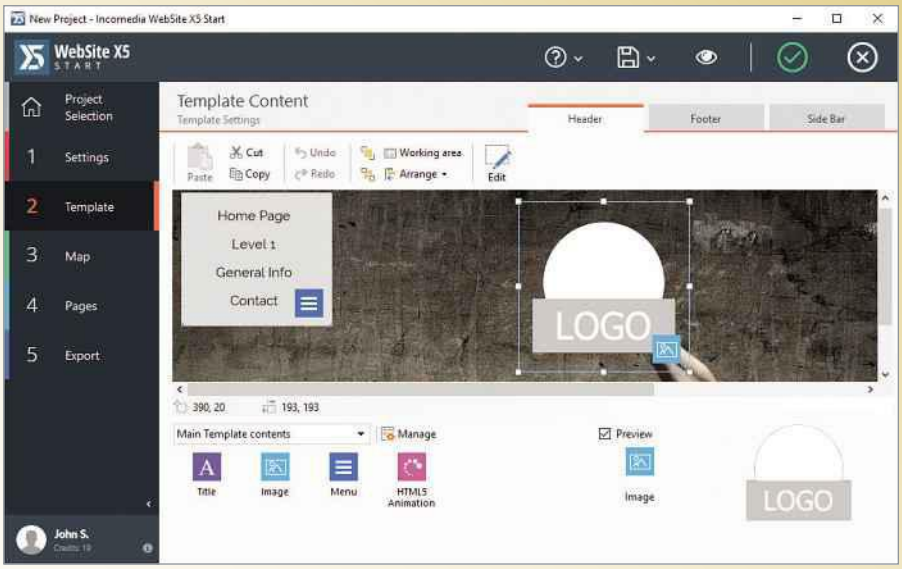

REQUIRES Windows 7 or later; 300MB hard drive space; online registration

Ashampoo Snap 9

Full product worth £30
ashampoo.com

REQUIRES Windows 7 or later; 200MB hard drive space; in-application registration

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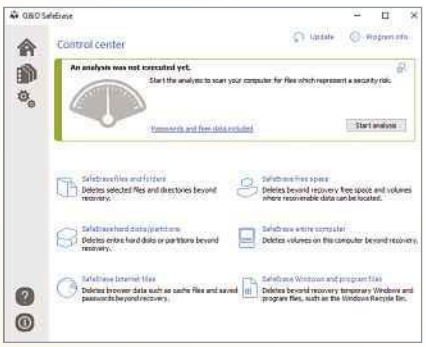
- Enter multiple email addresses for constant, simultaneous monitoring of all your contact details

O&O SafeErase 11 Professional



Full product worth £20
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OnePlus 6

The most expensive phone OnePlus has released, but also the best – it makes other flagships look £300 too expensive

ABOVE The screen size has grown from 6in to a whopping 6.3in, which means the OnePlus 6 is 14g heavier than the 5T

SCORE ★★★★★

PRICE 64GB, £391 (£469 inc VAT)
from oneplus.com

OnePlus has a simple formula for its phones. Squeeze in as much high-end hardware as possible while keeping the price reasonable. Back in 2014, that meant a phone costing £250, but without the style or finesse of the established incumbents. Today, it means a phone that's a match for all the flagships, both in terms of specification and design, but also one that's less of a bargain.

This time, it's crept up from the OnePlus 5T's £450 to £469, and that nudge upwards is reflected in its size. The screen has grown from 6in to a huge 6.3in, leading to 0.4mm more thickness and 14g extra weight. But the phone has shrunk marginally in height and width, softening the impact. It's still a big phone, though. While you can hold it in one hand thanks to the screen's 19:9 aspect ratio, it's tall.

The second difference is that OnePlus has joined the metal-and-glass design brigade, sandwiching the front and the rear of the phone in glitzy Gorilla Glass 5. It's available in three colours: "silk" white, matte "midnight" black and glossy "mirror" black, of which the silk white is the most attractive to my eye. Here, the glass has a smooth, frosted finish and a coloured layer beneath that's been impregnated with powdered pearl dust. It gives the OnePlus 6 a milky, mother-of-pearl appearance that I haven't seen before on a phone.

Note, however, that this is a limited edition, only available in the 8GB of RAM/128GB of storage configuration that costs £519. The mirror black OnePlus 6 comes in 6GB/64GB and 8GB/128GB configurations, while midnight black comes in a 8GB/128GB or a £569 8GB/256GB version.

Design tweaks

Elsewhere, the phone's dual camera has been repositioned to the middle, where it sits, exclamation mark-like, above the newly square-shaped fingerprint reader. And, on the front, visible from the moment you turn on the phone, is yet another notch.

I don't think that's a problem. In practice, you soon stop noticing it's there. Plus, the notch on the OnePlus 6 is smaller than that of the iPhone X, allowing more notifications and status icons to be squeezed into the gaps on either side. You can also "hide" the notch by enabling an option in the Display settings, although all this does is apply a black strip along the top of the screen. Notification icons are still shown either side of the notch in this mode, so it offers no benefit whatsoever.

PC PRO ★★★★ A-LIST

"OnePlus has joined the metal-and-glass design brigade, sandwiching the front and rear of the phone in glitzy Gorilla Glass 5"

Yet again, there's no IP rating for the OnePlus 6, which means it's not officially dust- or water-resistant. OnePlus states that it's "water resistant for everyday use" – but good luck getting it fixed under warranty if it gets soaked and stops working.

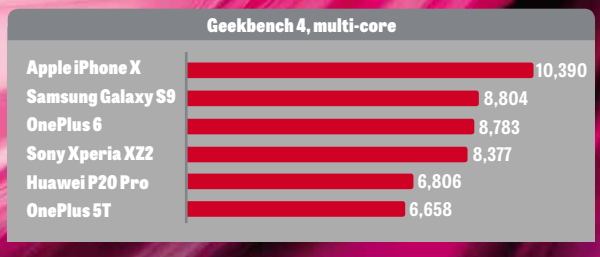
Elsewhere, the three-position alert slider switch, which is used to put the phone into vibrate and silent modes, has been moved from the left edge to the right. More usefully, it's accompanied by a software tag that shows you what mode you've selected as you move it up and down.

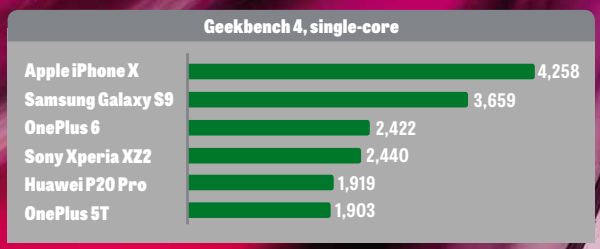
Otherwise, the physical layout remains largely the same as the OnePlus 5T, including the 3.5mm headphone jack, the USB-C socket on the bottom edge and the single speaker grille. As before, there's dual SIM capability but no microSD expansion or wireless charging, although OnePlus has boosted the phone's download speed capability from the 600Mbits/sec maximum of the 5T to 1Gbits/sec.

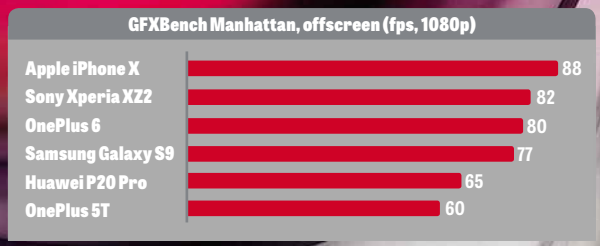
Benchmarks ahoy

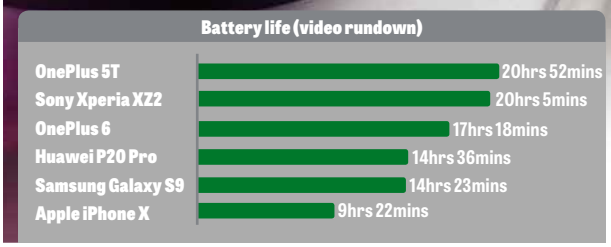
Aside from the contentious notch, the display is very similar to the previous generation OnePlus 5T. The OnePlus 6

ABOVE **The OnePlus 6 comes in three colours: matte "midnight" black, glossy "mirror" black and the limited edition "silk" white**









sticks with 1080p for the resolution (2,280 x 1,080), which is fine unless you're looking for a phone to use for VR. It's still an AMOLED panel, too, so black is dark and inky while colours are rich and vibrant.

You can choose between four screen "calibrations": default, sRGB, DCI-P3 and Adaptive. In testing, the sRGB and DCI-P3 profiles delivered good gamut coverage of 97.1% and 94.3% respectively. Colour accuracy isn't the best, particularly in dark green and light blue colours, where the screen renders colours a little darker than it should, but overall it's a strong showing: movies, photos and games all look sharp. One more minor complaint: a peak brightness of 415cd/m² means you might struggle to read your messages on a sunny day.

I knew what to expect when it comes to performance. OnePlus includes the octa-core Snapdragon 845 – the fastest available – and all the phones we've tested so far with this specification have benchmarked to within a few percentage points of each other. As the graphs show, the OnePlus 6 is no different; I tested an 8GB model, but the 6GB version will be no different.

While its battery life isn't quite up there with the stonking 20-plus hours of the OnePlus 5T, it still lasted an excellent 17hrs 18mins in our video-rundown tests. Expect a day-and-a-half under typical use.

Camera upgrade

What's definitely changed for the better is the photographs you can capture with the OnePlus 6 over the OnePlus 5T. And that's because, although the specifications look similar on paper, the main 16-megapixel camera module has been swapped for one with a 19% bigger surface area and with optical image stabilisation (OIS).

This helps the camera pick up finer details than ever, especially as the light dims. There's little evidence of visual noise no matter the lighting conditions. Simply put, the OnePlus 6's camera is among the best in the business.

When it comes to features, though, the OnePlus 6 is going to disappoint you this year. There's still no zoom capability – the second camera is there only to add depth data for the phone's blurred background portrait mode – and, although there is a slow-motion mode, it can't match the 960fps offered by handsets such as the Samsung Galaxy S9 and Sony Xperia XZ2. All you get is the ability to capture 480fps clips at 720p or 240fps at 1080p. The good news? You can capture 4K at 60fps with OIS enabled.

Software tweaks

While the OnePlus 6 runs Android 8.1 Oreo, it includes OnePlus' launcher software OxygenOS on top. This changes aspects of the way the OS works, but doesn't come with any unnecessary apps preinstalled.

New features include app prioritisation, fresh navigation gestures and a Gaming Mode. The latter is mostly aimed at improving performance and reducing distractions, but it can also limit frame rates and resolution to save battery life (this only works on titles developed with the Unity engine at the moment).

BELOW **The OnePlus 6's dual camera sits above a square-ish fingerprint reader**

Time to buy?

The OnePlus 6 isn't perfect. I'm surprised OnePlus hasn't added IP-certified water resistance or an optical zoom on the second camera, and remain baffled by the continuing lack of microSD card expansion.

It is, however, an improvement over the OnePlus 5T in every way. It's better looking, faster, and includes a superior camera. I expected all these upgrades to bump up its price to more than £500. Instead, you're getting a Snapdragon 845 phone costing £300 less than the smaller Samsung Galaxy S9 and Huawei P20 Pro. It's an absolute triumph. **JONATHAN BRAY**

SPECIFICATIONS

Octa-core 2.65GHz Qualcomm Snapdragon 845 processor • 6GB/8GB RAM • Adreno 630 graphics • 6.3in OLED screen, 1,080 x 2,280 resolution • 64GB/128GB storage • dual 20MP/16MP colour/mono rear camera • 16MP front camera • 802.11ac Wi-Fi • Bluetooth 5 • NFC • USB-C connector • 3,300mAh battery • Android 8.1 • 75.4 x 7.8 x 156mm (WDH) • 177g • 1yr warranty

Motorola Moto G6

Motorola reclaims its place as the king of budget handsets with a superb, well-rounded bargain

SCORE ★★★★★

PRICE £183 (£220 inc VAT)
from pcpro.link/286moto

If *Game of Thrones* has taught me anything, it's that the titular throne is tough to hold onto. The budget smartphone crown is similarly competitive, albeit with a lot less bloodshed. For Motorola, the latest twist in the saga is good news. After a couple of disappointing generations where it lost ground to both Honor and Huawei, the Moto G6 is a phone worthy of the Moto G name.

Winning by design

It starts with the stunning design. As with the rest of the industry, Motorola has enthusiastically adopted the tall and thin 18:9 aspect ratio display, and it looks a million dollars here. Clad in Gorilla Glass 3 on the front and back, and with a stylish curved design all the way round, the phone looks more flagship than budget.

Naming no names, some handsets use premium design as an excuse for dropping popular but fiddly features such as microSD card support and the 3.5mm headphone jack. The Moto G6 maintains these, as well as a fingerprint reader below the screen.

You can't have everything, though. There's no replaceable battery, with wireless charging and waterproofing also absent. While the phone has a p2i water-repellent coating, suitable for light rain or beer spillage, you shouldn't expect the G6 to last a voyage to the bottom of the bathtub. One more negative: the circular camera housing is a dust magnet.

Screen test

The Moto G6 has a 5.7in IPS screen with a 1,080 x 2,160 resolution that's ideal for a display of this size. It provides rich, pleasant colours – but there's a but. For a start, it's dim compared to the best: a peak level of 408cd/m² means that, on the two or three days of blazing sunshine we get in the UK each year, you might struggle to read things clearly.

Colour accuracy is also wayward, while sRGB gamut coverage isn't wonderful at 86.3% in the phone's Standard display mode. The contrast is a decent 931:1, which is a distance behind the very best performers. If the screen is your top priority, consider the cheaper Honor 9 Lite, which is 24% brighter and has a contrast ratio of 1,531:1. Fortunately for Motorola, this is by far the weakest point of the Moto G6 and, for the majority of consumers, these technical deficiencies will be a complete non-issue.

ABOVE With its Gorilla Glass cladding, 18:9 aspect ratio and curves, the G6 looks like a million bucks

Punching above its weight

Of far more import to most is raw performance, and the Moto G6 punches above its weight as the graphs here show (note that the Honor 7X and Sony Xperia XA2 Ultra cost £51 and £80 more respectively). The G6 is powered by the Qualcomm Snapdragon 450 processor, an octa-core 14nm chip running at 1.8GHz, with 3GB RAM and 32GB of onboard storage. There's also an Amazon-exclusive dual-SIM model with 4GB of RAM and 64GB storage for £20 more (**pcpro.link/286amaz**).

The G6 benefits from a minor graphics upgrade compared to the G5S, which is again reflected in the results. A 9fps result in Manhattan 3 shows this isn't the go-to smartphone for the latest, most graphically intense mobile games, but it eclipses the more expensive Honor 7X.

Another positive is that the Moto G6 runs what is pretty close to stock Android, and the few modifications have been introduced for the better. The Moto's gesture controls, for example, let you launch the camera with a double twist, or flick on the torch with a shake. In addition to the fingerprint reader, which is situated below the screen on the front, the Moto G6 also comes with a fast, reliable face-unlock feature.

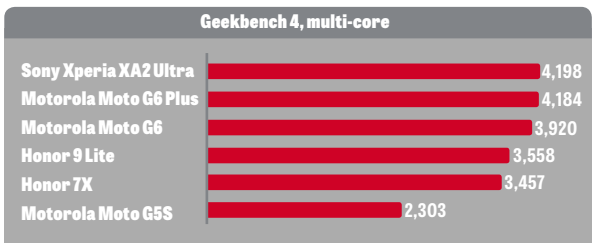
Battery life is a disappointment, with the G6 lasting only ten hours and 46 minutes in our video test. There's no sugarcoating this: that's a poor result, but in general use you should get a day's usage out of it fairly comfortably. It's also worth noting that the supplied "TurboPower" charger gives you six hours' battery life after a mere 15 minutes connected to the mains. My only concern is that, a year down the line, its life won't be great and, unlike the G5, you can't replace the battery.

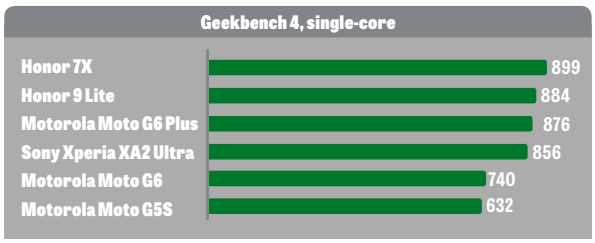
PC PRO RECOMMENDED

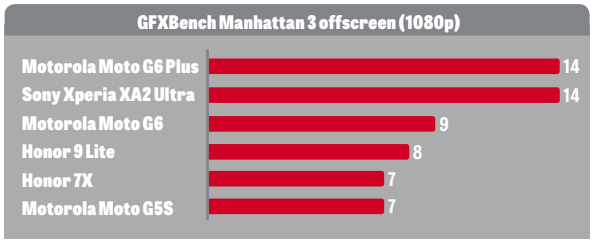
Dual camera array

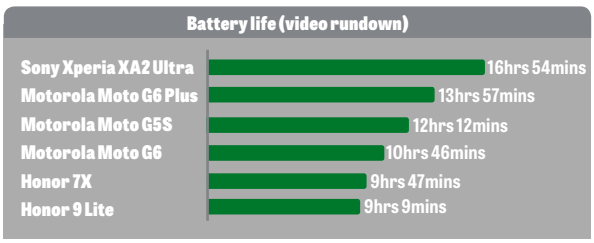
So, at the moment, you have a great-looking smartphone with an okayish screen and solid performance for £220. If you're still on the fence, the camera ought to seal the deal because it's nothing short of brilliant for the price.

Not that there's anything particularly special about the G6's dual camera array on paper. You're looking at a 12-megapixel camera with an aperture of f/1.8 and phase-detect autofocus. The second camera is only five-megapixels and doesn't offer either zoom or wide-angle









HIGHER IS BETTER FOR ALL GRAPHS

capabilities. What it does do, however, is supplement the main camera to add depth perception.

Pop the camera into portrait mode, snap a subject and you can edit the photo based on the extra data captured by the supporting camera. Blur, replace or desaturate the background at will – it works well, even if the edges are occasionally identified incorrectly.

Party trick aside, though, this is a phenomenal camera for the price. Admittedly, it's not a Pixel 2, Galaxy S9 or P20 Pro-beater, but it can be mentioned in the same sentence without looking comically out of place. Outside, and in good light, the Moto G6 captures images of a city skyline that are bursting with detail, with colours that are pleasingly accurate. Flick on HDR mode and you'll find that both bright and dark areas are equalised superbly, without adding a vibrant sheen that other phone cameras often can't resist.

The selfie camera on the front offers more of the same. Photographs aren't quite up to the same standard but, once again, they're both detailed and well balanced.

It's not all sunshine, lollipops and rainbows, but the compromises are made in the right places. First off, video capture isn't 4K – but it is 1080p at 60fps. More damagingly, the camera takes a while to actually capture the image after you press the shutter button. You'll get used to this in time, but it makes magic-moment photography more challenging, and I often found myself moving the phone early. The result? A blurry photograph doomed to the dustbin.

Buying decision

You can pick faults with the Moto G6, but every argument against it can be knocked down with a very simple reply: "It's £220." Yes, the processor isn't the fastest, the screen isn't great and the battery life isn't exactly stellar, but it's £220.

To counter those weak points, the Moto G6 has good qualities in spades: it looks stylish, the performance is solid and the camera is the best you can buy without spending over twice the money. All of which makes the G6 the easiest phone recommendation I can offer. **ALAN MARTIN**

SPECIFICATIONS

Octa-core 1.8GHz Qualcomm Snapdragon 450 processor • 3GB RAM • Adreno 506 graphics • 5.7in IPS screen, 1,080 x 2,160 resolution • 32GB storage • dual 12MP/5MP rear cameras • 8MP front camera • 802.11n Wi-Fi • Bluetooth 4.2 • NFC • USB-C connector • 3,000mAh battery • Android 8 • 72.3 x 8.2 x 154mm (WDH) • 167g • 1yr warranty

Motorola Moto G6 Plus

The G6 Plus is bigger and better than the G6 – if size matters then it's an excellent choice

SCORE ★★★★★

PRICE £224 (£269 inc VAT) **from carphonewarehouse.com**

What makes the G6 Plus different from its standard-sized sibling? First, the screen: it measures 5.9in to the 5.7in of the G6, with the same 18:9 display and 1,080 x 2,160 resolution. But you would be hard-pressed to notice unless the two were side by side.

It's a minor upgrade in terms of screen quality, too. While the percentage of the sRGB colour gamut it reproduces is slightly lower (83.8% versus the G6's 86.3%), it delivers more contrast (1,255:1 to 931:1) and is far brighter. The G6 peaks at 408cd/m², the G6 Plus' climbs to 536cd/m². In bright sunshine, the Plus will be much easier to read.

The G6 Plus also benefits from a nice specification bump over the G6, which is clear in the benchmarks. An octa-core 2.2GHz Qualcomm Snapdragon 630 processor, backed by 4GB rather than 3GB of RAM, is a notable boost from the 1.8GHz Snapdragon 450 inside the Moto G6.

This ensures a phone that feels fast and responsive and has no trouble with relatively intensive tasks. When it comes to pushing 3D graphics, the Moto G6 Plus gets a substantial boost on the G6, too. While 13fps in the Manhattan test may sound low, bear in mind it's deliberately intensive. In real-world conditions, the Moto G6 Plus can handle games such as *PUBG* – just not with as much detail as handsets from Samsung and Apple.

BELOW The Moto G6 Plus' impressive dual-camera array on the rear adds depth data to shots

The G6 Plus only gets an extra 200mAh battery life, but this translated to over three extra hours of stamina in our test. It seems the Snapdragon 630 is considerably more energy efficient than the 450.

The final big upgrade: the camera. Like the G6, you get a dual-camera array on the back of the phone: one 12-megapixel, one 5-megapixel. The latter adds depth data to shots taken by the former, meaning you can do some neat editing after a photograph has been taken.

The camera improvements are three-fold. First, it has a f/1.7 aperture – a touch brighter than the f/1.8 found on the G6. Second, it has dual-pixel autofocus, meaning focusing should be quicker and can lock onto subjects without hunting back and forth. Finally, the faster processor means the G6 Plus can shoot video in 4K at 30fps where the G6 is stuck at 60fps 1080p. However, the faster processor still doesn't fix the shutter lag we experienced with the G6.

These improvements combine to make an excellent camera even better. Pictures are packed with detail and bursting with realistic, vibrant colours. The camera's HDR handling is incredibly good, too, able to dig out an astonishing degree of detail in darker and lighter areas without lending an unnatural look to your photographs. The G6 Plus even performs admirably in low light. Without flash, there's a little noise, but enabling the flash produces clear images without an unnatural tint. The selfie camera isn't bad, either, producing well-balanced exposures that, in good light, have plenty of detail to them.

PC PRO RECOMMENDED

"The Moto G6 Plus is an improvement on the G6 in almost every way: it's faster, has a better screen and a better camera"

Ultimately, the Moto G6 Plus is an improvement on the G6 in almost every way: it's faster, has a better screen and a better camera. The bottom line, though, is simple: both phones are terrific value and you'll be happy with either. **ALAN MARTIN**

BELOW The G6 Plus has a modest 200mAh battery boost over the G6, but that equates to three extra hours

SPECIFICATIONS

Octa-core 2.2GHz Qualcomm Snapdragon 630 processor • 3GB RAM • Adreno 508 graphics • 5.9in IPS screen, 1,080 x 2,160 resolution • 64GB storage • dual 12MP/5MP rear cameras • 8MP front camera • 802.11ac Wi-Fi • Bluetooth 5 • NFC • USB-C connector • 3,200mAh battery • Android 8 • 75.5 x 8 x 160mm (WDH) • 167g • 1yr warranty

Mechanical keyboards

Cherry MX Board 3.0

SCORE ★★★★☆
PRICE £48 (£57 inc VAT)
from scan.co.uk

Cherry provides the mechanical keyboard components for many brands, offering four switch types with different characteristics. For example, Black provides a "linear" feel with a stiffer spring; Red is designed for fast reactions (making it popular for gamers); Brown has a more tactile feel that typists should love; while Blue is for lovers of old-style IBM keyboards with a loud click.

The MX Board 3.0 can be supplied with all four different switches – Cherry sent us the MX Red keyboard for review (code G80-3850LYDGB-2) – but whichever you choose, don't expect a lot of RGB colour. This is a business-like slab, with the only colour supplied by a backlit Cherry logo at the top of the keyboard and red LED status lights for the Windows and lock keys.

You can customise the 12 function keys using Cherry's clunky KeyMan software. This didn't recognise Chrome or Edge as browsers when we set F1 as a website shortcut, instead prompting us to use Firefox or IE. But, once you get over the interface, there are abundant options such as text macros and key sequences (complete with the number of milliseconds you pause between characters).

As a keyboard? Naturally, it's great. A steel plate and Cherry's promise of 50 million key presses for each key mean it should work just as well in five years as it does the day you buy it – considering that longevity, its £57 price is something of a bargain.

Cooler Master MasterKeys MK750

SCORE ★★★★★
PRICE £83 (£100 inc VAT)
from scan.co.uk

PC PRO RECOMMENDED

The MK750 is Cooler Master's latest mechanical keyboard, and arguably its most accomplished. It only requires one USB connection to power it, with added flexibility thanks to its USB-C port and detachable cable. You don't even need to preload your computer with the software: a 32-bit ARM Cortex M3 processor and 512KB of RAM mean it's intelligent enough to pick from predefined colour settings at the press of a button.

This doesn't mean Cooler Master skimps on effects: an understated colour bar sits on the base to complement the individually backlit keys, and you can customise any number of effects using the software.

Cooler Master also provides a wrist rest, which magnetically attaches to the front of the keyboard when you need it. Although "attaches" may be too strong a word, because it's a deliberately weak connection – if you drag the keyboard along, the strip will disconnect.

You can pick from three Cherry MX switch types. Cooler Master sent us the Brown version (MK-750-GKCM1-UK), but you may prefer Red for faster gaming response times, or Blue for louder clicks.

While it isn't cheap at £100, that includes a two-year warranty and the knowledge that it uses Cherry's hardened technology. This is a keyboard that should last for so long that even USB-C will be old-fashioned, making it our pick of an excellent bunch.

"The Masterkeys MK750 is a keyboard that should last for so long that even USB-C will be old-fashioned"

Cooler Master MasterKeys Pro L RGB

SCORE ★★★☆☆
PRICE £83 (£100 inc VAT)
from box.co.uk

I'll be frank. There's very little difference between the MasterKeys Pro L RGB and the newer MK750, and almost all the differences that do exist point to you buying the latter: the port is micro-USB, not USB-C; there's no magnetic wrist rest or strip lighting along the base; and it loses out on the four media playback keys above the number pad.

Instead, the Pro L RGB includes four shortcut keys – P1, P2, P3 and P4 – that allow you to quickly flip between the profiles. These can be set up to crazy levels of customisation to suit games, your mood or even (bizarrely) to play a version of *Snake* on your keyboard. The lights illuminate as the snake travels around, and you have to direct it to food while avoiding its tail.

But you can do precisely the same customisations with the MK750, and there isn't even any difference in terms of the specification: you get an identical 32-bit ARM Cortex 3 processor, the same 512KB of RAM, and precisely the same snappy responsiveness in games.

Cooler Master supplied the MX Brown version for testing (SGK-6020-KKCM1), but if you prefer the snappier feedback of MX Red switches then replace the KKCM1 with KKCR1. Even though both the Pro L RGB and MK750 use the same Cherry switch tech, I preferred typing on the MK750: when you start hitting the Pro L RGB at pace you hear a metallic, echoing effect that isn't there on the MK750.

This is still an excellent keyboard, but in light of the stellar MK750, it needs to drop in price to make it a more attractive proposition.

shootout

Looking for the best possible typing or gaming experience? **Tim Danton** and **Antony Leather** put six mechanical keyboards to the test

Corsair Gaming K95 RGB Platinum

SCORE ★★★★★
PRICE £145 (£174 inc VAT)
from scan.co.uk

Corsair is a dominant force for gaming keyboards, with its £105 K70 being the top choice of our sister magazine *Custom PC*. But it's the company's top-of-the-line keyboard that we tested here, with its most unusual feature being a volume wheel at the top right.

PC PRO RECOMMENDED

The K95 features six macro keys on the left, which are textured slightly differently so you don't press them by accident. The top chassis is made from brushed aluminium, which explains the high cost, and extra compensation comes in the form of a large, soft-textured detachable wrist rest, which does a great job of providing support while typing. You also get dedicated media control keys and two sets of replaceable textured grey keys for the much-used WASD and QWERDF key sets.

In addition to the LEDs on the Cherry MX RGB switches, which can be configured individually, there are 19 RGB LEDs along a light strip on the top edge of the chassis. Our sample had Brown switches, but you can order the K95 with exclusive Cherry MX Speed switches, too – these offer a reduced actuation point, so respond that fraction quicker to commands. The keyboard is a joy to use, with the Brown switches being well suited to gaming or typing.

Corsair's Utility Engine software is detailed and allows for full customisation, as well as macros and profiles, which can be stored on the keyboard's 8MB of memory or in the software. The K95 RGB Platinum may be expensive, but right now it's the ultimate mechanical keyboard.

Logitech Carbon G513 RGB

SCORE ★★★★☆
PRICE £133 (£159 inc VAT)
from logitechg.com

Logitech's gaming division is no stranger to mechanical keyboards, with six models that range from £100 to £159. This, then, is the top of the range beast, and it certainly looks the part.

In fact, it's the most stylish keyboard here, with a brushed aluminium finish that lends a subtle counterbalance to the RGB lighting of the keys. These don't light up from the bottom, with only the characters glowing: the keys themselves stay black. This means that, when switched off, the keyboard doesn't scream gaming in quite the same way.

Logitech also defies the norms by using its own switch technology rather than Cherry's. You can choose Romer-G Tactile (similar to MX Brown) or Romer-G Linear (MX Red), and while the numbers are a fraction different to Cherry's, the net effect – and feel – is the same.

> "This means you can press up to 26 keys simultaneously in a game and get the special move that matches"

The most intriguing difference is Logitech's support for 26-key rollover to the six-key rollover of most of its rivals. This means you can press up to 26 keys simultaneously in a game and get the special move that matches. That's great, but realistically no game we know of demands more than six.

Download Logitech's chunky 111MB software and you can customise this beast to the normal dizzy levels. However, there are no obvious reasons to choose this over the Cooler Master MK750 other than that metallic finish – especially when it needs two USB ports to power it rather than one.

SteelSeries Apex M800

SCORE ★★★☆☆
PRICE £142 (£170 inc VAT)
from steelseries.com

In what can only be described as unfortunate timing, SteelSeries sent us the M800 just as the product went to end of life. You can still buy it from the company, but only in German, Belgian or Portuguese versions. That's a shame, because the key technology behind the M800 is interesting – with a 3mm total travel distance, and 1.5mm actuation, they promised gamers who sought the quickest possible reactions a tempting alternative to Cherry's MX Red 4mm/2mm technology.

SteelSeries called this switch technology QS1, and sadly it doesn't exist in any of the company's other mechanical keyboards.

Oddly, in use the Apex M800 doesn't feel or sound like a mechanical keyboard at all. There's a solidity to the keys, but they're quieter and more typical of a standard membrane keyboard in terms of how they feel when you push them. Perhaps this is why they haven't gained popularity among gamers: you just don't get that same edge.

We're fans of the double-height spacebar, which is blissfully easy to hit – a boon to touch typists as much as first-person shooter fans. But, while it's great to see a column of macro keys down the left, we found them too easy to hit by accident.

The M800 comes with a number of colour schemes, or you can create your own using SteelSeries Engine. However, this doesn't offer anything unique over its rivals – other than a curious take on *Minesweeper*.

The M800 is a compelling alternative to its noisier counterparts and is worth serious consideration – if you can hunt one down.


CORSAIR
CORSAIR
GTX1080
S12/1
PALIT

POWER HOUSE PCs

In-depth reviews of eight supercharged systems costing between £999 and £1,599

Raw power: that's what this month's machines are all about. These systems sport AMD and Intel's latest and fastest CPUs. They pack high-end graphics cards that, alone, cost more than many computers found in PC World. They're housed in casings designed for optimal cooling and maximal expansion. They have ultra-fast SSD storage combined with high-performance, high-capacity hard disks, and they've been tweaked to hell and back to eke out every last MHz or MB/sec.

These are the PCs you buy when the mid-range looks measly and even a grand won't get you what you want.

Why do you need a PC with this kind of performance? Maybe you're a gamer looking to go beyond the console experience with true 4K visuals, ultra-wide screens, VR or multiple displays.

Maybe you're working in high-resolution photography, 3D graphics or Ultra HD video, where the extra horsepower will give you smoother, more responsive applications without the expense of a dedicated workstation.

Or perhaps you're just an enthusiast, looking for a PC that will handle all of the above – and more. Either way, if you've got between £999 and £1,599 burning a hole in your pocket, then you're in for a treat. We've rounded up eight incredible systems with the speed and features to run just about anything you want.

CONTRIBUTOR: Stuart Andrews

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PALICOMP INTEL I7 NEBULA


PC SPECIALIST VULCAN S-01


SCAN 3XS GAMER


WIRED2FIRE DIABLO NEMESIS

Ten commandments for a powerhouse PC

In the market for a high-end desktop? These are the rules to live by when you're about to press "buy"

1 More cores, more MHz

The days of Intel's unchallenged hegemony are over. Last year, AMD's Ryzen line fought back on both value and performance, with the Ryzen 5 and Ryzen 7 CPUs giving you more cores for less money than the Intel Core i5 and Core i7 equivalents. In response, Intel upped its game, with its new Coffee Lake i5 and i7 processors giving you four cores and eight threads or six cores and 12 threads at higher clock rates than the AMD competition. Now, AMD's second-generation Ryzen 5 and Ryzen 7 models have returned with higher clock speeds on six-core/12-thread and eight-core/16-thread processors.

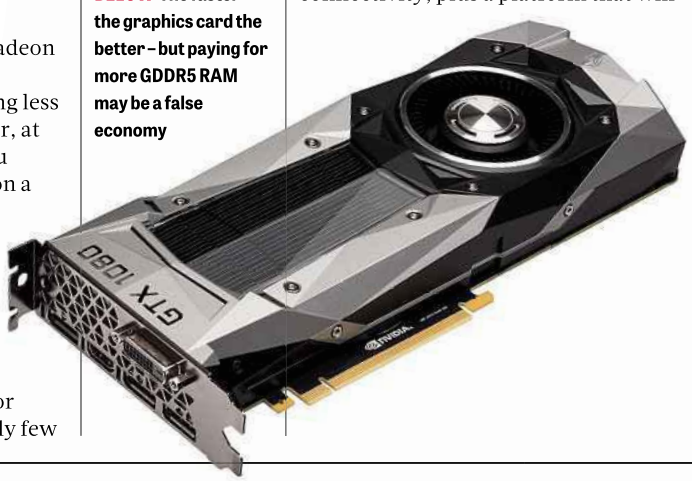
Which is best? Well, it depends on the scenario. Right now, a six-core Intel chip with a higher clock-speed will triumph in many games and many applications, but games developers are getting smarter at building game engines that can max more cores at any one time, so the balance is shifting towards more cores, even at slightly lower clock speeds. And if you're rendering video or 4K graphics, then the more cores, the merrier. With the latest six- and eight-core CPUs, we're seeing complex benchmarks that used to take several minutes to process handled in seconds before our eyes.

RIGHT Intel no longer has its own way at the high end, with AMD's new Ryzen chips also on

2 Go big on graphics

If you're playing games, you want the fastest GPU you can afford. The Nvidia GeForce GTX 1070 or Radeon RX580 is your absolute baseline, while a GTX 1080 or Radeon Vega 56 wins you entry into the 4K-gaming big leagues. Anything less will leave you stuck at a 1080p or, at best, a 1440p resolution. Did you really spend more than £1,000 on a PC just to get the same gaming experience you could have on a £300 console?

Spending more on your card will also buy you additional GDDR5 RAM for the beast. Don't be too concerned about getting a 6GB or 8GB card, though, as surprisingly few games will max out 4GB, even at 4K resolutions (although some are getting very close). However, the higher-capacity cards will give you a degree of future-proofing.



BELOW The faster the graphics card the better – but paying for more GDDR5 RAM may be a false economy

3 Don't skimp on the motherboard

The motherboard isn't just the bit that everything plugs into. This is the platform that defines both what your PC can do now, and where you can take it in the next few years. Luckily, the Coffee Lake and Ryzen processors in this month's Labs require a modern platform to run, so whether you pick something based on Intel's B360 and Z370 chipsets or AMD's B350 and X370 equivalents, you can expect mod-cons such as M.2 card slots and USB 3.1 connectivity, plus a platform that will support future CPU upgrades (not that you'll need them).

Just be aware that the lower-end chipsets (the B350 and B360) may be limited in terms of high-speed memory support or high-speed IO lanes for expansion cards. But don't buy blindly: this may not affect you unless you're planning to run multiple graphics cards or add more storage. In trying to differentiate their products, some motherboard manufacturers are also pushing high-performance networking features or audio support, but we regard these as nice-to-haves rather than necessities.

4 Pack enough RAM (and make it speedy)

DDR4 RAM has become the baseline standard, but many of the systems on test have left the basic 2,400MHz stuff behind for more exotic 3,000 and 3,200MHz variants. The higher-speed RAM has more bandwidth for demanding games and applications, not to mention enough headroom for overclocking. You can find even faster RAM, but you hit high prices and diminishing returns. Tests indicate that the performance difference between 2,666MHz RAM and 3,000MHz isn't that significant.

These days, 16GB is the sweet spot. 8GB is too little for some games and applications, while 32GB doesn't give you any tangible advantage unless

you're working with huge datasets, images or 4K video files. The money could be better spent elsewhere.

5 Balance storage capacity with speed

High-performance demands a SSD, with PCIe M.2 SSDs the fastest options, but the applications that need high performance also need the capacity to store game assets, images or massive 4K video files. As a result, any high-end system worth its salt will combine a 256GB to 512GB SSD with a 2TB to 4TB hard disk. Combine an M.2 slot and an Intel Z370 or B360 motherboard and you've also got the option of Intel Optane storage; right now an expensive alternative to conventional M.2 drives, but potentially the high-speed, low-latency storage of the future.

6 There's more to the case than looking good

Featureless beige and black boxes are a thing of the past. Every PC in this test has one or more distinctive features, whether a glass side-panel, glowing accents, LED strips or, well, all of the above. But, while every PC enthusiast wants a system that cuts *la bella figura*, remember that a case is practical as well. Is it easy to get into? Does it support a good airflow? Has it got room for additional storage? Is the cable management system any cop? It's worth spending extra on a system with a case that doesn't just look good externally, but is well-designed internally. It will save you a whole lot of cursing years down the line.

7 Stay frosty

Even at stock speeds, today's CPUs and GPUs need efficient cooling. A large, efficient CPU heatsink and fan will do the job and give you some headroom for overclocking, but it's no surprise that many high-end systems use watercooling to keep temperatures low. The most effective watercooling systems can be eerily quiet and cool the CPU efficiently enough to deliver serious levels of overclocking without making too much of a racket.

Case fans also have an important role to play here. Generally speaking, more fans or larger fans can work at lower speeds to deliver the same cooling airflow, meaning less noise. However, you'll be surprised how effective one or two fans can be in a well-designed case with optimised airflow. More isn't always more.

ABOVE Remember when PC cases were all a different shade of beige?

"You'll be surprised by how effective one or two fans can be in a well-designed case with good airflow. More isn't always more"

8 It's okay to overclock

It might seem unnecessary to overclock such powerful systems, but it can be a cheap and effective way to get more performance, smooth out frame rates in a game or prolong your processor's working life (unless you push it too far, in which case you'll have the opposite effect). Intel's K suffix processors and all of the Ryzen range are designed to support some degree of overclocking, but you'll need a more advanced cooler to get the most out of the chips without long-term risks. There's no need to fiddle with the hardware – all the features you need are supplied in the UEFI firmware. GPUs and RAM can also be overclocked, with graphics hardware manufacturers supplying their own tweaking tools.

Some of this month's review PCs come pre-overclocked, meaning the manufacturer has set them up with the CPU or GPU overclocked already, and they're covered by the warranty in that state. This works if they can find the right balance between speed and system stability and can be a good way to get a faster PC without spending more on higher-end components.

9 Make the right connections

Connectivity is important, but it's getting harder to find a PC that's weak in this area. Look for four or more USB 3 or 3.1 ports – and support for the newer, faster USB 3.1 Gen 2 standard; this makes a big difference when you're connecting external USB drives. And while front or top-mounted ports might seem unimportant, you'll really come to appreciate them when you're plugging in a mouse, headphones, USB memory stick or wired games controller; it's a whole lot easier than reaching around the back.

10 Let there be light!

Some PC gamers succumb to RGB madness and feel no high-end PC is complete without glowing strips around every major component and every opening. Others simple don't see the point. If you like the hot-rod style, go crazy, but it's not essential to performance and the effects can be migraine-inducing. Luckily, lighting systems are nearly always configurable and software controlled, giving you the tools to get a specific effect or simply turn down the more ridiculous stuff.

How we test

We award each PC an overall star rating from one to five, calculated by weighing up its performance, features, design and value for money. We also consider the warranty, service and support.

To test performance, we run our benchmark suite, which features demanding image-editing and video-processing tasks followed by a multitasking benchmark that involves transcoding MPEG-4 video while playing a 4K video file. These tests provide a score for each system, representing performance relative to a Core i5-4670K reference PC. So, a score of 150 is 50% faster than that baseline PC.

We also test each system's main SSD, then put its GPU to work running three game benchmarks – *Rise of the Tomb Raider*, *Far Cry 5* and *Metro: Last Light* – at 1080p and 2160p resolutions with very high or "ultra" graphics settings. We also tested them with the demanding Cinebench 3D rendering benchmark to see how they fare. We then measure power consumption while idle and under load, to see which systems will hammer your home energy bills.

Finally, we would like to thank Philips for the loan of its 32in, 4K 328P6VJEB monitor.




	LABS WINNER			
	CCL Reaper GT	Chillblast Fusion Titanium	CyberPower Infinity X88 GTX	Lenovo Legion Y720 Tower (Ryzen)
Overall	★★★★★	★★★★☆	★★★★☆	★★☆☆☆
Information				
Price (inc VAT)	£1,249 (£1,499)	£1,125 (£1,350)	£1,333 (£1,599)	£833 (£999)
Price of delivery (standard, inc VAT)	Included	Included	Included	Included
Supplier website	cclonline.com	chillblast.com	cyberpowersystem.co.uk	lenovo.com
Service and support				
Manufacturer's reliability/support rating[1]	N/A	93%/92%	N/A	87%/76%
Warranty	3yr C&R	2yr C&R plus 3yr RTB labour only	2yr C&R plus 3yr RTB labour only	2yr (1yr C&R, 1yr RTB, lifetime labour only)
Core components				
Processor	AMD Ryzen 2700	Intel Core i7 8700K	Intel Core i7 8700K	AMD Ryzen 7 1800X
Core/Turbo Boost speed	3.6GHz/4.2GHz	3.7GHz/4.7GHz	3.7GHz/4.8GHz (OC)	3.7GHz/4GHz
Total number of cores/threads	8/16	6/12	6/12	8/16
Motherboard	MSI B350 Tomahawk Arctic	Gigabyte B360M-DS3H	Asus Prime Z370-P	Lenovo 36E1 (AM4)
Expansion slots	PCIe 3.0 x16, PCIe 3.0 x4, 2 x PCIe 3.0 x1, 2 x PCI	PCIe 3.0 x16, 2 x PCIe 3.0 x1	PCIe 3.0 x16, PCIe 3.0 x4, 4 x PCIe 3.0 x1	PCIe 3.0 x16, PCIe 3.0 x1
Expansion cards fitted (not including graphics)	0	0	0	0
RAM fitted, type and speed	16GB DDR4 3,000MHz	16GB DDR4 2,400MHz	16GB DDR4 3,000MHz	16GB DDR4 2,400MHz
RAM slots (free/total)	2/4	2/4	2/4	2/2
Graphics card				
Make and model	MSI GTX 1080 4GB	Aorus GTX 1070 Ti 8GB	MSI GTX 1080 8GB Aero OC	AMD Radeon RX570 4GB
Outputs	HDMI, DVI-D, 3 x DisplayPort	HDMI, DVI-D, 3 x DisplayPort	HDMI, DVI-D, 3 x DisplayPort	HDMI, DVI-D, 3 x DisplayPort
Drives				
SSD make and model	Samsung 860 Evo	Samsung 960 Evo	WD Black WDS256G1X0C	Samsung PM961
SSD nominal capacity	250GB	250GB	256GB	256GB
SSD interface	SATA	M.2	M.2	M.2
Hard disk make and model	Seagate ST3000DM008	Seagate ST2000DM006	Seagate ST2000DM006	WD WD10EZEX
Hard disk nominal capacity	3TB	2TB	2TB	1TB
Hard disk spindle speed	7,200rpm	7,200rpm	7,200rpm	7,200rpm
Hard disk memory buffer	64MB	64MB	64MB	64MB
Optical drive	✗	✗	✗	DVD-RW
Case				
Case make and model	Corsair Carbide 275R	Phanteks Eclipse P300	InWin 101	Lenovo Legion Y720
Case dimensions (WDH)	211 x 446 x 436.5mm	200 x 450 x 400mm	226 x 480 x 445mm	206.4 x 478.9 x 503.5mm
PSU make and model	Antec Neo Classic 80Plus Bronze	Fractal Design 80Plus	CoolerMaster MasterWatt Lite	ACBel 80Plus Bronze
PSU rating	550W	600W	600W	400W
CPU cooler	Corsair H100i	Chillblast Centurion	CoolerMaster Seidon 240V	Lenovo
Interfaces				
Rear USB ports	3 x USB 3.1, 2 x USB 2, USB-C	4 x USB 3.1, 2 x USB 2	4 x USB 3.1, 2 x USB 2	4 x USB 3, USB 3.1 Gen2, USB-C
Rear ports (motherboard)	PS/2, HDMI, DVI-D, Gigabit Ethernet, 3 x audio	PS/2, HDMI, DVI-D, Gigabit Ethernet, 3 x audio	PS/2, HDMI, DVI-D, Gigabit Ethernet, 3 x audio	Gigabit Ethernet, S/PDIF, 5 x audio
Front/top ports	2 x USB 3, 2 x audio	2 x USB 3.1, 2 x audio	2 x USB 3.1, 2 x audio	2 x USB 2
Internal SATA connectors (free/total)	3/4	3/4	3/4	0/2
M.2 connector	1	1	2	1
Software				
Operating system	Windows 10 Home	Windows 10 Home	Windows 10 Home	Windows 10 Home
Company information				
Main location	Bradford	Poole	Gateshead, Tyne & Wear	Global
Number of permanent sales/support staff	10	4/8	5	N/A

1. Score in *PC Pro*'s Technology Excellence Awards 2017. See issue 280, p30 for details




RECOMMENDED		RECOMMENDED	
Palicomp Intel i7 Nebula	**PC Specialist Vulcan S-01**	**Scan 3XS Gamer**	**Wired2Fire Diablo Nemesis**
★★★★★	★★★☆☆	★★★★☆	★★★☆☆
£1,292 (£1,550)	£1,249 (£1,499)	£1,250 (£1,500)	£1,250 (£1,500)
Included	Included	Included	£20 (£24)
palicomp.co.uk	pcspecialist.co.uk/reviews	scan.co.uk	wired2fire.co.uk
N/A	92%/91%	83%/83%	N/A
3yr RTB	1yr RTB (30-day C&R) plus 2yr RTB labour only	1yr on-site plus 2yr RTB (parts and labour)	2yr RTB (30-day C&R) plus 1yr RTB labour only
Intel Core i7 8700K	Intel Core i7 8700K	AMD Ryzen 2600X	Intel Core i7 8700
3.7GHz/4.8GHz (OC)	3.7GHz/4.7GHz	3.6GHz/4.2GHz	3.7GHz/4.7GHz
6/12	6/12	6/12	6/12
Asus TUF Z-370 Plus Gaming	Asus TUF Z-370 Plus Gaming	Asus Prime B350 Plus	Asus Prime Z370-P
PCIe 3.0 x16, PCIe 3.0 x4, 4 x PCIe 3.0 x1	PCIe 3.0 x16, PCIe 3.0 x4, 4 x PCIe 3.0 x1	PCIe 3.0 x16, PCIe 3.0 x4, 2 x PCIe 2.0 x1, 2 x PCI	PCIe 3.0 x16, PCIe 3.0 x4, 4 x PCIe 3.0 x1
0	0	1	0
16GB DDR4 3,200MHz	16GB DDR4 3,000MHz	16GB DDR4 2,666MHz	16GB DDR4 2,400MHz
2/4	2/4	2/4	2/4
Palit GTX 1080 Jetstream 8GB (OC +150/+50)	Zotac GTX 1080 8GB	EVGA GTX 1080 8GB SC Gaming	Gigabyte GTX 1080 WindForce OC 8GB
HDMI, DVI-D, 3 x DisplayPort	HDMI, DVI-D, 3 x DisplayPort	HDMI, DVI-D, 3 x DisplayPort	HDMI, DVI-D, 3 x DisplayPort
2 x Samsung PM981 (RAID0)	Samsung PM961	WD Black WDS256G1X0C	Samsung Evo 960
256GB	256GB	256GB	500GB
M.2	M.2	M.2	M.2
Seagate ST2000DM006	Seagate ST1000DM010	WD WD20EZRZ	Seagate ST2000DM006
2TB	1TB	2TB	2TB
7,200rpm	7,200rpm	5,400rpm	7,200rpm
64MB	64MB	64MB	64MB
✗	✗	✗	✗
Kolink Observatory RGB	InWin 101	Corsair Carbide 275R	CoolerMaster Masterbox MB600
201 x 435 x 435mm	226 x 480 x 445mm	211 x 446 x 436.5mm	212 x 464 x 456mm
Corsair CS Modular 80Plus Gold	Corsair CS Modular 80Plus Gold	Corsair CXM 80Plus Bronze	CoolerMaster MasterWatt Bronze 80Plus
650W	650W	550W	750W
ID-Cooling 240mm FF+	Corsair H100i V2 Hydro	AMD Wraith Spire	CoolerMaster MasterAir MA410P
2 x USB 3.1 Gen2, 2 x USB 3.1, 2 x USB 2, USB-C	2 x USB 3.1 Gen2, 2 x USB 3.1, 2 x USB 2, USB-C	2 x USB 3.1 Gen2, 4 x USB 3.1, 2 x USB 2	4 x USB 3.1, 2 x USB 2
PS/2, HDMI, DVI-D, Gigabit Ethernet, 3 x audio	PS/2, HDMI, DVI-D, Gigabit Ethernet, 3 x audio	PS/2, HDMI, DVI-D, Gigabit Ethernet, 3 x audio	PS/2, HDMI, DVI-D, Gigabit Ethernet, 3 x audio
2 x USB 2, USB 3.1, 2 x audio	2 x USB 3.1, 2 x audio	2 x USB 3, 2 x audio	2 x USB 2, 2 x audio
5/6	5/6	5/6	3/4
2	2	1	2
Windows 10 Home	Windows 10 Home	Windows 10 Home	Windows 10 Home
Crewe	Wakefield	Bolton	Dorking
5	20	200	4

CCL Reaper GT

PC PRO LABS WINNER

While the all-white finish may turn heads, this PC's beauty isn't skin deep: it's a great spec for a great price

SCORE ★★★★★

PRICE £1,249 (£1,499 inc VAT)

from cclonline.com

Other enthusiast PCs have style and a whole lot of lighting, but the CCL Reaper GT is the only one with its own aesthetic. Forget bombastic displays of pulsating colour, here it's all about gleaming whites, with a white Corsair Carbide 275R case, a matching white MSI B350 Tomahawk Arctic motherboard and prominent white cabling, white DIMMs and a black-and-white fan on the MSI graphics card. It's a beautifully imagined high-end PC.

There's substance to match the style, starting with one of AMD's second-generation Ryzen processors – the eight-core, 16-thread Ryzen 2700. In terms of clock speed, it's not much different to the 2600X in the Scan Gaming 3XS, but the extra two cores and four threads can make a significant difference in heavily multithreaded applications, including video encoding, 3D rendering and recent high-end games.

CCL chooses a Corsair H110i watercooling system to keep things cool. It exchanges heat from the CPU through a heavy-duty radiator at the front of the case, itself cooled by two 12cm fans. While the Ryzen ran hot during testing, reaching peaks of over 90°C, we encountered no problems with stability and no serious levels of noise. In fact, after a fierce roar at startup, the CCL is very quiet.

That's helped by efficient cooling on the MSI GTX 1080 Armor 8G OC graphics card, which itself overclocks the GTX 1080 GPU with a 50MHz increase on the base clock and a 64MHz bump on the boost clock. You could even push both higher using the bundled MSI Afterburner app – this card will happily reach over 1,800MHz base speeds while gaming.

The B350 Tomahawk Arctic is also an interesting motherboard. As well as three USB 3.1 Type-A ports, USB-C and Gigabit Ethernet with gaming-focused bandwidth management, it supports 3,200MHz DDR4 memory. CCL hasn't pushed things quite that far, fitting a 3,000MHz Corsair Vengeance LFX instead, but that's sensible given the minimal speed difference and the costs involved.

Given the temperatures at the current speeds, we wouldn't be inclined to overclock the Ryzen 2700 further, but MSI's UEFI BIOS makes it tempting to try. It has some of the slickest tweaking tools around, complete with useful in-line help.

For storage, the Reaper relies on a 250GB Samsung 860 Evo M.2 SSD and a 3TB Seagate Barracuda 7,200rpm hard disk. The 860 Evo use a SATA3 controller and V-NAND flash, so it can't compete with Samsung's 960 Evo drives on raw performance. We measured sequential read speeds at 527MB/sec and write speeds of 287MB/sec, where the faster SSDs reach speeds of nearer 2,500MB/sec and 1,800MB/sec, respectively. There's compensation in an extra terabyte of hard disk space, but you wonder if CCL has hobbled the Reaper GT.

ABOVE CCL cleverly uses off-the-shelf components to create a PC with unique style

BELOW The stylish black-and-white finish extends to the back, aside from the occasional flash of red

Not really. The CCL still came fourth in our media and multitasking benchmarks and delivered a decent score in the Cinebench 3D rendering benchmark, where its eight cores, 16 threads and fast memory subsystem count more than SSD speeds. And while the CCL isn't quite up there with the fastest gaming systems, it's still a contender: it nearly matches the Scan 3XS Gamer in both the *Rise of the Tomb Raider* and *Metro: Last Light* benchmarks, and isn't far behind in *Far Cry 5*. While the Palicomp, Scan and CyberPower PCs will load your game slightly faster, the CCL doesn't fall behind while it's actually running.

With some fantastic high-end components and great attention to detail, the CCL is a beast of a PC. That it's also something of a beauty is the icing on the cake. If you're looking for ultimate performance, choose the Palicomp or CyberPower systems; but if we were splashing out on a £1,500 system, we'd take the icy cool CCL Reaper GT every time.

Chillblast Fusion Titanium

It can't match the spec of the fastest machines, but the Chillblast Fusion Titanium is undeniably great value

SCORE ★★★★☆

PRICE £1,125 (£1,350 inc VAT)

from chillblast.com

It says something about the size and power of this month's systems that Chillblast's Fusion Titanium is one of the smaller, more discreet PCs on test. Its Phanteks Eclipse P300 case is a good inch slimmer – and several inches shorter – than the larger tower cases sported by the Palicomp, Scan and CCL desktops. Chillblast also plays things subtle with the lighting. Look through the tempered glass side panel and you'll see a glow emitting from the Aorus graphics card and a blue strip near the bottom, but not the full-on lightshow of some rivals.

Chillblast opts for air-cooling over water, chilling the Core i7-8700K CPU with its own-brand cooler. This sports a massive heatsink and 80mm fan, but then it has quite a lot of work to do: the only case fan is a 120mm exhaust at the rear. But there's more to efficient cooling than more and bigger fans. With vents on the front and top of the case, the system keeps CPU temperatures below 67°C even when the Fusion Titanium is working hard. Noise levels aren't bad either, with a low hum that graduates to a not-unbearable whine when you're handling 3D renders or playing high-end games.

Connectivity is pretty standard. On the top of the case, near the front, you'll find two USB 3.1 ports and sockets for a microphone and headphones. At the rear, the Gigabyte B360M-DS3H motherboard packs in four USB 3.1 ports, two USB 2 ports for your mouse and keyboard, a Gigabit Ethernet port and HDMI and DVI-D ports, which are destined to remain unused given the supplied graphics card. Three audio ports have you covered for surround audio. There's no USB-C connector, digital audio output or onboard Wi-Fi, but the Realtek 8118 Gaming LAN module supports Gigabit Ethernet with automatic bandwidth allocation, designed to ensure that games and streaming apps get priority.

For storage, Chillblast opts for a Samsung 960 Evo NVMe drive in the M.2 socket plus a 2TB Seagate Barracuda connected via 6GB/sec SATA. The 960 Evo is arguably the sweet spot for M.2 SSDs right now, with sequential read speeds of over 2,400MB/sec and write speeds of over 1,800MB/sec, but without the price premium of the 960 Pro drive. Bar the Palicomp's dual Samsung PM981 RAID, the 960 Evo is the fastest SSD in any machine this month.

Want to add more storage? That's tricky. There are three 6GB/sec SATA ports available, but the compartment at the bottom of the case is already tightly packed, while the only PCI Express slot that's readily available is a single PCIe Gen3 x4.

ABOVE The heatsink is huge but performs its task well without making much noise

BELOW Compared with rivals, Chillblast's choice of case is positively discreet

At this point we should note the Fusion Titanium is one of the least expensive PCs on test. There are, however, compromises made to reach this price. With basic air-cooling and a B360 motherboard, overclocking isn't an option, while RAM is your basic 2,400MHz DDR4. Perhaps the most serious, though, is a GTX 1070 Ti graphics card when nearly everyone else is packing a GTX 1080.

In our 3D gaming tests, this meant scores were just a little off the pace, particularly at 4K. For instance, in *Far Cry 5* the Chillblast delivered an average 38fps where other systems manage 40 to 45fps. That's still not a massive difference, however, so you have to wonder whether the extra few frames per second are worth the cash.

It's a similar story in the mainstream 2D benchmarks, where the Chillblast falls behind some other Core i7-8700K systems, but not far enough behind that you would notice the difference in everyday use. In short, you could say that Chillblast's compromises are the right ones, giving you roughly 86% of the performance of the fastest machines for roughly 85% of the price. As a value proposition, the Chillblast makes a lot of sense.

CyberPower Infinity X88 GTX

A formidable price, but just look at what's inside: the Infinity X88 GTX is a true powerhouse PC

SCORE ★★★★½

PRICE £1,333 (£1,599 inc VAT)

from cyberpowersystem.co.uk

The Infinity X88 GTX is the most expensive PC in this test, but check out that specification. This is no average Core i7 CPU, but a watercooled 8700K with its six cores overclocked to hit a peak 4.8GHz. The MSI GTX 1080 Aero graphics card packs 8GB of 10,010MHz GDDR5 RAM. Throw in 16GB of 3,000MHz DDR4 RAM and a 256GB WD Black M.2 NVMe drive, and you have a system designed to burn through the most demanding applications or 3D games.

And so it does; a glance at the performance graphs on p90 and p91 hammers that home. The CyberPower runs *Rise of the Tomb Raider* at a 4K resolution 4fps faster than anything else and matches the similarly specified Palicomp in *Metro: Last Light*. Yes, it falls behind its rival in *Far Cry 5*'s internal benchmark, but any way you look at it, this is a seriously powerful PC.

It's also cool and quiet, with the CoolerMaster watercooling system shifting heat from the CPU through to a chunky radiator with fans venting downwards at the bottom of the InWin case. How ever hard we pushed the Infinity, CPU temperatures never drifted above 64°C and actually stayed south of 40°C much of the time.

That InWin case is large but practical, with a 120mm fan and a lot of space for airflow over the non-watercooled components. It's a joy to work inside, with excellent cable management and two easily accessible 3.5in drive bays attached to the power-supply compartment at the top. One of these is occupied by a 2TB Seagate Barracuda hard disk, while the other sits ready to be filled with a second 6GB/sec SATA drive. This gives you the capacity for images, audio, video and game files, while the M.2 drive delivers the performance these demanding applications need.

You can get to all this stuff with ease through the tempered glass slide panel, which has two click-and-clip pins that hold it securely in place. These feel a little cheap, but you can unclip the panel in a couple of seconds – something that can't be said for the average four-screw effort. There's not a lot of lighting inside or around the casing – just a small glow on the waterblock, a glowing MSI logo and red illumination on the Perspex InWin logo, but that's fine with us.

Beyond storage, there's not a whole lot of internal expansion potential. You can add two more DIMMs to the existing two 8GB Adata XPG modules or maybe sandwich a PCIe 3.0 x1 card in between the GPU and the radiator, but you're going to find the latter a struggle. Still, given the supplied specification, that's hardly a big deal.

ABOVE **Packed with star components, but the CoolerMaster watercooling system takes centre stage**

BELOW **We're fans of the InWin case, which is large but practical**

While connectivity isn't anything special, it's good to see six USB 3.1 ports, including two you can get to quickly on the top of the case near the front, alongside microphone and headphone sockets. Plug your mouse and keyboard into the two USB 2 ports and you've still got plenty of room for external hard disks or a VR headset.

The system comes pre-overclocked, but the Asus UEFI BIOS gives you plenty of options to tweak clock speeds and voltages – not to mention full control over the watercooling system and some nice automated tuning features. We'd stick to the existing settings, but it's nice to know that, if you need it, you could still eke out an extra boost.

All in all, this is an extremely impressive system, ready to run any games and applications you want to throw at it for a good few years. The only thing that spoils CyberPower's party is the presence of the Palicomp i7 Nebula, which gives you a very similar specification for £50 less. The Palicomp has faster storage, giving it the edge on the Infinity X88, but don't discount the CyberPower; it came incredibly close to carrying away an award this month.

Lenovo Legion Y720

The Legion looks the part but doesn't have the balanced spec to match the best here or cope with 4K gaming

SCORE ★★★☆☆

PRICE £833 (£999 inc VAT)

from lenovo.com

Big-brand gaming systems are nothing new. Dell has the Alienware and XPS gaming desktops, Acer its Predator line and HP the Omen series, all providing enthusiast-friendly, high-performance systems with a splash of hot-rod gaming style. Legion is Lenovo's foray into the field, with a range of laptops and predominantly Intel and Nvidia-based desktops – although the Legion Y720 on test is its Ryzen-powered variant.

In fact, the Legion Y720 backs AMD all the way, with a first-generation Ryzen 7 1800X CPU and an AMD Radeon RX570 graphics card. It's also the cheapest system by some margin. Given the price difference, you can't expect the Y720 to compete neck-and-neck with the faster, more expensive systems, but does it deliver a real taste of the gaming high-end?

Yes and no. The first-generation Ryzen 7 1800X is still a high-performance processor, with eight cores handling 16 threads at a maximum 4GHz (and going faster with judicious overclocking). Teamed with 16GB of 2,400MHz DDR4 RAM, you get fine levels of performance in 2D applications; it was actually the fastest machine on test in Cinebench.

That RX570 graphics card, however, is a different matter. There's enough horsepower to run games at a Full HD 1080p resolution with the detail levels pushed right up, but switch to 4K and the Lenovo can't maintain a playable frame rate – even 1440p is likely to be too much. As a gaming system, it's just unbalanced, with an excess of CPU power and a lack of matching GPU performance. Interestingly, Lenovo hasn't made the same mistake on its Intel systems, where the £1,299 Y720T ships with a relatively weedy Core i5-7400 but an 8GB GTX 1070.

Unfortunately, gaming performance isn't the only area where the Y720 falls flat. From the outside, it's every inch a premium enthusiast system, with its matte-black exterior punctuated by angular red glowing accents, giving the impression that this PC might be about to hurl lava over your desk and onto the carpet. We're almost as impressed by the case-opening mechanism. Slide the unlock slider across, click down on the raised area at the back and the side-panel just pops off. It's also good to have two USB 3 ports and two USB 2 ports at the front, even if the fact they're all red makes it tricky to see which is which.

ABOVE Lenovo needs to learn from others when it comes to internal design

BELOW We love the Legion's looks, while the DVD writer is a nice inclusion

Inside, this is a conventional PC, complete with an old-school sheet steel chassis. There are two 120mm fans at the front and another at the rear, plus a chunky heatsink fan, but the airflow is more obstructed than rivals. The Y720 isn't objectionably noisy, but the racket picks up when the system is under stress – it's one of the loudest here.

Nor is this the most upgradable system on test. There are no spare DIMM slots and only one PCIe 3.0 x1 expansion slot available, although there's space inside the drive cages for another three 3.5in hard drives should the existing 1TB Western Digital Blue drive and 256GB Samsung PM961 M.2 SSD prove insufficient. Everything's secured with hand screws, making the job even easier, and, if you prefer to buy your software physically rather than digitally, you might be glad to see a DVD-RW installed.

The problem for the Y720 is that it falls between two stools. In the past six months we have seen sub-£900 PCs that deliver better gaming performance than the Lenovo, even if they didn't have the eight-core Ryzen 7 CPU. And while the Intel versions promise a better balance of CPU and GPU horsepower, we'd still opt for the £1,350 Chillblast, which overall has the stronger spec. The Y720 isn't a bad big-brand take on the enthusiast PC, but some aspects need a rethink.

Palicomp Intel i7 Nebula

PC PRO RECOMMENDED

Awesome performance combines with a dazzling light show for a killer gaming system

SCORE ★★★★★

PRICE £1,292 (£1,550 inc VAT)

from palicomp.co.uk

Some PCs are content to sit quietly in a corner, unobtrusively going about their work. The Palicomp Nebula, however, is not one of those PCs, coming in a gigantic Kolink Observatory case with a glossy, semi-transparent mirror effect side panel and transparent front. Behind the latter you'll find three 12in RGB LED fans, with another one working at the back. Each fan has 16 RGB LEDs controlled by a bundled RGB controller, with a choice of over 300 lighting effects. On our test machine, Palicomp had pre-configured a rotating, colour changing light show; headache-inducing, perhaps, but even as you headed off to your darkened room you'd mutter about how spectacular it was.

Luckily, there's substance to back up the style. That starts with a Core i7-8700K overclocked to max out at 4.8GHz rather than the usual 4.7GHz. Then there's a Palit GTX 1080 graphics card, also clocked to a storming 1,858MHz with the 8GB of GDDR5 RAM overclocked to match. And as if this weren't speed-crazed enough, Palicomp has also fitted two 256GB Samsung PM981 M.2 SSDs in the two M.2 sockets, then configured them for RAID0 to maximise performance. Running the A-SSD benchmark saw sequential read speeds in excess of 3,250MB/sec and write speeds of over 2,800MB/sec. That's ludicrously fast.

The Asus TUF-Z370 motherboard is a great platform for this kind of beast. It supports the Palicomp's 16GB of 3,200MHz DDR4 and can even stretch to 4,000MHz. It supports extremely easy overclocking should you want to tinker further, plus RGB lighting controls, built-in light strips and full control of both fans and water pumps. Given that the i7 Nebula uses an ID-Cooling FrostFlow watercooling system, complete with a whopping 240mm radiator, heat shouldn't be a problem. In fact, we rarely saw CPU temperatures creep north of 60°C.

The case itself is spacious, with the combination of the cooling system and effective cable management making it easy to work inside. There's space for another two DDR4 DIMMs, plus two PCIe 3.0 x 1 expansion slots and another PCIe 3.0 x 16 slot if you can squeeze the card in past the double-height GPU. Down at the bottom of the case, there's a spare 3.5in drive bay, just below the one housing a 2TB Seagate Barracuda.

There's potential, then, to take this PC further. Yet where it's at right now is pretty great. The Palicomp proved the fastest system on test in our standard 2D benchmarks, with only the CyberPower providing any serious competition. The triumph continued when it comes to games, with the Palicomp 12fps faster than the next fastest-system on *Far Cry 5* at 1080p, and 2fps faster than the Scan at 4K.

ABOVE Palicomp pushes performance to the limit with this overclocked system

BELOW The colour scheme may be a bit crazy, but you can change it as you see fit

The figures for *Rise of the Tomb Raider* and *Metro: Last Light* need more explanation. In both cases, our benchmarks refused to run with the Palicomp at factory settings. We could only get it to run both benchmarks once we'd dialled the overclock down to the stock 1,607MHz. This enabled the CyberPower, with a smaller overclock, to sneak ahead in the *Tomb Raider* benchmark.

Has Palicomp over-egged its overclocking? Well, these issues only occurred in these two benchmarks, and not in other recent games we sampled. Given the extreme speeds on offer, even stock performance is fantastic in most games, so we'd suggest keeping the overclock for certain titles at 4K but stepping it back for others. Whatever proves stable.

A system such as this isn't for everyone and Palicomp went £50 over our advisory £1,500 price limit to pack all this good stuff in. Yet if you're looking for maximum performance without paying close to £2,000, then the i7 Nebula is tough to beat. It's big, it's brash and it's expensive, but it's also an incredible PC.

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PC Specialist Vulcan S-01

A well-built system with bags of potential, the Vulcan only misses out on the awards by a narrow margin

SCORE ★★★★½

PRICE £1,249 (£1,499 inc VAT)

from pcspecialist.co.uk/reviews

As Kermit once sung, it's not easy being green, so we have to congratulate PC Specialist for the attention to detail in its Vulcan S-01 system. Everything that can glow, from the LED strips on the motherboard to the DIMMs to the logo on the Zotac graphics card, does so with the same bilious hue, while strips above and below the tempered-glass side-panel continue the good work. And if you don't like green? Well, pick your own colour. Thanks to the Aura Sync capabilities of the Asus TUF Z370-Plus Gaming motherboard, you can have any tone you like.

What makes the Vulcan S-01 work so well visually is the InWin 101 case, the Corsair watercooling system and the clutter-free internal layout. Two chunky pipes connect the CPU waterblock to a side-mounted radiator with twin 12cm fans, and to great effect: the sound rarely rises below a low hum while temperatures usually stay well below 40°C.

The power supply is squirrelled away in a separate compartment at the top of the case, along with two slide-and-clip hard drive bays, one already filled with a 1TB Seagate Barracuda hard disk. This isn't the Vulcan's primary storage device, which is a 256GB Samsung PM961 M.2 NVMe SSD. The PM961 isn't quite as fast as the 960 Evo, but it's a cheaper and speedy alternative that won't feel much different in daily use. Using the A-SSD benchmark, we still measured sequential read speeds of 2,446MB/sec and write speeds of 1,117MB/sec.

What we like about the Vulcan S-01 is that it gives you a great platform for high performance. The Core i7-8700K is Intel's most desirable mainstream processor, and you can get the best out of it with the TUF 370-Plus Gaming motherboard. Its UEFI BIOS includes some of the simplest and most accessible overclocking tools around. PC Specialist packs in two 8GB 3,000MHz DDR4 DIMMs, with slots to fit another two.

The graphics card is a Zotac GTX 1080 running with a modest factory overclock that takes the base speed up to 1,620MHz. This isn't the fastest card around, but given the might of the Nvidia GTX 1080 GPU even at stock speeds, you can still expect awesome levels of 3D performance, with the potential to push things further through overclocking utilities.

With a few caveats, that's exactly what you get, with the Vulcan S-01 delivering the kind of frame rates most monitors can't cope with at 1080p and Very High or Ultra settings, and perfectly playable 30fps rates at 4K resolutions. Play a recent game such as *Far Cry 5* on a 4K screen and the frame rate will never dip lower than 35fps; for the most part, it will hold above 40fps quite comfortably.

ABOVE The Corsair watercooling system means this PC has room to go even faster

BELOW The power supply is tucked away in a separate area at the top of the case

Performance is just as good with 2D applications, where the PC Specialist was the fastest of the systems without a pre-overclocked CPU. Those PCs pull ahead on most benchmark figures, but that hardly leaves the Vulcan sitting in the slow lane. It has more than enough power for 4K video-editing, professional image-editing and just about anything else. What's more, stability is rock solid, without any hint of a freeze or crash.

Connectivity is another strength. As well as two top-mounted USB 3.1 ports near the front, the Vulcan S-01 features another two USB 3.1 ports, two further USB 3.1 Gen2 ports and even a USB-C port. Meanwhile, the Gigabit Ethernet connector works with Asus's Turbo LAN network optimisation software to prioritise your network traffic, focusing on the applications you use most.

You won't find the Vulcan atop this month's leaderboards, mainly due to other manufacturers being more ambitious with their CPU and GPU overclocks. Yet this is a beautifully built and designed PC with potential to grow. The award winners are that little bit more enticing, but we'd still put the Vulcan on our shortlist.

Ray tracing: where gaming goes next

With exciting new technologies in the pipeline, the PC will continue to fend off consoles when it comes to premium gaming

For most of the past decade, the PC has been the premium gaming platform. Sure, the Microsoft and Sony consoles had their big exclusives, but if you wanted to play *Doom*, *The Witcher 3* or the latest *Call of Duty* at their best then the PC was the only way to go.

Things have changed over the past two years. For less than a high-end PC graphics card, the Xbox One X runs some games at 4K at a solid 30fps or even 60fps, complete with HDR. Even the £1,500 systems in this test struggle to run current games with maximum detail settings at 4K above 30fps. Has the One X rendered high-end gaming PCs obsolete?

We should be careful of direct comparisons. For one thing, while the Xbox One X outputs games at 4K, some titles use a form of dynamic scaling where the image is rendered at a lower resolution, say 2,560 x 1,440, then upscaled to the 3,840 x 2,160 of a 4K screen. In other cases, a trick called "checkerboard rendering" is used to upscale lower-resolution visuals so they look like 4K. With a PC, you pick a 3,840 x 2,160 resolution and 4K is exactly what you get.

What's more, there's scope to push the frame rate further. While the Xbox One X will run *Far Cry 5* at 30fps, a PC can take it to between 40fps and 60fps for a smoother experience. Not to mention that consoles limit your quality settings.

Step change

Where the PC gets really exciting, however, is where it's headed next. Every few years there's a step change in gaming graphics, where a new technique or rendering feature becomes practical and the hardware is in place to support it. At this year's Game Developer's Conference, the standout presentations focused on the introduction of real-time ray tracing into the DirectX graphics pipeline.

Ray tracing is the dominant form of 3D rendering in movies, as it simulates the physical behaviour of light as it bounces off and transmits through different surfaces and mediums. While conventional rasterisation techniques use a lot of tricks to produce convincing 3D graphics, it's ray tracing to thank for the lifelike CGI we see in live-action movies as well as the beautifully-lit, complex cartoon visuals of a Pixar animated film. As Nvidia's Tony Tamasi described it at a GDC keynote, it's "the holy grail of rendering quality" but something that "hasn't really been practical or even possible to do in real-time". That's why Nvidia is pushing it now, both through Microsoft's DirectX RayTracing API and through its engine, RTX.

ABOVE The latest demos of ray-tracing lighting, shadows and reflections are enough to make your jaw drop

Demo time

At GDC, demos from Epic and Nvidia, working with ILMxLAB, showed movie-quality stormtroopers moving around a series of *Star Wars* sets, the results indistinguishable from what you might have seen in *Star Wars: The Last Jedi*. EA's SEED division showed a demo of robots at work inside a computer, featuring stunning ray-traced lighting, shadows and reflections. Remedy Games, of *Max Payne* fame, showed off truly photorealistic interiors inside its Northlight Engine. These demos are enough to make your jaw drop.

The interesting thing about DirectX RayTracing is that, while it will support new hardware features inside upcoming Nvidia and AMD GPUs, is happy to work within software running on the stream processors inside existing high-end GPUs. It needs a lot of horsepower, which is why Microsoft sees it as something that will initially supplement existing rendering techniques, providing more realistic shadows, reflections and global illumination – the simulation of how light and colour work across the entirety of a scene. It's possible that the first games with support will release later this year. Meanwhile, real-time ray tracing has obvious applications outside gaming, in visualisation, animation and design.

"DirectX RayTracing is happy to work within software running on the stream processors of existing high-end GPUs"

BELOW Ray tracing is what lends these stormtroopers their realistic looks

DirectX RayTracing should keep the PC on top as the premium gaming platform, with scope to grow as new graphics hardware emerges. Given that the next generation of consoles isn't expected until 2020 at the earliest, it should stay in that position for some time.

Scan 3XS Gamer

Others are faster in some areas, but this is a killer 4K games machine for a competitive price

PC PRO RECOMMENDED

SCORE ★★★★½

PRICE £1,250 (£1,500 inc VAT)

from scan.co.uk

Scan's choice of a Corsair Carbide 275R tower case is practically minimalist in comparison to the Palicomp's Kolink Observatory, although it's actually larger and more roomy. Look through the tempered glass side panel, and you'll spot some subtle illumination at the front, plus glowing accents on the motherboard and GPU, but no crazy light shows.

Scan is also one of only three manufacturers here to pick AMD over Intel, opting for the all-new Ryzen 2600X. It's a six-core, 12-thread CPU based on the enhanced Zen+ architecture, with a die-shrink and improved Precision Boost technology pushing clock speeds up to a base 3.6GHz with a 4.2GHz maximum boost. Scan also hasn't prioritised overclocking here, sticking to the stock AMD Wraith Spire cooler and fitting 16GB of relatively conservative 2,666MHz DDR4 memory. There's one 120mm system fan at the front and another at the rear, and for all its lack of watercooling the 3XS Gamer runs cool and quiet. Only when running games at 4K resolutions does the sound rise above a gentle hum.

The GPU, meanwhile, is an 8GB EVGA GeForce 1080 SC Gaming, with the SC standing for superclocked. This version pushes the GTX 1080 from its 1,607MHz base clock and 1,733MHz boost clock speeds to 1,708MHz and 1,847MHz respectively, with an impressively efficient cooling system to keep temperatures under control.

For storage, Scan partners a 256GB Western Digital Black M.2 NVMe drive with a 2TB Western Digital Blue hard disk. The SSD isn't quite as speedy as the Samsung 960 Evo drives on the Wired2Fire and Chillblast systems – we measured sequential read and write speeds of 1,531MB/sec and 294MB/sec – but we're still talking extreme levels of performance. The hard disk gives you enough space for 4K video, RAW photos and a whole lot of games, though the 5,400rpm spindle speed means it's slightly slower than the 7,200rpm Seagate Barracudas fitted elsewhere.

All these components connect via Asus's Prime B350 Plus motherboard. Its excellent UEFI BIOS offers plenty of tweaking and upgrade potential. Alongside the four USB 3.1 ports on the back, you'll find four of the newer, higher-bandwidth USB 3.1 Gen2 ports, with a further two USB 3 ports easily accessible at the front of the case. As well as the motherboard's Gigabit Ethernet port, Scan fits an Asus Wi-Fi card with two screw-in antennae. This still leaves one PCIe 3 x16 slot and one PCI slot available for further cards.

ABOVE As ever, Scan has built a machine with impeccable airflow and neatness

BELOW Scan supplies an Asus Wi-Fi card, but there's room for yet more cards, too

The Scan is every inch the thoroughbred, high-performance system. The only problem is that the competition's even faster. Powerful as it is, the six-core, 12-thread Ryzen 2600X is up against eight-core, 16-thread i7-8700K processors running at higher clock speeds. This, therefore, leaves the 3XS Gamer sitting relatively low down the table in our 2D benchmarks, particularly in the video-editing and multitasking tests where more threads and faster clock speeds really tell.

The news is better in the gaming benchmarks, where the Scan pulled out solid frame rates at both 1080p and 4K resolutions in *Rise of the Tomb Raider* and *Metro: Last Light*, while the EVGA graphics card soars in *Far Cry 5*, giving the Scan the second-fastest score in 4K. Given that some of the more exotic, watercooled systems come at a slightly higher price, this keeps the Scan in contention as a high-end gaming monster. Especially so when you consider that Scan doesn't create custom machines to enter group tests such as this: anyone can configure this exact machine on its website, or enter LN89436 into the search bar and it will be pre-configured for you.

If you simply want the highest frame-rates in games at 4K resolutions, then the Scan is the best PC under £1,500.

Wired2Fire Diablo Nemesis

A powerful overclocked system, but the competition is fierce this month: you could do even better

SCORE ★★★☆☆

PRICE £1,250 (£1,500 inc VAT)

from wired2fire.co.uk

If there's one thing that draws your attention in the Wired2Fire Diablo Nemesis, it's the CoolerMaster MasterAir CPU fan. At 13cm wide and nearly 16cm tall, it dominates the interior of the case, dishing out a constantly changing array of colours. And if you don't like the way Wired2Fire has it configured, you're free to switch it to any one of six preset modes and seven colour options.

What's more, Wired2Fire puts it to good use: the Core i7-8700K CPU is configured to run at the full 4.7GHz across all four cores wherever possible, with the Sync All Cores option in the Asus UEFI BIOS enabled. The 8700K is backed by 16GB of 2,400MHz DDR4 memory, while the graphics card is an 8GB Gigabyte GTX 1080 Windforce OC. As the OC in its name indicates, this comes factory-overclocked to run at a 1,632MHz base clock with a 1,771MHz boost, giving you a slight edge over Nvidia's default 1,607MHz and 1,733MHz speeds.

This all comes fitted to an Asus Prime Z370-P motherboard inside a CoolerMaster Masterbox MB600 case. One of the larger systems on test, there's plenty of room inside for tinkering; one PCIe 3.0 x16 slot sits empty, along with two PCIe 3.0 x1 slots. Air comes in through the front and a vent at the top and is exhausted, considerably warmer, by a single 120mm fan at the rear. Wired2Fire has made full use of the case's cable management features to keep the interior as clear as possible, while there's space for two 3.5in drive bays inside a compartment at the bottom, along with the 750W PSU.

One of these bays is occupied by a 2TB Seagate Barracuda hard disk, while the 500GB Samsung Evo 960 M.2 NVMe drive handles Windows and your most important apps. Wired2Fire provides double the SSD capacity of most machines on test, giving you the option of working with 4K video files directly from it, or installing games you're currently playing to the faster SSD. This will give you a more responsive experience and decreased loading times, so it's a welcome move. Nor are you short on options should you need to connect more storage. The Z370-P has dual M.2 sockets and includes RAID support, and can also take Intel Optane memory should the price come down.

This is a system built for overclocking, and the Asus UEFI BIOS makes it easy with simple, accessible tools for adjusting all parameters. All the same, we found that Wired2Fire had been a little over-optimistic with its efforts. With all cores set to run at 4.7GHz, the Diablo Nemesis couldn't make it through a run of our standard 2D benchmarks without the system cutting out and restarting.

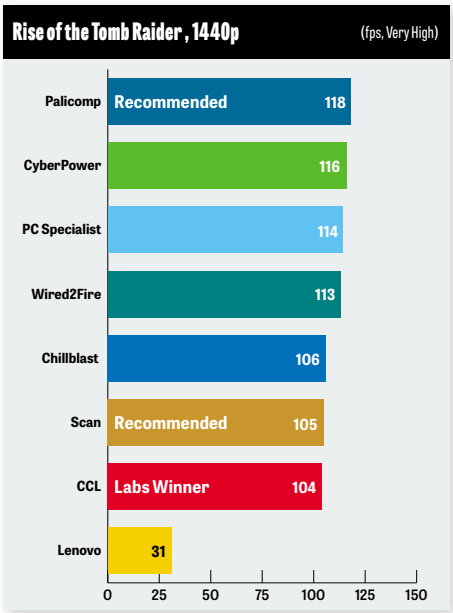
ABOVE There's no watercooling, but this system is still built for overclocking

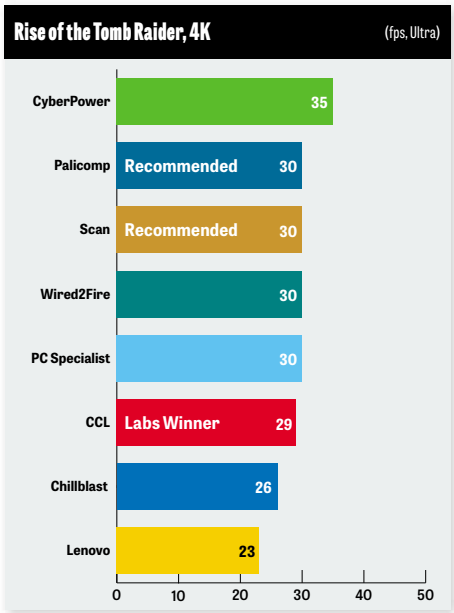
BELOW This fine CoolerMaster case is one of the roomiest on test

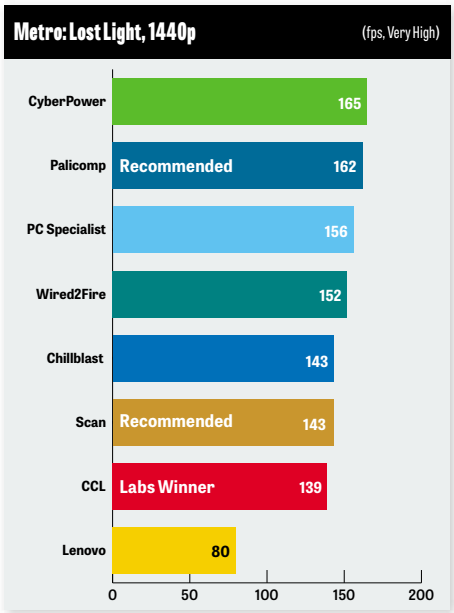
However, with the cores set up to boost to different clock speeds and the UEFI BIOS configured with its Type I overclocking preset, not only did the problems disappear but its results were excellent. The Wired2Fire was the third-fastest system in our application benchmarks, only falling behind the more expensive, watercooled and heavily overclocked monsters. The Diablo also scored well in our gaming benchmarks, most notably *Rise of the Tomb Raider* at 4K.

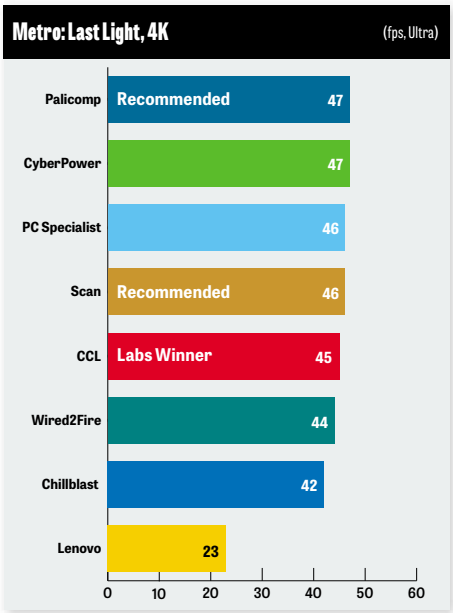
So, we're looking at another powerful, well-built system with some strong components. The only problem Wired2Fire has is that pesky competition. For £50 more, Palicomp gives you even more performance, better storage and more reliable, watercooled overclocking, while the PC Specialist Vulcan S-01 and Scan 3XS Gamer are slightly more potent when it comes to 4K gaming. And while it's faster than the Chillblast Fusion Titanium in 3D, it doesn't have price on its side. Put it all together and there's only one conclusion: much as we like the Diablo Nemesis, it doesn't quite stand out from the pack.

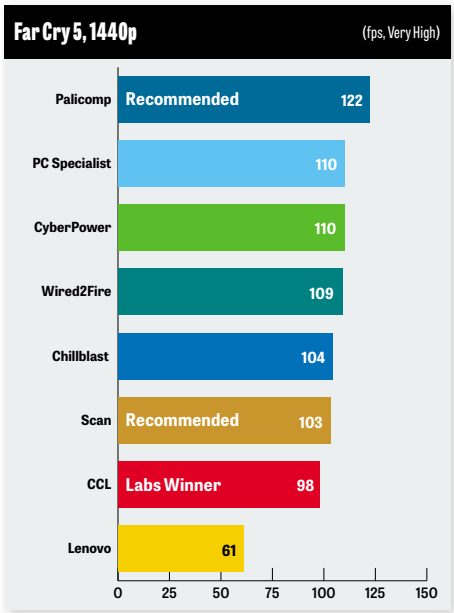
Performance graphs

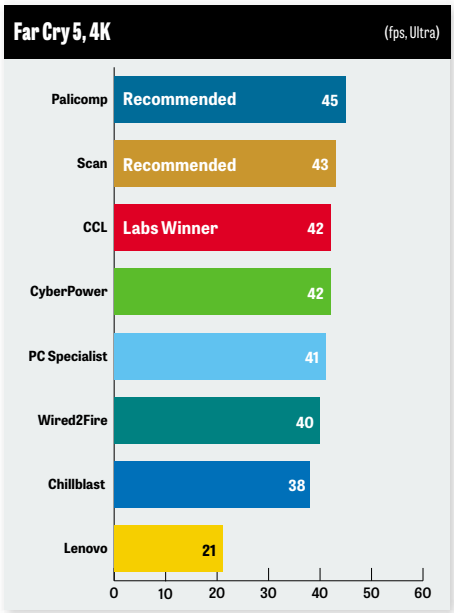


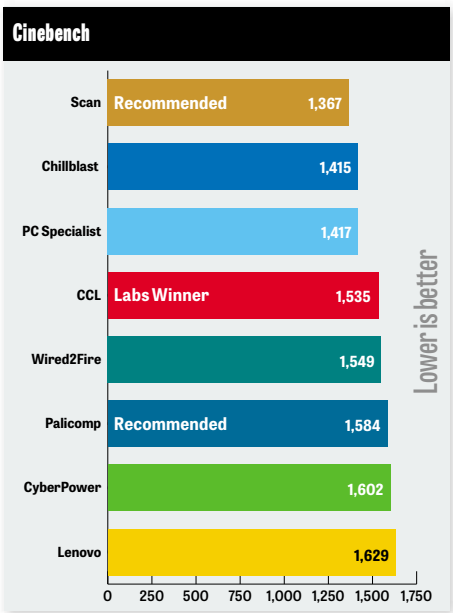


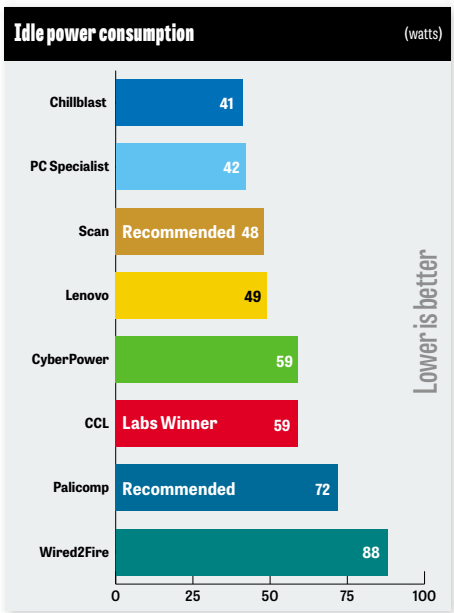


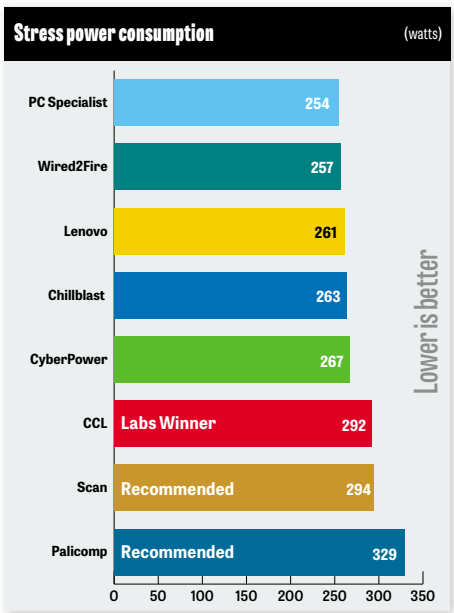












View from the Labs

It's fantastic to see AMD take the processing power battle to Intel, but Nvidia has had its own graphical way for too long

I'm both thrilled and mildly disappointed by the PCs in this month's Labs. I'm thrilled because these are incredibly fast systems, with the kind of processing and graphics horsepower I couldn't even have dreamed of when I built my first PC two decades ago.

I'm no stranger to next-gen consoles but there's a part of me that will always be a PC gamer, and that part loves to switch the resolution to 2160p and slide the detail settings to Ultra. At that level, even these machines can't deliver a smooth 60fps, but, heck, I remember playing *Doom* shrunk down into a window in the middle of my screen at 15fps: a steady 30fps to 40fps at 4K seems pretty good to me. Even the PS4 Pro and Xbox One X struggle to deliver graphics that look this good.

And the disappointment? There's something a little homogenous about the specs on offer, and this time it's not down to the choice of CPU. AMD has injected much-needed life back into the processor market, and many cores and many threads has become the norm. In that sense, things have never looked better.

Stuart Andrews is a former *PC Pro* reviews editor who now writes about games (and indeed PCs) for a living

If only I could say the same about graphics cards. Nvidia seems to dominate the mid-range to high-end graphics market almost completely. It's a difficult time for the graphics vendors and for buyers – the use of high-end GPUs to mine bitcoins has led to shortages and sky-high prices. Yet it would be great to see cards with new and genuinely interesting features; to see a step change in PC graphics like those we've had before.

That's going to take a combination of hardware and software, perhaps involving advanced ray-tracing technologies and new GPUs built to support them. When that comes, today's dream machines may need an upgrade to keep pace.

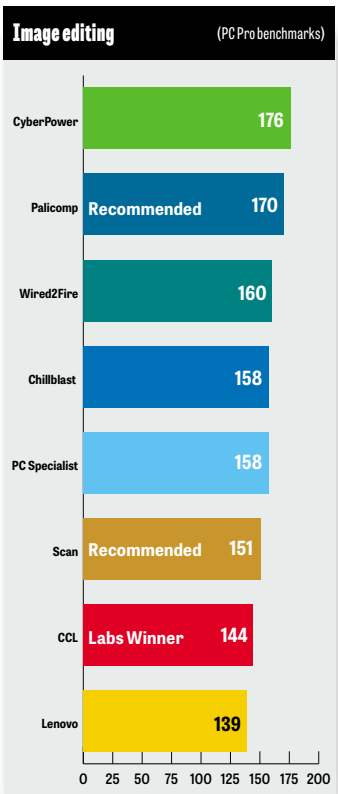
"It would be great to see graphics cards with new and genuinely interesting features; to see a step change in PC graphics"

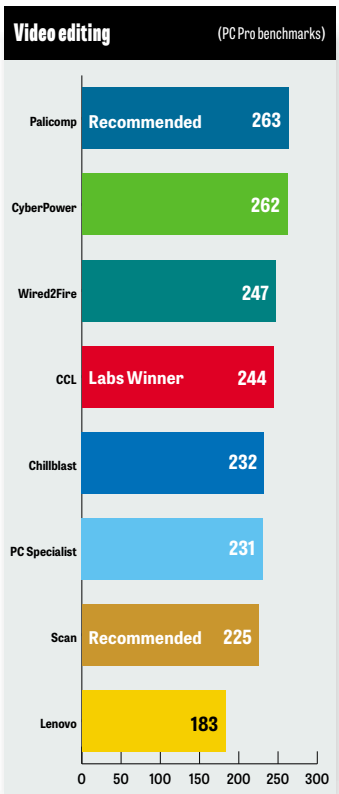
ABOVE AMD's Ryzen CPUs have shaken Intel, but Radeon graphics cards don't scare Nvidia – yet

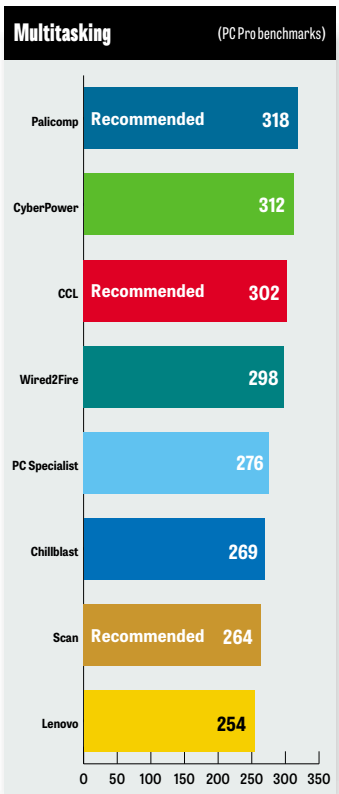
Right now, however, nearly any of these systems will cope with just about any application – and any game – giving you best-of-breed experience whether you're editing video, experimenting with movie-quality 3D animation or just enjoying the latest blockbuster releases from the likes of Blizzard, Ubisoft and Bungie.

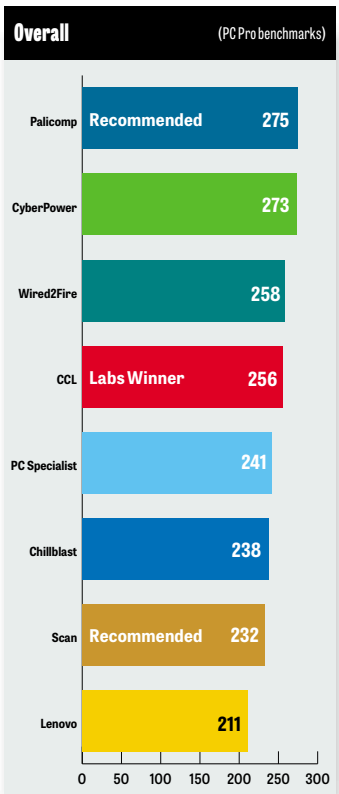
Consoles might be talking the 4K talk, but when that quality slider moves to the right, nothing beats a powerhouse PC. ●

Test results









The Network

Practical buying and strategic advice for IT managers and decision makers

BUSINESS FOCUS

Back up your business

Are you completely confident in your backup and recovery plans? Dave Mitchell tries out the best and latest business backup software

Data backup is something no business can afford to skimp on. If you're operating without a comprehensive strategy for protecting crucial data, you're gambling with your company's very survival. Yet, too many organisations just keep their fingers crossed: a report published last year by Small Business Trends (**pcpro.link/286sbt**) revealed that 58% of SMEs are unprepared for a data disaster – even though 60% of those that do suffer a major data loss are out of business within six months.

Backup doesn't have to be difficult, or expensive. There's a huge choice of products out there, to suit businesses and budgets of all sizes. In fact, the biggest hurdle facing SMEs today is probably the sheer range of solutions to choose from, which can make it seem like a daunting challenge to pick one that fits their data protection requirements.

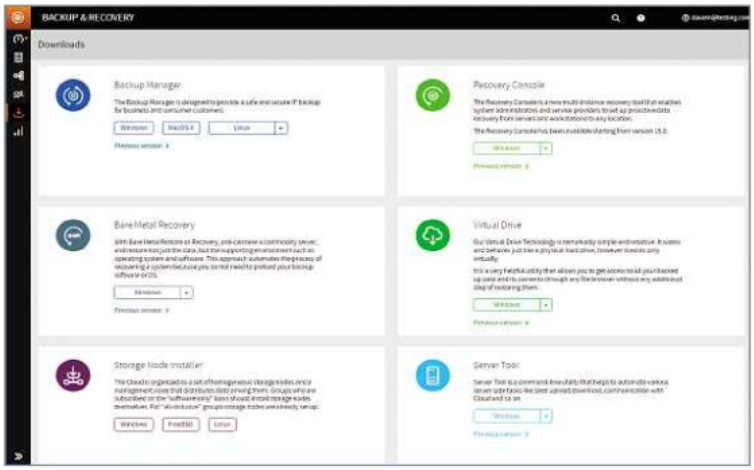
This month, we test four well-featured hybrid backup products aimed firmly at SMEs. They all combine cloud and onsite backup, so you get the advantages of both offsite and onsite storage – and they all come with free time-limited trials, so you can check each one out before buying to make sure you end up with the right backup product.

Two to tango

Cloud backup is almost a no-brainer for small businesses. Holding a copy of your data offsite protects against all sorts of unpredictable problems, from burglary to natural disasters such as fire or flooding. No surprise, then, that there's plenty of competition in the cloud backup market.

That doesn't mean every offering is a bargain, however. Storage costs vary hugely from one provider to another, so before you sign up, take a careful look at their prices. Check too whether the advertised rates refer to compressed or uncompressed capacity. The former is much better value as it effectively offers more cloud capacity for your money.

While the cloud has many benefits, it shouldn't be your only backup destination. If your internet connection or provider goes down, access to your backups goes with it. And service outages do happen: we



BELOW SolarWinds provides plenty of useful data backup and recovery tools

suffered a 36-hour outage whilst testing the Barracuda Backup Vx product, during which time we couldn't upload or restore anything.

That's why we recommend a hybrid solution. As well as protecting you against short-term outages, local backups can get you up and running more quickly if you need to restore a large amount of data. With the two working together, your business is well protected from most types of disaster. Indeed, this approach fits perfectly with a "3-2-1" backup strategy, where you retain three copies of your data, two on different types of local media and one offsite.

Human touch

Many businesses have learnt the hard way that backup jobs need to run automatically. A strategy that relies on human intervention is almost guaranteed to let you down sooner or later. All the products on test this month will run backups to your specified schedule – and you can choose how often to run full backups and when to supplement them with incremental or differential backups.

It's worth understanding the difference between the latter two models. A differential backup contains all new and changed data since the last *full* backup, whereas an incremental backup only copies data that has changed since the most recent backup – even if that was itself just an incremental backup. Incremental backups are a little more complex to manage, as restoring a set of files may involve accessing a whole chain of backup archives, but they're much more space-efficient, making them ideal for cloud operations.

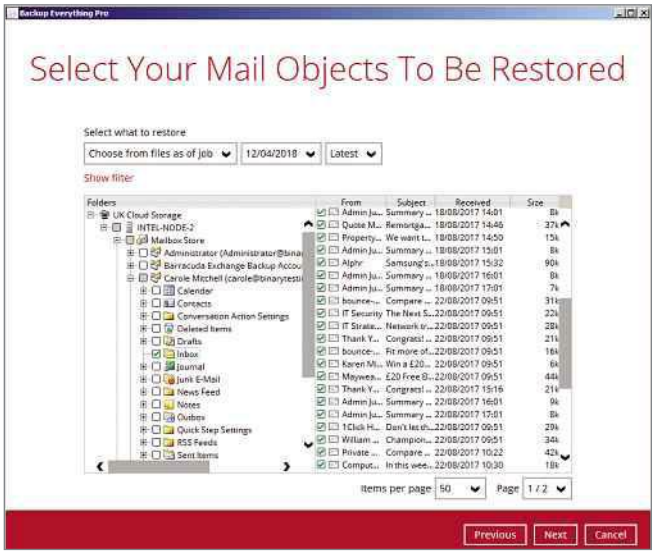
On the subject of management, it's wise to check that your chosen product lets you review and configure your entire business backup strategy – both local and hybrid – from one console. Keeping everything under one roof makes it much easier to deploy and monitor backup jobs, manage storage devices, keep an eye on problems and run remote restores.

Application protection

Backup isn't just about spreadsheets and documents. If your business relies on services such as Exchange, you need to ensure these are protected too. This can be a big differentiator between backup products: some only offer facilities to back up and restore the entire Exchange datastore, whereas others support message-level backups (MLBs), which allow you to dip into the backup and recover individual Exchange items, such as deleted emails.

In many businesses, critical applications will be running inside virtual machines, so it's also important to choose a backup product that will work with platforms such as Hyper-V and VMware. Again, features vary considerably in this area, but the best products offer granular recovery where you can pluck a file, folder or even an Exchange item straight from a backed-up virtual machine.

There's better news for SQL Server users: all the products we tested allow you to back up and restore individual databases. We tested with SQL Server 2014 and had no problems restoring databases to their original location, or duplicating them to another destination.



ABOVE Message-level backups can be used to quickly restore individual emails

LEFT Backup Everything Business can back up data directly from a Synology NAS box

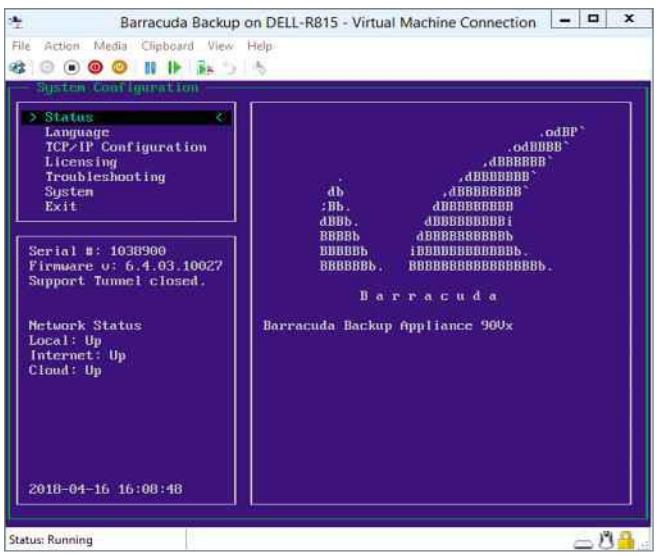
BELOW We tested Barracuda's Backup Vx appliance on our Hyper-V host

Backup security

With the GDPR now in force, all businesses that process personal information must be able to show that their backups, as well as their live data, are secure. This means you should ensure your backup product supports strong encryption. Again, though, there's good news: most providers implement tough 256-bit AES encryption for backed-up data, both in flight and at rest. Many providers even allow you to choose you own encryption keys, but bear in mind that – for added security – some won't store this key themselves, so you must keep secure records of the keys being used. If you lose them, all your data will be irretrievably lost.

You should also prepare for the possibility that your files might be maliciously encrypted by a ransomware attack. This means looking for a backup product with versioning support, which lets you easily restore previous versions of files. Again, this is something that all serious products support as standard; you can roll back to older versions of files going back days, weeks or months.

Once you've chosen your software, we've one final piece of advice: make sure you regularly test its restoration capabilities to be certain that, if and when disaster strikes, you can get your files back smoothly and reliably.

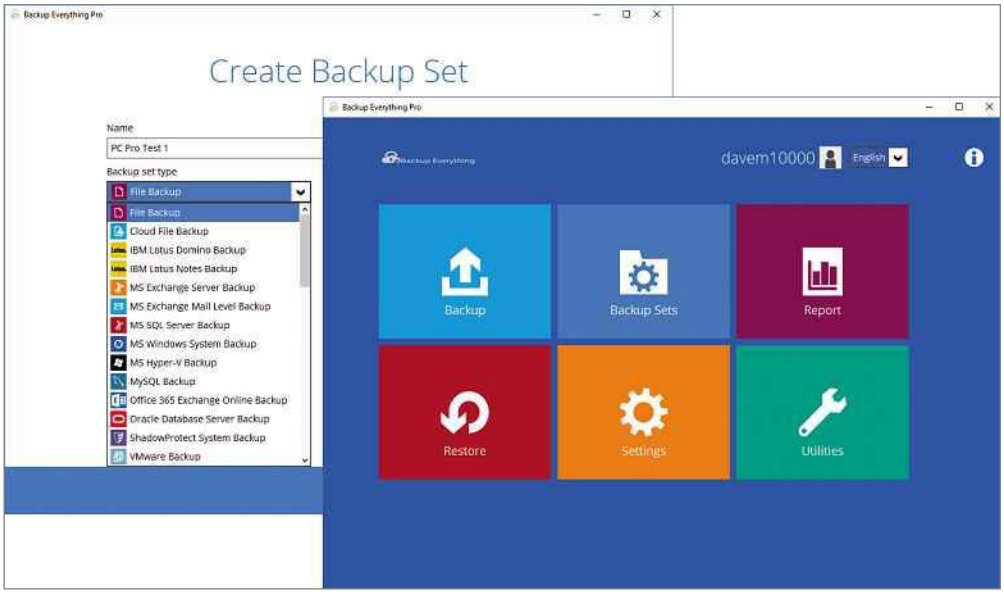


Backup Everything Business

Probably the easiest, most user-friendly hybrid backup solution we've tried – and it's great value, too

SCORE ✪✪✪✪✪

PRICE From £10 per month for 100GB (exc VAT) from backupeverything.co.uk



ABOVE **BEB's simple console is your gateway to a myriad backup options**

The name makes quite a claim, but Backup Everything Business (BEB) covers an impressive range of platforms. Windows, Linux, Mac, VMware, Hyper-V, Exchange, SQL Server, SharePoint – you name it and this product can back it up.

That makes it ideal for smaller businesses whose IT resources have grown organically. And the price will definitely suit such organisations: it starts at £10 per month for 100GB of cloud storage, with extra capacity costing a mere 10p per gigabyte per month. Those are compressed capacities with no client limits, and the company's two data centres are both based in the UK, so nothing leaves these shores.

To help you get up and running quickly, there's also a free vault-seeding service, which lets you physically deliver your first backup set on an encrypted removable drive, rather than having to upload everything over the internet.

Setting up your clients involves a little bit of work: there are no push services, meaning the BEB client has to be downloaded to each system in turn. Still, that only takes two minutes, after which you can get on with creating your backup sets from the main interface.

This is a cheery affair, with big colourful icons for the six main functions. Don't make the mistake of thinking this is a basic bit of software, though. Once you've picked the type of backup you want, you can choose to protect files, system states, virtual environments, Exchange datastores and message-level backups (MLBs), SQL databases and even data from Lotus Notes and Domino.

It's smart, too: when we selected Exchange, the client automatically checked the host and brought up the database ready for selection. You can choose specific mailboxes and individual items to protect. We were also able to pick which databases on our SQL Server 2014 system to back up, and which individual VMs on our Hyper-V host. One neat option is the ability to create local backups of selected VMs without compression or encryption, so they can be very quickly restored and brought back online in case of disaster.

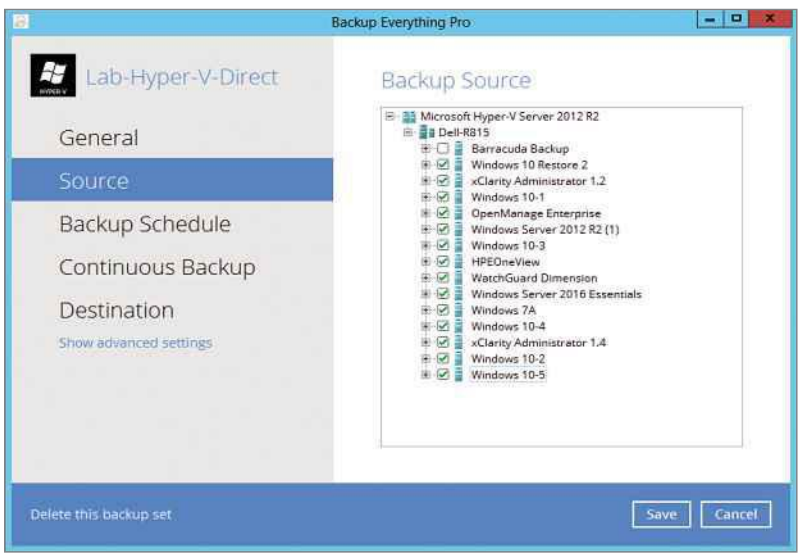
Another clever feature is that you can additionally back up files from your Dropbox, Amazon, Google, Azure, OneDrive, OpenStack and RackSpace storage. Synology NAS shares can also be included, if you install the BEB DSM package.

The final step is to set up backup schedules and destinations. Available destinations include cloud storage and all types of local drives and devices, and you can configure encryption options here, too. You can use your account password as the encryption key, provide a unique key yourself or let the client generate one for you. BEB keeps a copy of your key, so you can't accidentally lose access to your data – but keep your records up to date, as it will only be shared with the account administrator.

And, if disaster ever does strike, restore operations are a cinch. Simply choose the restoration option from the BEB interface, pick a backup set and decide what you want to recover. You can restore files and folders to their original location, or to another destination of your choosing, on any supported client. Similarly, SQL databases and Exchange datastores can be restored in place or as duplicates, while MLB item-level recovery is run at the Exchange host. And, if you've backed up your VMs without encryption, you can mount them as local volumes on the Hyper-V host for drag-and-drop data recovery.

"VMs can be backed up without compression or encryption, so they can be very quickly brought back online in case of disaster"

In all, Backup Everything Business offers a superb range of hybrid backup features for all the major platforms. It's highly flexible when it comes to restoring your data – and it's perfectly priced for smaller businesses.



LEFT **Backup Everything Business lets you back up individual VMs**

REQUIREMENTS

Windows 7/Server 2008 upwards ● macOS X 10.7.3 upwards ● Linux

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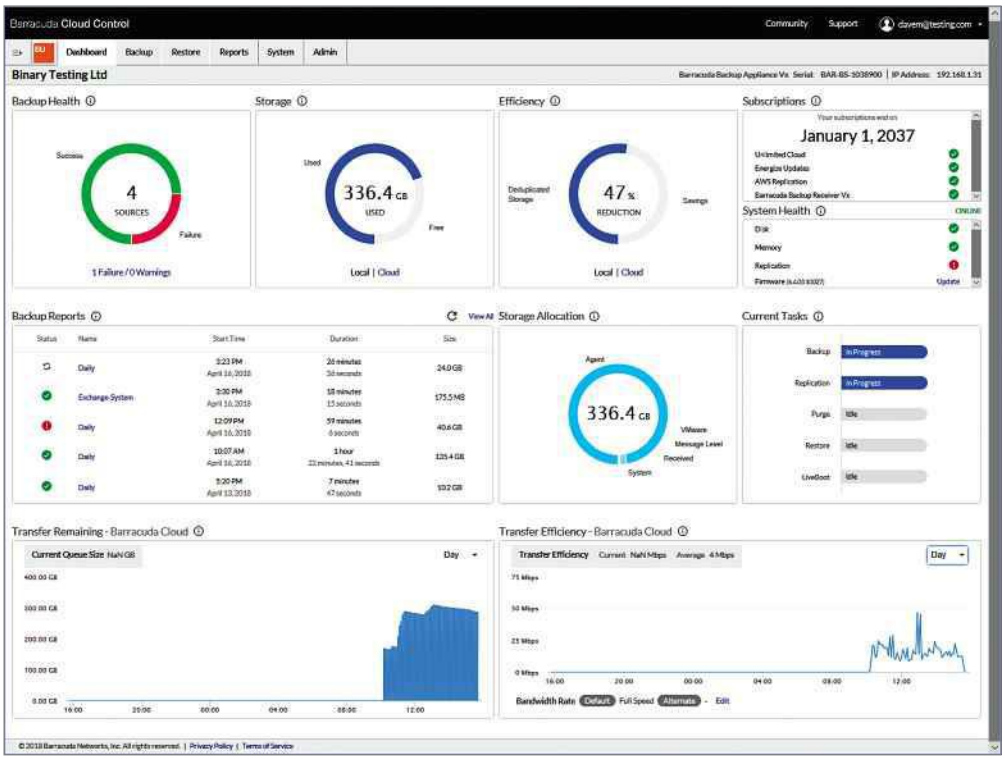
Whether you're an IT professional or a first time buyer, Dennis technology has a magazine for you, all of which are written and produced by expert editorial teams. We cover the whole spectrum of technology news, reviews and features.

Barracuda Backup Vx

Some unfortunate blips during testing, but overall this backup solution is ideal for virtualised environments

SCORE ★★★★☆

PRICE From £399 per year (exc VAT)
from barracuda-security.co.uk



Barracuda's backup solutions were previously offered in the form of hardware appliances; now the company has branched out with this clever virtual appliance that runs within a Hyper-V environment.

This makes it very quick to set up: we simply downloaded the image, imported it into our hypervisor, expanded its virtual hard disk, assigned it to a virtual switch and powered it up.

The final step is to link the Vx appliance to your Cloud Control account by entering its details in the web portal. Unfortunately, after we'd done this, the appliance continued to report that its cloud connection was down. A call to Barracuda's helpful support identified a problem with the appliance's certificate, and we were up and running within two hours.

From here on it should have been plain sailing – but, embarrassingly, before we'd even had a chance to upload our first backup, Barracuda's cloud service abruptly went offline. We could still back up and restore data from the local appliance, but we were without cloud services for a full day and a half – not an encouraging start.

Still, when everything's working as it should, Barracuda's backup solution is easy to get along with. Barracuda provides a single agent for all Windows versions and applications, and we were able to set up individual systems as backup sources by simply providing a hostname or IP address. By default, sources are fully backed up once a day, but it's easy to create custom schedules and select specific items to back up.

As well as everyday files and folders, we were able to back up individual Hyper-V and VMware VMs, plus SQL databases and an entire Exchange mailbox database. Message-level backups require a dedicated Exchange service account and a management shell command to define impersonation rights, but this is clearly documented, and took only a few minutes to set up. With this done, we were able to browse our Exchange datastore and select individual user accounts to be backed up.

For everyday management, Barracuda's web portal offers a wealth of information about backup health, available storage and deduplication savings. It's recently been updated, but if you prefer the old interface you can still access it from the appliance's own web console (which can also be used to initiate local operations).

ABOVE Barracuda's new portal provides masses of information about storage usage and activity

Data recovery is quite effortless: from the portal, we selected which systems we wanted to restore, chose specific files and folders, then selected whether we wanted to restore them to their original location or to the system running the portal. Likewise, with our SQL Server host, we were easily able to select databases and chose where to restore them. Selecting our Exchange MLB allowed us to view all users and opt to recover anything from an entire mailbox to a single email. And while VMs can of course be recovered to the host, we're also particular fans of the Cloud LiveBoot feature, which lets you launch backed-up virtual machine images in the cloud, and access them using VNC Viewer. This makes it fantastically easy to dig out lost data or test old application instances with zero upheaval.

"The Cloud LiveBoot feature lets you launch backed-up VMs in the cloud, and access them using VNC Viewer"

In short, Barracuda's Backup Vx appliance ticks all the important boxes. The initial outage shook our confidence, but we've no reason to believe it's likely to be a recurrent problem, making this a strong choice for any business that's invested in virtualised environments.

LEFT It's simple to configure backup and restore jobs from the appliance's console

REQUIREMENTS VMware ESX/ESXi 4 upwards ● Microsoft Hyper-V 2008 upwards

SolarWinds Backup 18.4

A great remotely managed backup service – it's pricey, though, and Exchange support could be smarter

SCORE ★★★★☆

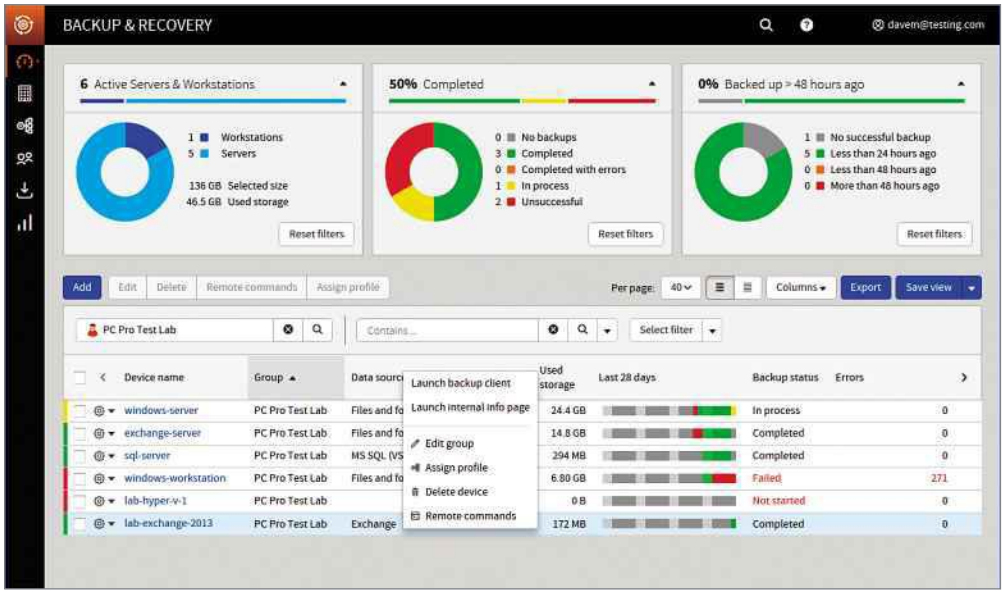
PRICE From £2,275 per year, ten OSIs and 1TB (exc VAT) from solarwinds.com

SolarWinds' network monitoring software has been a long-time favourite here at *PC Pro*. Now the company's latest backup product offers an entirely cloud-based service, allowing mid-sized and larger businesses to protect their servers, desktops and apps – wherever they may be – from a single web portal.

As is expected these days, the software takes a hybrid approach. The base subscription comes with a meaty terabyte of cloud storage, while the built-in LocalSpeedVault (LSV) feature adds onsite backup services for faster recovery. You can choose multiple local drives or LAN locations as destinations, and select which systems will make use of them.

The service isn't cheap. Prices start at £2,275 per year for your 1TB of cloud storage, and that only covers ten OSIs (operating system instances). Still, SolarWinds isn't restrictive about what these are. The product supports all versions of Windows, plus macOS and Linux, along with business apps such as Exchange, SQL Server, Oracle and SharePoint – and all OSIs can be either physical or virtual.

To get set up, your first port of call is the Backup & Recovery cloud portal. From here you can add systems to your account, and generate unique password-protected installation packages that can be downloaded or sent to users via an email link.



ABOVE The online console provides remote access to protected clients

Three types of agent are available: the regular version allows Windows, macOS and Linux users to choose their own backup sources, while the "Documents" version for Windows uses a predefined profile to automatically back up common document locations twice a day.

For more centralised control, the "Automated" package – again, for Windows only – picks up its settings from the backup profiles you create in the portal. You can configure options for specific drives and apps to back up, along with LSV locations and schedules. You can also remotely push profiles to selected systems, and lock them to stop them being changed.

One caveat is that when users install the package, they're prompted to provide a data encryption key. It's essential to keep a record of this; SolarWinds doesn't store a copy, and you won't be able to restore data without it.

You should also note that SolarWinds' Hyper-V support is a bit more fiddly than other providers'. Many backup systems only require you to install an agent on the host, but here you have to deploy the Backup Manager software onto each VM you want to protect. SolarWinds doesn't support message-level backups for Exchange either, relying instead on Microsoft's built-in single item recovery service.

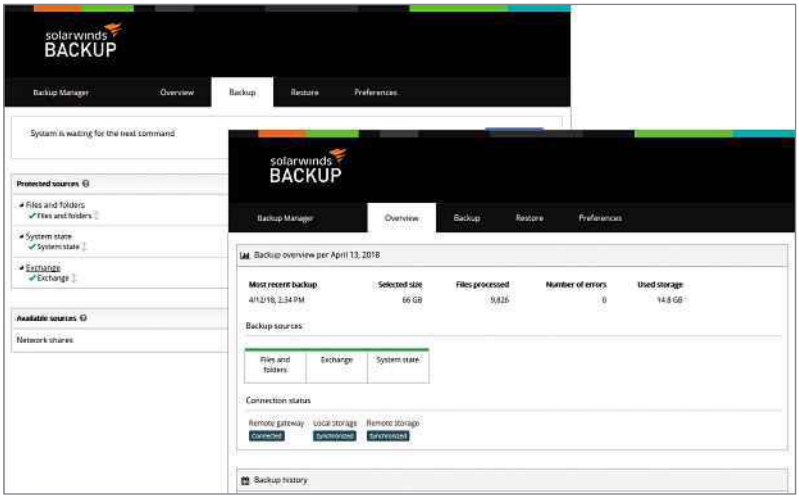
Finally, be aware that there's no direct vault seeding service. If you have a large dataset to back up, your best solution is to run a special backup job that copies everything onto removable media. This can then be imported onto a system with a fast internet connection, which in turn seeds the cloud vault.

When it comes to restoring your data, Backup Manager is impressively versatile. At its simplest, it presents a tidy tree structure of all backed-up data and apps; one clever trick is that support staff can remotely connect to the Backup Manager agent running on any individual client, making assisted data recovery a breeze.

"You can mount the latest backup as a virtual drive, so users can browse and restore files from Windows Explorer"

You can also mount the latest backup as a virtual drive on a client machine, so users can browse and restore files themselves from Windows Explorer via drag-and-drop. And if you need to perform a bare-metal recovery, there's a built-in restore tool that creates bootable USB boot media. This can be used to restore a backup onto a borked system, or onto new hardware.

SolarWinds Backup's cloud-first approach is ideal for businesses that operate across multiple different sites. And along with great platform and app support, it provides a handy range of data restoration services that are all easily managed from an informative central cloud console.



LEFT Backup tasks can be customised and monitored from the local client software

REQUIREMENTS Backup Manager: Windows • Linux • macOS X

Veritas Backup Exec 20

Great server backup features, slick recovery tools and versatile licensing make this a brilliant choice

SCORE ★★★★★

PRICE 1yr Bronze subscription, £370 per terabyte (exc VAT) from span.com

Backup Exec has always been a great on-premises backup service – with this latest release, it grows into a truly comprehensive solution. Along with support for SQL Server 2017, Backup Exec 20 (BE20) adds enhanced support for S3 cloud providers, instant recovery of non-Windows VMs and deduplication as standard.

Meanwhile, Veritas has simplified its licensing. The price above is for a one-year Bronze subscription with 1TB of backup storage. This supports all Windows, VMware and Hyper-V platforms, along with physical to virtual server conversions and the option to use one tape drive. The Silver edition adds support for Linux, Exchange, SQL Server and SharePoint plus up to four tape drives, while the Gold edition activates everything, adds unlimited tape drives and includes NDMP support.

The software runs on a 64-bit Windows server; we had it up and running on our Windows Server 2016 system in 30 minutes. The console opens with a highly informative dashboard, which can be customised by simply dragging widgets around.

Next, the client software needs to be installed on participating systems – which is no hassle at all, as you can push it out from the console using the remote deployment tool. The agent also installed happily on our Exchange, SQL Server and Hyper-V hosts. There's no need to deploy within VMs; the host agent takes care of them all.

Backup stores are configured next. We created a hard disk vault on the BE20 host server itself, but Veritas also supports physical and virtual disks, cloud, tape, deduplicating stores, network shares and removable devices, as well as S3-compatible cloud destinations.

ABOVE The Backup Exec console tells you everything you need to know about backup activities

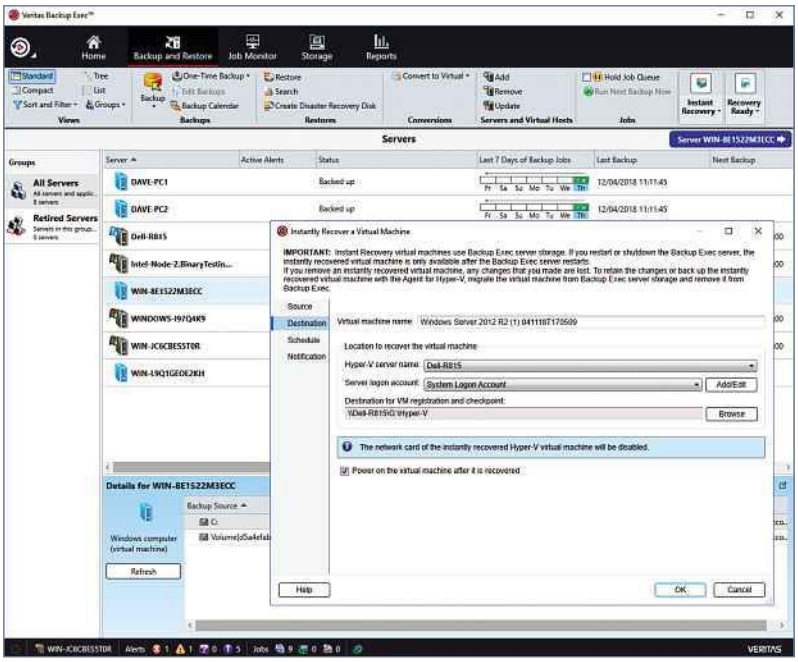
The software comes with predefined jobs for backing up servers to disk, or to the cloud. Naturally, you can customise sources, destinations and schedules, add extra stages such as migration to tape and set policies such as retention periods for individual destinations. The Job Monitor page shows all job activity, along with any issues encountered.

And restoring data, when the time comes, is a piece of cake. From the console you can choose a host, browse its files, folders or volumes, pick a backup or point in time and decide where to send them. Bare-metal recovery comes as standard too, while the Instant GRT feature lets you browse VM backups and restore any item within them – including SQL databases, Exchange datastores and individual mailboxes and emails.

"From the console you can choose a host, browse its files, folders or volumes, pick a point in time and decide where to send them"

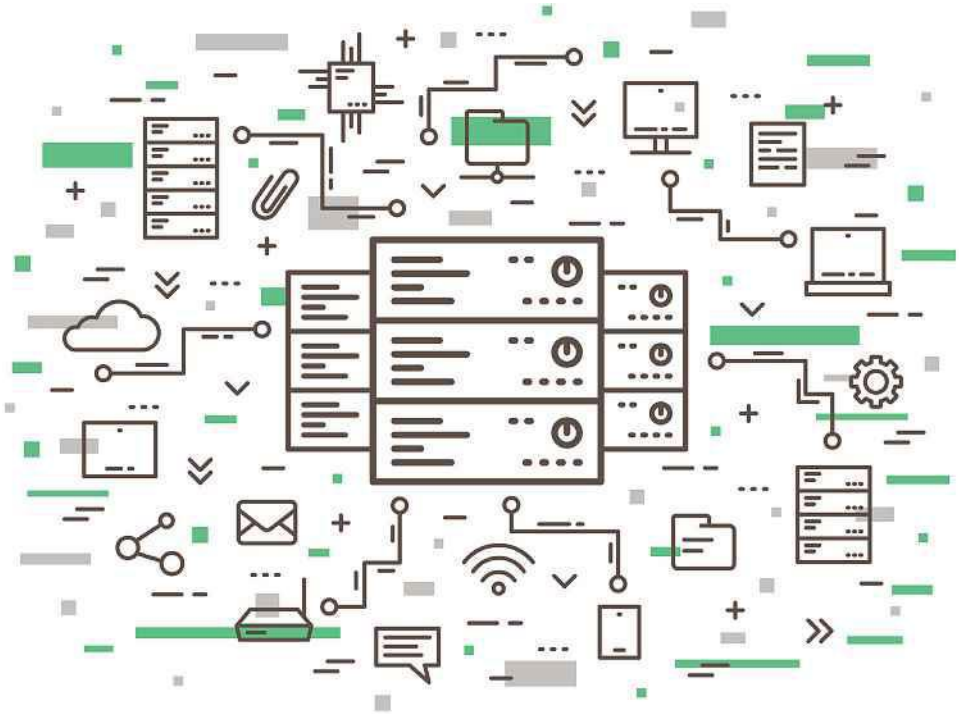
One last great feature is Instant VM Recovery, which can turn any backup into a VM. We found it took just four minutes to generate and boot a virtual duplicate of a past system state.

If you want total control over your data protection, Backup Exec 20 is the perfect choice. It's easy to use, yet provides a superb depth of features, and the price is within reach of even the smallest business. **DAVE MITCHELL**



LEFT The Instant Recovery feature quickly converts backups into VMs

REQUIREMENTS **Backup server:** Windows Server 2008 SP2 (64-bit only) upwards



Core-edge computing

Managing a diverse network is always a challenge; Steve Cassidy introduces a fresh perspective that can bring some clarity

Edge computing? Is this about that new web browser?
Microsoft has borrowed a trendy computing term for the name of its browser, but what we're talking about here is a whole new way of looking at your IT portfolio. Instead of thinking about physical PCs and servers, the core-edge model draws a distinction between the "core" machines that handle your principal business activities – web serving, databases and so forth – and the "edge", which comprises all the devices and software that are external to those functions.

Isn't that just a traditional client-server architecture?
A client-server model might map neatly onto your core-edge topology. However, for many systems, the old model no longer suffices. For example, oceanic meteorological buoys send data back to a server, but they also have considerable autonomy, so they can (for example) react when their tether is being chewed by a sperm whale – something that goes beyond a traditional client spec.

So what exactly are we calling an "edge" device?
You know when a Hollywood villain whips out a gadget and presses a tiny button to set his evil plan in motion? Anything that would work in that role counts as an edge device. Phones are in, as are tablets: one definition might be any device that isn't (or doesn't need to be) inside your firewall. One former client of mine manufactures huge oil pipeline machines: those are edge devices, as are Formula 1 cars, my Pebble watch, and the aircon control panel in my hotel room.

"Cutting down to just two categories of device makes it much simpler to identify stress points and plan improvements"

What are the benefits of thinking about computing in this way?
It's all about resilience. A lot of apps and services seem to have been designed in a vacuum, and they don't always talk to each other in efficient or reliable ways. The core-edge model exposes such behaviours, and helps developers and architects focus on the flow of communication. Switching to this mindset won't magically make your network more robust, but it can expose the cracks through which data might slip.

We're using a hybrid cloud setup – so isn't everything in our office both an edge and a core?
Don't get hung up on the physical locations of your devices. The division between edge and core is about where you would locate them in a network diagram.

Admittedly, this may not be immediately obvious. Desktop PCs are normally core devices, but if your business is cloud-based then they might be edge devices. The litmus test is whether you're accessing your own remote servers, or logging onto someone else's system.

How are our IT staff supposed to adapt to this new approach?
With a big sigh of relief! A modern network brings together servers, laptops, phones, tablets, IoT sensors and more. Cutting all that diversity down to just two categories of device makes it much simpler to visualise your network, identify stress points and plan improvements.

Best of all, the core-edge model comes free with IPv6, which lets devices have both temporary connection addresses and permanent subnet addresses. So your core-edge structure needn't be an abstraction – it can be fully embedded into your network topology. ●

Core-edge and the Internet of Things

A key part of core-edge thinking is that it doesn't categorise devices based on their physical location or capabilities. A little Raspberry Pi, running a small but important service, could be a core device – while a server in your back office could be, toplogically speaking, out on the edge.

Even so, it does no harm to acknowledge that the core-edge philosophy owes a lot to the growth of IoT devices – typically single-function sensors that have been designed for remote deployment and unattended operation.

With a bare minimum of computing power on board, IoT devices aren't expected to have much in the way of smarts, and frankly if you're deploying one then you need to anticipate that it might not be perfectly reliable.

That's certainly not a bad discipline, though – because nothing in life is perfectly reliable, and a good IT strategy will work with that reality. Adopting a core-edge mentality will stand you in good stead when your cameras, printers and desktop PCs unexpectedly stop behaving as they should.

DrayTek Vigor 2862Lac

A nigh-on perfect SME router, offering top-notch security and wireless features at a generous price

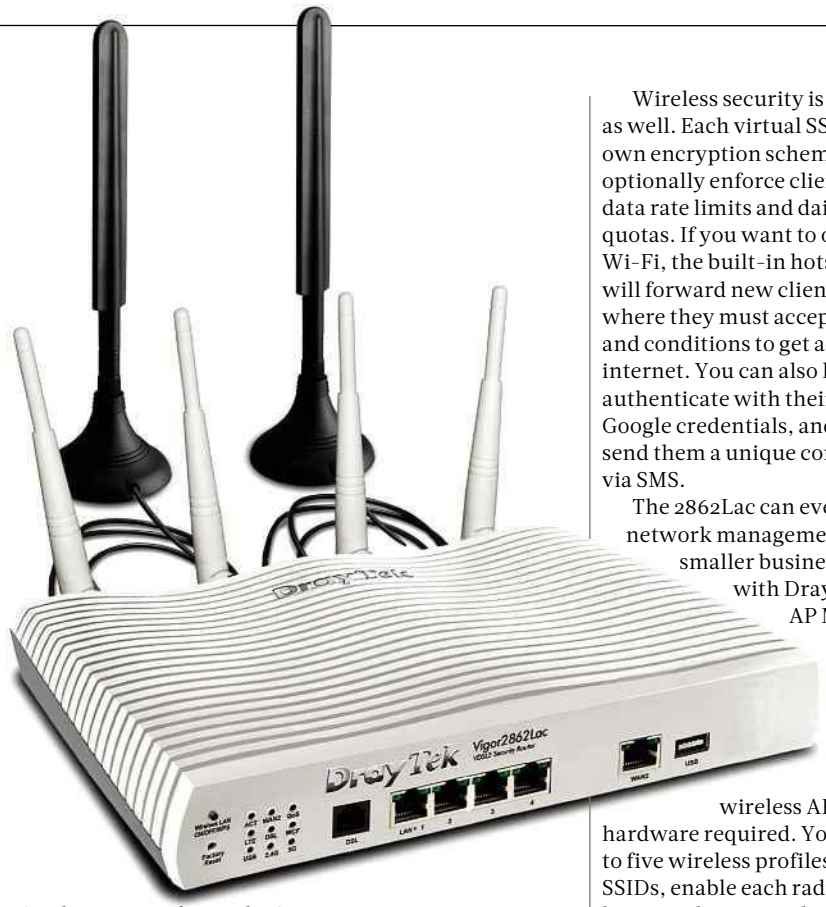
SCORE ★★★★★

PRICE £354 exc VAT from netxl.com

DrayTek is one of the premier names in the business router market – and the new Vigor 2862Lac is probably the company's most impressive offering yet. Replacing the previously A-Listed Vigor 2860Ln, it doubles firewall performance to 400Mbits/sec, expands VPN options and has WAN redundancy features in abundance.

What do we mean by that? Well, for starters, the price includes support for 32 IPsec VPN tunnels – and up to 16 SSL VPNs as well. Then, alongside the ADSL2+/VDSL2 port, the 2862Lac also features both a 3G/4G SIM card slot and a USB socket that will accept a secondary 3G/4G USB adapter – so you won't be knocked offline unless three different networks go down at once. Alternatively, you can set multiple WAN connections active, with the router performing load balancing. Or, it can bring your secondary connection online when traffic reaches certain thresholds.

Those capabilities alone would make the Vigor 2862Lac attention-worthy, but there's plenty more here to like. The front offers five Gigabit Ethernet ports (the fifth can be used for either LAN or WAN duties), and the 2862Lac supports concurrent 2.4GHz and 5GHz 802.11ac wireless services too, with four SSIDs per radio and a new scheduling feature that lets you decide when each SSID is active.

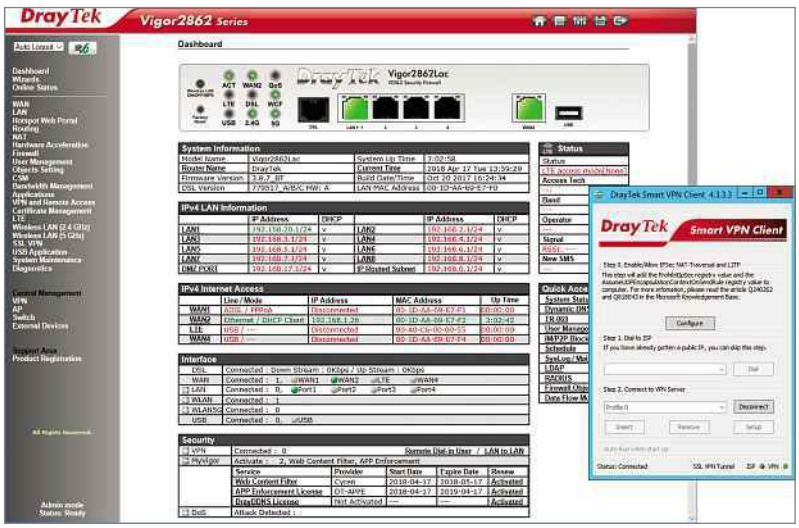


ABOVE **A fine set of ports gives you ample redundancy options**

On the security front, the SPI firewall is active by default, and easy to customise by setting up "data filters" – packages of rules defining traffic types, destination addresses and so forth.

There's also a basic keyword-based URL-filtering service. This isn't exactly sophisticated, but DrayTek's Cyren-powered URL category-filtering service costs a reasonable £35 per year and lets you create multiple web-filtering rules, based on over 60 site categories.

More impressive are the built-in application controls. Along with IM and P2P apps, you can manage access to various protocols, plus streaming, remote control and web apps. If Facebook use in the workplace is a concern, you can block both wired and wireless clients from logging in.



LEFT **The 2862Lac is bursting with security measures, including easy to use SSL VPNs**

Wireless security is well covered as well. Each virtual SSID can use its own encryption scheme, and you can optionally enforce client isolation, data rate limits and daily bandwidth quotas. If you want to offer guest Wi-Fi, the built-in hotspot service will forward new clients to a web page where they must accept your terms and conditions to get access to the internet. You can also let visitors authenticate with their Facebook or Google credentials, and the router will send them a unique connection code via SMS.

The 2862Lac can even serve as a network management appliance for smaller businesses; it comes with DrayTek's Central AP Management (CAM) feature built in, so it can discover and provision up to 20 DrayTek wireless APs with no extra hardware required. You can create up to five wireless profiles across four SSIDs, enable each radio, set traffic limits and activate client isolation. The auto-provisioning feature ensures that when APs come online, they will receive this profile automatically – or you can push custom profiles to selected APs. The 2862Lac can manage up to ten DrayTek VigorSwitch devices, too.

This might all sound like an overwhelming amount of technology to get to grips with – but it's a lot easier than you might imagine, as the router's web interface offers wizards for setting up internet access, securing wireless services and creating site-to-site or client VPNs. In just a few minutes, we were able to create an SSL VPN, allowing an external Windows 10 PC to connect to the LAN via DrayTek's free Smart VPN Client. Best of all, it proved remarkably speedy: we were able to copy files to the LAN at 5.4MB/sec – a fourfold boost over the 2860Ln.

"In just a few minutes, we were able to create an SSL VPN, allowing an external Windows 10 PC to connect to the LAN"

Clearly, DrayTek's Vigor 2862Lac is absolutely loaded with potential – even more so than its highly respected predecessor, and for only a few pounds more. There's almost nothing a business could ask for that it doesn't do, making it an easy choice for any switched-on SME. **DAVE MITCHELL**

SPECIFICATIONS

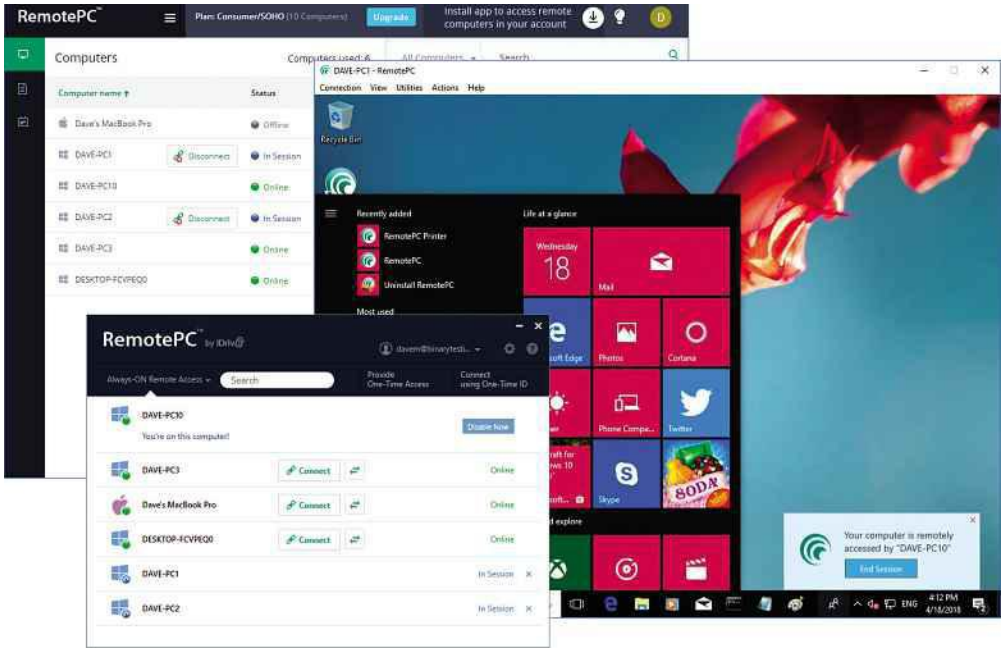
Desktop chassis • 5 x Gigabit Ethernet (4 x LAN, 1 x WAN) • ADSL2+/VDSL2 interface • 3G/4G LTE SIM card slot • 2.4/5GHz 802.11ac wireless • USB 2 • External power supply • 241 x 166 x 44mm (WDH) • 2yr RTB warranty

IDrive RemotePC

A complete cloud-hosted remote support system that's simple to use – and irresistibly cheap

SCORE ★★★★★

PRICE First year, from £4.80 for ten computers (exc VAT) from remotepc.com



Our cloud backup provider of choice for many years has been IDrive, partly because it's excellent value for businesses of all sizes. Now the company has expanded into remote support – and its RemotePC platform retains that sharp focus on affordability.

To be clear, the ultra-low price listed above won't last forever. It's a special offer that only applies for the first year. After that, you'll be renewing at the standard rate – but that's still just £49 per year for up to ten computers. You could literally pay for it out of petty cash.

And you get a lot for the money. Along with remote control of Windows, Mac and Android devices, RemotePC offers live chat, file transfer, remote printing, session recording and collaborative sessions. There are also apps for Android and iOS, so staff can even provide support while they're out on the road.

Getting set up is a modest project. The RemotePC app needs to be installed on each supported computer in turn, then connected to the main account. With this done, it runs quietly in the background; if need be, you can set a computer to be available when unattended by configuring a passcode, which the remote agent must then supply to gain access. For greater security, there's also a one-time access option: this generates a unique code that can be used to initiate a single session, then expires, leaving the computer locked down.

However you connect, the remote session window presents a view of the host's desktop, along with a menu bar at the top offering various support tools. If you have a dual-monitor setup, you can conveniently view the remote session on one of them, leaving your own applications and resources accessible on the other.

Certain features appear in their own windows. The file-transfer tool opens an Explorer-type interface, allowing files and folders to be copied to and from the client via drag-and-drop. Chat opens another window in which participants can message one another. Interestingly, the Sticky Notes feature allows you to make notes and save them to the host computer for later reference. You can also blank the host's screen, lock it to the login screen and take screenshots on demand. Indeed, as we've mentioned, you can capture video: choose "Record Now" and whatever happens next will be saved as an AVI file on the guest computer – perhaps useful for future analysis, or training.

ABOVE RemotePC delivers user-friendly remote control with a simple client app

All communications are TLS 1.2/AES-256 encrypted, and there's very little risk of users being spied on without their knowledge: always-on access can be denied from the client app, and host users can close a remote session at any time they want.

You can also keep an eye on who's connecting to what from the simple management portal, which lists all registered computers along with details of their last remote session and where it came from. Oddly, you can't initiate a session from this portal, but you can instantly shut down any suspicious-looking sessions you may spot.

"The simple management portal lists all registered computers along with details of their last remote session"

You can also get an overview of logged-on systems from the Android and iOS apps – and open a remote connection by simply tapping on a host. After entering the correct personal keys, we were able to use our iPad to remotely control both Windows and macOS systems. For convenience, you can call up a virtual keyboard and use touch interaction to simulate a connected mouse.

RemotePC is a great choice for small businesses that don't want to spend the earth on a cloud-hosted remote support solution. It may not have the bells and whistles of some competing products but, at this unbelievably low price, it's impossible to complain. **DAVE MITCHELL**

LEFT The RemotePC app let us remotely control our MacBooks from an iPad

REQUIREMENTS

Windows 7/Server 2008 upwards ● macOS X 10.9 upwards ● Android 3 and iOS 7 upwards

Software suppliers
The 800lb gorilla problem

Your business relies on certain software to function – so what happens when the publisher's interests don't align with yours? Steve Cassidy explores a widespread problem

I've visited a lot of businesses over the years and, time and time again, I've seen one particular scenario play out – one I call the "800lb gorilla problem". Indeed, it's not just limited to tech companies: it almost doesn't matter what business youre in.

That's perhaps not something you'd normally expect to hear from a consultant. The official philosophy is that every company is different, and a lot less wisdom than you'd hope is reusable from one firm to another. But then 800lb gorillas don't follow the normal rules. In the words of the old joke: where does an 800lb gorilla sit? Wherever it pleases. In this case, the gorilla is a de facto monopoly supplier. They crop up in all sorts of industries and, if your business relies on their services, you have little option but to shape your budgets, practices and roadmaps around theirs.

This isn't to say that every sector that's dominated by a single vendor is necessarily toxic. For example, most product designers use AutoCAD, which has an 85% market share in the CAD sector; lots of salespeople won't go to a job where they can't use Salesforce. In both cases, there's a fairly benign coexistence between the publishers and the users of the software. Firms treat the predictable licensing rates as a simple cost of business, and the software houses shape their plans and offerings to fit the market's majority population.

I only wish that such genteel relationships were the norm across the software business. Unfortunately, they're not. One hears plenty of stories about software suppliers mistreating their base of invested users, forcing through unwanted changes to the product or pricing, or ignoring desperate pleas for much-needed updates and improvements.

Indeed, once a gorilla company has set its direction, the possibility of a mutually productive commercial relationship often goes out the window. You're no longer dealing with a rational entity that can be negotiated with – not even in its own interest. Case in point: a certain Nordic cellphone company, which not too long ago enjoyed a world-straddling position of supremacy, but whose obdurate core of directors and developers refused to heed market forces and respond to the competition. Nowadays, it's just a small-town tech company.

"Once a gorilla company has set its direction, the possibility of a mutually productive relationship often goes out the window"

That story doesn't perfectly mirror the situation small businesses tend to find themselves in, however, because the consumer market is bigger than any single operator and such hubris tends to get its comeuppance before long. With business software, things are a lot harder: the market is smaller, and the power imbalance is greater, so big players can coast along for decades – and all we can do is put up with it.

Risky business

I know you're itching for more real-world examples, but before I go on, note that one part of the problem is that naming and shaming comes with a risk of legal action. Even if you, as the customer, are in the right, the cost of standing up for yourself can be prohibitive. If a supplier is dysfunctional enough to abuse their customers' goodwill, there's a fair chance they're going to be quite litigious as well.

That being the case, forgive me if this next example is less specific than I would like. Let's just say that one experience of mine involved a software rollout project in which the

supplier's project manager – a pivotal role – also happened to be a member of Team GB for the 2012 Olympics. For some reason, the software project implementation plan made no specific allowance for his absence during the games: the client simply had to assume and hope that everything would be all right.

In the event, things went very well indeed – for the project manager, who progressed through the heats and the quarter-finals and so on as the Olympics rolled on. The customer, on the other hand, was left sitting wondering whether they would ever see him again. In the end, final implementation was delayed by an entire year, because the chance to cut over from old to new system relied on specific annual dates.

This may sound like a unique turn of events, especially given the Olympic element to the whole affair, but there's something depressingly familiar about the attitude, if not the specifics. The software supplier is embedded in a specialised industry, and the customer has little option but to take on their product because it embodies all the industry knowledge and expertise that's needed to compete. To the publisher, however, that particular implementation is a low (or non-existent) priority: the implementation team probably had a clearer idea of the impact of the delay than the customer did, but that didn't matter, because there was nowhere else for the customer to go.

There are other expressions of this kind of problem, although they're often sunk so deep in the business culture that they're not always easy to recognise. Antivirus firm Kaspersky may have been in the news for the wrong reasons lately, but nobody would deny that CEO Eugene is a master of telling customer stories, and he has on several occasions drawn attention to another 800lb gorilla effect that relates to the security sector. Specifically, many businesses are under the thumb of a local gorilla that forces them – likely through inaction – to remain on Windows XP. When you see a power station or a sewage farm going to extreme lengths to secure its networks, or desperately trying to find a cloud solution to replace its local devices to dumb display status, it's often because they can't get the historic application developers to revisit or update their features they depend on.

ABOVE Customers often have little choice but to take on gorilla suppliers' products if they want to compete

"Many businesses are under the thumb of a local gorilla that forces them – likely through inaction – to remain on Windows XP"

At the bottom, the problem of the 800lb gorilla is more a business issue than a technical one. Software developers are often not red-hot profit-making demons by nature; it may well be that they'd love to be more supportive and amenable to their clients, with timely updates and customisations, but find themselves with no revenue stream to support such efforts.

This is a curiously open type of prison. There are many ways of structuring a company that could improve matters. For example, the developer might sell shares to the users, or they could buy a bond with a known rate of return, and receive the software as a separate valueless transaction.

ABOVE **One way to tame your gorilla supplier is to compare notes, and concerns, with other businesses**

However, most of the IT world is obsessed by "shrink-wrap" distribution, in which software is tangible and paid for up-front – and very few customers want to get caught up in venture capital funding, which places other restrictions on relationships between the provider and consumer.

Doing it the right way

While gorilla suppliers are a real and pervasive problem, let's not exaggerate the situation. Abusive business relationships make headlines: people who just get on with the job don't. I hear from aggrieved customers ten times for every time a happy, proud supplier gets in touch – and it might not be coincidental that the happiest of suppliers is also the largest, at least if you take the company's own statistics at face value. That's SAP, which hosts an annual ceremony and present awards to its own customers recognising and celebrating the successes they have had with its systems.

Perhaps this is the scale at which software relationships work best, because SAP has plenty of experience in a dominant-player role. Indeed, it may be instructional that the company is used to having a major presence in more than one sector at a time, and fosters a strong internal culture of sharing lessons learned in one sector with teams working in other areas. And it's difficult for manipulative or damaging behaviour to emerge when a typical project requires more than just a single consultant, trainer, project planner and so on. When I recently attended the SAP awards I saw teams from all over the world, competing with their internal SAP mentors to be judged best that year, ranging from a two-person team representing Tata Steel to a group of seven from Cape Town.

Of course, if you try to use SAP as the yardstick for every vendor you do business with, you're going to come away disappointed. Some of the attributes that make up the firm's customer service record are just not going to be available to other sectors, developers and businesses. Indeed, at the time you enter into a relationship with a supplier, there may be precious few clues that it's going to grow into an 800lb gorilla; businesses don't tend to start acting that way until they feel fully entrenched in a market. So while you can look for the red flags, even with the most careful diligence, you may still end up having to cohabit with a gorilla.

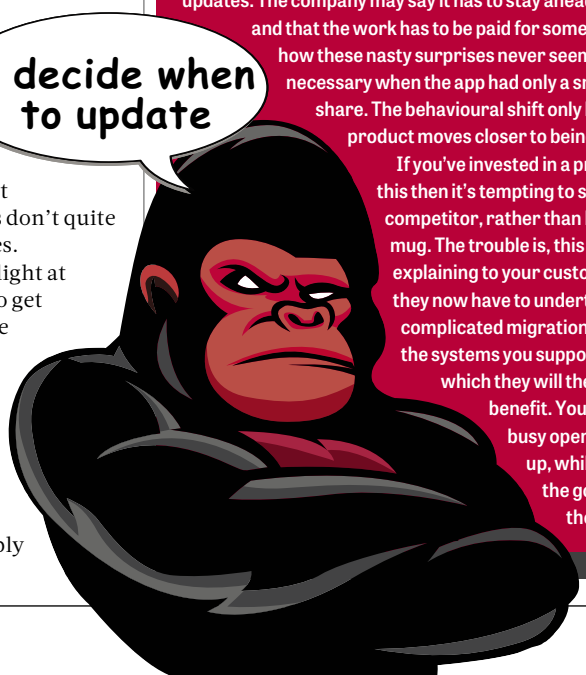
How to tame your gorilla

So, one way or another you've ended up in thrall to a market-dominating supplier. What can you do? There's no one-size-fits-all answer, because the precise nature of your gorilla is likely to be sector-specific – and formal resources such as project planning, contract law and human resources don't quite address the relevant issues.

One idea that came to light at last year's CeBIT expo is to get involved in a forum where businesspeople can vent their frustrations and compare notes with others in similar situations. This may illuminate ways forward, or just make you feel better. Conceivably it could even allow you to join forces and demand change, but don't bank on it – as we have mentioned, gorilla behaviour isn't always rational. The concept comes from Mexico, which is not so straight-laced as our own isles, so if we say that the meetings you should search for are known as "Muckup Nights", we would be only a typo away from the truth.

Alternatively, you could play the longer game. Start dipping toes into software development yourself, and run up a prototype or two of the system you'd like to be using, rather than the one that's become the industry default. Gorillas thrive on locked-in customers; you might find that a wet bank holiday with a trial copy of FileMaker Pro is all it takes to put the frighteners on a lazy developer. Failing that, well, let's not underestimate the challenges of following through, and genuinely developing and maintaining your own bespoke systems. But compared to the privations of living in Gorillatown, it's a possibility that's at least worth exploring. ●

"When you enter into a relationship with a supplier, there may be precious few clues that it's going to grow into an 800lb gorilla"



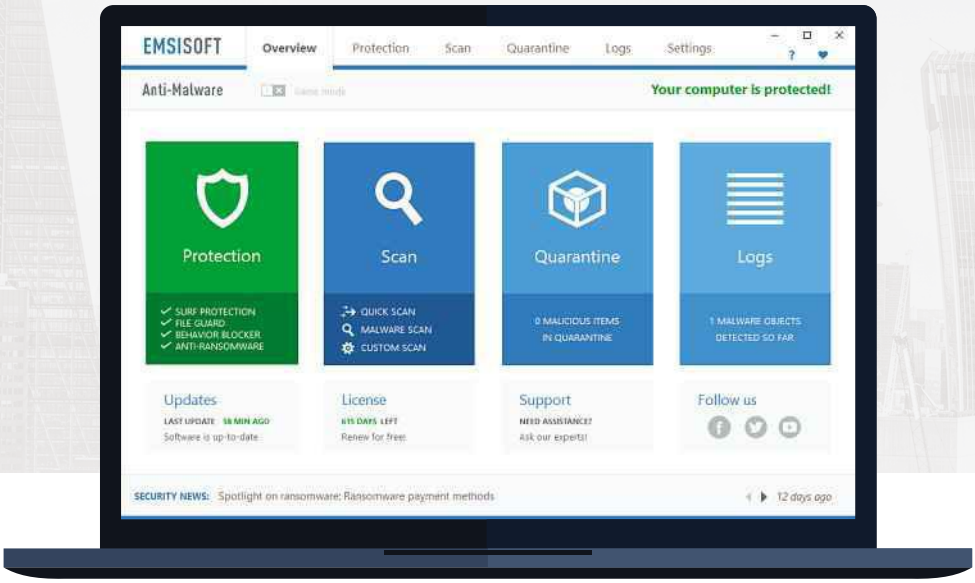
It can happen to anyone

If you're a small business using off-the-shelf software, you may think you're safe from gorilla syndrome – leaving aside the possibility of industry titans such as Microsoft and Google turning your infrastructure upside-down for reasons of their own.

But take the example of a classic IT support company. This used to be a merry and varied field of largely free services, but over the past few years, things have converged onto a very small number of products. I won't name the specific remote-access tool I have in mind here, but it has user counts and installs now up in the billions – and sure enough, it's started to act like an 800lb gorilla.

One way this manifests is licence fees. An annual business licence currently comes in at around the $2,000 mark, and this of course can be comfortably budgeted for – except when the company then starts hitting you with additional mandatory paid updates. The company may say it has to stay ahead of the hackers, and that the work has to be paid for somehow. But it's odd how these nasty surprises never seemed to be necessary when the app had only a small market share. The behavioural shift only happens as a product moves closer to being a monopoly. If you've invested in a product like this then it's tempting to simply move to a competitor, rather than being taken for a mug. The trouble is, this means explaining to your customers that they now have to undertake a complicated migration project on the systems you support – from which they will themselves see no benefit. You can't blame busy operators for paying up, while cursing the gorilla under their breath.

EMSISOFT



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THE BUSINESS QUESTION

How do I take my website to the next level?

The battle to reach Google's first page is more intense than ever, but experts argue that isn't always the key goal. Nik Rawlinson reveals all

However well your website's performing, it could do a bit better. Attract more clicks, generate fresh leads, convert new customers or climb the search rankings: whatever your measure of success, a tweak here and there can help you move towards your goal.

Is it time to give your homepage the heave-ho?

There's been a lot of talk about the death of the homepage – and the importance of multiple entry points. Not only do these increase your chances of ranking for specific content; they also mean there's a greater chance of visitors landing on just the information they need.

To JM Littman, this is nothing new. "Every page on a website has always been important," said the new media director of web design agency Webheads. "You never know who is going to land on that page."

David Gelb, managing director of web development agency JBi Digital, agrees. "The concept of multiple entry points is nothing new," he told *PC Pro*. "We talk about multiple mini homepages. People coming in through their mobile generally won't go to the homepage as much as before – and if they're arriving on the back of a push action they definitely won't. Mini websites [make for good] information architecture [suited to] targeted audiences."

But where should you put them? Is a mini homepage just a folder within the same domain, as the BBC's news pages are now, or is it better set up as a subdomain, as **news.bbc.co.uk** once was? In Gelb's view, the answer depends on your goal – as well as your resources. "If you start having extra domains, you need to manage them," he said, pointing to the increased cost and administrative burden. "But SEO is also a consideration. If you have extra domains, are you taking [the focus] away from your core domain?"

Does SEO matter anymore?

SEO means various things to many different people. For some, it's a case of gaming Google – but often they don't know why.

"If someone comes to us and says they just want to be number one on Google, we'd have a conversation about what that means. A lot of the time it turns out not to mean what they think at all: it actually means they want to win new business," said Jason Jenkins, director of content at marketing and PR agency Padua Communications. "We don't see search engine optimisation and catering for our clients' visitors as two separate things. You should be talking to the customer directly. By giving them well-written, good, relevant content, you'll inevitably rank for the sort of terms you want to target."

Littman, too, sees content as a key tool in ranking well. "A successful website is always going to be tailored towards the user. That means great design, great UX and great content. Without those three elements, you're going to fall flat somewhere along the line."

"By giving customers well-written, good, relevant content, you'll inevitably rank for the sort of terms you want to target"

Littman points out that stuffing a page with keywords isn't the answer. "If you're selling baked beans… repeating baked beans 100 times over a page may have worked a long time ago, but you've got to focus on what a customer wants when they land on a site. Make sure the information is clear, the typography is great and it's easy to read."

So, what should a business do if it's making no headway on Google, Bing or other organic search? "The first thing is to understand is where they're

struggling," said Gelb. "Is it getting footfall in the first place, in which case are they SEO-optimised, spending money on Google, making sure their ads are working, using the right kind of call to action and so on? If people aren't converting, they need to drill down into their stats and see where they're not converting, whether they're overcooking it with too much content – which is actually quite common – and whether their information architecture is good."

Understand your market...

Gelb stresses the importance of research, not just at the initial design phase, but when reworking an existing site and, if the budget will stretch that far, on an ongoing basis.

"A lot of businesses don't know all they should about their audience. We spend a lot of time on user research, stakeholder interviews, focus groups and things like that. Businesses really need to understand their audience, so they can make their user journeys a lot more personalised," he said.

Once you know who they are, you can start addressing potential visitors in a more relevant way. As Jenkins explains, when you know who you're talking to you can, "write content that's relevant to people in your market and think about how to label that so Google can find it more easily." For him, that "isn't any different to writing good content. If you write a really obscure headline or one that's a joke or a pun, the chances are it's not going to be picked up by a search engine for the keywords it's intended for. Keep it simple, clear, short, direct and honest. Tell good stories."

...and its way of working

"The web is definitely going in a more mobile-friendly direction," said Littman, confirming what we already suspected. However, it's not a universal shift. Webheads' business-to-business customers' stats show that where business-focused sites are concerned, 60% to 70% of the traffic comes through a desktop browser, and consumers also resort to Windows or the Mac for big-ticket purchases. "We might be looking at ordering stuff from Amazon on our mobile, but even there, if it's a high-value item, a lot of people search for it on their phone but want to look at it on a bigger screen. Desktop is definitely not dead, and I don't see it going anywhere soon."

Gelb agrees: "If you're developing for business-to-business, your visitors are predominantly in a PC-focused environment, which is why it's still heavily desktop-focused. It depends on the industry, though. If you look at business-to-consumer, mobile is huge. We've just designed a big site for a women's lifestyle brand and that was mobile-first, because everyone is buying on their phones."

So, while "mobile first" holds true, ignore the desktop at your peril. Responsive sites are still a must, but where "responsive" used to mean accounting for mobile users, now it means making sure you're bringing traditional visitors along for the ride.

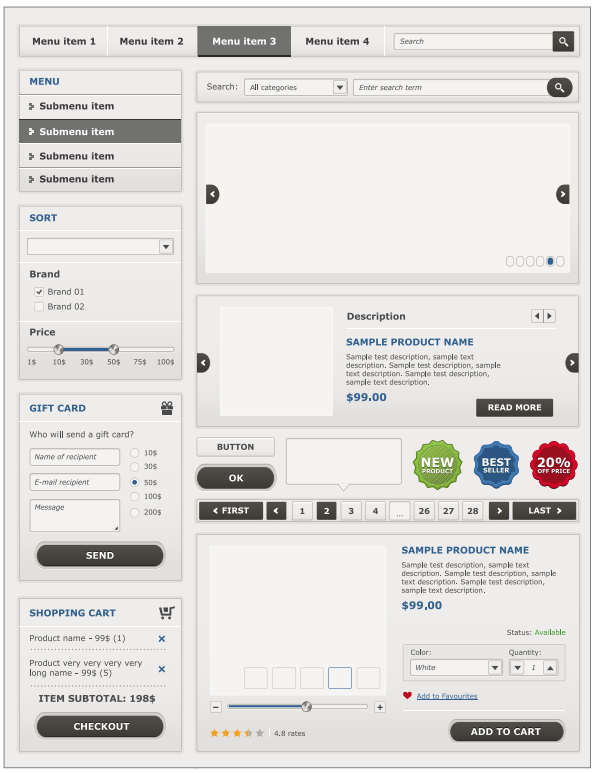
Why? It may be that the desktop or laptop screen is a more comfortable environment in which to read longer tracts or click between multiple tabs. "The larger the item they're buying, the longer they research it," Jenkins said. "People are researching all the time and use all the different methods of communication."

Hire the right help

Understanding your audience, what it wants and how you should talk to it will go a long way towards taking your site to the next level. Some businesses – particularly smaller ones – will be tempted to do the subsequent work themselves, developing a site on a consumer platform in the belief that, because they know the business themselves, they're best-placed to talk about it online.

There's some truth in this, but consulting with experts frequently pays high dividends. The key, said Gelb, is to pick the right team for the job, even if that means sourcing players from several organisations.

"Everyone has key areas of specialisation," he said, "and the more niche [your demographic], the more specialised you want to go [with the help you hire in]. If you have a very consumer focus looking at the 18 to 25-year-old women's segment, having a marketing agency that really understands that segment is much better than just using the web agency that built your site." ●



BELOW While the web is becoming more mobile-friendly, keep in mind that most traffic to business sites comes via a desktop browser

The expert view Tim Gee

Here's the bad news: the old SEO tricks for trying to fool Google into ranking your website are not only dead but more likely to do harm than good. The good news? Everything you must now do to help your pages rank on Google will also be the exact things that will help conversions, attract leads and build your brand.

With Google increasingly using data on how users interact with each site to decide who to feature, making your pages better for users is the safest bet to see them rise up the rankings. Whether it's speeding up load times, providing a clean design or writing engaging content, they all play a part in making sure your website is sending the right signals to Google – all the while supporting your business goals.

Something as simple as the speed a page loads can have a significant impact from both Google and user perspectives. A speedy website suggests a high level of professionalism and so trustworthiness – potentially helping conversion rate. Recent studies have suggested 53% of mobile users will abandon a website that takes longer than three seconds to load, while conversion rates drop by up to 7% for every second delay in loading time.

There are ways to help Google do its job: giving content a clear hierarchy and not allowing different parts of your site compete for the same attention is vital to help surface the landing pages you want.

While these kind of improvements aren't easy, some quicker wins are often available by minimising the "bad" signals your site sends. Factors such as having duplicate content on your site (either from another page on your own website or, even worse, from another website), a lot of "thin" pages with little or no content, and an accumulation of server errors can all impact how well your site will rank.

The reports of SEO's death may be greatly exaggerated but the era of quick, sneaky wins is definitely over.

Tim Gee is a senior content strategist at Dennis Publishing and has helped to reboot Coach, evo and Expert Reviews

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JON HONEYBALL

"I rebooted, only to have a Dell boot icon tell me that it needed to spend an hour contemplating its navel"

Jon does battle with Windows Update, discovers a Microsoft extension for Chrome, and says a few kind words on the passing of Apple AirPort

It was a somewhat grey and wet April Saturday. With a deadline looming, I'd come into the lab to try to get ahead with some work, and I needed a Windows machine to hand. My normal methodology here is to run everything in a VM, using either Parallels or VMware Fusion, both running on a decent spec of Mac. I like the separation of "church and state", by having the base OS be something entirely different to the host.

This is especially true when you're testing antivirus and network security software. Handling Windows malware is somewhat easier when you know it can't infect the base OS. And the Windows session itself is temporary, so can be blown away and restarted at a moment's notice.

But for some reason, I decided that this work was going to be done on a "real" Windows machine, where you run Windows on the base hardware. I know this is a common thing that people do, but over the years I've come to the conclusion that it's all just too much hassle. I'd even go as far as saying that Windows desktops should be run inside a VM, if you have a choice. Which, of course, you don't in a corporate environment. But for that you have the excellent OneDeploy technology I've raved about before, which lets you push out images to hardware with only a few clicks.

So, to solve my problem, I grabbed the Dell XPS desktop all-in-one that I've had kicking around for a few years. As a cheap Windows alternative to the iMac, it isn't a bad bit of kit and it's worked well for me. I started it up, and went to log in – which is when my troubles began. Windows wouldn't let me enter. I knew the password was correct, but the more I tried, the less cooperative it became.

I rebooted, only to have a big Dell boot icon – along with Windows-style spinning wheel – tell me that the hard disk was corrupted and that it needed to spend an hour contemplating its navel. I let it have three hours just to be sure, and got on with other work. After its generous time slot had ended, it was still saying the same thing. So, I hit reboot once more, only to discover that the machine had disappeared up its own fundament and I wasn't even getting the BIOS boot splash. Insertion of a genuine Microsoft Windows boot USB stick did nothing to help. Clearly, the machine had gone AWOL.

Fortunately, it has an HDMI input port, so I decided I could hook it up to a laptop and use it as a bigger screen. At this point I should have just given up on the whole idea and fired up some VM sessions. But, like a bull in a china shop, I wasn't going to give up now.

I reached for my Surface Book, the one with which I've had a love-hate relationship after spending umpteen thousands of dollars on it at launch, and then waiting months for the semblance of stable firmware for it from Microsoft. I have the desktop breakout box for it, which provides USB sockets, Ethernet and a video out. Finding the correct cable dealt with the interconnect issue, and I soon had the Dell running as a second screen on the Surface Book.

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BELOW Here's the message I faced when I checked the Updates on my Surface Book. Not helpful

Which would have been the end to my tale, except I went to Windows Update to ensure everything was indeed up to date. And there I found a bunch of firmware updates from last September for the Book that hadn't been applied. No, I have no idea why they weren't installed, but they were listed, loud and proud. So I fired off an update, and sat back.

Once that had completed, and the machine rebooted, I did a final Update check, only to discover in big red letters the phrase: "Your device is missing important security and quality fixes." Of course, being Microsoft, it wouldn't deign to tell me which ones were missing or what I should do to remedy this. Repeated pressing of the "Check for updates" button resulted in the same outcome.

At this point, my muttering became somewhat purple in nature, with me asking out loud into which orifices of a Microsoft engineer a Surface Book could be inserted. I looked at "View update history" to discover that it was blank – apparently some updates can clear the update history, which ranks as a truly inspired piece of coding.

I tried the Windows Update recovery tool. That didn't do anything useful. I even tried the command prompt method of shutting down the services, moving the update catalogue and log files, and


Jon Honeyball
Opinion on Windows, Apple and everything in between – p110


Paul Ockenden
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The wider vision on cloud and infrastructure – p120

restarting the Windows Update services. That didn't work either. There was nothing left to do but to start again. I booted from USB and wiped the machine.

Once the install had completed, checking updates showed the red message had disappeared – which was something of a relief. The first thing to be installed was Dashlane, to bring my password system onto the machine. A quick install of Office 365 followed, with the inevitable pondering of why the Office team tries so very hard to make you take the 32-bit version when a 64-bit version is available too. And then Dropbox, followed by another long navel gaze, even though by default all files are left in the cloud for just-in-time download.

At this point, it was 3pm. My will to live had mostly disappeared, and I went home via the pub. All my good intentions had been blown away by a dead Dell and a worryingly undead Surface Book. Never has a VM looked so tempting.

App updates

Last month I had quite a good moan about three UK companies, with tales of woe about their software updates. One good piece of news: Chord has shipped its iOS app for controlling the Mojo/Poly combination. The app is quirky but it does what's needed, so thumbs up there.

Naim did launch a firmware update and new iOS app. However, despite there being firmware for mostly everything the firm has shipped, there was nothing for the Uniti Core product. So, it remains stuck where it was, which is something of a disappointment.

I downloaded the Android app for the Hoover again, and found it still wants a full land-grab of every conceivable device, a bit of data, and anything else you might ever have thought of – which is nothing short of shameful. If Hoover's R&D director wants a grown-up to help, he knows where to look.

Slide rule

One of the items I inherited from my parents was my dad's study desk. It's filled with wonderfully evocative memorabilia from my youth, including a large selection of Ordnance Survey maps. In one drawer, I was thrilled to discover his slide rule made by Faber-Castell. It's at least as old as me, and I know he used it when he was a design engineer at English Electric Valve Company in Chelmsford in the 1950s and 1960s.

Many sneer at slide rules, saying they're an antiquity. Often such snobs are found to be wearing large watches made by Breitling, which have a slide rule built into the watch face – but let's not allow facts to get in the way.

Out of sheer curiosity, I went on an internet hunt for slide rules. And to my delight, I discovered that Faber-Castell still sells them. I went to its German site, where I found a whole range of brand-new items for sale. I couldn't resist, and bought a 12in technical slide rule – the modern equivalent to my father's treasured item. I felt beholden to continue the tradition, despite the price tag of some €87.

ABOVE **A Faber-Castell side rule takes me back to my youth**

"All my good intentions had been blown away by a dead Dell and a worryingly undead Surface Book"

LEFT **Finally, Chord has shipped its iOS app. It's quirky, mind**

At this point, I'd normally give you the URL for the item. But on visiting the shop just now at **faber-castell.de/service/integration-online-ersatzteilshop**, I see that: "Our online shop for spare parts will be integrated into the Faber-Castell online shop on 31.03.2018." Heading to said online shop shows no sign of the slide rules, at least as far as I can see.

If they've gone then it's a door onto my childhood that's been closed. I'm only pleased I managed to get one of the last ones. Maybe you can find a new item before they're gone forever. Or email Faber-Castell to see if they're still for sale.

Travelodge

A friend sent me the URL to the Travelodge website: **travelodge.co.uk/api/test_harness.php**. Do I really need to tell you what it exposed? Yes, a full test interface into its JSON/REST API test harness. Twenty-four hours later, it was properly locked away. But someone really messed up there. I imagine there are a few sore bottoms this morning from the spanking that was received – and rightly so.

One colleague said, "It makes me want to track down Travelodge's IT people on LinkedIn, just so I can add them to the blacklist of people I'd never employ in a million years." Harsh, but maybe not unfair.

Microsoft browser protection... for Chrome

Microsoft has launched an extension for Chrome. Yes, in this modern era of Microsoft openness, it's even developing Chrome enhancements. It seems to work on all platform versions of Chrome, so I had no issues installing it into Chrome for macOS.

Essentially, it's an anti-phishing engine, as used in the mainstream Microsoft products. It's been packaged up and made available for Chrome for free, which if nothing else is a nice gesture.

Now you might be wondering why you'd want to use this when Chrome has a strong anti-phishing engine built right in, and which is enabled by default. If you don't believe me, go to the Settings window and scroll down to the Advanced section. You'll find the setting, "Protect you and your device from dangerous sites", which is Google-speak for "anti-phishing".

I installed the Microsoft extension and disabled the built-in Chrome feature. Then I went to one of my regular anti-phishing test sites – which has a real-time feed of phishing sites – and tried it out. It achieved a high score over some 30 test URLs. I turned off the Microsoft extension and re-enabled the built-in Chrome feature. Re-running the tests, it returned a similar score but there were differences on a few sites that one got but the other didn't. Re-enabling both caught almost everything in one or the other.

So far, it doesn't appear to have gobbled up my system RAM or slowed my PC to a crawl. It seems to be an all-upside and no-downside add-on for Chrome. In the unlikely event that Chrome's toolkit doesn't catch a site first, the Microsoft tool might catch it as a backstop. Providing it proves to be a stable and reliable combination over time, this extension is worth having for those occasions it's needed.

Apple closes its AirPorts

Of no surprise to anyone, Apple has announced the end of life of the AirPort range of wireless routers. I'm a bit disappointed, because these AirPorts were pretty good products, especially in the early years when most everyone else was making garbage. A lot of thought went into the product; it was one of the few platforms that noticed if you were behind a double-NAT IP installation, warned you accordingly, and switched itself to passthrough switch mode.

But time moves on. The competitors have got better, and the new mesh system has surpassed the rather ancient master/slave solution that Apple deployed. Do I think this is the end of the line for Apple and wireless hardware? Not at all. I expect it's clearing the way for something entirely new; some super-fast, mesh-based-using technology to leapfrog the competition. After all, given Apple's much-rumoured desire to make its own radio chipsets, alongside its CPU designs and other custom silicon, it would make great sense to implement a bleeding-edge specification and try to own the space.

Not being reliant on a third-party chipset vendor would be a big win. Heck, Apple could even come up with an entirely new spec in the 5GHz open radio space. A gigabit mesh-enabled pico-cell-based Wi-Fi solution could be quite something. Only time will tell.

ABOVE **Apple's AirPort retires. No doubt it's making room for some new, superfast wireless hardware**

Netflix, Amazon Prime and Sky

It was one of those discussions that could only happen over dinner with guests. Should you have Netflix, Amazon Prime or Sky? I started off by saying that I'm in the fortunate position of needing all the services in the lab for testing, so at least I can compare.

Our guests piped up that they were thinking of dropping Sky. It wasn't an issue of money; they just didn't get enough use out of it. For myself, I find I watch a lot of stuff on Sky, especially series and boxsets. Netflix comes in a

BELOW **With so many fine programmes to watch on Amazon Prime and Netflix, do we really still need BBC and Sky?**

close second, and Amazon Prime is down in third – mostly there for the latest childish antics of the ex-*Top Gear* crew.

But it did raise an interesting question. All of these services can be watched on your mobile phone or tablet, so they can travel with you. They all offer a huge range of material, more than you could ever get through in a lifetime, or so it feels. Watching the irreplaceable Sir David Attenborough in 4K Blu-ray is one of life's great delights, but I can do that without engaging with the BBC on a day-to-day basis.

Then price kicks in. Netflix is just £9.99 per month for a premium account. A decent Sky Q package can run to far more than that, and the value question has to engage at some point. Amazon Prime as part of the annual Amazon package isn't expensive, and I'm left wondering if I too, like my friends, could manage without Sky. And according to the TV licensing website, I wouldn't need a TV licence either. Although whether I could cope with the ongoing hassle from the BBC enforcers over that is entirely another question, if the experience of a friend of mine is anything to go by.

British Computer Society

I recently gave a lecture to the British Computer Society branch at Manchester, hosted at the Manchester Metropolitan University. The title was "Personal data: How we gave it all away and the apocalypse to come when we are the product". Top marks to BCS for a strong turnout and excellent questions – and top marks, too, to MMU for the use of the lecture room and the provision of coffees, teas and sandwiches. Of course I rambled on and overran, but the topic was so huge I could have talked for another couple of hours.

Organisations such as BCS are well worth supporting, and there are many lectures and get-togethers around the country every month. If you're interested in this subject area, then get in touch with them at **bcs.org**. Who knows, someone might be mad enough to ask me to repeat this somewhere else. I'm available for lectures, children's parties, bar mitzvahs and funerals.

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PAUL OCKENDEN

"Use it on a still day or take it indoors and it's probably one of the easiest to fly drones I've encountered"

Paul Ockenden investigates a tiny new drone, and a Chinese competitor for the Raspberry Pi

As you may remember from issue 279, I'm a huge fan of DJI's £400 Spark drone. Sure, it doesn't quite offer the image quality of its bigger brothers, the battery life or even the range. But it's small, relatively quiet, and plenty of fun.

I was excited, then, to see it gain a little brother. Excited, yet apprehensive. The thing is, I've played with lots of "toy" drones and helicopters over the years – and they've been rubbish. Hard to fly, easy to crash, and quickly consigned to the back of my "why the hell did I buy this" cupboard – everyone has one of those, right?

I'd come to the conclusion that, with the Spark, DJI had the size just about right. It's tiny by "proper" drone standards, but big enough to pack in the sensors and the hardware needed for stable flight. And although the 16 minutes' flying time isn't best in class, it's decent considering its size. The Spark seemed to offer the perfect compromise.

So what is this little brother then? Well, the official story is that DJI has partnered with a Chinese startup called Ryze Technology to create an entry-level drone called Tello. And it looks exactly like the DJI Spark, only it's smaller. And lighter, too: the Spark tips the scales at 300g; the Tello weighs in at just 80g.

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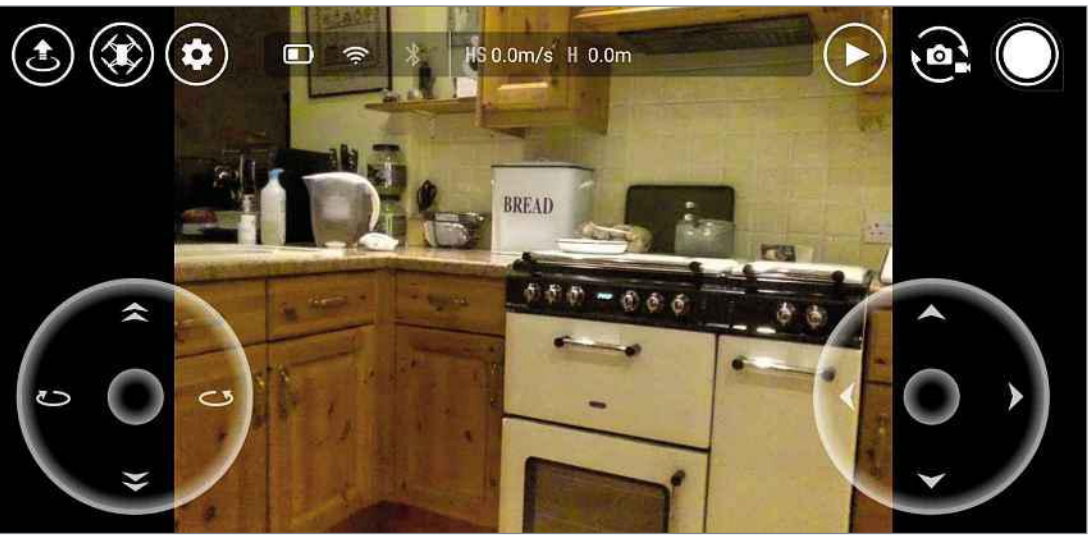
BELOW The Tello weighs just 80g, and fits in the palm of your hand

You'll see the story all over the internet about Ryze being a startup partnering with DJI (and Intel, which provides the processor). I decided to dig deeper and found something interesting. DJI's corporate address is "14th Floor, West Wing, Skyworth Semiconductor Design Building, No 18 Gaoxin South 4th Ave, Nanshan District, Shenzhen, China". Fancy having a guess where Ryze is based? Same city, same district, same road. Even the same building: Ryze is just a few flights of stairs down on the 10th floor. I guess there's a possibility that the links between the two firms are perhaps closer than either is letting on. It's interesting that one of the first places that you could buy the Tello was from DJI's own website!

So does the Tello's size make it impossible to fly? Well, take it outdoors on a windy day and, yes, you'll almost certainly lose it. Or at least break it. In fact, it struggles with even the slightest breeze. But use it on a still day or fly it indoors, and it's probably one of the easiest-to-fly drones I've encountered. It's quite safe to fly indoors, too, because it's light and has prop-guards. I guess it could knock an antique vase off a shelf, but other than that it's hard to see the Tello causing damage – even if flown by a six-year-old.

Unlike the Spark, it doesn't use GPS for positioning. It has a couple of downward-facing infrared cameras that allow it to judge height. These combine with the image from the front-facing camera to maintain stability. It works well; leave the Tello hovering and it hardly drifts at all. Send it forward and it actually goes forward. Dead-straight-line forward; not the slightly forwards, slightly drifting, slightly twisty motion you usually see with toy drones and helicopters.

It's controlled from an app via your phone or tablet, with the handset and



Tello communicating over a dedicated Wi-Fi network. It's a Tello-specific app that you can download from either the iOS or Android app stores, but will look familiar to anyone who's ever used DJI's Go 4 app.

You can use a hardware controller with the Tello, but it talks to the phone via Bluetooth and communicates using the handset's Wi-Fi link, so it's effectively just replacing the on-screen joysticks. The range of compatible controllers is miniscule, though – and, frankly, I can't see the point. The whole point of the Tello is that it's small and light, so packing a controller just feels wrong.

Flying is easy. Flick an on-screen switch and it takes off; it then just hovers in the air waiting for you to send it somewhere. Flick the same switch and it lands. It will land on the floor, a table, or even on your hand. The forward-facing camera offers a degree of collision-detection, too – although this is obviously of no use if you're flying backwards or sideways!

The Tello can even do some tricks. It has eight different flips available, all of which are usable indoors since they don't take up a huge amount of room. Plus, it includes a number of pre-programmed video-shooting modes, including circling round an object or flying up and away while keeping the subject in shot. This thing is so much more than just a toy drone!

One limitation is that if the battery gets too low the Tello will land where it is. The bigger DJI drones, from the Spark upwards, will attempt to return home before landing. Obviously, the Tello can't do this since it doesn't have GPS. As such, be especially careful when flying over water, because if the battery level suddenly falls, the drone will land on the water. And then sink like a stone.

There's live streaming of video available to your phone or tablet, and you can record video (720p) or take 5-megapixel stills. There's no gimbal to smooth out the footage, but steady flight combined with digital image stabilisation means that video quality is surprisingly good.

Flight time is 13 minutes – three minutes shy of the Spark. But given the smaller size and battery, that's to be expected. You can swap out the Tello's batteries, but you can currently only charge them in the drone. I'm sure external chargers will become available soon.

It takes about an hour and a half to fully charge the Tello battery, and you'll need to supply your own 5V 1.5A charger – it doesn't ship with one. It doesn't even ship with a micro-USB lead. That's a bit mean, but I guess it helps to keep the price down.

The Tello is programmable using Scratch, which is great for kids. It's bit of a faff to set up (you need to download and install Scratch itself, node.js, and the blocks definitions from the Ryze website) but then you can create programmed flight paths.

Internally, the Tello uses Intel's Myriad 2 VPU. As the term VPU suggests, it's a vision processing chip. But in the Tello, Ryze has also been able to port DJI's flight-control software onto the chip. This helps the drone to remain small and so frugal with its battery power. Ryze claims the chip has 14 cores, but the standard Myriad 2 only has 12 cores – so either Intel has delivered a custom version for the Tello, or else Ryze is using a special version of the truth known as "marketing speak".

Incidentally, as well as being small and light, the Tello is cheap too. Well, relatively speaking. If you buy direct from DJI it costs £99; you might pick it up for even less from a third-party vendor. To get this level of technology for less than £100 is stunning. You won't find another drone this capable for anywhere near that price.

ABOVE **Anyone who's ever used DJI's drone apps will feel at home controlling the Tello**

"The Tello can even do some tricks. It has eight different flips available, all of which are usable indoors"

Sincerest form of flattery

I know many of you like to play with Raspberry Pi, Arduino, and other cheap, single-board computers. Not only are they great fun, but you can also find some genuine uses for them.

I have a Raspberry Pi monitoring a flaky backup ADSL internet connection in one of my offices. It pings a known IP address every minute or so; if the ping fails three times in a row, it reboots the router. The setup trips around once a week, but it's back up again quickly.

I have another Pi at home running Domoticz, monitoring my heating and other home automation. I've received emails from readers who use these small and cheap boards to run DIY NAS systems, media centres and even to control 3D printers (*see p42 for some inspiration*).

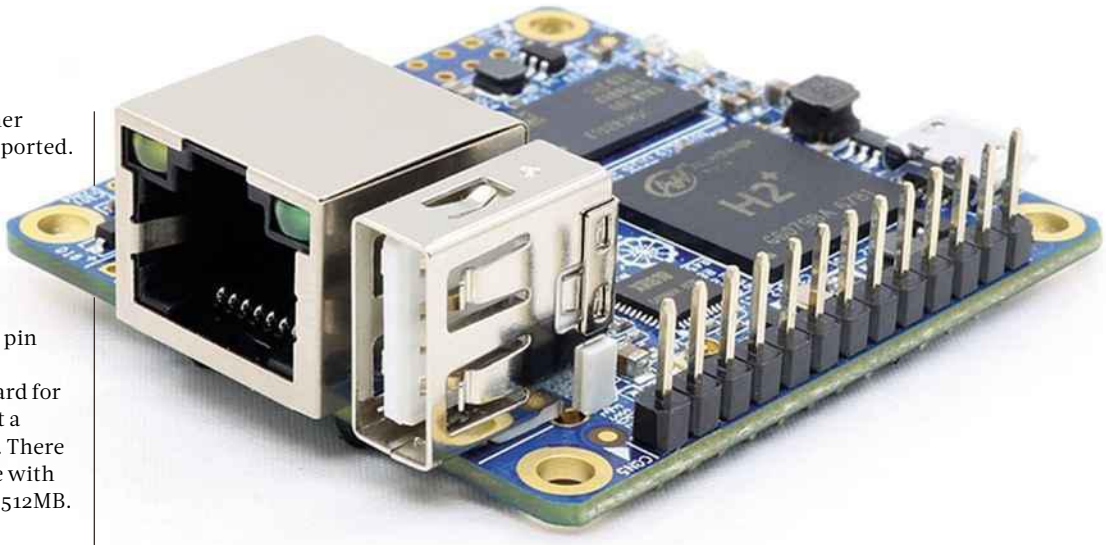
There's a new-ish kid on the block – it's been around for just over a year – in the form of the cheekily named Orange Pi, which hails from China. Now, you might be thinking that's it's just a rip-off of the British Raspberry Pi project, but Orange Pi products are significantly different from their Raspberry Pi equivalents. If there's anything being ripped off it's the "Pi" bit of the name.

In fact, unlike the various Raspberry Pi boards, Orange Pi kit is fully open-source hardware, with the full schematic and CAD files available for download. Many people think that Raspberry Pi is open source, but while it's true that the software is open source, the hardware design isn't – at least, not fully.

Although open source, the Orange Pi was designed by commercial firm Shenzhen Xunlong Software Co Limited, and most of the boards on sale are made by the firm. They're so cheap it probably isn't worth anyone else cloning them! As you might gather from the name, the company is located in the same city as Ryze/DJI, but it isn't in the same building – the Orange Pi manufacturer is a 30-minute drive away.

So what's an Orange Pi like? There are actually numerous different boards available, but the version I bought was the Orange Pi Zero (again, a bit of Raspberry flattery in the naming department!).

As you'd expect, it's a Linux-powered single-board computer,



although there's no reason other operating systems couldn't be ported. It's powered by an Allwinner H2+ SoC (comprising a 1.2GHz quad-core Cortex A7 processor with Mali-400 MP2 graphics). Although it has a GPU on board, the video output is buried on an obscure pin on the edge connector.

Most people employ the board for headless uses – that is, without a keyboard and screen attached. There are two versions available, one with 256MB of RAM, the other with 512MB. When I bought mine the price difference was minimal, so I went with the latter. It cost me the princely sum of £10, but the price does fluctuate with the exchange rate.

The Orange Pi includes a microSD card slot, a full-sized 10/100 Ethernet port, 802.11n Wi-Fi, a full-sized USB host socket and a micro-USB socket wired as OTG – this is used mainly to power the board, although you can also supply power using PoE on the Ethernet socket.

It has a 26-pin GPIO header, which you can use for connecting your favourite Raspberry Pi peripherals (including displays), although you'll have to adjust the pin mapping. On the opposite side of the board, a 13-pin expansion port exposes a USB port, line output, a mic input and an infrared receiver. Plus, the aforementioned composite video output. So it's all very comprehensive.

In terms of software, there are several options available on the Orange Pi website (**orangepi.org**/**download resources**) including Debian, Ubuntu, Android and even Raspbian. Strangely, the distribution that you won't find there is Armbian (**armbian.com**). I say strangely because Armbian seems to be the flavour most chosen among the Orange Pi enthusiast community. On the Armbian website you'll find Debian Jessie and Ubuntu Xenial-based versions, specially created for the Orange Pi Zero.

Once you download the correct version, just save the image to a good-quality SD card using Etcher (**etcher.io**), and your board should boot. There is a trick you can use to write your Wi-Fi credentials to the SD card, too, but the easiest way to initially connect is via the Ethernet port. You can SSH in using the username root and password 1234 (which you'll be asked to change on your first login). You should be able to find the IP address of the board from the user interface on your router – but if for some reason you don't have access to that, just download a copy of Angry IP Scanner (**angryip.org**) and that will find it for you.

Once you have access to the command line you'll be asked to do some initial housekeeping, such as setting up a user account. After that you'll want to update the operating system and utilities. You do this with the commands **sudo apt-get update** followed by **sudo apt-get upgrade**. You'll also want to set the time zone, for which you use **sudo dpkg-reconfigure tzdata**. There are a couple of different ways to configure the card's built-in Wi-Fi connection. The "official" way is to edit the file "/etc/network/interfaces", but if you're new to Linux text editors then that might not be easy. Instead, use the command **sudo nmtui** and use the Activate Connection option; it should be pretty straightforward.

Once all that is done, you're pretty much up and running. You can install whatever software you want to run.

One thing you might notice is that the H2+ chip can become rather warm. In fact, if you're running a CPU-intensive task it can start to throttle back the CPU speed. You'll find it can be too hot to touch, and if you use the command **sudo armbianmonitor -m** you'll see a constant readout of the temperature. This toastiness is common with many of the third-party ARM-based "Pi" boards available.

If this becomes an issue, you can do one of two things: add a heatsink to the chip, or install it in a case with a fan. Having said that, some people obsess more than is healthy about getting the heat down – I just accept that the chip runs hot!

Performance-wise, the Orange Pi Zero is much faster than the Raspberry Pi Zero – it's more on a par with the speed of the Raspberry Pi 3. The Orange Pi Zero I bought uses the H2+ SoC, but you'll find there are newer – and more expensive – versions called the Plus and Plus 2 that use the H3 or H5 chips. I've avoided these because most don't have the on-board Ethernet, and because the heat problems are likely to be worse.

Finally, what do I use my Orange Pi Zero for? Monitoring the OpenTherm communication between my heating controller and by boiler. But that's probably too geeky, even for this column!

@PaulOckenden

ABOVE The Orange Pi Zero has a comprehensive hardware lineup, especially considering its size

"Most people employ the Orange Pi Zero for headless uses – that is, without a keyboard and screen attached"

LEFT If you're not in a rush, the cheapest place to buy an Orange Pi Zero is Ali Express

KEVIN PARTNER

"I suspect Google knows more about me than I'd be comfortable with – but it's so darned useful"

Just like the Yellow Pages, Google isn't only for search. Kevin explains how to make the most of three of Google's "lost heroes": Forms, Keep and Sites

Over the years, I've found myself increasingly relying on Google for day-to-day work. Chrome replaced Firefox, Gmail took over from Thunderbird, Docs and Sheets supplanted Word and Excel. I suspect Google knows more about me than I'd be comfortable with, but it's so darned useful I can't get myself too exercised about that.

But not every Google project hits the big time. Some – especially its ham-fisted attempts at social networking – launch to a fanfare before being quietly withdrawn or left to wither on the vine. Others fulfil a niche purpose and bumble along, useful to those who know about them and invisible to everyone else.

Here are my three favourites.

Forms

Google Forms began as a basic surveying app, but features such as conditional branching, scoring and response-logging have turned it into a general-purpose tool for obtaining signups and feedback, as well as running tests. It's available to anyone with a Gmail account by going to **forms.google.com** when signed in.

Google Forms offers a range of templates including order forms, event feedback and a time-off request, but I've used it most often to run competitions and learn more about my customers. Here's how to create a customer satisfaction survey.

Go to **forms.google.com** and click the big "+" symbol to create a blank form. Give the form a title and description. Click the eye icon at the top right to get a preview of how it will look. Click the palette symbol next to it to set a colour scheme, then the picture symbol: either choose one of the presets or upload your own. If you choose your own image for the header, Google will generate a palette to fit the image.

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Now click on the cog. You can choose to collect email addresses but should do so only if absolutely necessary; you'd need to add explicit consent to the form to comply with the new GDPR regime. My approach is to deselect the "Collect email addresses" checkbox, and to manually add a field to the form with a tickbox giving consent for their email to be recorded – for example, if they're entering a competition.

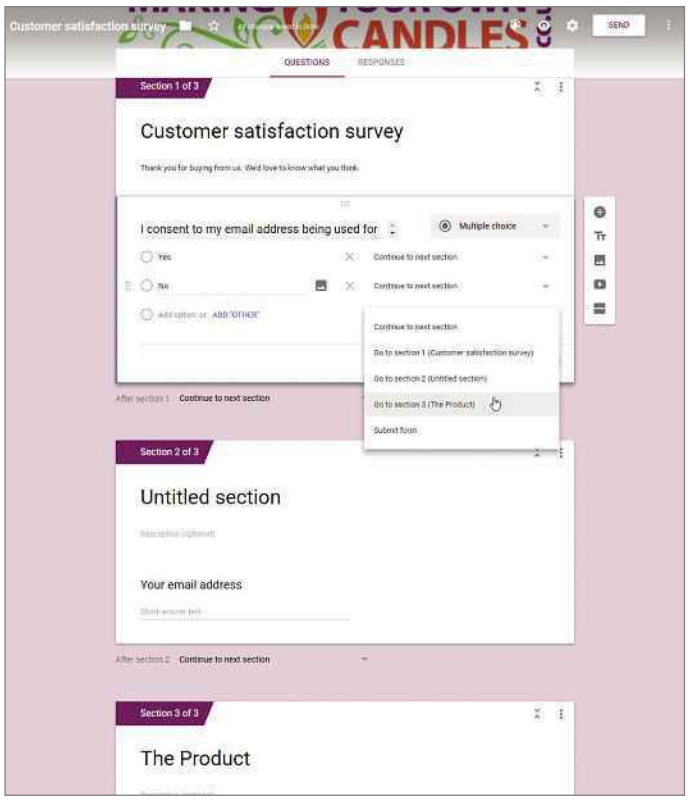
The form comes with one question already loaded. I'm going to change this to an optional email collection field. To do this, click where it says "Untitled Question" and change the question type to Short Answer. Now click the three dots at the bottom right and choose "Response validation". Use the dropdown boxes to choose Text then "Email address" – this will check whether the text looks as though it's in the correct format.

Now click the "+" symbol on the floating toolbar to add another question and change the question type to multiple choice. Add "I consent to my email address being used to contact me for marketing purposes" (or words to that effect), plus a Yes and a No option. Now drag that question above the first one.

Click the "=" sign on the toolbar to add a new section. Click in the Your Email Address question and add another section. Finally, go back to the first multiple-choice question, set it to Required, click the three dots and choose "Go to section based on answer". Next to Yes, leave it at "Continue to next section". Next to No, click the dropdown and set it to go to the section after the checkbox.

The effect of all this is that if the user is happy to have their email recorded, they're then asked for it. If not, the email address is bypassed. Conditional branching can be used in all sorts of ways to plot interactive paths through a series of questions, depending on how the user responds. This turns a bog-standard survey into something that not only feels more personal to the user, but is also shorter while simultaneously having a wider range of questions.

Alongside the standard question types – multiple choice, checkbox and text – Forms also includes the more sophisticated linear scale, multiple-choice grid and tickbox grid, which allow you to gather a lot of data in just the one question.



BELOW Google Forms includes conditional branching, so you can define paths through a survey based on how the user responds

Once the form is set up, you can choose how to share it. Typically, you'll make it public and have Google provide a link to which you can direct respondents.

The icing on the cake is that Forms can be set to export responses to a Google Sheet in real-time. To set this up, click Responses at the top and then the green icon to either create a new spreadsheet or add rows to an existing one. This is extremely useful for getting overall scores and averages. If you want to handle surveys on an individual level, Forms makes that easy too.

Google Keep

Keep is to Evernote what a pocket notebook is to a filing cabinet. I haven't managed

to make Evernote work for me. It appears to demand an organised mind, whereas Keep helps me to store snippets of information in a way that works with my somewhat chaotic nature.

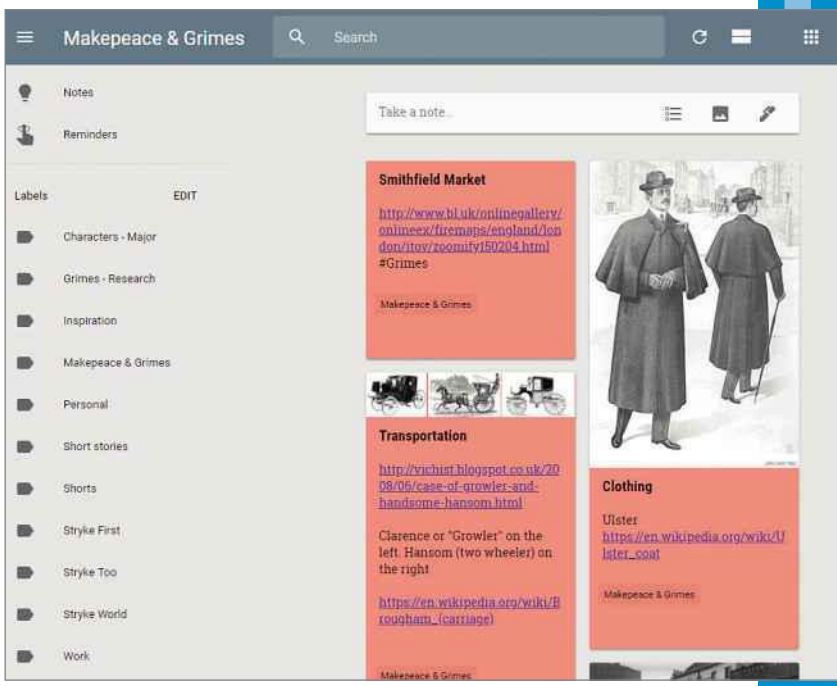
Keep is both a smartphone app and a web service. You can find it at **keep.google.com** and it works in a delightfully free-form manner. Add a text note simply by typing into the "Take a note field", or by tapping the microphone (on the smartphone app) and talking. You can base your note on a photo or image, taken directly from the camera, if you're using your phone. Keep will even convert the text from a photo into editable copy that you can retain as part of the note or transfer into Google Docs.

You can set up a reminder based on a note if you need the information at a specific time – ahead of a meeting, for example. As with other Google apps, you can invite others to collaborate, and even set up notes as lists.

Organising your notes is also more free-form than the folder-based approach of Evernote. Each note can have one or more user-defined labels attached to it, as well as a colour. Labels can be made to function like folders and show on the left-hand side of the Keep interface. I use this to group my notes, although it isn't as sophisticated as I'd like. There's no hierarchy, so you can't have labels within labels, and you have only one Keep notepad per account. This makes it difficult to separate personal and work notes, for instance.

Keep integrates well into other Google apps. Google Docs allows you to bring Keep in alongside the document you're working on – go to Tools | Keep to add a pane to the right of the screen. Annoyingly, you can't select which labels to view, so you get the entire Keep notepad and have to search for the notes you want to see there.

Despite its limitations, Keep is a cracking app. It makes the process of taking a quick note painless, while organising your scraps of information is simple, if basic.



Sites

This is a website-creation tool whose primary function is to quickly build websites incorporating Google content alongside your own. Say, for example, you wanted to create a website to support your new YouTube channel, but didn't want to invest the time, effort and money to make a professional site. Sites allows you to build an attractive, responsive home on the internet using drag and drop.

Go to **sites.google.com** to get going. Click Create then choose In New Sites. This means you're using the latest version of the platform, rather than the somewhat hokey version it replaced. On the right, at the top of the toolbar, click Themes. Make your choice and select an accent colour and font style.

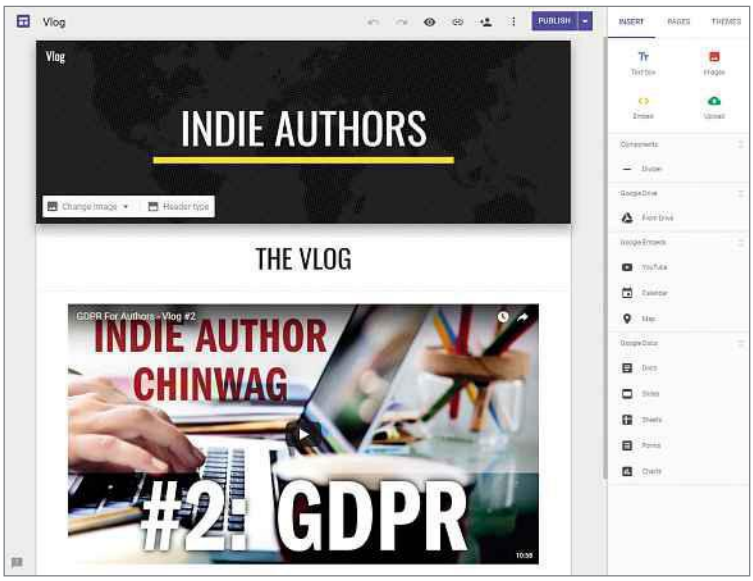
Click Pages to add sections to your site – these are automatically added to the navigation at the top right. Now click Insert to build the page itself. At the top you'll find the standard text and image options, along with an HTML embed box that allows you to bring almost anything into the site. You can also insert content from the main G Suite apps including Forms, Docs and Sheets, making it ideal for internal team communication.

Click the eye icon to preview your new site; you can also see how it will look on mobile devices. The Share icon allows you to decide who can see the pages. By default, it's only visible within your G Suite organisation, but you can change the publishing settings to Public. In that case, you must ensure that any Google content – such as spreadsheets or documents – is also set to public, or it will appear blank on the final site.

Once that's done, click the Publish button and you'll be asked to choose the web address of the site – this will appear as sites.google.com/[yourdomain]/[webaddress] for sites within a paid G Suite domain. For personal users, it's in the format sites.google.com/view/webaddress – in this case, note that you have to pick an address that's unique across all sites. You could even buy a domain name and have it point at the site, if you want an extremely cheap website.

Sites is a great way to build quick websites for specific purposes – such as projects and events – or to hold an archive of useful content.

ABOVE You can use both colours and labels to organise information in Google Keep (but that's about it)



BELOW Google Sites provides powerful tools for building websites based on your Google content

Honourable mentions

Did you know you can go to **contacts.google.com** to find and manage all your stored contact information? You can add, delete, edit and merge information you hold on people, and you can also set up a system of labels – as with Keep – to organise your contacts into business and family categories, for example.

Finally, if you're looking for a typeface to use in your documents or website, take a look at **fonts.google.com**. Google Fonts is a library of around 900 typefaces in various styles and weights that you can download and use on your computer for free.

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DAVEY WINDER

"The point remains: regular patching is a vital part of any defence-in-depth approach to security posture"

When is a security update not a security update? When it's an Android security update, of course

Last month I wrote about how secure future versions of the Android OS will be, but this month I'm concerned with how secure the current one is. The fractured nature of the Android platform ecosystem makes receiving timely security dates, or any security updates, something of a handset and network operator lottery.

That will surprise nobody, least of all me. Prior to the Samsung Galaxy S8+ I use as my main phone these days, I trusted a Google Nexus 6P to bring me both platform and security updates as soon as they were available. Front-of-the-queue access to updates is one of the drivers for owning a "Google" phone, after all. Samsung is further down the queue, so it took more than six months for my 8+ to get upgraded to Android Oreo, and then only because I was on the beta test distribution list.

Even the monthly security patch updates are less timely, usually running a month behind what I'd become accustomed to with the Nexus 6P. Still, at least my device is protected by those security updates, unlike devices out there running older versions of the OS, or not deemed suitable for updating by either vendor or network. Or is it? That's the question I'm asking following what some detective work by Security Research Labs (**pcpro.link/286gap**) revealed in Amsterdam during the Hack in the Box conference in April.

The presentation was subtitled "Uncovering the Android patch gap through binary-only patch analysis" – not the most inspirational of phrases, but the implications are huge. And surprising. The researchers, Jakob Lell and Karsten Nohl, started by investigating how fully patched Android phones could still be exploited. This led to the discovery of quite large "patch gaps" for most Android vendors across a myriad of devices.

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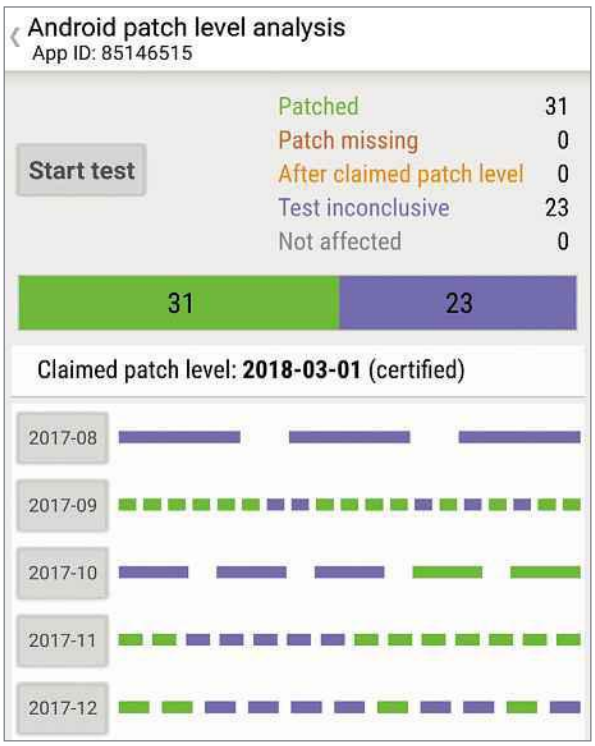
And we're not talking about timely delivery of those security updates here, but rather the shocking fact that not all the available patches for each update are actually being installed. This, despite the devices reporting that they were running with the latest security patch level.

Not only does this leave the device open to those who might exploit the unpatched vulnerabilities, it misleads the user into thinking that the device is protected against these threats. The research only looked at phones with fully patched levels dated from October 2017 onwards, and didn't test against every known patch. This suggests the scale of the problem could be even greater than reported, and the analysis of more than 1,200 handsets suggests no vendor (including Google itself) was free of blame. Some were missing as many as 12 patches, including critical updates.



BELOW SnoopSnitch isn't perfect, but if it raises red flags, you should be concerned

Cheaper handsets seemed to suffer most, with those having a MediaTek chipset averaging 9.7 missing patches per device, while Samsung-processor equipped phones had the least. On occasion, patches were omitted by accident, some because vendors removed a vulnerable feature rather than patch the vulnerability – although researchers claim the latter was a rare scenario. Most worrying is that "several vendors" didn't install any patches at all, yet still moved the security patch date reported by the phone to the user forward month after month.

Now let's not over-hype the real-world risk here. The researchers state that "a few missing patches are usually not enough for a hacker to remotely compromise an Android device. Instead, multiple bugs need to be chained together for a successful hack." But the point remains that regular patching is a vital part of any defence-in-depth approach to security posture, and that's as true for your smartphone as it is for your network. "Patching is critically important to uphold the effectiveness of the different security layers already found in Android," the researchers say, concluding "monthly patches are an accepted baseline for many phones; it's time to ask for each monthly update to cover all relevant patches."

So, how do you know if your phone is correctly patched? The answer is that you don't, and finding out for sure isn't easy. Not surprisingly, there is an app for that. Security Research Labs has released SnoopSnitch. Unfortunately, it isn't accurate. It's borked on Android 8.1, so I wouldn't bother running it if you have the very latest Android OS; even then, the results are hit and miss.

On most phones, patch-level analysis will almost always throw up "inconclusive" results, as it's unable to properly test for those vulnerabilities for whatever reason. Still, it should give you a picture of your patch status. My Galaxy 8+, with certified March 2018 patch level updates, didn't show any patches as missing, and 31 vulnerabilities were properly patched. However, the inconclusive total was 23, so I can't be sure if my device is properly patched.

It's also worth mentioning a report from Tenable Research, which put some numbers to the vulnerability disclosure and remediation problem in general. Although this wasn't Android-related research, the

findings are relevant in the context of the delay in delivering patches.

Tenable analysed its own user base and found that across 2017, some 63% of vulnerabilities were classified as severe or higher. Each month, customers were on average seeing more than 8,000 such vulnerabilities. It's a staggering number, but not the one that's of most concern. The research also suggested that for all the vulnerabilities with exploits published in 2017, the exploits were available in the wild on average within just seven days.

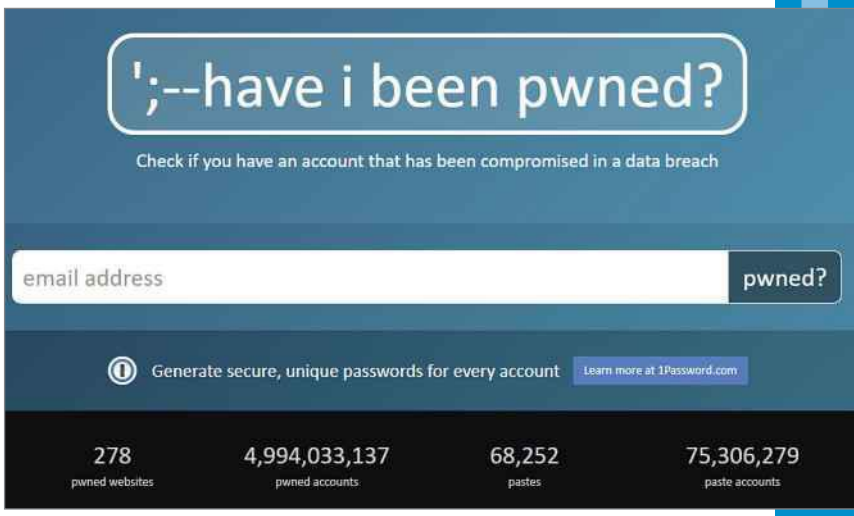
And here comes the worrying number: 12. That's how many days it took organisations to assess their networks and patch. With an exploit window of five days, no wonder the bad guys have such success. And let's not forget that in many instances, at many organisations, the threat window will remain open far longer. Now move this over into the context of the Android situation and, well, you get the rather dark picture that's being painted.

Manage a website? Read this

Although I'm going to specifically talk about WordPress sites here, the advice applies no matter the platform. The subject is password leakage. That is, the use of compromised login credentials to unlock admin rights to your website, which would then be used for nefarious purposes such as hosting malware, redirecting emails, using as a launchpad for social engineering scams, and so on.

Obviously, as a *PC Pro* reader, you'd never use the admin/admin default if offered. But are you making life easier for the would-be attacker anyway? Studying the methods used by attackers – also known as threat intelligence – is a sound way to understand where the weaknesses sit. For example, most simple attacks on my **happygeek.com** site don't get any further than entering what the attacker assumes is the admin username: happygeek. My admin username – and I'd recommend yours should be likewise – isn't related to my email address, the website, any other website I run, or indeed anything at all. It's as random and complex as my random and complex password, generated by software designed to spit out such things.

The same can't be said for all. If your username is easily guessable then that's one less variable to worry about in the hacking process. Make it two, if that person uses the same username or email address across multiple services and one is compromised. The username then becomes exposed to threat actors via databases of such info. If there are passwords attached to the usernames that are so exposed, different but not randomly complex ones, these can then give an attacker an idea of how your passwords are created. Even if this isn't the case, I recommend you avail yourself of the excellent Have I Been Pwned? service (**haveibeenpwned.com**) from Troy Hunt, to check if any of your email addresses show up in known breaches. If they do, make sure any straightforward usernames employed at those breached sites aren't being used for your website credentials, or anything vaguely related to them. Oh, and delete any old and unused admin accounts to reduce the potential attack surface while you're at it!



ABOVE Check for credential leakage that could aid hackers in further attacks

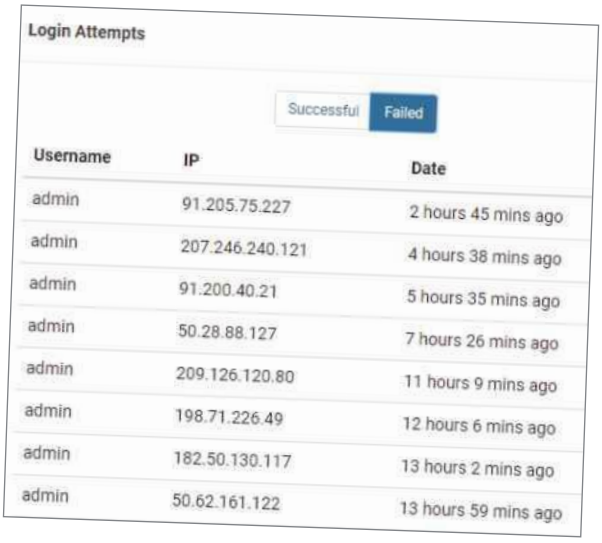
Poor security is as poor security does

I received an email from a small-business owner wanting my advice regarding his password vault. Well, I say vault. What the chap had actually done, because "I don't trust the cloud at all", was place all his passwords in a file, and that file was accessible from his Windows desktop.

Not trusting the cloud is perhaps a tad misplaced in 2018, especially if the cloud provider takes your security seriously – and most of them do – but that's his prerogative. The mistake I'm referring to is keeping his password file in plain sight on his Windows desktop. If you keep a local file, make it a hidden one. Mistake number two – revealed in short order by Mr I'm Very Security Aware (yes, he did tell me that) – was that the file wasn't encrypted; it was a plain text one. I'm not even going to go there.

"It took organisations 12 days to assess their networks and patch. No wonder the bad guys have such success"

BELOW If "admin" was my username, this site would have been toast long ago



Trouble is, neither could this chap: the file had apparently vanished. He told me he'd searched the drive for *.txt and it didn't turn up. He assumed he must have accidentally deleted it, and wanted to know how he could get it back. I did reply – as I'm a nice guy, even under such duress – that he might be lucky and the file hadn't already been partially overwritten.

I suggested he stopped using the PC at once to have the best chance of recovery, and take the drive out to be connected to another PC where a file-recovery application of his choice could be run.

I shouldn't have been surprised that he was also Mr I've Been Using Computers For Years and didn't think such an "extreme solution" was necessary. I humoured him with one final response: namely to run whatever file-recovery application he was going to use from a USB stick to avoid further risk of overwriting his precious password file. I also recommended he consider using a dedicated password vault service such as 1Password. Needless to say, he didn't bother replying.

What this demonstrates is both the importance of regular backups (as he would have had a copy of the file) and of taking security seriously. This means never keeping a list of passwords in plain text, let alone in plain sight. On the off chance he's reading this, here's my final advice for those who don't trust the cloud for such things: encrypt your password list with a strong passphrase that an attacker won't be able to guess or easily crack, and keep at least one copy of this file on a secure and separate storage device to the original.

Continued from previous page

Oh, and for everyone else who's ever lost anything on their PC and not been able to find it using the built-in search tools, may I suggest you grab a copy of the freeware Everything search application from voidtools. It's small, it's fast and really does search for and usually find everything.

And finally...

I was recently researching a piece for a report on Industry 4.0, distributed with *The Times*. My brief was to cover the main cybersecurity threats facing the industrial enterprise, particularly manufacturing. Smart supply chains were always going to be in there, what with the appetite for incremental gains in lean manufacturing processes.

Client device to client device "horizontal" interfacing is a big Internet of Things driver in this smart supply chain scenario; and we all know the insecurity problems that impact IoT. A lack of realistic security standards for IoT, both in the design and delivery process, coupled with API insecurities are proving to be a real headache for the sector. Not least as the available attack surface grows with every service that's added to the API ecosystem of "intelligent" agents connecting with IoT devices and the cloud.

One threat that may not have yet appeared on your radar is a twist on the everyday distributed denial-of-service (DDoS) attack: permanent denial of service (PDoS). Also being referred to as "phlashing", this attack methodology isn't new, nor is it only going to threaten Industry 4.0, for that matter. In 2016, the BrickerBot botnet was deployed with the aim of permanently bricking any IoT device that got caught by it.

Across a total of four iterations ending about a year ago, BrickerBot is suspected of bricking more than a million devices. The self-proclaimed creator of the botnet, who goes by the name of Janitor on hacker forums, claims the actual figure is as high as 10 million. The irony being that the botnet itself was thought to be largely comprised of poorly secured, and compromised, IoT devices...

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STEVE CASSIDY

"I've seen laptops consigned to the tin shed of posterity and decay, often by a basic viral infection"

Antivirus software not doing its job? Steve introduces a couple of unsung heroes in the fight against infections

Be honest: how many "don't touch it" machines do you have in cupboards? How many laptops that, no matter how patient you were, you were unable to restore to working order? I've seen some sin-bins of tens of laptops, consigned to the tin shed of posterity and decay, often by a basic viral infection.

This simple accusation, that it was "virus wot done it", often gets me into trouble, because the people carrying the keys to those tin sheds can't match up what they saw happening to my assertion about the machines they can't fix. "But," they say, "XYZ antivirus didn't say anything about finding a threat."

Sounds logical, but the truth is that nobody makes an antivirus product that announces it's given up repelling borders. You receive an alert when a threat is found, and you may get a distinction between a threat on-disk, in email, in memory and so forth. But a payload that succeeds in infecting is a different matter. My experience of machines of all ages, eras and platforms is that the point at which the AV tells you it's found something is days or weeks after the initial, high-quality stealth infection. In the intervening weeks, the infected PC is effectively put into a slave auction on the dark web, which means that it's pot-luck who buys the time connected to the backdoor access to your PC, or what they decide to do with it.

Those machines left in your cupboard, I find, have suffered from a consistent sub-species of this whole class of infection. Most have a clear trail of damage, which isn't about the old-school notions of what viruses are for: this isn't about showing you cackling skull animations or republishing your Christmas party pictures.

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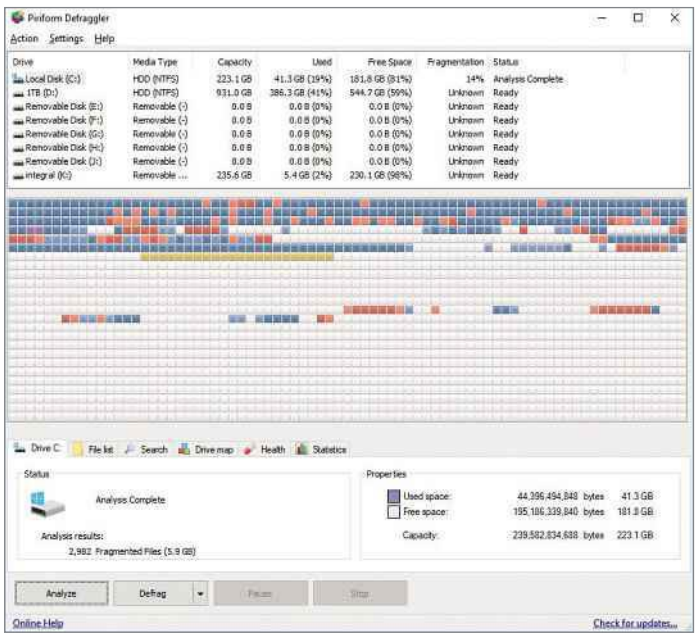
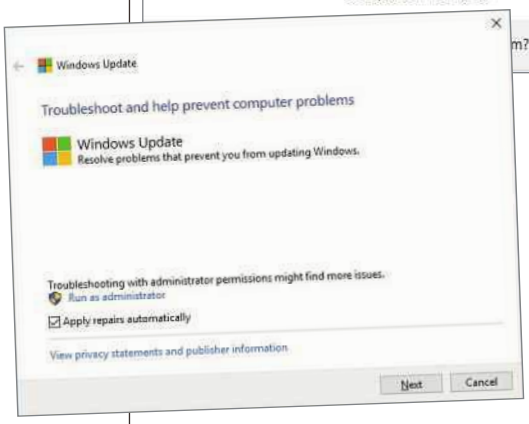
These machines have been crippled by a half-competent combination of efforts by experimenters. That isn't the same as being infected by automatic mechanisms: I could swear, sometimes, that what I'm watching is a night class in hackery, somewhere far away, all logging in to a remote-control tool and digging about in the Registry, unloading DLLs and seeing what happens.

How do you know if you've been hacked if your antivirus software won't tell you? By far the most common symptom is the disabling of Windows Updates. Windows Update is becoming a seriously tough nut to crack for our classical hacker friends – especially when it's time for a new major version. The current Microsoft strategy for those is to build a whole new Windows directory on your C drive, move the apps and DLLs and links over to it, and drop the old folder on the next reboot. This can lead to some remarkable slowdowns – but there's something you can do. Welcome, unsung heroes: Disk Cleanup and Defragmentation.



BELOW Don't believe in defragging your PC? Then explain why your system is quicker afterwards



ABOVE Don't dismiss troubleshooters out of hand – they can be very effective

Disk Cleanup is the semi-hidden utility in Windows 10 that removes unused or one-shot files from the disk. I know, this sounds like baby-steps stuff: but these are baby steps that you can't ignore, because the results are irrefutable.

There are two snags with Disk Cleanup. One is that it likes to be run as an admin account. The second that, for an effective clean-up, you need to spot the obscure "clean up system files" button. This makes the utility restart and rescan the whole drive. This is Windows XP look-and-feel at its finest, but there's no knocking the end result once you tick "previous operating systems" in the items-to-delete list. For small tablets and laptops with only 32GB of disk, this is a lifesaver.

But not on its own. The space freed up by Disk Cleanup isn't presented in a single lump: it's the result of hundreds of days of ownership, updates, and whatever else your stealth virus-mongering subtenants have been up to. The net end result is fragmentation.

I know, there's at least two sources of confident hogwash on the subject of defrag: for one thing, Microsoft itself did us no favours by asserting that NTFS disks don't need defragmentation. I still meet techies who repeat this one at every opportunity, and my stock reply is, "I'm sure you're right, so you'll be able to explain why your machine is faster after I defrag it?"

The fact is, the life of a PC has been through nearly two decades of evolution, and the limits on storage at which the assertion about NTFS was made have long since blown away.

The other hogwash comes in the subject of SSDs and defragmentation. This is more recent, and seems to have taken hold while SSDs were small, expensive and fast – all of which meant that they'd support only a fixed number of read/write cycles. To be honest, I've yet to come across an SSD in a personal computer (as distinct from a server) that has run out of these things. Besides, my argument here isn't about the lifecycle issue: it's about sector sizes.

There are some blogs where you can read up on this recondite matter, but the basic issue is best presented by an analogy. Assume your disk (spinning or SSD) is actually a lot of kitchen cupboards, and your files are a cook's ingredients scattered through the cupboards by a sloppy eater. Let's say your cupboards look full, because the sloppy eater always opens the sauce or salt or paprika or honey in a cupboard he grabs at random. After a while, *all* your sauce, salt and so on have been opened; *all* are part-consumed; and, probably, all have fingerprints on them. I don't know about you, but that drives me crazy.

Back on track here: what a defragmenter would do in this kitchen is to amalgamate all the part-empty containers, then re-fill the cupboards with full bottles and jars only. What starts out looking like a completely full storage space suddenly has several empty cupboards.

This is the problem of sector sizes on SSDs: they'll cheerfully store five files in a sector of the disk with room for 20, because the sector was full at some time, and now isn't. This is how you can have disks that can say "4GB available" and still tell you they don't have enough room to complete an update or a download. This is often referred to as "contiguous free space", and it's impossible to get it back on an SSD by any means other than using defragmenting tools.

I like using Defraggler from Piriform Systems, but there are others out there. Defraggler qualifies as an unsung hero, especially in 2018, when our entire industry believes that the use-case for it has completely disappeared.

"There are some baby steps you can't ignore, because the results are irrefutable"

I'm sure there are some people out there with veins standing out on their neck who are ardent Disk Cleanup users, and almost daily Defragglers, who still have the problem I started out describing here in the first place - that no matter how much disk space they free up, no matter what antivirus they were using, the machine still won't successfully download the updates it's due to receive.

This is where my final unsung hero stumbles into the limelight. Search Google for "microsoft update troubleshooter" and you'll come across the latest download heavily promoted by Microsoft. The Update Troubleshooter handles the grey area of the update mechanism: it looks as if Microsoft doesn't fancy telling the AV industry what a functional, operational Update subsystem looks like; and the AV industry doesn't count damage to Update as enemy action.

For me, the key revelation here is that the Update Troubleshooter, once you get it running, can sit on the machine for a good hour or more. Whatever it's looking for, it doesn't seem to find quickly. Once the Update Troubleshooter is done, you can expect the full glories of the update system to kick off without delay.

That isn't even the end of the unsung heroes section. You can run Windows Defender in an offline mode, if it looks like the damage to your OS and services is extreme – although I don't see the point. If a major feature update sets up a whole new OS next door and leaves behind anything unwelcome, then you simply trigger a scan once the OS update is complete.

It's a pity that most of the techies I now meet come with two ready-made excuses. The first being that Microsoft's own tools are crap (they're

not). The other is that defeating the new owners of an infected, compromised PC is inherently impossible. I've lost track of the number of instances where the solution was to take a deep breath, strip all the bloatware and fakeware virus removers off the machine, settle down with Bing Search in one window and Google in the other, and just work through the crud-removers and verifiably useful utilities before consigning the machine to the bin.

Don't leave your appreciation of what's being done to gossip from five years ago. Take a look at the tools released in the past year or two for what they are!

Business learnings from Consumer Labs

I received an invitation to McAfee's Consumer Labs tour, destination Paris. How could I say no? Not that I was expecting another invite from an antivirus company so soon.

Much of the industry knows to knock on Davey's door when it comes to security. However, in the past couple of years the categories have become hard to track, as mega-scale networking becomes both the transmission medium and the target for a lot of people in the business sector who choose to wear the black hat. The way that computing has become business and infrastructure, and then politics, and now pretty much everything, has torn apart much of the rulebook on security.

Foolishly, I thought I had a handle on this metamorphosis back in 2016, when I met a lot of guys who had very next-generation security products that had been born inside very old-school security companies. Back then, this looked a predictable bit of generational market turnover: the old brands would fade away and the new would take their place. I settled myself down to watch the market shakeout.

A sign that you should always read me carefully then expect the diametric opposite of what I've suggested: nothing like what I expected actually came to pass. The old brands – the guys, remember, who by definition must have been doing a pretty bad job for the whole industry to let infections both arrive and then settle in uncontested – just carried on in a gently amplified version of the same-old, same-old. The new men I'd been meeting set up shop in the corporate and government sector, and everything went comparatively quiet.

ABOVE McAfee uses its consumers' data to inform its business protection, and vice versa – it makes sense

That wasn't because the new or old tools had received a shot in the arm from genius coders: to me, with my old banker's hat on, it looked as if the long-trousered market makers had gone into cryptocurrencies with their kicking boots on. While Bitcoin and all 700 other cryptocurrencies had been on their extended bull run (banker speak for "increasing in value"), ransomware and viruses had a huge upswing. Once the nation-state agents got into the Bitcoin market and wrecked it, the antivirus attacks calmed down. Not because anyone improved any detection or protection code, but because it just got too hard to extract ransoms from victims.

This leaves almost all of the antivirus industry in something of a cleft stick. On the one hand, like any normal business, they want to trade on their brand and their reputation. But, at the same time, it's all about the white-hot leading edge. Last year's install might as well have been carved on tablets of stone, it's so out of date. Meanwhile, the threat landscape doesn't even have the good grace to evolve predictably: it jumps around, like a mad vivisectionist's evil experiment. Yesterday's threat gives almost no clues to tomorrow's. Antivirus companies have to be both trustworthy and immensely flexible.

So I wasn't that surprised to find that the Consumer Labs mostly showed me that McAfee largely treats corporates and consumers the same. Much of the code, tools and – importantly – the global threat-monitoring infrastructure are identical across the sectors.

That threat-monitor farm, incidentally, moves a bunch of data. It's in the billions of transactions per day, and by some measures is "bigger than Amazon". To me, that's more of a measure of the scale of the problem than it is of the skills of this or that cloud service. Besides, the billions of transactions in the threat machine are automated, whereas Amazon's traffic is humans clicking on "Buy it now".

It makes perfect sense for businesses and private consumers to share a threat database such as this. The more notifications they get, the quicker they can target the source and take action. When this point was made, the assembled representatives of the press leaned forward as one, because the obvious next question is: what actions?

"The threat landscape doesn't evolve predictably; it jumps around like a mad vivisectionist's evil experiment"

We didn't get the answers we wanted. This is where the reality of large-scale, planet-wide antivirus operations starts to bite. Information on what an AV vendor can or should do once they establish the size, spread and capability of a new threat is never going to be forthcoming – because it's just too valuable. And that value is on either side of the divide, between the evil virus overlords and the hard-pressed antivirus response teams. Of course, if you pay more for your antivirus and include a consulting relationship along with the software licences, then you can be assured of at least a few forms of notification that the home user doesn't get. The difference isn't in the code, nor in the ability to repel or detect the bad guys: it's in the fightback.

On one hand I can see the reason this suits the, erm, suits. Working out that threat X is a red herring and threat Y is a machine-killer is straight commercial value and advantage, no doubt about it. The question then becomes, how much should isolated consumers actually get to know about a threat, and what are the case studies that justify the current mix of public, corporate and consumer disclosure?

Having the antivirus sector make decisions on our behalf about what's public knowledge, and what's a supranational worldwide perpetual secret, deprives us of the kind of solid, high-reputation information that drives sensible decision-making.

The Consumer Labs were fascinating. But like most consumers, I ended up wanting to know far more about the topics hidden behind that "sorry, can't discuss that" barrier.

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Futures

We explore the trends and technologies that are set to shape the future

Why you could soon be paying for the web

1235 5864 2358 4779

Publishers are looking for new ways to charge readers for online articles, but so are Google and Apple. The future of the web may be as a paid-for platform, explains Nicole Kobie

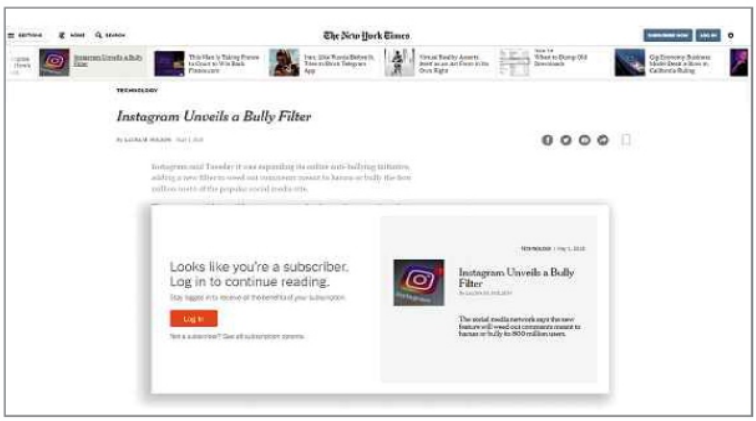
Historically, the web has been free – giving the idea away without charging royalties was Sir Tim Berners-Lee's main innovation, after all – but a number of factors point to a paid-for future. Most scary of all: it might be controlled by a Google paywall or yet another Apple subscription.

It started with music. Record labels tried their best to digitally protect albums and songs, but the ease of piracy and rise of Napster meant that a generation of web users saw paying for music as voluntary to the point of being stupid.

This culture didn't change due to harsh crackdowns on music pirates, but because of the simplicity of buying songs and subscription streaming services such as Spotify. According to the Recording Industry Association of America, music revenues in 2017 rose for the second year in a row, the first time that's happened since 1999. Similar evolutions have followed for television and movies, thanks to services such as Netflix and Hulu.

So where does that leave news and other written content? "Such a shift has already been going on for a while," said Professor Vili Lehdonvirta, digital economist at the Oxford Internet Institute, adding that iTunes and Spotify succeeded over free piracy because of convenience – and that hasn't yet happened for news. "Contrast that with some online newspapers when you just want to read that story, you still have to give them credit card details and set up an account. There's quite a few hurdles."

We've seen the costs of relying on advertising: revenues not only aren't strong enough, but behavioural tracking technologies gobble up our data, spurring a quarter of Brits to install ad blockers, according to the Internet Advertising Bureau.



BELOW **News sites, such as *The New York Times*, have installed paywalls to recoup some of the revenue lost to ad blockers**

Plenty of ideas have been kicked around to fund the next few years of the internet, from micropayments and memberships (*The Guardian*, which is close to breaking even) to paywalls (*The Times* and *The New York Times*) to subscription services, a so-called "Spotify for news". Each of those methods has likely been tried by a publisher whose stories, journalism or other content you read or watch.

"There isn't a silver bullet business model that's going to save the industry," said Pete Brown, senior research fellow at the Tow Center for Digital Journalism at Columbia University. "Right now, I'm not massively concerned about the big players. It's local journalism that has far more to worry about, in terms of finding

sustainable business models that enable them to do the work we all need them to do."

The challenge is convenience for readers and ease for publishers. Like the music industry, that could mean content creators and publishers feel forced to cede control to a platform, and Google and Apple are waiting in the wings with potential solutions.

Paywalls and micropayments

Plenty of publishers have tried paywalls, to varying levels of success. But there's a catch: many of us don't read a single news source. Because of that, and the hurdles of signing up for accounts at each and every site, the next version of the paywall may well be a platform. Compare it to taxis: rather than calling around to several different private taxi firms, none of which have your details or payment card on file, you simply tap a button in the Uber app. But like taxi drivers, there's plenty of reasons publishers don't want to hand their product over to a platform.

Google has been negotiating that tightrope for years, finally seeing some love from publishers thanks to changes to its paywall tool. Google would previously only give a high search ranking to news articles that were free to read, forcing publishers to offer at least a few freebies to ensure that their stories were visible to readers via Google Search and Google News.

At the end of 2017, Google dropped that requirement. But that's not all: Google is also offering a tool to manage visitors with ad blockers – popping up a message asking you to turn yours off to visit the site for free – and letting readers easily sign up for an account and subscribe using their Google account.

"This is something a lot of publishers seem pretty optimistic about," explained Brown. "Search – and Google in particular – obviously drives a lot of traffic, so news outlets have been looking to Google for help. Getting rid of the 'first click free' policy was big for subscription-based outlets.

"Google has huge amounts of data about its users, so the prospect of them sharing data about people who are most likely to be converted into paying subscribers, as has been mooted, is a welcome development," he added.

It's easy to see the Google paywall being used for micropayments – buy ten stories for £1 on Google, and it tracks your reading to dole the cash out to publishers – or for managing subscriptions, where it may have plenty of competition from Apple.

"It's a central cash register, that reduces the friction – and Google is in a great position to do that," said Lehdonvirta. "[But] publishers would not be too enthusiastic about it, as it further increases Google's power over the industry."

Lehdonvirta suggests media giants may be wise to band together to build their own cross-industry payment platform. There's been some industry support, notably investment from *The New York Times* for independent startup Blendle, which aims to let readers flip a micropayment to a publisher for access to a story.

Subscriptions

Apple is mooted to be working on a subscription news platform à la Spotify, furthering its work with the Apple News app – and even rumoured to be considering buying a magazine publisher. There have been previous attempts to apply the aggregated subscription model to magazine publishing, with Swedish startup Readly offering access to a digital selection of magazines under a single monthly payment.

ABOVE Plenty of publishers have taken the paywall route, but signing up for multiple subscriptions is a hassle for readers

Brown notes that the music streaming subscription model doesn't transfer as easily to news as it did to video. "There's more variety in the news industry," he said. If you want to read news, why pay when you can get it free from *The Guardian* or BBC? "So it isn't like people are going to flock to pay for news via Apple's new product because it's the only way to get news."

"Search – and Google in particular – obviously drives a lot of traffic, so news outlets have been looking to Google for help"

Plenty of us have a preferred news source, of course, but Brown notes that aggregated services reduce brand visibility, making the source less distinguishable. That's fine for music and television, where you want a wide range of material to listen to and watch. "I'm not sure news translates in the same kind of way," said Brown. "I'd guess that people have their

preferred news brands and that many of those who are happy and willing to pay for news are perfectly happy to pay directly to those outlets."

Paying for it

Apple and Google don't want to prop up news because they love the media. They want to take a cut – and are well placed to do so, because they already have payment card details. But other platforms could succeed, especially as society becomes more wary of the power tech giants hold. Blendle and Readly offer options (*see below*), but so too do smaller outfits such as micropayment site Patreon. "That's not huge yet, but niche content producers are using it to build a subscription model for their content," said Lehdonvirta. We also interview the founder of SatoshiPay on p22.

While a tech-company platform seems the obvious answer for ease of use, Brown says he's seen more bad ways of managing content payments than good ones – and that includes efforts from the major players. "Facebook's attempt at testing subscription support in Instant Articles was painfully clunky," he said. "It was no surprise to me that the outlets I saw taking part in those tests are no longer doing so. Whether that was their decision or Facebook's, I'm not sure – but if it was theirs I would certainly understand why."

In the end, the future of news payments may require publishers to ignore the first wave of internet users and focus on the second. Mock millennials all you want, but they're more likely to pay for their news than the generation that preceded them, says Brown. "There seems to be some evidence that, for some US publishers... growth in paid subscriptions is especially encouraging among young people," he said. "Some people put that down to those young people having become conditioned to paying for quality content via services like Spotify and Netflix."

For the news industry to finish its evolution to paid-for product, publishers may need to learn to give up a bit of control and we may need to be retrained to cough up the cash. As ever, the challenge isn't the technology, it's us. ●

The future of news... now

Here are two apps that provide a taste of the future of news consumption right now

BLENDLE

This Dutch startup was backed three years ago by no less than *The New York Times*, which is one of a dozen US publications to sign up to the micropayment platform. Rather than offer one-off subscriptions, Blendle acknowledges that many of us want to read from a range of sources, including *The Times* as well as *Vanity Fair*, *The Washington Post* and *The New Yorker*.

The site recommends popular reads and suggests articles based on your preferences. Each story can cost a different amount: a 15-minute-long *The New Yorker* story on healthy eating is priced at $0.49, while a seven-minute-long *Times* feature on a serial killer will set you back $0.19. So far, it doesn't seem possible to link it to your existing subscriptions, so if you already pay for one publication, you risk double paying. If you accidentally click on a story that doesn't interest you, or realise it's only a short story when you were settled in for a longer read, Blendle offers an instant refund.

Not all news is good news. In 2016, co-founder Alexander Klöpping revealed the company had a million users globally, just over two years after launch. But last summer, his co-founder Marten Blankesteijn departed the company, which laid off a tenth of its staff, admitting it had stretched itself too far with its American launch.

Sign up for the beta and get $2.50 free in your account to try it out.
blendle.com

READLY

This is the closest we've got to a Spotify for magazines, although in some ways, it's more of a Netflix – not everything you want is there, but for the price of the few bits of content you do want, you get a load of others for essentially free. For £8 a month, Readly doesn't have every magazine you would want to read, but it has plenty of them – including *PC Pro* – with the latest version as well as back issues.

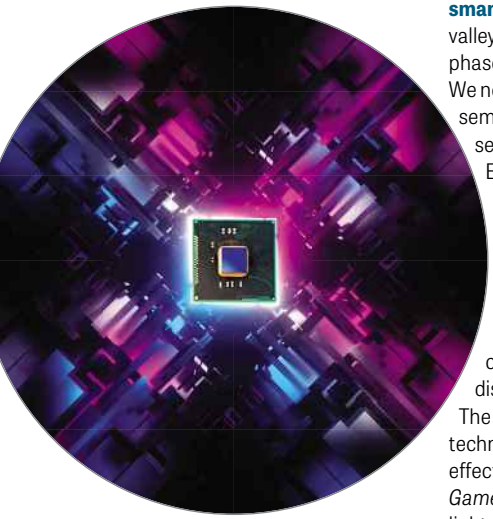
For the monthly fee, readers get access to 2,700 different magazines from around the world, but only in digital versions, so this likely only appeals if you don't mind staring at a device. It's shareable across five family members, so you can all read on your phones or tablets at once, and an offline reading mode makes it handy for commutes. There's an iOS, Android and Kindle Fire app, as well as a version for reading in a browser. Some of the magazines flow nicely into a readable format, but other titles are essentially PDFs, which makes them more difficult to read on smartphones and smaller tablets.

Alongside magazines, there's also a deal with Lonely Planet that offers travel books, so you can download the guide to Greece, have plenty of reading material on the flight over, and as many fluffy gossip magazines as you would like to read at the beach.
gb.readly.com

What is... Valleytronics?

Researchers at Berkeley Labs have made a breakthrough in this chip-building technique, as we chase new methods to meet and exceed Moore's law

Moore's law is dead. However, researchers have their eye on new ways to meddle with electrons for faster-than-ever chips with new materials and methods. You may have heard of "spintronics" – but the next big chip design is called "valleytronics". If researchers can get it to work, at least.



What is valleytronics? Aside from a great name for a band, valleytronics is a way of storing information: that all-important binary on and off position. Instead of switching the charge of an electron, as with standard chips, or tracking the spinning up or down of electrons, as with spintronics, this method uses something called the "wave quantum number" of an electron held in a crystal state.

Wait, what? Let's try that again. In valleytronics, we need to dump electrons into two piles for binary goodness. If you plot the energy of electrons versus their movement, you get a curve with two valleys, hence the portmanteau name combining "valley" and "electronics". Electrons are sent as waves through a 2D semiconductor, sorted into each pile depending on their energy levels, or quantum valley number. It's essentially it's a different way to use electrons as the "0s" and "1s" at the core of computing.

Can we try one more time? Smart people shine a light on a crystal and electrons bounce into one of two holes.

Why go to all the effort? Like spintronics before it, valleytronics is the result of efforts to store data faster than our existing techniques. This means faster chips, potentially returning us to the golden years when Moore's law still held true.

How long until it's in my smartphone? Not so fast: valleytronics is very much in the idea phase. There are two main challenges. We need a 2D material for the semiconductor and we need a way to separate the electrons into piles. Early versions used diamonds, but even Apple fans aren't likely to be willing to shell out such high costs. In the past few years, researchers have tried using different materials that aren't likely to be recognised by many of us: rhenium disulfide, tungsten disulfide and tungsten diselenide. The latter was paired with a technique called the "optical Stark effect" – feel free to think up your own *Game of Thrones* joke here – that uses light pulses to manage the electrons and push them into different valleys. Those light "excited" electrons are called "excitons", which isn't actually important to know, but is a great word nonetheless.

So this is still in the science phase, then? Yes, but the clever folks at the Department of Energy's Berkeley Lab have had a breakthrough on materials, using tin sulfide. It's handy for this use because it absorbs different light and selectively re-emits it. The researchers say it can be used not only for valleytronics, but also for standard electronic purposes, letting chip makers double up and make hybrid electronic/photonic chips.

How close does this breakthrough bring us to valleytronics in devices? There's more work to do, but the research is part of Berkeley Lab's "Beyond Moore's Law" project, which is chucking cash and clever people at the problem of next-generation computing – and working with the industry to accelerate the rate at which scientific discoveries get commercialised. So as soon as possible, whenever that is.

OPINION

Nicole Kobie

Do driverless cars need to be perfect – or just better than us?

After the autonomous Uber crash that killed a pedestrian, there's been a lot of debate as to whether driverless cars will ever be good enough to take the wheel from us humans – and while it's impossible to predict when fully self-driving cars will hit our streets, we do know how good the tech is now.

That's thanks to reports by the California Department of Motor Vehicles, which demands statistics from self-driving trials in the state.

Alphabet-owned Waymo's cars are leading the pack in one key metric: disengagements, or when a human needs to take over the controls. Over 352,545 miles, the Waymo car only asked for help 63 times – but that's still 63 more than is needed to call itself truly driverless.

Others faced more serious concerns, according to news reports. GM's Cruise Automation cars weren't great at spotting oncoming traffic, failed to brake hard enough at a stop sign and got confused by traffic cones. Both Delphi and Nissan had GPS signal woes, while the former "encountered difficulty identifying a particular traffic light". Hopefully that meant a light at a specific junction rather than all red lights.

Generally, the driverless cars faced problems with humans. When drivers ran stop signs, drifted through lanes, or cut off the automated cars, they didn't know what to do and asked for human help.

But while we humans can get away with rolling through that stop sign from time to time, or having a minor meltdown when someone drifts into our lane, we demand better from our machines. Indeed, a study of human drivers would turn up far worse road infractions, but we don't expect perfection from other people.

Should we go easier on driverless cars and accept inevitable mistakes on the road? Perhaps not. Humans rolling through a stop sign can be held accountable for doing something stupid, but that's not the case with machines. And good luck holding companies accountable – plenty have been trying to do that with tech giants of late, and it's not been easy.

While we risk the perfect being the enemy of the good by holding driverless technologies to a higher standard than humans, that's the point of the technology. Why invest billions into making cars that drive no better than us? If the AI is as clever as claimed, perfection is attainable.

@njkobie

Geek Day Out: Video games at the V&A

The famous London museum examines the design and disruption of video games – and lets you have a play while you're there

It's official: video games are art. If more proof was needed, just look at the serious consideration of the subject at the V&A Museum's forthcoming exhibition, *Videogames: Design/Play/Disrupt*, which opens in September.

The exhibition isn't the museum's first look at gaming – it's even advertising for a video game designer in residence – but it could be the most fun, with curator Marie Foulston promising there will be plenty of "playable works".

"The content of the exhibition is extremely eclectic," Foulston told *PC Pro*. "From beautiful indie games such as *Journey* and *Kentucky Route Zero* to blockbuster titles such as *The Last of Us* and Nintendo's *Splatoon*. The exhibition also highlights the incredible ways fans and players engage with games, from fan art and esports to the amazing building projects undertaken in *Minecraft*."

This isn't a historical look at the origins of video games, although there's still some nostalgia on show. "The exhibition explores the medium from the mid-2000s onwards, when major technological advancements radically changed the way video games are designed, discussed and played," Foulston explained. "At this time, technological advances such as the rise of broadband, social media, mobile technology and innovative new design tools democratised the means of making and provided space for new voices and ideas to flourish."

Indeed, the V&A has dug deep to find the most intriguing indie efforts, meaning even the most dedicated gamers should find something new. "I am most excited by some of the more rebellious parts of the show, as I think they will be quite surprising to a lot of visitors," Foulston said. "One such work is by Australian DIY games collective SK Games who, with the help of some power tools, cans of spray paint and a few cans of beer, converted half a Mitsubishi sedan into a bespoke arcade cabinet... It's a wonderfully rebellious subversion of the traditional arcade cabinet."

LEFT The exhibition will also feature surrealist René Magritte's mind-boggling painting *Le Blanc Seing*

TOP The exhibition will explore the ways fans – including this furry *Overwatch* fanatic – engage with video games

ABOVE As well as smaller-scale indie games, the V&A will explore the background of big-hitters such as *The Last of Us*

Alongside the half-car, half-arcade, there are also rarely seen prototypes, concept art and notebooks on show – collected during years of visits to game designers, Foulston revealed – as well as "spectacular" immersive installations "that allow visitors to see some of their favourite games from an entirely new perspective". Then there's a "truly sensational and arresting installation that showcases the creative spectacle and fascinating chaos of online player communities".

The V&A's aim is to challenge traditional perceptions of what video games are and can be in the future. "We hope to deepen our visitors' understanding of this important design medium by telling the story from the V&A's design perspective," said Foulston. "We hope our visitors will leave the exhibition inspired to play games or even to create their own games."

> "We hope our visitors will leave the exhibition inspired to play games or even to create their own games"

The V&A Museum's *Videogames: Design/Play/Disrupt* opens on 8 September 2018 and runs until the end of February. Tickets are £18 or free for members. For more details, visit **vam.ac.uk/exhibitions/videogames**

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FEATURES

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Please note: Labs and features are subject to change

Jon Honeyball escapes from a torrent of unwanted email in the Eifel mountains

It's been coming. The drip became a stream, which became a torrent, which became a tsunami and we now find ourselves fully submerged in GDPR hysteria. The result: I'm drowning in a flood of emails from companies asking me to click on their link to enable them to continue to send me emails. For some strange and unfathomable reason, I've been loath to do so.

What's more annoying are data requests from companies I've actually done business with. You wouldn't believe the amount of information that some of them have demanded, right down to detailed and intricate descriptions of the storage policies, locations and justifications for said locations of all of the lab's data.

Now, while this could be seen as a sensible box-ticking exercise, there's always the risk that one of the lawyers at these places is going to have a hormonal afternoon and decide that my processes aren't good enough. The resultant argument would be ugly.

It's perfectly clear to me that there's a huge wodge of Y2K about this. Companies are scared. Not of planes falling from the sky or bugs tripping up their code, but that they're going to be hauled into court and made an example of. And from now on, that won't be a mumbled mea culpa apology and token contribution to the corporate tax fund: in GDPR land, the resultant fines can be extraordinarily big. Billions big.

The end result is a whole bunch of people, myself included, who are tired of finding themselves on some mailing list, only to be told that we must have agreed somewhere at some point. No, my dear chap, I don't believe I did. I will now be issuing GDPR information requests from everyone who emails, demanding to know everything they know about me. Join me, my friends, and serial spammers will find themselves in a paperwork horror show.

But that's small beans compared to the reckonings that the big tech corporations must be anticipating. If I were a company like Facebook, I would be trembling in my billionaire socks at the prospect of a group of EU citizens mounting a class action lawsuit over data misdemeanours. Consider those alleged "phantom accounts", whereby Facebook apparently creates a hidden account and profile on someone even if they're not a member of Facebook. Maybe this was behind Mr Zuckerberg's reluctance to discuss the matter recently in front of the US Senate Committee. Or maybe, as seems more likely (I'm assured by *PC Pro*'s team of worried-looking libel lawyers), it's a load of tosh. Who knows?

Like all such legislation, the proof will be in the pudding. Without doubt, some lawyers are going to get very fat indeed on prosecuting headline-grabbing cases. I'm reminded of the brutal attack the EU made against Microsoft years ago, and the cost and hassle of the oversight that came from it.

Maybe that's the big plan here? The EU knows that corporate software is largely a USA-based phenomenon; that we've slid into a situation where there are effectively corporate superstates, who believe themselves to be above anything as petty as national jurisdiction. At the same time, it's watched as their accountants have dodged tax bills the size of Jupiter. Just maybe the EU's motivation isn't merely about protecting the privacy of its citizens but also protecting its own powers. And harvesting some cash along the way.

> "It's perfectly clear to me that there's a huge wodge of Y2K about this. Companies are scared"

Back in the real, physical Europe, I find myself on a long motorbike riding weekend with friends in Spa, on the Belgian/German/Dutch border region of the Eifel mountains. They are all super geeks, and the dinner discussions have taken interesting and twisting turns, much like the roads we have been enjoying.

One of us came up with the idea that soon a large corporation is going to declare that it's headquartered in a satellite in orbit, and that it is extraterritorial from all governments. The discussion robustly went onto a discussion of "well, just how far does territoriality extend vertically upwards?" – at which point more beer was ordered.

But it is an interesting concept. Given Elon Musk's plan to have a million people on Mars in just a few decades, might this be a intergalactic-sized opportunity to just move off planet?

You'll know something is afoot when your Facebook profile lists "Planet" as a new item after "Country" in your personal details form. At that point, it's time to run and hide.

Jon Honeyball is a contributing editor to *PC Pro* and, once he returns from his motorbike travels, is happy to stay in Fenland, England. Email jon@jonhoneyball.com

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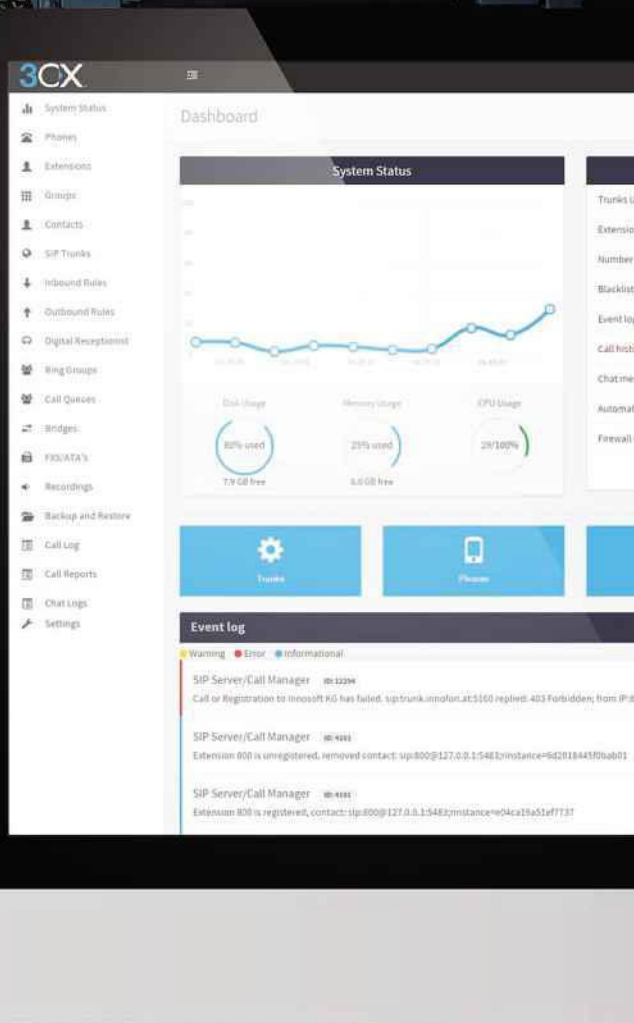
- Integrated Smartphone clients
- WebRTC based web conferencing



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