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HIGHLIGHTS THIS MONTH

Full contents overleaf

PRODUCT OF THE MONTH

HP Chromebook 13

There's much to like about Chromebooks. Easy to use. Stay secure automatically. Excellent battery life. So it's curious that, aside from Google's Pixel experiment, manufacturers have chosen to churn out cheap netbook-style devices rather than go head to head with Windows laptops. As you may have guessed, HP has ripped up that particular rulebook with the Chromebook 13, a glorious-looking, powerful and desirable laptop that might just be the harbinger of great things to come. Worth £600? Make up your mind after reading our review.

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TIP OF THE MONTH

Want to quickly access Windows' Settings without burrowing through menus? Simply press Windows and I. That's just one of the 49 time-savers revealed in our keyboard shortcuts feature.

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BUSINESS CHANGER OF THE MONTH

While our lead feature is all about securing your Wi-Fi, Steve Cassidy delves into the world of VPNs for business from p104.

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FACT OF THE MONTH

You may have heard of Brexit? Well, as part of our "How bad will Brexit be for tech?" feature on p46, we've tracked the Brexit effect on prices – and it's generally a 20% rise. Where was that on the bus?

PERSON OF THE MONTH

Kevin Partner

Never one to blindly follow trends, Kevin explains how to make money using that most unfashionable of tools: email. Read his tips on how to turn contacts into cash.

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Want to back up key files to the cloud? We've done some serious testing...

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50 Keyboard shortcuts

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We speak to the Cambridgeshire-based firm that has developed a smartphone screen technology capable of doubling as a high-quality speaker – but that's not the only trick up its sleeve.

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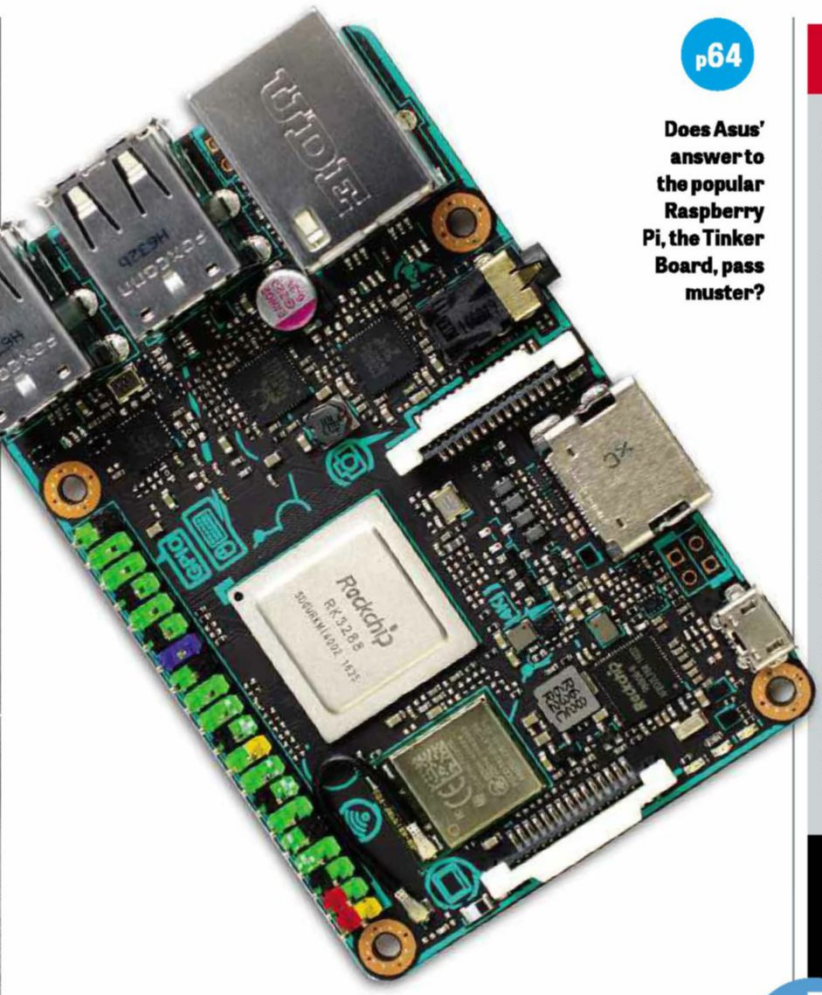

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Editor's letter

The Word is up: time to abandon old working habits

IN MY DEFENCE, I was tired, hungry and grumpy as I typed the message. "What on earth have you used that version for?" The keyboard bounced around my desk as I expressed my frustration through forceful fingertips. "That was last month's document!!"

The annoyance expressed by those two exclamation marks was clearly mirrored by Paul's response. "No," typed *PC Pro*'s art director, the "you idiot" he wanted to express being silent. "Look. Here's the doc." A screenshot swiftly followed, which did indeed show the old words, despite the document having the right month's name.

I uttered a few words that can't be expressed in a family-friendly magazine such as this. I opened the Word document on Google Drive and all seemed fine. I was about to point out that he must be looking in the wrong folder when he sent me a screenshot of the directory as well.

I took a deep breath. Clearly one of us was wrong and clearly it wasn't me. Ergo it must be him. Heck, I even knew Latin. I started to type a response to that effect when I remembered something: we were using technology! And I was assuming that the technology was working as it should, which is Rookie Mistake Number One.

I shan't bore you with the details, but it turns out this is a weird, unpredictable problem that stems from saving an old Word file as a new one, and Drive getting confused before deciding to revert to the original's contents. (Okay, I lied when I said I wouldn't bore you with the details.) 97% of the time it works fine; it's those 3% that are the killer.

So why not shift to a different system? I could use SugarSync, for example, which is one of the cloud backup services in our cloud backup group test this month (*see p76*). Or Dropbox. Or OneDrive. Or – you get the picture.

The trouble is, as Phil Collins lamented, I'm in too deep. *PC Pro*'s IT infrastructure, once built upon Exchange, Office and other Microsoft technologies, is now powered by a myriad of different tools: Slack for day-to-day comms, Skype for the podcast, Microsoft Office, LibreOffice for those who won't pay for a word processor… the list goes on.

But tool number one, the sun around which all other planets revolve, is Google. It's home to the office email and, crucially, our virtual document server. To shift elsewhere would mean either entirely extricating ourselves from Google or paying yet more cash to another supplier, along with the pain of changing systems and losing our hard-earned knowledge. Better to make do with the devil we both know and already pay for.

That means workarounds. I now use a belt-and-braces approach of sending Paul Word docs via Slack, along with the doc itself in his "in tray" on Google Drive. Arguably, I should shift to Google Docs, but I didn't spend 20 years getting to know Office inside and out for nothing. Did I?

Perhaps it's time. I'm typing this in Word, on my Windows 10 Dell XPS 13, but if I were being rational then I'd switch to the HP Chromebook 13 reviewed on p54. I now pay for Office 365 myself rather than the IT department, and – as we reveal in our Brexit-inspired feature on p46 – prices are only going up. When G Suite costs $3 per user per month, and comes with all of the storage I need, I'm effectively paying Microsoft out of laziness and familiarity. As Paul silently says many times a day, what an idiot.

Tim Danton
Editor-in-chief

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Adam Banks
Apple natives are getting restless as the company – some say – puts its focus on selling iGadgets and abandons creatives. Adam digs deeper on p36

Steve Cassidy
As employees work from remote locations more, it's important to provide easy, secure access to your network. Steve shares VPN secrets on p104

Stewart Mitchell
When an algorithm can decide whether you're too big a risk for health insurance, Stewart asks: who's watching the AI decision makers? See p14

Barry Collins
In two years' time we'll be out of the EU, so what does that mean for tech jobs, legislation and prices? Barry talks to those in the know on p46

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To tie in with our battery special in Futures this month (see p124), we asked: "Aside from lithium-ion batteries, what 20th century technology would you consign to history?"

HTML. Enabled absolutely anyone to become an awfully bad programmer, and thus stunted the evolution of programming for a couple of decades.

The PDF – the most anti-sociable document format ever created.

Inkjet printers with cartridges that dry and clog up – and the general approach to printer design to ensure re-buying.

TCP/IP. It was designed for a specific purpose and that's not what we have today.

Mechanical hard drives. Why? Because clunky platters of spinning rust will always let you down (just see p120 – Ed). Oh, and USB, or indeed any other plug and socket that has a right-way-up

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Please check web site for current model specifications.

Briefing

Background and analysis on all the important news stories

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Where do digital companies such as Amazon find their talent? p12

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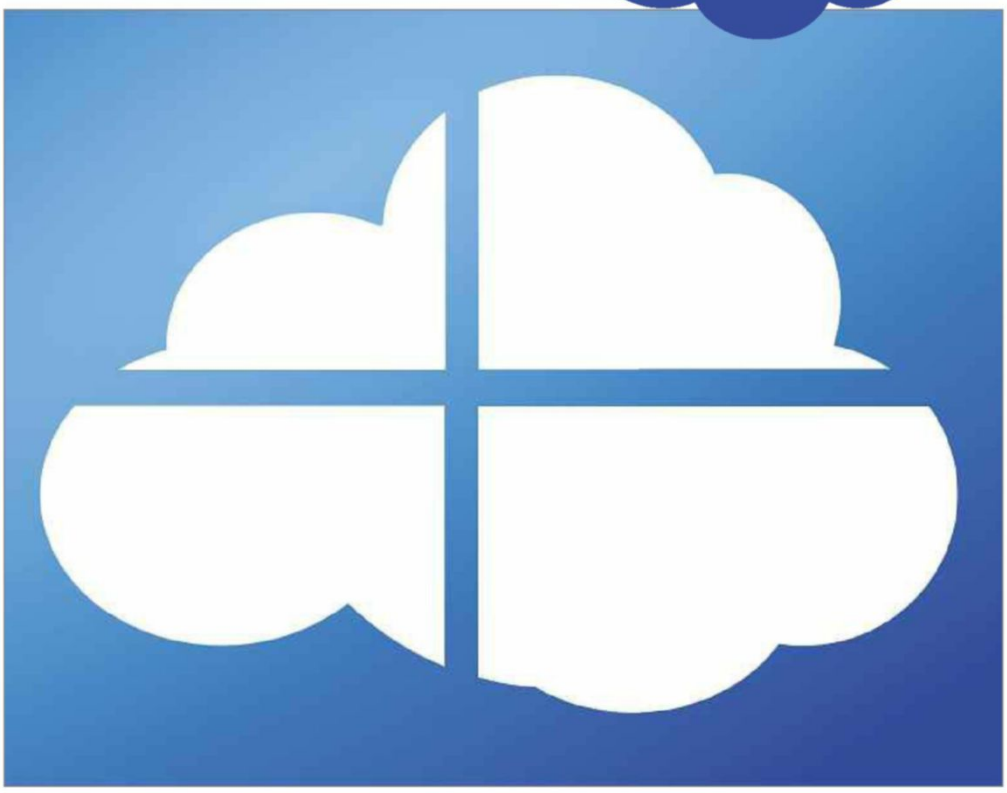
Industry pundits aren't excited by the new smartwatch OS p13

PC Probe
Who's watching the AI decision makers? p14

Windows 10 Cloud to take on Chromebooks

Microsoft is preparing a slimmed-down operating system, but doubts remain over app compatibility



MICROSOFT LOOKS SET TO release a fresh flavour of Windows aimed at low-cost machines in the shape of Windows 10 Cloud, providing direct competition for Google's Chromebooks.

The upcoming version of the operating system has yet to be confirmed by Microsoft, but screenshots have leaked online and reports from Microsoft watchers suggest that the rumoured variant could appear later this year.

The operating system is something of an echo of Windows RT, and will again only allow consumers to install Universal apps available from the Windows Store. However, there are some key differences between Windows 10 Cloud and its ill-fated predecessor, which was effectively discontinued with the launch of Windows 10.

"Where Windows RT was ARM only, Windows 10 Cloud will run on both Intel and ARM platforms," said Microsoft specialist Paul Thurott, who has gained access to early builds of the operating system. "It is a mainstream Windows product edition," he wrote on **thurrott.com**.

The other difference between the failed RT project and Windows Cloud is that users will likely be able to upgrade to a full edition of Windows if they later choose.

"Where Windows RT was a one-way, dead-end street because of its incompatibility with desktop (Win32/.NET) applications, Windows 10 Cloud isn't because it can be upgraded to Pro, and given that capability," Thurrott claims.

App limitations

However, while there may be a market for stripped-down, cloud-centric machines in schools, not everyone is convinced that there's a huge consumer appetite for such machines outside the classroom.

> "If it cannot run the apps that people want to use, and if developers do not write apps for it, then it will fail"

Windows 10 Cloud devices aren't expected to run x86 apps, which was one reason why Windows RT failed to ignite. Stores reported high return rates of Windows RT devices when consumers found they couldn't install regular desktop apps. It's possible that developers will be able to use the Desktop Bridge platform to make desktop apps work, but that's not possible with the build that's currently being put through its paces in early testing.

ABOVE Microsoft is remaining tight-lipped about even the existence of Windows 10 Cloud

"If, like Windows RT, it cannot run the applications that people want to use, and if developers do not write applications for it, then it will fail," Michael Cherry, a senior analyst with Directions on Microsoft, predicted.

"It is not just about the education market. When the trade-off for lower price is about restrictions on software that the device will run (and that the user has become committed to), the device generally fails. It has to run

ABOVE Analysts say that Windows must respond to the rise of Chromebooks

> "A lighter version of Windows, which would only run Universal apps, would mean a safer PC environment"

software people want, and attract developers to increase the library of software over time."

Nevertheless, other analysts are more upbeat, noting that Windows must address the rise of Chromebooks in the classroom, which, from Microsoft's point of view, could mean students continuing with Chrome into adulthood. For school administrators, for example, users being restricted to approved apps has significant benefits.

"For Microsoft, the market's growing comfort with the Chrome OS philosophy has been a concern and a response is warranted," said Raghu Gopal, an analyst with research firm CCS Insight. "Microsoft needs to react before the Chromebook creep becomes a torrent.

"As Google prods Chrome OS into Windows territory with offline applications, we expect Microsoft to acknowledge the growing success of virtual platforms with its response," Gopal added. "A lighter version of Windows, which would only run Universal Windows Platform apps, would mean a safer PC environment – a compelling thought for educators, consumers and enterprises."

At the time of publication, Microsoft was still remaining tight-lipped on a release date for the Windows 10 Cloud – and, in fact, its existence altogether – but market watchers speculate that it could be made available even as early as April, alongside the Windows 10 Creators Update.

Microsoft declined to comment when we asked for details.

Five stories not to miss

1 Mozilla calls time on Firefox OS

Browser developer Mozilla has pulled the plug on its Firefox OS project, with plans to refocus on its web browser and emerging technologies. The operating system failed to find traction in cheap mobile devices and was making little progress in its second potential market of IoT. The change of focus is expected to see 50 jobs cut at the organisation.

2 Mobile and video boost Facebook revenue

Facebook reported 51% revenue growth for the last quarter of 2016, in figures that put it streets ahead of the other tech giants. As Facebook benefited from mobile and video growth, Twitter's earnings grew by only 0.9%, while Amazon and Alphabet hovered around 20%. Apple and Microsoft grew at 3.3% and 1.2% respectively.

3 Surface lock-down tools tighten security

Microsoft Surface machines have been given an update that could increase their appeal to enterprise and government customers, with a lock-down tool that means the platform now meets US NSA standards for deployment on classified networks. The new Surface Enterprise Management Mode means admins can lock down elements that are viewed as risky, such as webcams and USB ports, either permanently or only when they are connected to a classified part of the network.

4 UK launches cyber security nerve centre

The UK launched its National Cyber Security Centre at GCHQ, with stark warnings of 188 high-level, national-security-threatening attacks in the three months running up to the centre's opening. The unveiling – part of a £1.9 billion plan to shore up the UK's network defences – came days after GCHQ officials blasted internet security companies for scaremongering by peddling "medieval witchcraft" in a bid to boost sales.

5 Slumping pound sparks major price hikes

The fallout from the Brexit vote is having a continuing impact on UK tech prices as currency fluctuations filter through into high street prices. Microsoft's top-end Surface Book went up by £400 in response to "market dynamics", while Sonos added 15% to 25% to the price tag on its range of speakers. See p46 for more on the Brexit effect.

JOB BOARD

WHO'S POACHING WHO?

Good people are hard to find, and tech companies often bemoan skills shortages in the industry. It's no surprise, then, that the biggest firms poach talented staff from rivals, resulting in a hop-on, hop-off career path as employees switch allegiances.

WHERE DIGITAL COMPANIES FIND THEIR TALENT

Recruitment firm Talentful trawled LinkedIn for employees at 15 major tech firms and compared their work history to show how much poaching goes on. Microsoft, for example, has 4,306 employees who worked at IBM, while Google has almost as many former Microsoft employees.

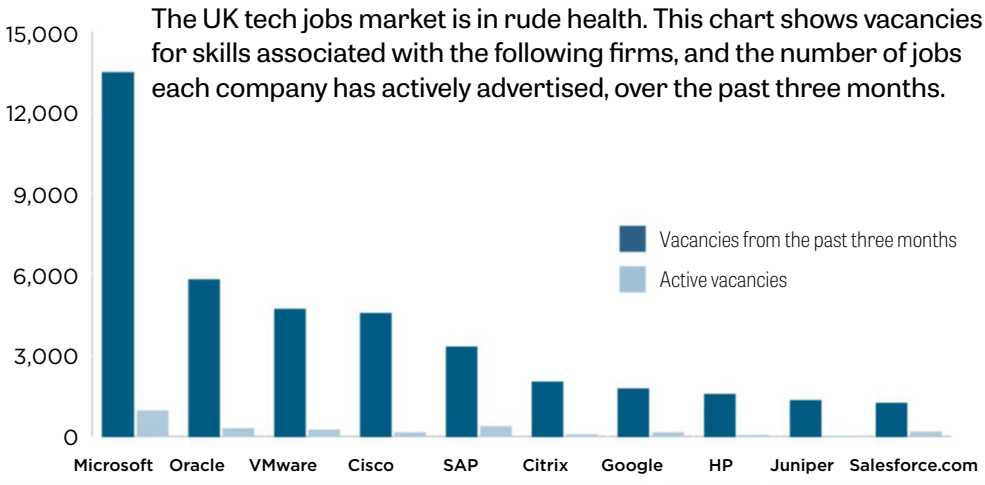
This table shows the number of staff 15 leading firms have poached from their rivals. So, for example, Uber has 298 staff who have previously worked for Amazon, while Google has 1,781 former Amazon employees on its books.

	Amazon (Past)	Uber	AirBnB	Google	Facebook	Apple	Twitter	Microsoft	LinkedIn	eBay	IBM	HP	Dell	Intel	Salesforce	Total
Amazon (Current)		41	11	761	73	492	27	3,711	38	218	1270	115	625	577	43	8,002
Uber	298		17	597	273	284	118	555	165	94	201	12	50	68	90	2,822
AirBnB	41	15		261	165	116	58	129	69	50	53	4	3	20	27	1,011
Google	1,781	44	31		691	1,308	225	4,151	269	451	2,040	140	330	1,076	261	12,798
Facebook	549	44	12	1,713		394	159	1,556	202	237	372	25	78	226	90	5,657
Apple	442	28	7	731	110		47	1,334	69	404	1,279	188	798	1,307	65	6,809
Twitter	94	8	1	435	118	106		281	36	46	85	7	12	31	70	1,330
Microsoft	2,061	25	3	896	145	714	19		52	157	4,306	418	1,492	1,597	213	12,098
LinkedIn	231	10	5	529	114	198	44	500		180	313	33	103	79	178	2,517
eBay	152	4	0	126	17	135	8	302	14		278	33	82	118	17	1,286
IBM	171	10	2	252	20	385	6	1,577	19	83		710	1,753	830	71	5,889
HP	29	5	1	32	9	127	1	251	6	25	653		425	260	5	1,829
Dell	68	8	1	55	6	281	1	729	3	19	2,302	355		500	15	4,343
Intel	94	2	0	89	11	287	3	683	6	36	1,645	219	484		6	3,565
Salesforce	145	12	4	190	46	207	29	967	62	131	1,208	63	302	129		3,495

Source: Research conducted by Talentful, based on LinkedIn data.

WHO'S HIRING IN THE UK?

The UK tech jobs market is in rude health. This chart shows vacancies for skills associated with the following firms, and the number of jobs each company has actively advertised, over the past three months.



Source: ITJobsWatch – figures for three months to 8 February

JOB MARKET WATCH

76%
Percentage of tech staffers planning on jumping ship in 2017

10%
Computer science graduates from 2015 still unemployed

1.56M
Workers employed in digital companies

Sources: Investors in People, Tech City 2016, Higher Education Statistics Agency

Android Wear 2: just about keeping time

Google has tried to breathe life into its wearables with Android Wear 2, but is the upgrade too little, too late?

ABOVE The new version of Wear lets your device run native apps without a phone nearby

WE ALL KNOW smartwatches haven't sold as well as many manufacturers hoped, with IDC figures showing that smartwatch sales crashed to 2.7 million units in the third quarter of 2016, decreasing a massive 51.6% from the 5.6 million units shipped in the same quarter a year earlier.

Those low sales were in part due to the late arrival of the Android Wear 2 upgrade, but the refresh has left market watchers cold. "Google fixed some of the things that it should have got right in the first place," said Carolina Milanesi, principal analyst at Creative Strategies. "Probably the most impactful addition is Android Pay," she added.

However, the new version of Wear does bring benefits to the platform, not least the ability to run native apps without the need for a smartphone nearby. It makes devices built on Wear standalone, with the watches working over Wi-Fi, Bluetooth or a mobile network instead of relying on handset tethering.

The new features mean users can stream music or take calls when away from their phones, while Google Pay and an improved Fit app that includes activity recognition could also be welcomed by some owners.

However, Milanesi says that complexity may also confuse the market. "If you saw the design of the LG watches, you could easily see how it is not for the mainstream, and the insistence on having now two models – one with cellular and more sensors, and one dumbed down for fitness – is not what the market needs."

The lack of a Google device to showcase the technology also raises question marks over the company's passion for wearables. "This is a non-priority for Google, in my view," said Milanesi. "For Apple, Watch is a key part of the ecosystem, but I do not see the same commitment with Google. If it moves to make its own wearable, like it did with Pixel, I might start to think it cares."

Google partnered with LG to launch the first devices using the updated OS, but some older devices will be upgraded if they meet requirements. Early flagship devices such as the Moto 360 and the LG G Watch are stranded.

Others are more upbeat about the new features. "It's not the ground-breaking revamp many were hoping for, but I believe it still brings plenty of incremental and necessary updates to the platform," said George Jijiashvili, wearables and VR analyst at CCS Insight.

"It's clear that Apple and Google have identified the need for watches to be less reliant on phones, which stems from the desire to eliminate the perception that smartwatches only duplicate smartphone functions, and to provide additional utility on top of the smartphone."

Government services login schemes at loggerheads

Government departments are reportedly fighting over the systems people will use to sign in to public services

THE LARGEST ONLINE service provider in the UK government is HM Revenue & Customs (HMRC), which uses an old Government Gateway access system boasting 50 million accounts for services such as tax returns.

ABOVE Verify is being lauded by the Cabinet Office as the key ID system for all public services

However, next year Gateway is scheduled to be taken out of service and replaced by Verify, which is being pushed by the Cabinet Office as a master key ID system for consumers using all public services.

There have been rumblings for months that HMRC lacked confidence in the system and wanted to develop an alternative based on Gateway, and its intentions were finally, if briefly, made clear in a blog post published in February. "HMRC is developing its own identity solution for individuals, businesses and agents. Other departments will use GOV.UK Verify for all individual citizen services," read the blog.

However, the government has set a target for getting 25 million users onto Verify by 2020, and would meet that target easily if HMRC accounts were migrated to Verify. This perhaps explains this swift volte-face from HMRC, which quickly edited the blog.

"HMRC is committed to Verify as the single identification service for individuals and is fully focused on delivering this," the blog backtracked. "The authentication service that HMRC is developing to replace the Government Gateway will complement the existing Verify service for business representatives."

One of the reasons that HMRC may be lukewarm on Verify is its poor usability. According to the service dashboard for GOV.UK, the proportion of "visits started on Verify that result in successfully accessing a service" is incredibly low. A mere 34% of visitors were able to access the site successfully, with the (unnamed) highest-performing service managing only 67% of successful logins.

Who's watching the AI decision-makers?

As everyday decisions are increasingly being delegated to computer systems, Stewart Mitchell investigates who's accountable for the software's verdicts

An insurance firm's algorithm decides that you're too much of a risk for health insurance; your credit limit is suddenly cut by a bank's automated system; the judge refuses you bail because a computer decides you pose a serious flight risk. As artificial intelligence is increasingly used to replace human decision-making, an obvious question arises: who's keeping an eye on the digital decision-makers?

According to AI specialists, the answer is nobody. Developers are building systems that make potentially life-changing decisions, but have no external oversight or standardisation. "It's not simply that AI algorithms can make mistakes, but that the whole ecosystem is a closed book, with little understanding of how decisions that have real-world impacts on people are actually made," said Sandra Wachter, a data ethics specialist at London's Alan Turing Institute (ATI). "Judges could also use AI to decide whether people should be given parole and the chances of them re-offending, so really important decisions are being delegated to AI systems that are hard to scrutinise. We don't know how they work and don't have any safeguards in place to make sure the systems are accountable and fair, and this is a major issue."

ABOVE Are AI systems making life-changing decisions without enough oversight?

Wachter believes that UK data laws leave consumers disadvantaged because, although companies might be required to inform people that AI was used in the decision-making process, there's no way of reviewing that process.

Wachter and her colleagues at the ATI and Oxford Internet Institute have written a report titled "Why a right to explanation of automated decision-making does not exist in the General Data Protection Regulation (GDPR)", which highlights the lack of transparency. "If I applied for a credit card and was declined, I should have the right to know how the algorithms made its decision – so what kind of data was used, what was the criteria, what were the weightings and how was the decision approached?" she said.

"We cannot say there's a right to explanation or a right to be informed under the proposed GDPR legislation. The problem is we don't have standards so we don't have certain techniques that are transparent and fair."

Removing the human factor

AI is in widespread use, and it's becoming omnipotent. A report from consultancy firm Accenture predicts that AI may significantly contribute to economic growth in the UK, adding $814 billion to the economy by 2035. "AI is poised to transform business in ways we've not seen since the impact of computer technology in the late 20th century," said Paul Daugherty, CTO at Accenture.

It's little wonder that businesses are keen to roll out AI quickly, but is accountability being sacrificed in the rush? One obstacle to transparency is that companies building AI systems have no incentive to open their software to inspection, preferring to keep their intellectual property to themselves. The IP is valuable, but experts believe that there's too much scope for abuse – and think a regulatory body or inspectorate is essential to police the technology.

Yet even if companies could be convinced – or forced – to break the seals on their software, there's no guarantee an inspectorate would be able to make sense of what they see. "Some systems are difficult to understand, and certainly deep-learning systems are quite opaque in the way they make decisions, so achieving transparency technically as well as giving commercial confidentiality may well be difficult," said Professor Alan Winfield from Bristol Robotics Lab.

"If you put something like an aircraft data recorder in systems,whether they're driverless cars or software AI systems – you could record exactly what happened at each moment in time and with each input to the system and the outputs," he said.

Simply recording the process may not provide sufficient transparency, however, with concerns that, as machine learning refines the systems, it becomes unclear which factors are affecting decisions. AI could change the weighting given to an element in the decision-making process based on previous results – so the same inputs could have a different output from one day to the next.

Such a situation makes transparency more difficult, but platform developers could still include checks and balances – a monitoring tool that can forensically inspect what's happening at a given time, say. "If it's a learning system that's continuously evolving, then the system may – and this is hypothetical – make a different decision today than it actually made yesterday," Winfield said. "To overcome that, you need to take a snapshot of the system periodically – these are deep technical problems, but there's no doubt we need to try and solve them.

"Even with deep learning, it's essentially a large neural network trained with large datasets. I don't believe that it's impossible to build systems that can allow us to get an explanation for why they've made a decision."

Fear of regulation

Academics may be push for greater transparency, but the industry isn't so keen. Not surprisingly, industry players are seeking a soft approach that would allow the sector to grow without the hassle of regulated consumer protection.

"One thing we must not do is put too much red tape around this at the wrong time and stop things developing," Dr Rob Buckingham, director of OC Robotics, told a Commons committee which, in late 2016, published a report on robotics and artificial intelligence.

"One of the key points is to make sure that we're doing testing in the UK transparently and bringing the industry here so that we understand what's going on, and that we start to apply the regulation appropriately when we have more information about what the issues are."

Trade group TechUK also that warned "that over-regulation or legislation of robotics and AI at this stage of its development, risks stalling or even stifling innovation".

However, there's now momentum from non-profit groups for a set of standards or regulations that could work in practice. "The technology needs to be sufficiently transparent to give answers as to how it works when required and the regulatory structures need to be in place so that, if necessary, companies and suppliers are compelled to give those answers," said Winfield.

Working with the IEEE, Winfield is proposing an auditing programme in which trusted bodies would be able to examine the internal workings of AI systems, and report top-level results that don't reveal commercial secrets. "In a sense, you can get around the problem of commercial confidentiality by setting up an independent inspectorate, and the deal is that the inspectorate conducts its work within strict boundaries of confidentiality," he said, adding that there are plenty of examples.

"In existing safety-critical systems like railway software, there's an inspectorate that's allowed access to commercially sensitive material because it's well understood that that is a confidential exchange and only the abstract or high-level details of what went wrong are made public, but not the intellectual property behind the decision."

> "The technology needs to be sufficiently transparent to give answers as to how it works when required"

Systems could even be issued with a certificate for meeting criteria for transparency before being rolled out. "You could have a body that would issue certifications," said the ATI's Wachter. "So you could have a certification system in place before an algorithm is deployed, with a seal that says it's fair and accountable."

AI – international rescue

At the end of 2016, UK, EU and US officials all released reports outlining how they could monitor and regulate artificial-intelligence systems as they grow more prevalent. All three reports flagged the need for accountability, but they took significantly different views on who should lead.

UK officials have proposed a "co-ordinated approach" between the government and a standing committee, with current interpretations based on the UK Data Protection Act. In the US, on the other hand, private industry is expected to work with the government to set ethical standards.

Meanwhile, the European Commission and a new advisory agency would apply the General Data Protection Regulations due to be implemented in 2018. Although the GDPR will apply to the UK before Brexit is completed, the British government will of course be able to repeal any legislation at a later date. However, that may harm Britain's chances of being able to transfer data within European boundaries.

The A-List

The best products on the market, hand-picked by our editors

PC PRO A-LIST

PREMIUM LAPTOPS

Dell XPS 13 (New)

13in ultraportable from £1,149

dell.co.uk

Dell only needed to refine its brilliant XPS 13 design to keep top spot, and that's what it does: it's slightly quicker and adds more options, but it's the edge-to-edge 13.3in display and super-compact chassis that lift it above the opposition. Oh, and it's now available in Rose Gold. REVIEW **Issue 270, p54**

ALTERNATIVES

Lenovo ThinkPad X1 Yoga
A dream laptop that turns into a 14in tablet with the swivel of a keyboard – yet it still weighs under 1.3kg. Simply beautiful design from Lenovo. **From £1,670; lenovo.com/uk** REVIEW **Issue 263, p56**

Apple MacBook Pro 13 (2016)
The high price stops it from taking Dell's top spot, but a nine-hour battery life, sleek design and – for a premium – the Touch Bar make this a stunning machine. **From £1,449; apple.com/uk** REVIEW **Issue 268, p54**

Dell XPS 15
Dell takes the XPS 13's beautiful design and applies it to this blistering 15.6in laptop. End result: the best 15in all-round laptop on the market. **From £1,349; dell.co.uk** REVIEW **Issue 258, p62**

SMARTPHONES

Samsung Galaxy S7 Edge

Android, 32GB, £589

shop.samsung.com/uk

With the Galaxy Note 7 gone forever, it's not all bad news for Samsung: its replacement on the A-List is the S7 Edge, with its dual edge 5.5in AMOLED screen still the pinnacle of quality. Despite the arrival of the Pixel and iPhone 7, it's the best phone in town due to its brilliant camera, expandability via a microSD slot, weather-proofing and astronomical battery life.
REVIEW **Issue 261, p70**

ALTERNATIVES NEW ENTRY

OnePlus 3T
The 3T is faster, has a bigger battery than the 3 and an improved selfie camera – enough to keep it as the top mid-range choice. **From £399; oneplus.net** REVIEW **Issue 269, p68**

Lenovo P2
It may only cost £200, but you're getting a high-quality metal chassis, 5.5in AMOLED screen and a staggering amount of battery life. **£200; lenovo.com/uk** REVIEW **Issue 271, p60**

Apple iPhone 7
Not a world-beater, but water-resistance, superb design and numerous tweaks add up to a great phone. **32GB, £599; apple.com/uk** REVIEW **Issue 266, p54**

TABLETS

Apple iPad Pro 9.7

Pro tablet from £549

apple.com/uk

While the Surface Pro 4 is our top tablet choice for serious work, the iPad Pro 9.7 retains its A-List crown as an all-round tablet. Add the Smart Keyboard and Pencil and you have an amazingly versatile computer. It's superb for taking down notes by hand, for typing when necessary, and a glorious tablet when you need it.
REVIEW **Issue 261, p64**

ALTERNATIVES

Microsoft Surface Pro 4
Lives up to Microsoft's promise of a tablet that can replace your laptop, with a stunning screen. **128GB, £749; microsoftstore.co.uk** REVIEW **Issue 264, p88**

Google Pixel C
The next OS update will make this beautiful piece of hardware even more usable. It's the best Android tablet by a country mile. **32GB, £479; store.google.com** REVIEW **Issue 264, p83**

Apple iPad mini 2
A price drop due to the iPad mini 4's arrival makes this old-timer more attractive than ever. **32GB, £239; apple.com/uk** REVIEW **pcpro.link/almini2**

EVERYDAY LAPTOPS

Asus ZenBook UX330UA

Stylish and powerful, £850

pcworld.co.uk

An everyday laptop doesn't need to lack power, style or portability, as the excellent UX330UA from Asus shows. Weighing 1.2kg, it packs in a Core i5-6200U processor, 8GB of RAM and a 256GB SSD, not to mention a top-quality 13.3in 3,200 x 1,800 screen.
REVIEW **Issue 266, p62**

ALTERNATIVES NEW ENTRY

Acer Chromebook R11
Quite simply the most attractive and practical Chromebook you can buy today, weighing 1.25kg and complete with a 11.6in IPS display. **£229; pcworld.co.uk** REVIEW **pcpro.link/alistr11**

HP Chromebook 13 G1
HP produces a stylish and high-quality laptop, but with Chrome OS, not Windows. It's fast, has all-day battery life and wouldn't look out of place in a boardroom. **£610; amazon.co.uk** REVIEW **Issue 271, p54**

Asus ZenBook Flip UX360CA
Brings the style and substance of the UX305CA (our A-List choice) but adds extra flexibility thanks to a 360-degree hinge. **£700; currys.co.uk** REVIEW **Issue 265, p70**

ENTHUSIAST PCs

NEW ENTRY

PC Specialist Enigma K2

Base unit, £800

pcspecialist.co.uk

With a 3GHz Kaby Lake Core i5-7400 processor, 16GB of RAM and GeForce GTX 1060 graphics, there's very little the Enigma can't do at speed. Add a 240GB SSD, 1TB hard disk and Cooler Master case and it's a great all-round package. REVIEW **Issue 271, p74**

Chillblast Fusion Strix Gaming PC

A winning debut for Kaby Lake, with Chillblast overclocking Intel's top-end chip – the Core i7-7700K – from 4GHz to 4.2GHz and supporting it with 16GB of 3GHz DDR4 RAM and a superfast Samsung SSD. The great case is the icing on top. **£2,150; chillblast.com**
REVIEW **Issue 269, p54**

Palicomp i5 Focus

If you're looking for a little more power than the Enigma, the Core i5-6600K – overclocked to 3.5GHz – coupled with a 256GB Samsung SM951 M.2 SSD, 16GB of RAM, and GeForce GTX 1060 graphics add up to one super-powerful machine.
£1,000; palicomp.co.uk
REVIEW **Issue 266, p88**

WORKSTATIONS

Scan 3XS Classic 3D

i7-6950X workstation, £4,750

scan.co.uk

An overclocked Core i7-6950X combined with Nvidia's new Quadro P5000 graphics, with a high-quality supporting cast of components and chassis, translate into a superb content-creation tool for the right price. REVIEW **Issue 270, p84**

Lenovo ThinkStation P910

Lenovo pulls no punches with this amazing workstation: a pair of high-end Xeon E5-2867W v4 processors, Quadro P6000 graphics, 128GB of RAM, four 512GB SSDs and four 4TB hard disks tell their own story. Incredibly expensive, but worth it.
£12,250; lenovo.com/uk.
REVIEW **Issue 270, p83**

Workstation Specialists WS-X1100S

This NAS-sized device packs the power of a tower system, with the choice of specification near-identical to the Scan's winning formula. You just need to decide if it's worth paying extra for the miniaturisation.
£5,899; workstationspecialists.com.
REVIEW **Issue 270, p85**

EVERYDAY MONITORS

NEW ENTRY

Eizo FlexScan EV2450

1080p display, £264

scan.co.uk

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**

Samsung CF791

It may seem expensive, but this is a top-quality 34in 3,440 x 1,440 curved monitor. At 1500R, it's very nearly the same curvature as the human eye, which justifies the term "immersive" whether you're playing games or working. **£809; morecomputers.com**
REVIEW **Issue 271, p61**

AOC AGON AG271QX

AOC targets gamers with this 27in screen, which offers 144Hz refresh rates at its native 2,560 x 1,440 resolution, but it's a fine all-rounder too. With excellent colour accuracy, even photo and video editors should be happy. **£410; amazon.co.uk**
REVIEW **Issue 270, p69**

PROFESSIONAL MONITORS

Eizo ColorEdge CG277

Professional monitor, £1,600

wexphotographic.com

Spectacular image quality; stunning colour accuracy; amazing flexibility. Just three reasons the ColorEdge CG777 won our Labs dedicated to monitors for professionals.
REVIEW **Issue 260, p88**

Dell UltraSharp UP2716D

This 27in screen couldn't match the Eizo CG277 for outright quality, but compared to most screens it offers superb colour accuracy – especially for the price. It supports hardware calibration, has ultra-thin bezels and is packed with connectivity. And you can buy almost three to each CG277. **£725; dell.co.uk** REVIEW **Issue 260, p86**

NEC SpectraView 232

A great choice if you need a single colour-accurate monitor to final-check work but don't want to pay a fortune. It's undeniably expensive for a 23in 1,920 x 1,080 screen, but stunning image quality and an array of features sweeten the deal.
£519; wexphotographic.com
REVIEW **Issue 260, p92**

WEARABLES

Apple Watch Series 2

Smartwatch, from £369

apple.com/uk

This refined and upgraded Apple Watch – complete with GPS and water resistance – is the best all-round watch/fitness tracker around. No more just a notification centre on your wrist, it's now a genuinely helpful tool. REVIEW **Issue 266, p62**

Fitbit Charge 2

The fitness tracker lacks only built-in GPS. In return, there's everything you need – including an OLED display and heart-rate monitor – packed into a sleek design. Note it's designed for ease of use rather than in-depth data analysis, so fanatics should look elsewhere. **£120; johnlewis.com**
REVIEW **Issue 268, p78**

Pebble Time

Now discontinued, but we still love the simplicity of the Pebble Time, a fun, practical watch that works with both Android and iOS. App support is limited, but all the fundamentals are covered, and the colour e-paper screen helps the Time achieve five days of battery life. **£79; amazon.co.uk** REVIEW **pcpro.link/alpebble**

WORKGROUP PRINTERS

Kyocera P6035cdn

Colour laser, £374 exc VAT

printerland.co.uk

An affordable workgroup colour laser with classy print quality at high speeds, hitting 29ppm in our tests. Running costs of 1p and 5p colour are commendable too. **REVIEW Issue 262, p96**

Brother MFC-L5750DW

This mono laser delivers crisp results at 46 pages per minute, while a generous 8,000-page starter cartridge and 12,000-page replacements mean running costs work out at 1p. Great scanning and cloud features round off the deal. **£206 exc VAT; printerland.co.uk REVIEW Issue 269, p101**

HP PageWide Pro 452dw

Forget all you thought you knew about office inkjets: speeds of over 50ppm and costs of less than 1p per mono page are more than a match for similarly priced lasers. It's a bit picky about paper, though. **£218 exc VAT; printerbase.co.uk REVIEW Issue 262, p95**

HOME OFFICE PRINTERS

NEW ENTRY

Epson WorkForce WF-3620DWF

A4 all-in-one inkjet, £95

amazon.co.uk

This includes everything we look for in a home office printer. It's speedy, hitting 17.4ppm when printing black text, while offering low costs of 6.1p per page of mixed test and graphics. It even includes a fax! **REVIEW Issue 271, p71**

Brother MFC-J5620DW

It may look dull, but this boxy A3 inkjet is user-friendly, delivers decent speeds (our 20-page mono doc appeared in 91 seconds) and has low running costs of 0.6p for a mono page and just 4.5p for colour. Watch out for occasional low-price deals, too. **£188; printerland.co.uk REVIEW Issue 262, p81**

Lexmark CX310dn

Lasers still win for pin-sharp text, and this colour unit impressed in a number of areas: great all-round quality, solid 18.7ppm mono and 11.9ppm colour speeds, and good running costs for a laser at 2.1p/9.7p per page. There's a 50-sheet ADF, but no Wi-Fi. **£180; ebuyer.com REVIEW Issue 262, p85**

ROUTERS

Netgear Nighthawk X4S

802.11ac router, £260

broadbandbuyer.co.uk

In return for that staggering price, you're getting top-end performance, today and in the future – thanks to support for multi-user MIMO. Bags of advanced features only add to its allure. **REVIEW Issue 256, p86**

Synology RT1900ac

Until now, Synology was probably best known for NAS drives, but this 802.11ac router suggests it may become a major player here too. Not only fast, easy to use and packed with features, it also comes at a price that undercuts rivals by up to £50. **£136; ballicom.co.uk REVIEW Issue 256, p87**

BT Smart Hub

If you're a BT broadband customer, this is something of a bargain at £50 (discounted from its "full price" of £130). It lived up to BT's bold speed and range claims, with fast and reliable performance even at distance. It's free to new Infinity subscribers, too. **£130; home.bt.com REVIEW Issue 264, p64**

SMB ROUTERS/ACCESS POINTS

DrayTek Vigor 2860Ln

Secure router, £320 exc VAT

misco.co.uk

A brilliant router for businesses that demand excellent security features, while its VPN support is second to none – the price includes support for 32 IPsec VPN tunnels. It's worth every penny. **REVIEW Issue 258, p95**

TP-Link Auranet EAP330

This access point provides an affordable, secure and high-performance wireless network, while its bundled management software offers scope to grow and control your network without having to pay anything extra. A great choice for growing businesses **£169 exc VAT; ebuyer.com. REVIEW Issue 270, p101**

Linksys LRT224

We weren't overly impressed by the LRT224's performance in our speed tests, but if your main concern is business VPN options then take note: this compact steel box can handle up to 50 site-to-site or client VPNs, despite its low price. **£121 exc VAT; box.co.uk REVIEW Issue 258, p96**

SCANNERS

Visioneer Patriot D40

Network scanner, £379 exc VAT

tradescanners.com

67ppm scan speeds, impeccable paper handling from the 80-page ADF and a fine software bundle makes this a great choice for small businesses with big demands. **REVIEW Issue 264, p100**

Brother ADS-3600W

With a scan rate of 50ppm, impressive output quality, wide support for cloud services and a comprehensive bundle of features, the Brother ADS-3600W has every document-digitising feature a small or medium-size business could possibly need. A fine alternative to the Patriot D40. **£462 exc VAT; ebuyer.com REVIEW Issue 263, p96**

Fujitsu fi-7480

This scanner is overkill for most businesses, but it delivers astonishing scan speeds – 68ppm for A4 pages – and impeccable paper handling, backing it up with excellent scan quality and OCR abilities. It could revolutionise document management. **£1,995 exc VAT; tradescanners.com REVIEW Issue 267, p102**

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PRTG NETWORK MONITOR

SECURITY SOFTWARE

Kaspersky Internet Security 2017

Little changes in the 2017 update, but it still offers perfect protection in tests – and now adds a VPN and tools to update and manage software. **3 PCs/1yr, £20; amazon.co.uk REVIEW Issue 267, p64**

Avast Free Antivirus

Avast Free Antivirus can't match paid-for suites for virus detection, but it remains a strong performer with some nifty features. Against tough rivals, this is the pick of the free crop. **Free; avast.com REVIEW Issue 265, p84**

Bitdefender Internet Security 2017

While the interface is a step back from 2016, everything else that's great about Bitdefender stays: most notably the silent but deadly "Autopilot" protection. **3 PCs/1yr, £25; amazon.co.uk REVIEW Issue 267, p65**

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. **From £120; office.microsoft.com REVIEW pcpro.link/aloffice16**

LibreOffice 5

The interface looks a little dated, and the lack of collaboration features is a shame. But interoperability with Word and Excel is better than ever, making this a fine upgrade if you don't want to pay. **Free, libreoffice.org REVIEW pcpro.link/allibre**

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. **£29; literatureandlatte.com REVIEW pcpro.link/alscrivener**

CREATIVITY SOFTWARE

Adobe Creative Cloud 2017

Adobe entrenches its position as an indispensable resource for creative professionals, with useful upgrades to the core print-orientated apps such as Photoshop, and some exciting new additions for digital designers too. **Complete plan, £46/mth; adobe.com/uk REVIEW Issue 268, p72**

Adobe Photoshop Elements 14

Despite few new features, this is still the best home image-editing tool around. Consider subscribing to Lightroom and Photoshop proper instead, though. **£50; amazon.co.uk REVIEW pcpro.link/alelem14**

Steinberg Cubase Pro 8

A big bump in performance and a handful of UI improvements keep Cubase at the top of the audio-production tree. A worthwhile upgrade. **£400; dv247.com REVIEW pcpro.link/alcubasepro8**

RACK SERVERS

HPE ProLiant DL20 Gen9

The ProLiant DL20 Gen9 packs a powerful hardware configuration into the smallest of rack spaces. It's very affordable and versatile, and its silent running makes it highly suited to a wide range of deployment scenarios. **£1,273 exc VAT; uk.insight.com REVIEW Issue 260, p101**

Broadberry CyberServe XE3-RS300

There's little to fault in the well-priced CyberServe. Small businesses will particularly appreciate its versatile storage arrangement, combining top SSD performance with plenty of growth space. **£1,195 exc VAT; broadberry.co.uk REVIEW Issue 260, p99**

PEDESTAL SERVERS

HPE ProLiant ML30 Gen9

An excellent choice for SMBs with an eye on the future. The low price makes it great value, it has the best remote management features in town and offers plenty of upgrade space. (On test: model 830893-031.) **£763 exc VAT; uk.insight.com REVIEW Issue 265, p99**

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. **From £399 exc VAT; dell.co.uk REVIEW Issue 265, p98**

SECURITY

Kerio Control NG100

The NG100 is probably the smallest UTM appliance you can buy, but it's no lightweight. It runs the full version of Kerio's Control software, providing SPI firewalling, IPsec VPNs, IPS, deep-packet inspection and bandwidth management. **With 1yr unlimited licence, £389 exc VAT; kerio.com REVIEW Issue 262, p101**

WatchGuard Firebox T70

This UTM appliance offers SMBs a wealth of security measures, teamed up with a super set of remote management tools, at a competitive price. **With 1yr Total Security Suite, £2,178 exc VAT; watchguard-online.co.uk REVIEW Issue 268, p103**

NAS APPLIANCES

Qnap TS-831X

A great-value package for SMBs with an eye on the future, the TS-831X is 10GbE-ready with room to expand. Plus, Qnap's software offers a superb range of data protection apps. **Diskless, £710 exc VAT; broadbandbuyer.com REVIEW Issue 266, p98**

PowerNAS Rackmount 2U

A fine choice for storage-hungry businesses. It's a powerful and affordable appliance with all the features of Windows Storage Server 2012 R2, and big expansion potential makes it a solid investment. **From £1,952 exc VAT; powernas.co.uk REVIEW Issue 266, p97**

BACKUP

HPE StoreEver LTO-7 Ultrium 15000

As if to prove that tape backup will never die, along comes the seventh generation of LTO. HPE delivers an amazing package that bumps up speeds to 300MB/sec and cartridge capacities to 6TB. **£2,618 exc VAT; uk.insight.com REVIEW Issue 263, p100**

Arcserve Backup r17

Simply brilliant for SMBs: it supports Windows and VMware VMs; works with Windows 10 and Exchange 2016; the price includes data deduplication; and it's easy to use too. **File Server Module, £899 exc VAT; arcserve.com REVIEW Issue 261, p101**

VOIP SERVICES

Sipgate Team

For a harried IT manager, Sipgate Team offers all the benefits of VoIP with none of the hassle. There's no minimum contract, no on-site server, and easy management via a web portal – plus all the features you'd expect. **From £15 per month exc VAT; sipgate.co.uk REVIEW Issue 263, p101**

3CX Phone System

If you want to host your own IP PBX then 3CX Phone System does everything you could ask for. It's easy to install while offering an incredible range of call-handling features for the price. **4-channel licence, £270 exc VAT; 3cx.com REVIEW Issue 261, p94**

Profile

BACKGROUND INFO ON INNOVATIVE BRITISH COMPANIES

Redux

A British firm has developed a smartphone screen that doubles as a speaker – and that's not the only trick it has up its sleeve

KEY FACTS

Redux's technology can turn mobile screens into speakers, as well as adding haptic feedback to any rigid material, by gently bending the surface

FORMED
2013

BASED
St Neots, Cambridgeshire

EMPLOYEES
20

WEBSITE
reduxst.com

Most companies are happy to have a product that serves one need – the paradoxically named Redux has one product that meets two.

Not only can its technology turn a display into a speaker, potentially saving phone and tablet makers from having to find room for separate speakers in their already sardine-like chassis; it also provides dynamic haptic feedback on the screen, enabling developers to create virtual, tactile buttons on almost any type of surface.

If it works as promised, Redux is sitting on a technology that could utterly transform mobile devices as well as industrial machinery – all those flat screen displays used on factory floors could suddenly provide haptic feedback, letting workers know they actually pressed a "button" even above the din of machinery.

For the time being, however, the company is only planning to pursue one of those avenues. We sat down with CEO Nedko Ivanov to find out which and why.

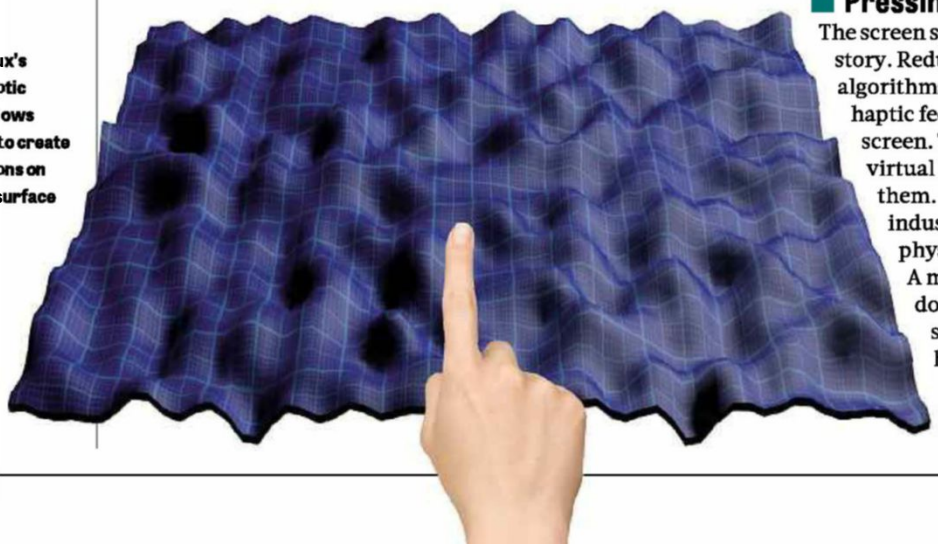
Good vibrations

You might be used to our smartphone and laptop reviewers marking devices down if they show any signs of bend or flex, but that ability to flex a rigid surface is precisely what Redux takes advantage of – albeit at a miniscule scale. "The technology is based on bending waves," Ivanov explained. "The bending waves that are created by bending a rigid surface. It can work across any rigid surface, most typically displays where we have an opportunity to bend the cover glass of the display, but it can work on metal or plastic or any other surface."

Those waves create an extraordinary double effect. "When the bending waves are created on the surface, at the low part of the frequency range they create a haptics effect, and at the high end of the frequency range they produce an audio effect," explained Ivanov.

That audio is of sufficient quality and volume to surpass the speakers found in today's mobile devices, Ivanov boasts. "Compared to a micro-speaker in the smartphone, compared to a micro-speaker in tablet or laptop, this is where we can create significant benefit – creating a lot bigger bandwidth, much better-quality sound, much louder – and this actually comes at a space-saving effect in a device where space comes at a significant premium."

Even if audiophiles quibble over the sound quality, there are other distinct advantages to building speakers into a screen, aside from creating more room inside the device itself. Lay the screen flat on a hard surface such as a desk, for instance, and it turns that desktop into an additional loudspeaker. What's more, by building the speaker into the screen, you close off another point of entry for device-nuking substances such as water or dust. "With our technology, not only can you create a much better-quality sound, you can also seal the device and make it totally waterproof or dustproof, and much more of a pleasure to the eye," said Ivanov.



RIGHT Redux's dynamic haptic feedback allows developers to create virtual buttons on almost any surface

Pressing the right buttons

The screen speakers are, of course, only half the story. Redux can also use signal-processing algorithms to focus that low-frequency haptic feedback onto particular parts of a screen. That means Redux can both create virtual buttons on a display and can move them. So if the menus on a piece of industrial machinery change, the physical buttons beneath them move too. A machine that previously needed a dozen buttons might now need only a small slab of glass. What's more, the haptics are of such high fidelity that users can even feel a button's edge under their finger, according to Ivanov.

ABOVE If you lay the tablet screen flat on a hard desk, it will turn the desk into an additional speaker

TOP LEFT Redux claims its sound is both better-quality and louder than normal speakers found in phones

And although many other virtual button solutions exist – most notably the home button on Apple's iPhone 7 – Ivanov claims Redux's technology is far ahead of its rivals. "One of the reasons for not adopting this technology [at present] is because it's very badly implemented," he said. "If you look at the iPhone 7, you don't really have the flexibility to change the strength of the haptic feedback, to change the sensitivity of the button, to change the size of the button. And actually, when you provide the haptic effect, it vibrates pretty much the whole device."

This ability to alter the size and sensitivity of feedback has applications across a wide range of machinery, not just consumer devices. "There are applications pretty much across every sector that has user interfaces," said Ivanov. "There are applications in industrial controls, there are applications in medical devices, there are applications in payment terminals…"

Yet even though he continues to list a huge number of potential uses for the haptics technology, Redux is currently focusing its resources on the screen speakers. "We have multiple proof of concepts with customers in the smart-home space, in the tablet and laptop space, as well as automotive industries," the CEO claimed. "We have currently about ten live customers and you're going to see products live in 2018, in mass production."

> "A machine that previously needed a dozen physical buttons might now need only a small slab of glass"

Why not chase the industrial machinery market at the same time? "As a small business if you don't focus your efforts, you run out of cash very quickly," said Ivanov. "We decided to focus on automotive and consumer electronics at this stage."

The second attempt

When Ivanov warns of the dangers of the firm spreading itself too thin, he speaks from experience. Redux was formed in 2013, having acquired the intellectual property portfolio and key engineering resources from a company called HiWave.

HiWave was a FTSE-listed company, born out of the 2010 merger between NXT and Audium Semiconductor, but it seems the company soared too close to the sun. According to a report from Cambridge-based *Business Weekly*, "NXT saddled itself with a millstone of over 500 patents, which have cost the company [HiWave] a small fortune to maintain". When no buyer was found for the company, Redux was formed and cherry-picked the patents it needed to bring its technology to market.

"The patent portfolio was expensive," said Ivanov. "We had to trim it down, because it was very expensive to maintain. But in addition to that we have continued to innovate over the past four years." The company now has in the region of 180 patents, with another 50 pending – a portfolio of less than half the size that helped send its predecessor to the wall.

The company remains in Cambridgeshire with a modest staff of 20 people, further keeping costs under control by working with contract manufacturers in Asia, rather than attempting to manufacture the components needed for its displays itself.

The end game

If Redux's technology delivers on its promise, you'd think it would be a very valuable company indeed. Innovation among smartphone manufacturers has almost ground to a crawl – when was the last time you saw something as groundbreaking or exciting as a screen that also doubles as a speaker?

That, we put it to Ivanov, must surely make Redux ripe for a takeover from a company keen to have this potential game-changer to itself, rather than licensing its tech to a variety of manufacturers across different industries. "My experience from the past is that if you try and build a business to be sold, you're at a very high risk of selling yourself short of the opportunity," said Ivanov.

Not that he's writing off the possibility. "We build the business to be a great business. If along the way, somebody comes with an offer, we'll consider it, shareholders will consider it and if it's an attractive offer, we'll sell the business, of course."

Indeed, he goes on to suggest that gaining exclusive rights to the technology creates "a very, very good case for buying us," before stopping just short of putting out For Sale signs on the company's front lawn. "We're a tech starter business and the ultimate goal, of course, is to provide a return on investment to shareholders, so exit is always something that we will consider, for the right price at the right time."

If you're a smartphone, tablet or laptop maker who doesn't like the look of those speaker grilles on the base of your devices, you know who to call. **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

Smartwatches aren't dead – just waiting for smart design

If the smartwatch is going to break out of its niche, we need to think outside of the box – literally

Darien Graham-Smith is *PC Pro*'s associate editor, and a fan of wrist-borne technology since his very first calculator watch.
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It's here! Hang out the bunting and crack open the bubbly: Android Wear 2 has arrived!

Or, as it might be, give a shrug and get on with your life. Because the fact is, the latest major update to Google's smartwatch platform is a cause for great excitement among a particular geeky constituency, and of no interest whatsoever to anyone else.

In my view, the world ought to be a lot more excited about smartwatches. But I understand where the apathy comes from. I remember the first smartwatch I ever tried out, a mid-2014 Samsung Gear 2. Frankly, it felt like a toy. Carrying on a conversation with your wrist, through the watch's tiny speaker and microphone, was fun, but obviously not practical for everyday use. And while the built-in camera was a neat idea, I quickly discovered that shooting from wrist-height is mostly useful for capturing the view up people's noses.

Factor in a battery life measured in hours, rather than the years I was used to from my regular timepiece, and even I refused to pay £250 for this half-baked effort.

The thing to remember is that this was an early smartwatch concept, from the days before there was any such thing as Android Wear. And the technology improved quickly: within six months, we had voice control, instant Google searches, timers, reminders and all sorts of apps. For me, this swung the deal. I retired my trusty Timex and picked up an Android watch of my own. Many friends and colleagues did the same.

For whatever reason, though, the message never seemed to get out beyond these geeky circles. It's not for lack of evangelism; whenever anyone expresses curiosity about what's on my wrist, I'm always enthusiastic in my response. "Smartwatches are great!", I'll say. "They can do this, and this, and this... you should think about getting one." They never do. I'd like to say they're hung up on the shortcomings of those early forerunner devices; truthfully, I think they simply see smartwatches as exclusive property of the techie community.

It's an attitude that frustrates me. After all, it's not just geeks who can benefit from notifications and reminders. In the early days, I put my hope in the idea that the Apple Watch might inspire people to take a fresh look at wrist-borne computing. Let's face it, tablet PCs had always seemed like awkward niche devices until the iPad came along, so perhaps the same magic would work here. The Apple Watch would open the floodgates, and we'd end up at last with a smartwatch on every wrist.

> "At this point, it's going to take something spectacular – much more so than an OS update – to rehabilitate smartwatches"

To be fair, when Apple showed its hand, it made an impact on popular consciousness in a way that Google has never managed. To this day, people ask if I'm wearing "one of those Apple Watches". (They've rarely even heard of Android Wear.) Unfortunately, Apple's decision to position the device as a super-exclusive aspirational item put the kibosh on any possibility of mass-market appeal.

And so here we are in 2017, having made very little progress. Yes, for some of us it's an exciting time: Android Wear 2.0 brings neat new features, including a truly interactive voice-control interface. We've been eagerly checking for the update several times a day, since Google's staggered rollout strategy means you can never be quite sure when the update will arrive on your particular device.

But I'm not fooling myself that Google's update is going to make the slightest bit of difference to the overall profile of Android Wear, or wearables in general. At this point, it's going to take something spectacular – much more so than an OS update – to rehabilitate smartwatches. And the latest flagship watches aren't going to do it either, with their incremental design and iffy battery life: the forums are suggesting new customers give them a miss and invest in last-generation hardware instead.

Nevertheless, I'm not ready to write off smartwatches. In this connected world, where we're accessing our data more and more casually from more and more locations, the idea is an obvious winner in the long run. The trick, perhaps, is to find a new way into the idea, since the smartwatch as a discrete product clearly hasn't taken off.

Here's what I'm thinking. Before smartwatches came along, people happily wore regular dumb watches on their wrists for centuries. They did so because the benefit – always knowing the time – outweighed the cost of occasionally winding it (or, latterly, replacing the battery). With modern smartwatches, that calculation obviously isn't holding: the benefit isn't perceived as worth the costs, such as purchase price, complexity (real or imagined) and the need for constant recharging.

So let's rebalance the proposition. How about a device that is, first and foremost, a regular watch – something anyone can feel comfortable using, with a timekeeping function that will operate for years on a modestly sized battery. Rather than being the core of the watch, let's make the smart component module that can be charged, woken up and operated independently from the watch basics. In this arrangement, the owner can try out the smart features as and when they wish. Once they do, they will quickly get comfortable with the idea – and the geeky stigma will evaporate.

It's not that I've anything against geeks: I've even heard it said that geeks are cool nowadays. If we want a technology to really succeed, though, it needs broader appeal. Android Wear 2.0 is a welcome arrival, but I'm saving the real celebration for the day people stop asking me what's on my wrist – because the same thing's on theirs.

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Why Libratus could be America's Trump card

The poker-playing supercomputer that could be destined for far greater things

Barry Collins is a former editor of *PC Pro* and campaign manager for Libratus 2020. Tweet your support at @bazzacollins

In the good old days at *PC Pro*, we used to have after-work poker tournaments in the office. A crate of beers, enough salted snacks to grit half of London during a cold snap, and a table of very mixed abilities. With all due disrespect to colleagues past and present, I hated those games.

Why did I loathe these evening sessions of Texas Hold'em? Because I'm spectacularly fond of winning, and these games were impossible to read. Half the table had no idea how to play the game, no sense of when to call or fold, no concept of strategy. I recall bombing out of a tournament early, when my pair of queens was beaten by someone who had gone all-in on a four and a two – one of the weakest hands possible . It wasn't a bluff, they'd just got bored and shoved their chips in, fluking out when the final five community cards delivered them a straight (2-3-4-5-6) that beat my three queens.

Now, it turns out my erstwhile colleague was actually something of a poker genius. Recently, four of the world's best poker players got their proverbial backsides handed to them by a computer, Libratus, which comprehensively thrashed them over a mammoth 20-day tournament. How did the supercomputer take the shirt off their backs? By becoming utterly unpredictable.

Libratus didn't learn poker the usual way – by watching other people play and picking up the mores and strategy as it goes along. Nor did it take the normal supercomputer approach of studying moves from millions of previously played games and working out the best possible play in every scenario. Instead, its masters from Carnegie Mellon University taught the computer the rules of Texas Hold'em and then let it work out how to play the game by itself.

Using an algorithm called "counterfactual regret minimisation" (which, by the way, is the title of my forthcoming autobiography), Libratus taught itself by first playing hands at random, refining its skills by playing trillions of hands against itself. It wasn't influenced by how humans play the game – it devised its own strategy. "We give the AI a description of the game. We don't tell it how to play," Noam Brown, one of the students who built Libratus told *Wired*. "It develops a strategy completely independently from human play, and it can be very different from the way humans play the game."

Indeed, it seems Libratus' strategy was to bet often and heavily, even if – like my *PC Pro* colleague of yesteryear – it didn't have the cards to warrant such aggression. The pros didn't know how to read the computer, and even if by the end of the day they had begun to spot patterns in Libratus' betting, they were back to square one when play resumed the next morning. Each night, a meta-algorithm analysed which patterns of play the pros had identified and the top three were patched by the time they sat back round the baize again. Libratus wasn't trying to find holes in its opponents' strategy, or look for the "tells" that human players rely on to decide if a player is bluffing; it was making sure there were no chinks in its own armour.

In a Reddit "Ask Me Anything" (AMA) session, the poker pros seemed absolutely crestfallen. "Once you face Libratus, there's nothing worse any human could ever do to you," said one of the beaten players, Jason Les, who's won over $1.5 million in tournaments over the years. "We're seeing the bot play like a strong human player, but also putting way more pressure on us than any human can correctly."

The pros even admitted that they would be trying to emulate Libratus' style of play in the future. "We are definitely going to start overbetting more frequently," said Les, and fellow pro Dong Kim. But before you shoot off down the casino and throw your pension pot at a succession of weak hands, the players cautioned: "It takes a lot of studying to figure out the right way to do it, though. The moment you're somewhat imbalanced there (bluffing too much, or bluffing too little) then you're making a huge mistake."

And that's the most terrifying thing of all: Carnegie Mellon just built a machine that can out-bluff humans. Hold'em poker is not like chess or Go, the other games in which supercomputers have famously outwitted the world's best players: the AI must make decisions without seeing all of the cards, without knowing what might happen. Carnegie's developed a branch of AI that's adept at making decisions with partial information, and Lord knows what implications that might have for stock trading, or negotiating with terrorists or any other scenario that requires you to call someone's bluff.

> **"And that's the most terrifying thing of all: Carnegie Mellon University just built a machine that can out-bluff humans"**

Then it struck me: the similarity between Libratus and the 45th president of the United States. Both overcame opponents with very aggressive tactics, with both relying on an enormous degree of bluff. If the Democrats want to retake the White House in 2020, I suggest they speak to Carnegie Mellon. After all, President Libratus has a nice ring to it.

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Don't be fooled: Silicon Valley is looking after number one

Tech leaders haven't shown much care for us before, so why does everyone expect decency now?

Nicole Kobie is *PC Pro*'s Futures editor. She still won't be taking Uber to her local protest. @njkobie

There's a witch hunt in Silicon Valley, and Travis Kalanick was clearly worried he wouldn't float. Following an American executive order banning visitors from seven countries, most of the tech industry gasped incredulously, then loudly criticised the policy – although most initially spoke out of concern for their own staff, lamenting how difficult it was to find good people. That Silicon Valley skills gap is hard to fill without international visas, after all.

There was genuine concern, of course. Many tech leaders are immigrants, and Sergey Brin showed up at a protest in San Francisco while very publicly donating $2 million to a "crisis fund" supporting the likes of rights campaigners the American Civil Liberties Union (ACLU).

In some cases, such donations were the only way to avoid a PR disaster, as company statements on the ban were picked apart for appropriate fervency. If not deemed genuine or sufficiently passionate, that communications-team-written memo would draw damnation in headlines, as IBM duly discovered with its "embarrassingly weak" response. SpaceX and Tesla founder Elon Musk was battered for his participation in the president's business council, forcing him to rationalise his membership by claiming he's taking a seat at the table only to fight the dark side… by working with it.

Then there was Uber, an app I've already uninstalled for reasons previously laid out

in this column, so I'm no fan of CEO Travis Kalanick. The ride-hailing app cancelled its surge pricing – when it bumps up fares to draw more drivers to the road during peak times – at the same time that New York taxi drivers went on strike, refusing to take rides from JFK International airport in support of protests there against the travel ban.

Uber was accused of trying to break the strike, which was only an hour long. Had it charged surge pricing, it probably would have been accused of trying to profit from the strike. Either way, rival Lyft took the opportunity to publicly donate $1 million over four years to the ACLU, intentionally or not sparking a witch hunt. Faced with a #DeleteUber campaign that saw 200,000 people shut down their accounts, Kalanick spent the next few days backtracking faster than a Prius reversing away from a dodgy looking fare. Uber spent $3 million setting up a fund to help people hurt by the immigration ban; then Kalanick pledged to bring up the issue to the president's face at the business advisory council, before the panicking CEO dropped out of the council altogether.

Has Kalanick suddenly grown a heart *á la How the Grinch Stole Christmas*? Will he now start respecting local laws and treating drivers like humans? Or did the bad PR merely bully him into a politically expedient position? Witch hunts work, it would seem.

I have no complaint about the result, regardless of what's really in Kalanick's heart. It gives me a warm, fuzzy feeling to see fear in the eyes of an arrogant CEO, and anyone who supports a ban against people based on where they're born or what religion they practise is worthy of outrage. But why do we expect tech companies in particular to be the ones to step forward and take action? No-one is switching to Coke over Pepsi because of politics, or cancelling trips to Disneyland because the CEO's statement on immigration was too strong or not strong enough – indeed, I haven't a clue what those companies think about the executive order. Disney remains on that business advisory council, but hasn't made headlines.

Corporate activism may well do good work, and the ACLU certainly appreciates the donations, regardless of the motivation. But caring about people starts before it's politically necessary, and shouldn't depend on being a smart PR move. These firms don't care about you – they just want your data and credit card details, not your well-being.

If Silicon Valley is only on the side of decency because it's easily bullied, we're in a precarious position – that witch hunt can always change direction, after all.

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The analogue revolution may just be going too far

As the world becomes more analogue, we'd be fools to ignore the freedom going digital offers

Dick Pountain is editorial fellow of *PC Pro*. He's an analogue sort of guy who can also swing digital.

Our industry is notorious for its love of buzzwords (think "agile", or "responsive", or "passionate") but currently the most egregious one, the one that makes me reach for my imaginary Luger, is "creative". It's one of those words, like "love" or "cool", that's so unabusable, so self-evidently good and desirable, that it's guaranteed it will be continually abused. I consider myself creative, like everyone else in the friggin' world, but I've recently been prompted to examine more closely what that means. This reflection was provoked by a Bill McKibben review in the *New York Review of Books* of *The Revenge of Analog: Real Things and Why They Matter* by David Sax.

Sax's thesis is that we're witnessing more and more islands of analogue refuge among the foaming waves of digital media and communications: places where we can relax and think, and where we touch physical objects instead of bitmaps. An example is the rediscovery of vinyl records by young people, in sufficient numbers to warrant the reopening of several pressing plants.

> **"We're witnessing more and more islands of analogue refuge among the waves of digital media and communication"**

Another is the recent fashion for carrying a Moleskine notebook, even among folk who clutch the latest iPhone in their other hand. (This sent me off down a timewasting diversion about pronunciation: Brits call it "Mole-skin", Europeans and ex-Europeans like me say "Mol-ess-kinay".) The company recently went public, valued at a positively digital €490 million, for a quintessentially analogue product. Sax talked to architectural software firms who hand out the notebooks and forbid their designers to turn on their computer until they've brainstormed an initial design on paper. The electronic whiteboard utterly failed to displace paper pads and marker pens, as used by this very magazine in our own brainstorming sessions.

Sax continues to push this argument a step too far for me. Moleskine's ads claim its notebooks helped Picasso and Hemingway to success: "Creativity and innovation are driven by imagination, and imagination withers when it is standardised, which is exactly what digital technology requires– codifying everything into 1s and 0s, within the accepted limits of software."

Perhaps, but remember that paper was all they had. We can't know whether Picasso would have taken to Procreate or Zen Brush on an iPad, but my guess is he'd have loved it. The 1s and 0s objection is "a 10ad of 01d b0110x" in the era of GUIs.

I've written about my quest for usability in pocketable devices, and this book review played right into my latest discovery, namely that Google Keep has just added a sketching facility. I can now knock out line and tone drawings with my finger on phone or tablet as fast as I could with a Moleskine and a pen, and they automatically appear on all my devices without scanning. If I need more features, Autodesk's Sketchbook is installed on my tablet too, and Android's ubiquitous Share menu shuttles pics between.

I've also written here about the thousand-odd processed photographs that I keep on Flickr, and about my Python-based music composition system. In both these media, I respect Sax's aversion to "standardisation": for example, when I apply dozens of filters and blend-modes to a photo, I deliberately refrain from writing down the sequence so the image is unique and unrepeatable – although it's easily *copyable*, which is a principal joy of digital versus analogue. I do the same when composing tunes: while I keep the Python source code for each family of tunes, I don't record every parameter (for example, random ones) for each instance, so these tunes have the same uniqueness as my photos.

A deep attachment to matter is desirable, given that we're all made of it, but it can also stray into the sentimental. It cuts two ways: while matter has a permanence and leaves a historical trace – we still have pottery and statues made thousands of years ago – most people believe that digital data is impermanent, volatile, easily lost (which can be true if you have a sloppy backup regime). But that volatility is also a strength of the digital realm. Art is all about essences, representations and images, and handling these digitally produces far less waste of both materials and time. Check the price of oil paint and canvas: it's an expensive way to learn. Best overcome any aversion to 1s and 0s, design and edit your work in the digital domain and turn it into matter when it's good enough. That's what 3D printers and record-pressing plants are for.

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Readers' comments

Your views and feedback from email and the web

Tech and health data

As an NHS professional working to develop improved data handling, I read your feature, "Can technology save the NHS?" (*see issue 270, p30*), with great interest. I know from experience that there's a great desire to improve data sharing among NHS organisations and beyond, but I feel your article didn't touch on the biggest hurdle, data protection.

For many of us, our medical data is considered among the most private of all information. This presents some significant challenges when it comes to sharing data, as even the slightest risk of identifiability is (rightly, in my opinion) deemed unacceptable, yet completely anonymising such data is a non-trivial endeavour.

Furthermore, patients don't always have an appetite for their information to be shared even within an NHS organisation. While most have no qualms about information being shared for their own care, they aren't always willing for it to be passed to decision-makers, such as commissioners. **Name supplied but withheld on request**

Backup is getting my back up

The General Data Protection Regulation (GDPR) introduces a new "right to erasure" or "right to be forgotten". Some might see this as welcome, but it potentially raises serious issues regarding personal data stored in backups. Erasing one subject's data from a single backup would require restoring the data from that archive, deleting the specific data, then re-creating the backup. However, organisations are likely to have many backups, possibly with parallel sets created locally and in the cloud. Do we trash all our backups, or quietly ignore such an onerous requirement? This question will need to be addressed by many public and private organisations.

Perhaps this can be addressed by sensible procedural workaround, such that erasure is only performed on the (rare) occasion that a previous backup needs to be restored for business reasons.

The ICO's current GDPR overview (**pcpro.link/271gdpr**) doesn't currently address this backup issue. I, therefore, raised it with the ICO, its answer being, "the right to erasure does not provide an absolute 'right to be forgotten'". Well yes, but what about all the cases where the right does apply?

I do hope that representatives of business and other organisations will push back on this issue. Maybe this part of the GDPR was drafted without considering backups. **Mike Garrett**

Star letter

Faced with the question, "Can technology save the NHS?" (*see issue 270, p30*) as a technology person, my obvious reaction was positive and I found myself reading a really interesting article. There was much new information highlighting what can be done. I haven't worn a watch for years, but I can see the time will shortly come when a smartwatch will be with me continuously. That is, when the geriatric-fitness version is released.

However, it wasn't all good news. With a lifetime of computer experience behind me, I knew as soon as I read the words "technology-led development" that the Summary Care Record was going to be a tale of woe. We recognised 30 years ago that the more complicated the project, the more important it is to have both a complete and precise requirement specification at the beginning. And when the project is primarily to provide a service to users, the users are the best source of what is required.

Good treatment will clearly benefit with timely access to all relevant information. I expect almost every one of us would be happy for all our personal information to be available to those with our wellbeing in their hands, but not to all and sundry. Our data must be secure from criminal activity and human incompetence. But how? It occurred to me that perhaps the safest place for our data is with each of us, but that raises the issue of how to ensure it is available when needed, especially when the need is unexpected.

One thought was that a flash drive chip could be embedded; like chipping a dog, but more elaborate. This rather unsettling thought was still with me when I reached the end of the article and turned the page. And there it was, already happening. And now nuclear batteries have been invented, the issue of battery life will in fact be for life. And on that uplifting thought, I leave you until the next edition of *Our Life In Our Hands*; oh, and our robot carer, of course. **Alan Wheatley**

This month's star letter wins a metal-bodied, durable, 64GB USB 3 Flash Drive Bar from Samsung. Visit samsung.com/uk for more details.

IP camera security

Your review of IP cameras (*see issue 270, p92*) featured some very capable and impressive devices. However, in view of the recent DDoS attacks, which were unprecedented in their size and launched from compromised IP cameras, I was surprised to find no mention of security in the article. In a few minutes at **shodan.io**, I identified 187 instances of the reviewed D-Link device and over 300,000 Hikvision instances of some sort on the internet.

No doubt at least some of these will be protected using default passwords, which could be found simply by downloading the user manuals.

Resolution, night vision, ease of setup, codecs and PoE along with many other features are important for anyone venturing into this field, but an introduction to in-built security features, how to use them effectively and the consequences of not doing so was surely something of an omission. I keep being reminded of the wit who remarked that the "S" in "IoT" stands for secure. **Philip Le Riche**

RIGHT Reader Philip Le Riche is concerned about the ease with which IP cameras can be hacked

Falling out of love

I have been a contented user of Microsoft operating systems since the 1990s, at which point I was using my first 386 PC. Since upgrading from Windows 7 to Windows 10, though, my views have changed.

All was well at first, but then I found that the Edge browser didn't work with certain websites. So I switched to Firefox.

Then my copies of Word Starter and Excel Starter 2010 had times when they would refuse to open. After Word Starter had done this

three times my patience ran out and I tried Word Online, but it only took about ten minutes to realise that this program was far too basic even for my simple needs. So I installed LibreOffice instead. Writer is not as good as Word, but there is much to like about LibreOffice and I find that I now use it even when Word or Excel are behaving themselves.

Since upgrading to Windows 10, my PC sometimes now asks me to log in with a password even though I haven't set one up. I don't know what the password should be but luckily a restart has cured this problem so far. My laptop also joined in the fun with a period when the Settings button stopped working.

> "There's much to like about LibreOffice and I find that I use it even when Word or Excel are behaving themselves"

I have gone from being someone who would recommend Windows to someone who finds himself gradually making his way out of the Microsoft ecosystem. I have never wanted to go over to Apple, but maybe I would be happier there now? **Richard Lund**

Editor-in-chief Tim Danton replies: Have you walked past any black cats recently? More seriously, all OSes have their quirks and annoyances; even if you switch to a Mac or Linux, you'll need a username and password to log in. Your problems with the Edge browser are less expected, but they may be addressed in the forthcoming Windows 10 Creators Update, which is set to include functional improvements to Edge and, who knows, perhaps some behind-the-scenes compatibility tweaks.

Information insecurity

Organisations are increasingly exposed for having serious information security failings, which can lead to the theft of customer data. It's making me ask: why isn't the use of the ISO/IEC 27001 Information Security Management standard (and the wider ISO/IEC 27000 series) more prevalent?

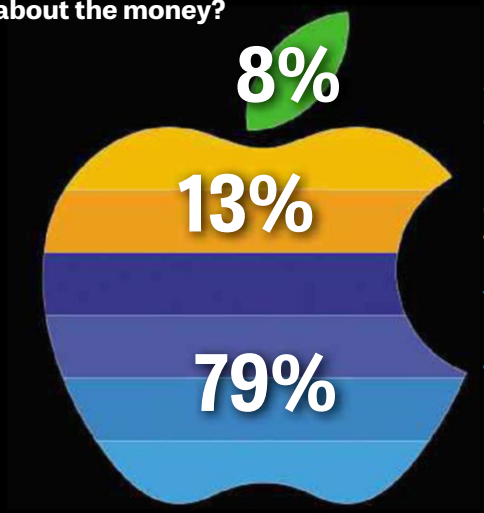
In the 1990s, when I worked for a huge computer services company, it became *de rigueur* to be ISO 9001 (Quality Management) certified. Large organisations back then would insist that suppliers were certified and those that weren't simply lost business as a result.

Do organisations today insist on suppliers being ISO 27001 compliant and if not, why not? **Greg Kendall**

Readers' poll

Is Apple losing its touch?

To tie in with our Apple investigation on p36, we asked readers to share their views on Apple. Is it still thinking differently, or is it all about the money?



No. Apple's lineup and focus is as strong as ever

Possibly. But it's probably got something lined up for the next keynote

Yes. It's too focused on making money and shiny things for the masses

Apple has just released another stellar set of financial results, but we wanted to know if you thought it was focusing too much on the bottom line and not enough on developing technology.

There were a few glowing written responses, including Eiren's belief that "Apple continues to push the envelope, long before most realise it exists", but most responses demonstrated a low opinion of the company.

"Cheap nasty products, removing ports for no reason and focusing on margins rather than a quality product. Horrible company who will end up going the same way as Nokia," wrote Keith Radcliffe.

Si said Apple was "getting greedy", and Nick requested "don't overlook the pros and innovate". One reader wrote: "never owned an Apple product but... there's hardly a direct rival to its products. Many close but not quite there; all seem compromised."

> "Releasing something every year to please shareholders is taking priority over making amazing products" Anonymous

> "Apple's obsession for producing lighter, thinner, shinier products that cost more comes at the expense of battery life, connectivity and overall functionality" C Owen

> "Desktop Macs missing in action" Anonymous

> "Apple needs to stop coming up with gimmicky hardware with reduced features, all in the name of a 1mm-thinner MacBook" John O'Connell

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SECURE YOUR

10 STEPS TO STOP HACKERS

Davey Winder explains how to lock down your Wi-Fi network and find devices that are stealing your bandwidth – and, potentially, your data

The days of worrying about your data allowance are largely a thing of the past, courtesy of faster broadband speeds and generous tariffs. But that doesn't mean you should forget about who's using your Wi-Fi. Whether you're a home or small-business user, identifying who and what is on your network is as important as ever.

An unauthorised user could be streaming pirated movies, hogging your bandwidth and, potentially, landing you in a spot of legal bother. They could be indulging in more nefarious activity, maybe even trying to hack into your systems. This shouldn't come as any great surprise when research commissioned by Broadband Genie shows 54% of British broadband users are concerned about someone hacking their router, yet only 19% had accessed the Wi-Fi router configuration controls, and a measly 17% had changed the admin password from the default.

Avast recently scanned over 4.3 million routers and found 48% had some sort of vulnerability. Thankfully, there are plenty of tools and tricks to identify who's on your connection and how to get rid of them.

1 CHANGE THE ADMIN PASSWORD

If you want to know what your wireless network is up to, you'll need to roll up your sleeves and head straight for the admin gateway of your router: BT will usually default to 192.168.1.254; Sky users should try 192.168.0.1; and all TalkTalk routers have an internal IP of 192.168.1.1. If you've swapped out the supplied router for one of your own preference, Google is your friend.

Alternatively, you can head over to **routerpasswords.com** – most makes and models are listed there, complete with login details. And if that doesn't convince you to change your router from the default settings, nothing will…

Default login settings should only be used to get up and running out of the box, after which you should change the password to something long and complex, and change the username if your router allows it. Long and random is great passkey advice, which is almost always ignored on the basis that people want to join the Wi-Fi network without any hassle. Well, duh! Ask yourself this: how often does any user actually have to enter the Wi-Fi password manually? Certainly within the home, and for many small-business scenarios, the answer is usually hardly ever after the initial setup.

A key that's over 20 characters long, with a randomly generated mix of upper and lower-case alpha-numericals, with special characters, is your best bet. LastPass' tool (**pcpro.link/271pass**) is excellent for producing randomly generated and secure passwords.

ADVISING USERS TO DISABLE WI-FI-PROTECTED SETUP (WPS) MAY SEEM COUNTER-INTUITIVE, BUT IT'S BROKEN

2 DON'T BROADCAST YOUR ROUTER DETAILS

While you're in your router settings, you should change your service set identifier (SSID). This is the name of your network that the outside world sees; it commonly defaults to the router manufacturer's name. In light of how easy it is to find admin logins online, best not make the hackers life any easier than it already is. A determined hacker isn't going to be prevented from detecting and accessing your network simply because there's no SSID being broadcast, but using a random name rather than the factory default makes sense. Not least as it suggests the user is more security savvy than someone who is still broadcasting the router manufacturer.

BELOW Online databases of router logins are surely reason enough to change the defaults

RouterPasswords.com

Welcome to the internets largest and most updated default router passwords database.

Select Router Manufacturer:

ZYXEL

Find Password

Manufacturer	Model	Protocol	Username	Password
ZYXEL	PRESTIGE	HTTP	n/a	1234
ZYXEL	PRESTIGE	FTP	root	1234
ZYXEL	PRESTIGE	TELNET	(none)	1234
ZYXEL	PRESTIGE 643	CONSOLE	(none)	1234
ZYXEL	PRESTIGE 652HW-31 ADSL ROUTER	HTTP	admin	1234
ZYXEL	PRESTIGE 100IH	CONSOLE	n/a	1234
ZYXEL	PRESTIGE 650	MULTI	1234	1234

3 DISABLE WI-FI-PROTECTED SETUP (WPS)

Wi-Fi-Protected Setup (WPS) uses the press of a button, or entry of a PIN number, to establish an encrypted connection between a device that supports it and your network. Advising users to disable WPS may appear counter-intuitive, but it's broken. It makes use of what appears to be an eight-digit PIN code – but looks can be deceiving. The last number is always a check digit, so already the PIN is reduced to seven numbers, which makes brute-forcing much easier. As does the fact that most routers don't include a cooling-off timeout between WPS guesses. Here comes the stinger, though: as far as validation is concerned, the first four digits are seen as a single sequence, as are the final three. That means the possible number of combos just shrank from over ten million to around 11,000. No wonder pen-testing tools such as Reaver (**pcpro.link/271reaver**) can brute-force WPS in a matter of seconds.

4 UPDATE YOUR FIRMWARE

The same Broadband Genie research mentioned earlier also shows only 14% of British broadband users had updated their router firmware – and, to be honest, we're surprised it's that high. If you're one of the 86%, though, do it today. Updating your router firmware boosts your security at no cost and in very little time, yet it's a step that most home and small-business users fail to take.

Why? Because our mindset is wrong. In the home, and in many small businesses, the concept of "patch management" doesn't exist – but it should. We're all used to watching Windows disappear into the land of suspended resource time as it installs an update, after all. The majority of routers will have an automatic update option, so hunt it down and enable it. Be advised that sometimes a firmware upgrade might default the router back to original settings – do a quick check afterwards to be on the safe side.

5 TRY A DIFFERENT DNS SERVER

Just as you can install an alternative to the firmware that runs your router, you can choose a different Domain Name System (DNS) server instead of the ISP default. There may come a time when the DNS servers used by your ISP come under attack, by a distributed denial-of-service (DDoS) attack, for example, or someone changing the DNS to effect a cloned banking fraud. The bigger ISPs are a target for this, since the consequences of hacking their DNS servers would be enormous.

We've seen the DNS servers of the larger providers suffer downtime, so having a backup and knowing how to flick the switch is useful. The most common choice will be Google Public DNS server (on 8.8.8.8 and 8.8.4.4 for the IPv4 service) or OpenDNS (on 208.67.220.220 and 208.67.222.222). There's a setup guide at **pcpro.link/271dns**, which details changing your DNS for home routers, laptops, smartphones and servers.

Essentially, though, open your router admin panel and look for the Domain Name Server addresses configuration page; input a primary and secondary DNS IP. Some routers will have a third server option, and for OpenDNS this would be 208.67.222.220. And that's it, other than to test it's working by hitting the Test button on the OpenDNS guide pages.

Certain providers prevent you from adjusting the DNS server addresses in their own-brand routers, but you can still set individual computers to seek alternate servers.

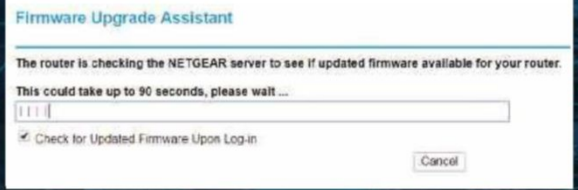
LEFT Switching to OpenDNS is dead simple with the handy online guides

6 INSTALL ALTERNATIVE FIRMWARE

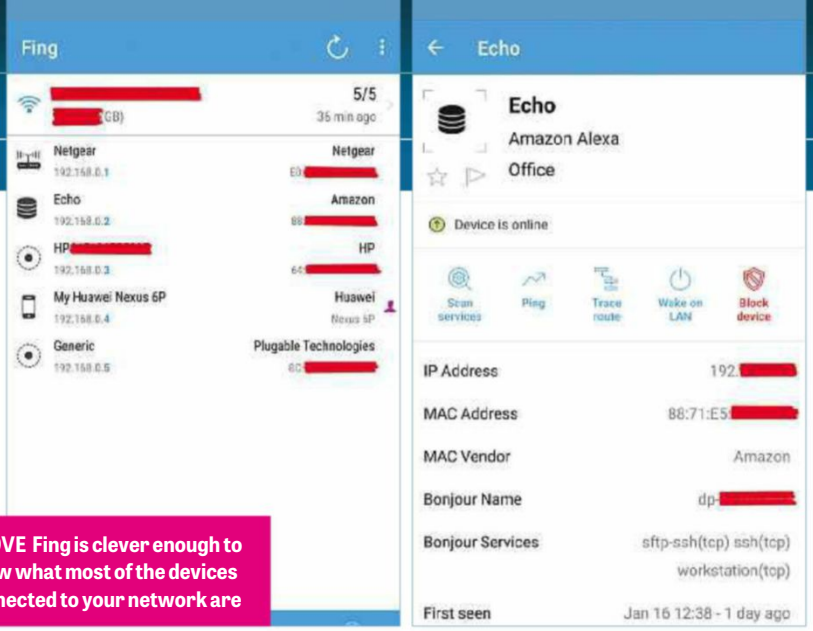
The more adventurous user may take the "update your firmware" message a step further and install totally new firmware from an alternative source. If you think of your router as being a mini-computer, it's akin to changing the OS on a laptop from the supplied Windows install to a Linux distro.

Why would you do this? To gain functionality missing from the original firmware, especially relating to security. And why wouldn't you? Your warranty will be invalidated, so it's best left to older routers. If you go ahead, you'll probably find yourself choosing between DD-WRT and Tomato, which is easier to use but at the cost of being less feature-rich.

BELOW Regularly check for updated router firmware



WE'VE SEEN THE DNS SERVERS OF PROVIDERS SUFFER DOWNTIME, SO HAVING A BACKUP IS USEFUL



ABOVE Fing is clever enough to know what most of the devices connected to your network are

7 SNIFF OUT ROGUE DEVICES

Now we've covered most of the major security precautions you could take, how might you discover who's actually using your Wi-Fi? You can do this from your router gateway, and it varies from router to router as to where the option will be.

With BT's Smart Hub, you should click on the My Devices tab, for example, whereas most Netgear routers will hide the attached devices list in a Maintenance menu. There are lots of tools out there to help you do the same, and they don't have to be as complex as something such as Nmap (*see Tips for small businesses, opposite*).

One of our favourites is Fing for Android or iOS. This app scans any IP range and shows what's connected – and in plain English, where possible. So whereas the BT router will often only list a device's IP address, Fing usually spells out the device's manufacturer, making it easier to identify the dozens of devices we have connected these days.

If the numbers don't add up, it's a good idea to determine why. If you only have a laptop, a phone, an Android-powered TV set and a printer connected to your hub, why are there nine devices using your Wi-Fi? And how do you know how many people are using it and what those devices are?

See something you don't recognise and Fing will, at the touch of a button, reveal the information you need to block it from your router admin gateway. That you can do all of this from your smartphone, anywhere in the home or office, makes keeping tabs on who's using your Wi-Fi hassle-free.

8 EMPLOY MAC FILTERING

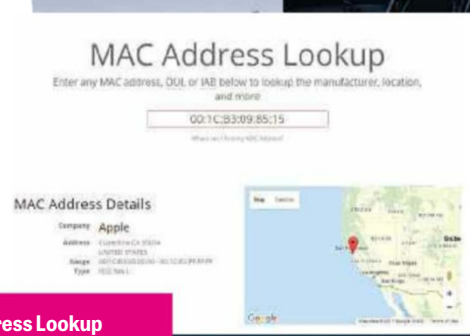
The information that Fing reveals when you want to block something from using your Wi-Fi is our old friend the Media Access Code (MAC), which every device connecting to a network is allocated. It's a 48-bit digital identifier used by the device to tag network packets, to be precise.

By default, your router will connect to anything that wants access, provided it has the correct password. If you want to prevent a device from connecting, even if the user has the correct password, that's where MAC filtering comes in.

Once you have a MAC address code, you can use an online specialist site such as What's My IP (**pcpro.link/271mac**) or MAC Vendor Lookup (**macvendorlookup.com**) to identify any piece of connected kit that you don't recognise. Fing does the MAC lookup for you in the background and then automatically displays the device maker on-screen as part of its auditing process.

When you've identified the culprit, head to the "access control" section of your router controls, which is MAC filtering by another name. Here you can either block all new devices, so before anything can join the network you'd have to whitelist the device's MAC address, or block individual devices by blacklisting their MAC.

It isn't foolproof: most devices allow their MAC to be changed in software, so a determined hacker could clone a device that you whitelist and gain access. Ultimately, if you don't want someone to use your Wi-Fi, don't give them the password. If they're already using it, then change the password to something more complex.



ABOVE MAC Address Lookup searches can be found online, in case your app doesn't display the translations automatically

9 USE A VIRTUAL PRIVATE NETWORK

Whether you're using the original router firmware or have installed an alternative, there's a strong chance that virtual private networks (VPNs) will be supported. When people think of a VPN, they think of a third-party application that re-routes all their internet traffic through a proxy server – at a cost. What's less commonly considered is operating your own VPN through your router.

This will give you the advantage of being able to securely access your home network, across an encrypted internet tunnel, when you're away. It gives you the same end-to-end encryption as a subscription service, so you can securely use that coffee shop or hotel Wi-Fi, but with no fees or bandwidth implications. You'll almost certainly need a Dynamic DNS (DDNS) service to resolve a domain name to your router as a home user, to get around the fact that most ISPs don't offer a static IP address for your router; the free-to-use No-IP (**noip.com**) is as good as any for this.

THERE'S PLENTY TO BE SAID FOR ADOPTING THE "THINK LIKE A HACKER" APPROACH

10 SET UP A GUEST NETWORK

The trouble with passing out your Wi-Fi passkey to family and friends who visit is that, every time you do, it dilutes your security. Not only do they know your password, but they might also give it to someone else. You could change to a new password after every occasion, which is the most secure, if not the most convenient, solution. More conveniently, and pretty secure as well, is going the whole nine yards and setting up a guest network for visitors. If the concept of a properly secured guest network isn't supported by your router, all is not lost: simply buy a better router or change the firmware as mentioned earlier (*see step 6 on p33*). The popular replacement router firmware Tomato (**polarcloud.com/tomato**) supports a guest mode, and means you can provide users with a key that puts them online on a virtual network without exposing your own connected devices.

TIPS FOR SMALL BUSINESSES

➜ There are plenty of tools out there to help map your network and see what's connected at any given time, as well as identify your network's weak spots. The good news is that these needn't cost a fortune – or, indeed, anything at all. Even if they don't require a direct financial investment, however, they do require you to invest some time to learn how to best use them and properly understand the results they're returning.

For the small business that really wants to get to grips with network security, there's plenty to be said for adopting the "think like a hacker" approach. Using the same vulnerability discovery tools as they do is one great example, and such tools don't come any better than Metasploit.

Unfortunately, Metasploit is no longer free, although the owners (Rapid7) do offer a free small-business edition (**rapid7.com/products**) that lets you simulate real-world attacks on your network to expose holes a malicious hacker may otherwise exploit. Individual users (look for the Community Edition) also get access to the Rapid7 Nexpose vulnerability scanner, which provides a contextualised view of the network attack surface.

➜ **If your small business has a security budget then it's well worth investing in a business-grade firewall that goes beyond password-only access, and takes Wi-Fi into the realm of certificate-based EAP-TLS authentication. Simply put, this would mean that every client and every router would have to identify itself to the other using public-key cryptography before any connection is allowed. That's all fine and dandy, until you mention the Internet of Things...**

➜ The majority of IoT devices are built to budget, and a low one at that. This means certificate-based authentication (as described above) almost certainly won't be supported. All is not lost, however, as most consumer-grade routers actually support the use of multiple virtual LANs (VLANs) and will even go as far as managing the port-forwarding options as well. This means it's possible to circumvent some of the insecurities of IoT devices by connecting them to a VLAN that's different than that to which your laptops and smartphones are connected.

➜ **Your router firewall, assuming it has such functionality, is worth enabling for an additional layer of security. Layered security is usually a good thing: if a casual attacker peels off one layer and there are even more to burrow through, then they'll likely give up. A determined hacker, who has good reason to compromise your network and the skills to exfiltrate your data, will most likely succeed whatever you do, so it's almost worth considering them a lost cause to defend against.**

If that sounds defeatist, it really isn't: 99% of the attackers probing your networks will be casual hackers trying their luck. The good thing with the firewalls that are built into routers is, for the most part, they can be used to set up rules that will lock devices down as well the ports that might broadcast information to non-trusted parties. You can also set up firewall rules so that traffic isn't allowed to cross between VLANs, with the exception of connecting from your main network to the guest, and not the other way around.

➜ **Something the home user doesn't have to worry about, for the most part anyway, is the physical security of IT devices. Let's face it, whose house have you visited where the router was secured with a Heath Robinson Kensington lock contraption? While the small business may not have to worry too much about someone stealing the router, a prankster resetting it could be more than a little problematical. Keeping it secure in a locked cabinet makes good sense all round, but may not always be practical.**

If not, then try locating on a high shelf or cupboard top, where stealthy access is simply impossible. It also makes it much harder for a would-be data thief to simply walk up and plug a cable into a spare Ethernet port in an attempt to sidestep your Wi-Fi security measures. Talking of which, ensure your Wi-Fi network is firewalled off from the rest of your network.

HAS APPLE ABANDONED PROS?

Apple's personal computers are more popular than ever, but power users aren't happy. Are Macs still for pros? Adam Banks, former editor-in-chief of MacUser magazine, investigates

From its beginnings as a niche computer maker to its dominance as a lifestyle brand, Apple has maintained one proposition: its hardware is worth more because it's better. The logo's association with creative professionals was built on the Mac's features and performance.

However, as Apple flourished amid a shrinking PC market, the Mac Pro desktop tower was discontinued. Even 2013's belated new Mac Pro desktop was compact rather than expandable.

Meanwhile, MacBooks became the laptop of choice, but the designer's favoured 17in was replaced by slim, light and general-purpose models. By 2016, it was common to see headlines such as "Apple's disgracefully outdated Mac lineup is killing sales". When an update to the MacBook Pro range finally arrived in October, many pros were less enthused by its innovative Touch Bar than frustrated at its limited specs and even higher prices. Has Apple lost interest in the pro market?

SURRENDERING THE HIGH GROUND

Henry Capper is sales director at Amsys, which supports predominantly Apple systems for businesses. Does he think Apple still meets the needs of high-end users? "It depends what you mean by high-end users," he told us. And thereby hangs a tale: even within this category, requirements vary widely. "We work with a huge number of design companies, but 'design' is a funny word. What you require in a computer can range from '16GB is more than enough' to the guys who need 64GB," explained Capper, referring to the controversial 16GB RAM ceiling of the MacBook Pro.

Among Amsys' clients, "day-to-day users tend to find any mid-range Apple device off the shelf is exactly what they need. We have a lot of very big brands doing a lot of heavy design work, and it's very rarely we have someone say, 'Look, I'm completely under-specced.'"

For the minority who need more, he adds, "the Mac Pro does pick up the top end. It seems to work." No concerns that this machine hasn't been significantly updated since 2013? "It's not something I'm hearing." This isn't surprising, as Apple expects a Mac buyer to keep it for four years, and many last far longer.

IF ANYTHING, MORE DESIGNERS ARE WILLING TO MOVE ACROSS TO APPLE

In the past, deploying Macs in business was seen as problematic, but Capper says the tools around Apple in enterprise have been "completely revolutionised". While Apple's own efforts have helped, for example through its partnership with IBM, third parties have also stepped in. "Apple tools like Profile Manager don't do the job, but then you look at something like Jamf Pro and it's a fantastic management-deployment solution," Capper said.

What of the users themselves? "If anything, more designers are willing to move across to Apple," reported Capper. He credits this to the Mac's focus on usability. "Apple builds its devices around 'just working'". When it comes to concerns about spec, "I think this is more of a PC-led question".

Horace Dediu, who runs market intelligence site Asymco (**asymco.com**), also sees a decoupling of user needs from tech specs as characteristic of Apple. "I believe Apple is very keen on 'high-end' Mac users, but does not think of them in terms of product specifications, rather what they do with those products."

RIGHT The MacBook's thin chassis restricts the choice of GPUs

BELOW CEO Tim Cook promises Apple is still "committed to desktops"

PERFORMANCE IS FOR PC

The idea that talking about performance is for PC users, while Macs just do the job, is something Apple would endorse: it avoids competing on specs with rival brands. This would, arguably, be meaningless as other PCs come in a vast range of configurations.

For some users, though, that's the point. "The MacBook Pro is too minimalist," said Andrew Reid, who runs the EOSHD videography blog. "It's fine to simplify things for consumers, but not for pros. Not enough ports, not enough expansion options, too many major parts soldered in, and underpowered GPUs because of the thinner chassis."

IT IS FINE TO SIMPLIFY THINGS FOR CONSUMERS, BUT NOT FOR PROS

Experimental designer Brendan Dawes also struggles with Apple's stripped-down ethos. "I'm not one of these people who upgrades all the time, although some of the stuff I work on is for very large screens, so a powerful GPU is good. I have a MacBook Pro, but not the new one – I need USB ports, an SD card slot and a bloody headphone jack," he said.

The macOS's old nemesis, compatibility, can still be an issue. "I'm using Derivative TouchDesigner, and the Mac beta isn't as fully featured, so I'm speccing up a kick-ass PC," said Dawes.

Photographer and former *PC Pro* staffer Dave Stevenson also mourns the SD slot, a victim of Apple's wholesale move to USB Type-C. "I hate the idea of toting around a card reader, and I use Gigabit Ethernet to connect to my image library NAS, so I'd be one of those tedious folk who moans about dongles," he said.

Ports aside, however, Stevenson doesn't believe a PC would deliver more. "Show me a laptop, spec for spec, pixel for pixel, that doesn't cost just as much." We show him an Asus K501UX with a 4K screen, Core i7 and Nvidia GeForce GTX 950M for less than £900, compared to more than £2,000 for the cheapest comparable MacBook Pro, but have to concede that it features an older-generation CPU, half the battery life and weighs 50% more.

Nor does it take more than 16GB of RAM. Video editor Reid accepts that Apple offsets this restriction – a design decision to help the MacBook Pro achieve ten-hour battery life, while Intel's CPUs remain unable to address low-energy RAM in higher capacities – by implementing "very good memory management and compression" in macOS. But this doesn't benefit third-party software such as Adobe Premiere Pro CC to the same extent as Apple's Final Cut Pro X. Meanwhile, small cases and limited macOS support restrict the choice of GPUs even in the desktop Mac Pro.

James Tonkin is the founder and director of Hangman Studios, which produces video for high-profile clients. A happy Final Cut Pro X user, he has thoughts about what Apple needs to offer. "Our 2013 Mac Pro, the trashcan, does still perform pretty well, but now that we finish almost exclusively in 4K, we're seeing some limitations," he said. "I respect Apple's closed-hardware approach, but the option of faster GPUs on Windows and Linux systems is something we can't ignore."

One answer is external graphics processing (eGPU), using Thunderbolt 3 to connect third-party graphics cards outside the case. "An Apple-certified eGPU is what I'm most interested in," Tonkin explained. He will stick with Apple, if possible: "We love the speed and integration benefits between the hardware and software. Apple isn't ignoring the pro market – when you see Final Cut Pro X's support for the latest £50K-plus cinema cameras, that isn't for consumers. As professionals, we do demand faster hardware, but we also want it rock-solid for 20-hour post days."

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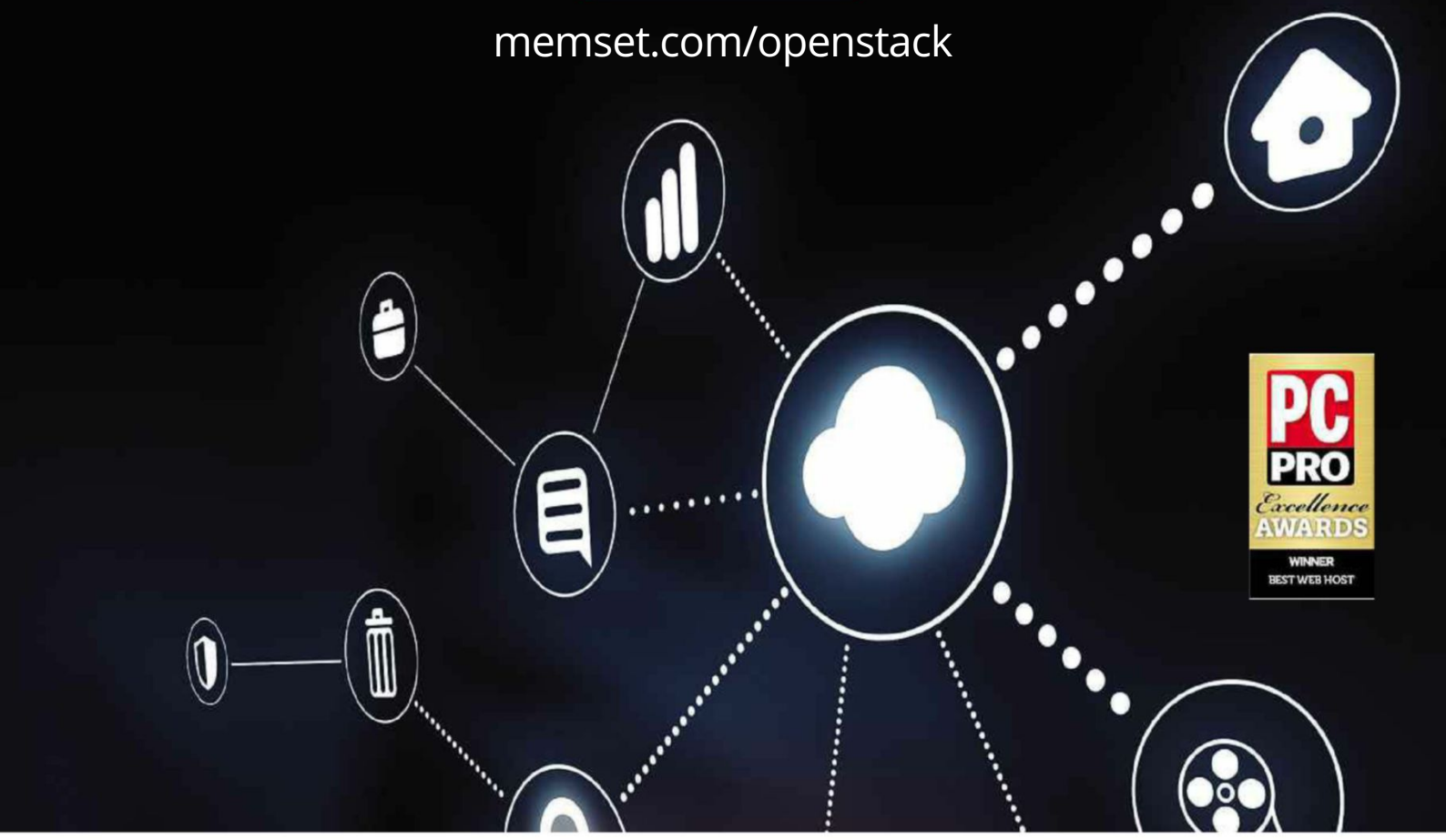

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Ultimately, though, "our clients don't care what machines we render on, as long as people aren't waiting all night," said Tonkin. The point is echoed by Peter Kosminsky, director of films and TV dramas including the multi-award-winning *Wolf Hall*. "I work with VFX teams, sound teams, picture graders and editors, but they choose their apps and platforms," he said. Kosminsky's faith in Apple was shaken by the cancellation of Aperture, its pro photo editor – leaving him and others fearing for the prospects of Apple's remaining pro apps, Final Cut and Logic Pro X. Recent upgrades, however, seem to have shown commitment.

ATTACHMENT TO APPLE PRODUCTS HAS UNDOUBTEDLY BOOSTED THE MAC

"With the recent price hike and the lack of anything new or exciting for quite a while, I can't help feeling [Apple has] slightly lost its mojo," said Kosminsky. But "it will take much, much more than that to make me bail. I use Apple for all my personal computing."

THE PERSONAL TOUCH

This personal attachment to Apple products has undoubtedly boosted the Mac. "CEOs buy an iPhone, and then they buy a Mac, and all of a sudden they're turning to IT directors saying 'what could these do in our business?'," explained Amsys' Henry Capper. And macOS does delivers benefits to enterprise: "They're easier to maintain, and with people's experience of using them at home, they empower users to solve some of their own issues."

Keith Martin, a senior lecturer at London College of Communication, part of the University of the Arts London, echoes this sentiment. "Over the past ten years, we've installed more and more computers, almost all Macs. The major software runs on both platforms, but macOS does seem to fit more smoothly into the minds of design and media students." His experience with support mirrors Capper's. "Our IT people know both platforms inside out, and despite the Macs outnumbering the PCs by way more than ten to one, they have more maintenance to do with those PCs."

Martin, whose own practice includes 360-degree photography, doesn't believe Apple has let performance become a problem. "The idea that every creative spends their days juggling 50 layers of gigapixel imagery is nonsense. Sometimes when I'm working with large chunks of data I'd like a bit more speed, but mostly the bottleneck is me."

As for the demise of user-upgradability, Martin adds: "I'm generally fine with that now. Years back, computers were barely keeping up with us. Today's Macs are more than enough for most people."

So are many PCs, of course. Digital designer Anna Halsall admits design clients "expect you to be a Shoreditch-working, Bernie Sanders-voting, rice-milk-drinking yogi who travels the world with your elegant MacBook in your Swedish backpack," yet her laptop isn't an Apple. "I have an Acer that I love. I agree the MacBooks' battery life is better and the screens are awesome," but prices are significantly higher "and if your Mac breaks, the repair will cost a fortune".

Although independent Apple repair shops might dispute that claim, Halsall's point is clear: "I simply calculated what I'll actually use it for in order to justify the price." She also sees Apple's corporate image as a negative, citing concerns about supply-chain workers, tax avoidance, and the unjustified worship of Steve Jobs.

RIGHT The Mac Pro hasn't had a significant update since 2013, but is still powerful enough for most purposes

RIGHT Some were enthused by the new MacBook Pro's Touch Bar, but others were frustrated by the specs and high prices

STOPPING SWITCHERS

Choosing Windows or Linux means investing in a platform with a far more extensive choice of hardware. So is the Apple usability advantage enough to prevent professionals from decamping? Motion designer Darren McNaney finds himself on the cusp. "My current iMac is starting to struggle [with processing and rendering], and certain 3D processes are impossible," he told *PC Pro*. "If I was a dedicated 3D animator, I'd have switched to PC. If Apple just updates the iMac's components this year, I'll go for it – even though it's still likely to feel dated [when compared to desktop PCs] – because the thought of Windows is horrible. I'm sure I'd adapt to the OS, but I'm concerned about privacy and malware."

McNaney is also put off by Apple's price increases: "Professional doesn't mean you can keep shelling out thousands." For the past decade or so, a top-end MacBook Pro or iMac to suit a demanding user would come in at a little over £2,000. Today, the cheapest 15in MacBook Pro, with a Core i7 processor and 16GB of RAM, starts at £2,349, but has only a 256GB SSD, which can't be upgraded later. A more practical 1TB adds £540, while bumping the AMD Radeon Pro 450 to a 460, giving the 4GB of video RAM required for some tasks, costs £180 – breaking the £3,000 barrier.

Some of the cost reflects the fall in sterling, but Apple's base dollar prices have risen too, partly thanks to the Touch Bar, a multi-touch display strip now included as standard. During October's launch event, this was demoed in tasks including video editing. McNaney was unimpressed: "The mock-up of an edit suite was laughable. Their idea of a 'professional' seems to be a hipster sitting in a Starbucks uploading YouTube content shot on an iPhone 7 while sending emojis via the Touch Bar. Ugh."

Videographer James Tonkin sees more potential: "Any possibility to speed up workflow by putting the tools directly at your fingertips is a benefit." Asymco's Horace Dediu identifies the Touch Bar as a reinforcement of what distinguishes the Mac from "third-wave" touchscreen devices. Soon after the Touch Bar launched, he wrote: "The keyboard and mouse/trackpad are what define the Mac… The Touch Bar coupled to the other two inputs is a totally new way to interact. It's not an "easy" interface… Indirect inputs are powerful and lend themselves to muscle memory. This is the way professional users become productive."

We put it to Dediu that high-end users couldn't be productive without high-end systems. "By this definition, a high-end car user would be one who would not buy an 800-horsepower car because there exists a car with 1,000 horsepower. Yet driving at 60mph requires only about 60 horsepower, and a bicycle with 0.3 horsepower might be faster in a city."

FAILING TO KEEP PACE

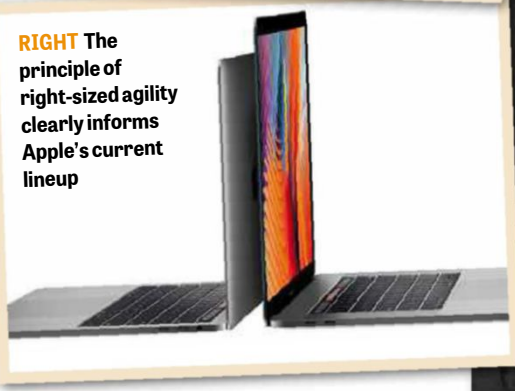
As we've seen, though, some of Apple's most loyal customers are racing drivers. And every marque has a souped-up top-end supercar, even if few are sold. Doesn't the same logic apply to Apple if it wants to remain a premium brand? "Tough question," said Jean-Louis Gassée, the former senior Apple executive and co-author of the Silicon Valley blog, Monday Note. "Let's see what Apple does later this year with the Mac line. Let's see what the iPad does with new models." The iPad Pro attempts to expand the third wave to the high end of the spectrum, but so far it's estimated to account for barely a third of iPad sales, far smaller numbers than the Mac.

PROFESSIONAL DOESN'T MEAN YOU CAN KEEP SHELLING OUT THOUSANDS

Still, the bicycle was one of Steve Jobs' favourite metaphors, and the principle of right-sized agility clearly informs Apple's current lineup. It's hard to argue this isn't working: as Dediu points out, last year Apple became one of the top five PC vendors for the first time, despite a lull in Mac sales as buyers waited for new models. Furthermore, despite complaints, the late 2016 MacBook range broke sales records, according to Slice Intelligence, beating the earlier launch of the popular 12in MacBook by a factor of seven over the first five days.

However, Jobs also recognised the importance of professional users. "I met with Steve the second day he came back to Apple in 1997," recalls veteran tech consultant and columnist Tim Bajarin, "and asked him how he planned to save Apple. He told me that he was going back to taking care of their core customers, creatives. He felt that the people who ran Apple had forgotten them."

RIGHT Final Cut Pro X's support for the latest cinema cameras is one sign Apple is still dedicated to creative professionals



RIGHT The principle of right-sized agility clearly informs Apple's current lineup

That said, Bajarin doesn't believe history is repeating itself. "I do expect [Apple] to innovate around the Mac. I know from talking to them that they really understand the creative audience and will continue to support them, as I believe Jobs instructed them to do before he passed away."

Users aren't necessarily feeling the love, though. "I've remained loyal since my first Apple studio computer," said musician Robin Rimbaud, also known as Scanner, "but I don't think I'm alone in questioning where to move to next. The latest MacBook Pro again demonstrates a complete lack of understanding." The company's notorious secrecy also rankles. "It's as if they're simply too arrogant to care. Don't they realise that without creative professionals they wouldn't have the aesthetic and appeal that they do?"

In December, Jobs' successor, Tim Cook, told employees in a leaked memo that the company was "committed to desktops". "Let me be very clear: we have great desktops in our roadmap. Nobody should worry about that." The statement, of course, implied somebody was worrying. But Cook was explicit: "The desktop is very strategic for us. It's unique compared to the notebook because you can pack a lot more performance in… Desktops are really important, and in some cases critical, to people."

Indeed. We'll only know when new models appear, but perhaps Apple does still understand that, as James Tonkin puts it: "We just need hardware that doesn't limit our creativity."

MAC UNIT SALES (000S)

1998	2,763
1999	3,448
2000	4,558
2001	3,087
2002	3,101
2003	3,012
2004	3,290
2005	4,534
2006	5,303
2007	7,051
2008	9,715
2009	10,396
2010	13,662
2011	16,735
2012	18,158
2013	16,341
2014	18,906
2015	20,587
2016	18,484

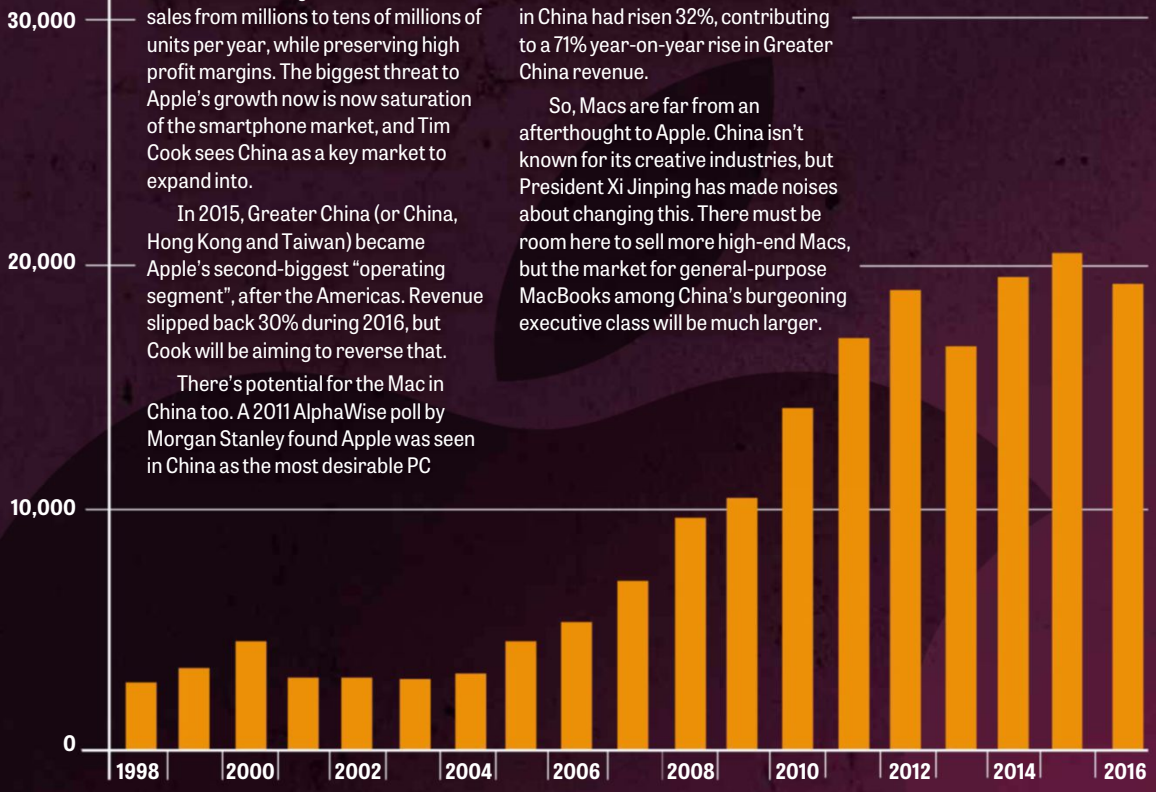
HOW MUCH DO MACS MATTER TO APPLE?

The iPhone has far outstripped sales of Macs, but its rising tide has lifted Mac sales from millions to tens of millions of units per year, while preserving high profit margins. The biggest threat to Apple's growth now is now saturation of the smartphone market, and Tim Cook sees China as a key market to expand into.

In 2015, Greater China (or China, Hong Kong and Taiwan) became Apple's second-biggest "operating segment", after the Americas. Revenue slipped back 30% during 2016, but Cook will be aiming to reverse that.

There's potential for the Mac in China too. A 2011 AlphaWise poll by Morgan Stanley found Apple was seen in China as the most desirable PC brand. By the second quarter of 2015, Tim Cook disclosed that Mac unit sales in China had risen 32%, contributing to a 71% year-on-year rise in Greater China revenue.

So, Macs are far from an afterthought to Apple. China isn't known for its creative industries, but President Xi Jinping has made noises about changing this. There must be room here to sell more high-end Macs, but the market for general-purpose MacBooks among China's burgeoning executive class will be much larger.



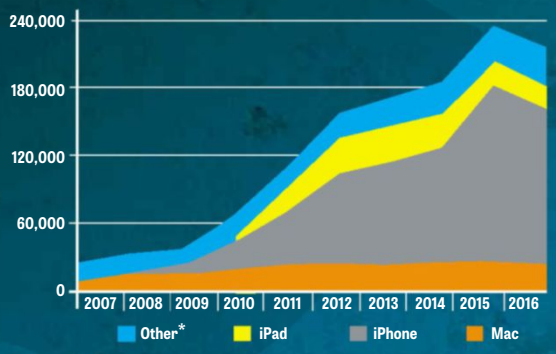
WHO BUYS MACS?

We asked Slice Intelligence, a company that analyses brand demographics, to produce a report to assess who buys Macs. Looking at purchases by individuals over the past four months, it found 34% of Mac buyers were millennials and 33% "generation X", outnumbering "baby boomers" at 26%. The iPad Pro was more attractive to older buyers, with boomers accounting for 34% of sales. Over 45% of online MacBook buyers had at least a bachelor's degree and over 45% had an income greater than $75,000. Fair to say, then, that Apple addresses the high-end market.

SALES REVENUE BY PRODUCT LINE ($MILLION)

	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Mac	10,314	14,276	13,780	17,479	21,783	23,221	21,483	24,079	25,471	22,831
iPhone	123	1,844	6,754	25,179	47,057	80,477	91,279	101,991	155,041	136,700
iPad	N/A	N/A	N/A	4,958	20,358	32,424	31,980	30,283	23,227	20,628
Other*	13,569	16,359	16,003	17,609	19,051	20,386	26,168	26,442	29,976	35,480

*Includes iPod, software, services not counted in other segments

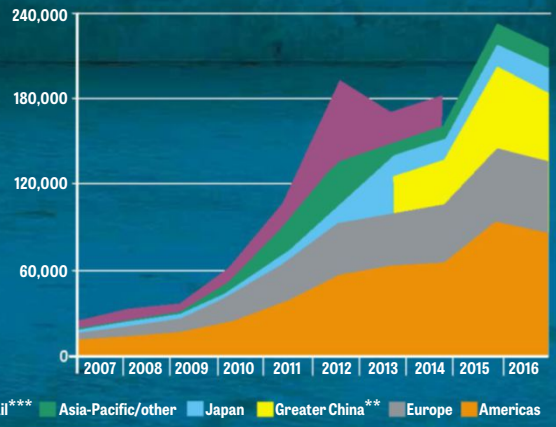


SALES REVENUE BY REGION ($MILLION)

	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Americas	11,596	14,573	16,142	24,498	38,315	57,512	62,739	65,232	93,864	86,613
Europe	5,460	7,622	9,365	18,692	27,778	36,323	37,883	40,929	50,337	49,952
Greater China**	N/A	N/A	N/A	N/A	N/A	N/A	25,417	29,846	58,715	48,492
Japan	1,082	1,509	1,831	3,981	5,437	10,571	13,462	14,982	15,706	16,928
Asia-Pacific /Other	1,753	2,460	2,625	8,256	22,592	33,274	11,181	10,344	15,093	13,654
Retail***	4,115	6,315	6,574	9,798	14,127	55,977	20,228	21,462	N/A	N/A

**Greater China was first broken out as a region in Apple's filings in 2013; here included in Asia/Pacific until 2012

***Retail sales were included in region totals from 2015



Cambium Networks Wi-Fi anywhere

Wi-Fi in new locations can give your business a boost in more ways than one

Wi-Fi is a valuable tool for your business, no matter which industry you're in. Whether it's in a warehouse letting your workers use mobile barcode scanners and stay up to date on orders, in an outdoor seating area providing internet access to your guests, or hosting an outdoor concert where people can live stream and take selfies like there's no tomorrow, high speed always-on internet access is essential. There's just one problem: how to get Wi-Fi where you need it. This doesn't have to be difficult or expensive – as long as you make the right choices. Let's run through some of the issues to help get you up and running.

BELOW **There's no need to dig a trench if you choose Cambium Networks**

Do I have to dig a trench?

The most common problem with getting Wi-Fi to new locations isn't the Wi-Fi itself – it's the connection from your router back to the internet. After all, that Wi-Fi traffic won't do much good if it can't go up into the cloud and back. The internet connection is delivered to the Wi-Fi router via a cable in your main office, but extending that cabling to where you need Wi-Fi is very expensive, and if you need to cross large outdoor spaces or someone else's property, often impossible. If it's an outdoor space or remote building, chances are good that your ISP won't offer coverage there either, and if they're willing to, you'll be stuck with the fees for them to lay cable, install equipment and then a monthly fee thereafter.

Enter wireless backhaul

The leading technology to resolve this issue over long distances with high bandwidth and high reliability is wireless backhaul, provided by ePMP from Cambium Networks. Typically operating in the 5GHz band, it operates like a wireless network cable. A point to point wireless backhaul link is made up of two radio units, each with a normal RJ-45 Ethernet port. To get your Wi-Fi router talking to your internet connection, install one radio unit at the Wi-Fi router with a line of sight to the radio unit installed at the internet connection in your office. After a short alignment process to get the best signal, you can easily achieve speeds up to 200Mbits/sec, with no monthly fees or expensive cable runs.

Can't I just use Wi-Fi?

Wi-Fi is great for what it was designed for – providing bandwidth to multiple client devices in a small area. It does this by being contention-based – whilst a Wi-Fi device is transmitting, all other Wi-Fi devices in the area wait until the transmission finishes before attempting to transmit their own data. The problems start when trying to use this technology for wireless backhaul. Unlike the inside of a home, where Wi-Fi was originally intended for, wireless backhaul links can cover long distances (easily up to several kilometers) and are subject to interference from many different sources on their way from A to B. A standard Wi-Fi connection used here will try to wait until all interference is clear, which it never is, before transmitting. The result? A flaky, unusable backhaul link and terrible Wi-Fi.

LEFT Our technology uses a point to point system – literally

BELOW Just attach each dish to an outside structure and direct them at one another

Network integration

Integrating wireless backhaul with your existing network is easy. At its simplest, ePMP works as a transparent bridge, so data coming in one end of the wireless link leaves the other. It's that simple. This gives IT full, transparent management access to the Wi-Fi router (and ePMP) from the office, as if they were sat next to them. If more advanced network configurations are required, such as NAT and QoS, these can be configured directly on ePMP itself, without the need for a dedicated router to handle these functions in every location.

Security

Like any other piece of IT infrastructure, security is a vital consideration. Wireless backhaul doesn't mean less security than a cable – every piece of data transmitted and received across the link is encrypted with AES-128, and none of the data is stored on either radio unit. The IT department can handle firewall rules, access control and other security issues just as they would for Wi-Fi inside the enterprise. Wireless backhaul extends their reach, like a wireless cable, providing total visibility and security.

Where do I start?

Anywhere you need outdoor network connectivity, consider wireless backhaul with ePMP. For WiFi, IP video surveillance, or anything else, it's an affordable solution to your business need.

Cambium Networks™

With over 5 million radio modules deployed worldwide, Cambium Networks has been the best in wireless networks for over a decade – from 2m to 245km with end-to-end cloud management. Whatever your network needs, contact us and see how we can help you.

cambiumnetworks.com

RIGHT Provide a fast, reliable connection for your guests, no matter where they end up sitting

HOW BAD WILL BREXIT BE FOR TECH?

How will bursting out of the European Union affect tech jobs, legislation and the prices of tech goods? Barry Collins investigates

Hard Brexit, soft Brexit, Brexit over-easy. For months there has been fevered speculation about the implications of last summer's vote to bid adieu to the EU, but finally we have some certainty over Britain's plan to parachute out of Europe.

We won't remain members of the single market, although we're seeking the "freest possible trade" with our chums from across the Channel. We'll be leaving the customs union, but are hoping to negotiate "a customs union agreement" with the rest of the EU. There will be an end to free movement of labour, although it isn't yet clear whether we'll follow an Australian-style points-based system, work permits or something different altogether. And we won't be bound by the European Court of Justice, the body that ensures EU legislation is applied in member states.

In short, we know enough that – with the help of industry experts – we're able to make educated guesses about the likely impact of Brexit and what consequences it will have for tech jobs, legislation and prices.

Indeed, we don't even need the crystal ball to examine some of the implications of the Brexit vote, as anyone who has bought a Dell laptop or app for their iPhone will know, with prices already heading north thanks to the weakness of the pound. Are pricey laptops the worst of it, or is Britain's tech industry in for a hard landing?

British jobs for British workers

One of the clearest implications of the vote to leave the EU was curbs on immigration. The enshrined rights of EU citizens to live and work in any member state were always going to be a casualty of a leave vote, and the government has made it absolutely plain that it will seek to control the number of people coming to Britain from Europe, as it already does for the rest of the world.

Britain's tech industry is dependent on foreign labour, and several leading firms have expressed concern about tighter controls on immigration. "We have 300 people in Cambridge right now from mainland Europe, and more could start tomorrow," Simon Segars, the chief executive of chip designer ARM told *The Financial Times* in October. "If there was some law enacted that said every employee has to be from the UK, the business would fail."

One in three of Britain's tech workers were born overseas

While it's highly unlikely the government would be draconian enough to outlaw foreign recruitment, any increased restrictions would exacerbate Britain's long-standing skills shortage. "There are a finite number of [UK] engineers with the right skills that we can hire," Segars added. "We have to be able to play unencumbered on a global playing field – that's really important for us."

ARM's warning is all the more prescient given that the company was bought by Japanese investment group SoftBank last year, which immediately sought to allay fears about the sale by pledging to keep ARM's headquarters in Cambridge and to at least double the number of employees in the UK over the next five years. Segars has already warned that any kind of visa system would "slow us down".

That warning appears to have fallen on deaf ears at the Home Office. Home Secretary Amber Rudd has outlined plans to make British companies declare how many foreign workers are on their books, arguing that some firms are "getting away" with not training enough British workers and that "we should be able to have a conversation about what skills we want in the UK".

Tech London Advocates, which calls itself a "private sector-led coalition of more than 4,000 expert individuals from the tech sector", claims that one in three of Britain's tech workers were born overseas; industry analysts agree that, if the drawbridge is wound up, there simply isn't enough local talent to fill the gaps. "Companies need access to the best talent," said Richard Muirhead, who has set up three of his own software firms and is now general partner at early stage venture capital firm OpenOcean. "They would be choosing the talent locally if they could find it," he added.

"It's a global market for technical talent. Making it harder for companies or universities to get hold of it seems highly unlikely to increase the competitiveness of our universities or companies."

Muirhead thinks the uncertainty over what will happen with immigration controls is already having an impact on companies' ability to hire the right staff. "The target is a

net immigration number, and it's probably possible to ensure the right people make it in to support the long-term prosperity of the nation.

"At the same time, it isn't clear what that programme will be. People are making decisions now about where to study, and where to set up companies," said Muirhead, adding that it will take at least two years before there's real clarity on the immigration controls.

Not everyone is gloomy about the British tech industry's prospects outside of the EU, however. Although the value of IT contracts has taken a hit because of the devaluation of the pound, global tech advisory firm ISG says there are reasons to be cheerful.

"Britain is one of the world's leading centres for technology," said John Keppel, partner and president of ISG. "The fact that the UK is the authority on Fintech [financial technology] and dominates the market with its intellectual property will continue to make it a highly appealing trade partner.

"Ultimately, we believe that a post-Brexit environment where we are seeking tighter trading relations outside of the EU with countries such as the US and Israel, both outstanding innovators in the tech space, should only serve to enhance Britain's position."

Inflation island

One consequence of the Brexit vote that's beyond doubt is that we're going to end up paying more for our tech. Several tech companies have used the plummeting value of the pound – down around 20% against the dollar – to push up their prices.

The cost of Microsoft enterprise software such as Microsoft Office went up by 13% in January, while Azure customers were hit with 22% hikes. Dell increased prices by 10% in the UK not long after the votes were counted, and HP quickly followed suit. Apple has raised prices across its portfolio several times since the vote, first on iPads and iPhones last September, followed by Macs in October and then the App Store in January. A $0.99 app now costs Brits 99p – a straight pound for dollar conversion, albeit without US sales tax taken into consideration.

All of these companies have cited exchange rate fluctuations among the litany of excuses (taxes, cost of doing business, market conditions) used to justify the price hikes. But is it just that – an excuse to push prices north? "We have seen price rises of around 10% for many technology products since the Brexit referendum in the UK," said Andreas Olah, lead analyst for IT in retail at Current Analysis. "This varies, however, with some vendors using currency fluctuations and uncertainty as an excuse for much higher increases, while others are under pressure to keep prices down and rather risk lower margins."

Olah isn't surprised that Apple has been one of the most aggressive with its increases, arguing that "higher-end products from major brands such as Apple are more likely to see a price increase than lower-end products from less-known manufacturers".

"This is due to higher price competition at the lower end of the market, where customers are more sensitive to price changes," he added.

Olah predicts that prices will eventually settle down again, as factors aside from the exchange rate – such as competitors' pricing and the disposable income of consumers – come into play. And companies that push the exchange rate excuse too hard may find themselves shut out of the British market. "Retailers will have to settle for slightly lower margins, although larger store chains will try to push back against vendors' price increases," Olah explained. "Although it's rather unlikely that a store such as Carphone Warehouse would pull out of selling Apple devices in the same way as Tesco dropped Marmite, it is a possibility for less-known manufacturers that are likely to feel the squeeze."

ABOVE Tech prices have risen since the vote for Brexit, including a 10% increase for Dell products and 20% rise for Office 365

Letter of the law

There must be some benefit to leaving the EU, right? If there is, many would consider being unshackled from European regulations and the auspices of the European Court of Justice one of them. Let's not forget, it was the EU that was behind the ePrivacy Directive that forces every website to enquire whether you'd like cookies or not, forcing you to click OK on every new site you visit while generally leaving you none the wiser about the implications of said cookies.

THE BREXIT TECH TIMELINE

The key dates in the Brexit timetable for the tech industry

March 2017

The government (at the time of writing) planned to invoke Article 50 by the end of March, finally kickstarting a two-year process to extricate the UK from the EU.

May/June 2017

The government will include the Great Repeal Bill in the Queen's Speech. Regarded as a "tidying-up exercise", it will give parliament the power to absorb all or parts of EU legislation into UK law, and dump the parts it doesn't wish to keep.

May 2018

The European General Data Protection Regulation (GDPR) comes into force. This strengthens privacy safeguards, forcing companies to seek explicit consent (pre-ticked boxes on web forms aren't good enough, for example) to process personal data. As the UK won't have left the EU by this date, the legislation will be enacted.

March 2019

Britain's exit from the EU will be complete. The UK will have the freedom to tailor its own privacy and data protection legislation, although it's highly likely, according to the legal experts we spoke to, that UK law will mirror EU legislation at this point. The big question is what will happen with immigration: Brexit voters will be expecting controls to be imposed. The most likely scenario, according to the experts, is some kind of points-based system that now applies to EU citizens as well as the rest of the world. This will increase the bureaucracy for tech firms wishing to hire staff from overseas.

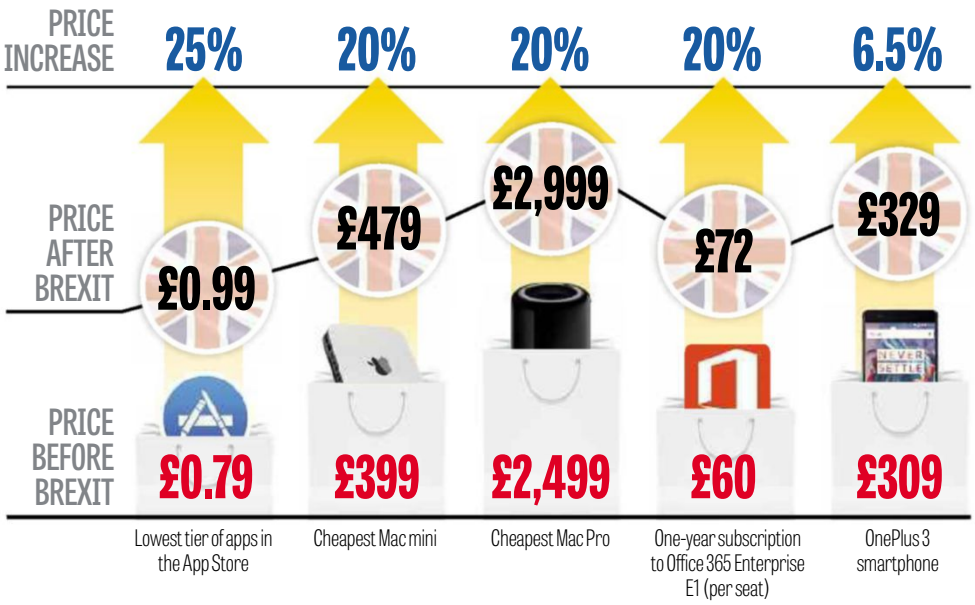
Leaving the EU will indeed leave Britain free to make its own legislation, but it certainly won't be an overnight process. "The prime minister has already indicated there will be a Great Repeal Bill, which will incorporate all of those regulations into UK law," said solicitor Peter Wright, who runs DigitalLawUK and is chair of the Law Society's Technology & Law Reference Group. "They can be reviewed at the leisure of parliament, and the decision can be taken over whether we want to maintain regulatory equivalence with the European Union, or whether we want to go down a slightly different, more liberalised path."

In the meantime, the European General Data Protection Regulation (GDPR) is set to be implemented in May 2018, and as Britain won't have parachuted out of the EU by then, the new, tighter data regulations will be enacted. But if Britain decides that the EU's data laws are too stringent and veers towards the American model, British businesses could be cut loose. There's already concern that the UK may fall foul of European standards thanks to the implementation of the government's "Snooper's Charter" (*see p102*).

"The EU will have to make a determination with regards to the United Kingdom, whether personal data can be transferred within its laws," said Wright. "There has already been an indication that this determination may be in difficulty because of the very intrusive surveillance legislation that has just become law in the form of the UK Investigatory Powers Act."

If the EU decided that the UK didn't have sufficient privacy safeguards, "it might make it difficult for data to be transferred from organisations where it is gathered inside the European Union". For firms that have UK data centres serving customers across Europe, this could be a big problem.

BREXIT TAX: PRICES BEFORE AND AFTER THE VOTE



Campaigners from the Open Rights Group (ORG) say the UK must resist the temptation to make Britain's data privacy laws more business friendly, not only to protect people's privacy, but to eliminate the risk of the EU deciding the UK isn't a safe place to store data. "Given the possibilities for challenges [from human rights organisations] or simply other countries trying to take business from the UK... we think it would be quite a mistake – indeed, really dangerous – to re-open the legislation," said Javier Ruiz, policy director at the ORG. "Even if it isn't perfect, even if it could be improved, the moment you try to improve it... the risk of being found not in compliance increases."

> We haven't written our own privacy laws for more than 30 years

There's another reason why attempting to rewrite regulations such as the GDPR is fraught with risk: we haven't written our own privacy laws for more than 30 years. Consequently, we're out of practice and don't have departments set up to do it. "It's true that most privacy legislation has been drafted in more detail at the European level," said Ruiz. "It would be quite difficult for the UK to draft better legislation.

"It isn't just the capacity of civil servants or legislators to do it," he added. "It's the fact that, for all its criticisms, the legislative process in Brussels has been the product of huge amounts of lobbying. The end result reflects a very complex argument, which tries to take into account views from all kinds of industries and human rights groups."

Nevertheless, for all the risks of being ostracised by Europe, Peter Wright believes that the UK will eventually end up with data laws that sit somewhere between the tight privacy safeguards afforded by the EU and the more business-friendly regulations of the US. "You only have to look at all of the apps that so many consumers use on their phones and tablets; the majority of them are created not within the environment of the European Union but in California," he said.

"You ask yourself where is the UK's Uber? Where is the UK's Facebook? Where is the UK's Airbnb? The answer is sometimes they've struggled for wont of finance, or they've struggled because of what can be quite restrictive data protection laws," Wright argued. "It's going to be open to the UK government in future to decide which path it wishes to follow to encourage those sorts of businesses."

BREXIT IT JOBS TRACKER

	Vacancies Jan 2016	Vacancies Jan 2017	Increase
Developers	25,569	29,171	14%
Agile software development	23,410	24,547	4%
Financial	18,330	23,018	26%
SQL	17,312	21,637	25%
JavaScript	14,679	15,993	9%

This table compares the number of permanent vacancies in the top five most in-demand IT skills on **itjobswatch.co.uk**. Figures are for the three months ending Jan 2016 and Jan 2017 respectively.

BECOME A KEYBOARD WIZARD

Want to turbo-charge your productivity? Nik Rawlinson says let go of the mouse and learn these simple keyboard shortcuts

There are many ways to be more productive. You could always spend longer at your desk – but the ideal is to work not harder, but more efficiently. A simple but effective way to do this is to stop relying on your mouse (or trackpad, or touchscreen). Every time your fingers leave your keyboard, you're breaking your flow and taking your concentration away from your work. A few keyboard shortcuts can make you faster and more focused.

In this article, we'll list the most time-saving shortcuts – and explain how to create your own.

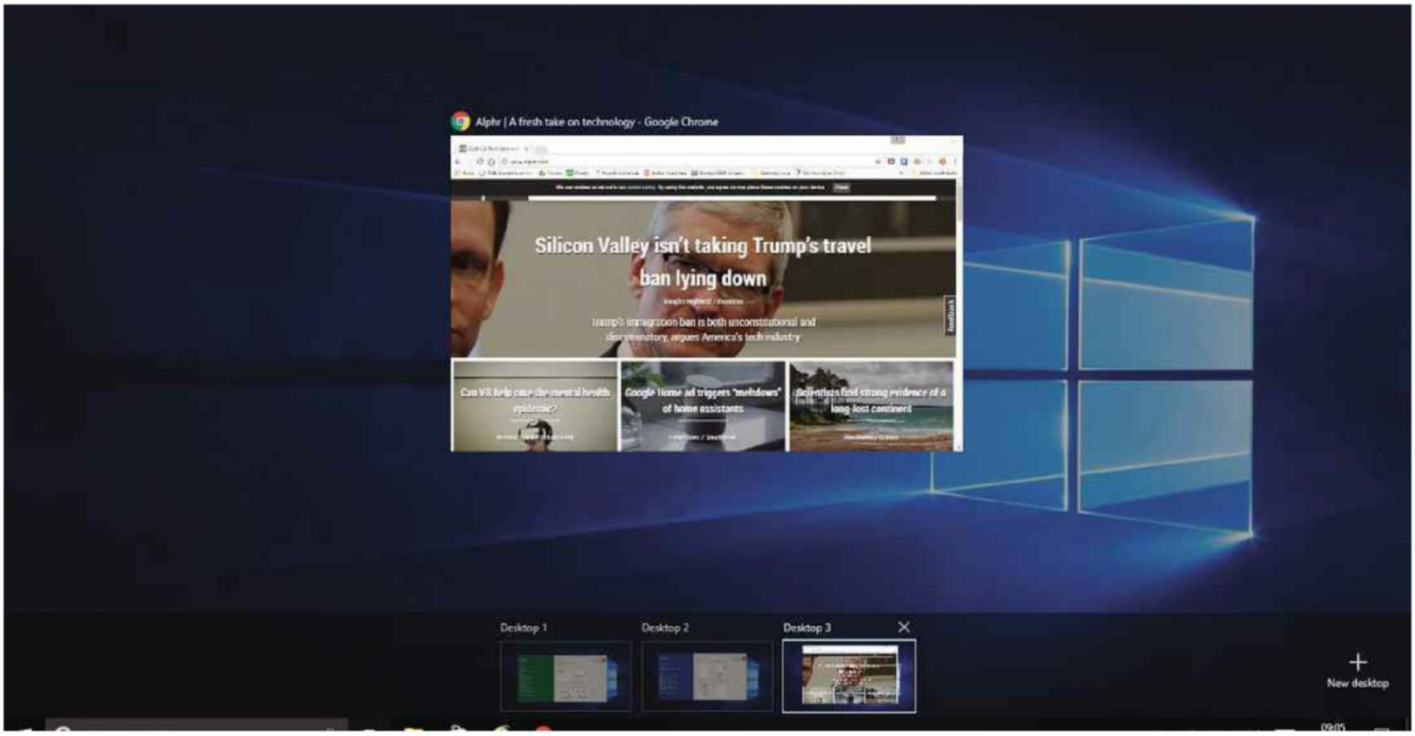
The versatile Windows key

Let's start with the easy ones. As we expect most *PC Pro* readers will already know, combining the Windows key with a variety of others gives you direct access to a range of useful functions:

Windows + E Open a new File Explorer window
Windows + D Hide and restore your active windows – an easy way to quickly clear your screen if you don't want someone else to see what you're working on
Windows + M Minimise all active windows to expose your desktop
Windows + I Open the Settings app (in Windows 8 and 10)
Windows + L Immediately lock your PC – useful if you need to step away from your desk
Windows + R Open the Run dialog, for launching apps and running commands by name

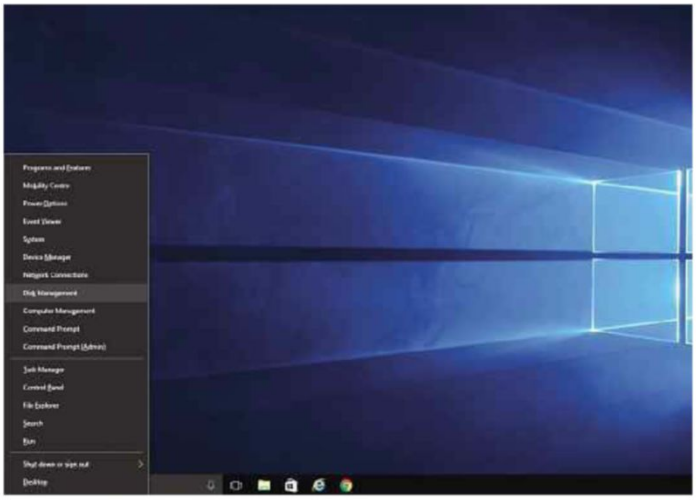
You can also use the Windows key to organise your application windows. Hold it down and tap the left or right arrow keys to snap the active window to the left- or right-hand edge of the screen. Use it with the up and down arrow keys to maximise or minimise the open window. If you have too many windows, don't try to line them all up; tap Windows + Home to close everything except the window that has focus.

The Windows key also comes into its own if you're using Windows 10's multiple virtual desktops. You can instantly switch to a new desktop by pressing Windows + Ctrl + D, and page back and forth between your open desktops by holding down Windows + Ctrl and tapping the left or right cursor key. Windows + Ctrl + F4 closes the current desktop, while Windows + Tab gives you a preview of the apps running on each desktop. You can jump to an open application or desktop by clicking on it with the mouse – or, navigate to it with the cursor keys and hit Return.



The hidden Start menu

The Windows key can also open a hidden power user menu, offering quick access to configuration utilities such as Command Prompt, Power Options, Device Manager and Disk Management: to open it, simply press **Windows + X**. Each menu item has its own shortcut, indicated by an underlined letter, so you can (for example) jump straight to the Network Settings applet by pressing **Windows + X then tapping W**.



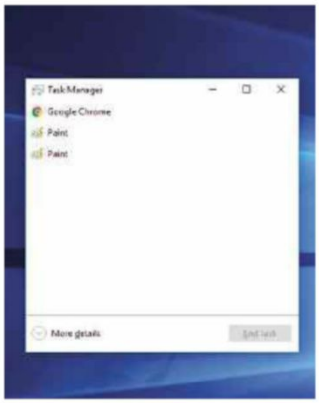
Save your screengrabs automatically

If you need to take screengrabs for training or problem solving, you probably know about hitting PrtScn to copy the display to the clipboard – or, **Alt + PrtScn** to capture only the active window. These shortcuts are all well and good, but after using them you still need to paste the captured image into something like Paint and decide where to save the result. Speed things up by pressing **Windows + PrtScn** instead, which saves the grab directly in your Screenshots folder (inside the Pictures folder).

Jump straight to the Task Manager

The **Ctrl + Alt + Del** key combination is probably one of the best known and longest-lived shortcuts in Windows, taking you directly to the Security screen. Many people head here when they want to open the Task Manager, typically to kill an unresponsive application. But you can cut out the middleman by pressing **Ctrl + Shift + Esc** to launch the Task Manager.

While these are some of the most useful shortcuts in Windows, they're by no means the only ones – head to **pcpro.link/271keys** to find a long list of shortcuts.



Application shortcuts

Many keyboard shortcuts work across multiple applications: **Ctrl + P** generally means print, **Ctrl + F** means find and so forth. Certain shortcuts, however, have specific meanings that only apply to certain apps, or types of app. Here's a handy selection of shortcuts for Microsoft's Edge browser and the Windows Mail app – although many of them will work in other browsers and mail clients.

EDGE

Backspace	Go back
Ctrl + Tab	Move to the next tab (add shift to move to the previous tab)
Ctrl + Shift + T	Reopen the last-closed tab
Ctrl + J	Open the downloads panel (**Ctrl + H** for the history panel)
Ctrl + D	Add the current site to your Favorites or reading list
Ctrl + K	Open another instance of the current tab
Ctrl + R	Refresh the current page

You can also press Ctrl + Enter together to wrap "www." and ".com" around whatever you've typed into the address bar.

Facebook

It's not just Windows and apps that recognise keyboard shortcuts. Many websites support a wide range of shortcuts to help you whizz around their interfaces. Here are some handy shortcuts for Facebook. Note that the way you access these differs depending on your browser. In Chrome, press **Alt +** the key detailed below; for Firefox it's **Shift + Alt**. In Internet Explorer, press **Alt** plus the shortcut key, then Return.

0	Help
1	Home
2	Timeline
3	Friends
4	Inbox
5	Notifications
6	Settings
7	Activity Log

For more details of how the keyboard shortcuts work in Facebook, visit pcpro.link/271face

Gmail

Gmail supports all sorts of shortcuts, but they're disabled by default. To enable them, click the cog icon, select Settings, scroll down to Keyboard shortcuts, select "Keyboard shortcuts on" and click Save Changes. A wide range of shortcuts now becomes available. Here are some of the most useful ones, plus specific shortcuts for Gmail and Facebook.

P	Step to the previous message in an open conversation
N	Step to the next message in an open conversation
Ctrl + Enter	Send
Ctrl + K	Insert a link
Ctrl + M	Open spelling suggestions
**Ctrl + **	Remove formatting
Ctrl + Shift + 7	Numbered list
Ctrl + Shift + 8	Bulleted list
Ctrl + Shift + 9	Quote
Ctrl +]	Indent (press **Ctrl + [** to indent less)

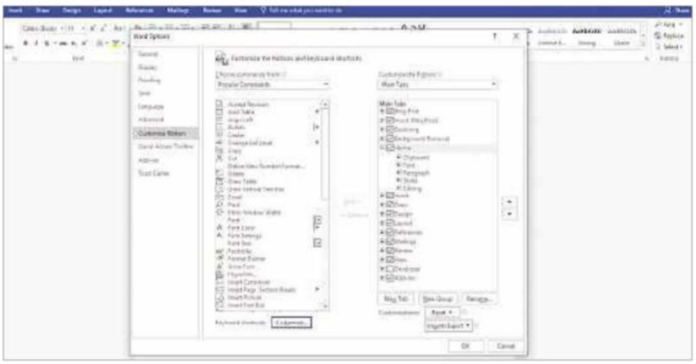
You'll find a complete list of Gmail keyboard shortcuts at pcpro.link/271gmail.

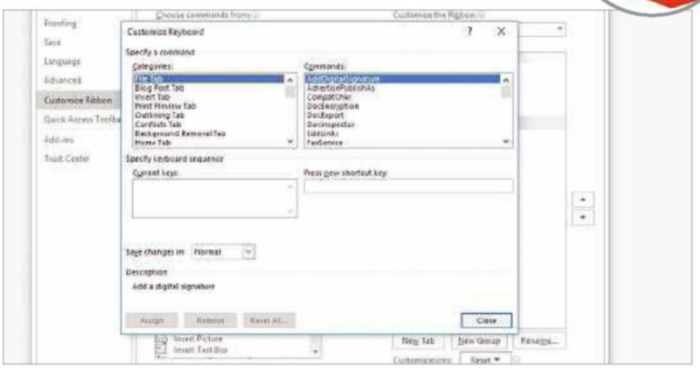
Mail

Ctrl + R	Reply (add shift for Reply All)
Ctrl + F	Forward message
Ctrl + J	Flag as junk (or not junk if it's already flagged)
Ctrl + M	Move message to a different folder
Ctrl + U	Mark message as unread (use **Ctrl + Q** to mark as read)
Ctrl + Shift + U	Only show unread messages (use **Ctrl + Shift + A** to go back)

Create keyboard shortcuts in Microsoft Office

Learning shortcuts is one thing, but creating your own lets you accelerate the tasks you perform most often and work efficiently. The good news is that the world's most popular productivity suite makes it easy to do. Here's how to define shortcuts in Microsoft Office.



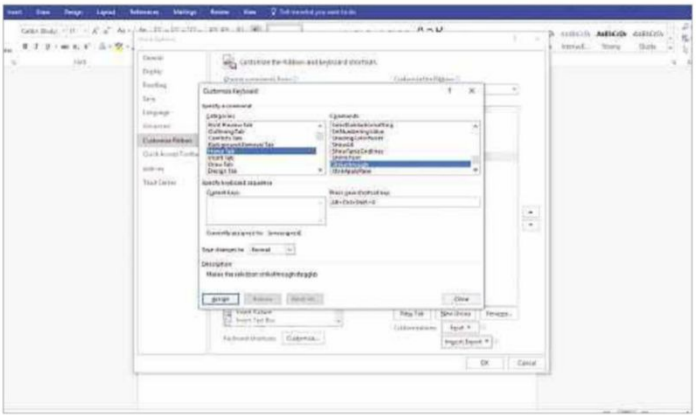


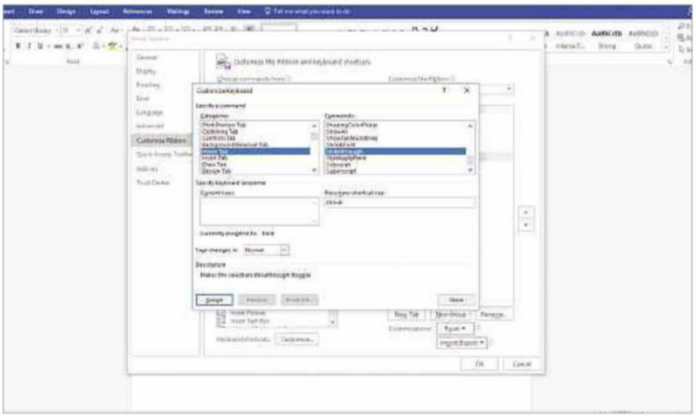
1 Find the keyboard shortcuts panel

We're working in Microsoft Word, but the principle is the same in the other Office applications. Start by clicking File, followed by Options. Then pick Customize Ribbon from the sidebar and click the Customize... button beside Keyboard shortcuts. You can ignore everything else in the Ribbon customisation dialog.

2 Find the function you need

Microsoft has helpfully broken down each of the applications' options according to the tab on which they appear, and put a few specialist ones – such as Publish Blog – in bespoke categories of their own. Find the menu tab you need in the Categories window and scroll through the various commands until you get to the one you want to customise.



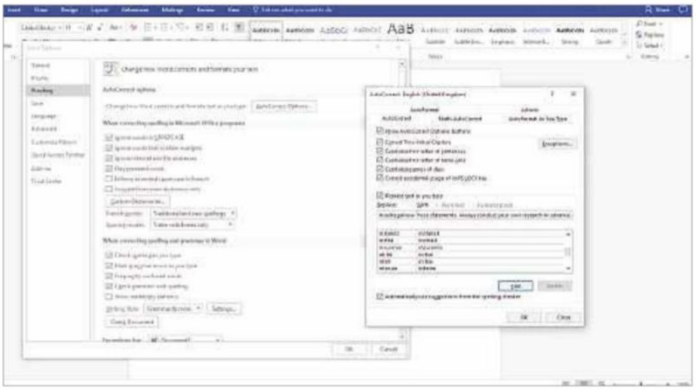


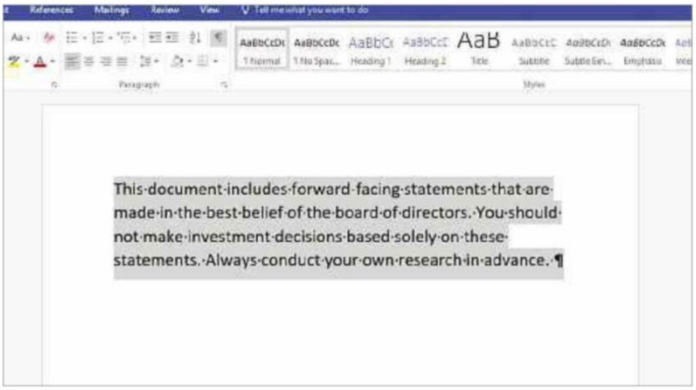
3 (Re)define the keyboard sequence

If your selected function already has a keyboard shortcut, it'll be shown in the Current keys box. In this case, we want to apply a new shortcut to Strikethrough, which doesn't normally have a shortcut of its own, so we've selected it, clicked in the "Press new shortcut key" box and pressed Ctrl + Shift + Alt + X to assign it that combination.

4 Check for conflicts

As you can see beneath the Current keys box, this combination hasn't yet been assigned to any other function. If it had – say, for example, we'd pressed Ctrl + B, which normally sets bold text – we'd have seen a warning allowing us to choose a different key combination. Now press Assign followed by Close to save the change to the Normal template.





5 Less typing, more words

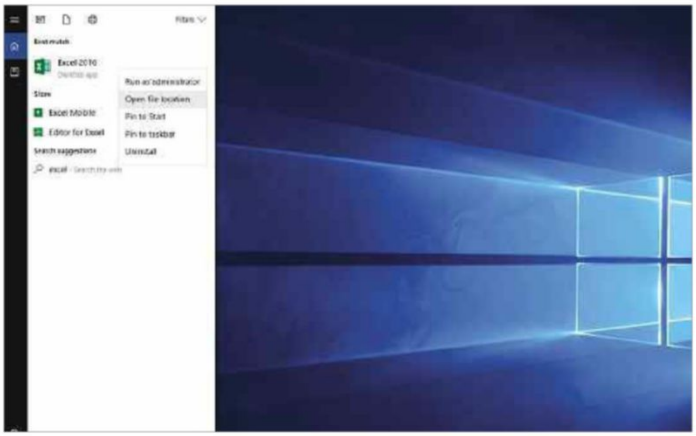
If you frequently insert the same block of text into documents, you can save time here as well by setting up Word (or another Office app) to add it for you when you type a shortcut. As an example, let's set up a standard legal disclaimer: start by clicking Proofing in the Options sidebar, followed by AutoCorrect Options...

6 Enter your AutoCorrect text

Now click in the "Replace:" box and add the trigger text. This needs to be something you wouldn't generally type: we've chosen "insertlegalnow". Enter the legal text in the "With:" box, then click Add, followed by OK. Finally, test the replacement (and check the spelling) by typing insertlegalnow in a document and watching the defined text automatically replace it.

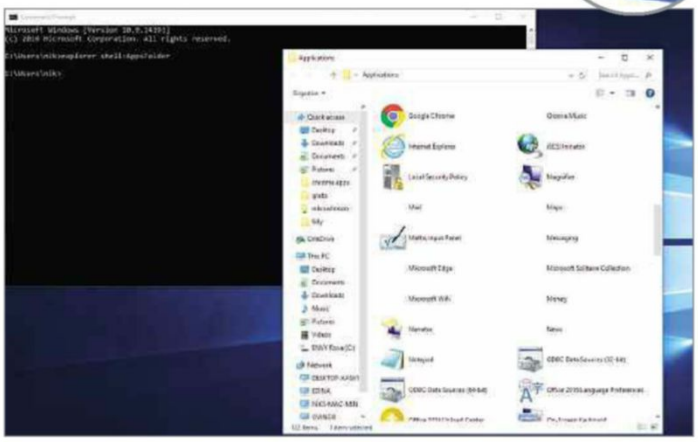
Create your own Windows shortcuts

Most of us spend the vast majority of our time inside a fairly small number of applications. If you set up keyboard shortcuts for each, you can launch them instantly, without having to mess around with the taskbar, desktop or Start menu. All in four steps...



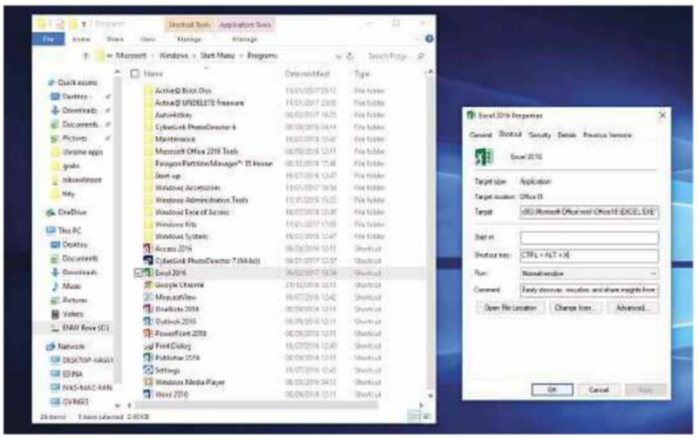
1 Find the app executable

Let's say we use Excel every day and want to create a keyboard shortcut to launch it quickly. First, we need to find the program file. To do this, press the Windows key and type Excel, then right-click its entry in the list of results (it will probably be the "Best match") and select "Open file location".



2 Alternative routes

You can also open the complete list of applications in the Start menu, right-click Excel and navigate through "More" to "Open file location" – or open the Applications folder directly. To do this, press Windows + R to open the Run prompt, enter "explorer shell:AppsFolder" and hit Return.



3 Create a shortcut

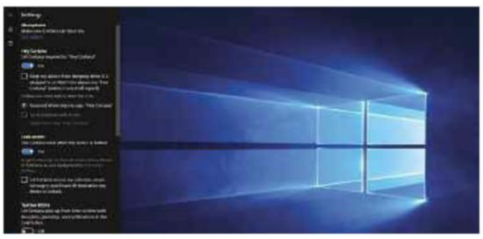
Right-click on the application's icon, select Properties and click in the box beside the Shortcut key. This is where you'll define the key combination you want to use. This must be a single letter or number, which you'll press along with Ctrl + Alt to launch the shortcut. We're using X for Excel, as that's easy to remember.

4 Test the shortcut

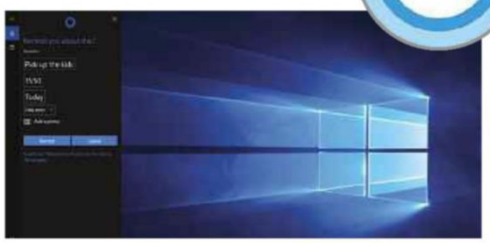
Choose if the application should launch in a normal window, minimised or maximised from the dropdown menu beside Run, then click Apply. Confirm Administrator privileges if you're prompted to do so, then click OK. You're all set: to test the shortcut, close the Explorer window and press Ctrl + Alt + X to launch Excel.

Hey Cortana, what's even quicker than a keyboard shortcut?

Keyboard shortcuts offer tremendous efficiency gains, but Windows 10's speech recognition capabilities can be even more of a time-saver. That's because their scope isn't limited to the app you're using at the time: you can execute all sorts of tasks without switching away from the document or web page you're working on. For example, if you're busy working on a spreadsheet and suddenly remember you need to buy cheese, you can use a voice command to add it to your shopping list in seconds – without leaving Excel.



You can also turn on "Hey Cortana", which makes Windows 10 listen out for those words and act on any command that follows them. So if you say "Hey Cortana, remind me to pick up the kids in ten minutes", a calendar event will be created, without you having to take your hands off the keyboard.



To activate "Hey Cortana" recognition, just click (or tap) the search box on the Windows 10 taskbar, then click by the cog to open Cortana settings. If you'd prefer not to allow your computer to listen in to everything you say, you can use Windows + Shift + C to invoke manual listening mode instead.

HP Chromebook 13 G1

Super-thin, powerful and seriously portable, HP's latest Chromebook is in a league of its own

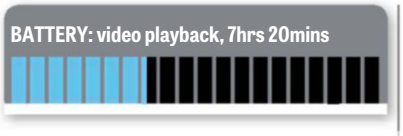
SCORE ★★★★½
PRICE £508 (£610 inc VAT)
from amazon.co.uk

You might start reading this with a deep-rooted cynicism toward Chromebooks. And for good reason: laptops powered by Google's OS have had their reputation sullied over the years due to a series of plastic-ridden, Celeron-powered devices with sub-par screens. Yes, there was the glorious and heinously overpriced Google Pixel, but that was a lone flame: HP's latest Chromebook 13 is the first Chrome-powered laptop that feels like a mainstream machine.

Inside and out, HP makes few sacrifices. Its looks are bewitching, with its dark grey brushed-aluminium chassis accompanied by a backlit keyboard. This sophisticated Chromebook makes my previous favourite, Acer's Chromebook 14, look like a dull also-ran.

PC PRO RECOMMENDED

Standing 12mm tall, and weighing a dainty 1.2kg, it's also one of the slimmest and lightest Chromebooks around. The whole package feels reassuringly expensive, which is just as well given the steep asking price: to put HP's £600 tag into perspective, Acer's Chromebook 14 costs only £200.



Intriguingly, though, HP isn't solely taking aim at those who want a high-quality alternative to Windows laptops: it describes this laptop as "business-ready". So could your next business laptop really be a Chromebook?

Business credentials

There are certainly arguments for Chrome OS in a business environment. With automatic updates and no direct threat from traditional viruses, it should be easy to manage. If your business has already shifted to cloud-based applications, what's really tying you to Windows?

HP adds to the business credentials by embedding a TPM 1.2 security chip and selling an optional Elite USB Type-C docking station, which may look ugly – think black, square power brick – but can output to two Full HD screens simultaneously via DisplayPort and HDMI. It also adds a handy RJ45 connector and five USB ports. Oh, and about £200 to the price.

As with most Chromebooks, the port selection on the laptop itself is restrictive: there are two USB Type-C ports (with one used for charging) and a single regular USB 3.1 socket. If you don't want to buy the docking station, you can use that spare Type-C socket to connect the HP Chromebook to a variety of high-speed peripherals, including external monitors.

A solitary microSD slot for expandable storage is tucked away on the right-hand side. That could be welcome, with the 32GB of eMMC flash storage perfectly respectable for a Chromebook – and complemented by 100GB of Google Drive storage for two years – but still easy to fill.

As for networking, you'll have to either stick with the onboard 802.11ac Wi-Fi adapter (there's no built-in Ethernet socket) or buy an adapter for use over USB. Finally, there's Bluetooth 4.2 for connecting additional peripherals such as headphones, mice and keyboards.

First-class flyer

Whether you buy the HP Chromebook 13 for yourself or employees, you should have no complaints about speed: HP crams the chassis with nippy core components. For £600, you get a dual-core, 900MHz Intel Core m3-6Y30 processor, 4GB of RAM and that 32GB of storage – it adds up to a Chrome OS-powered laptop that's well ahead of the pack.

It scored 128 in the JetStream browser benchmark – the highest we've seen – twice that of HP's elderly Chromebook 14. It felt wonderfully nippy in general use, flitting between multiple Chrome tabs just as fast as a premium Windows laptop. What's more, due to the fanless design, it's nigh on silent in operation.

The Core m3 is a tad more power-hungry than its Celeron rivals, though, draining the Chromebook 13's 5,000mAh battery in 7hrs 20mins in our video-playback test. You should eke out a full working day from a single charge, but don't run the screen at maximum brightness.

Screen burn

Which brings us to the screen itself. Forget Full HD – HP ships this Chromebook with a Quad HD IPS panel. First, the good news. This 13.3in, 2,560 x 1,440 display beams out at 358cd/m², perfect for sunny afternoons, while an sRGB coverage of 88% promises accurate colours. Then the bad: due to a lowly 474:1 contrast ratio, images had a flat, washed-out look. It's by no means awful, but for this price I expected better.

I also hoped for a touchscreen. If nothing else, this would make those ported Android apps on the Chrome Web Store much easier to use. And, while it's hardly HP's fault, Chrome OS still struggles with resolution scaling. At any resolution higher than Full HD, it displays a laughably microscopic mouse cursor and such small app icons you have to squint. I had to nudge it down a notch or two to make it usable.

ABOVE HP claims the Chromebook 13 is well suited to business, and it sure looks the part

I'm a bigger fan of the keyboard, which includes individually backlit keys to add to this laptop's premium feel – as well as being useful. The keys are nicely spaced inside the 13in chassis, and although the shallow travel takes some getting used to, the stiff switches make for crisp, responsive typing.

The touchpad is generously sized, too, and responsive both to standard mousing and multitouch gestures. I'm not a huge fan of integrated buttons, but here they're easy to get along with.

Brushed Chrome

HP's Chromebook 13 may seem overpriced but, in reality, it's the standout Chrome OS laptop. It offers great performance and a crisp (if not perfect) high-resolution display, and the ultra-light chassis and all-day battery life make it a portable workhorse that's a joy to use.

"If your business has already shifted to cloud-based applications, what's really tying you to Windows?"

There are still tempting Windows alternatives – just look at the A List on p16 – but if you want the simplicity of Chrome OS and top-quality components, then this is the Chromebook to beat. **NATHAN SPENDELOW**

SPECIFICATIONS

Dual-core 900MHz Intel Core m3-6Y30 processor • Intel HD Graphics 515 • 4GB RAM • 13.3in 2,560 x 1,440 IPS display • 32GB eMMC SSD • HD webcam • 802.11ac 2x2 Wi-Fi • Bluetooth 4.2 • 2 x USB Type-C 3.1 • USB Type-A 3.1 • microSD slot • Chrome OS • 320 x 220 x 13mm (WDH) • 1.29kg • 1yr RTB warranty

BELOW It's slim, it's light, and it's beautifully formed

PC Specialist Ultranote IV 15

A solid choice if you seek power on a tight budget, but build quality is undermined by a tepid screen

SCORE ★★★☆☆

PRICE £550 (£660 inc VAT)
from pcspecialist.co.uk

If Batman built himself a laptop, it would look like this. While most modern offerings are finished in shiny silver aluminium or brightly coloured plastic, the Ultranote IV is an ode to monochrome. The only attempt at decoration is a couple of triangular cutouts, which only add to the stealth chic feel. There isn't even a logo on the lid. LED lights, hi-fi speaker logos and gaudy marketing stickers are conspicuous by their absence.

Not that we're complaining. Rivals might be more eye-catching, but the Ultranote's got it where it counts. Despite a few clunky bits of detailing, it's fashionably slim and light, tipping the scales at 2.18kg despite its 15.6in screen. Build quality feels sturdy enough to carry around without layers of padding, even if there's a bit of flex here and there in the matt black plastic. It's almost handsome, in an angular, brutalist kind of way.

The chassis is made by a Taiwanese company, Clevo, which has a long history of supplying laptop designs to British system builders. The likes of PC Specialist then make their mark by choosing the right mix of components for the right price.

Here, it starts with Intel's new Kaby Lake generation of processor chips, fitting a dual-core 2.5GHz i5-7200U alongside a sensible 8GB of memory. Windows 10 Home is installed on a 128GB M.2 SATA SSD, but there's also a 1TB hard disk to ensure you don't run out of storage too quickly. The result is a capable all-round machine, powering to a score of 44 in our benchmarks – exactly what we'd expect for this spec.

For this price you don't get a dedicated graphics card, but the Intel processor's integrated HD 620 Graphics chip is capable. It can even handle some recent 3D games if you sacrifice resolution and quality settings, with older titles hitting respectable frame rates at 1080p.

The absence of a graphics card takes the pressure off the relatively small 31Wh battery, so the Ultranote IV lasted an acceptable five hours and 20 minutes in our video playback test. It's a far cry from the ten hours of some laptops, but you're not compromising on performance or paying over the odds.

For general use, this is a pleasant laptop to work on. The keyboard, often a giveaway of poor build quality on cheaper machines, is comfortable to type on, being firm and rigid in all the right places. There's even backlighting to keep you hitting the right keys in dark rooms. Unlike many, the touchpad has two proper buttons rather than incorporating them into the touch surface, which provides smooth cursor control and two-fingered scrolling.

Where I'm less enamoured is screen quality. Colours look flat, and the limited range makes the Ultranote a poor choice for colour-critical graphics work. Where it wins is for size and clarity: the mix of a 15.6in screen diagonal and 1,920 x 1,080 resolution means you'll never be squinting at text, while the matt finish keeps reflections at bay.

ABOVE The backlit keyboard is one indicator that this is a good-quality chassis

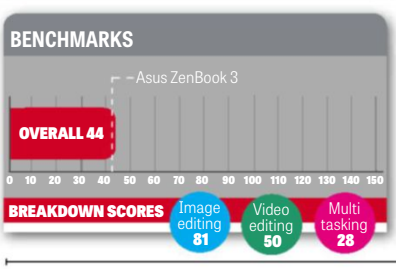
"The only attempt at decoration is a couple of triangular cutouts, which only add to the Ultranote IV's stealth chic feel"

For movie watching, whether from the internet or from the built-in DVD writer, the headphone socket is a better option than the tinny built-in speakers. Talking of sockets, you get a full set, including Gigabit Ethernet and three conventional USB ports, as well as a single Thunderbolt-compatible Type-C port.

That's one factor that might help PC Specialist win some customers from the big PC brands, but competition is certainly stiff. Dell's Inspiron 15 5000, for example, starts at £579 with the same i5 processor but no SSD; for a similar price to the Ultranote, you can get a dedicated AMD graphics card thrown in. This is a solid all-round laptop for sensible money, but look elsewhere if you're looking for a top-notch screen.

SASHA MULLER

ABOVE The no-logo approach extends to a welcome lack of marketing stickers



SPECIFICATIONS

Dual-core 2.5GHz Intel i5-7200 processor • 8GB memory • 128GB SSD • 1TB hard drive • DVD writer • 1,920 x 1,080 IPS screen • 802.11ac Wi-Fi • Bluetooth 4 • 1MP webcam • USB 3 • 2 x USB 2 • USB Type-C • Gigabit Ethernet • HDMI • Windows 10 Home • 377 x 259 x 24mm (WDH) • 1yr RTB (first month C&R) plus 2yr RTB labour-only warranty

Synology®

DS216play | DS716+II | DS216+II

4K TRANSCODING & STORAGE SOLUTION

Ultra HD 4K · dlna CERTIFIED · AirPlay

4K VIDEO TRANSCODING

Transcode 4K videos to make them suitable for all screens and bandwidths whether they are local media players or remote mobile devices.

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Access and share all the multimedia files stored on your Synology NAS anytime, anywhere for home or work through our large range of apps.

STORE AND STREAM YOUR MEDIA

Stream digital content with Roku, Apple TV, Chromecast, Samsung TV and all Bluetooth, Airplay and DLNA devices effortlessly.

For where to buy visit www.synology.com

Available mobile Apps

iOS

Synology's Media Accolades

PCR awards 2016 WINNER

PC PRO BEST NAS BRAND 2016 SYNOLOGY WINNER

BT Whole Home Wi-Fi

BT's multipoint wireless system delivers on its promise, with a fast, reliable signal throughout

SCORE ★★★★★

PRICE £250 (£300 inc VAT)
from shop.bt.com

After years of living in the shadows, suffering the merciless bullying of disgruntled internet users, the beleaguered wireless router is at last fighting back – and BT's Whole Home Wi-Fi is in the vanguard. It's part of a new wave of multi-box wireless "mesh" systems that aim to banish dead spots and blanket your home with strong, solid Wi-Fi.

The concept is simple. By spreading the wireless signal around the home using not a single router, but many, you get a strong signal everywhere. And because these systems are built with ease of use in mind by one manufacturer, they're typically simple to set up and maintain.

While it's certainly possible (and much cheaper) to use wireless repeaters to extend the reach of your network, the improved range they offer typically comes at the expense of simplicity of setup and performance.

Signal to noise

This is a relatively young product type, so the market isn't awash with alternatives right now. Until Whole Home Wi-Fi came along, the most impressive system I'd come across was Netgear's Orbi. Designed to replace your single-box wireless router, Orbi comes as a two-box system, one hub connected to your broadband and one satellite placed a short distance away to spread your network that bit wider.

Others are coming, though. Linksys debuted its Velop router system at CES 2017, where it picked up a *PC Pro* best-of-show award, and this looks highly promising. We'll have a full review of the Velop in next month's issue, but note that a set of three costs £500. There's also the Sky Q multi-room TV system, in which each TV box doubles as a wireless access point. To get Sky Q, though, you must subscribe.

For price and convenience, BT's offering looks promising. Where Orbi costs £370 for the two-box starter kit, Whole Home Wi-Fi is both cheaper at £300 and includes an extra wireless access point, giving you potentially wider coverage.

ABOVE The pack includes three discrete discs that look at home in the living room

PC PRO RECOMMENDED

BT's system works in a very similar way to the Orbi and, just like that system, it's designed to be completely plug-and-play. Download the app, run through step-by-step instructions, and you'll be up and running in minutes.

It really is that simple. You connect the first disc-shaped wireless unit from its single Gigabit Ethernet port to your existing wireless router. Once this automatically configures itself, you're ready to plug your second and third discs into the mains; these automatically pair up with the first and establish a simple "mesh" network.

Side by side

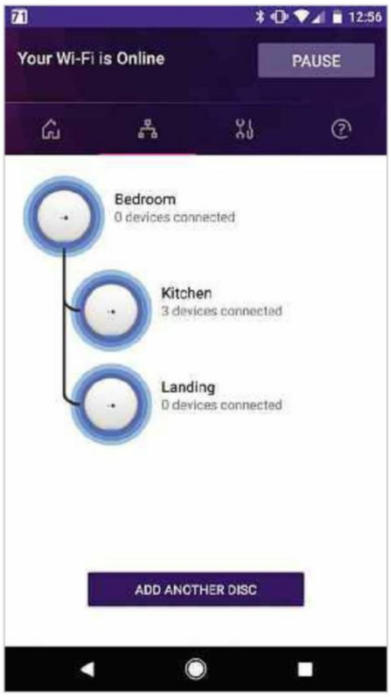
Place the discs wherever you like to start with: to get the best coverage and the strongest speeds, the app monitors signal strength and lets you know if you could do better by positioning the second and third satellite discs closer to the hub.

Once you've done this, you've pretty much finished with the setup. There's nothing else to do other than pluck the plastic tab from the rear of one of the router discs, and enter the preconfigured security key into all your devices.

Although BT Whole Home Wi-Fi offers dual-band connectivity – each disc is effectively a 4x4 MIMO 802.11ac router offering speeds of up to 1,733Mbits/sec over 5GHz and 800Mbits/sec over 2.4GHz – it doesn't surface two separate networks in the way a normal wireless router would.

Instead, the system uses a technique known as band-steering to assess each connected device and hook it up to the most appropriate frequency band and to the disc

BELOW Setup is simple: connect the first disc to your router and then place the other two discs



ABOVE RIGHT **The app is well designed and packed with useful features**

offering the strongest connection. It works, too.

The one misstep here is that BT's system insists on creating its own separate wireless network from your original wireless router's; if you don't want your devices to automatically connect to your old, inferior network, you'll either have to disable wireless on that router or go around deleting the old network from all your devices. That's not ideal.

Still, if that's the only inconvenience, I'm willing to put up with it. The app itself is easy to get to grips with, and I particularly like the "pause" button, which allows you to temporarily shut down Wi-Fi household-wide. A handy tool for parents who find it a challenge to make children put down their devices and take part in conversation. Similarly, there's a nice tool to show you who's connected to your network.

Speed 3

What's most impressive is that performance is stellar across the board. I tested it at home, where my usual setup is a Sky Q wireless mesh network, and it blew it away in terms of both range and throughput speed.

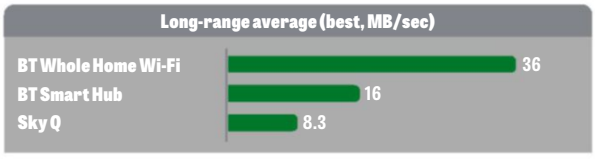
My broadband connection comes in on the first floor at the front of the house, and this is where I carried out my first, close-range test. Using an Apple MacBook Pro equipped with a 3x3-stream Broadcom Wi-Fi adapter as the test client, I saw average throughput of 89MB/sec (yes, that's megabytes, not megabits).

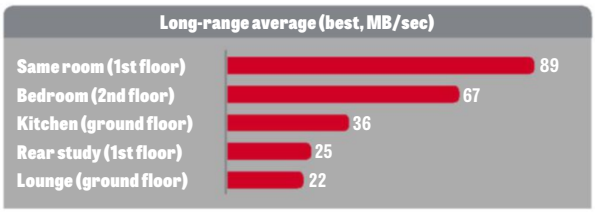
That's up there with the best standalone routers I've tested; it's faster than the BT Smart Hub and more than twice as quick as the Sky Q Hub, which itself is no slouch.

Next, I moved down one flight of stairs and into the kitchen at the rear of the house. Note that, when setting up the system, I tried to replicate as closely as possible the positions of the various Sky Q access points and booster boxes in my original network. I only tweaked the positions slightly on the advice of the BT Whole Home Wi-Fi app.

I normally see throughput speeds of around 8MB/sec on the Sky Q network in the kitchen, but the BT Whole Home Wi-Fi system flew past it with an average throughput of 36MB/sec. That's easily strong enough to stream 4K Netflix via a Chromecast Ultra, and it's double the speed the BT Smart Hub was able to muster in that position.

Moving to a second-floor bedroom immediately above the primary Whole Home disc revealed even more impressive results. Here I saw an average of 67MB/sec throughput. The slowest throughput speeds I saw were in the study at the rear of the house (25MB/sec) and the living room at the front of the house, immediately below the primary Whole Home Wi-Fi disc (22MB/sec).





"I particularly like the app's 'pause' button, which allows you to temporarily shut down the Wi-Fi household-wide"

Your numbers will be different from mine, of course – every home and office is different – but what's promising about the performance of the BT system is that even in the trickiest of spots I was getting a strong signal and decent throughput. That can only be a good thing.

Shopping spree

It's difficult to say if BT's Whole Home Wi-Fi is the best you can buy, because it's only one product in a field that's about to get a whole lot more competitive. I haven't tested Linksys' Velop system yet, but that promises equally impressive coverage and speed. Then there's Devolo's GigaGate, which is cheaper but more basic in terms of the features it offers.

What's clear, though, is that BT Whole Home Wi-Fi achieves what it sets out to – and then some. It delivers solid range and impressive throughput to parts of the home that single-box routers struggle with; it's remarkably easy to set up, and it's more affordable than Netgear's Orbi.

If you've always struggled to get strong wireless coverage across the whole of your house, it's the only Wi-Fi solution I can currently recommend. But if you can wait until I've put the Velop through the same tests, and don't baulk at the extra cost, it might be worth holding off your purchase. **JONATHAN BRAY**

SPECIFICATIONS

3 x 802.11ac Wi-Fi discs • AC 2500 • 2.4GHz/5GHz dual-band • 4x4 MIMO antennae • WPA/WPA2 encryption • maximum 32 connected devices per disc • iOS and Android apps • 2yr warranty

Lenovo P2

With monster battery life, the P2 will keep on going long after others have died – a brilliant-value phone

SCORE ★★★★★
PRICE £160 (£200 inc VAT)
from lenovo.com/uk

Remember when your phone lasted more than a day on a single charge? Well, the glory days are back and Lenovo's P2 is the saviour: it lasted a staggering 28hrs 50mins in our continuous video test. That's a full five hours longer than our previous winner, Motorola's Moto Z Play (*see issue 268, p62*). Anecdotally, after a heavy weekend's sightseeing filled with Google Maps, selfies and the odd game of *Mini Metro*, the P2 never dipped below 70%.

Lenovo achieves this by cramming a 5,100mAh battery – most phones' batteries sit around the 3,000mAh mark – into the P2's metal body, but this isn't a bulky phone. It feels a little fatter than super-svelte flagships such as the A-Listed Galaxy S7 Edge, but at 8.3mm thick and 177g it's only 0.6mm thicker and 20g heavier than the Samsung.

A handy fingerprint reader sits beneath the screen, and a volume rocker and power button on the right edge, while the left treats you to the dual SIM slot and an intriguing battery saving switch. Flick it up and your P2 enters Ultimate Power Saver mode, switching off data and disabling apps. It could be a handy "Defcon 1" function, but given the already impressive battery life, it's unlikely to see much use.

We're treated to a Full HD, 5.5in AMOLED display on the front, covering 99.9% of the sRGB colour gamut. And, as with all AMOLED displays, its contrast ratio is effectively perfect. Some of the darker tones – deeper reds and dark blues – were oversaturated under the scrutiny of *PC Pro*'s colour calibrator, but you won't spot this day to day.

One sticking point is the P2's peak brightness of 326cd/m². While that's fine for gloomier winter days, you'll be squinting at your phone once the sun finally pokes through the clouds. The Honor 6X (*see issue 270, p58*) is much better suited to such conditions with a peak of 502cd/m².

For the price, the P2 is a surprisingly nippy performer. Powered by Qualcomm's 2GHz octa-core Snapdragon 625 chip and 4GB of RAM, overall performance was silky smooth. With a Geekbench 4 multi-core score of 3,130, the P2 bested the Moto G4 by almost 700, and wasn't far behind the 6X's 3,319.

Switching to games, it scored a 10fps average in the onscreen GFXBench Manhattan benchmark, beating both the Honor 6X (8.4fps) and Moto G4 (7.7fps). *Sky Force: Reloaded*, a game that grinds to a halt on lower-powered devices, ran without a single frame drop, even during those action-packed enemy encounters.

That's near-full marks then – but then we come to the camera. It's not that the P2's 13-megapixel rear camera is bad; it's just that it loses out compared to Moto's G4. Outdoor test shots under gloomy skies picked up plenty of colour, with noise kept at bay. Flicking on HDR gave mixed results, with oversaturation on the orange bricks in our test shot, but it did help to balance exposure levels.

Where it falls down is indoors, especially in low light. Under close inspection our test subjects looked grainy and, while colours were vibrant, noise was apparent. Try to use the P2's camera outside with plenty of natural light, if you can.

The P2's camera software is also a tad clumsier to use than its rivals. Navigating through tedious menus isn't ideal for on-the-fly photography, while the P2 would have benefitted from Huawei's one-hand-friendly left and right swipes. At least Lenovo's Pro mode allows you to delve into settings such as ISO and white balance.

The final and relatively minor con is that Android 6 Marshmallow feels a little dated after the recent move to Android 7 Nougat. We're told an over-the-air update is coming in the near future.

Do these criticisms matter? Arguably not. That absurd battery life alone is well worth the price: don't forget, you're buying the longest-lasting smartphone by far. And it doesn't stop there: the P2's display, performance and build quality are all top-notch given the price, and it's a worthy competitor to much more expensive flagships.

There is still tough competition to fend off. You can buy the Moto G4 for £40 less, and in return get a rear camera that's a better performer in low light. Or the Honor 6X is arguably sexier, for around £25 more. Yet still we come back to the P2's amazing battery life and all-round strength. The Lenovo P2 is the new budget smartphone king. **NATHAN SPENDELOW**

ABOVE The 5.5in AMOLED is just as brilliant – in all senses – as we'd expect

PC PRO RECOMMENDED

LEFT Lenovo adds curves to distract from the P2's comparative girth

"At the flick of a switch you can enter Ultimate Power Mode, switching off data and disabling apps – a handy 'Defcon 1' function"

LEFT The P2 is a little thicker than rivals, but slips easily into a pocket at 8.3mm thick

SPECIFICATIONS

Octa-core 2GHz Qualcomm Snapdragon 625 processor • 4GB RAM • Adreno 506 graphics • 5.5in 1,920 x 1,080 AMOLED screen • 32GB storage • 13MP/5MP rear/front camera • 802.11ac Wi-Fi • Bluetooth 4.2 • NFC • micro-USB • 5,100mAh battery • Android 6 • 76 x 8.3 x 153mm (WDH) • 177g • 1yr warranty

Samsung CF791

Another fantastic quantum dot curved monitor from Samsung; expensive, but worth it

SCORE ★★★★★

PRICE £674 (£809 inc VAT) from morecomputers.com

PC PRO RECOMMENDED

There are two main categories for curved monitors: those built for gamers and those built for professionals. But what if you want the best of both worlds? A monitor with a fast refresh rate, low input lag, fast response time, good viewing angles and fantastic colour reproduction? Step forward the CF791, a 100Hz curved monitor that combines Samsung's quantum dot technology with a gamer-friendly VA panel.

The price may seem high, but even at these dizzy heights there's plenty of curved monitor competition from the likes of Acer (Predator Z35, £800), Dell (U3417W, £930) and Philips (BDM3490UC, £730).

Where the CF791 immediately wins is looks, with low-profile silver bezels and a white rear giving it a suitably premium and futuristic look. The stand is beautifully engineered and provides both height and tilt adjustments, while a VESA mounting kit is included in the box if you want to wall-mount it.

Samsung also makes plenty of fuss about its 1500R curvature: the aim, it says, is to get as close to the human eye's natural 1000R curvature as possible; early curved screens started at 4000R. Combined with a 21:9 aspect ratio and a 34in diagonal, you really do feel like you're being sucked into the action when playing games and watching films.

Don't be put off by its slower response times and refresh rates than dedicated gaming monitors. Firing up *Counter Strike: Global Offensive* showed this screen's 4ms response time will satisfy even the most demanding gamer, and there's support for AMD FreeSync.

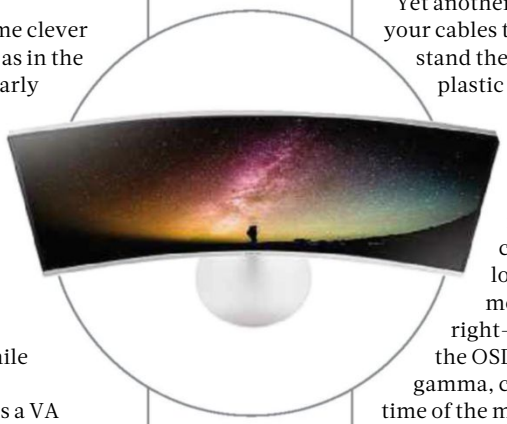
I found a very slight difference when cycling through the Response Time options in the onscreen menu, with Standard offering a slower response than Faster and Fastest, but I saw no signs of overshoot ghosting in any modes, so I could use the monitor set to Fastest without having to worry about ruining the visuals. Plus, unlike the Samsung C24FG70FQU (*see issue 270, p68*), there's no brightness cap in Faster and Fastest modes; the CF791's brightness remained untouched at 315cd/m². That's fine even in sun-drenched rooms.

The CF791 uses the same clever quantum dot technology as in the C24FG70FQU, with similarly excellent results. An average Delta E of 0.56 means this screen is ideal for colour-critical work, and sRGB coverage hit an impressive 99.1%, Adobe RGB coverage 81.2% and DCI P3 gamut coverage is again strong at 87.2% (while set in sRGB mode).

Because the CF791 uses a VA panel, its contrast ratio is much higher than your average IPS display. Indeed, I measured a contrast ratio of 2,330:1, which translates to amazingly lifelike imagery.

It's evenly lit too, while viewing angles are immaculate – that's in contrast to many other ultrawide panels, such as the Philips BDM3470UP, where the display tails off if you view it off-axis.

Connectivity is another strength. There's DisplayPort, a pair of HDMI 2 inputs, a 3.5mm headphone jack and two USB ports. It also has two integrated 7W speakers, which produce incredibly good sound for a monitor; I'd be happy to listen to music and streaming TV audio through the CF791's speakers. Coming from someone who typically listens to music via headphones and a discrete DAC/headphone amp, that's quite some praise.



ABOVE & BELOW The curved screen is no gimmick – it does make a difference – but you pay for it

Yet another nice touch: if you route your cables through the monitor's stand then you can clip on the plastic cover at the back to keep it all hidden away.

It's also good to see Samsung avoid the use of touch buttons, instead offering a clickable joystick located at the back of the monitor in the bottom-right-hand corner. Through the OSD you can adjust the gamma, colours, and response time of the monitor.

The Samsung CF791 might be expensive, but justifiably so. It's simply a fantastic all-rounder. Its dramatically curved 21:9 ultra-wide panel provides an immersive, cinematic experience whether you're working, playing or watching. The 3,440 x 1,440 resolution provides ultra-crisp visuals and, coupled with great colour accuracy and a lack of motion blur, it's suitable for not only the photo editor but also the competitive gamer. If you can afford it, don't hesitate to splash out. **CHRISTOPHER MINASIANS**

"Combined with a 21:9 aspect ratio and a 34in diagonal, you really do feel like you're being sucked into the action"

LEFT Hide unsightly cables away using the plastic cover that snaps onto the stand

SPECIFICATIONS

Curved 34in VA panel • 3,440 x 1,440 resolution at 100Hz • 4ms response time • DisplayPort • 2 x HDMI • 2 x USB • 3.5mm headphone out • 100mm height adjustment • -2°/14° tilt • 1yr warranty • 808 x 309 x 516mm (WDH with stand) • 8kg

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Asus Tinker Board

Powerful hardware let down by poor software, Asus' entry into the maker market needs more time in the oven

SCORE ★★☆☆☆

PRICE £46 (£55 inc VAT)
from currys.co.uk

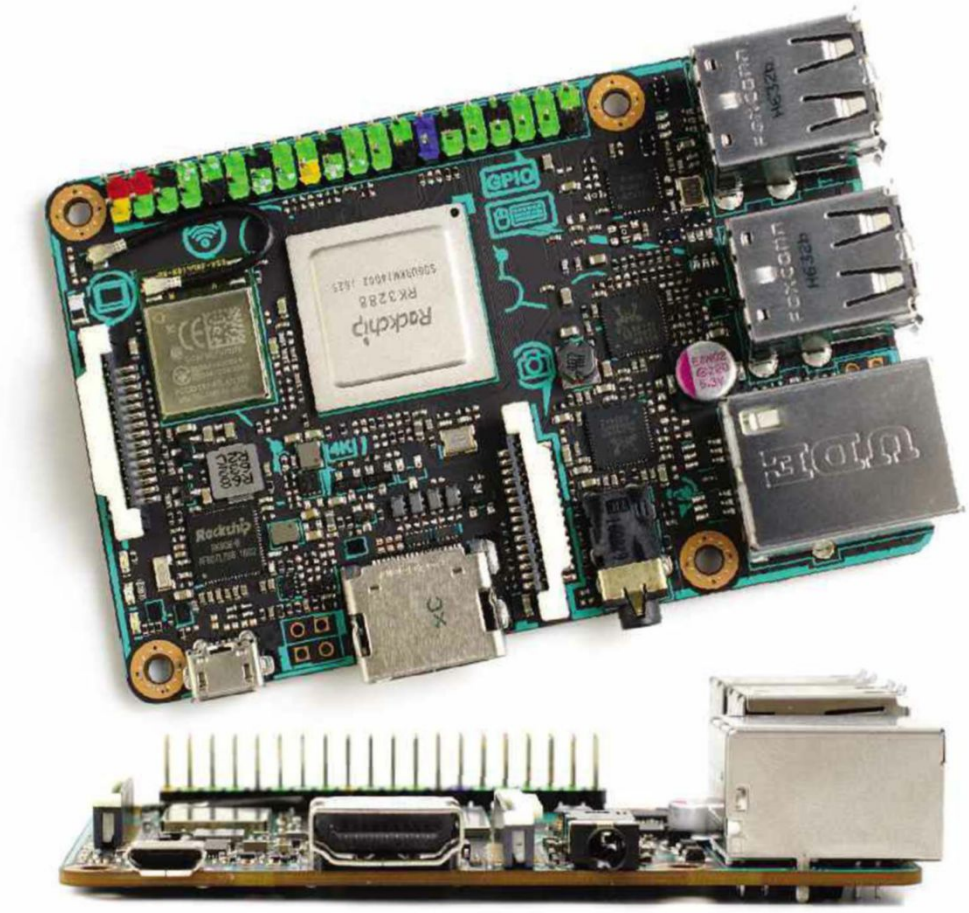
The success of the Raspberry Pi came out of nowhere. Nobody, not even the Raspberry Pi Foundation itself, could have predicted it selling in such numbers. Following its success, though, it's no surprise to find rivals popping up from all quarters.

Asus' entry follows a familiar template: in layout and functionality, the Tinker Board is a near-perfect clone of the Raspberry Pi 3, right down to the 40-pin general-purpose input-output (GPIO) header, four USB ports, and connectors for CSI and DSI peripherals.

Having copied the layout of the Raspberry Pi closely enough to fit in any third-party case, Asus' team turned their eyes to an area where they felt comfortable competing: specifications. The Tinker Board boasts a 1.8GHz processor to the Pi 3's 1.2GHz, albeit using the older 32-bit ARM Cortex-A17 cores rather than the new 64-bit Cortex-A53; the memory is doubled to 2GB; the graphics processor has the ability to decode H.264 and H.265 video at resolutions up to 4K; the audio is upgraded to support 24-bit 192KHz playback; and the Ethernet port is upgraded to Gigabit and given a dedicated channel to the processor, rather than sharing a single USB channel as on the Raspberry Pi.

On paper, then, the Tinker Board should easily best the Raspberry Pi in most ways. In raw speed terms, that's certainly the case: it completed the SysBench CPU benchmark in 31 seconds to the Pi 3's 49, despite the older CPU cores, while the Linpack benchmark – compiled to take advantage of ARM's Neon accelerator instructions, present in both the Raspberry Pi 3 and Tinker Board's processors – reached 1,325 million floating point instructions per second (MFLOPs) to the Pi 3's 459 MFLOPs.

Sadly, outside raw CPU performance the Tinker Board begins to flounder. The operating system, a mildly modified version of Linaro Linux 8.5, feels barely finished, and the GPIO port itself is functional only in the most basic of ways – and at that only by using libraries, RPi.GPIO and Wiring Pi, ripped from the Raspberry Pi community and modified to allow them to run on non-Pi hardware.



ABOVE **Asus designed the Tinker Board to fit in the same chassis – and with the same connectors – as the Pi**

There are more fundamental problems, too. The supposed "Gigabit" Ethernet port connects at full speed but is hobbled by a bottleneck, pushing its actual performance down to 89.6Mbits/sec – no better than the 10/100 port of a Raspberry Pi, despite its direct connection to the CPU. Even then, a mistake in either software configuration or the board's hardware means it generates a random MAC address on each reboot – preventing the board from being given a static address via DHCP reservation or being properly tracked in a managed network environment.

Even the 4K video playback support, a major string in Asus' bow, failed to operate properly during testing: while 720p resolution videos would play back perfectly, anything at higher resolutions was a juddering mess even when running Asus' own build of the Kodi media centre software. Had it worked, the 4K support would only have been partial at best: Asus readily admits that everything aside from hardware-accelerated video is rendered at 1080p (Full HD) and upscaled.

The Tinker Board feels like reasonably mature hardware – the review sample is marked as Revision 1.2 – with alpha-quality software. The scant documentation available to early adopters includes the promise of features which simply don't yet exist, such as hardware pulse width modulation (PWM) for servo and motor control on the GPIO header, and no real sign of when such support might arrive.

Asus says that it's working to address this, with a raft of supporting and educational materials in the works. That's great, but I remember similar promises from others trying to break into this space – including VIA, which launched then abandoned its own APC range of single-board computers.

"If Asus can get the software up to scratch and provide enough community engagement, the Tinker Board has huge potential"

If Asus can get the software up to scratch and provide a similar level of community engagement to the early-years Raspberry Pi Foundation, the Tinker Board has huge potential. At present, though, it's simply not ready – and at £55 asks too high a premium over the Raspberry Pi 3. **GARETH HALFACREE**

SPECIFICATIONS

Quad-core 1.8GHz Rockchip RK3288 • Mali-T764 graphics • 2GB RAM • microSD slot with adapter • Gigabit Ethernet • 802.11n Wi-Fi • Bluetooth 4 • 4 x USB 2 • 40-pin GPIO • CSI, DSI, HDMI outputs • 3.5mm analogue audio • Linaro 8.5 Linux • 87 x 58.4 x 18.3mm (WDH) • 30g (excluding heatsink)

Misfit Phase

A stylish smart(ish) watch with some elegant touches, but its simplicity can lead to frustration

SCORE ★★★☆☆

PRICE From £138 (£165 inc VAT)
from misfit.com

ABOVE **Misfit offers a choice of straps, and you can mix and match depending on your outfit or activity**

With wearables, it seems you can either have the feature-packed or good-looking definition of "smart". The part of the Venn diagram where the two cross over is vanishingly small, especially when you add a third circle labelled "decent battery life". The Misfit Phase attempts to square this circle: a hybrid smartwatch that looks great and has six-month battery life.

The first thing you'll notice is that there's no screen, just hour and minute hands that tick around the minimalist circular face of the watch. There aren't even numbers, just lines and a tiny logo at the top. Two buttons adorn the right-hand side, but there's no crown to set the time, as this is handled by the accompanying app.

Our model came with a comfortable leather strap, but the shape of the lugs meant that no matter how tight I pulled the straps, the watch was never flush with my wrist. That's not a critical problem with no heart-rate monitor, but it's a quirk all the same. The leather version costs £185, a rubbery sports-strap edition £165, but both can track swimming.

The Phase is an activity tracker first and foremost. It tracks the number of steps you've taken and can tell if you're running as well. The latter is handy, but there's no GPS so the watch can't tell how quickly you ran a mile, just that you were moving faster than normal.

In fact, the watch itself won't really be telling you anything. The app does the heavy lifting, with no separate dial to see your steps directly from the watch. Instead, you can see how much of your daily activity target you've hit by tapping the top button, at which point the minute and hour hands jump around to indicate a percentage.

It's an elegant solution, but things fall flat when it comes to complicated phone interaction. That's the job of the second button, but by default it can only handle one kind of input at a time. The preset functions give you a choice between tagging a physical activity, playing music, taking a selfie and advancing presentation slides. The app does let you assign functions to double, triple and long presses, but some functions can only be assigned to a long press, and this kind of setup is just asking for mis-presses.

What of notifications? There are two ways the watch lets you know your phone wants attention. The first is that it vibrates, but as that could mean anything from an urgent text message to junk email arriving, the watch offers you a clue in the form of a colour-coded circle at the bottom of the watch face.

The idea is that you set a specific colour to a certain kind of notification, so you can immediately tell if the buzz relates to a WhatsApp message or a fitness notification. You can even assign a contact to a number on the face, so the hands will point to that number when they text or call. It's clever in theory, but I could never remember which colour corresponded to what kind of notification.

"The watch itself won't be telling you anything – the app does all the heavy lifting, with no dial on the watch to track your steps"

Perhaps more important, however, is that if I glance at an Apple Watch and see an email has arrived, I immediately know who it's from and can judge as whether to grab my phone and respond. With the Misfit Phase, I'm told it's an email, but I have no idea as to whether it's my girlfriend, manager or the lawyer of a late Nigerian prince.

Finally, there's sleep tracking. This is detected automatically based on movement, and Misfit breaks down your night into "awake", "light sleep" and "restful sleep". It did a good job of detecting when I was sleeping and correlating my night-wriggling to how well rested I felt – plus the six-month battery (a coin battery that's easy to replace) means no overnight charges.

Think about the problems you have with smartwatches right now, and the Misfit Phase ticks off almost all of them. However, this is a closer relative of the Fitbit Flex 2 than the Apple Watch. If you're after a basic fitness tracker, that isn't a bad thing. Just accept that when your watch buzzes it's time to pick up your phone for closer examination. **ALAN MARTIN**

LEFT **We were sent the leather strap version for review, but even this is suitable for swimming**

Your bonus software

We scour the globe to negotiate the best software deals for our readers, from extended licences to full programs you don't need to pay a penny for. Here's this month's lineup

Total value this month £144

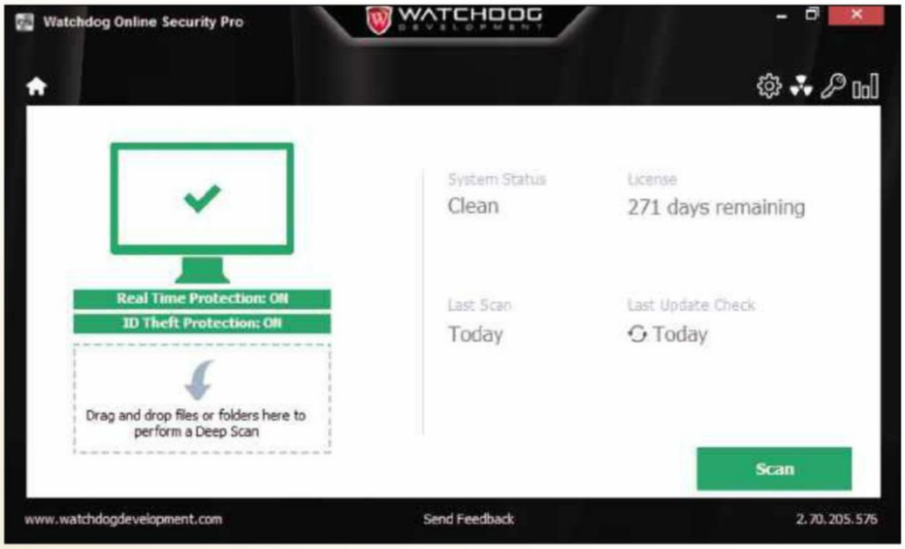
Watchdog Anti-Malware 2

- **12-month licence worth £22**
- **watchdogdevelopment.com**

THIS COMPREHENSIVE SECURITY TOOL uses multiple antivirus engines to detect threats that regular software might miss. It digs through your hard drive and, when it finds something suspicious, passes a fingerprint (not the whole file) to its cloud scanner for further analysis.

Once it's finished, it sends back its verdict – but you don't need to be a technical expert to decipher its findings. Simply cast an eye over the list of threats it's found, choose what to delete, quarantine or exclude, and then click to clean your system.

Watchdog Anti-Malware also offers real-time protection, so it can warn you about potentially dangerous files before they're executed, and runs a speedy "Smart Scan" when your system starts. If you don't need that level of protection, it can be tweaked to your requirements or disabled entirely in the Settings dialog.



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

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ABOVE If you've bought the Bonus Software edition of *PC Pro*, it will include this card between the current pages

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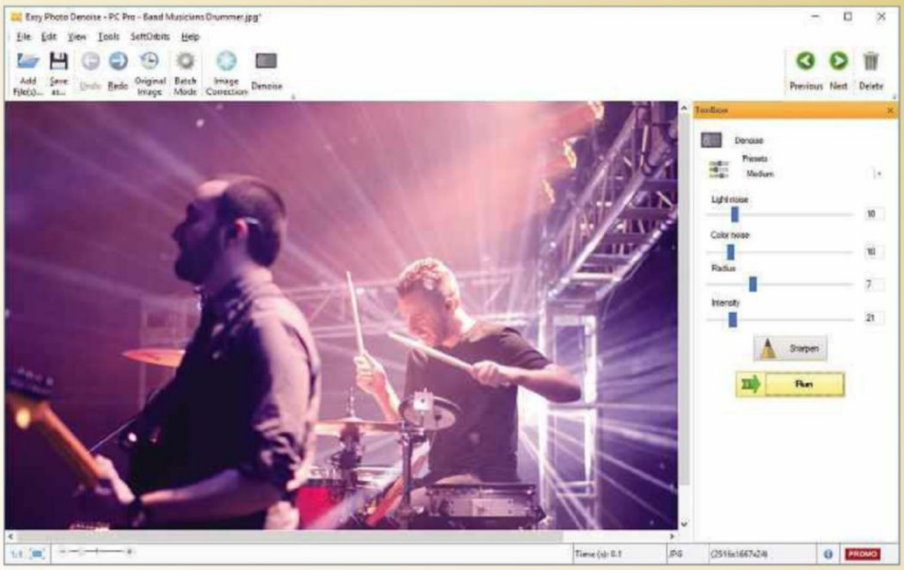
Easy Photo Denoise

- **Full product worth £49**
- **softorbits.com**

PHOTOS TAKEN IN LOW light tend to suffer from digital noise. Easy Photo Denoise removes the speckles without softening the details of your image. It can work with single files, or process a series of images with its built-in batch mode.

You can use default settings, or adjust the sliders by hand. The "Light noise" and "Colour noise" settings compensate for variations in brightness and colour, while Radius and Intensity adjust the strength of the filter.

There's also a host of touch-up features, including rotation, resizing, cropping, and adjustments for brightness, contrast, saturation, temperature, tint and gamma. Once you're happy with the results, you can output your cleaned-up picture as a fresh JPEG, or a range of other formats.



REQUIRES Windows XP or later; 50MB available hard drive space; in-application registration

Abelssoft AntiLogger 2017

- **Full version worth £16**
- **abelssoft.net**

REQUIRES Windows 7 or later; 20MB available hard drive space; in-application registration

- Detect and remove keyloggers, which can record everything you type and transmit it to unauthorised third-parties
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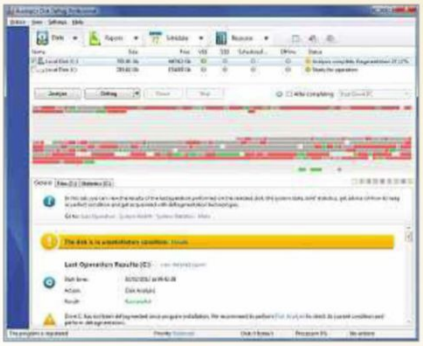
Auslogics Disk Defrag Professional 4.8



- **Full version worth £27**
- **auslogics.com**

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

- Optimise your hard disk, with a choice of algorithms for file access time, modification time and more
- Specify which files should be written to the fastest part of your drive for peak performance
- Defragment individual files, folders or complete partitions; can also be run before Windows launches to optimise system files

iolo System Mechanic 16

- **Six-month licence worth £15**
- **iolo.com**

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

- Everything you need to clean and speed up your PC, fix system problems and protect your privacy
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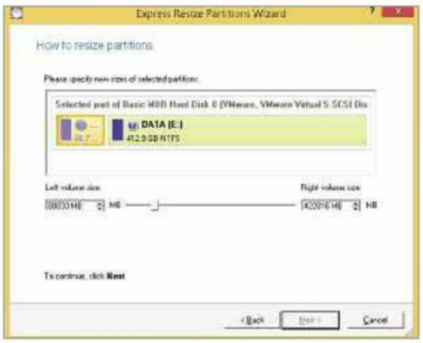
- AcceleWrite technology improves hard drive efficiency, while SSD Accelerator keeps solid state drives running at peak performance

Paragon Partition Manager 15 Home



- **Full version worth £15**
- **paragon-software.com**

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

- Rearrange partitions on your internal and external hard drives without losing your data
- Organise your files more conveniently by splitting large drives into multiple logical storage units
- Simplify the task of cloning a drive for complete backup
- Create a multi-boot system with a choice of operating systems

Creative Sound BlasterX Katana

A soundbar for Windows PCs? It may sound crazy, but you'll fall in love with the Katana's output

SCORE ★★★★★

PRICE £198 (£233 inc VAT) from morecomputers.com

Until now, soundbars have been associated with TVs. That's despite modern incarnations offering not only TV inputs but wireless streaming, Bluetooth connectivity and even USB playback. The Creative Katana offers an extra trick: it can be connected to a Windows PC through USB and even provides a line out/mic in for your headphones. Creative even describes the speaker's primary purpose as an "Under Monitor Audio System" (the not-so-catchy UMAS for short).

At £233 inc VAT, it's pitched up against some tough TV-focused competitors, including the Cambridge Audio TV2 (v2) at around £200. Creative packs in a lot for the price, though, including a subwoofer, a remote and two wall-mount brackets.

Its build quality and looks reflect that price, too. The brushed-aluminium design couples well with the RGB light strip under the speaker, making the Katana your go-to disco bar. The lighting can be customised through the Sound Blaster Connect for Windows application (Mac users must phone a friend), and while some might find it garish, I love the fluid transition of colours. And you can always just switch the lights off.

The Katana can be used as a standalone speaker – either via Bluetooth with your smartphone or a flash drive plugged into the USB Type-A port – but to get the most out of it, you'll need a Windows PC, connected via USB and controlled through the Sound Blaster Connect software. This is easy to use and offers a plethora of options. For example, it's possible to select preconfigured settings designed by professionals in the music, film and game industry, or quickly toggle settings.

The Sound section is the most interesting. Here, you can play around with effects such as Immersion, Crystalizer and Dialog Plus. you can also enable Dolby Digital sound. Through the Voice tab, you'll have the option to reduce background noise – a simple toggle, useful for those who plug their microphones into the soundbar. The app is also the place where you can fully customise the bar's RGB lights.

The Katana is a relatively small soundbar, since it's designed to sit under your monitor instead of a large TV. Don't let its size fool you, though: there are four drivers crammed inside – two upward-firing 2.5in mid-bass drivers and two front-facing 34mm tweeters – plus a 5.25in driver found in the separate passive subwoofer.

The soundbar includes a multi-core digital signal processor (DSP), which controls three separate amps with a total output of 75RMS/150W peak power. Impressively, that proved capable of delivering large-room sound without distortion.

The Katana supports 24-bit 96kHz audio through its Dolby Digital decoder (only via PC connection), and when connected via optical or USB it doubles up as a sound card, bypassing the audio processing on your computer. Connected to a PC with Creative's software, you can even enable virtual 7.1 surround sound.

This bar does have its limitations, though. In "neutral" mode and with bass set to +2 (it can be adjusted from -4 to +4 depending on your preferences and room), I found the Katana capable of producing great sub-bass frequencies, where the lows extend well; the downside was that it cut off the lower sub-bass regions. Given the small size of the subwoofer and driver (5.25in), this shouldn't come as a surprise.

Its mid-bass has fantastic control, and explosions in movies and gunfire in games are accurate and not too bloated. However, due to the relatively small size of the drivers, you don't get the thumping feeling you do with other speakers, such as the Cambridge Audio TV2 (v2).

Lastly, the Katana delivers an expansive soundstage that can be further widened using Creative's software. I always look out for instrument separation in speakers, especially soundbars, as there's a tendency for them to sound congested and jumbled. This is where the Katana shines, providing an immersive sound that doesn't jumble frequencies. This comes down to the DSP-controlled amplifier, which assigns the right frequencies to the five drivers and handles the crossover between them.

ABOVE Meet the first soundbar explicitly designed for sitting under a monitor rather than a TV

"Its brushed-aluminium design couples well with the RGB light strip, making the Katana your go-to disco bar"

PC PRO RECOMMENDED

There's little here to fault; my main criticism is the price, which is considerably more expensive than the more refined Cambridge Audio TV2 (v2). However, the Creative Sound BlasterX Katana is still a great soundbar and much more flexible than the TV2. For keen gamers who want something flexible for movies and music as well, it's a great buy. **CHRISTOPHER MINASIANS**

SPECIFICATIONS

2.1 soundbar plus subwoofer • remote control • multi-core DSP • 75RMS/150W peak power • digital 5.1 audio via optical in • virtual 7.1 audio via Windows PC • optical in • Bluetooth 4.2 • AAC and SBC codec support • USB Type-A • 600 x 79 x 60mm (WDH) • 1.5kg • 2yr RTB warranty

BELOW Not a fan of the colours beaming out? Fear not, they can be switched off using the software

pcspecialist

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- 500GB Hard Drive
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- 3 Year On Site Warranty

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Epson WorkForce WF-3620DWF

If you're not worried about printing photos, this is the perfect home or small-office all-in-one

SCORE ★★★★★

PRICE £79 (£95 inc VAT) **from** amazon.co.uk

We're not fans of throwaway printers at *PC Pro*: rather than be lured in by the false promise of £50 inkjet multifunction printers (MFPs) that plague supermarket shelves, we think it's better to invest in a high-quality printer with affordable ink cartridges.

The Epson WorkForce WF-3620DWF is exactly such a printer. It's equally well suited to a home office as it is a demanding household, to support a mixed output of photos, letters and homework.

It's also one of Epson's best-value inkjet MFPs. It's already cheap at £95 inc VAT, but until at least the end of March 2017 it comes with a free three-year warranty and a £20 cashback offer, which transforms it into something of a bargain.

That's perhaps a reflection of this product's age because – unusually for something we review – it's been around for a couple of years. This is our first opportunity to test the WF-3620DWF, though, and we were pleasantly surprised by what we saw.

First, you'll be immensely relieved to hear it includes a fax modem, because you just never know when the 1980s might get in touch. It's also equipped with wired and wireless networking, plus duplex print, scan, copy and faxing. There's a 35-sheet automatic document feeder (ADF), and USB, SD and Memory Stick slots, so you can scan to or print from an inserted device – the only obvious omission is direct PDF printing.

Epson claims a 20,000-page-per-month duty cycle, which is reflected in the sturdy 250-sheet input and 125-sheet output trays, while the scanner lid sits on beefy hinges that extend to cope with thicker books or stacks of documents. The design isn't perfect, however: opening the WF-3620DWF's scanner lid flips open the dust cover on the single-sheet special media slot at the rear.

The WF-3620DWF uses a combination of touchscreen and physical buttons, but it's not entirely idiot-proof. The screen can take time to register touches, and the layout of the top level of the menu baffled me for a minute. There is one very welcome addition, however: unlike its predecessor, the WF-3620DWF supports multitasking, so you can scan a document while it's busy printing or vice versa.

I wouldn't expect blistering speed at this price, but the WF-3620DWF is fairly quick. Tested over a wired network connection, it reached 17.4 pages per minute (ppm) when printing black text, and almost 5.4ppm on our far more complex colour graphics test. Photographs aren't this printer's forte, though: it delivered one 6 x 4in print every two-and-a-half minutes, and quality isn't up there with HP's similarly priced OfficeJet Pro 6960.

Photocopies are quick: a single mono copy took 13 seconds, while using the ADF to copy ten pages took less than a minute and a half. In colour, the equivalent tests took 17 seconds and two-and-a-half minutes. Scans were fast, too, with a 300 dots-per-inch (dpi) capture of an A4 sheet needing only nine seconds, and a 1,200dpi scan of a 6x4in photo taking 33 seconds.

The quality of those scans is impressive, even by Epson's high standards; the results are unusually sharp and display an excellent dynamic range. Prints and photocopies are also very good, if not perfect: colours lack saturation, and draft-quality text was very faint.

ABOVE **Available with a £20 cashback until the end of March, this is a bargain machine**

PC PRO A-LIST

"You'll be relieved to hear that the WF-3620DWF has a fax modem, because you never know when the 1980s might get in touch"

The WF-3620DWF takes XL-rated colour inks, which last for 1,100 pages each, and an XXL black cartridge that's rated for 2,200 pages. Using these, running costs work out at a competitive 6.1p per A4 page of mixed text and graphics. Epson has stopped estimating the page life of the additional maintenance box that catches waste ink in WorkForce printers, but based on earlier models it's likely to be tens of thousands of pages, and costs less than £20 to replace.

The WF-3620DWF performs well, has some great features, and is reasonably cheap to buy and run. It's not ideal for photographers, and the interface takes a little getting used to, but it's a near-perfect MFP for home or small-office use, and a cut above the cheap MFPs you'll find on the supermarket shelves. In particular, it has an edge over its closest OfficeJet rival from HP thanks to its longer-lasting cartridges and that attractive cashback offer. **SIMON HANDBY**

BELOW **The XXL black cartridge is rated for 2,200 pages**

SPECIFICATIONS

4,800 x 2,400dpi A4 inkjet • 2,400 x 1,200dpi colour scanner • claimed 33/20ppm mono/colour printing • 6.8cm touchscreen • 802.11n Wi-Fi • 10/100 Ethernet • USB 2 • fax modem • SD card slot • 250-sheet input tray • 35-sheet ADF • duplex • Epson Connect software • 1yr RTB warranty • 449 x 417 x 243mm (WDH) • 9.7kg

Serif Affinity Photo

At last, a serious and powerful rival to Adobe Photoshop – and for a fraction of its price

SCORE ★★★★½

PRICE £41 (£49 inc VAT) **from** affinity.serif.com

There can be few Adobe Photoshop CC subscribers who don't look at that steep fee leaving their account every month and wonder if there's a cheaper alternative out there. Until recently, the search for competent alternatives would have drawn a blank. But the arrival of the £49 Affinity Photo on Windows changes everything.

If you're thinking £49 per month still sounds teeth-suckingly steep, relax. This isn't a monthly subscription but a one-off fee: cheaper than a mere three months' worth of Photoshop. Can something so inexpensive really compete with Adobe's industry standard? Yes, yes it can.

Pick a persona

At first tilt, Affinity Photo appears to be something of a crossbreed of Lightroom and Photoshop, offering different stages of workflow (Develop, Photo, Export etc) as "personas", whilst offering the full editing capability of Photoshop.

Open a raw photo in Affinity and you'll be thrust into the Develop persona, where you can make a series of adjustments to your file. There are sliders for tweaking exposure, saturation, vibrancy and other tonal parameters; tools for applying lens correction and vignettes; plus options to boost the sharpness of the image and apply noise reduction. Largely, the same tools you'll be used to from Adobe's Camera Raw importer.

Once the raw photo has been "developed" it moves into the Photo persona, which is roughly akin to Photoshop's default editing workspace. Immediately, you'll notice that the strip of available editing tools down the left-hand side of the screen is populated with familiar names from Adobe's behemoth: crop, selection tools, healing brushes, dodge and burn, mesh warp. So far, so familiar.

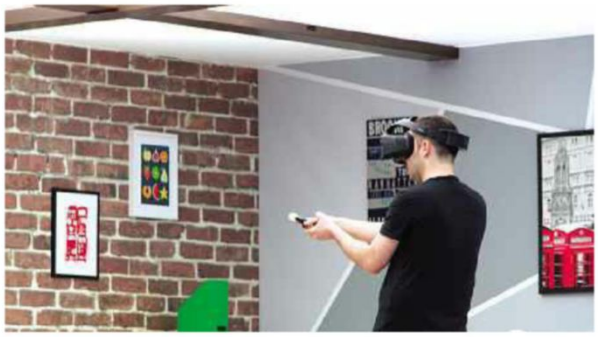
There, are, however many subtle differences in the way tools and filters are applied in Affinity Photo versus the way they are in Photoshop. Take the dodge and burn tools. To burn some extra fury into dark clouds, for example, Affinity Photo provides a live preview of the burn effect when you hover the brush over the affected area, giving you a chance to adjust the strength of the effect without having to apply and undo an edit. The same is true of most brushes.

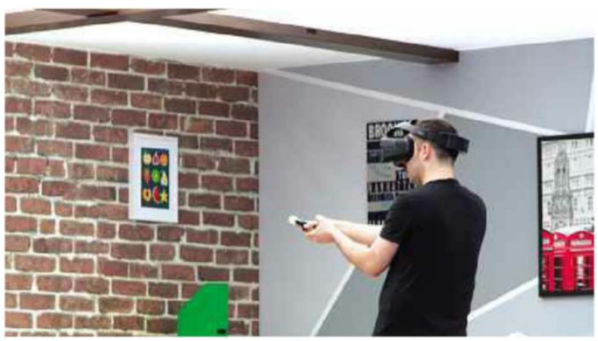
Then there's the live filter layers. Instead of applying filters to the whole image, filters can be added as layers. This means you can apply a depth of field filter (mimicking the effect of using a wide aperture in-camera) and switch that layer on or off, making it a totally non-destructive edit.

Talking of which, I'm a big fan of the way Affinity Photo lets you scroll back and forth through the history of your edits. As with Photoshop, there's a History window that lets you jump back to any previous step of the edit. However, Affinity also includes a History slider that you can drag back and forth and return the image to a previous state, whilst watching a live preview of the changes in the editing window. It's extraordinarily slick.

ABOVE **Rather than apply filters to the whole image, you can do so to layers alone**

PC PRO RECOMMENDED





BELOW **Affinity's Inpainting tool allows you to brush objects, such as this poster, out of existence**

Power tools

Affinity's not short of power tools, either. Photoshop's Content-Aware Fill, for instance, is a great tool for photographers who want to remove a stray object or interlopers. Affinity has an equally powerful alternative called the Inpainting Brush Tool, where you simply brush over the item you wish to remove and it attempts to heal the background.

It performed admirably in several tests, including quite a tricky job of removing a painting from a brick wall background (*see below left*). There was some distortion on the brickwork, but nothing a little work with the clone brush wouldn't fix – and it didn't warp the shape of the bricks in the same way Photoshop did. As with Photoshop, the Inpainting tool is also available to stitch gaps in panoramas.

Other power tools include a superb HDR merge facility, which opens one of Affinity Photo's other personas – Tone Mapping. This provides fine control over the various tonal qualities and allows you to prevent that HDR effect from becoming too overblown. The Tone Mapping persona can even be used to give a convincing HDR quality to single exposures, adding punch in the highlights and shadows.

Many of these tools are difficult to master if you just wade in, but Serif has published a large Vimeo library of video tutorials (**pcpro.link/271aff**), which diligently walk you through all manner of advanced techniques.

The final step in Affinity Photo's workflow is the Export persona,

which offers a wide selection of formats to save your photos in. These include the usual suspects of JPEG, PNG and TIFF, plus PSD for continuing to work in Photoshop and other Adobe applications, and esoteric options such as 32-bit Radiance for HDR photography.

However, we were a little bemused by the Save dialog itself. Even when exporting as JPEG, this describes the file type as "Affinity Files" – fear not, the image is saved to disk in the correct format.

Laptops beware

If there's one fly in the ointment, it's performance. Affinity Photo seems to lean much more heavily on the graphics chip than Photoshop, so if you're relying on integrated graphics, as I was on my test laptop, you're going to suffer significant lag.

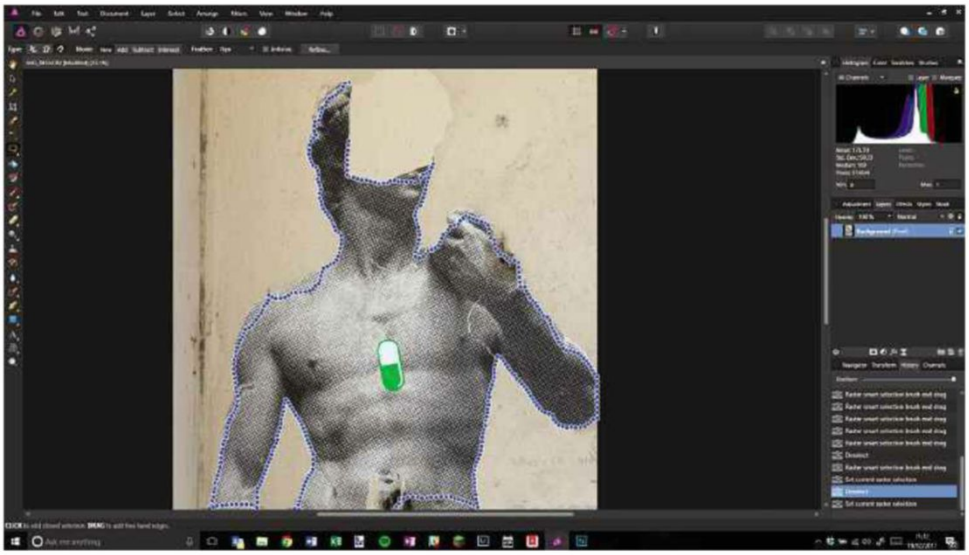
It's far from unusable, but even on my Core i7-6600U ThinkPad with 16GB of RAM, I found myself waiting ten seconds or so for a raw file to open in the editor and over a minute for HDR merge to complete with three raw images.

Photoshop CC 2017 is, by comparison, a gazelle on the same system, with the same photos ready for editing in a second or so, and no significant wait when processing or exporting single images, as there was with Affinity. Given that many photographers tote around a laptop for on-the-job editing, that's a significant black mark for the usurper.

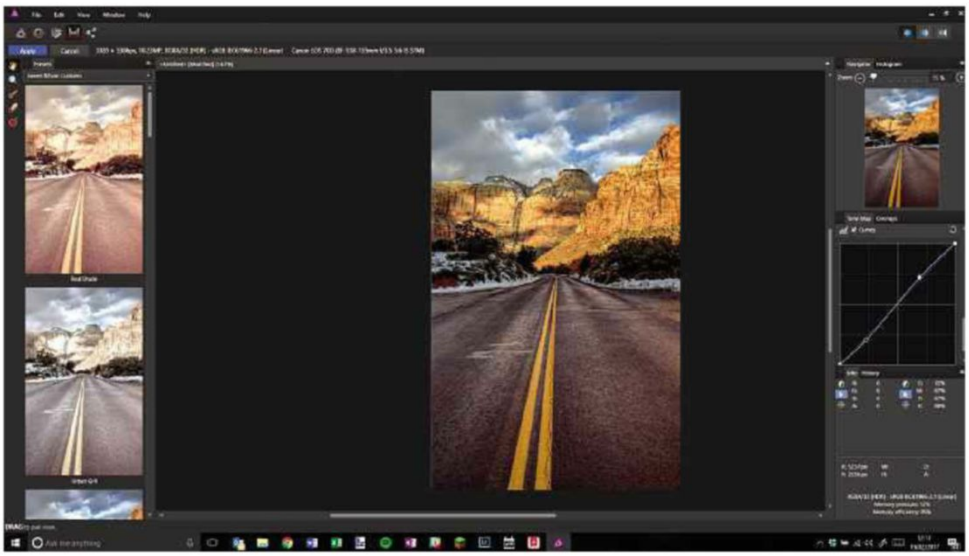
Even still, when you consider the range of features you're getting for less than £50, many photographers may well conclude that it's a compromise worth making. For photography enthusiasts who crave Photoshop-like power but can't justify the subscription fee, Affinity Photo is a no-brainer. It will even give professionals some serious pause for thought. **BARRY COLLINS**

REQUIREMENTS

Windows 10, 8, 7; OS X 10.7.5 or later • 2GB RAM (4GB recommended) • DirectX 10-compatible graphics or above



ABOVE Affinity's "Magic Wand" Selection Brush automatically detects edges and more



BELOW One of Affinity's greatest strengths is its versatile HDR merge facility

£800 PCs shootout

Chillblast Fusion Arrow

SCORE ★★★★½

PRICE £667 (£800 inc VAT); free delivery from chillblast.com

Chillblast's Fusion Arrow makes a statement right away with its striking purple trim; turn it on and colour-matched LEDs glow through the front fan and windowed side. If purple isn't your thing, you can switch it for red, green, blue or a bold white design, but we rather like it as is.

This compact case is well appointed, with three USB ports at the top (one of which supports SuperSpeed USB 3), twin audio jacks and an SD card reader. Round the back, the Asus H110M-A motherboard offers an additional pair of USB 3 connectors, plus four USB 2 sockets and twin PS/2 connectors for anyone still wedded to an ancient keyboard.

It's powered by a 3GHz Core i5-7400 processor, built on Kaby Lake architecture, but the technical improvements in Intel's latest chips are largely to do with power consumption rather than performance. In our desktop benchmarks, the Fusion Arrow achieved an overall score of 101, indicating it's effectively no faster than a Haswell-era Core i5-4670K. Still, this is a very powerful computer that will leave almost any laptop in the dust.

It's also a capable gaming machine. The supplied 3GB Nvidia GeForce GTX 1060 graphics card won't whizz through the toughest games at 4K, but its performance at 1080p impressed us. In *Metro: Last Light Redux*, with all detail settings set to high, it kept up a slick 53fps. That represents enough power to keep you gaming for several years to come.

One point worth noting, though, is that the Fusion Arrow comes with "only" 8GB of DDR4 memory. That's plenty for almost any modern workload, but there are no spare DIMM slots. Finally, storage comes in the form of a 250GB SATA SSD and a 1TB Seagate data drive. It's an unremarkable provision, but there's an M.2 slot on the motherboard if you want to upgrade later.

The Fusion Arrow isn't a groundbreaking PC, but it comes with the best warranty here and has enough power to eat up desktop applications and games alike.

KEY SPECS 3GHz Intel Core i5-7400 • 8GB RAM • GeForce GTX 1060 graphics • 250GB SATA SSD • 1TB hard disk • 5yr RTB warranty (first 2yrs C&R) • 195 x 375 x 390mm (WDH)

"While the Enigma K2's specs are similar to the Chillblast, the machine itself is physically quite different"

PC Specialist Enigma K2

SCORE ★★★★★

PRICE £667 (£800 inc VAT); free delivery from pcspecialist.co.uk

PC Specialist's £800 PC follows a similar blueprint to the Chillblast, partnering a Kaby Lake Core i5-7400 processor with an Asus H110M-R motherboard. This is basically identical to the H110M-A, so you get the same set of connectors at the back, and the same internal expansion options.

One difference worth noting, however, is the lack of an M.2 connector. To be fair, the 240GB Kingston SATA SSD does a fine job of keeping Windows 10 running smoothly, and it's supplemented by a 1TB WD hard disk.

It's also worth noting that the H110M-R, like its brother, has only two DIMM slots. In this case, however, they come populated with a pair of 8GB modules, adding up to a generous 16GB of DDR4. That should be enough to accommodate the most demanding workloads you encounter during the life of this PC. The extra RAM doesn't make a difference to everyday computing, though: the Enigma K2 achieved an overall score of 102. That's functionally identical to the Chillblast, and indeed to mid-range systems from previous generations, making this a strong rather than exceptional performer.

It's the same story when it comes to gaming: with a 3GB Nvidia GeForce GTX 1060 once again sitting pretty in the motherboard's sole PCI E x16 slot, high-detail 4K gaming is out of reach. Stepping down to 1080p, though, saw a tasty average frame rate of 50fps in *Metro: Last Light Redux*, with all visual settings dialled up to maximum.

While the Enigma K2's specs are similar to those of the Chillblast, the machine itself is physically quite different. The Cooler Master K350 case is taller, deeper and squarer, not to mention more imposing. Unlike the Chillblast, it will take an internal optical drive. Note that it offers only two front-facing USB ports – one USB 2 and one USB 3.

Such minor matters are easy to look past, though. The Enigma K2 offers all the same core strengths as the Chillblast save for the M.2 slot, and it doubles the memory, making this a more complete all-rounder.

KEY SPECS 3GHz Intel Core i5-7400 • 16GB RAM • GeForce GTX 1060 graphics • 240GB SATA SSD • 1TB hard disk • 1yr RTB warranty (30-day C&R) plus 2yr RTB (labour only) • 200 x 450 x 415mm (WDH)

If you're looking for a new system but don't want to pay a fortune, Darien Graham-Smith has four great contenders on review

Wired2Fire Diablo Ultima v2

SCORE ★★★★☆

PRICE £667 (£800 inc VAT) plus £24 delivery from wired2fire.co.uk

PC PRO RECOMMENDED

In its unassuming Corsair 88R case, the Diablo Ultima v2 isn't the most attractive system here, but it's what's inside that counts. And Wired2Fire pushes the boat out with a Core i5-7600 – a significantly faster chip than its rivals, with a core speed of 3.5GHz and a maximum Turbo frequency of 4.1GHz.

In our benchmarks, this drove the Ultima v2 to an excellent overall score of 124. If you need hardcore multitasking capabilities then there's still nothing to match a Core i7, but for everyday workloads this CPU will rarely disappoint.

It's backed up with 16GB of RAM, and Wired2Fire has also managed to stick an Intel 600p SSD in the M.2 socket. From this we measured sustained read speeds of 1,398MB/sec – almost three times the maximum rate you'll see from a regular SATA SSD, and fast enough to ensure that applications and documents open snappily. As a special treat, it's accompanied by a 2TB data drive.

"The Diablo Ultima v2 is a powerful and well-equipped PC that you won't need to upgrade for many moons – if ever"

The catch? To fit all this good stuff in, Wired2Fire has compromised on gaming performance, supplying a 2GB AMD Radeon RX 460 graphics card that's a significant step down from the GTX 1060 cards found elsewhere. In our 1080p *Metro: Last Light Redux* benchmark, the Ultima v2 averaged a juddery 18fps: we had to disable anti-aliasing to get it up to a playable 34fps, and drop the detail level to medium for a smooth 63fps. It's fine for casual gaming, but don't expect all the visual treats.

There are a few additional bonuses: the Asus Prime B250M-K motherboard offers four USB 3 sockets at the rear, as well as two USB 2 ports, and Wired2Fire also throws in a PCI-E 802.11n Wi-Fi card. Clearly the Diablo Ultima v2 isn't such a balanced system as its rivals, but if application performance is your priority, then it's a powerful and well-equipped PC that you won't need to upgrade for many moons – if ever.

KEY SPECS 3.5GHz Intel Core i5-7600 • 16GB RAM • Radeon RX 460 graphics • 256GB M.2 SSD • 2TB hard disk • 802.11n Wi-Fi • 2yr RTB warranty (30-day C&R) plus 1yr RTB (labour only) • 198 x 448 x 378mm (WDH)

Yoyotech Warbird RSG1

SCORE ★★★☆☆

PRICE £667 (£800 inc VAT) plus £15 delivery from yoyotech.co.uk

The Warbird RSG1 is taller and shallower than your typical desktop PC, but the mesh-wrapped Aerocool QS-240 case is certainly eye-catching. It also offers three front-facing USB ports, which we're always happy to see.

Internally, the Intel Core i5-7400 makes another appearance, as does the 3GB Nvidia GeForce GTX 1060. Together, these deliver the performance you'd expect: the Warbird RSG1 achieved a score of 101 in our tests, precisely on par with the Chillblast.

In fact, in our gaming test, Yoyotech's system managed to pull slightly ahead of its competitors, with an average of 54fps in *Metro: Last Light Redux* at 1080p and maximum detail settings. Perhaps that's thanks to its superfast 3,000MHz DDR4 RAM – but it's not a big enough difference to get excited about.

What sets the Warbird more decisively apart from its peers is the MSI B250M Pro-VDH motherboard. This offers six USB ports at the rear, including three regular USB 3 sockets and one USB Type-C port – a connector that's growing in usefulness. There's also an internal M.2 connector, should you wish to upgrade the storage, but you'll have to get your screwdriver out to access it as it's tucked away behind the graphics card. If the supplied 8GB of RAM isn't sufficient for your needs, the board also offers two spare DIMM slots.

While this is all good to see, Yoyotech provides a mere 120GB SSD as its system drive. That's not a comfortable amount of headroom for a system that will – we very much hope – last you at least three or four years. Yes, it's partnered with a mechanical drive for your documents and personal data, but at 1TB that's not particularly generous either.

Otherwise, the Warbird RSG1 has plenty going for it – but once you start loading up on applications and games we can foresee housekeeping becoming a regular chore. If you're taken by the overall concept, we recommend you skip this base configuration, and pay an extra £27 for a 240GB SSD – or, consider the £896 configuration that comes with a much faster 256GB M.2 drive.

KEY SPECS 3GHz Intel Core i5-7400 • 8GB RAM • GeForce GTX 1060 graphics • 120GB SATA SSD • 1TB hard disk • 1yr RTB warranty (30-day C&R) plus 2yr RTB (labour only) • 209 x 372 x 419mm (WDH)

Cloud backup

We put ten of the most popular cloud backup services to the test to help you decide where you should store your irreplaceable data

We all know the importance of backing up our data, but it's easy to find excuses not to do it. Setting up an external drive or NAS box, for example, is an expense and a hassle.

However, the modern generation of cloud backup services make the job effortless. Getting started is as easy as downloading and installing a lightweight client – and then sitting back, secure in the knowledge that your files are being continuously replicated to a remote data centre. You can download copies whenever you need them, and the off-site approach means they're safe even if your home is hit by a fire or burglary.

Of course, not all cloud backup services are the same. Depending on who you go with, you'll pay differing amounts for different allowances of online storage. Performance may vary, with some systems taking much longer to back up and restore files than others. Features can make a difference, too: for example, some clients will let you set up multiple backup sets, and duplicate your backups to a local drive for easy restoration, while others keep things as simple as possible.

We've put ten of the biggest cloud backup services to the test, to help you find one that's worth entrusting with your precious data.

Contents

6 questions to ask before buying cloud storage

Buying the wrong cloud storage service could be costly in both how much it costs and the time it takes to unpick the mess

1 How much storage do you need?

Let's reframe the question: what do you actually need to back up? This may be a lot less than you imagine: even if your hard disk is nearly full, a lot of that space will be taken up by Windows and program files, not to mention miscellaneous downloads and temporary files that don't need to be archived for the ages. Carry out an audit of what really needs protecting and you may find it's just a gigabyte of documents and spreadsheets.

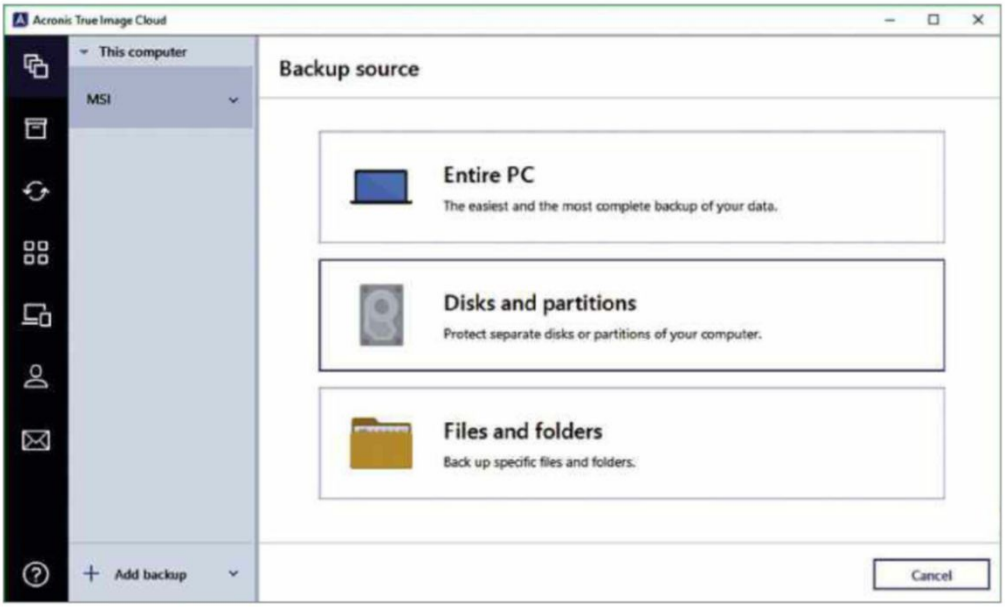
It's worth thinking about whether you want to include music files and photos in this audit, since these are likely to take up the lion's share of your personal storage. If your songs were bought from iTunes or a similar service, you can normally redownload them for free in the event of a crash. Alternatively, you can use free cloud services such as Google Play Music and Google Photos to store backup copies of your songs and pictures. That said, always read the small print: uploaded files may be compressed or transcoded, so they won't retain the full quality of the originals.

And don't be too discriminatory about what gets backed up. It's easy to think of backup services primarily as protection against system failures, but they can also provide a safety net when you delete a file that seems unimportant at the time, then later realise you need it after all. But for that to work, you need to start by backing up all the files that don't, at the time, seem useful.

ABOVE If you want to protect a household of computers, look for one subscription that covers them all

In all, we'd recommend an inclusionist approach. If there's any doubt in your mind as to whether an item should be backed up, play it safe and include it in your audit. Then, pick a cloud backup option with plenty of room for this, plus all the updates and new files you're going to make in the foreseeable future. Since this may well be hard to estimate, you might be tempted to go for an unlimited-storage option – although you can save money by picking a service with a fixed quota.

"In all, we'd recommend an inclusionist approach: if there's any doubt as to whether an item should be backed up, play it safe"



BELOW Acronis True Image 2017 stores the most recent 20 versions of a file

2 What devices should you protect?

In this month's Labs, we're focusing on personal backup services, which are mostly aimed at single users. That often means you pay a monthly or annual fee to back up files from a single PC or Mac. Under a licence like this, if you want to back up a second system, you'll normally need to pay for a second subscription.

If you want to protect a whole household full of computers, it's a good idea to look instead for a service that covers them all under one subscription. These services typically come with fixed storage limits, because if they were to offer unlimited uploads from five or ten PCs, the sheer quantity of data would be cost-prohibitive to store.

What if you want to back up the contents of an external drive? As our feature table overleaf shows, some providers will count a USB hard disk as just another drive and back it up under a single-PC licence; others see this as an additional service. Similarly, if you want to back up a NAS drive, you may well find your regular service doesn't cover it, which is fair enough if you're talking about multiple terabytes of data, but a bit annoying if it's just a few folders.

Most cloud backup services also offer dedicated smartphone apps for Android and iOS. Some of these only let you browse and download files that have been uploaded from the desktop, but others let you back up downloads, photos and other items from your phone.

3 How many file versions?

Backup isn't just about recovering files that have been deleted. On occasion, you may need to turn back the clock and access an older version of a file, before it was edited and all the useful information about x was replaced with more up-to-date information about y.

Most cloud backup services will automatically detect when a file has been updated, and will keep a copy of the old version alongside the new one. Exactly how this is handled varies

from service to service: some offer a time-limited rollback period, while others retain a set number of versions. For example, Acronis True Image 2017 automatically stores the most recent 20 versions of a file, ready to be recovered with a click.

Very few services will store unlimited file versions, though – so if you want to be sure of not losing potentially useful data, it's a good idea to get out of the habit of repeatedly updating and overwriting old files. It's far safer to rename them in some self-explanatory way (for example, add "2016 version" to the end of the filename), then copy their contents into a new file and work from that.

4 Continuous or scheduled backup?

Traditionally, it's been considered good practice to run backups to a fixed schedule: a business, for example, might typically run a big central backup job in the middle of the night, when no-one's around to be impacted by the increase in network activity and server load.

For personal cloud backup, however, continuous backup is the norm: in other words, when you edit or save a file, you can expect it to be backed up right away, or at worst within an hour. This makes a lot of sense as the most common file types are pretty small and can normally be sent up the line in a matter of seconds, meaning you get very good protection with little or no impact on your computing experience.

However, there may be situations in which continuous backup isn't appropriate. For example, you might be working with very large files, and not want to tie up your connection with constant uploads. Or, you might be making lots of little edits all day that you don't want to count towards your versioning limit.

In this case, a nightly or weekly backup run might make sense – or you might even prefer your software to launch a backup only when manually triggered. As you'll see from our feature table overleaf, most systems let you control scheduling, but some are more flexible than others.

5 Do you need hybrid backup?

As we detail to the right, one of our tests this month involved timing how long it took to restore files from each of the cloud backup services. Most providers let us download our files at close to the full speed of our internet connection. But if your line is slow, you could still be left waiting around for hours to recover critical files.

If you're concerned about long restoration times, the answer could be hybrid backup. That sounds like enterprise jargon, but it simply means simultaneously backing up to both the cloud and a local destination such as an external hard disk or NAS appliance. This means that when you need to recover files from your archive, you can get them from a local source rather than having to download them over the internet.

ABOVE Continuous backup is the norm because most of the common file types are small

"Hybrid backup ensures that you'll be able to get at your backed-up files, even if your internet connection goes down"

If you need to restore multiple gigabytes of data, the speed advantage can be huge.

There's another benefit to hybrid backup too: it ensures that you'll be able to get at your backed-up files, even if your internet connection goes down or your cloud provider goes out of business. Certain cloud backup services include hybrid backup features. However, if yours doesn't, there's nothing stopping you from installing a basic free backup tool and setting it to make local backups in parallel with your chosen cloud client.

6 What about data security and encryption?

Many cloud backup services are based in the US, so unsurprisingly that's where your data gets stored. In all cases it's encrypted at rest, so you don't need to worry too much about an opportunist hacker getting into the system and rifling through your personal emails and so on.

Note, however, that by default the encryption key is held by the backup operator. They could be legally compelled by the powers that be to decrypt your data and hand it over. Or, in the case of a major security breach, a dedicated hacker could theoretically even get their hands on the key and thus unlock your private information.

These scenarios seem very unlikely, but if you're wary of the US authorities, you may feel happier choosing a provider whose servers are in a different locale. For absolute peace of mind, several services also let you specify a custom encryption key which is never seen by the operator (the encryption and decryption are handled locally on your PC). This makes it effectively impossible for your data to leak from the data centre – but it puts a big responsibility on you to take care of the key, because no-one in the world can get your files back if it's lost.

How we rate the products

Each of the backup products on test this month is awarded a star rating out of five. In determining this score, we start by fully exploring the user interface and features: we're looking for a client that's easy to use and offers a good range of useful configuration options.

Next, we test the speed of each product. For details of how we do this, and the results, see p91.

Finally, we consider value for money, in light of each product's features and performance, and how much cloud storage is included in the price. All of these considerations are factored into the overall score.

	RECOMMENDED			LABS WINNER						
	Acronis True Image 2017	Backblaze	Carbonite	CrashPlan	IDrive	Livedrive	MozyHome	Norton Online Backup	SpiderOak One	SugarSync
Overall	★★★★☆	★★★★☆	★★★★☆	★★★★★	★★★★☆	★★★★☆	★★★☆☆	★★☆☆☆	★★★☆☆	★★★☆☆
Website	acronis.com	backblaze.com	carbonite.com	crashplan.com	idrive.com	livedrive.com	mozy.co.uk	uk.norton.com	spideroak.com	sugarsync.com
Data centre location	User-selectable	USA	USA	Not stated	USA	UK	UK	Not stated	USA	USA
Free trial	30 days	15 days	15 days	30 days	5GB free service	14 days	None	30 days	21 days	30 days
Personal plan from: [1]	£30/yr per PC, 50GB	$50/yr per PC, unlimited storage	$60/yr per PC, unlimited storage	$60/yr per PC, unlimited storage	$52/yr, unlimited devices, 1TB storage	£5/month per PC, unlimited storage	£55/yr per PC, 50GB	$49/yr for 5 PCs, 25GB	$5/month, unlimited devices, 100GB	$7.49/month, unlimited devices, 100GB
Business plan from: [1]	£60/yr per PC, 1TB	$5/TB/month	$270/yr, unlimited PCs, 250GB total storage	$10/month per PC, unlimited storage	$75/yr per PC, 250GB storage	£15/month, up to 5 PCs, unlimited storage	£110/yr, unlimited devices, 10GB storage	N/A	$12/month, unlimited devices, 1TB	$55/month, 3 PCs, 1TB
Desktop platforms	Windows 7, 8, 10, Home Server 2011; macOS 10.9 or later	Windows XP, Vista, 7, 8, 10; macOS 10.6 or later	Windows 7, 8, 10; macOS 10.6 or later (Plus and Prime packages for Windows only)	Windows 7, 8, 10, Server 2008, Server 2012; macOS 10.9 or later; Red Hat Linux 7.1 (64-bit) or later; Ubuntu 14.04 (64-bit) or later	Windows XP, Vista, 7, 8, 10, Server 2003, Server 2008, Server 2012; macOS 10.8 or later	Windows Vista, 7, 8, 10; macOS 10.8 or later	Windows Vista, 7, 8, 10; macOS 10.6 or later; see website for Linux options	Windows XP, Vista, 7, 8, 10; macOS 10.6 or later	Windows XP, Vista, 7, 8, 10; macOS 10.8 or later; Debian/Fedora/ Slackware Linux	Windows 7, 8, 10; macOS 10.6 or later
Mobile platforms	Android 4.1 or later; iOS 8 or later (restore only)	Android 4 or later (restore only); iOS 8.1 or later (restore only)	Android 4 or later; iOS 8 or later (restore only)	Android 3.2 or later (restore only); iOS 7 or later (restore only)	Android 4 or later; iOS 9 or later	Android 4.1 or later; iOS 9.3 or later (restore only)	Android 2.2 or later; iOS 7 or later	None	Android 4 or later (restore only); iOS 8 or later (restore only)	Android 1.6 or later; iOS 7 or later
Features										
Back up external drives?	✓	✓	With Plus service ($100/yr per PC)	✓	✓	✓	✓	✓	✓	✗
Hybrid backup (to local media)	✓	✗	Business plans only	✓	✓	✗	✓	✗	✓	✗
Restore files from web	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Custom encryption key	Optional	Optional	Optional	Optional	Optional	✗	Optional	✗	✓	✗
Two-factor login	✗	Optional	Optional	✗	✗	✗	✗	✗	✗	✗
Cloud sync	✓	✗	✗	✗	✓	✗	✗	✗	✓	✓
Backup schedule	Continuous /daily/ weekly/monthly/ manual	Continuous/daily / manual	Continuous/daily	Continuous/daily	Continuous	Hourly/daily	Idle/daily/weekly	Automatic/daily/ weekly/monthly/ manual	Continuous/daily	Continuous
Multiple backup sets	✓	✗	✗	✓	✗	✗	✗	✗	✗	✗
Versioning	20 versions	30 days	30 days	Adaptive	10 versions	30 versions	90 days	✗	Unlimited	5 versions
Other major features	Explorer integration, clone disk, rescue media builder	Find missing PC, email alerts	Explorer integration	None	Explorer integration, disk image backup, script access for Linux	None	Explorer integration	None	Explorer integration	Explorer integration
Support options for home users	Live chat, email, UK phone (chargeable)	Email	Email	Live chat, web form, US phone	Live chat, web form, email, US phone	Web form	Live chat, web form	Live chat, UK phone	Email	Email, US phone (chargeable)

1. All UK prices include VAT

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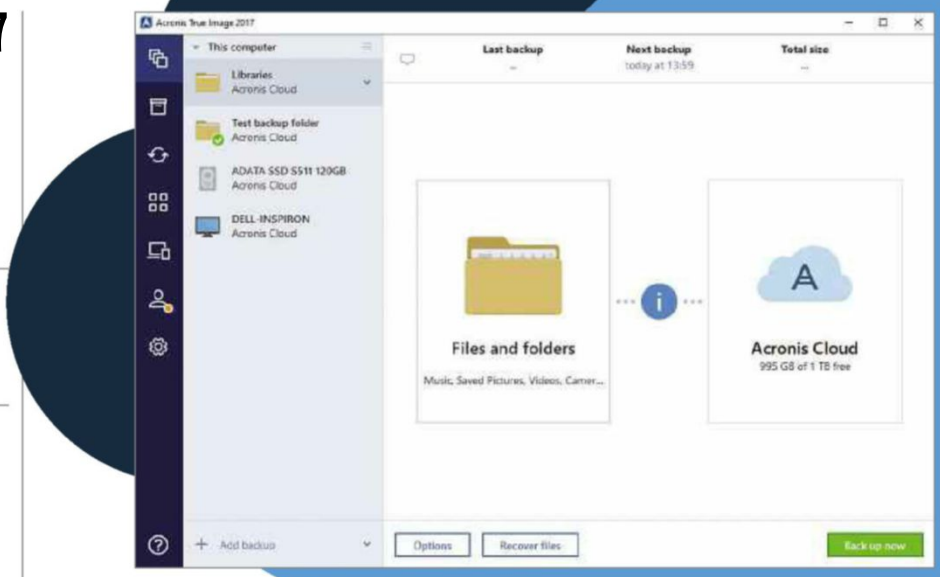
Acronis True Image 2017

Far more than just a cloud backup agent, this feature-packed data-protection suite is in a class of its own

SCORE ★★★★☆

PRICE From £30/yr per PC, 50GB from acronis.com



We've been fans of Acronis True Image since long before "the cloud" came along. While this latest release fully embraces remote backup, it doesn't ditch the flexibility and features that made it a favourite back in the days of tape drives. Depending on your needs, you can buy it as a standalone backup client, with no cloud component, for a one-off fee of £35.

The more modern option, however, is Acronis' personal subscription service, starting at £30 per year. This gets you the full client – and updates while your subscription remains current – and 50GB of cloud storage.

That may look a bit mean next to the unlimited quotas of Carbonite and CrashPlan, but if you have only a small amount of critical data to protect, it's cheaper in absolute terms. Upgrade options are affordable, too: a 500GB account will cost you £44 a year, or you can step up to 1TB for £60 a year. The top tier offers a gargantuan 5TB, at an annual cost of £180.

Accessing your cloud storage is simple. When you launch the True Image client software, Acronis Cloud is automatically selected as your default backup location, and a non-stop backup of your personal files begins in the background. We were impressed by how fast this happens: although Acronis wasn't quite as fast as Carbonite or MozyHome, it backed up our 5GB of data in a respectable 2hrs 14mins. With this done, a click on the "Recover files" button directed us to the Acronis website, from where we were able to redownload a Zip archive of all our files in a superfast 19 minutes.

While non-stop backup makes sense for critical data, alternative scheduling options include daily, weekly, monthly or manual backups – or you can configure Acronis to run a backup job whenever you log on, log off, restart or shut down your PC. Furthermore, there's an option to set the backup only to run when the computer is idle, and disable sleep/hibernation to ensure your uploads don't get cut off.

For those who like to take control, there's a whole bunch of additional advanced features. You can set up email notifications, to provide confirmation of completed jobs; change the backup process priority, to balance network usage against backup speed; and – uniquely among the clients we've tested – select a cloud destination from a variety of data centres in different countries. This means that if you're not comfortable with your data being stored in the US, you can choose to have it kept in the UK, Switzerland, Singapore or a variety of other locales. You can also optionally provide your own encryption key, to ensure that Acronis can't access or share the information you upload, even if asked to by government authorities.

One capability that sets True Image 2017 apart from almost all of its rivals is its support for multiple backup sets. You can define dozens of different jobs, each with its own files and folders, its own security settings, its own schedule and even its own destinations – so you can, for example, keep a secondary backup of critical files on a local hard disk or NAS box, for high-speed disaster recovery.

You can also carry out periodic backups of your entire PC, or even upload an image of an entire disk or partition, separately from your regular backup regime. A handy rescue media builder lets you create a bootable USB flash drive or CD, so you can restore your entire system from either local media or the Acronis Cloud in the case of a catastrophe.

ABOVE We were able to redownload a Zip archive of all our files in a mere 19 minutes

PC PRO RECOMMENDED

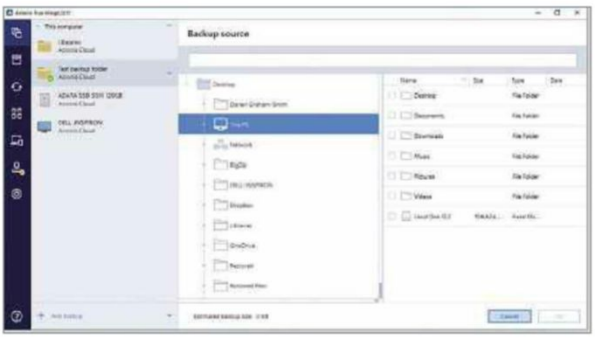
True Image Home 2017 isn't really intended for corporate environments – businesses are advised to buy the professional Acronis Backup 12 suite and add Acronis Cloud services as needed. Those working from home, however, may be tempted to upgrade to a Premium subscription: starting at £70 per year with 1TB of storage, this adds a trio of data-protection tools to the suite. Acronis Active Protection steps into antivirus territory by monitoring your system for ransomware-like activity, as well as automatically recovering files that have been maliciously encrypted.

"Uniquely among the clients we've tested, you can select a cloud destination from a variety of data centres in different countries"

Meanwhile, the Acronis Notary and ASign services use blockchain technology to archive document checksums and digital signatures, allowing you to establish with certainty that a file was in a certain state, and acknowledged by certain parties, at a specified date – which could be useful for resolving legal or business disputes.

If we had to criticise True Image 2017, we'd point out that its interface could be clearer: buttons and menus aren't always where we'd expect to find them, and there's too much reliance on cryptic, unlabelled icons. And if you've multiple terabytes of data to protect, there are certainly more cost-effective options.

Still, when you look at Acronis' performance, and the tremendous range of data-protection features it offers, it's an appealing package for anyone who values their data.



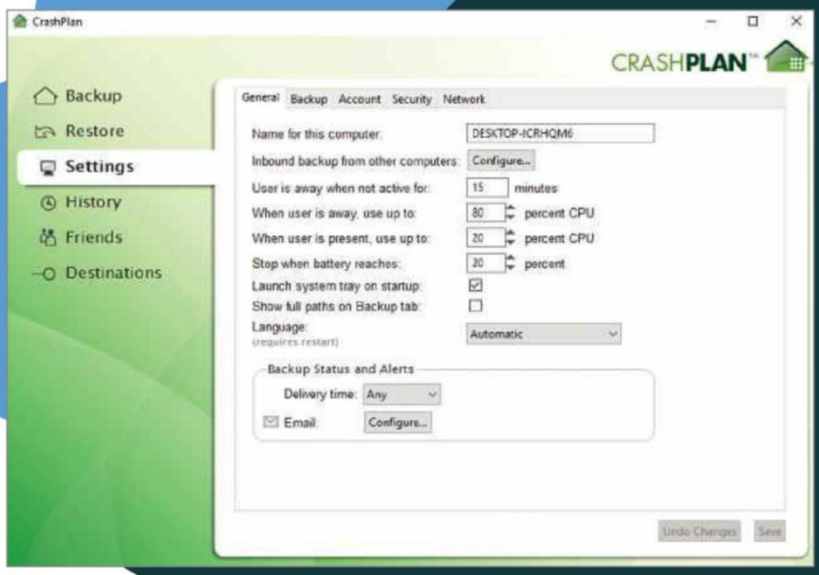
BELOW What sets True Image 2017 apart from nearly all of its rivals is its support for multiple backup sets

CrashPlan

This seemingly cheap and cheerful service offers a rich range of features – and great backup performance

SCORE ★★★★★

PRICE From $60/yr per PC, unlimited storage from crashplan.com



ABOVE **CrashPlan offers granular control over the client's CPU usage**

There are a few other welcome options. You get nice granular control over the client's CPU usage, both for when your computer's in use and when it's idle. You can also switch between continuous and scheduled backup, and use wildcards to exclude files from backup – although, since your storage is unlimited, it's hard to see why you'd bother, unless you're generating gigantic files that will bottleneck your network connection.

There's a good range of security options, too. You can password-protect the application itself, to prevent unauthorised users from accessing your download settings, and optionally specify your own backup encryption key. If you do this, you can choose whether to share it with CrashPlan or keep it secret: the latter option provides unbreakable data security, making it impossible for anyone to decode your backed-up data – something you might welcome, since CrashPlan coyly doesn't reveal the location of its data centre. But, as with all backup services, if you keep the key private and then manage to lose it yourself, you're sunk.

Like Acronis True Image 2017, CrashPlan also elevates itself above the crowd with its support for multiple backup sets. From the one client, you can have specific files and folders backed up to the cloud according to one schedule, while a second backup job runs at different times, moving another set of files to a range of destinations.

This brings us to another of CrashPlan's strengths. In addition to CrashPlan's own servers, and your own local and network drives, you can also upload your (encrypted) data directly to a friend's computer. This is a simple way to gain an additional offsite backup without paying a penny – assuming that your friend doesn't bill you for the storage. As long as CrashPlan is running on both computers, getting set up is as easy as sharing the unique six-character code that's generated by the program, then configuring your backup task as usual.

"In addition to CrashPlan's servers, and your own local and network drives, you can upload your (encrypted) data to a friend's computer"

BELOW **Uploading to a friend's computer is as simple as sharing the code shown in the client software**

Along with the standard home-user licence, CrashPlan offers a business-level "Pro" service, costing $10 per device per month. It's a very similar service, but with centralised management, which allows the administrators to remotely configure and update clients, as well as initiate backups, monitor resource usage and enforce policies.

While the basic formula of cheap, unlimited storage is hardly unique to CrashPlan, the package is more rounded overall than its rivals. Your subscription even includes telephone support – although you'll want to keep an eye on your phone bill, since you'll be calling the company HQ in Minneapolis. It may still not be quite as feature-packed as Acronis, but if you've got a substantial archive of data, CrashPlan is an impressively versatile and cost-effective way to keep it safe.

Backblaze

A low-cost cloud backup system that's endearingly simple – though it's not particularly fast or flexible

SCORE ★★★★☆

PRICE From $50/yr per PC, unlimited storage from backblaze.com

Backblaze's headline offering is the same as CrashPlan's, namely unlimited cloud backup for $5 a month. In fact, if you pay for a year upfront, it's cheaper than CrashPlan, coming in at just $50.

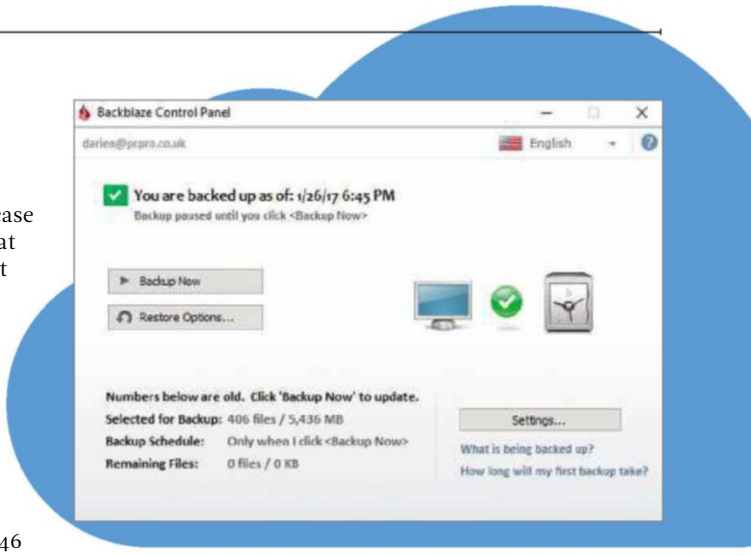
The philosophy is very much "set-and-forget": simply point Backblaze at a hard drive and it will start continuously backing up almost everything it finds, meaning you don't need to fiddle about configuring complicated backup parameters or schedules. Generously, external drives are backed up, too.

That said, there aren't many advanced options to configure. You can throttle bandwidth and CPU usage, as well as optionally specifying a private encryption key for unbreakable security. It's also possible to use the Backblaze web interface to track the geographic location of a registered client, in case it's lost or stolen – a nice touch that could spare you from having to set up a separate anti-theft system.

Backblaze does come with a few caveats, the first of which concerns performance. Our 5GB test folder took 4hrs 35mins to upload to Backblaze's American data centre, making it one of this month's slowest services. File recovery was on the sluggish side, too: we had to wait 46 minutes for our data to come back down the line, while other services supplied it in less than half that time. However, if you're in a screaming hurry to restore a lost file, Backblaze will send you an external drive containing your selected files by next-day international courier. Naturally, this service certainly isn't cheap, costing $99 for a 128GB USB flash drive, or $189 for a 4TB external hard disk.

You should also be aware that Backblaze isn't a full-system recovery solution. While the software takes a liberal approach to file types and locations, it won't back up your OS and application files. It's also not a long-term archival service, as files that are deleted from your system are purged after 30 days. If you're using Backblaze to back up external drives, this means you'll need to ensure your media is connected at least once a month to prevent those files from dropping off the system.

If those limitations don't put you off, though, Backblaze is worthy of your consideration. While it's not the fastest or most comprehensive way to get back on your feet when disaster strikes, it's admirably straightforward, and for annual customers it's the cheapest unlimited deal around.



ABOVE **Backblaze may not be the fastest option, but it's very easy to use and reasonably priced**

Carbonite

The first unlimited cloud service, but the basic package struggles to compete on features

SCORE ★★★★☆

PRICE From $60/yr per PC, unlimited storage from carbonite.com

Carbonite is the original all-you-can-eat cloud backup service, and the basics work just as you'd expect: once installed it continuously backs up most user files, including documents, spreadsheets, email archives and music. If you prefer a more structured timetable, you can configure a single daily backup at a specified time, or specify quiet hours so Carbonite doesn't interfere with your working day.

One distinctive feature of Carbonite is its Explorer integration. Adding items to your backup is a simple case of selecting them in Windows Explorer, then right-clicking and selecting "Back this up" from the Carbonite contextual menu. A coloured blob should then appear overlaid on the file's icon: green means safely backed up, orange means awaiting upload.

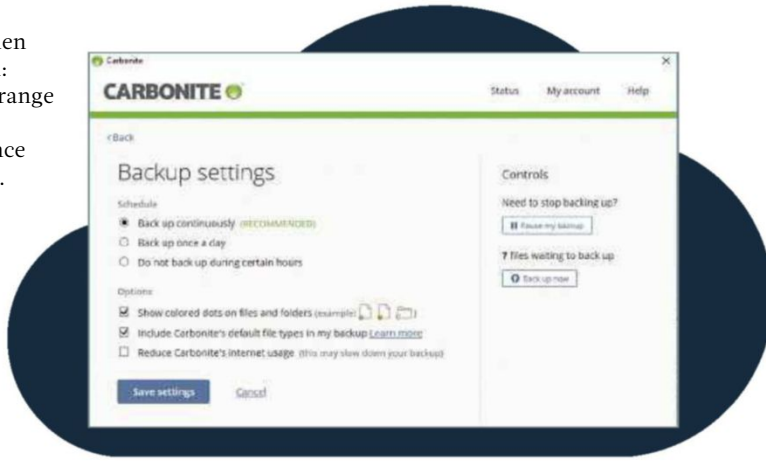
It's a great way to see at a glance what's backed up and what isn't. Unfortunately, if you're already using another utility that uses icon overlays (such as Dropbox or OneDrive), you might find the dots don't appear. This isn't Carbonite's fault – it's a limitation in Windows – and it can be fixed with a Registry tweak, but it's still an unwelcome speedbump.

Carbonite put in a good performance in our backup test, beaming our 5GB of personal files up to the cloud in just 1hr 32mins – faster than any of the competing packages. Restoration was less impressive though; we waited 52 minutes for the same files to come back down the line, while some clients managed the same feat in under 20 minutes.

Carbonite has some other limitations to be aware of, too. The regular edition of the software won't back up files stored on external drives – that capability comes only with a $100-per-year Carbonite Plus subscription, which also adds the ability to create a recovery image of your entire system.

There's no option to mirror your backed-up files to local media for quick access either, and weirdly video files aren't automatically backed up unless you shell out for a $150 Prime subscription. If you live in the US this tier might have its appeal, as it also includes a courier recovery service for speedy restoration of large archives – but that isn't available in the UK, making the deal a very poor one indeed for us Brits.

What Carbonite does it does well, and we're big fans of the icon overlays – when they work. At the end of the day, though, it's hard to recommend when CrashPlan offers greater flexibility at the same price.



ABOVE **By default, Carbonite backs up continuously, but you can take control of the schedule yourself**

IDrive

A well-equipped multi-device backup service, but we hit big problems with performance

SCORE ★★★☆☆

PRICE From $52/yr (£41), unlimited devices, 1TB storage from idrive.com

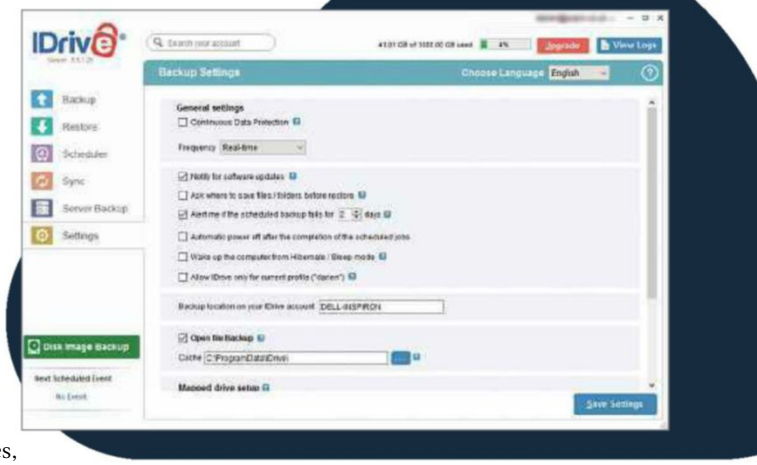
While most cloud backup services restrict you to one PC, IDrive supports unlimited devices. The trade-off is a fixed storage quota, although we doubt many individuals will be seriously constrained by the standard one-terabyte allocation.

To help you make the most of your space, IDrive doesn't automatically select what's going to be backed up and what's not. The client opens with a list of personal data folders, which you can customise to your heart's content. Continuous backup is enabled by default, or if you prefer you can set your backup to run at certain times and on certain days. It involves a little back-and-forth, but you can define multiple backup jobs to run at set times, and back up files to both the cloud and local destinations.

IDrive can also automatically synchronise files across linked computers, like Dropbox but with a much greater storage allowance. And there's a built-in Disk Image Backup wizard, which can create a complete copy of your system drive in case of disaster – although this must be saved to a local drive, rather than being directly uploaded to the cloud.

While IDrive ticks a lot of boxes, it sure wasn't a winner in our performance tests. Our 5GB folder backup completed in a respectable, if not superfast, 3hrs 10mins, but restoring it was another story. Across repeated attempts and different devices, we found the archive consistently took more than 18 hours to download, at a glacial average speed of around 80KB/sec.

We raised the issue with IDrive technical support, but after a round of diagnostics were told that nothing could be done. To quote its report: "... we will not be able to increase or decrease the speed from our end. The connection speed largely depends on the number of inter connections and the routing hoops that exist between your network and IDrive Server." When we put the service to the test in a different location, with a different ISP, results did indeed improve, albeit not enough to challenge our winners. If nothing else, this emphasises how important it is to try a service yourself.



ABOVE IDrive enables continuous backup by default, but you can set it to run at certain times and on certain days

Assuming it does work for you, and note you can always sign up for the free 5GB account, there's much to like about IDrive (indeed, IDrive Business is our recommended choice for larger businesses; see a separate review on p97). As a personal cloud service, however, it's up against tough – and, in our tests, faster – competition.

Livedrive

A fairly minimal service that offers decent backup performance, but doesn't quite stack up on value

SCORE ★★★☆☆

PRICE From £5 per month per PC, unlimited storage from livedrive.com

Livedrive is yet another lightweight backup client offering unlimited cloud storage. It's a bit more expensive than rivals, but you might appreciate not having to commit on a yearly basis.

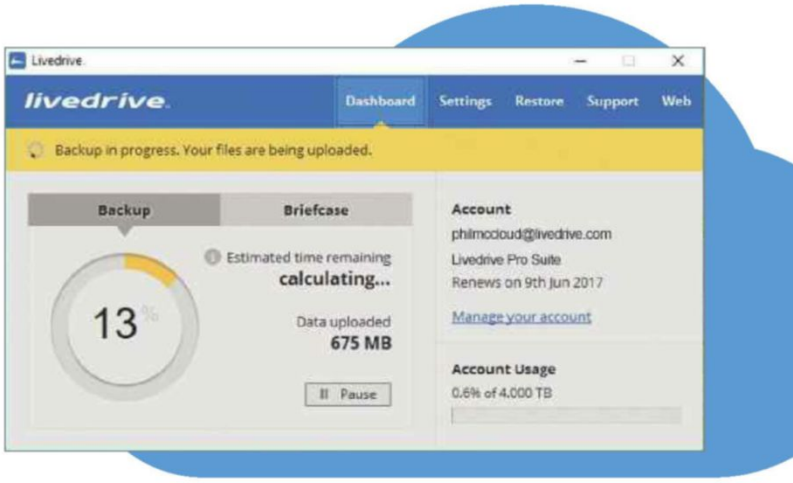
Getting started is easy. You can select folders to be backed up by drilling down a directory tree in the main console; external drives can be added as well as internal ones – although USB flash drives aren't supported – and up to 30 older versions of updated files are retained.

It's also a decent performer: our 5GB folder of personal data was backed up in 2hrs 18mins, which isn't bad at all, and when we hit restore, the files came back down the line in 33 minutes. It probably helps that the data doesn't have so far to travel as it does with other backup systems: Livedrive's datacentre is located here in the UK.

In light of recent legislation, if you're worried about privacy, that may not be a good thing, and it's worth noting that Livedrive doesn't support custom encryption keys, so there's no way to ensure that the company can't access your files. You can however password-protect the client itself, so that intruders can't mess with your backup regime.

When it comes to advanced features, there's not much on offer. You can adjust the frequency of backup runs, but your options are limited. You can either tell Livedrive to upload new files at a fixed interval, ranging from one to 48 hours, or launch a backup every day at a set time. Network throttling is available too, but the configuration options are similarly basic: there's no scheduling element, so you can't set uploads to be slow during the day and fast at night.

The client also invites you to set up your Livedrive Briefcase – a Dropbox-type service that automatically synchronises your files across multiple PCs. This requires a separate subscription costing £10 a month. That's not necessarily a bad deal, as it gets you a whopping 2TB of storage, but we find it a little distasteful to see a paid product pushing additional services.



ABOVE Livedrive restored our files in 33 minutes, probably helped by the data centre's UK location

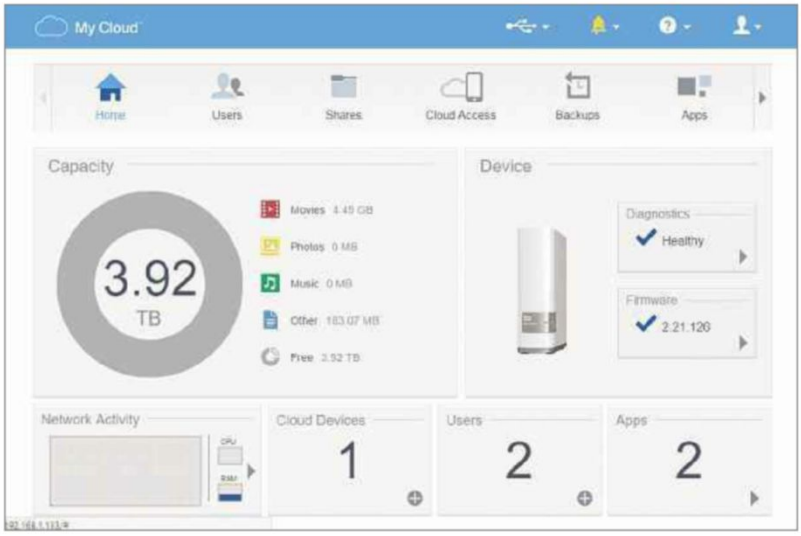
Livedrive handles the basics perfectly well, but it's a stripped-down solution that lacks features such as multiple backup sets, hybrid backup to local devices and custom encryption. Even if you don't need those features, it's also more expensive than its direct competitors, so we'd suggest you look elsewhere.

Build your own personal cloud

If you want to keep control of your own data, there is an alternative to cloud backup – we put two "personal cloud" boxes to the test

If you'd rather not get tied into a rolling subscription, you can always take the traditional route of backing up your data to a local device. Of course, this means your data will be at risk if (Heaven forfend) your house or office burns down, but if you buy a NAS appliance you may still have the ability to browse and access your files from anywhere in the world. This is often referred to as a "personal cloud".

There are other pluses to this approach. Because a NAS appliance lives on your local network, you can browse and restore old files at the full speed of your LAN connection, which will be many times faster than any internet service. There are plenty of options to choose from, with devices from the likes of D-Link, LaCie, Seagate, Synology and Qnap. We've gone hands-on with two such products to see how they stack up against pure cloud options.



RIGHT **Western Digital makes it easy to access files from any device**

WD MyCloud 4TB

£125 (£150 inc VAT) from currys.co.uk

Western Digital offers a range of MyCloud NAS appliances, in capacities stretching up to a mighty 16TB. We tried out the MyCloud 4TB, an unobtrusive unit no bigger than a regular external hard disk – although it naturally plugs into your router, via a wired connection, rather than directly into a client PC.

Alongside backup, you can use the MyCloud for regular file storage. The friendly, web-based setup routine guides you through the process of creating user accounts for everyone in your household, after which you can connect in the usual way (and optionally map a drive letter) in Windows Explorer.

"If you seek the very fastest transfers, and don't mind getting stuck into network settings, enable port forwarding on your router"

Backup duties are handled by WD's own SmartWare Pro package: despite the "Pro" moniker, this is lightweight software that backs up your chosen files either continuously or to a schedule. We found the interface fiddly and unclear (thanks to buttons that aren't obviously clickable until you hover the mouse over them), but you're not obliged to use it – any backup client worthy of the name will do the job just as well. And since everything only has to travel on your LAN, backup speeds are vastly quicker than any cloud service: we were able to back up our 5GB test folder in a mere 5mins 56secs.

RIGHT **The MyCloud 4GB is a sleek device, but consider getting the RAID-equipped MyCloud Mirror**

The MyCloud's key selling point is its personal cloud capabilities, which allow individual users to access their personal folders (and any others you've given them access to) from any computer, smartphone or tablet. Setting this up couldn't be easier: to connect, you simply generate a user-specific 12-digit access code from the MyCloud web portal, then enter it into the MyCloud mobile app for Android or iOS – or the MyCloud desktop app for Windows and macOS.

By default, your remote connection to the unit is relayed through WD's central server, so you shouldn't have any problems with firewalls. If you're seeking the very fastest transfers, and don't mind getting stuck into some network settings, enable port forwarding on your router and connect to the MyCloud device directly via your router's external IP address.

It's worth noting that not only does the MyCloud lack the reassurance of an off-site backup, it only contains a single drive – so if that disk suffers a mechanical failure, your data is gone for good. We suggest you step up to the twin-drive MyCloud Mirror, which uses RAID 1 mirroring to protect your files from exactly that danger. Inevitably, though, that's a bigger, more expensive unit, with the 4TB model coming in at £255.

It's also possible to add a further layer of protection using the MyCloud's built-in self-backup agent:

you can set it to automatically back itself up to a regular external hard disk, connected via the USB 3 socket at the rear of the unit. Or, most interestingly, you can configure it to regularly back up selected folders to a remote NAS device, located anywhere in the world – as long as it accepts remote connections and file transfers over SSH.

The MyCloud isn't the most fully featured NAS device in the world: the 4TB unit we tested will act as a streaming server for DLNA and iTunes clients, but it doesn't let you install third-party apps like Plex or WordPress. It's very easy to use, though, and for £150 it's good value: you can easily pay £100 for a basic USB hard disk in this size, so if you're looking for remote access, it's a tempting option.

Buffalo LinkStation LS520DE

£78 (£93 inc VAT) from amazon.co.uk

Where WD's MyCloud aims for simplicity, Buffalo's two-bay LinkStation LS520DE feels more techie-friendly. That starts as soon as you open the box: the unit comes unpopulated, so your first job is to screw a pair of 3.5in hard drives into the supplied caddies and clunk them into place. Once you've hooked it up to your router, your next port of call is Buffalo's NAS Navigator utility, which helps you locate the LS520DE on the network and view technical diagnostics.

From here, you can launch the web-based setup wizard, and things get a bit easier. You can choose to configure your two drives in striped, mirrored or JBOD configuration, although for backup purposes we strongly recommend mirroring: the other options let you use the full capacity of both drives, but if either one of the drives should fail you're almost certain to lose data. With this done, the device opens up its home screen: this looks a lot like a Linux desktop, which shouldn't be much of a surprise as the LinkStation runs a stripped-down Linux core. You can easily browse your files and shares, but there's plenty of technical information and advanced settings just a click or two away.

Buffalo's backup software of choice is NovaBackup 18: the LinkStation comes with a licence for up to five clients, but no entitlement to technical support. It's an ugly bit of software, but a highly versatile one. You can set up any number of custom backup sets, each running to its own schedule, as well as taking a complete image of your system and creating a bootable CD or USB flash drive for "bare metal" recovery, should the need arise.

RIGHT Buffalo's Linux-based interface might scare some but it's techie-friendly

Personal cloud functions are provided by Buffalo's WebAccess feature. This isn't a hosted service like WD's, but rather requires your router to forward incoming connections on a specified port to the LinkStation. Setting this up isn't as daunting as it may sound: if you don't want to choose a port yourself, and set up forwarding manually, you can enable UPnP and let the router sort it out.

BELOW Your first job is to populate the box with your own pair of 3.5in hard disks

Aside from that, you simply need to come up with a unique name for your LinkStation, such as MyNAS123. Once you've registered this within the LinkStation's settings page, you can visit buffalonas.com/MyNAS123 from any browser and be forwarded directly to your LinkStation. There are mobile apps for Android and iOS too, so you can browse and download files on the go.

When it comes to backing up the LinkStation LS520DE itself, there's a built-in backup app, but this will only back up from one local directory to another, or to a USB 3-connected external hard drive; there's no option to maintain an off-site copy of your files. What's more, while the interface is quite technically sophisticated, there's no way to install additional apps, so you can't easily install a more versatile backup agent.

All the same, if you're looking for a capable NAS that will let you get at your files from anywhere in the world, this is a cost-effective option – especially if you already have some suitable drives to populate it with. We'd feel happier if it had some sort of off-site replication option, but RAID mirroring goes a good way to reduce your risk of data loss.

Encrypted backup

When your most sensitive data resides physically inside your own home or office, it's easy to assume it's completely secure. Unfortunately, even if your data is encrypted at rest – which is certainly not something you can take for granted – resourceful burglars and opportunist hackers may still be able to get in, by taking advantage of insecure or saved passwords.

For the most sensitive files, therefore, your safest bet is to invest in a specialist device. Regular readers will have seen Davey Winder and Jon Honeyball write, in particular, of the iStorage datAshur Pro. This flash drive uses AES-256 encryption and is physically secured with a PIN, so it can't be accessed by anyone until the correct code is entered on its keypad. It's available in capacities up to 32GB, typically costing £100, so it makes most sense for data you can't afford to lose.

MozyHome

A fast backup service with a good set of features – but the storage allowance is too meagre for the price

SCORE ★★★☆☆
PRICE From £55/yr per PC, 50GB
from mozy.co.uk

The MozyHome front-end is tastefully compact, but click on Settings and a rich interface opens up. You can select which files to back up according to type rather than location, then easily add specific items and folders using the directory tree view – or by right-clicking in Windows Explorer and using the MozyHome contextual menu.

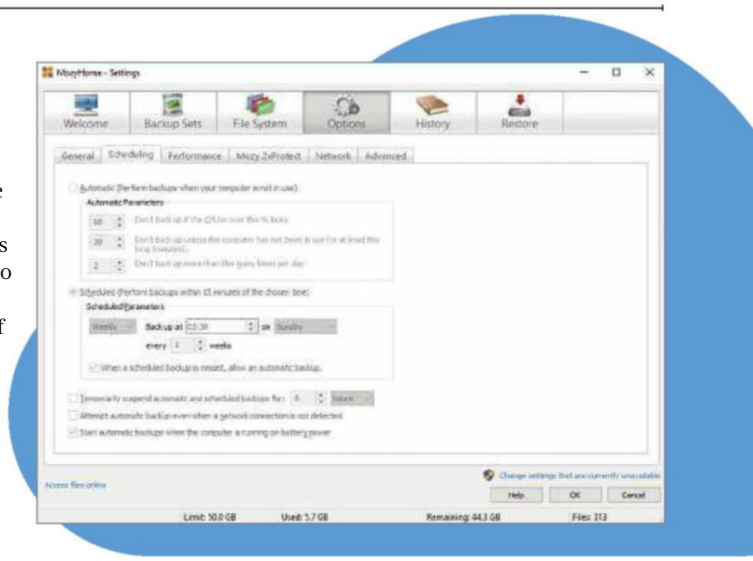
By default, backups run when your computer is idle, and you can specify what that means in terms of CPU usage and user input. If you prefer your backups to run at a set time, you can set a schedule from every day to once every seven weeks.

One nice feature is the "Mozy 2xProtect" option, which lets you mirror your cloud backups to a local volume for quick recovery. Using local media also extends your versioning options: MozyHome itself will store old file versions for 90 days, but you can make your local archive go back as far as you like. Of course, having to fall back on a local disk does somewhat undermine the point of paying for cloud storage in the first place.

This brings us to MozyHome's greatest weakness. Although the package itself works well, the pricing is terribly uncompetitive. The default 50GB storage allowance is tight – you could easily fill it up if you have a lot of old projects and images you want to keep safe – and the price is tough to justify when numerous alternatives offer unlimited storage for the same price or less.

It also seems unnecessarily mean that your subscription is tied to a single PC; the 125GB plan covers three computers, but that pushes the price up from £5 to £8 per month.

It's a shame, because we can't fault MozyHome's performance: as with Livedrive, the service offers a UK data centre that enabled us to back up our 5GB test folder in a swift 1hr 49mins, and download it again in 21 minutes.



ABOVE There's a rich range of features on offer if you want them

That's incredibly speedy. Unlike Livedrive, however, MozyHome allow you to specify a custom encryption key when you first set up your backup options. This ensures that, even though your data resides in the UK, it's impossible for the authorities to get their hands on it.

Unfortunately, whatever MozyHome's strengths, the pricing issue is inescapable. There are modest discounts for annual and two-year subscriptions, but even so you'll find much better value – and, in many cases, a comparable set of features – elsewhere.

Norton Online Backup

The agent-based approach is refreshing, and multi-PC support is nice too – but it has too many shortcomings

SCORE ★★☆☆☆
PRICE £40/yr for 5 PCs, 25GB
from uk.norton.com

Norton Online Backup doesn't have a local interface to speak of: all that's installed on your PC is a lightweight agent that runs in the background. Backup parameters and other actions are handled from the web console, which opens when you double-click on the Norton icon.

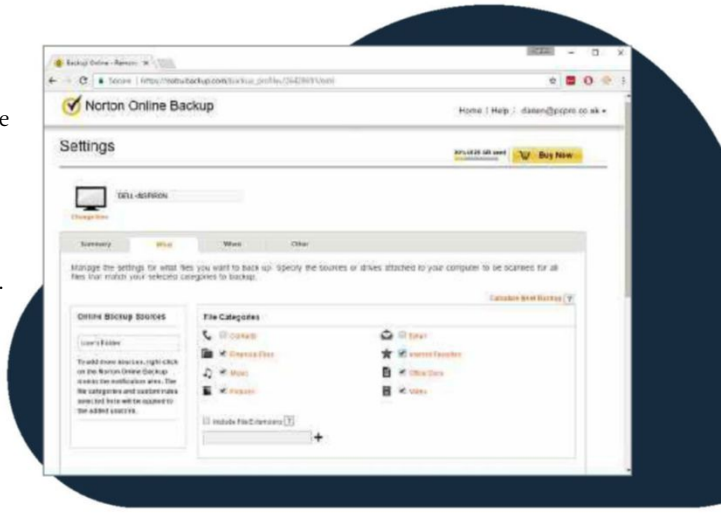
In truth, there's not much to configure: your options divide into three tabs headed "What", "When" and "Other". The first of these lets you specify the types of file to back up – such as music, pictures, contacts and so forth – and add or exclude specific files and folders. Under "When" you can switch from continuous protection to a daily, weekly or monthly schedule.

Finally, the "Other" tab lets you throttle backups by dragging a slider from "fastest" to "slowest", although there's no indication of what the scale really means. You can also enable or disable event alerts and automatic product updates. As feature sets go, it's rather rudimentary.

One area where Norton is quite versatile, however, is file restoration. From the online console you can send an archive to any connected PC (up to five can be linked to your subscription), directly download individual items or generate a time-limited link enabling others to access selected files.

Sadly, Norton proved to be one of this month's slowest backup systems. The company doesn't reveal the location of its data centres, but we suspect they're not local: it took 7hrs 19mins to upload our 5GB test folder, while some other services managed it in less than two hours. Restoration was slower than it should have been too, taking 53 minutes. If the worst does come to pass, the likes of CrashPlan will rescue your files in half the time.

There's no support for hybrid local backup, so you can't speed things up that way, and nor does Norton support sophisticated ideas such as multiple backup sets and custom

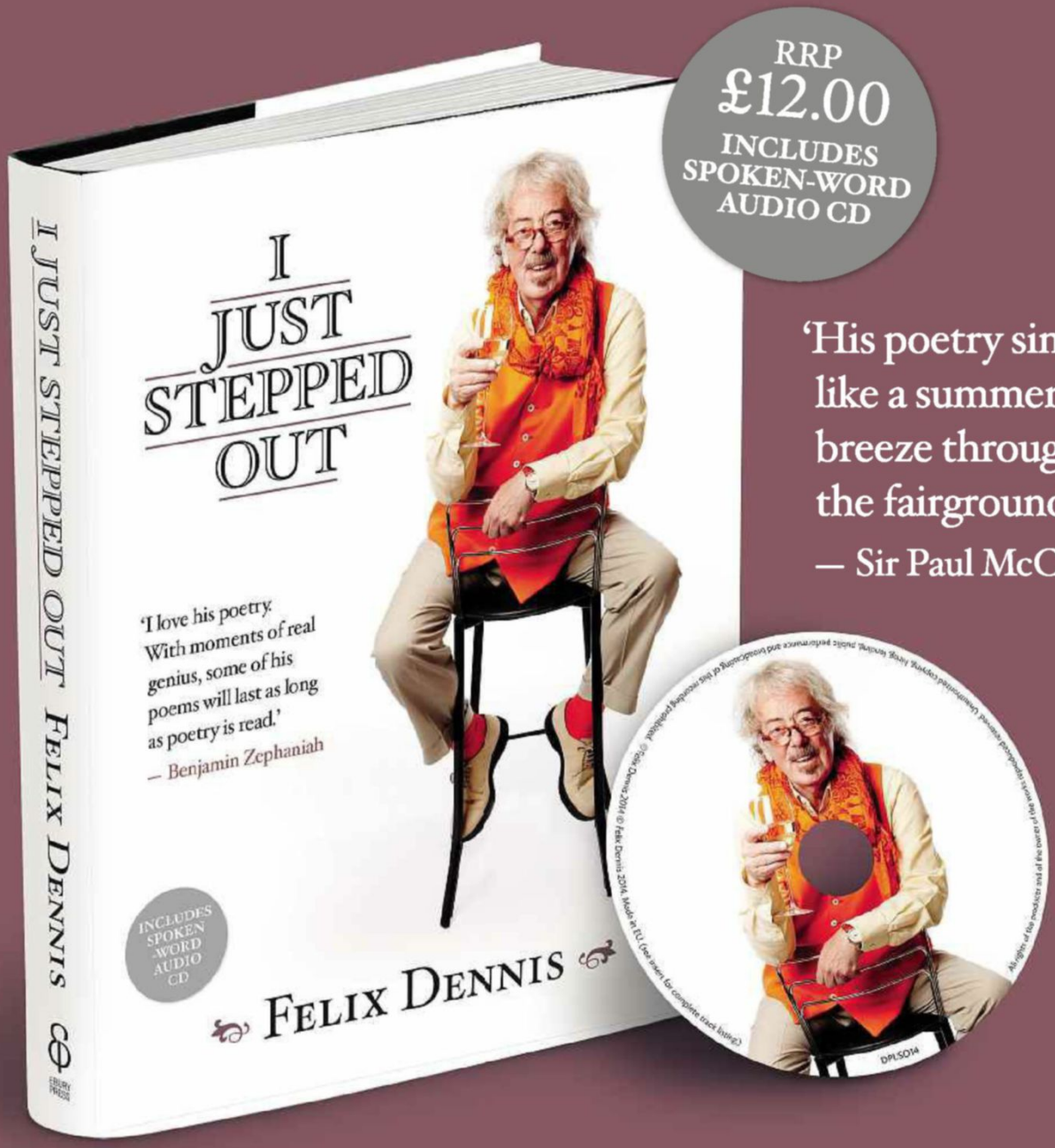


ABOVE Norton Online Backup provides relatively few options, but it's speed where it disappointed us

encryption keys. The real kicker, however, is Norton's storage allowance. Your £40 annual subscription buys you just 25GB of cloud space: that's very miserly by modern standards, especially if you want to use the software across multiple PCs. You can buy extra space, but it's not cheap: going up to 50GB almost doubles the yearly price.

We don't dislike Norton's approach, which imposes almost no footprint on your PC. But it's slow, comparatively lacking in features and expensive for what you get, making it a poor choice overall.

I JUST STEPPED OUT



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SpiderOak One

An interesting take on cloud backup, with sharing and synchronisation features that set it apart

SCORE ★★★★☆

PRICE $5/month, unlimited devices, 100GB from spideroak.com

SpiderOak might not be the best known name in backup, but it has some interesting plus points. For one, you get unlimited file versioning, so you can roll back through history as far as you like – at least, within your 100GB allowance.

The client also uses local encryption as standard: everything is encoded on your PC before it's uploaded, using your account password as the encryption key. By default, this password isn't relayed to SpiderOak, so as long as you stick to using the desktop client, the company has no way of decrypting your information. If you log in to the web console, the company's "zero knowledge" position is lost, but from here you can download files to any PC, and set up password-protected sharing to allow friends and family to access selected items.

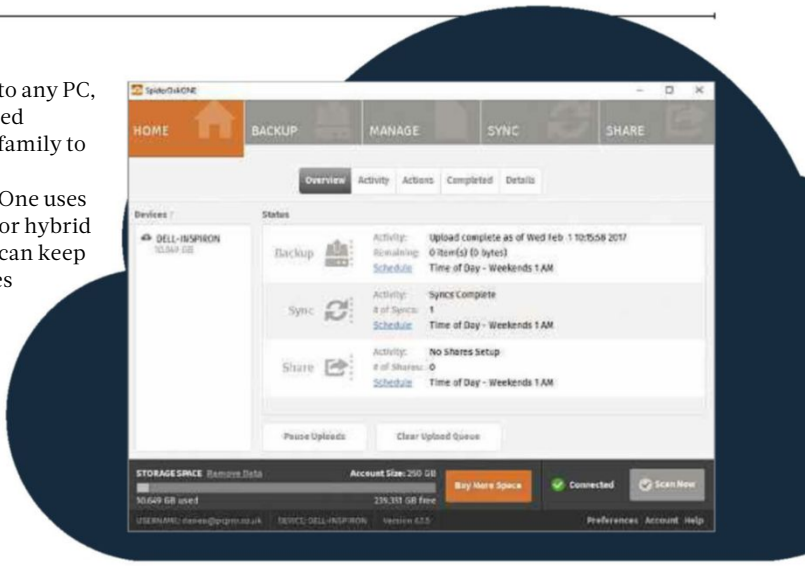
Interestingly, SpiderOak One uses the same encryption model for hybrid backup as for the cloud; you can keep a copy of your backed-up files on a local drive, but you'll need to log into the SpiderOak client to unlock and restore them. As for what gets backed up, you can select items using a familiar directory-tree interface or right-click on files and folders in the Windows Explorer.

As well as regular backup, SpiderOak One supports Dropbox-style cloud syncing: the contents of your "Hive" folder are automatically synced across connected PCs, and count against your 100GB cloud storage allocation.

In our speed tests, SpiderOak ONE took 2hrs 57mins to back up our 5GB test folder: that's not too discouraging, but it is nearly twice as long as the super-quick Carbonite. The good news is that, when we needed to get our files back, they came rocketing over the internet in just 19 minutes.

Clearly, in terms of raw storage per pound, SpiderOak One can't compete with the unlimited services. 100GB isn't too much of a squeeze, though, and if you need more space you can upgrade to 250GB for $9 a month, or a full terabyte for $12. Business plans add centralised management from $9 per user, and, if you step up to the Enterprise tier, you even get Active Directory integration.

Those who just want a no-fuss backup at the lowest possible cost are unlikely to be won over by SpiderOak. But its distinctive feature set deserves a look from anyone wanting a bit more from their backup product.



ABOVE As well as backup, SpiderOak supports Dropbox-style cloud syncing

SugarSync

A two-in-one solution for those requiring both backup and sync, but you'll find more flexibility elsewhere

SCORE ★★★☆☆

PRICE $7.49/month, unlimited devices, 100GB from sugarsync.com

SugarSync is an unusual backup service. At first you might take it for a cloud-syncing tool rather than a true backup solution, and certainly it can be used in that way, keeping files and folders continuously in sync across all PCs with the client installed. You can also share public links to your uploaded files, and share folders with other SugarSync users, offering either read-only or full access.

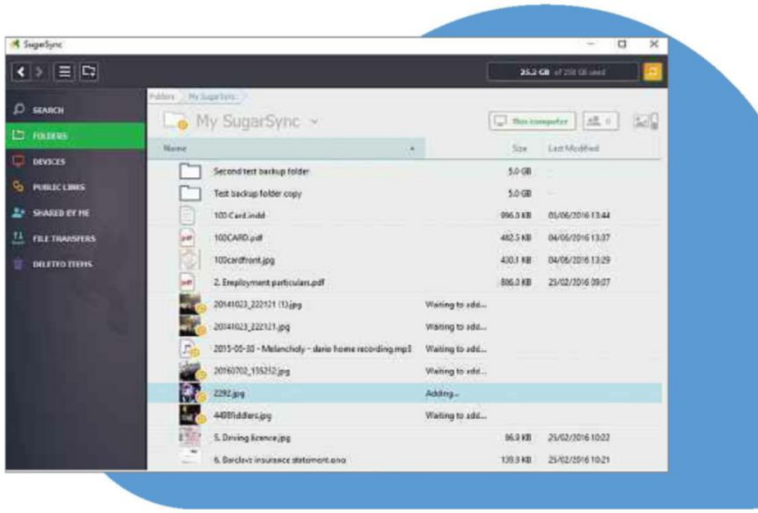
To that extent, SugarSync makes a perfectly good alternative to the likes of Dropbox and Google Drive. Where it differs is that you're not limited to a specific folder. SugarSync works with any number of folders, located anywhere on your system, so you don't have to adjust your way of working to suit it. You can also specify that certain folders should be synchronised across multiple PCs, while others are only to be backed up to the cloud. The only notable limitation is that you can't upload from external or network drives.

This novel philosophy means some of the traditional expectations of backup software don't hold. There are no scheduling options at all; everything happens right away, although you can temporarily pause syncing, or optionally throttle upload speed to 80% or 10% of available bandwidth. There's also no support for setting up multiple backup sets, and no specific options for hybrid backup to local volumes – although the local sync options effectively do a similar job.

In our speed tests, SugarSync gave an undistinguished performance, taking 3hrs 2mins to upload our 5GB of files and 37 minutes to download them again using the desktop client. Others are twice as fast.

When it comes to versioning, the ability to roll back through five older versions of a file is pretty good, and it's nice that only the most recent version counts towards your quota – but other services offer much longer histories. You can also recover deleted files from the past 30 days.

Although SugarSync is one of this month's more expensive options, and not the most versatile in terms of pure backup, it could be a smart way to consolidate your needs if you're already paying for Dropbox or Google Drive. Note, though, that syncing happens via the cloud, so large files can take a few minutes to propagate across PCs. Hopefully a future update will add LAN-based syncing capabilities to speed things up.



ABOVE SugarSync allows you to recover deleted files from the past 30 days

View from the Labs

Darien Graham-Smith has a backup confession to make, including the tale of a NAS drive that went pop

This month's Labs has been of more than professional interest to me. The truth is, I need to sort out my own backup situation. Yes, I'm one of those terrible people who lectures friends and colleagues about backing up, yet doesn't have a proper system in place himself. In fact, I'll admit it: my home setup illustrates some quite serious backup mistakes.

It's not that I'm blasé about the possibility of losing my data. At home I have a 6TB NAS appliance, which hosts File History data for all my Windows machines – plus Time Machine for the increasing number of Mac clients in my household. So I know that if I manage to leave my laptop on the W7 bus, my data at least can be recovered.

So far so good; my first big mistake was to assume, on setting up this system, that it provided all the data security I needed. In reality, as we detail on p86, there are some scenarios in which on-site backup simply won't suffice.

That's something I learnt the hard way early last year. Luckily for me, the wake-up call wasn't anything so dramatic as a fire or a break-in, but rather a good old-fashioned hardware failure. For that I count my blessings: if I had lost both my computers and my NAS box, I would have been completely sunk.

Darien Graham-Smith is associate editor of *PC Pro* and vows to be a better backer upper. Email darien@pcpro.co.uk

In the event, when the NAS drive went pop, I was able to keep on working without any immediate interruption. However, I lost access to older versions of my files – and any new work I did wasn't being backed up. What's more, here's my second big mistake: somewhere along the way I had got into the habit of using my NAS appliance not merely for backup, but for archiving my largest, most rarely accessed files. At the time, this seemed like a clever way to free up space on my desktop clients; when the unit died, it dawned on me that the "backups" I had lost were my only copies of certain files.

"My first big mistake was to assume, on setting up the NAS appliance, that it provided all the data security I needed"

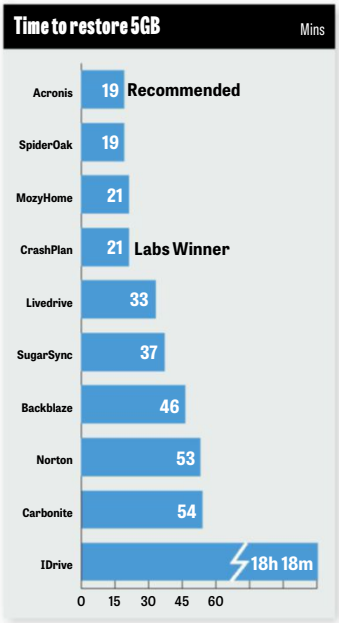
The story has a happy ending, more or less: I was able to take the disks out of the NAS drive and, with the aid of a four-bay USB enclosure, hook them up to a Linux VM, mount the RAID array and copy my data off onto a fresh NAS device.

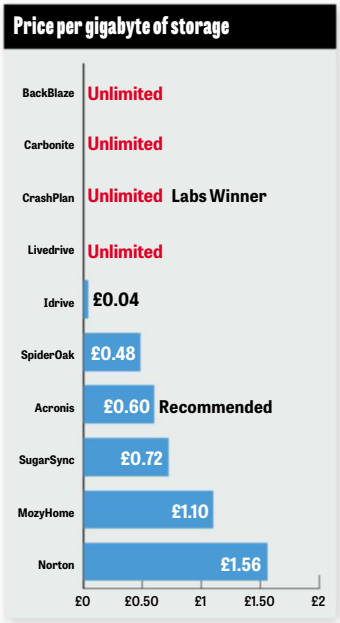
But I don't mind telling you that, until the files were safely recovered, I was holding my breath. And at the end of the process, one fact was clear. This stressful, complicated and time-consuming procedure would never have been necessary if I'd relied on a reputable cloud backup service to either replace my NAS box or mirror it.

Yes, some part of me still bristles at the idea of paying good money for an online service that – touch wood – I may never need. But I've come to realise that a reliable backup service is worth whatever your data is worth. Hopefully, if you're still on the fence about backup, my story will inspire you to do the right thing.

One last piece of advice: after reading our reviews and choosing your preferred backup provider, I suggest you take advantage of the free trials offered by most services. Not only will this help you confirm that the features and interface suit the way you work, it also gives you an opportunity to test performance for yourself (read the IDrive review on p85 for an illustration of this issue in practice). Our figures below represent our own real-world experience, but depending on your line speed, location and ISP, you might get different results.

Test results





How we test

We test performance by backing up and restoring a 5GB folder of personal files, including Word documents, PDFs, images and audio files. To ensure a level playing field, we disable any bandwidth- or CPU-throttling features; the backup is carried out over a domestic fibre broadband connection, rated at 52Mbits/sec downstream and 10Mbits/sec upstream. We time this upload, and then measure how long it takes to restore the files again from within the client. Naturally, we're hoping for both operations to be as fast as possible.

The Network

Practical buying and strategic advice for IT managers and decision makers

Cheat Sheet: Facebook Workplace
Why shifting company comms onto Facebook could be a smart move p99

The Business Question
Should I worry about the Investigatory Powers Act? p102

VPN secrets
Steve Cassidy reveals the options when it comes secure access p104

BUSINESS FOCUS

Choose the right backup for your business

Dave Mitchell shows you what to look for when choosing a backup solution, and subjects four contenders to testing

Most modern businesses are entirely reliant on their IT systems – so if you fail to protect your company's data and essential applications, you're taking a dreadful risk. And there's no need to: there's a huge range of data protection solutions to choose from, to suit all budgets and types of organisation.

If anything, the problem is that the sheer number of options can be quite bewildering. From software solutions to cloud-based and hardware backup systems, there are a lot of variables to consider. And it's important to pick the right one: if you suffer an unexpected data loss, the suitability of your backup solution might be all that stands between your firm and disaster.

This month, we've assembled four different backup solutions from the biggest names in the market. We test-drive purpose-built backup appliances (PBBAs) from Arcserve and Barracuda, as well as software from Veritas and a cloud backup service from IDrive (see our main group test on cloud backup, p76, for more choices). We pull them apart in the lab to help you make the right buying decision.

Strategise and survive

One key principle of backup is that it should be automatic. If your data protection strategy relies on human intervention, it's guaranteed to let you down sooner or later. Only choose products that provide full scheduling features, ensuring backup jobs are run regularly – even if the person who's responsible for backup is unavailable.

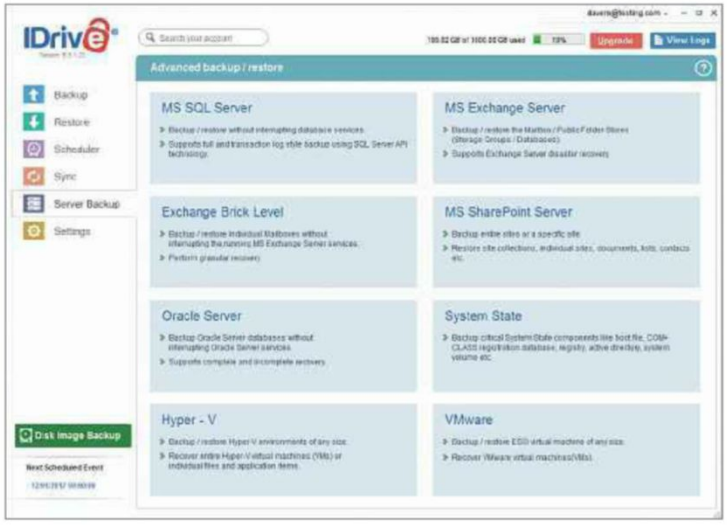
All the products on review will do this and let you configure a strategy for making full and partial backups of each system. Full backups are just what the name implies, allowing you to completely restore a PC even if the operating system becomes corrupted. Incrementals only copy data that has changed since the last backup – a much more space-efficient approach.

Some products use an "incremental forever" strategy, which entails taking a full backup of the target system and updating it with regular incrementals. Also called "changed block tracking", this approach is quick to run and can also provide quick restore facilities.

RTO and RPO

A fast backup is desirable, but also think about recovery speeds. Your business continuity plan should include recovery time objectives (RTOs) – in other words, you should work out how long your business can comfortably survive without access to its systems and data, and ensure that your backup system can bring you back online within this window.

You may find you need more than one RTO. A server running your core



BELOW IDrive Business provides backup facilities for all your critical apps

Exchange services may have a much shorter RTO than a basic print server. In our "always on" world, services such as order tracking and social media may be important, too: there's a risk of damage to your reputation if you can't communicate with customers or respond to queries. For many businesses, therefore, RTOs are likely to be measured in hours rather than days.

Another important factor to work out is your recovery point objective (RPO): this defines the amount of data loss your business can tolerate, and therefore determines how often you need to run backups. If, for instance, you back up every day at midnight, what happens if your systems fail at 4pm the following day? Can you afford to lose all the data created during that period?

Hard and soft options

There are key differences between appliance-based and software-based backup solutions. A particular attraction of PBBAs is their ability to keep business-wide backup operations simple. They provide a single management console with consistency across all clients, which can ease support overheads and reduce operational costs.

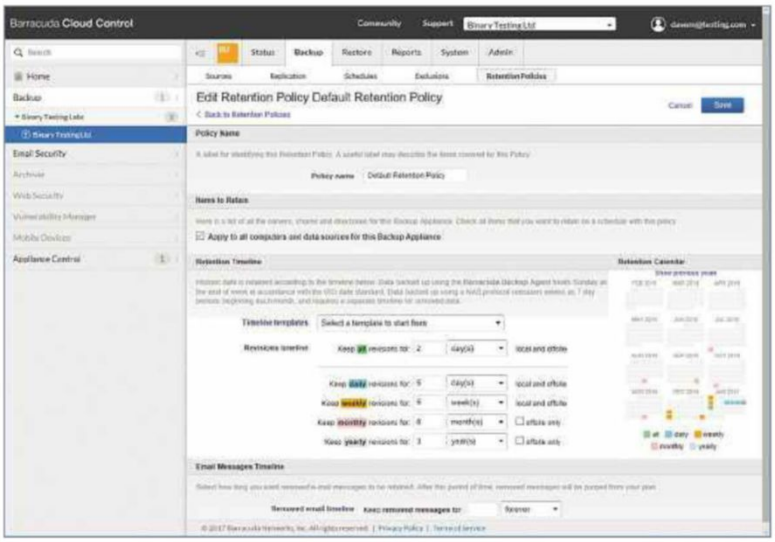
PBBAs normally also come with internal storage preconfigured as the primary on-site backup target. This means you don't have to worry about providing your own storage, although you'll need to make sure your PBBA has enough capacity to meet your needs and accommodate future growth. Most vendors offer a wide choice of PBBA capacities; calculate how much you will need in a year or two, and make sure you can expand your storage if required without any major disruption.

Backup software is less of a plug-and-play solution. You'll need to provide and maintain your own host system, and install and configure the software yourself. It can, however, be tailored to suit a wide range of scenarios: with total control in your hands, you can decide how, when and where to secure your data. Many packages offer a modular licensing scheme, so you can pay only for the functions you need.

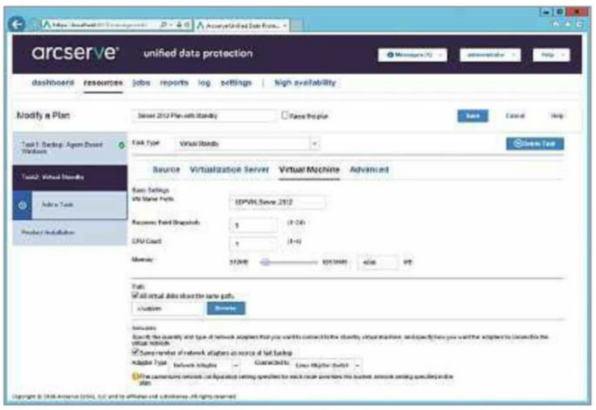
Cloudbusting

Every disaster recovery plan needs to include off-site backup to ensure your company data is kept safe even in the event of a burglary or natural disaster. For small businesses, cloud backup services are an ideal way to achieve this. With competition driving down prices, you've a good chance of finding a provider who fits both your needs and your budget.

Be warned, though: we don't recommend using the cloud as your only means of backup. If you lose your internet connection, or if your provider goes belly-up, you will instantly lose access to your data. Rather, consider it one part of a complete backup strategy, providing an off-site failsafe for your main data protection solution.



LEFT Barracuda lets you decide how long to keep all your backup versions



ABOVE Arcserve UDP can create a standby virtual machine from a backup to cut restore times

Furthermore, you should make sure your broadband service is up to the job before signing up. If you are planning to regularly back up servers, workstations and business apps, a lightweight DSL connection may be swamped by the sheer volume of data. You'll end up annoying your employees and potentially increasing costs.

And connection speed becomes an even more critical consideration when it comes to your RTO. Restoring large files such as virtual machines or Exchange databases could take a very long time over a slow broadband link. Check if the product has a hybrid backup option that allows you to simultaneously back up to the cloud and to local storage devices that can provide fast restore speeds.

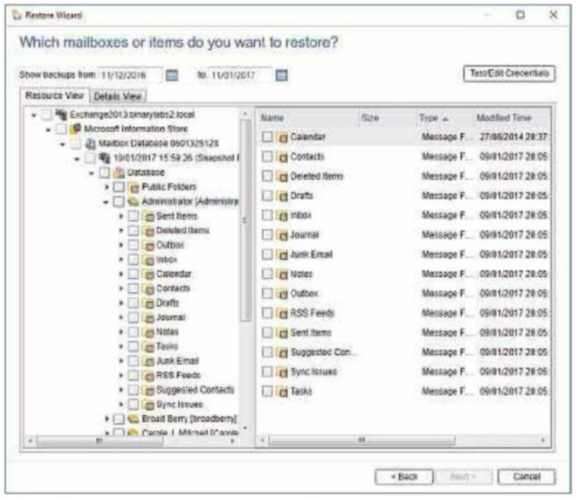
Ransom notes

There has always been a host of good reasons to make regular backups, but a comparatively new problem that's arisen in recent years is the threat of ransomware. If your business is hit by an exploit that encrypts crucial files, the ability to roll back to a previous version can save the day.

To do this, you need a backup product that supports file versioning. All the products on review support this, and will let you recover file versions going back days, weeks or even months. Consequently, if you get hit by malware that demands a ransom to decrypt your data, you can simply browse the file history and restore an unencrypted copy of the file from before the attack.

"Whichever solution takes your fancy, we recommend giving it a trial run before you start relying on it to protect your critical data"

Whichever backup solution takes your fancy, we recommend giving it a trial run before you start relying on it to protect your mission-critical data. All four of the backup products on test this month are available for evaluation. Even once your data protection solution is up and running, you should test its restore capabilities regularly to ensure any potential issues are spotted and addressed before disaster strikes and you need to use them in earnest.



LEFT Backup Exec 16 provides a slick Exchange GRT restore wizard for recovering mailbox items

Arcserve UDP 8100

A powerful appliance that is an all-in-one solution for protecting physical and virtual environments

SCORE ★★★★☆

PRICE From £10,183 exc VAT

from arcserve.com

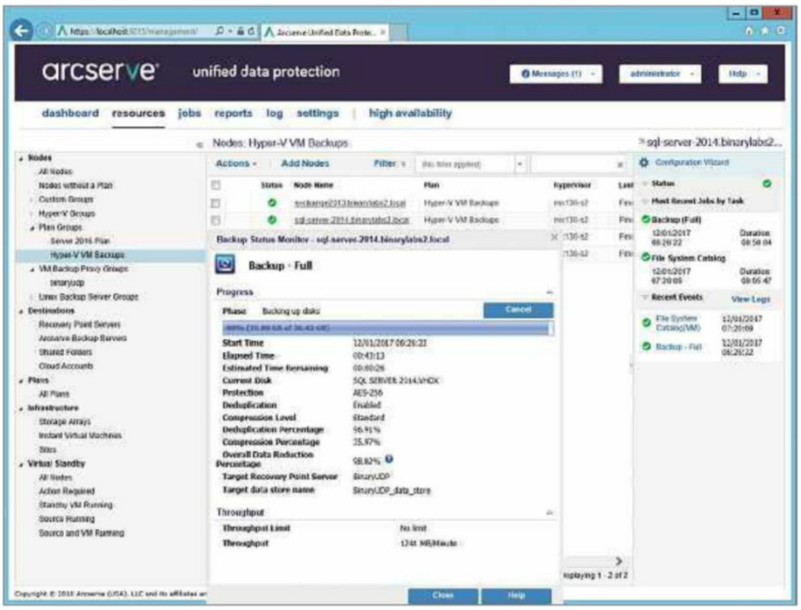
If you're a medium-sized business with big backup requirements, Arcserve's UDP appliances could be perfect. They provide a one-stop shop for backup and recovery of physical and virtual environments. As standard, they include replication, high availability and space-saving deduplication technologies.

The latest UDP 8000 series appliances also offer a wide range of capacities; the entry-level 8100 model starts with 4TB of backup storage, courtesy of three 2TB SAS3 hard disks in a RAID5 array. This is managed by an Avago SAS RAID card, while a 120GB Intel SATA SSD handles UDP's deduplication hash tables. There's also a fourth drive bay for expansion.

As the price implies, this is no lightweight backup unit. It's powered by a six-core Xeon E5-2609 v4, with 64GB of DDR4 memory and dual gigabit data ports. Here, too, there's room to grow via optional 10GbE upgrades. The 8100 is supplied with Windows Server 2012 R2 Standard, and the Arcserve UDP software preinstalled, and after attaching a local monitor, mouse and keyboard, we were able to follow the quick start wizard to join the appliance to our domain, add member nodes and create a protection plan in 20 minutes. All declared nodes have the agent automatically pushed to them, taking around ten minutes for each one.

A key feature of the Arcserve package is its recovery point server (RPS), which defines data stores on the appliance where data is backed up to. Plans define the number of recovery points required, with schedules for full and incremental backups that can be run every 15 minutes. You can add tasks to a plan, with options that include remote RPS replication, file copying and, if you've loaded the Arcserve Backup software, migrating data to a tape drive attached to an optional SAS host bus adapter.

Another feature is Virtual Standby, which uses recovery points to create local VMware or Hyper-V VMs of selected nodes. The VM is kept up to date with the latest data so, if the primary node goes down, the standby VM is fired up to provide continuity.



LEFT **Arcserve's well designed web console makes light work of backup and recovery management**

ABOVE **This is no lightweight backup unit: the 8100 is powered by a six-core Xeon E5-2609 V4**

There's also a new Instant VM feature, which creates on-demand VMs from node recovery points. This is impressively quick: we set it to create a new Hyper-V VM from our latest Exchange 2013 backup and had it ready to boot in 30 seconds.

Alongside D2D and D2D2T migration strategies, UDP supports the Arcserve Cloud service. Coming in 3TB, 6TB or 9TB annual subscriptions, this allows data to be replicated off-site and provides cloud-based Virtual Standby for disaster recovery.

When it comes to restoring data, the Arcserve is flexible. You can load the agent interface from the UDP console or locally at the client, browse recovery points, select drives and folders and choose where to restore them. SQL databases are as easy to restore as individual files, and the 8100 can even make entire data stores available as network shares.

"SQL databases are as easy to restore as individual files, and the 8100 can make entire data stores available as network shares"

The only part that required more legwork was granular recovery for Exchange. We accessed our Exchange agent and mounted the latest restore point as a new drive on the UDP server. After loading the GRT restore utility and pointing it at the Exchange backup, we could then browse our users, view mailbox contents, connect the utility to our live Exchange server and restore individual items.

For agent-based backups, UDP performs deduplication both locally at the source and globally on the RPS data store. We were impressed by its data reduction efficacy: we backed up 615GB of data, which deduplication and compression scrunched down to only 216GB.

At more than £10,000, the Arcserve 8100 isn't a budget option, but its credentials are beyond reproach. It's easy to deploy and provides top-notch data protection features.

SPECIFICATIONS

1U rack server • 1.7GHz Intel Xeon E5-2609 v4 • 64GB DDR4 (max 160GB) • Avago SAS 9361-4i PCI-E RAID • 3 x 2TB Seagate Enterprise SAS3 hot-swap drives in RAID5 array (max 4) • 120GB Intel SATA SSD • 2 x Gigabit Ethernet • 2 x 500W hot-plug PSUs • 3yr hardware warranty

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SEE OUR REVIEWS ON TRUSTPILOT

"Amazing! They are with you every step"
★★★★★
Lisa, 21 October

"Very impressed and was smooth and hassle free from start to finish"
★★★★★
David, 9 September

"Thank you and we would buy through you again"
★★★★★
Clancy, 21 August

"I'm loving my new ride. I would recommend this service to anyone"
★★★★★
Tatiana, 8 September

Barracuda Backup 290

Hybrid backup doesn't get any easier than this: it's an excellent choice for time-poor SMBs

SCORE ★★★★☆

PRICE Appliance with 3yr full subscription, £4,446 exc VAT from barracuda.com

Barracuda's Backup 290 is a slick hybrid product, combining local backup with simple one-click cloud replication. It will be of particular interest to growing businesses, as the price includes support for unlimited clients and critical business apps.

We tried the entry-level Backup 290 appliance, which has a single 1TB drive for local backup storage. That may not sound like much, but the 290 performs variable block-level deduplication, so you can effectively squeeze much more than a terabyte of data into that space.

The cloud storage side of things costs £1,699 exc VAT for a three-year subscription, which is automatically linked to your cloud portal account. The beauty of an integrated approach is that local backup jobs can be set to replicate to the cloud with the click of a single button during job creation.

Setup proved to be outstandingly simple. Connecting the appliance to our Cloud Control account took only 20 minutes; with a local monitor and keyboard, we quickly configured the Backup 290's network settings, then simply entered its serial number and code pairing into the cloud portal to link the two.

Client deployment is easy too: Barracuda provides one agent on the cloud portal for all Windows clients and applications. With this, we declared each of our test systems as backup sources by configuring their hostname or IP address, along with file-share credentials, then ticked the box to have backups replicated to the cloud.

Once systems are registered, you can assign them to the default backup schedule, which automatically backs up everything once a day. It's easy enough to create custom schedules, assign specific systems plus items, and repeat jobs as often as every hour.

The appliance worked fine with our test systems, which included a Windows Server 2012 R2 domain controller, plus hosts running Windows Server 2016, Hyper-V, Exchange 2013 and SQL Server 2014. Individual Hyper-V VMs and SQL databases are easy to back up too. Moreover, message-level Exchange backups can be configured by following the clear instructions for creating a dedicated service account and running a shell command to define impersonation rights. After five minutes of setup, we could select individual Exchange users and back up their mailboxes, calendars, contacts and more.

ABOVE The Backup 290 has a 1TB drive for local backup storage, but much more can be squeezed in through deduplication

The cloud portal's status page keeps you posted on appliance and backup status and provides a rundown on used storage capacity. You can also see how much space deduplication is saving you: for instance, our 900GB of backup data was reduced to less than 200GB on the appliance, an effective reduction ratio of nearly 5:1.

File recovery is swift: you simply select target systems from the portal, then choose whichever files and folders you need to restore. These can be either returned to their original location or copied to another system. The same window also provides access to the cloud repository: from here it's a simple case of hitting "Download" to copy the data to a local system.

"File recovery is swift: you select target systems from the portal, then choose whichever files and folders you need to restore"

In this way, we found it easy to restore Hyper-V VMs, either to our host or an alternative location, and download their virtual disks from the cloud. SQL databases can be restored in the same way, while for Exchange backups, you can restore the entire database or drill all the way down to recovering individual emails.

The Backup 290 also handled bare-metal recovery well. To test it, we booted a Windows server from a Barracuda ISO disk image. After the recovery environment had loaded, we were able to select the System Restore option from the cloud portal and let it restore the entire system from the last backup.

Since the appliance itself uses a single hard disk with no data redundancy, it's risky to use it as a standalone backup solution. However, partnered with the cloud service portion, it's a very capable offering that's a cinch to deploy and use, making it a great choice for hybrid backup.

BELOW The user-friendly cloud portal keeps you posted on all local and cloud backup activity

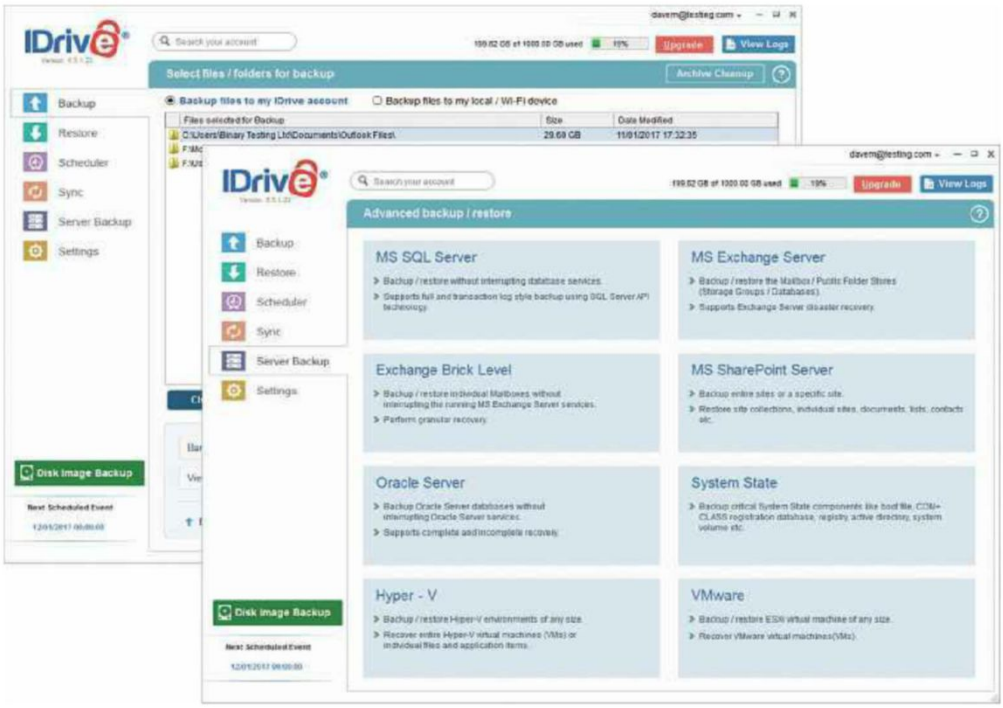
SPECIFICATIONS

1U rack chassis • 1TB SATA hard disk • Gigabit Ethernet • 2 x USB 2 • VGA • price shown includes 3yr subscription for Energize Updates, Instant Replacement and unlimited Barracuda cloud storage

IDrive Business

Great value, super features and extensive platform support makes this a top cloud choice for SMBs

SCORE ★★★★☆
PRICE 250GB, £41 exc VAT first year from idrive.com



Small businesses on a tight budget will love IDrive Business, which offers plenty of backup features at pocket-friendly prices. Costs are based purely on how much cloud storage you need, starting at just £41 for 250GB for the first year.

That very affordable subscription includes support for unlimited Windows, OS X and Linux systems. And it's app-friendly, too: along with facilities for backing up Hyper-V and VMware hosts, you get options for securing Exchange, SQL, Oracle and SharePoint servers, along with their system states, as standard.

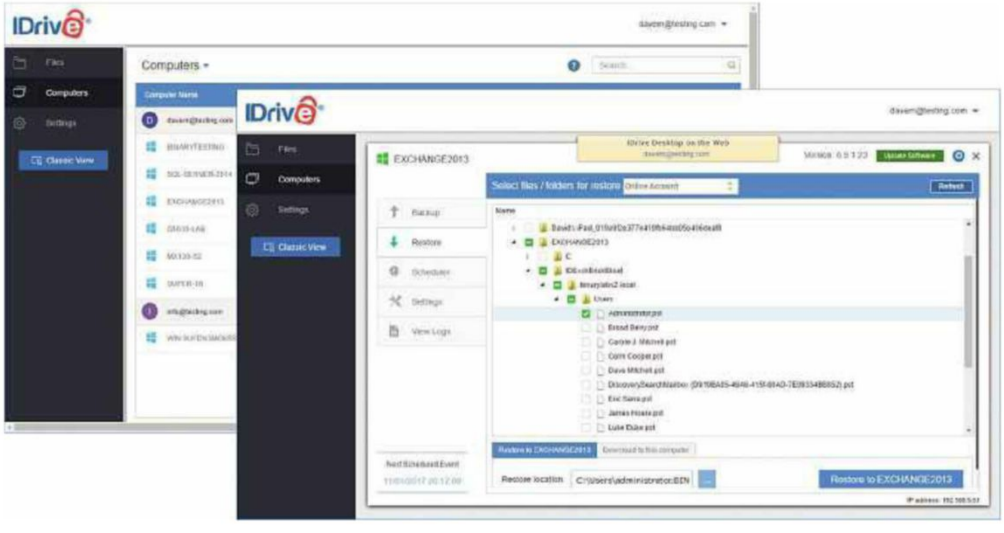
Setup involves a little more work than some other backup services. There's no push installation, so on each system that's to be protected you'll have to log into the IDrive web portal, download the client software and connect it by hand. The process isn't complicated, though, and once it's done you can remotely manage all systems via the new web portal dashboard. Settings such as default backup content, alerts, bandwidth throttles and schedules can all be modified for connected clients as and when needed.

You can also set up accounts to delegate backup and restore tasks to other users. When you create a new account, a verification code is emailed to the user. When first connecting and providing this code, they'll be prompted to set a password, to reduce the risk of unauthorised access.

Configuring file backups is easy enough. A set of common files and documents is preselected for you; these can be customised from the local or remote consoles, with a handy Explorer menu option for quickly adding a file or folder to your backup set. Tasks can be scheduled to run at regular hourly and daily intervals; by default, IDrive starts with a full backup followed by incrementals. If you have a lot of data that needs safeguarding in a hurry, you can use the IDrive Express service, which lets you perform an initial backup to a removable drive, which is then couriered back to IDrive to seed your cloud account. IDrive Express can also be used for quick restores; your subscription allows you to use the service up to three times per year at no additional charge.

ABOVE The IDrive client provides an intuitive interface and an extensive range of server backup features

PC PRO RECOMMENDED



BELOW Here, using the web dashboard, we remotely accessed our Exchange server to restore a user's mailbox

We had no problems backing up our Windows 10 desktops, nor any of our servers. Although Server 2016 isn't officially supported, we were able to back up its data and system state. For Exchange, we were able to secure the entire message database, and restoring it was easy thanks to IDrive's handy online video tutorials. You can also run separate brick-level backups – although these aren't as good as message-level backups, since you can only use them to restore an entire mailbox. This simply needs access to a backed-up PST file, which can be accessed from the local IDrive copy or the cloud repository.

IDrive Business also supports image-based backups, continuous data protection for real-time file backup, Dropbox-like file syncing and free apps for iOS, Android and Windows mobiles. We used the iOS app on an iPad to secure our videos and photos and browse the cloud repository for quick restores. AES-256 encryption is applied to keep your backups secure, and you can let it handle the key for you or create your own and save it locally.

There's also support for hybrid backup architectures; by setting up separate jobs we were able to back up data to a mapped NAS share on our local network. Owners of Synology, Qnap or Netgear NAS appliances can also use the relevant IDrive app to secure data directly to the cloud.

IDrive Business offers a superb range of cloud backup features, with excellent platform support, at a very tempting price. Indeed, it's what we've been using to protect our lab systems for over two years, and it's never let us down yet.

Veritas Backup Exec 16

A simple backup suite offering affordable capacity-based licences and support for Windows Server 2016

SCORE ★★★★★

PRICE 1TB Capacity Edition Lite, £1,052 exc VAT from lambda-tek.com

Veritas acquired Backup Exec from Symantec in 2015, and it hasn't dragged its heels when it comes to updates: the software comes with full support for Windows Server 2016's core server operations. That's in addition to support for cloud providers including Microsoft Azure and Amazon S3, allowing businesses to easily migrate data off-site and manage it from the same console. The new Instant Granular Recovery Technology (GRT) speeds up data recovery from VMs too, and it's also ready to go with vSphere 2016.

Another welcome change from the Symantec days is a less tangled licensing scheme. Veritas now offers a simple choice of Capacity or V-Ray licensing – the latter being designed for virtual environments, and charged for on a per-socket basis. For most SMBs, the Capacity Edition Lite is the place to begin, starting with 1TB of front-end storage and most features: all that's missing is multi-drive tape libraries, deduplication, NDMP support and Linux server protection.

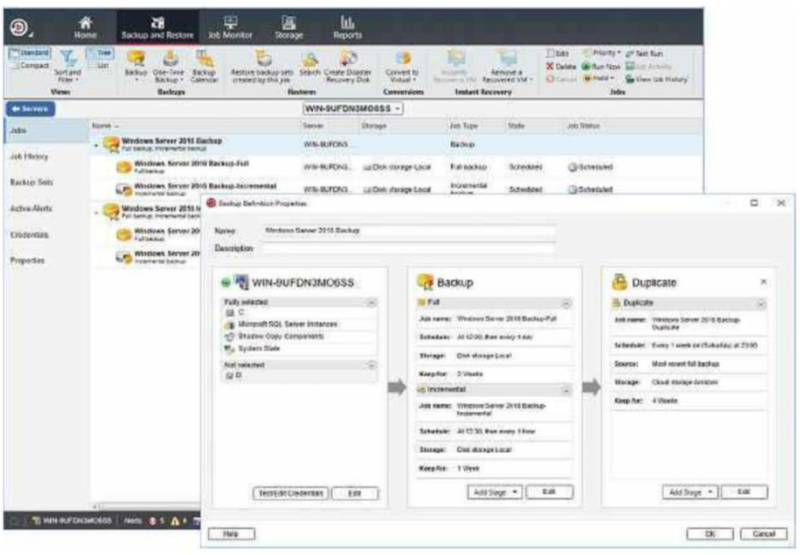
As advertised, BE16 worked fine with our Windows Server 2016 host system, and we had it loaded and ready in 30 minutes. The central console has seen a few minor cosmetic changes since the last release, and opens with a customisable dashboard offering a choice of widgets showing details such as job status, VM backups, storage usage and alerts.

We started by defining our backup storage – you can choose from disk, cloud, tape or pools. Disk-based storage options can include standard hard disks, deduplicating stores, network shares and removable devices such as RDX cartridges.

We also had no problems setting up Amazon S3 as a cloud backup destination. Choosing the network storage option, we had to provide our account ID and key, pick a bucket and decide on the number of simultaneous write operations to permit.

From the console, we then pushed agents to our Server 2016, Server 2012 R2, Hyper-V, Exchange 2013 and SQL Server 2014 systems. The latter two were running as VMs, but this was no problem: the routine pushed agents to them for us when we selected the Hyper-V host system.

ABOVE The Backup Exec console home page provides a good overview of all things backup-related



LEFT Backup Exec ran on our Windows Server 2016 host, where we backed it up to disk and Amazon S3

Backup operations are further simplified by BE16's resource-centric model. This speeds up the creation of protection plans by reducing the number of steps required and makes it easier to include multiple backup stages using different media.

Each job starts with a full backup followed by daily incrementals, but this is easy to edit. You can change backup sources, destinations and schedules, replace incrementals with differentials and add extra migration stages such as tape or cloud storage. One caveat here is, if you want a job to use a specific disk backup device, BE16 defaults to using any available device. It's easy to change this, however. VMware fans can also have backups converted to VMs on completion.

"We could delve into our VM backups and pluck out files, folders, SQL databases, Exchange data stores and mailbox items to restore"

To secure our Exchange and SQL Server VMs, we simply needed to create a job for the Hyper-V host server with these VMs selected. Here the Instant GRT feature really showed its worth: we could delve into our VM backups and swiftly pluck out individual files, folders, SQL databases, Exchange data stores and mailbox items to restore.

All recovery tasks are simple, as the job restore window only displays the relevant data for the system. The Exchange Restore wizard is a winner, providing one-click options to restore the entire database or mailbox items, along with a search facility for finding an email, contact or calendar item.

If you're after a do-it-all backup solution, Backup Exec 16 is the choice. It makes light work of managing a company-wide backup and recovery strategy, and the Capacity Edition licence is affordable. **DAVE MITCHELL**

Facebook Workplace

Steve Cassidy finds out why shifting company communications onto Facebook could be a smart move

We've tried Facebook before. It was hard to keep coming up with new content to post, and it didn't seem to benefit us much.
You're echoing the experience of many organisations who have tried using Facebook as a marketing tool. The fact is, while Facebook's potential for promotion and relationship-building can be formidable, it's not right for everyone. "Workplace by Facebook" is something quite different: simply put, it's a custom version of the Facebook environment for messaging between co-workers.

This sounds like a terrible idea – won't people be distracted by chit-chat and memes when they're supposed to be working?
It must be admitted, the Workplace vision of what people get up to at work isn't universal. I certainly wouldn't suggest that a company of forestry workers or a brass band try to use Facebook on the job.

Yet, the evangelical slogans about embracing social media aren't entirely off base. If you trial Workplace and get nothing more from it than a chance to remind your staff to get on with their jobs, that's still better than souring the working environment with glowering intrusions to check up on what they're doing online.

It sounds like my employee communications will be running inside someone else's cloud. What about security and privacy?
At the time of writing, Workplace offers a fairly simple framework providing virtual private meeting places for people who work in different businesses. The idea is to allow discussion of mutual projects without exposing other information and resources.

To be sure, it's hard to overlook Facebook's historic habit of eagerly rolling out new features and letting users do the field-testing. But there are good opportunities here. You can create and tear down a collaborative group more or less on a whim. It might exist for only an afternoon; it might also be that it has only one external member, advising a whole internal team (think legal matters, or health and safety). Adapting your mindset beyond the email model is a key part of getting the most from these consumer crossover platforms.

At the end of the day, isn't this just another online chat system?
Facebook's communications credentials certainly started with simple chat, but have blossomed to include both audio and video connections. This means you can substitute Workplace for services such as Skype, WhatsApp and dedicated VoIP systems. Yes, there are some notable gaps in the feature set, like the absence of a POTS (analogue phone service) gateway such as Skype Out, or true multi-feed videoconferencing for virtual meeting room creation. Still, Facebook brings other advantages – for example, Facebook Live sessions, which are not only streamed but stored for future reference.

What's more, like it or not, Facebook has tremendous member loyalty. For some people it's the first place they go in the morning, and the last at night. Harnessing that feel-good factor to foster both collaborative and productive relationships isn't a silly thing to be doing. If you can get employees to feel more positively about work, you've achieved something.

That sounds good, but I'm still concerned about oversight. We have to own our own business-critical systems.
That's not an issue on Workplace. There are at least two defined classes of super-user, namely administrators, and "IT Teams". Administrators can define the entire environment, in terms of how existing Facebook accounts are allowed into the Workplace separate playpen, and how the Workplace system handles things such as single sign-on with mature Windows networks. What's more, Facebook provides one-on-one help for admins, so you can always get a guided support session and ask as many questions as you need. In short, whatever arrangement works for you ought to be attainable.

> **"Harnessing Facebook's feel-good factor to foster both collaborative and productive relationships is not a silly thing to be doing"**

And how do we handle things such as oversight and legal compliance?
This is where that second group comes in. They're referred to in terms of IT, but they really act as compliance officers: these are the guys who make sure you're not breaking any laws or conditions of service, and keeping paper trails as required. Over the years, we've seen many collaboration platforms created by brilliant but inexperienced youths, which entirely lack the oversight features a business needs. Consequently, the fact that Workplace by Facebook doesn't fall into that trap is itself a definite recommendation. ●

What does Workplace cost?

There's a popular saying about Facebook: "If you're not paying for the product, you *are* the product." In other words, the company makes its money by exploiting the information you entrust to it.

Happily, Workplace isn't built on that business model. Here, you do pay for the product: the basic fee is $3 per user per month for up to 1,000 users within an organisation. The price then drops to $2 for up to 10,000 users, and to $1 for extra licences beyond that. That includes unlimited storage for files of all types, plus that all-important personal support.

All the same, it goes without saying that before you sign up, you should take a close look at to the terms and conditions – see **pcpro.link/271workplace** – and make sure you know exactly what you're agreeing to before you start entrusting your business-critical communications to a third party.

AVer VC320

It's not cheap, but AVer's feature-rich VC320 makes on-demand video conferences a cinch to set up

SCORE ★★★★☆
PRICE £490 exc VAT
from morecomputers.com

Measuring just 30cm tall and weighing under a kilogram, AVer's go-anywhere videoconferencing solution is perfect for mobile workers. Despite its small size, it has everything you need to quickly set up voice and video conferences at client sites, huddle rooms and your own office.

The VC320 feels solidly built, although the glossy piano-black finish on the front is a magnet for grubby finger smudges. The f/2.0 lens at the top of the unit provides a 1080p video stream with a wide 110° field of view. It features a 5x optical zoom with pan and tilt functions, or can be manually angled up and down as required.

Below it you'll find an NFC sensor, omni-directional mic and four status indicators for video conference and HDMI presentation modes; usefully, these indicators double up as touch-sensitive buttons for changing modes and muting the mic. A single 5W speaker is mounted in the base, behind a forward-facing plastic grille.

At the rear sit a goodly range of ports, including micro-USB for PC and Mac connections and HDMI out for a TV or monitor. There's an HDMI input too, so you can connect a device such as a Chromecast 2 streamer; this can also link up to the 2.1A USB port for charging. Expect around eight hours of voice calls, or two hours of video.

LEFT Weighing less than a kilo, this little contraption can travel with you anywhere

The remote control provides pan, tilt and zoom controls, plus buttons for changing the volume, making or ending voice calls, selecting the connection type and activating the digital privacy shutter. It clips neatly into the magnetic recess at the back, covering up the ports.

Getting set up on both a Windows 10 PC and MacBook Pro running OS X 11.6 was simple. On both platforms there's no need to load external drivers; the VC320 was recognised the moment we connected the generous 5m USB cable. As Skype fans, however, we chose to install AVer's PTZApp, which loads two plugins that enable the call accept and end buttons on the remote control handset.

The app also has a firmware update feature, which automatically updated our camera, along with controls for tweaking video quality, controlling PTZ functions and running diagnostics for the camera, sound and Bluetooth/NFC pairings.

Those that can't find the remote control can also install AVer's EZHuddle iOS app. Loaded on our iPad and connected over Bluetooth, this provided a keypad that mirrored the handset controls.

"After pressing the EZCrop button, it drew green boxes around everyone's faces and zoomed, panned and tilted to make sure we were in shot"

Once we were all set up, the VC320 worked fine with Skype and Cisco's WebEx. The mic has a good range; participants said they could hear us clearly at up to 15 feet away. The speaker is lacking slightly in bass but we found it is easily loud enough for small meeting rooms.

Image quality is decent, with good colour balance but a softer focus than we'd like. Still, the VC320's wide field of vision means there's no need for participants to crowd together.

There's also an EZCrop feature, which is great for getting meetings set up quickly: it uses facial recognition to crop the picture so that all participants are in view. This isn't just a gimmick either. After pressing the EZCrop button on the remote, it drew green boxes around everyone's faces and zoomed, panned and tilted to make sure we were all in shot.

AVer's main competition comes from Logitech's ConferenceCam Connect, which costs around £130 less. Its 90° view is quite a bit narrower, and the unit is heavier too – but it offers superior audio and video quality, and its internal battery has greater longevity.

Still, the VC320 scores well for features, with its dual HDMI ports and extra software apps. It's just as user-friendly as the Logitech alternative, and the wide-angle lens and EZCrop feature ensure everyone is in the big picture.

DAVE MITCHELL

BELOW A wide-angle lens ensures you can fit everyone into the picture

SPECIFICATIONS

f/2.0 lens • 1080p • 30fps • 110° FOV • 5x optical zoom • optical pan/tilt, manual tilt • omni-directional microphone • 5W speaker • H.264 • UVC • NFC • Bluetooth • USB 2 • micro-USB • HDMI 1.3 in/out • internal battery • remote-control handset • 5m USB cable • external PSU with 3m cable • 900g • 65 x 100 x 300mm (WDH) • 3yr RTB warranty

Thecus W4810

An affordable Windows domain controller in a box, with good data backup and recovery features

SCORE ★★★★☆
PRICE £512 exc VAT
from span.com

Thecus's W4810 is a four-bay NAS appliance running Windows Storage Server 2012 R2 Essentials (WSSE R2). That means it can do a lot more than a basic enclosure: its capabilities include full Active Directory Primary Domain Controller (AD PDC) services, plus slick workstation backup and recovery features.

It runs on a speedy quad-core 1.6GHz Celeron N3160 CPU with 4GB of DDR3 RAM. There's no option to upgrade the memory, but we found that wasn't a problem as the OS rarely used more than 2.6GB. There's also an internal 60GB SATA SSD, on which the OS resides, leaving the four main drive bays free for use.

Getting set up is easy: AD newbies will appreciate the wizard-based installation procedure, which walks you through configuring the OS, creating an administrative user and creating a new domain. Make sure you get your chosen domain name correct, though, as this can't easily be changed later on. The Essentials Dashboard then helps with creating user accounts, setting up remote access, connecting clients and linking to Microsoft's Azure cloud storage and Office 365.

When it comes to setting up storage, WSSE R2 lets you go beyond standard RAID with Storage Spaces – versatile pools of disks within which you can create virtual disks (VDs), with mirrored or parity resiliency and optional thin provisioning and deduplication. For testing, we loaded up the W4810 with three Seagate 10TB IronWolf NAS drives and created our volumes.

For best performance, we started out by creating a mirrored VD, then mapping a drive to it from an HPE ProLiant DL380 Gen9 Windows rack server. From here we saw our 25GB file-copy test complete with fast average read and write speeds of 112MB/sec and 110MB/sec. Our backup test went well too, with a 22.4GB folder containing 10,500 small files copied to a share at 68MB/sec.

Parity volumes deliver slower write performance, being essentially software-managed RAID5 drives. On a parity VD, we saw our 25GB file-copy test complete with average read and write speeds of 109MB/sec and 62MB/sec. Transfer speeds for our backup test also fell, but not by too much: 52MB/sec is still respectable.

Accessing the W4810 is simplicity itself. Windows clients can simply point a browser at the appliance and download the Connector and Launchpad apps. We tested this with multiple Windows 10 clients, all of which promptly appeared in the Dashboard ready for action. The Launchpad software provides quick access to backups, shared folders, the Anywhere Access web portal and, if permitted, a remote Dashboard.

Backup features are excellent. The appliance supports a customisable schedule for backing up all connected clients, using fast VSS snapshots and block-level deduplication. A separate schedule lets you back up the server itself to external media.

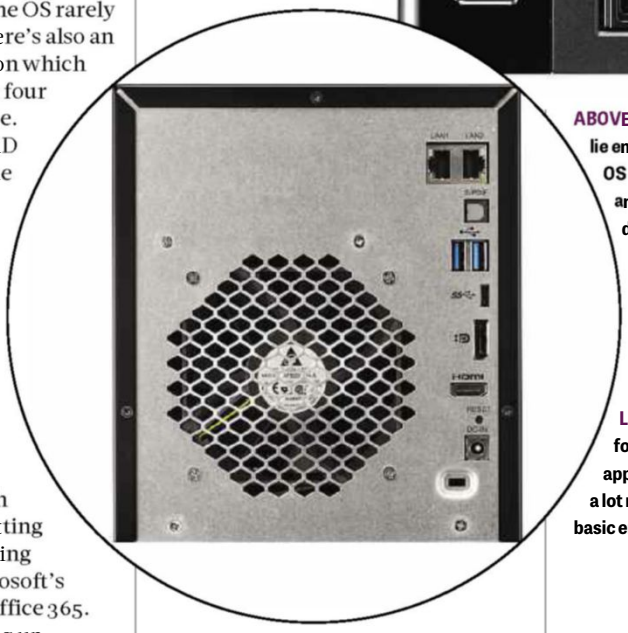
File and folder restoration is again straightforward. We simply selected a client from the Dashboard, chose a backup job, picked what we wanted recovered and decided where to send it.

If bare-metal recovery is required, you can create a bootable WSSE Full System Restore USB stick to rescue a client system. We also tested the appliance's PXE network service, which allowed us to boot a sick PC into the WinPE recovery environment, select the latest backup and return it to active duty within 20 minutes.

Some IT departments may be considering holding out for Windows Server 2016, but that's an expensive step up: the Essentials edition (which supports the PDC role) costs nearly as much as the entire W4810 appliance. For small businesses, Windows Storage Server 2012 R2 offers all the key features, with good performance for mirrored VDs and automated client backup and recovery features – making the W4810 an affordable and easily managed first server.

DAVE MITCHELL

ABOVE All four bays lie empty, with the OS installed on an internal drive



LEFT This four-bay NAS appliance can do a lot more than a basic enclosure

"There's a customisable schedule for backing up all connected clients, using fast VSS snapshots and block-level deduplication"

SPECIFICATIONS

Desktop chassis • 1.6GHz Intel Celeron N3160 processor • 4GB DDR3 RAM • 60GB internal SATA SSD • 4 x hot-swap SATA drive bays • 2 x Gigabit Ethernet • 3 x USB 3 • DisplayPort • HDMI • S/PDIF audio • external PSU • Windows Storage Server 2012 R2 Essentials preinstalled • 172 x 250 x 198mm (WDH) • 2yr RTB warranty

THE BUSINESS QUESTION

Should I worry about the Investigatory Powers Act?

The so-called Snooper's Charter has wide-ranging effects for businesses, as well as individuals, so what should you do next? Nik Rawlinson asks the experts

How would you feel if we asked you to send us your browsing history? What if we were the Food Standards Agency? Or your local fire and rescue authority? Since the Investigatory Powers Act (IPA) gained royal assent at the end of 2016, only one of those – *PC Pro* – isn't entitled to see where you've been online.

The Act's supporters may claim that those with nothing to hide have nothing to fear, but that's only true if things that are legal now aren't made illegal in the future. If a law change is applied retrospectively, records of your gambling or browsing of legal pornography might be enough to mark you out for investigation.

Is it any surprise that China used the IPA to justify new surveillance and decryption laws that were passed in late December? China's actions were, said Li Shouwei, deputy head of the parliament's criminal law division, "basically the same as what other major countries in the world do".

A changing legal landscape

Yet, although the Act has been passed, only part of the IPA is in force: the part that replaces the Data Retention and Investigatory Powers Act 2014 (DRIPA), which authorised collection of communications metadata in bulk.

IPA doesn't apply to your average company with an IT department, as Nicola Fulford, partner and head of data protection at law firm Kemp Little, explains. Instead, the onus for data collection is on telecoms operators, "and even then only when they receive a Home Office or other authority notice that they need to start keeping [a log of your online activities]. There's no obligation under this law or DRIPA for an ordinary company to keep information just in case somebody comes asking for it."

In that respect, IT departments are off the hook as the Act doesn't require them to track employees online. The data that can be captured by a firm's upstream provider, though, may still be either commercially-sensitive for the business or embarrassing for employees. Either would be ripe for exploitation, should the records ever be compromised.

DRIPA concerned itself primarily with metadata – who was contacting who and when – but IPA digs deeper, examining not only when someone went online but what they viewed.

"[The data] reveals a lot about people's private lives, such as if they are looking at online support groups, or websites about particular health conditions," Fulford said. "If [an ISP is] holding all of this information it could suffer a hack or breach and some of the information could come into the public domain. They have [a duty of care] to keep the data secure but if it was deleted or never retained in the first place, there would be nothing for them to lose."

"The Investigatory Powers Act digs deeper, not only examining when someone went online but also what they viewed"

There's also a risk that information gathered for one purpose may be exploited in other ways as authorised agencies find new methods of exploiting the Act. The debates that led to the IPA's passing focused primarily on terrorism, but the list of agencies authorised to access your records includes many whose connection to preventing attacks and fighting international crime is tenuous at best.

There are safeguards surrounding who in each organisation has the right to request your records. Bodies that want to examine the data need a valid reason, and each must have dedicated officers and points of contact who are authorised to make requests. They will have received training to ensure they're working within the bounds of the Human Rights Act, and Fulford's

advice for anyone receiving a warrant for data is to make sure the person making the request is authorised to do so. Beyond that, there are no grounds on which a communications provider could avoid complying.

How will IPA affect your business?

The websites your employees visit will be logged, and the log, your "Internet Connection Record" maintained for a year. It will include only top-level domains, not specific pages, but the privacy implications are obvious: not only could your ISP find out if your staff are accessing explicit material during working hours – as will anyone to whom it releases the data – but it could build a detailed profile of the services on which you run your company, including cloud storage sites, SaaS providers and more.

What the Act doesn't do is outlaw encryption, which may have put it in conflict with the EU, even post-Brexit, since the Information Commissioner's Office (ICO) is committed to keeping parity between British and European data regulations. These state that any company suffering a data breach could face a fine of up to £500,000 in the UK, or 4% of global earnings if the case is heard in Europe. For ISPs gathering large amounts of data about their subscribers, this puts pressure on them to treat records with care.

What will come out of the Brexit negotiations remains to be seen, but even if the ICO's plans were to change, UK businesses would need to remain mindful of GDPR, Europe's General Data Protection Regulation. This will come into force in May 2018 and apply to any business that wants to trade with an EU member.

As Kev Jefcoate of encrypted hardware manufacturer iStorage explains, "while GDPR applies to the EU, businesses outside of Europe [but that are doing business inside the Union] still need to comply if they're carrying personal data. If you fail to protect personal data and it's breached, you're liable to the same fines as a company inside Europe."

iStorage sells its products to American Express, Google and the Swiss Army, and Jefcoate sees the requirements of both IPA and GCPR as a potential point of conflict. "IPA is counter-intuitive to everything the GDPR is trying to achieve, as it says companies should provide backdoors that allow third-parties to check on your encrypted data… We don't have any backdoors. Part of our process is that we engineer technology without them, and we'll stay true to our aims of always making the most robust encrypted hardware."

It's important to remember that IPA concerns itself with who goes where and when, and it doesn't allow the Home Office or other body to read your encrypted data, but other regulations could compel a British company or individual to release the keys that would unscramble it if required.

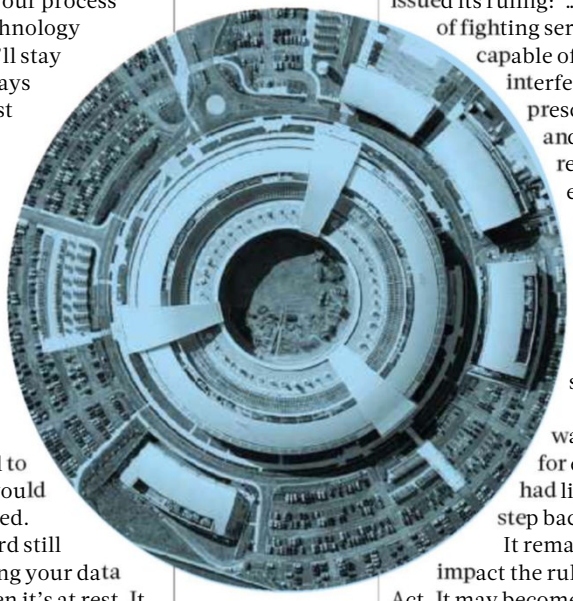
Kemp Little's Fulford still recommends encrypting your data during transit and when it's at rest. It won't stop hackers from finding out where you've been online if they access your ISP's records, but it does provide an extra level of defence.

IPA and Europe

The IPA isn't without its critics, but at its second reading in the House of Commons, in March 2016, it was passed with 281 votes in favour and only 15 against. That margin of "success" might not have been so great had fewer MPs abstained.

Its precepts were challenged by David Davis MP, who questioned the legality of GCHQ's DRIPA-based bulk interception of call records in the High Court. He won, and the government appealed to the European Court of Justice. Davis travelled to Luxembourg, where he accused the government of treating the entire nation as suspects, and shortly after the IPA gained royal assent in December 2016, the Court issued its ruling: "…only the objective of fighting serious crime is capable of justifying such interference. Legislation prescribing a general and indiscriminate retention of data … exceeds the limits of what is strictly necessary and cannot be considered to be justified within a democratic society."

"The sites your employees visit will be logged, and the log, or your 'Internet Connection Record', maintained for a year"



ABOVE MP David Davis questioned the legality of GCHQ's DRIPA-based bulk interception of call records in the High Court and Europe

By then, Davis was secretary of state for exiting the EU and had little choice but to step back from the case.

It remains to be seen what impact the ruling will have on the Act. It may become a point of contention during trade negotiations after Brexit, or it could be surplus, but in either case, the government said it was "disappointed" at the European court's ruling. Will it have to rethink its plans? Probably not, in the short term at least.

The best advice for UK businesses may be to ensure their staff are aware of the new powers the Act enables, but continue with "business as usual". ●

The expert view Davey Winder

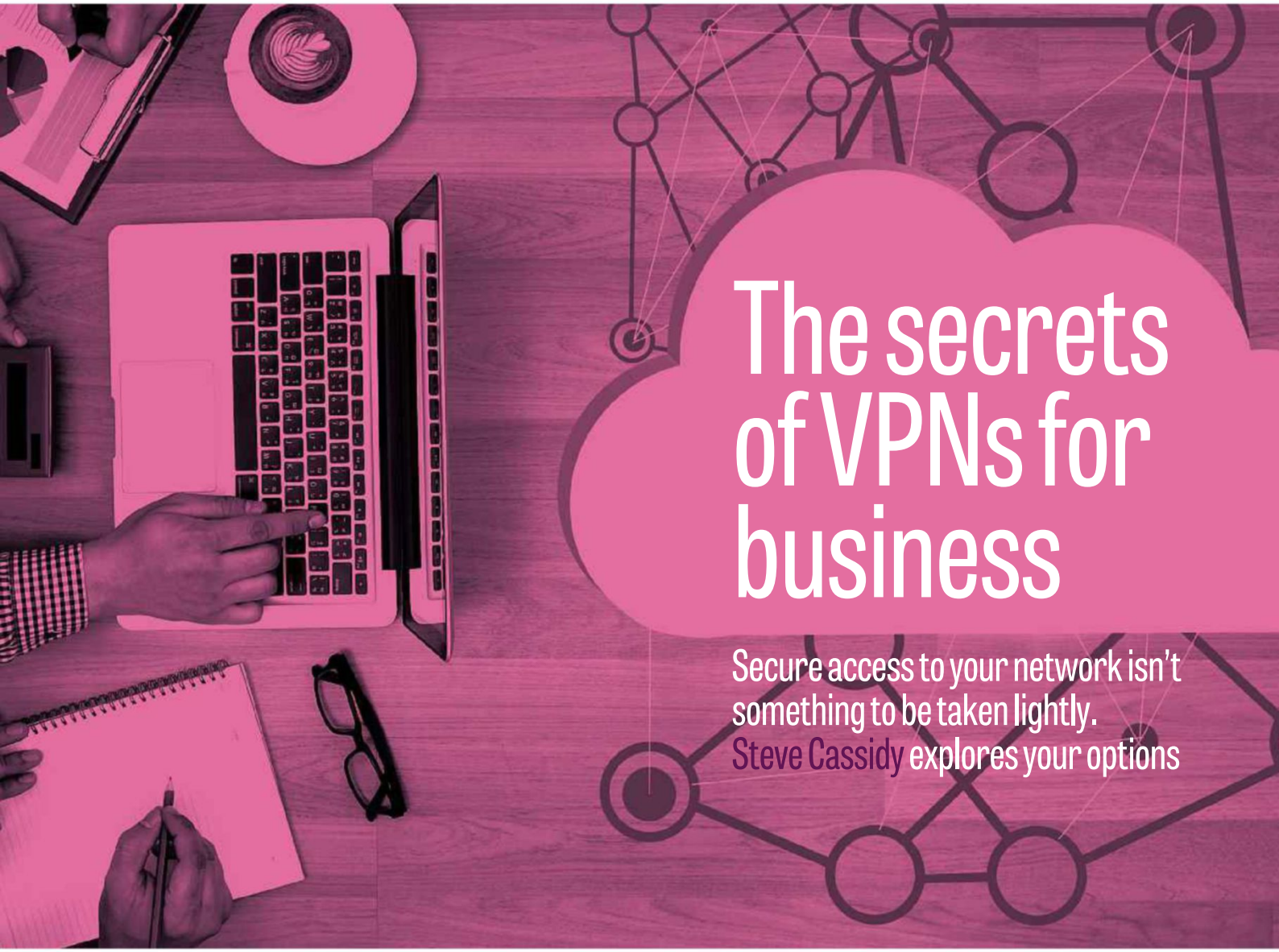
The Investigatory Powers Act extends the compulsory retention of data right down to "Internet Connection Records," which means a list of the sites each and every one of us has been browsing. These records are far more intrusive than just the kind of metadata we are always assured that law enforcement is concerned about. In fact, it means that an ISP could be required to generate a detailed site-level browsing history of an individual or organisation.

If that's not bad enough, and honestly it really is, with every ISP being obligated to maintain a database of such browsing information to enable federated searches by law enforcement, it also broadens the threatscape for attackers. There is no requirement, as far as I can tell, for those databases to be encrypted. Indeed, that they must be available for searching by government agency upon legal request suggests that they won't be.

I'm guessing we won't have long to wait for the first reports of an ISP being hacked and the IPA database being compromised. And, talking of encryption, at least we should be happy that there was no explicit requirement for backdoor access to be built into encryption services. Apart from the fact that there was.

A "technical capability notice" could require removal of encryption applied by or on behalf of a service provider. Remember that an ISP might "provide" an end-to-end encryption service and that would then become liable for such a notice. That this needs the approval of a judicial commissioner is neither here nor there – I can't imagine them turning such a request down for the most part.

The IPA requires service providers subject to such a notice to notify the government of any new services and products in advance of their launch so that it can "allow consideration of whether it is necessary and proportionate to require the CSP to provide a technical capability on the new service". Oh yes, and a technical capability is defined as including the removal of electronic protection from encrypted communications…



The secrets of VPNs for business

Secure access to your network isn't something to be taken lightly. Steve Cassidy explores your options

If you're not certain if you need a virtual private network (VPN), or how you'd go about setting one up, that's okay. Those three little letters represent a minefield around terminology, compatibility, even legality: ask the younger generation what VPNs are for and they'll think of anonymous, untraceable access to the shadier corners of the internet. Or, they might picture hackers and ransom-demanding pirates taking control of their victims' machines.

Those bad people are using a VPN, since technically the term can mean any encrypted, encapsulated link from one internet address to another. That says nothing about what it's used for, what it can or can't do, who owns it or whether it's even working. What attracts the bad guys to such technology is the fact that no-one can peer into the data that moves inside those encrypted packets – although the source and destination addresses aren't encrypted, so it's always going to be apparent that a link is active.

This is why business VPN solutions generally offer extensive security features: the value of the proposition lies in its impenetrability.

Unfortunately, as a result, the marketing spiel can lean towards impressive-sounding gobbledegook, intended to bamboozle senior management types simply looking for "the most secure VPN we can buy". If you want to make the right choice, you need to start by understanding what's possible. Then you can choose a way to do it – and stay on top of the accompanying security obligations.

The benefits of a VPN

The most important benefit of a VPN is that it cuts your internal security problems down to size. Recently, embarrassingly so, there was a time when a Windows network could be constructed over global, public IP addresses, and many early design documents and even practical implementations made use of this configuration. Quickly, it became clear how inadvisable this was: even now, the interval between opening up an unsecured machine to the internet and its being compromised is typically measured in minutes.

A VPN can help here in two ways. First, you can shut off malicious connections entirely if you make a blanket rule only to accept VPN traffic. Second, you can close off the most prevalent exploits by using a border device that doesn't run Windows. Adopting these two simple measures is much less onerous than having to keep on top of patches and threats to your entire Windows ecosystem.

"The marketing spiel can lean towards impressive-sounding gobbledegook intended to bamboozle senior management types"

This isn't to say that Windows makes a bad entry point for a VPN, or even a bad firewall. But it tends to be best used as part of a multi-device design, with firewalls, routers and SSL concentrators all playing their part in filtering, directing and brokering the traffic before it gets to the server. And

there's certainly no need to use it for regular VPN duties: one thing that's moved forward in this field over the last half-decade is the burgeoning variety of ways you can land a VPN. Let's not get bogged down in the technology, however, but look at this from a business perspective.

Small businesses

The most common way to deploy a VPN in a small business is via a slightly smart router, with some small-scale features to support roaming Windows and Apple software clients. This kind of system will do the basic job, but it's likely to be using L2TP/IPsec for tunnelling and encryption, which often has a painful effect on internet performance as the router struggles to do all the required processing.

It's also not guaranteed to keep up with changes in the environment. Many organisations relying on a setup like this have recently hit unexpected problems, thanks to changes in the VPN client in Windows 10. On paper, these promise more versatility and better security, but old routers have been left out, and the recommended solution has often been simply to go out and buy a new one. To be fair, it's difficult to blame manufacturers alone, because communication on Microsoft's part has been woeful, too. If you can't make your VPN work on Windows 10, not only are you unlikely to get a clear explanation as to why, you'll also look in vain for reassurance that whatever solution you come up with won't be borked in an update.

Even if your router-based VPN is nominally working, many businesses experience intermittent service (and hence high levels of user irritation) because the kit has to work hard and doesn't tend to cope well with issues. It's not easy to run tests on a router that can't reliably tell you when you need a hard reboot – especially when your whole organisation is relying on it for connectivity.

One solution is to move your VPN services into the cloud, rather than keeping them inside a box with some LEDs on it. However, if you're only dealing with a dozen clients, this may well be overkill. Businesses tend to assume it's the necessary next step when their low-cost router starts to struggle, when in fact stepping up to a slightly more capable local appliance could solve their problems much more cheaply.

Mature mid-sized businesses

Larger organisations are more likely to have specialist IT staff – guys who've been doing remote access since the days of the whistly-noise modem and character-based terminal. For them, VPN is the latest faddy way to do it, and they're happy to jump onboard.

But this presents risks of its own. These guys tend to be early adopters, which might be fine for them but can imply a steep learning curve for everybody else. They're also likely to want to set things up just so. This can lead to situations where changing anything at all – inside the LAN, outside it, with hardware, software, supplier or anything else – has unexpected consequences. A single cable popping loose might result in two routers both advertising as the single authoritative endpoint, causing security errors and leaving users locked out. Tracing the trail of cause and effect in a lovingly designed VPN can be agonising.

Let's not panic too much, though. Such situations are rare and high-end architecture can deliver legendary levels of reliability, especially when the people connecting to the VPN are doing so in consistent ways, from their homes or branch offices. It's when things are more chaotic and unpredictable that issues arise. Which brings us neatly to the cloud.

Modern cloud-based ventures

If you've managed to cast off the traditional shackles of information technology, then good for you. But when your assets and services are all up in the cloud, the demand for secure access doesn't just evaporate: it becomes ubiquitous.

Accordingly, both Amazon and Microsoft prefer you to present your entire pool of client machines, tablets and phones in a privately connected way. This can go as far as setting up a dedicated, and very physical, fast link between you and their nearest cloud-access point. Whether you go that far or not, both of the providers use a popular VPN technique, namely connecting over Secure Sockets Layer (SSL).

"When your assets and services are up in the cloud, the demand for secure access doesn't evaporate: it becomes ubiquitous"

Most people are familiar with SSL in the form of HTTPS, which provides secure access to web services, but that's by no means all it can do. Transporting data through a secure pipe between your browser and a website is functionally indistinguishable from a regular VPN workload – and, while many ISPs and public hotspots will block unusual connection types, they can't block SSL, as this would make most of the web inaccessible. It's not a coincidence that firewall vendors charge extra for SSL connections, controlling how many VPN users you can have operating simultaneously.

Passing your VPN traffic over SSL ought to be a no-brainer, especially if your business transacts a lot with the cloud. Unfortunately, it comes with an extra level of complexity to deal with, in the form of SSL certificates. These require renewing biannually, and come with their own classes of phishing attack, malware and spam. You'll even have to contend with competing certificate issuers engaging in dodgy customer-capturing strategies.

BELOW Microsoft and Amazon present your pool of client machines, tablets and phones in a privately connected way

Once you're in a cloud-centric business, it's very likely that all of this grief will come to visit anyway. All the same, you'll need to take a step back and evaluate how to manage the risks associated with relying on certificates. In theory, it should be fairly simple, but failures can be protracted and fantastically disruptive: being cut off from your entire computing resource is something that modern cloud businesses don't fire-drill for enough.

Another potential pitfall for heavily cloud-connected businesses is not paying enough attention to local infrastructure. A typical issue that might arise is a router wanting

to do its own thing with SSL packets, rather than loading up the certificate that's been issued. It may not be easy (or possible) to resolve the problem, short of throwing the router in the bin and replacing it with a more expensive, better-behaved model.

VPNs and the distributed business

The stereotypical use case for a VPN involves executives travelling around the world with their laptops, but this isn't how most people work in daily life. In many cases, it's about working from home, while maintaining reliable, secure access to professional-grade resources. These can include videoconferencing facilities: I've even seen bedrooms with one corner painted in the company standard hue, along with a company standard desk, printer, wired phone and desktop PC, all transported from the mothership.

This sort of environment is what the big firewall companies make small firewalls for. Rather than messing with distributed traffic gateways and the challenges of remote support, it's far easier to look at the lifecycle costs of setting up proper little IP subnets at each home office, each one supporting whichever devices the job requires.

Ensuring that an arrangement such as this is properly fault-tolerant isn't a trivial matter. There are pressures from all sides. Plenty of ISPs will offer something like this as a turnkey solution – but they'll run it over their own wires, rather than over the public internet. This means users can't plug into their home router and go, and you're stuck with the provider's timetable for maintenance operations, which can be in the order of weeks rather than days.

And what if the line goes down? You can get routers with 4G SIM cards, to keep an internet connection going if the main line is lost, but there's absolutely no way to guarantee performance. Apart from anything else, your teleworking neighbours may well be in the same boat and hitting the same cell. No wonder distributed businesses are becoming increasingly interested in the new wave of collaborative productivity platforms, which are usually presented via web browsers and can be used over any consumer-grade connection.

ABOVE **Several cloud VPN services only do IPsec and not SSL, meaning you can't rely on connecting from anywhere**

A few final caveats: remote access can be tricky to manage if you have a high staff turnover. Very few distributed VPN services are responsive enough to disconnect a departing staff member in the time it takes them to leave the office and drive home. Another issue is whether the local council approves of turning an employee's home into their regular place of work: there have been cases of two-up two-downs being re-rated as business premises, with all the associated tax implications.

Cloud VPN providers

As mentioned, there's no technical need to invest in a full physical VPN hardware solution. Cloud VPN services let all your clients connect (via the provider's endpoint software) through a hosted server, which then connects to your central resources.

One big advantage of these services is that they're normally very prompt with fault rectification, since they do nothing else all day. They can also be much simpler to manage for an uncomplicated business setup – but you may hit conflicts if you're signed up with a big cloud provider that requires you to use its VPN to access your hosted resources.

"One big advantage of these services is that they're normally prompt with fault rectification, since they do nothing else all day"

Another disadvantage is that several of them only do IPsec and not SSL, so you can't rely on being able to connect from any old café or hotel lobby. This can cramp the style of a mobile workforce: thinking about the peripatetic nature of *PC Pro*'s editorial team, I doubt I'd survive recommending they use a cloud VPN product that couldn't do SSL... ●

Nearly VPNs

Depending on your needs, a classical VPN might not be the only, or best, solution. One alternative is remote desktop access, via services such as GoToMyPC, TeamViewer and LogMeIn. These products appeal to managers who fear the complexity and costs of a full VPN, and they tick the key boxes: the traffic between the controller and the controlled PC is encrypted, and you can normally connect from anywhere.

But if you want to take this route, there are some significant issues to consider. Offering a convenient gateway for users to connect to a machine inside your company's firewall necessarily means opening up the same opportunity to unscrupulous hackers. Some businesses address this by sending their remote-control traffic over their VPN, just to make you think about that combination. What's more, while the costs may seem low at first, the licensing structure can quickly become restrictive and expensive. Some of the product-support remote-control apps come in at £1,500 per year per starting licence, which may quickly turn you back onto more traditional VPN solutions.

Another idea that could, in theory, replace a conventional VPN service is taking advantage of IPv6 to open a secure connection directly to any internet-accessible device. I've seen Microsoft staff do this in meetings: if they've left a relevant file on their desktop PC back in Redmond, they simply pop open an IPv6 Teredo tunnel, from wherever in the world they happen to be at the time, and grab it.

This shouldn't be taken as a recommendation, however, not least because I honestly have no idea what sort of defences Microsoft has at the edges of its IPv6 network. I suspect that its security resources are formidable indeed, and the number of companies who can match them is evidently small, because I seldom see anyone else even trying to dip a toe in the water.

Indeed, although IPv6 was originally envisaged as a general-purpose transport for connecting any two devices in the universe, there's a whole range of alternatives out there, including completely private protocols, such as those underpinning Amazon's services. Rather than becoming the universal transport, IPv6 may end up being an ancestor of the eventual winner – which isn't at all clear right now, and may not even exist yet.

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JON HONEYBALL

"Most AV companies make my cynicism-o-meter hit the end stop and bend around a few times thereafter"

Jon reflects on the most interesting products from this year's CES, including a security-focused router from Symantec that might just live up to its promise

While trying to recover from the inevitable post-CES flu, and catching up on the work backlog, I've been going over several items that raised their heads at CES.

One that really piqued my interest is the new security router/Wi-Fi unit from Norton, a Symantec-owned brand. Now it's probably best to put my cards on the table, and this may shock you, but I'm a naturally cynical person. And most of the AV companies make my cynicism-o-meter hit the end stop and bend around a few times.

If you want to see examples of just how cynical these firms can be, browse their websites and try to work out which features are included in the various OS versions of their products. If you can do so, you're a better person than me. Especially when it comes to nitty-gritty issues such as, "does this feature work on Android 6 or 7?" Or explaining why almost nothing works on iOS – because, as we know, iOS is locked down hard and needs none of that stuff.

Anyway, I digress. Symantec creating some hardware is an interesting move, for a number of reasons. First, the home Wi-Fi router market is populated by products that would put a psychopathic chicken molester to shame. Let's just drop double NAT into your network; that sounds like a whole bundle of fun. Want some configuration screens? Come over and play with this web interface, which is written in unreadable-speak using terms that require sandals, a ponytail and poor personal hygiene.

As a parent you want to set up parental controls, time-filtering and content-monitoring. Excuse me, because I need a good five minutes to recover from this laughing fit. Do you have any faith that the settings you've engaged actually work? I accept that you've done your best, but do you have any confidence?

Want to ensure that the firmware is up to date, to try to ensure that some remote script kiddy in Moscow isn't hacking into your router and injecting poison into your DNS? Ah, that requires you go to the manufacturer's website, find the product buried deep in what laughably passes for a support section, only to realise that there are seven different hardware versions of your beloved box.

Having groped around the back of the box to see if it's the B or C revision hardware, you must then choose which firmware version to download.

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@jonhoneyball

Now I don't know about you, but 3.45.16-AB_QWAK-14-AJ.ZIP sounds less like a firmware version and more like someone having a sneezing fit when hitting Save As. Even better is when it isn't a ZIP but some other compression format that you've never heard of, and requires the download of an un-compress tool from a website that also appears to offer Spanking Grandmothers.

Hey, we now have the BIN file! Time to install it, so you fire up the incomprehensible website within the router, struggle to the relevant bit, hit the "Choose file" button, then the BIN file; then sit back and wait. Once it's rebooted or, even better, has crashed on the shutdown routine so needs a hard reset, your router is back up and running. Except that it isn't, because it has managed to lose all the configuration information. So it has no idea where its ISP is, or what login information is required, or even what IP addressing it's supposed to use.

The Wi-Fi configuration has gone, too, so your laptop now needs an Ethernet cable to connect to it – and this is one of those modern laptops that doesn't have an Ethernet port. So you go looking for the USB-to-

BELOW The Norton Core doesn't just look different to normal routers, it treats security in a totally different way too

ABOVE Can you spot the router?


Jon Honeyball
Opinion on Windows, Apple and everything in between – p110


Paul Ockenden
Unique insight into mobile and wireless tech – p113


Kevin Partner
Make your email communication more effective – p116


Davey Winder
Keeping small businesses safe since 1997 – p118


Steve Cassidy
The wider vision on cloud and infrastructure – p120

Ethernet adapter, and a cable too. Now it's in the loft *somewhere*...

Does any of this sound familiar? Is it any surprise that grown-ups are turning to solutions such as Cisco Meraki for their home networking, on the grounds that everything described above is the very definition of untrustworthy?

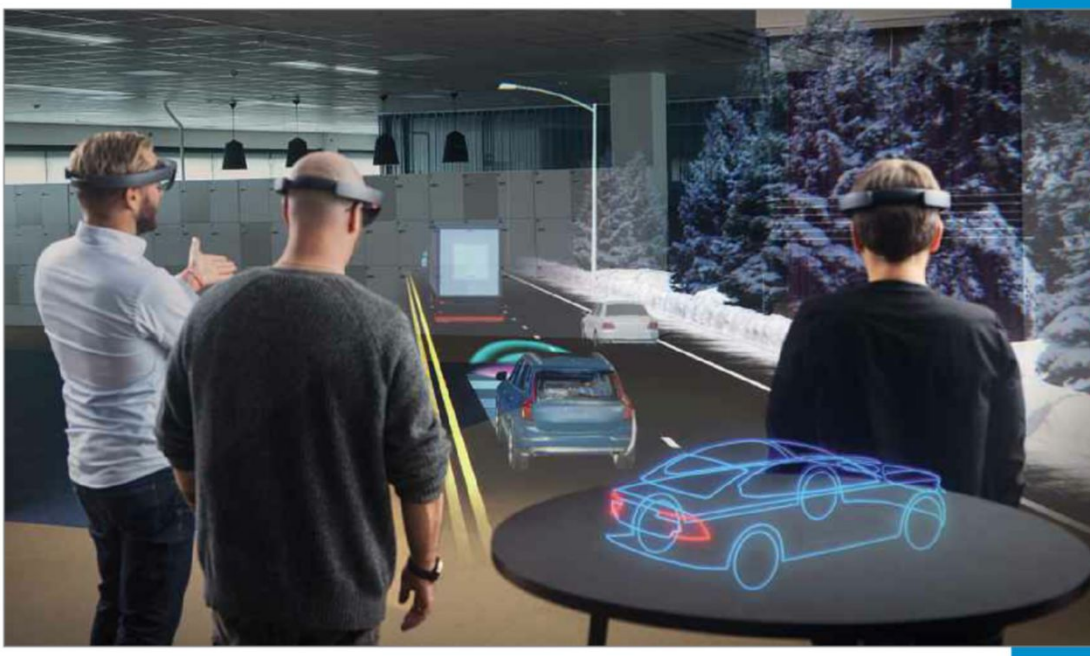
Not surprising, then, that Symantec thinks it can do better. I had a meeting with the lead developers behind the firm's box – and I'm impressed. I threw every "I hope you aren't doing this?" question at them, and they responded with sensible answers. They have an app under development that looks like it wasn't written by Martians, and that will hopefully be usable by the man in the street.

They're not using the 192.168 address range, instead trundling down to the mostly forgotten 172.16.x.x to 172.31.x.x range. Why? Because it's then totally obvious whether an IP address has come from the DHCP in the Norton box.

It's likely that the upstream feed to it will have been NAT'ed already by the ADSL/fibre/cable box, and it's almost certain that this is presenting on the usual 192.168.x.x range. So it makes it obvious if you're in 192.168 land (and, hence, upstream of the Norton firewall/Wi-Fi/router) or in 172 land, in which case you're downstream of it. Most other vendors simply like to play footsie in the 192.168 space, so is it any wonder that confusion reigns?

Impressed, I dug deeper. The aerial design is interesting and I had a long chat with the lead hardware designer. It's capable of full mesh mode, so it can handle full-speed re-routing between a number of Norton boxes, but this may not be available in the first release of the firmware. The iOS software – as it stands today – is a little flaky, but is functionally nearly complete. Plus it shows a clear understanding of what's required to get such a product up and running, and properly configured in the home environment by normal human beings who aren't Cisco professionals. Or ones with sandals, a ponytail and poor personal hygiene.

So yes, I'm intrigued by this box. I like the clear thinking that's going into it. Symantec has genuinely started with a clean sheet of paper and is working towards a product solution that fits the home needs for 2017. The reason it isn't shipping until the summer is because it isn't quite ready, but it was ballsy of the company to sit its team down with me and go into full "politeness as an offensive weapon" mode with its key players. They survived the two hours with good grace and solid, interesting answers. Without doubt, this is a product move worth keeping an eye on. I sincerely hope Symantec doesn't mess it up between now and the summer.



ABOVE **CES had lots of VR on show, but I'm more interested in enhanced reality offerings such as the Microsoft HoloLens**

"It can be configured by normal human beings who aren't Cisco professionals; or who have sandals and a ponytail"

VR headsets and data rates

There was lots of VR on show at CES 2017. Lots and lots of VR. If you weren't strapping something on to your body, it wasn't a real tech (that's quite enough of that – Ed).

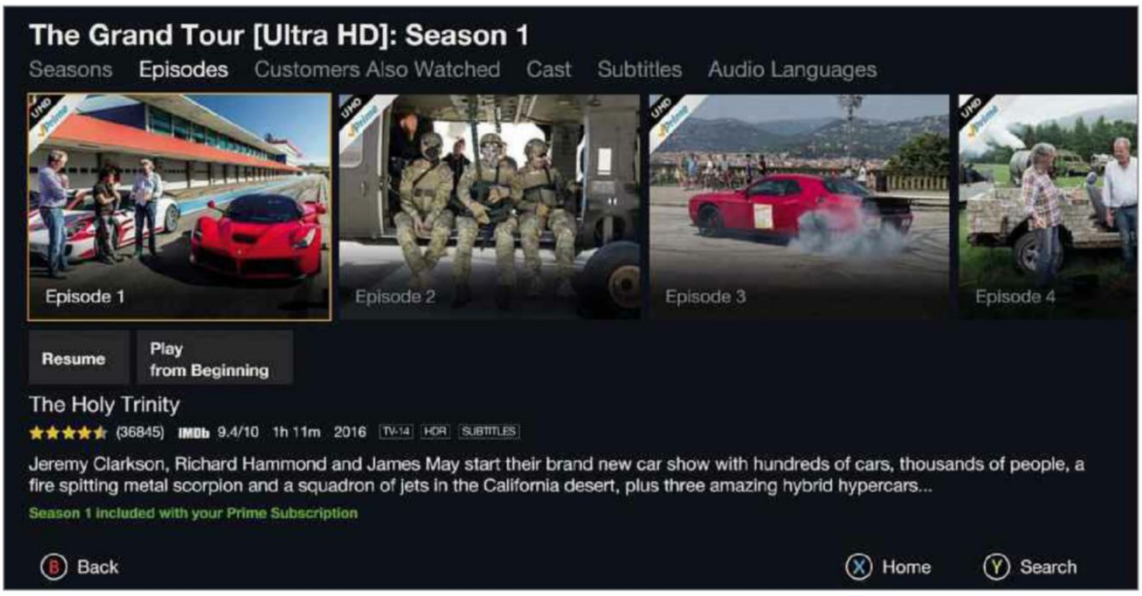
But here's the problem. Want to make VR work properly? It requires high-resolution images; let's say 4K as a good starting point. It needs two, one for each eye. Now let's just ignore the issues of strapping such a thing onto your head and hoping it doesn't bring on a major bout of head droop as your neck muscles give up the battle to keep your head level.

Instead, think about the sort of processing required to generate an immersive 3D space that's then rendered onto two 4K screens. This isn't the stuff of cellphones plonked into cardboard cut-out headbands. I've tried that on my Samsung Galaxy S7 Edge, and it's horribly low resolution. This is the stuff of a seriously high-end gaming rig, the sort of object that makes a teenage lad come out in even more spots.

No, VR isn't going to be serious for a long time. However, enhanced reality – where you drop artificially created things into your field of view – is an entirely different bag of frogs. Often one eye only, with potentially a lower-resolution display space, simply because the projection space isn't the full field of view. I know Google tried this, but it screwed its own project right from the start by insisting that the utterly irrelevant camera was built in, thus rightfully opening up a huge and wholly distracting argument about privacy.

BELOW **Sorry Samsung, but the Gear VR ain't high-res enough for me**

I'm much more interested in this enhanced-reality solution than VR. I know it doesn't have the "whizz bang" wow factor of VR, but it's genuinely useful to a far wider range of users. And you can walk around



with it too. Whether it needs to be a full quasi VR headset in the way of the Microsoft effort is something that only time will tell. I suspect not, but let's wait and see.

Stuttering Grand Tour

I have a love/hate relationship with *Top Gear*. I loved the huge cinematic films that the show created, and I loved the pub-style banter among friends. It told me nothing about the cars, but that wasn't the point. As it went stale, and then fell off a cliff with the truly execrable 2016 reboot version, I was worried that the good bits were gone forever.

With the *Grand Tour*, Clarkson and crew are making a valiant effort to bring back the original magic. I'll not mince my words: much of the new series has been enough to make me wince. But the large cinematic pieces have been glorious. Why? Because they've taken the bold and brave decision to film everything in 4K. That means four times the data rate/storage of HD. And when you watch it via an Amazon Fire TV HD box on a big 4K HDR TV, the results are stunning.

That's until the picture stuttering kicks in. I have super-fast internet at home (two FTTC lines giving me 80Mbits/sec downloads) and even faster in our IEC-specification listening/viewing room at the lab. But even on that, the picture can take on a jerkiness that's deeply annoying, of the type that I haven't seen using Netflix in 4K. I think I need to dig out the network analyser tools to see what's going on. I suspect it's an upstream bottleneck issue that needs nailing.

On the subject of internet speeds, I've just upgraded the primary interconnect speed at the lab to 1Gbit/sec in/out on fibre. Cue the jokes about being able to download truly eye-watering amounts of porn in an unfeasibly short time period. The connection is between us, building number two in our office complex, and number five – which is our ISP (**merula.net**).

So I now have 1Gbit/sec between us and its data centre, which means I can move our boundary firewall into its data centre, and thus put storage and archive boxes in there that can be addressed at full LAN speed. This provides a level of additional security and resilience, because it's unlikely that a building fire at number two would spread across to number five.

Of course, this is all in addition to the other archiving and off-siting that goes on. But the useful upside is that we now have access to Merula's core network at full gigabit speed.

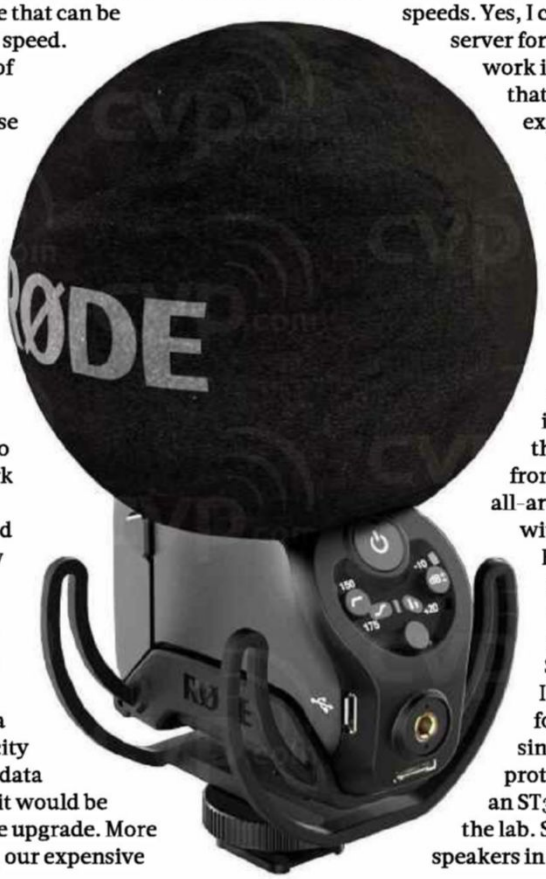
What's that – you'd be interested to know what sort of speeds we can get on a Speedtest.net check? Well, it runs to about 175Mbits/sec in/out. Merula doesn't have a spare gigabit of capacity for me to the London data centres, but I'm sure it would be happy to quote for the upgrade. More importantly, though, our expensive Cisco Meraki firewall tops out at about 250Mbits/sec when doing full packet inspection. Given that the whole point of a firewall is to firewall, doing full inspection with all the knobs turned to 11 seemed to be a good idea. At that point, it can cope with about 250Mbits/sec of throughput, which isn't unreasonable. I could get a faster one, but it would cost far more.

Aha, you say, my WankyWoo Firewall Plus costing 120 notes can do faster than that. Maybe it can if the firewall isn't actually doing any work. But check the specs to see how well it can handle full firewalling on multiple devices. A few years back, when we had a mere 100Mbit line, I bought a well-regarded firewall that claimed it could cope with this throughput easily. No, not when you demand it does some real work. It might be worth looking at your firewall and working out just how well it can do real work in a meaningful way.

Having increased our line speed, it's easy now to update 20 Windows laptops to current builds at full speeds. Yes, I could use a local update server for this, but it wouldn't work in this case for reasons that are too boring to explain.

ABOVE The Amazon-exclusive *Grand Tour* looked great but suffered from some stutters during streaming

BELOW I'm quite unreasonably excited about the Rode VideoMic Soundfield



Final thoughts

First, I'm incredibly excited by the acquisition of Soundfield Solutions by Rode. Soundfield is a UK company that makes the Soundfield microphone. This is an incredibly clever device that records left/right, front/back, up/down and all-around, and it comes out with something called B-format, which you record on four channels of a digital recorder such as the Sound Devices 788T. I've used Soundfield kit for more than 30 years since the earliest prototypes; and we have an ST350 portable rig in the lab. Setting up eight speakers in a cube to do full

height of playback of Spitfire planes going overhead is truly astonishing to hear.

Rode is a top-flight microphone manufacturer based in Australia. Its products are high-quality at affordable prices. That's why you'll see its VideoMics on just about any sort of camera rig at shows such as CES. It's the go-to manufacturer in this space.

So why the acquisition? Well Soundfield has been going nowhere fast for far too long. It kept going by selling small numbers of mics to loonies such as me at prices that even I find embarrassing, and by getting into the surround marketplace for large stadium TV work – where it's done well.

Just the sheer mention of B-format, and what it can do, should make you think of VR, and all the platforms that support that (including YouTube). So I'm thrilled to see that Rode has already announced its VideoMic Soundfield, which is under development now. This allows you to pop one of these devices onto your serious camera of choice, and to be able to record B-format audio for post production. I can't wait to try it.

Speaking of B-format, the lovely software plugin called Harpex (**harpex.net**) has just been upgraded to version 1.4. And I see from the release notes that it now has default configurations to support Dolby Atmos.

We have a full calibrated Atmos setup in the listening/viewing room at the lab, using a large system from Pioneer with 5.1.4 or 7.1.6 output. Height information from Atmos-encoded Blu-ray or 4KBD (Ultra HD Blu-ray) is stunning. Being able to take my B-format recordings and output them onto the Atmos setup will be a fun project to try over the coming months. And it also allows videographers using the VideoMic Soundfield to do the same.

Second final thought. I don't like politicians, and I don't trust any of them. But given the actions in the first week of President Trump, one wonders how happy you might be with your data held by a US corporation now. Just a little thought to make you pucker up.

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PAUL OCKENDEN

"If you don't stump up a monthly fee then the camera just becomes a very expensive peep-hole"

Looking for a cloud-connected camera? Then you're in luck, as Paul concludes his roundup of the latest "cams"

As promised last month, I'm going to look at a few more cloud-based cameras in this column. On the desk in front of me I have a Nest Cam, a Ring Stick Up Cam (complete with solar panel accessory), a Y-Cam Evo HD, and finally, the new Arlo Pro I mentioned last month. All apart from the latter were kindly loaned to me by the folks at Vesternet.

Let's begin with the Arlo Pro. I'm using the new camera with my original Arlo base station, so I'm not able to test the siren or the local USB recording that the complete updated system provides; I'm just focusing (excuse the pun) on the updated camera. And I'm sure the fact that it will work in existing installations will please those who have already invested in Arlo setups.

The new camera is bigger and heavier than its predecessor, but it can be used with the same magnetic mounts, since it has the same circular "dent" in the body. As a result of the extra weight, I find it can wobble a little more when used outdoors, especially in a strong wind, but not to the point where it causes problems.

Paul owns an agency that helps businesses exploit the web, from sales to marketing and everything in between
@PaulOckenden

BELOW The Arlo Pro is similar in design to the original Arlo, but slightly bigger and heavier

Since I've been testing the new camera, I've noticed that it requires a stronger wireless signal than the old one. I had one original camera that was right on the edge of reception, but when I swapped it for the Arlo Pro, I couldn't get a connection at all. A second camera was mid-range with the old Arlo system, but when I swapped it for the Arlo Pro I began to see break-up in my video recordings. Perhaps these problems would be resolved if I'd also used the new base station? I'll let you know as soon as I get access to a complete Pro system.

There are several benefits to the new camera, the most obvious that it can handle audio as well as video. This not only means that your video clips will be recorded with a soundtrack, but that you can trigger the recordings from sound pickup as well as motion – perhaps a door slamming or a vehicle approaching. The audio facility is two-way, so if you receive an alert that there's someone at your front door, you can see it's the Amazon guy and tell him to leave the package in the garden shed.

I mentioned last month that with the original Arlo system there exists a bit of a lag between motion detection and the start of recording. In fact, it's one of the main complaints by users. This is an issue you'll find to a greater or lesser extent with all battery-powered security cameras, but the delay is greatly reduced with the Arlo Pro. So much so, in fact, that I suspect it won't be an issue for most people.

What else is new with the Arlo Pro? Well a significant difference is that it now contains a rechargeable battery. It's a custom battery pack, though, so you can't just insert standard rechargeable batteries. And nor can you plug the charger into the battery pack; you have to charge it either in the camera (which probably means taking the whole thing down), or you can buy a separate charging station and plug the battery into that. This all feels a little awkward to me.

The micro-USB port used to plug the charger into the camera can also be used to permanently power the device. Although, frankly, I can't see the point – if you don't need a truly wire-free camera then there are better options out there, some of which I'll come on to shortly.

All in all, the Arlo Pro is a worthy improvement over the original model. The two-way audio and faster startup times are especially welcome. But with more flexible charging options and better wireless sensitivity, it could have been even better still.

Ring ring

Sticking with completely wireless cameras, let's look next at the Ring Stick Up Cam. By the way, notice how so many of these devices are now called "cam" rather than "camera" – there's a definite trend here.

Ring is a company best known for its connected doorbell range, but given the fact that these feature a built-in camera, it was a logical brand extension to build a standalone wireless "cam". The Stick Up Cam is suitable for outdoor use, although I note that the manufacturer describes it as "weather-resistant" rather than waterproof. It might be best to mount it under the eaves, or somewhere that provides similar protection from driving rain.

The key difference over the Arlo cameras (or, indeed, Blink – which I also mentioned last month) is that you don't need a base station. The Ring Stick Up Cam hops onto your Wi-Fi – and that's it. Much like the other two systems, recordings are stored in the cloud. However, there's no free option with Ring; if you don't stump up a monthly fee of £2.50 then you'll only be able to use the camera in "live view" mode, turning it into a very expensive peep-hole. It's important to factor in the subscription cost when comparing these products. Actually, £2.50 isn't bad; it's the price of a coffee. Some other camera systems have much higher subscription charges, as we'll see in a moment.

Design-wise, the Stick Up Cam is less discreet than the Arlo or Blink cameras, so you might be concerned that people may notice it and steal it. But Ring offers to replace any stolen cameras for free (if the theft has been reported to the police).

ABOVE **The Ring Stick Up Cam isn't discreet, but Ring will replace any stolen units**

One fascinating optional extra is a solar panel, which keeps the internal battery topped up. The fact that you don't need access to change or charge batteries means you can mount the camera in places that are harder to reach. Throughout my time testing it, I haven't noticed the battery level drop below 90% with the solar panel attached – even on cloudy days.

As is usual with such items, the Ring Stick Up Cam is controlled via an app, either Android or iOS. There's also a web interface, but that provides access only to the (paid-for) recordings; you can't use the live-view mode from a web browser. This is an annoying limitation. I've also noticed that, using the app, live-view can sometimes take quite a while to connect to the camera – usually around ten seconds, but it can take up to a minute.

The night-time view uses infrared LEDs to illuminate the scene, but, curiously, it doesn't switch to monochrome mode in the way of most other cameras. You can still see some colours, although you shouldn't rely on them for identification purposes. A black fleece jacket that I was wearing looked light blue at night!

Like the Arlo Pro, the Ring Stick Up Cam features two-way audio, and the quality is great – probably the best of the wireless cameras I've tested.

"The fact that you don't need access to change or charge batteries means you can mount it in places that are harder to reach"

Motion detection, on the other hand, can be laggy. It's on a par with the original Arlo cameras. Unless you position the device carefully, you'll find yourself recording lots of people as they just walk out of frame.

Ring has created a well-made, solid device, and in the box you'll find everything you need – not just the usual screws and Rawlplugs, but also a screwdriver and a masonry drill bit! I'm still undecided whether that's truly helpful or just a bit gimmicky, but let's give Ring the benefit of the doubt.

So, overall it's a great product. If the recording delay could be improved and a basic free tier provided for cloud recordings, the Ring Stick Up Cam would move to near the top of my list.

Nesting instinct

Next up is the Nest Cam. It's important to note that the version I'm looking at here is the indoor model. The outdoor version is essentially the same thing, but with waterproofing and a longer power lead. Actually, there's a small difference with the hardware, too: the indoor version uses 2.4GHz and 5GHz Wi-Fi, whereas the outdoor version is old-school 2.4GHz-only. Although, confusingly, in the USA the outdoor model does 5GHz as well. To be fair, because of the range limitations of 5GHz, you'd probably have to use 2.4GHz outdoors anyway. It certainly isn't something to worry about.

Since the Nest Cam has a permanent power supply, it's able to work slightly differently to the other cameras I've looked at so far. The latter have all used PIR detectors to wake up the camera on sensing warm bodies. But when armed, the Nest Cam's camera is active all the time, and looking for movement based on changes in the actual picture it sees. This provides added flexibility.

Now, Nest is better known for its wireless thermostats and smoke alarms. The cameras came latter (Nest bought a company called Dropcam), and you get the impression that it's been somewhat shoehorned into an existing infrastructure. Control is via an app and a website, but at times both can seem a little clunky. It probably makes more sense if you already have other Nest services, but when used purely for camera control, the Nest Cam isn't as slick or as intuitive as the others here.

Without a subscription you get only a live view. A cloud option called Nest Aware is available: £8 a month provides ten days of recording; £24 a month allows 30 days of recording.

Yes, you read that right – £24 per month. Or £240 if you pay for a whole year in advance. There's a 50% discount on the subscription for additional cameras, but to run a six-camera setup will still cost a staggering £840 per year.

With other cameras offering free cloud storage, the price seems excessive. However, with a Nest camera you're potentially recording a lot more than you would with one of the battery-powered cameras. You see, it doesn't just upload clips to the cloud when motion is detected; the Nest Cam records constantly. As a result, the company must surely be using far more storage (it's hosted on a combination of Amazon and Google cloud platforms). I suspect that accounts for at least some of the high subscription price.

This constant recording will eat into your monthly broadband bandwidth, and could pose a problem if you use a capped service. Typical use is around 60GB per month, but it can peak at up to 380GB if you select the highest quality. You certainly wouldn't want to use the Nest Cam if you rely on a mobile connection for your data!

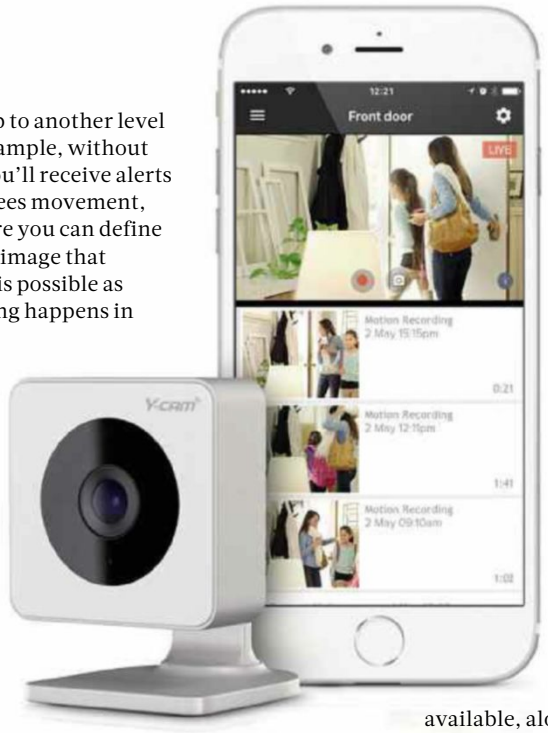
Even without the cloud subscription, the Nest Cam is useful because the quality of the image is excellent, and the streamed video works well. You can even embed it in an iframe on your website. But add the Nest Aware cloud subscription and things move up to another level completely. For example, without the subscription you'll receive alerts when the camera sees movement, but with Nest Aware you can define "zones" within the image that trigger alerts. This is possible as the image processing happens in the cloud.

I really like the Nest Cam. It's solidly built, displays superb image quality, can use even the weakest of Wi-Fi signals, and (when used with Nest Aware) offers constant recording – the only camera here to do so. I also like that you can control the LED on the camera from the app; in some situations it's important that people can see they're being recorded, but for other uses you want a device that doesn't draw attention to itself.

I just wish the subscription costs were more reasonable. £240 a year running costs for a £150 camera is hard to swallow.

Why the Y-Cam?

My final option, the Evo HD from London-based Y-Cam, offers much lower running costs. And I must say it's great to have a British product in this roundup.



ABOVE The tiny Y-Cam Evo is great, but the Android app seems much more polished than the iOS equivalent

The first thing that strikes you is the size of the camera – it's tiny. Matchbox-sized. It's super-light, too. So much so that I was tempted at first to just stick it to a wall using VHB tape. Unfortunately, this isn't possible because the micro-USB power connector is on the back, rather than the side. You really need to use it with the supplied stand or wall mount, which is also tiny.

As usual, there are Android and iOS apps available, along with a website. The Android app works well, as does the web interface, but I struggled a little with the iOS app. It seemed sluggish, and would often miss the first few seconds when playing back a captured video clip. I think it needs some more time in the QA lab.

In fact, sluggishness is something that seems to crop up at various places in the Y-Cam system. Even when using the website, it would sometimes take quite a few seconds to connect to the live video stream. On occasion, I also found that I'd receive a notification around 20 minutes after a clip had been recorded. At other times, I'd receive a notification of movement, but it would then take a while before the clip showed up in the app.

This is a shame, because in most other respects the Y-Cam Evo has plenty going for it, including the fact that you get seven days of cloud storage for free. There's no 24/7 recording, as with the Nest Cam, but for most people that won't be an issue. Especially since the camera uses an internal buffer, so the recordings it saves start a few seconds before the motion is detected. There's no control over the flashing LED when recording, though, so despite the small size, this camera will never be discreet. Two more pluses: the on-board speaker provides two-way audio and audio quality is pretty good, too.

So what's my final verdict? If you want an outdoor camera then I'd suggest the Arlo Pro. For indoor use, it's a toss-up between Blink and the Y-Cam Evo. For 24/7 cloud recording, go for the Nest Cam – just be aware that you'll need deep pockets.

@PaulOckenden

"Even without the cloud subscription, the Nest Cam is useful because the quality of the image is excellent"

LEFT Nest Aware offers 24/7 recording in the cloud... for a princely sum

KEVIN PARTNER

"As marketers we need to become cleverer with the way we encourage our customers' attention"

Want to earn more from existing customers? Kevin explains how to personalise your emails and provides five tips to boost customer numbers

Despite the rise of social media, email is still king of the internet marketing heap. I ran a promotion recently with a group of other creatives, using a combination of email, Facebook and Twitter promotion, and you won't believe what happened next. Over the period of the promotion, 87% of transactions could be attributed to an email, 8% to Facebook and the rest to Twitter. This, despite the social media audiences being an order of magnitude bigger than email lists.

The continuing effectiveness of email makes it all the more surprising that marketers don't innovate in their communications with customers. For example, it's common to use an email sequence to sell a product. The sequence usually begins with educational content and ends with the selling phase. Wouldn't it be nice if the marketer stopped sending sales emails once you'd bought the product, perhaps opting for a welcome email and tips on using it instead? By doing this, emails appear less impersonal to the customer and they feel they're getting the information they need – rather than being blasted by spam.

Similarly, many people sign up for an email newsletter because they like the overall content, but end up ignoring emails because too many are irrelevant. It's common for larger firms to have several lists into which they sort customers, based either on past behaviour or what the marketers think they might be interested in. However, it's much more effective to give subscribers the option, within any message, to opt out of subjects that don't interest them without unsubscribing from the list as a whole.

Debenhams, for instance, becomes interesting to me precisely twice a year: before Christmas and around the time of my wife's birthday. The rest of the time, its emails lie unopened in my inbox.

Kevin is a serial entrepreneur who has set up a number of successful online businesses
@kevpartner

"Debenhams becomes interesting to me twice a year; the rest of the time its emails lie unopened"

The two faces of marketing email

Broadcast emails are one-off messages to a mailing list. They're most often used to promote specific events, such as sales, so if customers open the email too late then the offer might have expired. Broadcast messages are the default form for email marketing, since they're both easy to set up and can produce instant results.

Autoresponder sequences (often called automations), however, are the bread and butter of most long-term internet marketing campaigns, producing results month in, month out, as new subscribers join the list. According to email analytics firm Litmus, while automated messages make up only around 5% of the emails sent by a firm, they contribute more of its income than any other form. Traditionally, an autoresponder begins as soon as a subscriber signs up; emails are sent at a set interval until the pre-programmed sequence is complete.

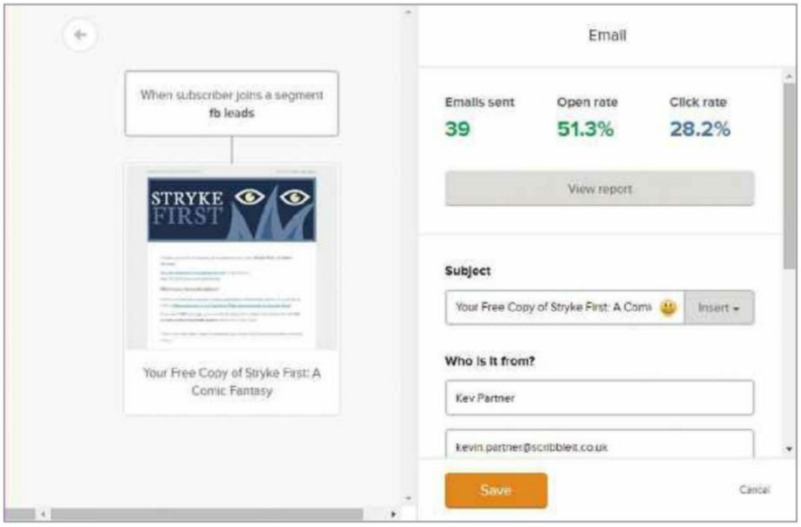
As inboxes fill up and the number of marketing messages a customer receives passes the saturation point, the days of "set and forget" are behind us. As marketers, whether that's on behalf of a corporation or our own micro-enterprise, we need to become cleverer with the way we use and encourage our customers' attention.

Relevant, informed and personal

One way to get future customers onto your mailing list is to offer something they value in exchange for their email address. Classically, this would be a report written to appeal to the specific market the business is targeting. Having provided their email address, the subscriber expects to immediately receive a link to download their report. This is typically the first email in a sequence that both expands on the information already provided and prepares the way for a later sale.

However, these sequences are almost always linear and assume the subscriber has both downloaded and read the report. If they haven't done either, the later messages are irrelevant and will likely be ignored. A better approach, then, is to set up the automation so that it takes a different path, one that depends on the actions of the subscriber.

For example, if the subscriber doesn't click the link to download their report, the next email should be a gentle reminder to do so. Those who do click it receive a different message – one that thanks them for downloading it and, perhaps, offers suggestions about the best way to consume the material. This same message is sent to those that didn't download the message at first, but subsequently clicked on the link; subscribers that never click the link are removed from the automation sequence entirely.



RIGHT MailerLite is a lower-cost alternative to MailChimp with excellent workflow features

Which email provider?

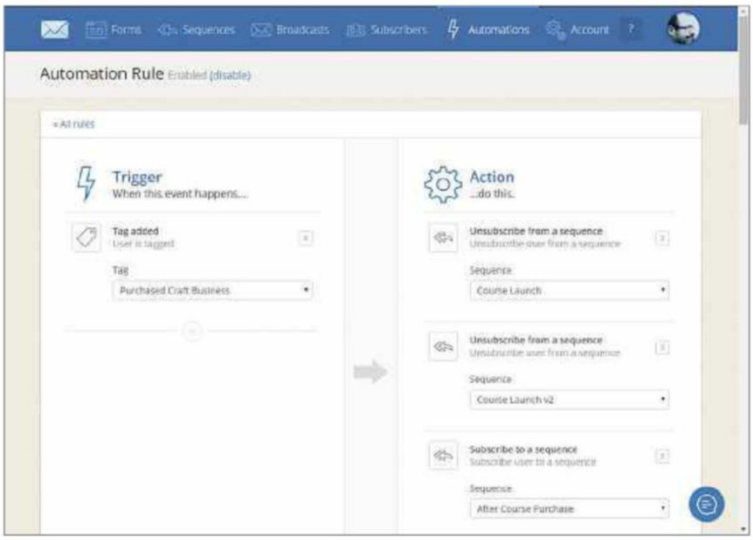
All the main email marketing services offer automation of some sort, but the level of sophistication varies according to price. MailChimp (**mailchimp.com**) is the default choice of most marketers and has been beefing up its automation in the past couple of years to the extent that it can now, for example, send an email based on whether a link has been clicked. MailChimp also integrates with many other services, including several ecommerce providers, so it can be used to send emails to customers who abandon their shopping carts. This is an effective way of increasing your conversion rate at no extra cost.

MailerLite (**mailerlite.com**) is a cheaper alternative to MailChimp and is my favourite budget service. It offers most of its competitor's features, but its new automation workflow is easier to use than that of MailChimp, amounting to dragging-and-dropping a flowchart with decision blocks and multiple email sequences all in one automation.

Compared to MailChimp and MailerLite, ConvertKit (**convertkit.com**) offers a step up in the sort of personalisation you can use. By adding tags to subscribers in response to their actions, you can set up different automations for different combinations of tags. For example, you may have a tag that's automatically set when a subscriber completes a purchase. You then know not to ever email them again asking them to buy that product.

ConvertKit is powerful, but expensive. For a smallish list of 2,000 subscribers, it charges $49; MailChimp is $25 and MailerLite $10. ConvertKit is only worth the extra if the subscribers on that list are valuable enough to justify the extra expense – and if you'd convert more of them into customers as a result. A small firm building a list by sending out a monthly newsletter with the aim of keeping themselves in their customers' minds would be better off with MailerLite.

Whichever tool you use, the success of your email marketing depends on how you exploit its potential: successful email marketing is about getting the message right. And, to do that, marketers need to worry less about what they want to say and more about what customers want to read.



ABOVE **ConvertKit's support for multiple outcomes depending on triggers means you can personalise email communications**

Five ways to use email to boost conversion

1 Abandoned cart reminders

Typically, only around 10% of visitors to an online shop will add products to their shopping cart – and of those, between 30% and 50% will buy. Of those who leave the site without buying, some will be because they were distracted or unable to complete the transaction at that time. By sending a well-written, polite email the following day, you'll convert at least some of these to paying customers. Almost all ecommerce systems will preserve the contents of a cart for a while, so the customer doesn't usually need to add their products again.

I've tested this at my online retailer and routinely rescue sales that would otherwise have been lost. Some ecommerce providers include this functionality, and MailChimp integrates with others, so the process is entirely automated.

2 Transactional emails

I'm sure you've noticed that, for all the effort most firms put into their sales emails, when it comes to your order confirmation and shipping notice, the message looks as though it's been spewed straight out of a database, without ever passing across a designer's desk. And yet it is here that the customer is most positive about you and your company. In most cases, you'll have tried to generate enthusiasm in the customer during the sales process; this should continue afterwards. Once they've bought, it's the perfect opportunity to reinforce your brand and to make the customer feel good about their purchase and about doing business with you again in the future. You may even be able to cross-sell or offer a discount on future purchases.

"Marketers need to worry less about what they want to say and more about what customers want to read"

3 Build a customer profile

Ask subscribers what interests them early on and send emails on those subjects – in automated sequences and as broadcasts. For example, if Debenhams bothered to ask me about my buying habits, it would send me emails about women's boots at Christmas and not in between.

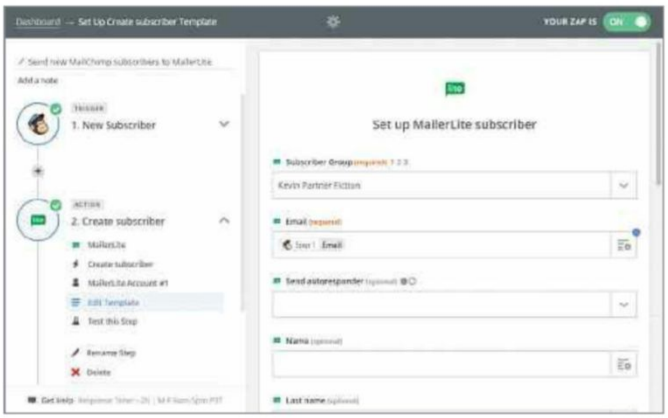
4 Make them interesting

Most emails read as if they were written by a machine. In an ever more crowded inbox, you can make your emails stand out by projecting your personality into them. This won't be appropriate for some businesses, but, in general, customers like to feel they're dealing with people rather than corporate systems. Having said that, you should avoid the sort of fake personality used by the biggest firms, particularly in the media industry.

5 Send an email only when you have something to say

There's a lot to be said for having a regular schedule of email broadcasts, but don't think that customers will miss it if you skip one. In general, they're not that interested in you. This schedule exists to get you into the habit of formulating a regular email, but it shouldn't mean you send one when you have nothing to say. Every email must be interesting: if you're busy planning a major launch, the last thing you should do is send a filler message the week before. All that achieves is to lower the open rate for your launch email.

kevin.partner@nlightn.net



BELOW **Zapier allows me to copy subscribers from a free MailChimp account across to MailerLite when I need the latter's superior automation**

DAVEY WINDER

"I'd much rather people were using the wrong acronym than no form of additional login requirement at all"

Davey explains the difference between 2FA and 2SV, and reveals why your wireless mouse – and the attached computer – could be at risk

I start this month's column with a question: which type of user authentication system is the most secure? Is it a hardware token, a code-generating application, a code delivered by text message, or a system using push notifications?

I guess that most readers will be in a similar situation to me, being faced with all sorts of additional verification being sought to access one service or another. My business bank makes me input a passkey on my smartphone, which then spits out a time-limited code; my personal bank relies on me recalling a lucky dip of characters from a passkey, having already entered a PIN; and PayPal likes to send me one of those time-restricted codes by way of an SMS text message. Then there are other online services that ask for a code generated from the authenticator app of my choice, or request that I insert a hardware token into a USB port to finalise my login.

My favourite example of additional verification requirements is the Dashlane password manager, which I currently have configured to require a long and complex passkey that's committed to muscle memory – my fingers literally go into automatic typing mode when it's needed. Oh, plus a time-limited code generated by an authenticator app. Following all that there's a successful fingerprint scan required to gain access to my password vault.

You can use a resource such as Two Factor Auth (**twofactorauth.org**) to find out what methods any given online service offers.

The thing is, with so many methods of user verification out there, which should we be using when given the choice? The simple answer is any of them – because any is better than none. However, let's assume we accept that as a given; so which of these additional layers of security is the most secure?

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You'll have noticed that most involve your phone in some way. This begs the question of whether this introduces an unnecessary weak link into the secure login chain? Let me repeat: using any form of Two-Factor Authentication (2FA) or Two-Step Verification (2SV) makes the account you're trying to access far more secure than just sticking with a bog-standard username and password.

You'll have spotted that I've mentioned 2FA and 2SV; in most articles about login security you'll see only the former. The truth is, there's a difference between the two, and true 2FA is a more secure method of identifying the owner of an account than 2SV. However, once again, using either is better than using neither.

In brief, there are three kinds of authenticating factor: something you know, something you have, and something you are. The knowledge factor is most often your username and password combo used to initiate the login process. A common technical error is describing a "Time-based One-Time Password" (TOTP) generated by an app on your smartphone, or sent via SMS to it, as being a second factor, and systems that combine a login with such a TOTP as employing 2FA. This is actually 2SV, because the TOTP is also something you know, and malware is capable of intercepting it.

True, 2FA requires distinct factors, so a good example would be a login followed by a fingerprint hardware token (such as a YubiKey) scan. It's also true that two distinctly separate authenticating factors are more difficult to compromise than a single one with multiple verification requirements. However, in most scenarios, I feel it's just a game of security semantics.

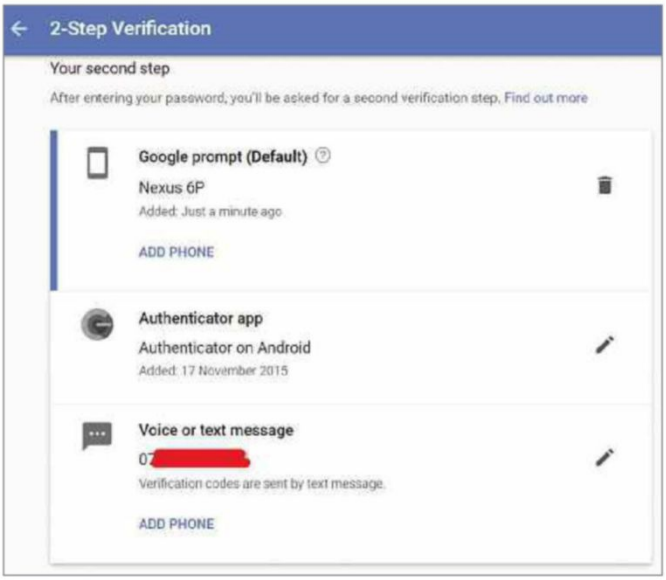
Introducing multiple acronyms into the "more secure" equation only serves to confuse the would-be user, rather than clarify distinctions that mean little to most people outside of the security industry. I'd much rather people were using the wrong acronym than not using any form of additional login requirement, and I'd rather that was easy to deploy and use than adding layers of complexity into the security concept.

Which brings me nicely back to "which is more secure?". The answer, as you probably now realise, is the hardware token, for all those 2FA versus 2SV reasons. Yet hardware tokens also tend to be the most complex to deploy and expensive, be it for the small business or home user. SMS text messaging of codes would be last on my list since it demands a phone signal, and for the determined hacker, there are numerous methods of intercepting these codes.

New to the scene last year was Google prompt. This makes the process of authentication as simple as a popup on your smartphone asking if you just tried to access something, and giving you Yes/No buttons to press. It's easy to configure (*see right*) but there remains the potential for malware to intercept the notifications.

The same is true of authentication code-generating apps, which have been shown to be vulnerable to privilege escalation exploits, plus the encryption used to seed the codes could be broken by a determined attacker.

I'm happiest with services that let me pick how the authentication code is generated, so I can use the authenticator app of my



BELOW Google certainly doesn't skimp on user verification options

choosing and then ensure that I make accessing it as difficult as possible for anyone who isn't me. As it turns out, that's pretty easy as my phone is encrypted, the lockscreen requires a fingerprint to dismiss, and my authenticator app also requires a fingerprint to open it. None of this would prevent a determined actor in possession of my smartphone from being able to circumvent my security; but if such a clued-up actor had possession of my phone, then it's game-over already.

MouseJacking!

While the rampage of ransomware was the attention-grabbing story of last year, the subtitle for 2016 was comprised of just three words: Internet of Things.

Four words if you precede "things" with the almost obligatory "insecure". Many of the headlines concerning IoT technology focused on the fantastical. "Pisspoor IoT security means it'd be really easy to bump off pensioners" and "Can your kettle take down the internet?" were both real 2016 stories.

The first in *The Register* – which had a subtitle of "Killing pensioners, two keyboard taps at a time" – was a light-hearted look at DoS attacks against internet-connected central-heating thermostats. The second, in the *Daily Mail*, warned of the dangers of not changing default passwords in devices such as kettles. Interestingly, it spoke about these everyday devices being overlooked when it comes to the basic security smarts people have begun to understand with regards to laptops and smartphones.

That connected devices are of interest to hackers – and connectivity is all we're really talking about when we drop the IoT bomb into conversation – should come as no surprise. The devices themselves are usually a conduit to the real target, rather than being the target themselves. And so it's another set of everyday objects that have, perhaps understandably so, skipped the attention of all but the most security-minded on both sides of the legal fence: mice and keyboards.

As unlikely as it may seem, my favourite bit of technical hacking from 2016 was a class of vulnerabilities dubbed MouseJacking. A MouseJack is, per the Bastille Threat Research Team (BTRT) that discovered it, an exploit that can inject unencrypted keystrokes into a target machine from up to 225m away using cheap, non-Bluetooth radio transceiver USB dongles. Dismiss it as being just another theoretical code-injection exploit if you like, but for me this has a touch of evil genius about it. Sure, it's a bit low-rent when compared to the state-sponsored style of a Stuxnet attack, with multiple high-value zero-day exploits sacrificed to the gods of espionage; ten quid's worth of dongle and a total of nine vulnerabilities from brands that really ought to have known better is all it took.

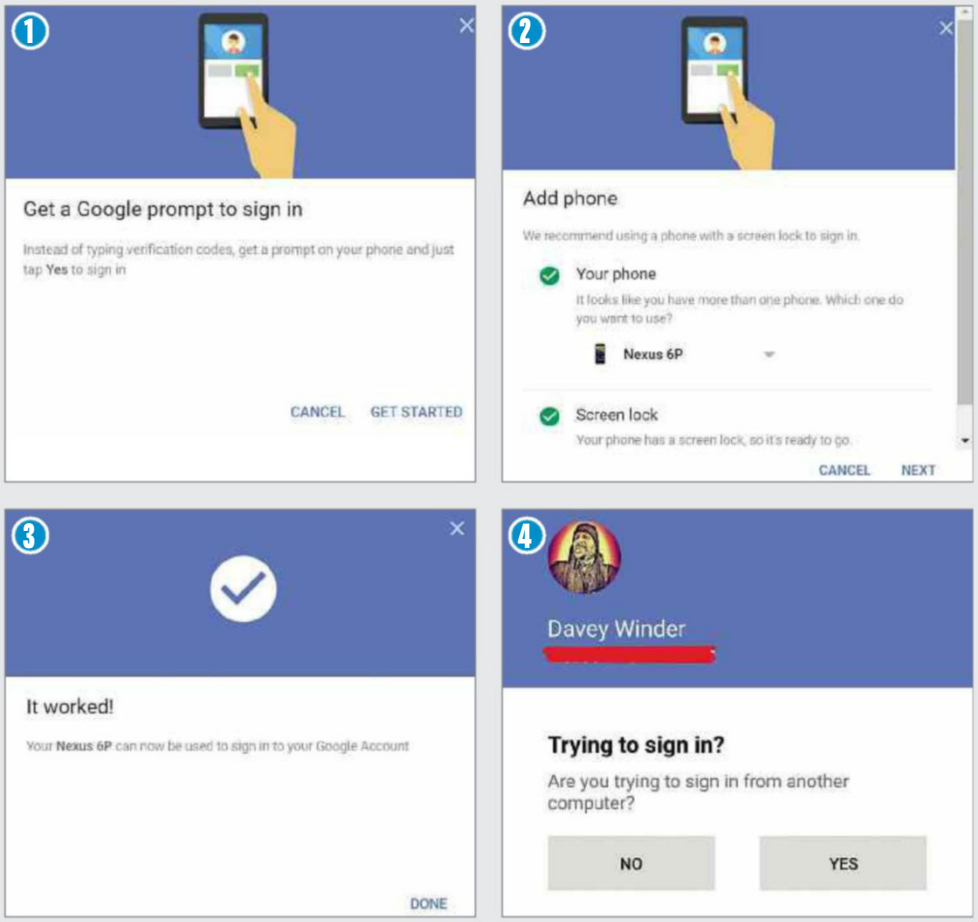
Wireless keyboard manufacturers have pretty much wised up to the eavesdropping threat, and so keystrokes are sent encrypted when no wires are involved these days. A couple of years ago, writing on these very pages, I mentioned how weak wireless keyboard signals tend to be, and thus the risk of remote capture was, well, remote. I also mentioned how signal encryption was a key part of the wireless keyboard spec (every pun intended) and even specialist devices such as the KeySweeper – which captured and decrypted keystrokes – wasn't a threat to modern kit. Microsoft started using AES encryption after 2011, and KeySweeper couldn't hack these. So what's changed with MouseJack?

The clue is in the name. It makes the most of wireless proprietary protocols operating in the 2.4GHz "Industrial, Scientific and Medical" (ISM) band, which don't bother themselves with all that encryption nonsense. Instead, they happily use unencrypted communications between the mouse and the USB dongle attached to the computer.

Non-Bluetooth wireless mice from Amazon (Basics), Dell, Gigabyte, HP, Lenovo, Logitech and Microsoft were all found to be vulnerable to an attacker spoofing mouse movements and generating keystrokes. All the time, the target dongle thinks it's communicating with the wireless mouse or keyboard, but is getting the code the malicious actor is sending from a replacement dongle costing around £25 instead.

BELOW Many makes of wireless mice are still vulnerable, and it's all due to the RF dongle

Google prompt: step-by-step setup instructions



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The attack mode could be used to send malware to the target machine, or extract credentials data from it. That Bastille managed to link a series of vulnerabilities to circumvent the keyboard encryption is impressive; that it even managed to work with dongles that required encrypted comms (by targeting the mouse instead) even more so. The clever bit is that the exploit can spoof a wireless mouse that tricks the target PC into thinking it's talking to a keyboard.

This spoofing element could become even more interesting over time, and as IoT grows ever bigger. Why is that, I hear you ask? Well, if it can trick a computer into thinking a spoofed mouse is a real keyboard, then what other cross-device treachery can RF-based protocol hacking come up with?

In typical IoT fashion, most of the vulnerable devices will need to be binned if security matters to the users. Firmware patches are thin on the ground in IoT territory, and that's also the case with wireless dongles and RF mice; the transceiver chips are designed to be programmable only once and so can't be updated. A decent list of at-risk devices can be found at **pcpro.link/271bastille**, along with vendor responses and links to firmware patches where available.

Back in 2015 when I wrote about KeySweeper, I concluded that there were too many caveats to make it a real-world threat: distance, model of keyboard being used, the Heath-Robinson home-built hacking device requirement, the fact that Bluetooth mitigated the risk – albeit at the cost of introducing some of its own. The best risk mitigation back then was to suggest not using a wireless keyboard unless you had no other choice. Wired keyboards tended to be more reliable and were a lot cheaper.

That's not true anymore, and MouseJack plugs the real-world gap in terms of distance, cost of the attack dongle, and choice of likely target devices. My advice about not going wireless isn't going to stick with many folk now, but I'd suggest you stick with Bluetooth if you're going to snip the wires from your working life.

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STEVE CASSIDY

"Formatted for a Windows machine, sent in a Jiffy bag, this 2.5in 1TB USB disk was effectively worth $10,000"

Steve contends with a hard disk that's "just become a bubbling, evil swamp of despair", containing all a company's VMs and with no backup in sight

It's one thing to talk about preventing disaster; real experience is both rare and valuable. What happens when you're actually sitting down to work out what's left of a business' data, with the owner breathing down your neck and the clock ticking on both your diagnosis and the likely action plan? Like almost everyone I talked to during this month's crisis, I have a full repertoire of ways of keeping restorable backups; not a full repertoire of tools to try to drag data out of a hard disk that's just become a bubbling, evil swamp of despair.

So, feel free to do what all those colleagues and contacts did, taking up too much of my crisis-management time: ask a series of questions that might, in a different situation, have served up a restorable backup.

No, there wasn't a cloud backup product in place (in this case, the database supplier had elected to help out with that at one branch, but not the other). Yes, there was a RAID – of that rather irritating kind that VMware specialises in constructing, where it's up to the guest VMs to lay out a fault-tolerant disk architecture.

No, the available mirrors didn't seem to be usable. No, there was no hard deadline for recovering the database, but there also wasn't a month available for long scans of the misbehaving 2TB media in pursuit of potentially useful, but initially corrupt, mirror partitions.

No, the backups that had been taken off the database by the software supplier weren't deposited on a different server – indeed, not even on a different drive letter. Usefully, that particular discovery helped to fix a looming "too many cooks" problem, with all these questions – none of which speed up the data recovery, mind you – slowly drip-feeding in from said supplier and then suddenly falling silent when the boss-man realised why I was being so critical.

Steve is a consultant who specialises in networks, cloud, HR and upsetting the corporate apple cart
@stardotpro

The downside to that being, of course, that I was on my own. I'd arrived with the assumption that the problem was the drive controller circuitry, and I knew I still had an exact match for the drive, so I pulled the board off my drive and put it in my pack for the trip.

This is one of those bits of voodoo work that aren't widely understood outside of the server-fixing, data-recovering professions. In theory, every controller board on a traditional hard disk can be swapped for one from a known working identical device. But in practice, it isn't always the board that's the seat of the drive problem. In this case, it took only a few minutes to work out that the 2TB WD Red drive with the dead VMFS volume on it actually had a better board on it than the one in my pack.

BELOW WD Red drives have easily dismounted controller boards – useful in a crisis, if not this one

WD Reds have easily demounted controller boards, with all the contacts between drive and board made by spring-loaded fingers and neat, flat pads – but mine was heavily marked with dirt so fine that it resembled toner. The one on the troublesome drive was as clean as a whistle: I quietly hid mine away and went back to the original search, which was for data-recovery tools that recognise VMware's own VMFS disk and partition format.

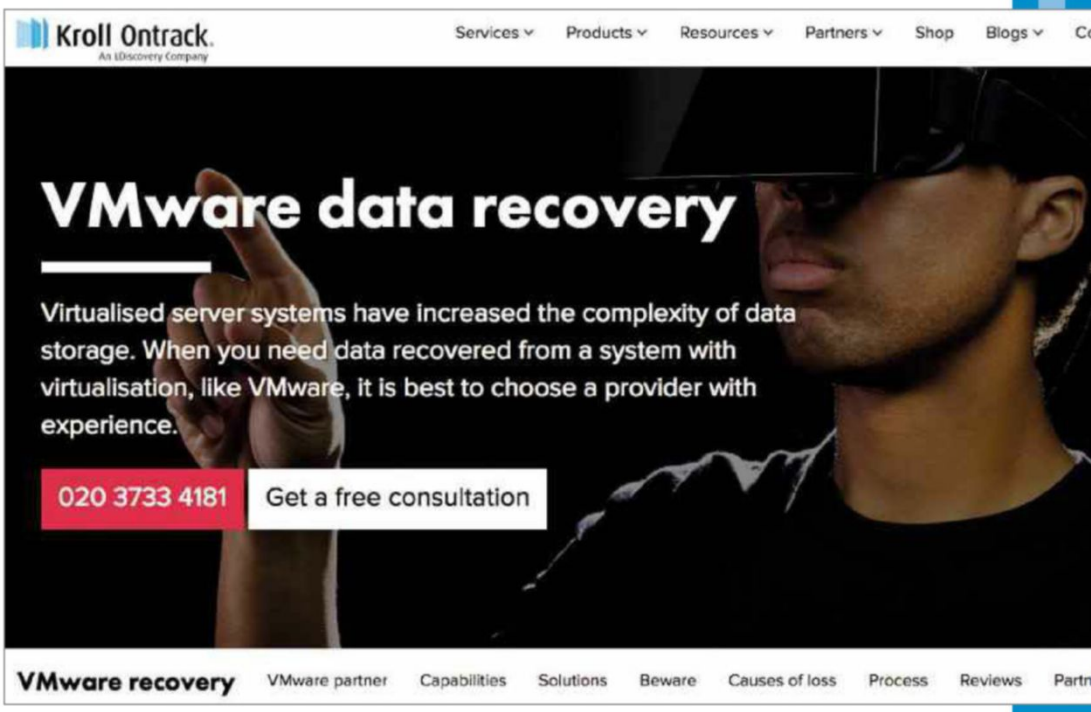
This was one of the most frustrating searches I've ever undertaken. First, you have to penetrate the vast numbers of ignorant but opinionated helpers who lurk in internet product and support forums: not just this year's edition, but those of every year. Perhaps the most useful filter for their contribution is to put "-should -ought" into your Google search string. I don't want to think about the number of threads I worked through, where one or both of those terms reveal that a "helpful" answer is being delivered by someone with absolutely no clue about how to achieve what they're talking about.

No, dear internet, it isn't true that VMware volumes of the modern kind are plug-mountable to a Linux system by USB adapter. No, VMFS does nothing wonderfully magical with a single SATA volume to be inherently fault-tolerant. No, inquiring about snapshots is a dead end – the volume won't mount, never mind what's on it on other, not-really-similar systems with not-really-related disk failures.

After an intense run of research late into the night, I felt I had two options the following morning. One was a partition-rebuilding process, documented in superb detail on a chap's blog; the other was a complete VMFS volume-recovery tool. Both use the VMware command line connection. Since this would be a long and involved install on a machine set up to manage the VM host, I felt a morning start on these tools was in order.

Bright and fresh the next day, with the command line on Windows nicely hooked up to the VMware hypervisor on the broken server, I dived into the instructions for repairing the apparently non-existent partition table on this horrible little specimen of a disk. The first few stages went well, bringing up all the data that the rest of the recovery process wanted. I even learned the interesting snippet that VMware only writes back to the partition table (when needed) at system shutdown, which appears to justify the care taken to make a safe, clean shutdown a convoluted process.

But I digress: the first dead-stop moment came at the point where I had all the information to overwrite whatever was being used as the GUID Partition Table – and then I ran into the follow-on comments to the blog entry, which came from people who had wanted to do a recovery "on their lab server". This is nerd code for "the autograph is for my son/daughter".



It seems that just corrupting that one bit may be common enough, but some forms of disk damage can cause the numbers used to recreate the table to be mis-read. Typing them back in can make subsequent attempts at recovery – by this or any other method – less likely to proceed. Therefore, it isn't recommended as a fix for disks that don't have backups of their contents held somewhere safe.

My finger literally hovered over the Enter key on that one, then shifted to the Delete key. This wasn't a lab; that was, after exhaustive searching, definitely the only usable copy of the data.

Plan B – the actual tangible bit of software – was looking a lot more attractive. VMFS Recovery it said, among many other kinds. Able to sit on a Windows PC and remotely interrogate the disks of a VMware server, reporting back what it finds after one of several scan types, and configured to do that with the free download. Writing back or downloading found data requires a licence, which costs $800.

The initial download and data-analysis run are best described as easy but long. If you've ever wondered how long it takes to read every bit on a single 2TB disk over Gigabit Ethernet, the answer is around 15 hours. This doesn't mean that much of value came up in the scan. While the faster short scan revealed a list of typical VMware files, the longer one just seemed to say "1 file found". That was it. Not much for 15 hours. And the short scan report gave just generic file names that could have been any VMware volume.

My reluctance re-emerged at this point, because I'd been unbelievably bored by the bits of the 15-hour scan that weren't in the middle of the night, and during that time I couldn't find a satisfactory information trail for this product. Sure, it had a Facebook page, with a few sparse posts from apparently happy customers – but none from the developers. Some loose links to a community of Russian or Ukrainian IT types, with a history of similar interests around VMware and storage in general, but nothing like enough proof that these identities were active or even correct. No visible comments or contributions in that vast labyrinth of forum postings on this subject from them – and suspiciously dead-end designs in their contact pages (which is one of several reasons why I'm not putting a link or even a screenie in this piece, to any of these sites). It just didn't add up.

ABOVE Contrary to what the internet says, VMware doesn't do anything magical to make a single disk fault-tolerant

"If you've ever wondered how long it takes to read every bit on a 2TB disk over Gigabit Ethernet, it's around 15 hours"

In fairness, though, its software did use the VMware CLI to make a remote smart link to the VMware server; it did tell me exactly what type of drive it was; and it did show a few bits of disk info that countered my suspicion that this was scamware. But $800 is just too much to spend speculatively, especially for something this vital. I really wanted these guys to be on the phone, and talk me through what the screens were saying, and explain why some of the features seemed to be completing while others weren't so happy. And I couldn't.

So I bit the bullet on the silent, invisible pressure coming at me from the business owner, and said that in my view the lack of social or professional footprint was enough to

put me off the Ukrainian option. Especially given that the local office of Kroll Ontrack was only a couple of hours away via courier. Even though its suggested pricing for a VMware system recovery topped out in five figures, well over ten times what the Ukrainian software men were asking, Kroll's approach gave far more cause for comfort.

Several phone calls in rapid succession followed to establish the scale of the problem, the scale of the charges, and the timescale, and for there to be a bit of gentle probing as to whether or not I could be trusted to make their job harder. Collectively, we agreed that it wasn't complex in terms of the amount of actual kit involved; it was quite likely (but no promises) that recovery was possible; but paying for the super-duper express option was almost completely pointless, since this would be a series of long-scan and recovery processes. I began to feel as if my job here was almost done and could hear the departures lounge beckon.

But first, Kroll's own remote diagnostic software had to be let loose on the server, in a setup remarkably similar to the anonymous Ukrainians – although Kroll didn't need the command line tools. It seems perverse to trust a company to run installs on a machine inside your LAN, and run another long bit-scan of the drive with far less visible, interactive utility programs, even before you've signed a contract or made a payment. But the results were reassuring and offered an explanation of why all the other approaches had failed. After Kroll's run finished, we had a curt voicemail: the drive media is physically damaged. Could we pack it up and send it to them for the next phases of analysis and, possibly, recovery?

Since Kroll's offices were very close to the airport, I volunteered to take the drive with me: much easier than arranging a courier, I thought. Kroll Ontrack disagreed, pointing out that almost all its jobs moved around on courier services, which showed a much lower failure-to-deliver rate than a lone driver in a strange country in bad weather. I was mortally offended – right up to the point where I couldn't drive on to the autobahn because there was a huge air ambulance helicopter parked right on the top of the access ramp. I had plenty of time to look at the 42-tonne truck lying on its side in the field by the carriageway in the ensuing diversion traffic jam, while pondering whether it was the groupage delivery for Kroll's' preferred courier in a little fit of schadenfreude.

As I flew home, after a total of 30 hours of deep bit-scanning and data-copying, Kroll Ontrack got everything back. Only the partition table had been "physically damaged", although neither I nor the client really wanted to spend any more money on validating what had actually happened, given that Kroll used the same courier to send back a single, tiny disk in a Jiffy bag. Formatted for a Windows machine, this 2.5in 1TB USB 3 disk contained all the missing VMs. It was, in my client's opinion, a $10,000 external disk.

We had already copied over the backed-up VMs that had been completed from the separate NAS box; it seemed almost an anti-climax to plug in that little drive and get the missing data up and running.

Hyperconvergence for the rest of us

It's remarkable how slowly the whole industry updates its network infrastructure. Gigabit is the standard I encounter most often, even though most small networks don't achieve the practical maxima possible using that standard. Part of this is because the experiment to see if higher speeds are possible can be amazingly disruptive, even in a network with no other lurking configuration issues. But also because there's an incredible hike in cost between little plastic-case switches with "gigabit" written on the front and a full scale, web-configured, intelligent routing switch with customisable module ports, multiple ports on the front and back, and service access controls for the intensely paranoid network manager.

But time has been passing, and affordable 10GbE hardware is now creeping into the second-hand, ex-corporate market. I'm aware that lots of readers think this is one of my obsessions, but it seems to follow on that if you have scars from any kind of network tweaking, then your natural response should be to move forward with some low-cost experiments that don't put your head on the block.

ABOVE As prices drop, isn't it time you experimented with some 10GbE hardware?

"Kroll's remote diagnostic software had to be let loose on the server, in a setup similar to the anonymous Ukrainians"

This goes double for 10GbE networks, because the main prospect for kudos out of such an upgrade is to make use of hyperconvergence. That state where a server just has a single lead going into it, which can easily and fluidly balance all the different traffic types passing through it. Not something we should be finding difficult in 2017, surely?

Unfortunately, it is difficult. Especially with virtualisation leading to much more varied traffic types, all trying to live together. I'm pretty sure that a lot of the people who have a hard time "going virtual" are reporting failures based on single servers, connected by a single cable to a single switch, as a consequence of which they rarely see network speeds of as much as 25MB/sec.

And some of those converged services – such as iSCSI – don't like to cooperate or, indeed, even recover from a traffic jam on a crowded Gigabit connection. Trying a completely converged server can be disappointing, even on a fully tuned Gigabit LAN: I tend to use the relatively plentiful multi-port Gigabit Ethernet cards, but that may be because I love the cat's cradle complexity that they permit.

If you want the icing on the cake, then Microsoft says it won't support hyperconvergence on anything less than a 10GbE LAN. Here, right now, I have two 10GbE-capable devices: a Netgear XS716E for copper connections, and an SMC 48-port, which only presents 10GbE using a fibre port on the back of the switch. Just having them stacked up together in the computer room means that I can select a 10GbE card and pick my way through the traffic management setup, rather than the virtual port setup, in either VMware or Hyper-V: and my users have no idea it's happening.

That's the best way to dip a toe in the subject.

cassidy@well.com

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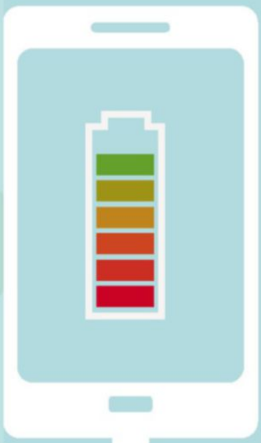
Futures

We explore the trends and technologies that are set to shape the future



Power up: what's next for lithium-ion batteries

Slow to charge and sometimes dangerous, lithium-ion batteries may not be the best way to power our devices. Nicole Kobie reveals the research that may replace them

Flaming Samsungs aside, most of us lament our batteries for their lifespan and charging time. But what if there was a better way?

Researchers are searching for an alternative to the standard lithium-ion, redesigning how batteries work and trying new combinations of chemicals, in the pursuit of a long-lasting, fast-charging and safe alternative for smartphones, laptops, electric cars and more.

They've come up with a range of ideas, redesigning them from the ground up and substituting new materials. Although chemical challenges and funding complaints mean we'll likely be stuck with lithium-ion for a while, the future of charging could be just over the horizon. Here's what researchers are considering – and why.

Problems with batteries

It's impossible to discuss lithium-ion batteries without acknowledging their apparent propensity to overheat and scorch people – or, in the case of one unlucky Samsung fan, go up in flames and burn their car. Paul Shearing, senior lecturer in chemical engineering at University College London, warned not to get caught up in headlines. While lithium-ion batteries can fail and lead to fires, it isn't as common as it sounds.

"It's important to remember the complete ubiquity of lithium-ion batteries across all modern societies, from mobile phones to laptops to satellites to electric vehicles to aeroplanes," Shearing said. "The chance of failure is really extremely low." When they do fail, it's generally due to short circuits in the battery that cause heat and failure within the cell – a process called thermal runaway. Such batteries have safety features to avoid overheating, but manufacturing flaws, corner-cutting, or trying to cram too much battery into a smaller form factor can cause problems.

Another problem with lithium-ion batteries is discharge cycles, which are usually limited to 800, or two years if recharging every day. "The battery is fine for the mobile phone because people tend to upgrade their phones every two years," said Donald Sadoway, professor of materials chemistry at MIT. "But when it comes to something like automobiles, people are not going to be trading in their automobiles every two years."

Such batteries have improved over the past decade, but optimisation has remained incremental – leading certain researchers to look not just for tiny improvements, but for the design and materials that will eventually replace lithium-ion.

LEFT Lithium-ion batteries are ubiquitous in smartphones

Possible solutions

Alternatives to lithium-ion need to tick the same boxes, notes Dr Martin Foster, professor of electronic engineering at the University of Sheffield. They need to be better on cost, capacity, charge/discharge rate, size, safety and available capacity. "Most of these can be addressed but only to a certain degree [and] batteries are limited by material fundamentally," Foster said. "For instance, the lithium-titanate battery we have at Willenhall [an energy storage demonstrator] can be charged/discharged at higher rates than other lithium batteries, but they are more expensive."

There are a few promising options, however. Shearing's pick for the best alternative battery design is using solid-state materials instead of liquids, making them safer. Shearing said this involves "replacing some of the fallible liquids that are in the current generation of lithium-ion batteries with folate materials because those are known to be much, much safer".

Because they're less of a risk, they're easier to use in devices without as many safety precautions. Plus, they last longer and are lighter. While Shearing admits they're currently "precommercial", Dyson last year bought solid-state battery company Sakti3 for $90 million.

Another way to upgrade batteries is using new materials in place of lithium. Options include sodium-ion, lithium-sulphur, and lithium-air.

Sodium-ion batteries are more likely to find a home in grid storage than consumer devices. They may be cheaper and more stable than lithium versions, but they're also heavier and have less energy density. Lithium-sulphur has seen investment from carmakers and NASA, which hope to use its increased energy density to power travel, be it down to the shops or far into space.

For our gadgets, researchers are considering air. Last year, University of Cambridge researchers claimed to have boosted energy density by five times using lithium-air versus lithium-ion. Plus, they could be recharged 2,000 times – more than double lithium-ion models. Such results were echoed by an MIT study that used "solid oxygen" cathodes, helping batteries to hold onto energy and capacity for even longer.

Shearing said options such as air and sulphur had "huge promise", but were, again, "a little way off from commercial reality at the moment".

MIT's Sadoway said his eyes are on aluminium to replace lithium-ion because "aluminium is the third-most abundant element in the Earth's crust," he explained. "And if we make a battery that's based on aluminium, it's going to be cheap." Researchers at Stanford University unveiled an aluminium-ion version in 2015 that not only charged quickly and withstood 7,500 recharge cycles without capacity loss, but is so safe you can drill through it – making it less risky than lithium-ion and ideal for flexible devices. Similar options include magnesium and iron – anything that's "abundant and cheap", Sadoway said.

Beyond material changes, batteries could be completely redesigned – take a look at some of the more unusual ideas on the next page. The wonder material graphene makes an appearance in designs for supercapacitors, an alternative to batteries that store energy electrostatically rather than using chemical reactions, while bio-batteries that use biological structures such as amino acids could provide an alternative infrastructure. Don't hold your breath, though: much more research is needed.

ABOVE Carmakers, along with NASA, are investing in lithium-sulphur batteries to increase energy density

Why it's not happening

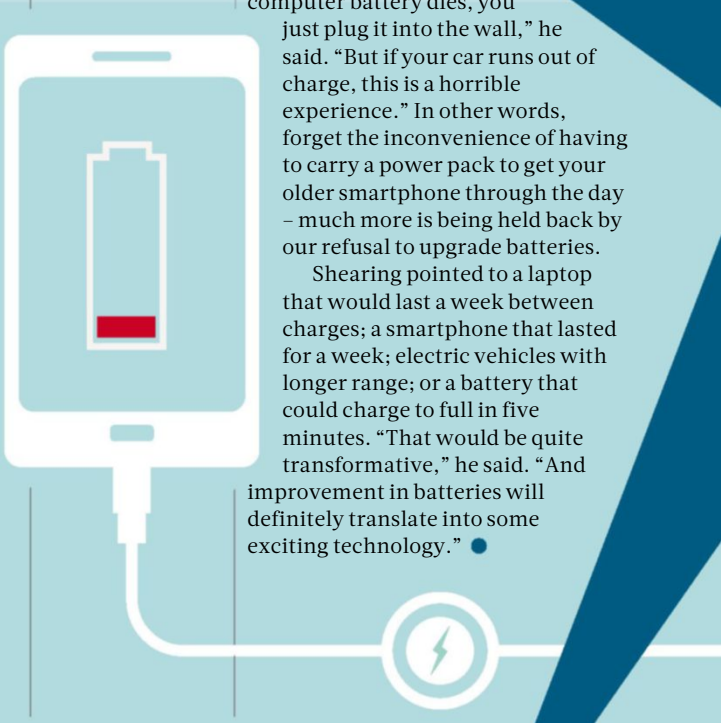
With all these options available, why are we stuck on lithium-ion? Sadoway pins the stagnation on the battery industry and a lack of funding in innovation, noting that lithium-ion itself didn't come from that sector, which preferred to stick with its investments in nickel-metal hydride batteries. Instead, it came from Sony, and he sees the same resistance to change now.

"We should be bolder and more imaginative in looking at something beyond lithium-ion," said Sadoway. "And my fear is that we're just not doing it." Instead, manufacturers are focusing on making lithium-ion "incrementally better". At the same time, the American government has over the past few years slashed research budgets, which remain low aside from life sciences, Sadoway said.

The lack of research funding on new designs or materials means none of the aforementioned options have yet proven to be commercially viable. Sadoway said that could be because they simply don't work, because we haven't spent enough money developing them, or because "of the collective IQ problem" – not enough researchers means not enough "intellectual horsepower" to leap the hurdles holding them back.

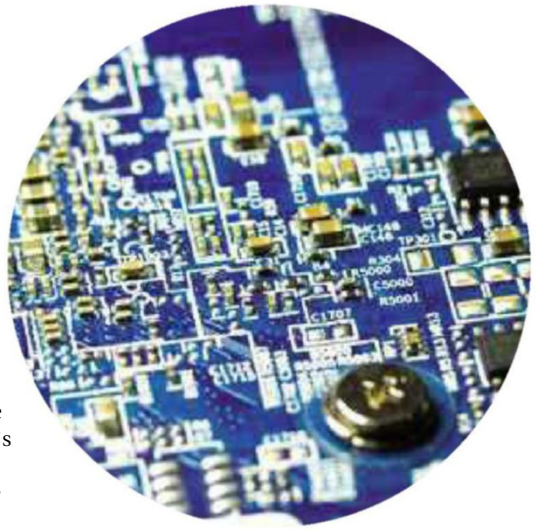
"The industry is not innovators," he added. "The industry is focused simply on driving down the costs." For mobiles and laptops, that's less of a problem than for electric cars. "If your computer battery dies, you just plug it into the wall," he said. "But if your car runs out of charge, this is a horrible experience." In other words, forget the inconvenience of having to carry a power pack to get your older smartphone through the day – much more is being held back by our refusal to upgrade batteries.

Shearing pointed to a laptop that would last a week between charges; a smartphone that lasted for a week; electric vehicles with longer range; or a battery that could charge to full in five minutes. "That would be quite transformative," he said. "And improvement in batteries will definitely translate into some exciting technology."



Q&A Harvest energy and never need a new battery again

What if our devices didn't need recharging or new batteries? University of Cambridge researchers are hoping to build wearables that harvest energy from transistors and can last years without a recharge



ABOVE **The most obvious use is for wearables and healthcare monitoring**

RATHER THAN IMPROVE batteries, why not reduce the need for them? Researchers at the University of Cambridge have designed transistors that scavenge for energy from their own environment, meaning devices could have power for years without a new battery.

The ultra-low-power transistor borrows from computers in sleep mode, harnessing leaked electrical current from transistors. The experts compare it to water dripping from a faulty tap, and such leaks are characteristic of all transistors, offering a free energy source – if only it can be captured and used.

To do so, the researchers made use of the point of contact between the metal and semiconducting points of a transistor, known as the Schottky barrier. Transistor engineers usually try to avoid such barriers, but the Cambridge researchers instead tapped it for power.

Harvesting that energy means low-power devices won't need new batteries or recharging for years, with the researchers claiming that the energy in an AA battery could be made to last for a billion years using their transistor design.

We spoke to researcher Arokia Nathan, professor at the University of Cambridge's Department of Engineering, to see why it was worth harvesting energy to cut battery use and what devices such a design could be used to develop.

Arokia Nathan is a professor at University of Cambridge's Department of Engineering

■ What innovation did you come up with for this to work?

You do have this in silicon, the kind of thing that's already used in computers [such as low power draws when they're put to sleep]. But what we've done is basically use technology used in a lot of displays. This is very nice for wearable applications.

Wearable technology is fussy about how much energy you consume, because you don't want to be carrying around batteries when you wear something. We were looking at how to cut back on the energy consumption... in thin films, you get a much better performance than with silicon technology. That's why we went with the non-silicon approach. We actually had to come up with a new device architecture from the start, which provided this performance.

■ What devices could this work with?

It's ideal for cases where speed isn't important... It's [not ideal for] application in the very high-frequency stuff that you use in cell phones; it's more for wearables and IoT.

That could be monitoring health, the body or even buildings. Basically, anything that you would want to monitor remotely, so that you don't keep going back to change the battery all the time.

The most obvious things are wearables, healthcare monitoring (heartbeat, blood pressure): we design sensors for these things. We develop circuits using this architecture to read out sensory information.

Degradation in matter – buildings or anything else – is a very slow process so we'd be looking at constantly monitoring.

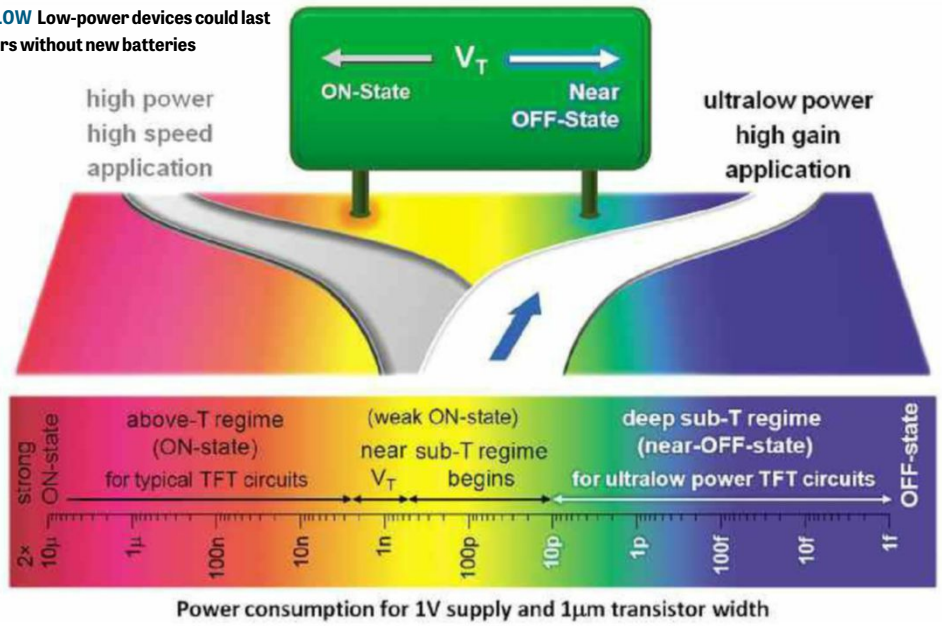
■ Thinking longer term, could this ever work for smartphones?

Smartphones constantly go for higher frequencies – they're going to 5G now. What comes after that will be even faster, right? For that there are well-established silicon technologies. They may have to think about how to cut back on power, but not using our approach.

■ Why are you looking at cutting power rather than boosting batteries?

Many people are working on increasing the energy-storage capacity of batteries, but they're not really addressing how to cut down the use of batteries. If we were restricted in terms of energy storage or battery capacity, how do we make electronics that would consume very, very little? That's what we were thinking. ●

BELOW **Low-power devices could last years without new batteries**



Power consumption for 1V supply and 1µm transistor width

The future of batteries is weird

Researchers are looking to odd sources of inspiration for battery innovation, from nuclear waste to your gut. We reveal five of the strangest projects

Inspiration for new battery tech comes from the weirdest places: tattoos, intestines and a girl's best friend. Here are five ways researchers are looking to spark innovation.

Easy to digest

We have a gut feeling you'd be pleased if your phone battery lasted five times longer. It's an improvement promised by researchers at the University of Cambridge, who have solved one of the hurdles holding back lithium-sulphur batteries: degradation of the materials in the electrodes, which reduces their longevity.

Inspired by the villi cells lining the intestine, the researchers added tiny fingers of zinc oxide to the surface of one of the electrodes, helping to trap the material inside the battery and keep it working for longer. "By taking our inspiration from the natural world, we were able to come up with a solution that we hope will accelerate the development of next-generation batteries," said the lead author, PhD student Teng Zhao, in a statement.

Such lithium-sulphur batteries offer five times the energy density of lithium-ion versions, but won't be commercially ready for years to come.

Mouldy bread

Speaking of stomach-turning, the fungus that causes bread mould could lead to rechargeable batteries, say researchers at the University of Dundee. The fungus *Neurospora crassa* – or red bread mould – can manage the trick of transforming manganese into biomass materials that work well as supercapacitors.

"In comparison to other reported manganese oxides in lithium-ion batteries, the carbonised fungal biomass-mineral composite showed an excellent cycling stability and more than 90% capacity was retained after 200 cycles," said Professor Geoff Gadd, head of the Geomicrobiology Group at the University of Dundee, suggesting mould could help extend the lifespan of rechargeable batteries as it shortens the life of your bread.

Diamonds are nuclear waste's best friend

If you shove nuclear waste inside a diamond, it can power low-current devices without any recharging or emissions. That extreme idea comes via experts at the University of Bristol, who showed a working prototype at the end of 2016, embedding Nickel-63 inside a man-made diamond and using it to generate a small current. The aim is to shift to a new nuclear material, Carbon-14, which is a waste material created in nuclear power plants.

"There are no moving parts involved, no emissions generated and no maintenance required, just direct electricity generation," said Tom Scott, professor in materials at the Interface Analysis Centre, in a statement. "By encapsulating radioactive material inside diamonds, we turn a long-term problem of nuclear waste into a nuclear-powered battery and a long-term supply of clean energy."

The nuclear-powered diamond batteries generate a tiny amount of current but last a phenomenal time: a battery with one gram of Carbon-14 would offer less power than an AA battery, but would take 5,730 years to reach 50% power. That means they won't be used in your phone, instead finding a home where it's more difficult to replace batteries. "Obvious applications would be in low-power electrical devices where long life of the energy source is needed, such as pacemakers, satellites, high-altitude drones or even spacecraft," said Scott.

Clear vision, fast charges

Slow charge times are a pain point for power-hungry devices, but experts from the universities of Bristol and Surrey have found one solution – inspired by contact lenses. Working with local firm Augmented Optics, they developed a supercapacitor, which is an alternative to batteries for holding power. They charge and recharge quickly, but have poor energy density so require larger form factors to be useful.

Researchers believe they've found a way to change that by boosting density using flexible polymers, similar to those in soft contact lenses. These could let phones or electric cars be recharged in seconds. Jim Heathcote, CEO of Augmented Optics, hopes we won't have to wait long: "The test results from the new polymers suggest that extremely high energy density supercapacitors could be constructed in the very near future."

ABOVE Researchers at the University of Cambridge have taken inspiration from the intestine's villi cells

> "Mould could help extend the lifespan of rechargeable batteries as it shortens the life of your bread"

Biofuel tattoo

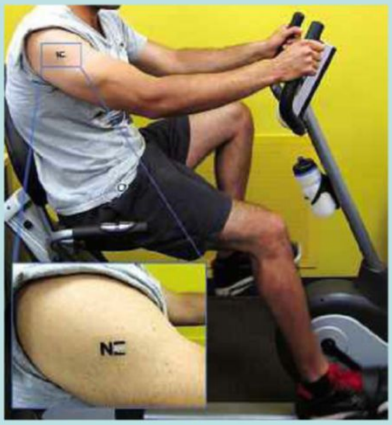
Sadly, the reminder of the affection you hold for your mother that's inked on your skin won't power a smartphone, but researchers at the University of California, San Diego, have created a temporary tattoo that's also a biofuel battery cell.

The researchers were looking for a way to measure lactate in sweat to avoid subjecting people to blood tests, but found a way to create power from the chemicals on your skin gathered via a temporary tattoo.

"The current produced isn't that high, but we are working on enhancing it so that eventually we could power some small devices," said Wenzhao Jia, a postdoctoral fellow at the university.

Don't worry if you're out of shape: those who were less fit produced more power because they form more lactate.

BELOW Researchers have discovered a way of generating power via a temporary tattoo



Geek Day Out Needles Old Battery and New Battery

Britain's shot at space is on show, alongside military history and magnificent views

With high cliffs overlooking white, rocky outcrops crumbling into the sea, the Needles at the Isle of Wight are a dramatic natural site worthy of a visit on their own. But we humans have added our own layers of interest, notably a Victorian military battery and a secret rocket-testing site.

The first battery – and yes, that is our tenuous pun to include it in this Battery Special – was built in the 1860s to ward off French invasion, with the New Battery built 30 years later to house more powerful guns, many of which are still on display. A century later, the site had a second life as the secret base of the High Down rocket-testing site between the 1950s and 1970s – part of Britain's ultimately unsuccessful "race for space".

"The landscape and underground rooms that existed from its original purpose made this a valuable position for some hugely important developments in space technology," said Scott King, the National Trust site's visitor experience officer. "In the underground rooms of the New Battery, which were the nerve centre of this highly secret operation, there are models of the rockets Black Knight and Black Arrow, and the satellite Prospero."

Alongside that sneak peek at formerly secret rockets, there are a host of natural and historical features to keep visitors busy. "Visitors should not miss the view of the famous Needles Rocks and Lighthouse from our subterranean tunnel at the Old Battery, the incredible 12-tonne guns positioned on the parade ground at the Old Battery, and the atmospheric underground rooms housing a recreation of one of the rocket testing control rooms at the New Battery," King added, citing artwork by Geoff Campion illustrating the history of the site as another highlight.

PC Pro readers will also appreciate historical tech on show. "We have two range finders for visitors to observe," King said. "These were developed as mechanical computers with input data to process, and consequently provide target-acquisition data. Simply put, these were used to help decide where to point a gun."

LEFT The New Battery has models of two rockets and a 1970s satellite

ABOVE LEFT The top-secret rocket-testing site at High Down was in use between the 1950s and 1970s

ABOVE RIGHT Visitors are treated to a stunning view of the Needles from the tunnels in the Old Battery

There's also tech from the rocket-testing era. "At the Needles New Battery, various computer devices were used, at the very time when computer technology was being further developed to observe and study the output of the rocket engines as they were fired from their position on the cliff face," King said.

From 1 June 2017, the site is celebrating a special anniversary of the High Down facility, with a new exhibition created with help from a former rocket engineer who worked at the site. "We're celebrating 60 years of the High Down rocket-testing site with the unveiling of our recreated Cold War-era control-room display," King explained, "created in collaboration with original 'Rocket Man' Mike Elliott, now a National Trust volunteer at the New Battery site."

> "We're celebrating 60 years of the testing site with the unveiling of a recreated Cold War-era control-room display"

Visiting the New Battery is free, while admission to the Old Battery costs £7.15 for adults and £3.60 for children. For more information, visit **pcpro.link/271battery**. The National Trust site is separate to the Needles Landmark Attraction (**theneedles.co.uk**), which contains a co-located funfair, chairlift and boat rides that reopen for the season at Easter.

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It's time to switch off the fake news and do something more interesting instead, says Jon Honeyball

You may just possibly have noticed that there's a lot of news floating around about news right now, and in particular how accurate it is. Mr Trump's team frequently claims that all the news outlets aren't telling the truth, and that this is a bad thing that must be punished. Part of their communication strategy is to bypass the mainstream and go straight to the end user via Twitter, with typical directness.

The inevitable result, like a flamethrower in a dry forest, is a firestorm about "what exactly is truth in news?"

It's a fascinating subject, because it goes to the heart of why we have channels through which we consume such information. In the past, a news organisation was the only way in which news, and opinion about that news, was collected together and then disseminated to its audience. Other than these few news outlets, there was no other meaningful route from the event to the reader.

We had to trust the news organisation because we had no other way to verify or invalidate the stories. Out of this came the underlying belief by news organisations that they were special, or "blessed" to deliver news and opinion. You might think that this view applies to this very organ, but it doesn't – we deliver opinion and insight and analysis, which is a somewhat different thing.

Then along comes the internet and all the rules change. Fortunately for the news organisations, they have huge momentum and infrastructure. But, over the past decade, this momentum has been chipped away. It's not been helped by some news organisations clearly having "agendas", be they political, social, financial or a mix of all three. In attracting those of similar views, they inevitably push away those of dissimilar views. Over time, this leads to a fractured landscape where otherwise reputable organs are viewed as unreliable.

Such an outcome naturally plays straight into the hands of the social media agents. And hence the rise of the "influencers", people who just say (and video) whatever they want and are paid to get a sponsored message over to thousands or millions of consumers.

Unfortunately, the task facing the end user has got a lot harder. Not so many years ago, it was relatively easy to decide over time whether you trusted BBC News, *The Times*, *The Daily Mail*, CNN or whatever. Today, when faced with thousands of potential feeds, curation has become impossible due to the sheer volume of "stuff" out there: real-time tweets, posts, blogs, YouTube channels and so forth.

So we have turned to "platforms", many of which are effectively crowdsourced and crowd-managed. On Facebook, I have many friends, but they are real friends. I keep out "acquaintances" and colleagues because I want to control the flow of information – and to ensure it comes from a relatively reputable source

This works, most of the time. However, it is still far too easy for what appears to be official or trustworthy information to circle the world in a few minutes before anyone has bothered to check if it's real. Trusting sources without verification or validation is the underlying issue.

> **"Faced with thousands of feeds, curation has become impossible due to the sheer volume of 'stuff' out there"**

You might be thinking, post-Mark Zuckerberg's manifesto, that Facebook has the answer. That its mix of machine learning, grandiose thinking and new emphasis on surfacing shared posts after people have actually read them – rather than just the headline – is all you need.

No. We can't rely on Silicon Valley algorithms. We must all apply a little more fact-checking to the things we read, consume and pass on. No amount of "All facts here are checked!" banners and symbols will help. In fact, quite the opposite. Such devices make it even easier for partial truths to be "accredited" and, consequently, gain a reputation of quality that is not deserved.

Maybe there's no such thing as truth. It's entirely possible that there are just opinions at a point in time, and that everything has a spin, a bias or a perspective. It all depends on how you look at things. Which means that everything is a bit like Schrödinger's cat.

So how do you survive? The best solution might just be to ignore it all. That sounds a little drastic, but if I look at the amount of heat, anger, vitriol and other emotions created by the election of Mr Trump on my Facebook feed, it would be hard not to be swept up by the tidal wave of it all. Maybe there is such a thing as too much news – if you can't contain it, trust it, validate it, and make reasoned judgements about it, then why read it at all?

Jon Honeyball is a contributing editor to *PC Pro*. He has been entirely trustworthy for the past 270 issues. Email jon@jonhoneyball.com

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