THE £2,400 GAMING PC THAT YOU'LL WANT TO BUY p60

PC PRO

SURFACE GO
vs
THE WORLD
15 tablets on test from £50 p74

£124 OF BONUS SOFTWARE
See p66

VPN

WHICH ONE CAN YOU TRUST?

Who's looking at your data? | Can you stream US Netflix? | Who slashes your speed? p30

Samsung Galaxy Note9
Probably the best phone in the world p50

Google Home Max
The craziest smart speaker yet p68

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HIGHLIGHTS THIS MONTH

Full contents overleaf

REVIEWS OF THE MONTH

### Apple iPhone Xs Max and Samsung Galaxy Note9

The question isn't whether you need a new phone: it's whether you can read our reviews of the iPhone Xs Max and Galaxy Note9 and resist buying them. The one thing we know for sure is that the days of 4in screens are well and truly over, as the phones in our pockets turn into true computers. We'd say "and they're priced like them too", except that isn't true: these monster phones cost twice as much as the HP Pavilion x360 laptop on p62. So we come back to the original question of whether you can resist the temptation. Turn to p50 and p56 to find out.

p30

TIP OF THE MONTH

Whether you want to avoid the government sniffers or hackers aiming to eavesdrop on your digital conversations, a VPN is the answer. We reveal the best – and whether you can trust them.
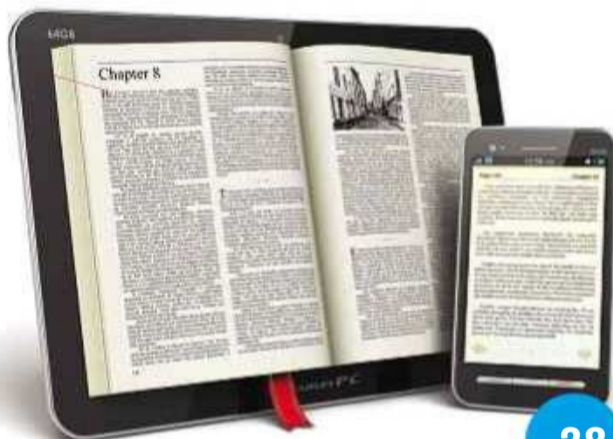
p38

LONG READ OF THE MONTH

Want to sit back and revel in great writing? Well, first you should read Nicole Kobie's article about where ebooks are going in the future… and only then consume one of the works she describes.

p126

STARTUPS OF THE MONTH

Breathe in. Breathe out. Then cough as the air pollution hits your lungs. Urban life doesn't need to be like this say our three startups of the month, as they use technology to give us a fresh way of thinking.

APP OF THE MONTH
APART OF ME

p22

Apart of Me isn't your run-of-the-mill app. Developed by Bounce Works, it aims to help young people who have lost a parent by giving them a different way to process their grief.

THE LABS IN ONE NUMBER

p74

That's how many tablets we put to the test, as Acer, Amazon, Lenovo and now Microsoft attempt to dethrone the iPad king. Find out if they succeed from p74.

FEATURES

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p68 The Google Home Max is a beast of a speaker. We find out if it's worth the sky-high price

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Tablets group test

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REAL WORLD COMPUTING

110 JON HONEYBALL Jon looks back wistfully on Windows 95, turns any HDMI source into a webcam, and attempts to resurrect his aunt's coffee-soaked Vista laptop.

113 PAUL OCKENDEN Trying to go paperless actually involves lots of paper, discovers Paul, who also looks at an innovative single-board computer.

116 MARK NEWTON Mark shares the story of how he went from 3D printing novice to producing a half-metre-square rendition of Orkney's Ness of Brodgar dig.

118 DAVEY WINDER Davey fans the rumours around a Facebook rival to the Echo, celebrates the latest version of Chrome, and explains why ransomware isn't dead.

120 STEVE CASSIDY Steve laments the process of choosing remote access software, and uncovers a web page that was disrupting a small business' net connection.

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How to not fall foul of online regulations.

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Nik Rawlinson explores the different options.

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AI is automating small tasks that eat up time.

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The plans to solve our air pollution problem.

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How to make games frighteningly realistic.

128 Ditch the petrol
Forget flying cars, electric vehicles are the key.

Editor's letter

Embrace the right medium for the right job

I DOUBT MANY people will read Paul Ockenden's column this month without suffering a shudder of recognition (*see p113*). In it he explains how he's using a five-year-old scanner to fight against ever-growing piles of paper, and having just completed a clear-out of my office, I'm tempted to follow suit (I especially like his approach to dealing with the daily post).

Because there's no disputing one fact: paper is as big a pain as it is a boon. Naturally, I love paper. I scrawl daily notes into a Leuchtturm1917 notebook that then becomes an archive of my year, and you may have noticed that *PC Pro* is primarily a paper magazine. Paper is both tactile and permanent in a way that nothing else can match.

The downside is obvious: space. I spend 90% of my working life in a glorified 12 x 8ft shed at the end of my garden, and with each passing month my mounds of paperwork and magazines grow higher. Even after my clearout, I have two full boxes of papers to sift through, just to make sure I'm not chucking something I'll need roughly ten seconds after the recycling lorry has consumed it.

Like Paul, I don't believe in the paperless office, but I am cutting down my paper carbs. Where I can get an electronic receipt, I will – so much easier to find. If I'm going to read a pulp novel – I have a weird addiction to the Harry Bosch stories that I can't explain – then I'll do so on my Kindle. But for "proper" novels, I'll always opt for the paper route.

I did try reading magazines on my first and only iPad, but we never got on. I like to soak up information from magazines, and while tablet editions are a great backup if you can't get the real thing – I know we have readers all over the world who can't buy the paper version of *PC Pro*, even though they'd like to – there's no substitute for holding something "real" while sitting on a chair, bed, or that other place where I know people read magazines.

So, while we have just switched to a new app for iOS and Android, which I encourage you to download and try (search "PC Pro magazine"), you'll only find me reading magazines on a tablet if I'm travelling by plane. Even then, I'm more likely to be doing work. I fell a little in love with the Surface Go, reviewed as part of our tablets group test on p74, because it's tiny yet capable of doing real work.

I accept that it falls down compared to the iPad when it comes to apps. Despite Microsoft's best efforts, Windows 10 is years behind iOS and Android for entertainment on the move; to continue my example, I find playing *Ticket to Ride* an excellent way to fill the hours of a cross-Atlantic flight when I've finished tapping away in Word. It's available for both iOS and Android, but the Microsoft Store only offers scorekeeping apps for the physical board game.

Even so, of all the tablets in this month's group test, the only one I'd buy – indeed, the only one I have bought – is the Surface Go. But that's because I know what I want from my tablet. As phones have become bigger, they have become my consumption device, and I want a tablet to be my portable creation tool. I'm far more likely to buy the Galaxy Note 9 (*see p50*) or iPhone Xs Max (*see p56*) than any non-Windows tablet.

But that's just me. Here's hoping that this issue, which is packed full of the latest technology, can guide help you with your buying decisions whether for home, office or – as in my case – a mixture of both.

Tim Danton
Editor-in-chief

CONTRIBUTORS

Barry Collins
Whether you want to protect your privacy or stream the BBC abroad, Barry reveals which VPNs you can trust – and why you should be wary – from **p30**

Mark Newton
Find out how Mark went from being a 3D printing novice to creating a gigantic 3D replica of an Orkney archeological dig on **p116**

Gareth Ogden
After using 15 very different tablets for a month, Gareth delivers his verdict on which you should buy in our uber group test from **p74**

Nicole Kobie
A breath of fresh air – that's what Nicole hopes to deliver, courtesy of three startups seeking to reduce pollution in urban areas. Find out how on **p126**

PC PRO

Do you use a VPN? If so, why do you use it and which one do you use? (*Read our feature on which VPNs you can trust from p30*)

"I haven't yet chosen a VPN, but when I do it'll be a router-level one, so I don't have to muck around installing client software on each of my family's 15-odd devices."

"Only when I'm trying to break into iPlayer from abroad, although having researched this month's feature, I might use one more often."

"Quite a lot of my consulting jobs are about encouraging companies to stop using low-powered routers as if they were enterprise VPN endpoints. The home-user definition of 'VPN', as a privacy enhancer, really only touches my world where they get into IPv6."

"Yes, I VPN from my mobile phone and laptop back to the office LAN for security, especially when using a hotel or coffee house Wi-Fi."

"I use private VPNs all the time, and have done so for decades. But when people talk about VPNs these days they normally mean something quite different."

"Mostly when staying in hotels and at airports, despite mostly avoiding Wi-Fi and sticking with my own 4G – as an extra layer of security to the connection. I also use one when watching the rugby on BT Sport on mobile while out of the UK. For speed, reliability and privacy, I find Nord hard to beat."

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Dennis

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Briefing

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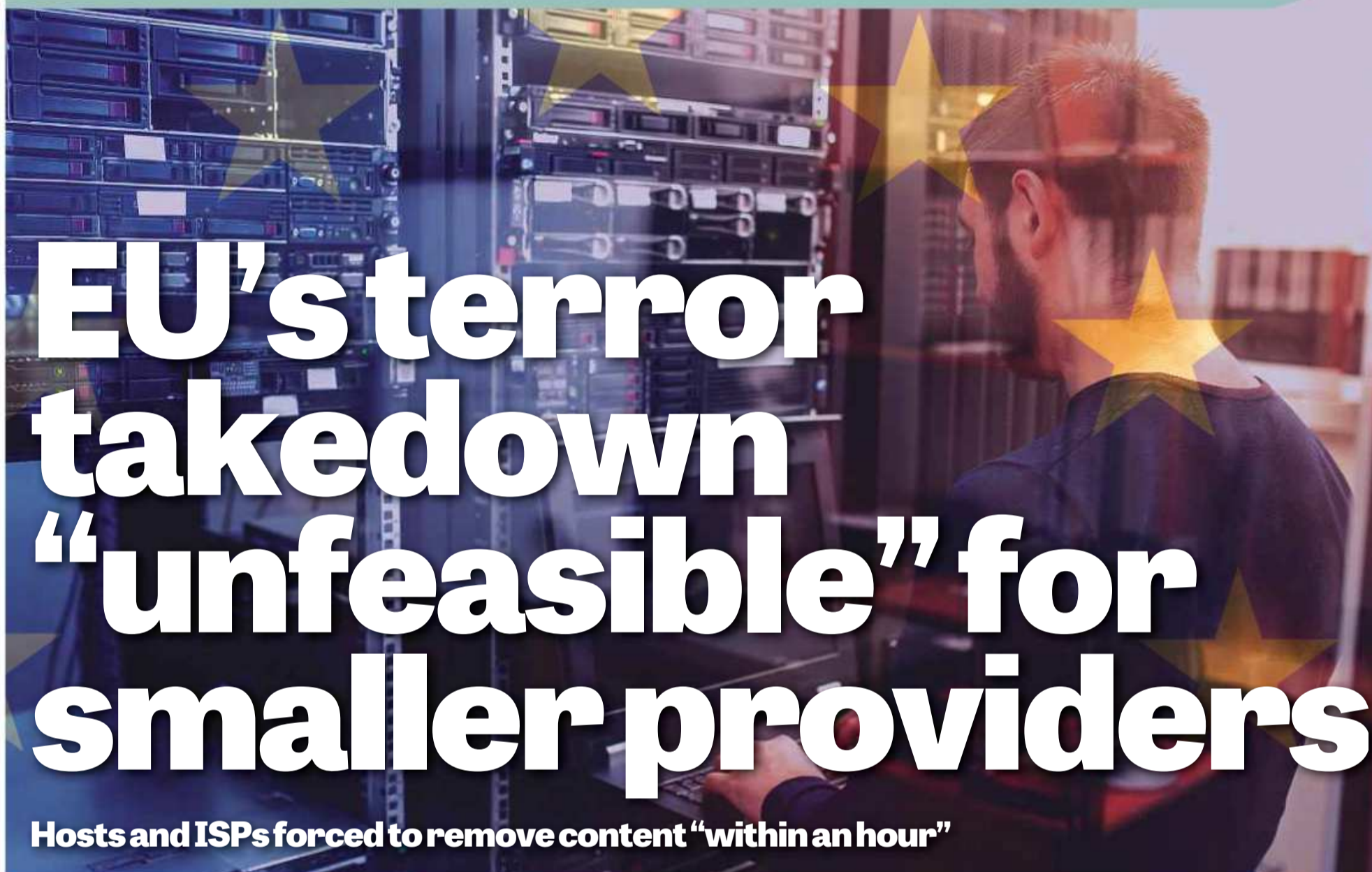
EU's terror takedown "unfeasible" for smaller providers

Hosts and ISPs forced to remove content "within an hour"

SMALL WEB HOSTS, ISPs and sites will be forced to make "unfeasible" changes to their businesses or risk severe fines under EU proposals aimed at reducing terror-related content online.

Under proposals designed to restrict extremist content – a problem that's also being targeted by the UK government – web companies would be forced to remove flagged material within an hour of notification or instead face fines of up to 4% of their annual turnover.

While the main focus of the plan are web giants such as Google, Facebook and Twitter, there's no get-out clause for smaller operators, who would struggle to finance the changes.

"Looking at the draft, it wouldn't just cover the big platforms – it covers hosting service providers and that's defined by the facilities that a company provides, not by its size," explained Neil Brown of tech specialist law firm Decoded Legal. "The text expressly says that it can't

carve out small providers because terrorism can be promoted on smaller platforms, too."

According to Brown, notices would be issued by an official body, such as a branch of the police in the UK, and companies that failed to comply within an hour could face significant penalties, especially if the failure was systematic.

While companies with huge resources should be able to adhere to the proposed regulations, smaller companies may not. "It obviously covers the likes of Facebook and Google to some extent, but it's any companies that are providing web-hosting services, of which there are hundreds, and what about companies that have comments systems on their websites?" Brown told *PC Pro*.

"So every small web hosting provider, every company that operates a comment facility will need to have the capability of being

contactable and take content down within an hour 24/7 and 365 days a year. It's unfeasible."

■ Proactive censorship

Web firms will be forced to do more than just react to notices, however. Internet companies will also be required to take appropriate measures to protect customers from extremist content, which could include filtering out a blacklist of recognised material before it's published.

On top of issuing take-down notices, the "competent authority" in each country would also issue referral notices, where the host would be asked to assess whether material was extremist.

"It puts hosts in an unenviable position," said Brown. "They are expected to be providing a technical facility for hosting services – they are not experts in knowing whether that content meets the definition of terrorist content."

ISPs confirmed that the proposals would be challenging, and may require them to change their policies to comply. "Yes, as an ISP, without routine 24/7 support (we have people on call for emergencies), we would have some issues with removal of content from our servers within one hour," said Adrian Kennard, MD of ISP Andrews & Arnold.

"Maybe we'd have to move to a model where the servers 'belong' to our customer and so they are responsible for one-hour takedown and not us. It will depend on the exact wording."

According to Kennard, not only would the plans prove costly, but terror groups would quickly find ways to publish material that bypassed controls. "It will also be massively ineffective as such material becomes more 'illicit' (and hence appealing)

> **If you treat everyone like Google, all that you will have left in the marketplace is people like Google**

and still fully accessible via encrypted private networks like Tor and others," he said. "It just hides the problem, if there is indeed a 'problem' to solve."

Article 13 angst
The move comes in the wake of European officials voting to impose restrictive copyright protection under Article 13 of the Copyright Directive and is part of a wider trend that removes some of the protections web firms have enjoyed as intermediaries rather than publishers.

The controversial Article 13 was designed to protect copyright holders and publishers from their content being republished online, but critics believe the move – as with the extremist material plans – gives an advantage to tech giants that can more easily put systems in place to filter copyrighted content.

"It seems to be part of a broader ethos of imposing greater obligations on service providers, whether it's takedown of terrorist content or entering into deals with rights holders about content that you host. The idea of the intermediary seems to be fading away," said Brown.

"If we regulate the web and services as if everyone is a large provider, all we will do is entrench the position of those existing large providers," he said. "If you treat everyone like Google, all that you will have left in the marketplace is people like Google."

Five stories not to miss

1 UK snooping ruled illegal by human rights court
The European Court of Human Rights ruled that the UK's huge online surveillance systems – exposed by Edward Snowden in 2013 – were illegal. According to the court, the programmes, which included "population-scale interception", were incapable of keeping the "interference" to what is "necessary in a democratic society".

2 UK government pushing for compulsory backdoors
The UK government – and its "Five Eyes" allies (see p30) – has called for mandatory backdoors to be applied to encryption. A statement said countries "may pursue technological, enforcement, legislative or other measures to achieve lawful access solutions" if technology companies did not provide access.

3 Microsoft under fire over Edge adverts
Microsoft riled its critics when an Windows 10 update included pages that effectively warned against using Firefox or Chrome. The firm has been pushing its Edge browser, but opponents cried foul when an installation screen for rival browsers claimed "You already have Microsoft Edge – the safer, faster browser for Windows 10".
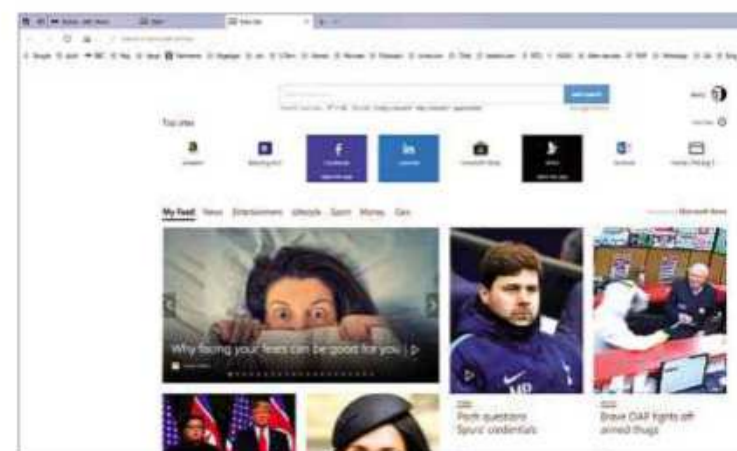
4 Apple bins Trend Micro apps over privacy concerns
Trend Micro became the latest company to face censure for over-harvesting user data with the firm's Dr Cleaner, Dr Antivirus and App Uninstall apps all ejected from Apple's Mac App Store. Privacy watchers spotted that the company was hoovering up and recording customer browser histories without permission – an increasingly common issue, according to reports.

5 BA in spin over payment cards breach
British Airways is facing a £500 million lawsuit over a credit card-skimming hack that saw 380,000 customers' financial details stolen during August and September. The airline warned travellers to contact their banks and said customers would not be left out of pocket if their details were used. The legal claim seeks £1,250 per victim.

IFA 2018
Pick of the products

We pick out the most exciting and interesting launches from the 2018 edition of Europe's largest consumer electronics show, IFA Berlin

PC PRO
BEST OF IFA 2018

Toshiba Portégé X30T
PRICE From £1,249
AVAILABILITY October
Toshiba knows how to make brilliant business laptops and this detachable comes darn close to perfection. We genuinely enjoyed typing on both its keyboards thanks to their 1.4mm travel – the main keyboard, which includes a second battery, weighs 600g or you can choose the travel keyboard that weighs 390g. The 13.3in tablet itself weighs 799g, and our only complaint is you'll need to use the kickstand to ensure that it doesn't fall over when you're typing.

Acer Aspire Z 24 all-in-one
PRICE From £900
AVAILABILITY October
There's life in the all-in-one yet, with Acer announcing a slick 24in machine at its IFA press event. We had a chance to play with it at the show, and confess to being a mite smitten: it's super-slim at 11mm, boasts Alexa integration via four far-field microphones, and should be pretty powerful thanks to support for eighth-generation Core i7 chips and up to 32GB of Intel Optane memory. Let's hope it lives up to its promise when it lands in our lab.

Lenovo ThinkPad X1 Extreme
PRICE From £1,360
AVAILABILITY Now
For us, Lenovo released one standout machine at IFA: the ThinkPad X1 Extreme. What's so extreme? To start, it supports Intel's latest and fastest Coffee Lake H processors, up to 64GB of memory, two storage slots and graphics up to the GeForce GTX 1050 Ti. And, naturally, it's all wrapped up in the usual high-quality ThinkPad design, including a 15in display and an 85Wh battery that promises up to 13 hours of life.

Asus ZenBook 15 Pro UX580

PRICE Core i9 version, £2,200
AVAILABILITY Q4 2018

Almost any one of Asus' new laptops could have made this list – the new slim-bezel "plain" ZenBooks look fantastic, too – but the Pro 15 grabs its spot due to the amazing Full HD trackpad. That's right, it's a screen in its own right, with modes such as calendar, calculator and number pad. Or you can set it to be a second screen, and then drag, say, a football match to play whilst you finish that report.

Acer Swift 5 15in

PRICE From £1,099
AVAILABILITY November

Acer had one goal with this 15in laptop: to get it under 1kg. It snuck in with 6g to spare, and the result is something a little bit special. With a combination of metal alloys for the whole chassis, it feels perfectly sturdy, while the newly released Core i5 or Core i7 chip inside means it can – or so Acer claims – last up to ten hours on a single charge.

Lenovo Yoga Book C930

PRICE From £900
AVAILABILITY Now

You may remember Lenovo's first stab at the Yoga Book, with an E Ink screen where the keyboard used to be – well, it's updated it for 2018 with a more believable typing experience thanks to haptic feedback and animation on the keys. This means it can act as a laptop when you need it and a tablet (the screen flips round) or sketchpad when you don't.

Huawei Kirin 980

PRICE Not applicable
AVAILABILITY October in new phones

Huawei designs and makes its own SoCs for its phones, and the company gave a confident display of its new chip's power at an IFA keynote. If its claims bear up to scrutiny in independent benchmarks, this chip looks like it will be significantly faster than the Snapdragon 845 in everyday tasks, whilst its AI skills will edge photos that little bit closer to DSLR quality.
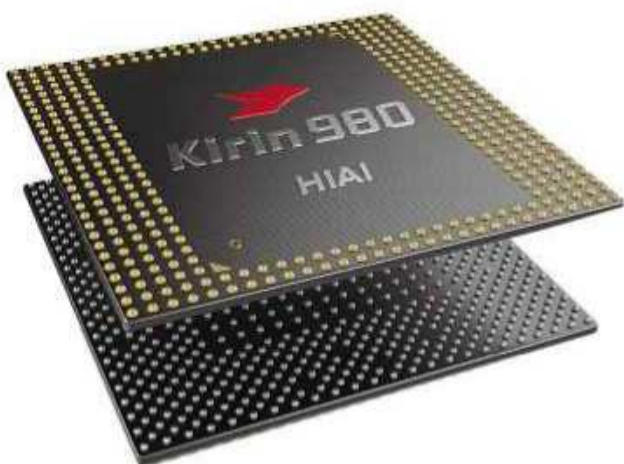
Casio Outdoor Watch WSD-F30

PRICE To be confirmed
AVAILABILITY Early 2019

It may be powered by the latest version of Android Wear, but this is no me-too watch. Its dual-screen design means it can be a full smartwatch when you want and drop down to a more basic device when you need to conserve battery life. With an emphasis on ruggedness – this is the kind of watch Bear Grylls would wear – it's likely to cost upwards of £400.

Dell XPS 13 2-in-1

PRICE To be confirmed
AVAILABILITY To be confirmed

It's no coincidence that Dell announced its new 2-in-1 Dell XPS 13 just hours after Intel revealed an update to its Amber Lake processors, with the flippable design coming with a choice of low-powered Core i5-8200Y or Core i7-8500Y chips. Dell claims that its new iteration of this dinky convertible should last for up to 15 hours of life, and we look forward to putting that boast to the test.

PC Probe

Rare earth mining puts tech in China's hands

Despite warning signs in 2010, China could hold technology producers to ransom in a trade war. Stewart Mitchell unearths the facts

When Tim Cook stepped in at the eleventh hour to persuade Donald Trump not to impose Chinese tariffs on his company's products, he had good reason not to further provoke the Chinese.

The global tech industry remains dependent on China when it comes to critical rare earth elements, a situation that could lead to production lines grinding to a halt.

The scale of the risk is highlighted by the variety of tech where manufacture would be impossible without one of the 17 rare earth minerals for which China holds more than 80% of the world's supply.

"Neodymium, for example, makes the strongest permanent magnets [NdFeB] – used in all sorts of equipment from direct drive motors in electric vehicles, speakers in mobile phones and computer hard disk drives," said Professor Frances Wall, a specialist in rare earths at the University of Exeter's Camborne School of Mines.

"Practically all red colour in display screens comes from europium. The problem is that the whole part of the supply chain is concentrated in China. If China choose not to export rare earths and rare earth alloys and compounds, it would be difficult to manufacture any of these things outside China."

China has a history of choking supply for its own political gain, too. In 2010, a trade dispute with Japan saw severe restrictions on exports – a tactic that resulted in a huge spike in prices and led to a scramble to activate mines and production plants elsewhere. Between 2009 and 2011, as the shortage kicked in, the price per metric ton of neodymium soared from around $15,000 in 2009 to $250,000 in 2011.

Inevitably, such swings have an impact on the prices of the gadgets the materials are used in. "An increase in NdFeB permanent magnet prices would have a greater impact on hard disk drive [HDD] prices than it would mobile phones," said Ryan Castilloux, managing director of market watcher Adamas Intelligence.

"In mobile phones, NdFeB is used in the loudspeaker and vibration motor, while in HDDs NdFeB is used in the voice coil and spindle motors.

"If HDD prices went up, that would absolutely hit the bottom line of data centres, which still use HDDs in abundance."

> **People would like to believe that rare earths are everywhere and that there is no reason to worry about access**

BELOW China holds the lion's share of crucial minerals that are used in mobile phones

Bullish tactics

Opinions are divided on whether China would repeat its tactic, because the sudden increase in price meant other companies and countries with rare earth materials were motivated to start or restart production.

"Two players did enter the market," said Tim Worstall, an independent rare earth trader and commentator. "Molycorp reopened the US's Mountain Pass and then went bust again. And Lynas opened in Australia.

"China exploiting the monopoly would, or at least could, lead to new market entrants," he speculated.

Amid the price rises in 2010, both companies and nation states put resources into seeking alternative supplies, yet interest waned once prices adjusted back to near previous levels.

Now, as China looks to expand its own industries and investigates renewable energies, experts fear production may not always be sufficient to meet demand. Chinese authorities have already clamped down on companies that were over-producing their quotas.

"When the rare earth crisis of 2010 sent prices through the roof, there were headlines of new discoveries, but money for ventures to extract them mostly dried up when the market corrected itself," said Sophia Kalantzakos, a distinguished professor in Environmental Studies and Public Policy at New York University.

"People would like to believe that rare earths are everywhere and that there is no reason to worry about uninterrupted access.

"This kind of wishful thinking does not address the main issues: that China controls the supply chain for a number of rare earth uses, and that as it turns to high-tech production and renewables, China will need to consume what it extracts and less will be available for industries elsewhere."

Geopolitical strains

In a world of increasing political tension, the emergence of new deposits – even if they're currently too expensive to mine – has raised security issues, especially in areas being made accessible because of climate change.

ABOVE Chinese companies are also investing in rare earth mines around the world

With Arctic ice retreating, several countries – including Russia and China – are eyeing rich deposits, and observers believe this could escalate tensions in the area.

Deposits have been identified in Canada, Greenland and Russia, but China and other players are already exploring the possibilities of extracting oil and gas in the region.

"Human nature is inherently aggressive and this is true when critically important economic and national security resources are involved," said Bert Chapman, a professor in Government, Information, History and Political Science at Purdue University. "Increasing international economic and national security dependence on rare earths makes conflict over areas containing them more likely.

"Existing international government organisations such as the Arctic Council have zero enforcement abilities to carry out their lofty aims."

In a recent UK report into Arctic threats, the Defence Committee also raised concerns that Britain wasn't well placed to defend any rights in the area and stressed that the retreating ice meant the area was a potential hotspot.

"Easier access to resources raises the potential for regional competition and conflict," the official government document read. "The region is also thought to contain considerable reserves of rare earth metals and minerals."

Although a physical conflict remains unlikely, the changing state of world economics means China could use its dominance as a tool for other political goals, especially in disputes with the US over trade. "Resource scarcity is something that policy makers need to factor into geopolitics, economics and security," explained Kalantzakos.

"The use of economic statecraft is a salient political weapon in geopolitical competition. China has understood the strategic importance of rare earths for quite some time and strategised to make itself able to dominate the market in an unprecedented way."

The US was eventually persuaded not to include rare earth materials in its final list of items that could be hit with tariffs in Donald Trump's latest round. "The US included rare earths in the preliminary list of Chinese imports it had targeted and China responded accordingly," said Kalantzakos. "If rare earths had been included on the final list, US industry would have had to buy them more expensively… there must have been some serious reconsideration taking place in Washington."

■ Colonising competition

China is also staking a claim to international sources of rare earth materials. Either the state or Chinese companies have made huge investments in projects in Kvanefjeld in Greenland and that Mountain Pass plant in the US.

"China has become increasingly involved in certain rare earth projects outside the nation," said Castilloux. "For the most part, these efforts are being led by private Chinese companies rather than the large state-owned enterprises that dominate the market in China.

"In other cases, we see China taking a more opportunistic approach by involving itself in foreign rare earth projects at a time when prices are suppressed and company valuations are down, enabling them buy in at a discount to long-term value."

In other words, even when rivals are available, China has a controlling stake. If that wasn't already sufficient cause for concern, most of the mined materials from around the world are shipped back to China to be turned into useful raw materials.

"A really good example is Mountain Pass in the USA, which went bankrupt and is now back working, partly in Chinese ownership," said Wall. "The ore is being shipped to China for further processing rather than using the new plant at Mountain Pass. Most mines planning to open now would export their rare earths to China."

Kalantzakos estimates that getting a mine and processing plant up and running would cost $1 billion and take a decade. In the meantime, the tech industry will be hoping relations with China don't turn sour. ●

Are they really 'rare'?

The rare earth metals tag is a misnomer, as the elements are actually found far and wide.

"The metals themselves aren't rare," said Worstall. "Cerium, just one of the 17, is on its own more common than copper. We mine millions of tons of copper a year, while all 17 rare earths combined are only 120,000 to 130,000 tons a year."

But separating rare earth materials from each other presents a huge challenge in the processing plant, which means rivals can't enter the market.

"Chemistry depends upon the outer electron shell and nearly all REs [rare eartghs have the same number of electrons in that outer shell, which makes using chemistry to separate them, one from the other, ineffective," said Worstall. "So, we've got to use some aspect of physics – magnetism, density, size of [an] atom maybe."

As the samples can be rebalanced only minutely during a process that includes boiling in strong acids, each sample may need to go through thousands of iterations and the process must be tailored for each source. So while the minerals are by no means rare, viable manufacturing product certainly is.

The A-List

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

PREMIUM LAPTOPS

Dell XPS 13 9370

Ultraportable from £1,248

from dell.co.uk

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

ALTERNATIVES

Apple MacBook Pro 15in (2018)
A machine for true power users with amazing specifications, including that infamous Core i9 – and up to 4TB of SSD storage. **From £2,349 from apple.com/uk REVIEW** Issue 288, p48

Dell XPS 15
We all know what to expect from Dell's XPS 15 range, yet it continues to reign supreme – this time thanks to sheer speed, courtesy of Intel's latest chips. **From £1,399 from dell.co.uk REVIEW** Issue 289, p62

Razer Blade 15
A gaming powerhouse as you would expect. We recommend buying one of the specs with a 144Hz Full HD screen and GeForce 1070 graphics. **From £1,700 from razer.com REVIEW** Issue 288, p63

TABLETS

Apple iPad

9.7in tablet from £319

from apple.com/uk

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

ALTERNATIVES

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

NEW ENTRY

Amazon Fire HD 8
If you're just looking for entertainment, save money and buy the Kindle Fire HD 8. It's simply superb value. **£80 from pcpro.link/290fire8 REVIEW** Issue 290, p87

NEW ENTRY

Microsoft Surface Go
We weren't expecting much from the Surface Go, but the £509 version is a highly portable work companion. **128GB, £509 from microsoft.co.uk REVIEW** Issue 290, p80

SMARTPHONES

OnePlus 6

Android, 64GB, £469

from oneplus.net

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

ALTERNATIVES

Asus ZenFone 5
A quite simply brilliant phone for the money, with a highly respectable camera, all the speed you need and a beautiful 6.2in screen. **£350 from asus.com/uk REVIEW** Issue 289, p71

NEW ENTRY

Honor Play
If you can look past its mediocre camera, the speedy Play offers great battery life and a highly respectable 6.3in screen. **£280 from store.hihonor.com/uk REVIEW** Issue 290, p72

NEW ENTRY

Apple iPhone Xs Max
Yes, it's expensive, but this is the best Apple phone out there. Fast, gorgeous and a killer screen. **128GB, £1,099 from apple.com/uk REVIEW** Issue 290, p56

EVERYDAY LAPTOPS

HP Envy 13 (2018)

A bargain ultraportable, £849

from hp.com/uk

If you care about the colour accuracy of your laptop screen, this isn't for you. But, for everyone else, it's a bargain. It has buckets of power thanks to a Core i5 processor, 8GB of RAM and GeForce MX150 graphics in our review model (ah0001na), as well as the fit and finish of a luxury machine. **REVIEW** Issue 288, p61

ALTERNATIVES

Asus ZenBook UX410UA
A superb value 14in laptop, with the looks of a much more expensive machine. The pricier 8GB/256GB version is best, though. **£539 from pcpro.link/280zenbook REVIEW** Issue 280, p68

Asus ZenBook 13
A brilliant 13.3in ultraportable that packs a very impressive specification into a slender 1.12kg frame – including Nvidia graphics. **£1,200 inc VAT from johnlewis.com REVIEW** Issue 286, p58

NEW ENTRY

HP Pavilion x360 14-cd0008na
We freely admit that this isn't the perfect laptop, but if you're on a tight budget and want a family-friendly machine then it's still a great choice. **£699 from pcpro.link/290hp REVIEW** Issue 290, p62

ENTHUSIAST PCs

NEW ENTRY

Scan 3XS Vengeance RTX

Nvidia RTX 2080 PC, £2,400

from scan.co.uk

Scan combines Intel's i7-8086K processor with a Nvidia GeForce RTX 2080 graphics card. Finished with Scan's understated panache, this machine will deliver stunning speeds now and has the potential to go even faster in the future. **REVIEW Issue 290, p60**

CCL Reaper GT

In a world of big black boxes, the Reaper GT's all-white finish stands proud. As you'd expect, it includes some cracking components (an AMD Ryzen 2700, 16GB of RAM, a 250GB SSD and 8GB GTX 1080 graphics) with watercooling for good measure. A brilliant high-end PC. **AMD Ryzen 2 PC, £1,410 from cclonline.com REVIEW Issue 286, p80**

Palicomp Intel i7 Nebula

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

WORKSTATIONS

Scan 3XS WI6000 Viz

Core i9-7980XE workstation, £4,650

from scan.co.uk

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

Apple iMac Pro

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

Scan 3XS WA6000 Viz

The A in this machine's name stands for AMD, with the 32-core Threadripper 2990WX CPU making its phenomenal debut. You can buy better all-rounders, but if your tasks including rendering using CPU-bound applications then it offers amazing value for money. **£4,800 from scan.co.uk REVIEW Issue 289, p59**

MONITORS

Eizo FlexScan EV2450

1080p display, £278

from pcpro.link/263eizo

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

ViewSonic VP3268-4K

It's true that you can buy 32in 4K monitors for around £500, but we think it's still worth spending the extra money on this ViewSonic. In return, you get superb colour accuracy and terrific all-round quality. **£882 from pcpro.link/286view REVIEW Issue 286, p65**

Iiyama ProLite X3272UHS-B1

Looking to kit an office with 4K displays? This 32in screen is a perfect option, with image quality and value for money taking precedence over features you may never use. **£430 from box.co.uk REVIEW Issue 288, p72**

ENTHUSIAST/SMB NAS DRIVES

Synology DS918+

Four-bay NAS, £500

from laptopsdirect.co.uk

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

Qnap TS-453Be-4G

Qnap markets the TS-453Be at businesses rather than home users – although, in our opinion, it's equally at home in both situations. It's straightforward to use and a very solid performer, as well as being extremely versatile. **£558 from pcpro.link/284qnap REVIEW Issue 284, p80**

WD My Cloud EX4100

If you're looking for a solid, speedy NAS – particularly for a small office – then take note of the affordable WD My Cloud EX4100. Despite that reasonable price, it includes four bays, and its mid-range specification can handle office duties well. **£291 from pcpro.link/284wd1 REVIEW Issue 284, p83**

WIRELESS NETWORKING

Zyxel Multy X

Mesh networking, £250

from pcpro.link/282multy

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

Linksys EA9500 Max-Stream

If a mesh network isn't for you, this feature-packed router is an excellent choice. It's packed with eight Gigabit Ethernet ports and can work as DLNA server. Most importantly, it delivers extremely fast speeds. **£225 from pcpro.link/288link REVIEW Issue 288, p82**

Tenda Nova MW3

Don't want to spend over £200 on a Wi-Fi upgrade? The Nova MW3 is a bargain choice, killing off notspots and spreading Wi-Fi throughout your home. It's not as fast or wide-ranging as the Zyxel Multy X, but boy does it win on value. **£83 from pcpro.link/288tenda REVIEW Issue 288, p69**

WORKGROUP PRINTERS

Xerox VersaLink C600DN

Colour laser, £780 exc VAT

from printerland.co.uk

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

Brother HL-L9310CDW

If you can't quite afford the Xerox VersaLink C600DN, consider this good-value rival from Brother. This colour laser provides great output quality, low running costs (1.1p/7.8p) and speeds of up to 32ppm, as well as plenty of security features. **£440 exc VAT from printerbase.co.uk REVIEW Issue 283, p94**

Kyocera Ecosys M5526cdw

Low running costs and easy maintenance are the key factors here, with 1.3p per mono page and 9p for colour. Print quality is great too, even if you're kept waiting a little longer for 600dpi prints. **£376 from printerland.co.uk REVIEW Issue 279, p101**

HOME OFFICE PRINTERS

HP PageWide Pro 477dw

All-in-one inkjet, £339

from ebuyer.com

While this isn't the most compact inkjet MFP, it is one of the fastest – it hit 44.8 pages per minute in our tests. With excellent print quality and low running costs, the only thing that counts against it is that you'll need good quality paper to take advantage. **REVIEW Issue 287, p81**

Canon Pixma TX6150

Squarely aimed at home users with a creative bent, the Pixma TS6150 produces excellent photos, and quickly, too: it took 70 seconds for a borderless 6 x 4in print. With respectable running costs, it's a very classy multifunction printer for the money. **£100 from pcpro.link/287can REVIEW Issue 287, p80**

Xerox WorkCentre 6515DNI

Just like the HP, this isn't the world's smallest printer – but for a £299 colour laser, it's amazing what you get in return. Pin-sharp scanning, great all-round printing, and solid speeds of over 20ppm. Only high running costs count against it. **£299 from printerland. co.uk REVIEW Issue 287, p85**

VIDEOCONFERENCING

Polycom RealPresence Trio 8800 Collaboration Kit

Full VC kit, £1,209 exc VAT

from pcpro.link/275poly

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

Lifesize Icon 450 and Phone HD

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

Logitech ConferenceCam Connect

If you need a portable solution for smaller rooms, this sleek device can be set up in seconds. Despite its size, it can't be faulted for quality and the price is right, too. **£243 exc VAT from pcpro.link/275log REVIEW Issue 275, p97**

BUSINESS WI-FI

DrayTek Vigor 2862Lac

Secure router, £354 exc VAT

from netxl.com

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

WatchGuard AP420

Not cheap, but SMBs wanting enterprise-class wireless security and central management will find it money well spent. The cloud portal is one of the best we've seen, performance is great and WatchGuard's WIPS delivers smart wireless security. **£647 exc VAT from broadbandbuyer. co.uk REVIEW Issue 281, p97**

TP-Link Omada EAP225 V3

A brilliantly affordable AC1350 access point that's a great budget choice for small businesses wanting to create a secure, easy-to-manage wireless network in the office. Plus, it can scale up as your needs grow. **£53 exc VAT from scan.co.uk REVIEW Issue 288, p101**

SCANNERS

Xerox DocuMate 6440

USB scanner, £353 exc VAT

from printerbase.co.uk

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

Brother ADS-3000N

Aimed at mid-sized workgroups, the ADS-3000N is a solid deal: it supports both USB and Gigabit Ethernet network connections, while offering 50ppm scan speeds, a robust 5,000-page daily duty cycle and a generous software package. **£385 exc VAT from pcpro.link/278ads REVIEW Issue 278, p94**

Plustek SmartOffice PL4080

Looking for a flatbed scanner? The PL4080 fits the bill nicely, combining a fast 40ppm duplex ADF with an A4 flatbed scanner. With Plustek's intuitive DocAction software thrown in, it's a great buy. **£345 exc VAT from grooves-inc.co.uk REVIEW Issue 278, p97**

SECURITY SOFTWARE

Bitdefender Internet Security 2018

A stellar selection of extras, including ransomware protection, along with rock-solid antivirus protection makes this our top choice for 2018. **3 devices, 1yr, £25 from bitdefender.co.uk** REVIEW **Issue 279, p85**

Avast Free Antivirus

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

Kaspersky Internet Security 2018

The best choice for power users and tinkerers, with little different from last year's offering – but with so many features already, that's fine by us. **3 devices, 1yr, £17 from pcpro.link/279kas** REVIEW **Issue 279, p86**

PRODUCTIVITY SOFTWARE

Microsoft Office 2016

We'll be honest: there's very little here for anyone upgrading from Office 2013. However, Microsoft's is still the best office suite for professionals. **Home & Student, £65 from pcpro.link/254off** REVIEW **Issue 254, p62**

Google G Suite

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

Scrivener

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

CREATIVITY SOFTWARE

Adobe Creative Cloud

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

Serif Affinity Photo

Don't be fooled by the low price: this is a serious rival to Adobe Photoshop in terms of features, even if it does require a hefty system to make it fly. Even professionals should give it a look. **£34 from affinity.serif.com** REVIEW **Issue 271, p72**

CyberLink PowerDirector 16 Ultra

An excellent tool for 360 video production and also a fine choice for normal video, with powerful plugins that boost it yet further. Not cheap but worth it. **£55 from pcpro.link/278cyb** REVIEW **Issue 278, p73**

RACK SERVERS

Broadberry CyberServe Xeon SP1-208S

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

Lenovo ThinkSystem SR550

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

PEDESTAL SERVERS

HPE Proliant ML350 Gen10

A perfect expression of HPE's "buy now, upgrade later" mantra, you can upgrade every part of the ProLiant to your needs. We reviewed the model 877621-031, which features an eight-core 2.1GHz Xeon Silver 4110 CPU, 16GB of RAM and a Smart Array RAID card – a fine starting point. **£1,799 exc VAT from ebuyer.com** REVIEW **Issue 288, p96**

Lenovo ThinkSystem ST550

Not as expandable as the HPE ProLiant, but this is a great hardware package – the Xeon and RAM are the same as HP, but it has a Lenovo RAID 930-8i card and a management platform that costs £23 per year. **£1,809 exc VAT from ebuyer.com** REVIEW **Issue 288, p97**

SECURITY

Panda Adaptive Defense 360

We didn't think Adaptive Defense 360 could get any better – we were wrong. Panda packs this latest version to the gills with new features, including improved management, a great range of endpoint protection services and a data-monitoring policy to help GDPR. **25 seats, 1yr subscription, £1,231 exc VAT from pandasecurity.com** REVIEW **Issue 289, p97**

WatchGuard Firebox M270   NEW ENTRY

The M270 dispels the notion that high UTM performance has to come at a high price. It offers a persuasive range of security measures and is ideal for SMBs that want the same protection as enterprises. **£2,743 exc VAT from watchguard-online.co.uk** REVIEW **Issue 290, p101**

NAS APPLIANCES

Qnap TS-1277

Thought AMD's Ryzen processors were for consumer PCs only? Qnap clearly doesn't, as evidenced by the eight-core 3GHz Ryzen 7 1700 inside this blisteringly fast NAS appliance. The TS-1277 raced through our performance tests, but impressed just as much for deployment, data protection features and cloud backup. **Diskless, £2,436 exc VAT from span.com** REVIEW **Issue 283, p101**

Broadberry CyberStore 224S-WSS

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

BACKUP

Veritas Backup Exec 20

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

Backup Everything Business

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

VOIP SERVICES

3CX Phone System 15.5

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

RingCentral Office

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

tp-link

deco™

High-Speed Wi-Fi for Your Smart Home

Deco M9 Plus
AC2200 Tri-Band Mesh Wi-Fi System
with Smart Home Hub

HomeCare™

Parental Controls
Antivirus
QoS

3 year free service

Connect more than 100 devices. Easy control with the Deco app.

Smart Sensor

Smart Lights

Smart Plugs

Smart Camera

Smart Thermostats
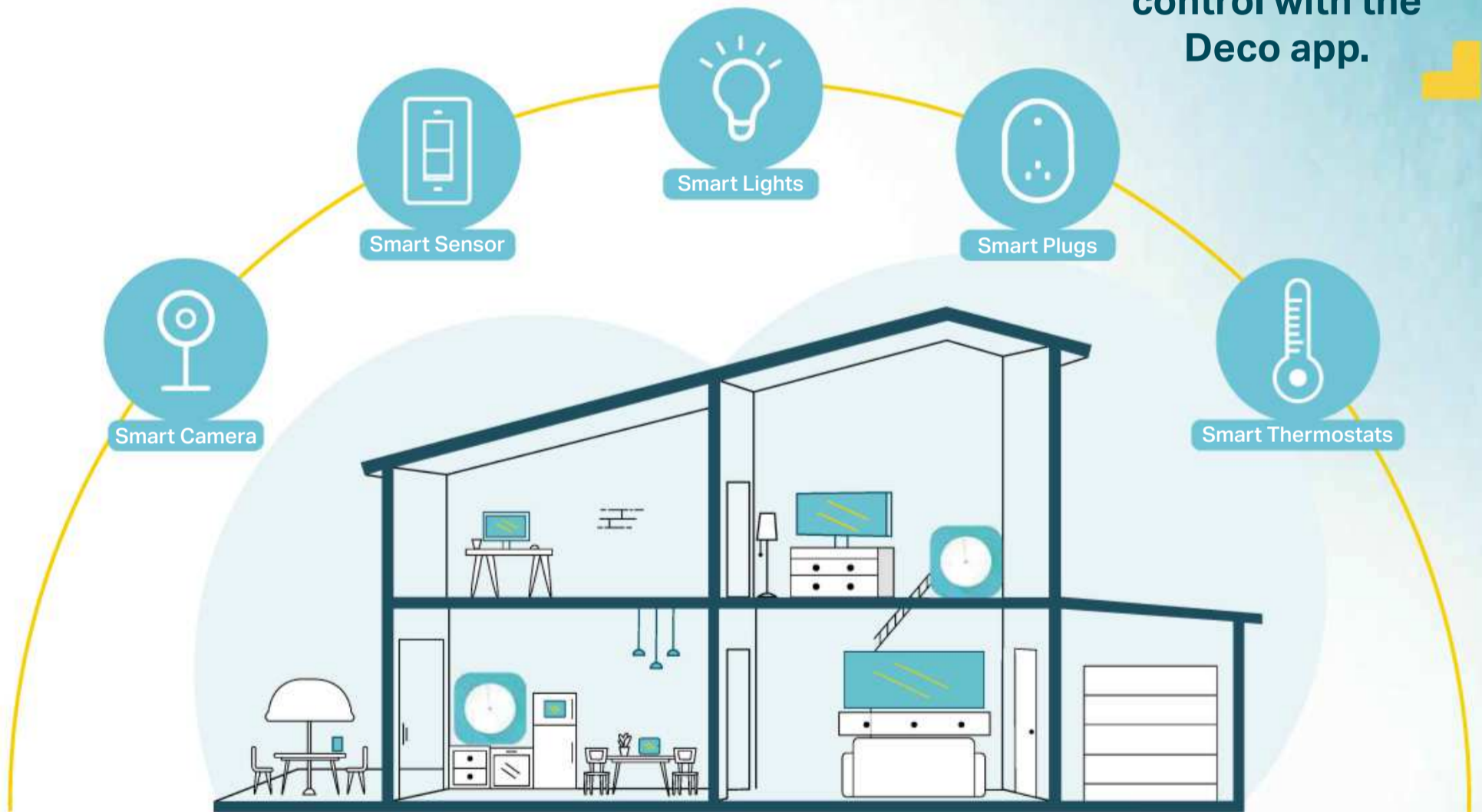
Wi-Fi Dead-Zone Killer
Eliminate weak signal areas with whole home Wi-Fi. No more searching around for a stable connection.

Tri-Band Wi-Fi & TP-Link Mesh
Three high-speed wireless bands plus strong, dynamic backhaul delivers fast, stable Wi-Fi across your home.

3-Year Free Built-In Antivirus
TP-Link HomeCare™ protects all connected devices in your home from viruses and malware.

Integrated Smart Home Hub
Replace many smart hubs to save money and space. The Deco app controls all your smart home devices from a unified screen.

Setup and Control with the Deco App
The Deco app makes setup simple and is your console to control all connected smart devices.

Compatible with
amazon alexa

Works with
IFTTT

BACKGROUND INFO ON INNOVATIVE BRITISH COMPANIES

Bounce Works

Can an app help children cope with the loss of a parent? A small British firm is sure that it can

No parent should ever have to bury a child, as the saying goes, but what about the child that has to cope with the death of a parent? On average, one child in every school class will have lost a parent and no two children will deal with the loss in the same way.

Getting children to discuss their emotions after the death of a parent can be difficult, especially with a family dealing with their own grief around them. The child may feel they don't want to make the surviving parent even more unhappy by discussing their feelings, for example.

Bounce Works aims to tackle this problem in the form of an app. Described as an "emotional support system", the *Apart of Me* app aims to help families talk about death by placing the child in a virtual world that encourages them to explore their feelings and share them with people in the real world. It launches this autumn and we caught up with one of the two co-founders at the BT Tech4Good Awards to find out more about the app that everyone hopes they will never have to use.

Help in the hospice

An app like *Apart of Me* doesn't just come from a flash of inspiration. Bounce Works co-founder Louis Weinstock was working as a family psychotherapist in a hospice, helping the children of parents with a terminal illness, when the idea germinated.

"Louis was approached by the hospice to look into digital approaches to bereavement counselling," said Ben Page, the company's other co-founder. "Often young people are hard to reach in that situation, not surprisingly, and digital seemed to be a good avenue to reaching them." Page, with almost 20 years of software development experience, decided to lend his technical expertise.

Page and Weinstock ran some focus groups with families, looking at the existing apps and tools that were designed to help children cope with bereavement, but they weren't landing. "Their feedback was pretty much 'we wouldn't use that, we'd be doing other things on our phone'. One of those things was gaming, and so it seemed obvious we should approach it using gaming technology."

Bounce Works won a grant from the Nominet Trust to develop *Apart of Me*, and then engaged the services of a professional games developer to design the app. "It's a virtual environment on the young person's mobile phone that they can enter whenever they want to help them process their grief and understand their emotions," explained Page.

"The aim is to take some of the real-world consulting techniques that Louis is using in the consulting room and produce a digital version."

An island of their own

Apart of Me takes the form of a virtual private island, a place the child can visit to be alone with their thoughts. There's no online interaction or parental/carer supervision – no sense that the child is being watched or observed.

"When you arrive, you're met by a guide who welcomes you and introduces themselves as someone who's been through a difficult situation in the past and who can guide the young person on their journey," said Page.

The game takes the form of a 3D adventure that challenges the player to take on various quests. The quests help the player understand life and death and how to cope with their own emotions. Far from encouraging the child to bottle up their emotions or confine their communication to their virtual guide, the quests also include real-world challenges, such as 'talk to someone who knew your father and find out what their favourite movie was'. In the longer term, Page wants to add a 'digital memory box' to the game, so that players can store photos, audio or video of their parent.

"One of the problems anyone has when they're going through grief is accepting their own emotions and understanding that whatever they're going through is okay, and they're not alone in feeling those things and other people have been in similar situations," said Page. Indeed, there's a section of the island where players can listen to the stories of other young people who have suffered a bereavement.

"There's an educational element to it – learning about different emotions and coping strategies if you're overwhelmed by those emotions."

Well done. You have found your first message in a bottle!

Oracle

Measuring the response

Apart of Me has no direct output – there's no reporting of the child's progress or how far they've got through their journey. Nobody wants the player to feel like they're being evaluated or that they have to hit certain targets. It's not an exam.

However, without any direct means of seeing how players are interacting with the game or progressing through its different quests, it's harder for the design team to see how improvements can be made. This isn't the kind of app that you can run past randomly selected focus groups, because children who haven't suffered the loss of a parent won't have the same emotional attachment to the journey. Needless to say, recruiting recently bereaved children to test an app isn't appropriate, either, so the team had to strike a delicate balance when it came to getting feedback.

"We had a prototype and we've evaluated it with a hundred young people and families, all of whom had been 'youth advocates' and people that Louis had worked with at the hospice," said Page. "They're maybe a bit further down the line than our target audience, but we obviously have to be careful about who we're testing these prototypes on." Of the 100 families who tested *Apart of Me*, around 80% said they would recommend it to a friend in a similar situation, said Page.

The ongoing challenge is to develop a way to evaluate whether the app helps improve the emotional wellbeing of the player. "We're implementing a feature we're calling the emotional check-in," said Page. "Young people, every time they use the game, can record how they're feeling. It's a very simple journaling exercise."

Gearing for launch

Apart of Me relied on grants and a crowdfunding campaign to provide it with enough money to launch the app. The

> **There's an educational element to it – learning about different emotions and coping strategies if you're overwhelmed**

company itself is a social enterprise – it's not primarily driven to make a profit.

Which is probably just as well, because the app is being given away for free in the app stores and – by its very nature – it's targeting a niche audience. This is not going to become a mainstream hit.

Promoting the app is also a challenge. Again, this isn't the kind of app that would necessarily benefit from a mass marketing campaign, even if the company could afford one. Instead, it will be working with charities in the sector, such as Child Bereavement UK and Grief Encounter, to spread the word and reach the people that need the app most. "Social media is very helpful and there are good networks of people who are either supporting bereaved young people or who were bereaved young people themselves and can now really see the benefit of what we're doing," said Page.

Bounce Works will need all the word-of-mouth and promotional support it can get, because there won't be a huge PR department when the app drops in the stores this autumn. Bounce Works was formed by two people and remains just two people: Page and Weinstock.

Yet, because of the nature of the app, Page has found that people are willing to chip in. "The nice thing is that because we've got a very compelling product, lots of people want to help us. We get very good rates and a lot of spare time from people, so we're making good progress," he said.

And *Apart of Me* is just the first of a line of products the firm hopes to launch. "We're really set up to investigate and explore how digital products can help emotional wellbeing in young people," said Page. **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

After 20 years, it's time for Google to buck its ideas up

Technology has got Google this far, but it's customer satisfaction that keeps companies on top

Darien Graham-Smith is *PC Pro***'s associate editor. He still thinks fondly of Lycos from time to time.**
 @dariengs

I'm writing this on the 20th anniversary of the establishment of Google Inc. Do you remember where you were when Larry Page and Sergey Brin made it official? I'm sure you don't, because even in the middle of the dotcom boom, the arrival of a new web-search company was hardly newsflash-worthy.

I do, however, remember the occasion when Google first came to my own attention. It was during an email exchange with an old friend of mine named Dan Smith – now a high-flying litigator, then a hard-working law student. The details of the conversation are lost in the fuzz, but I clearly recall his mentioning that he had looked something up on Google – not "on the web", as one might have said at the time, but specifically on Google. Well, I thought, if a chap as fastidious as Dan is buying into this new site, it must be worth a look. And to this day Google remains my own go-to search engine.

Yet I can't say I'm in love with the company. My issue isn't its business model; some of my friends take offence at the way the company makes money off the back of their personal data, but among the endless scammy app developers, clickbait publishers and other abusers that plague the web, Google seems fairly well-intentioned. In 20 years, I don't feel that it's ever tricked or coerced me into anything.

No, the problem with Google isn't malice, but thoughtlessness. One expression of that is the way its apps and web services keep abruptly changing and mutating in the dead of night. Tim Danton tells me off for banging on about app updates, but I wouldn't keep talking about it if it didn't keep happening. As a former IT manager, just thinking about it makes me anxious and angry.

And it's not just about change. As far as I can see, Google isn't even very interested in whether the user experience gets better or worse. I lose count of the number of times the company has rolled out a new version of something – often a flagship app such as Gmail or Google Calendar – which introduces new features that I didn't ask for, while deprecating the ones I use every day. A recent case in point is the Google Fit app, which I have been using to remind me to go for regular walks. The latest update introduces a new activity metric called "move minutes", but removes the step-count goals and notifications that brought me to the app in the first place.

> ❝ As far as I can see, Google isn't even very interested in whether the user experience gets better or worse ❞

Sure, you can click the feedback link and express your dissatisfaction, but don't expect it to make a blind bit of difference. Because that's another thing about Google: it's incredibly unresponsive. Yes, G Suite administrators get phone and email support, but if the likes of you and me hit a problem, we're on our own. I'm not just talking about free services, either: last year, I paid several hundred pounds for an Android Wear watch with a specific feature set. Now, after a series of mandatory updates, some of those features no longer work. I search the web for answers and all I find is other customers posting the same problems. Google simply isn't listening.

It seems baffling to me that a company that has produced such incredible technologies – and which is staffed by some intimidatingly brilliant people – can be so pig-ignorant when it comes to the customer experience.

But when you look at Google's history, perhaps it shouldn't be surprising. From day one, it has been a success story – first off the back of its exceptional search engine, and then through a burst of inspired business moves, which saw it launch Gmail, acquire Android and snap up YouTube all within a two-year period. Consequently, it's never really had to worry about growth: it has had the privilege of being able to take customers for granted from day one. Do we think that might have had an effect on the company's internal culture?

Google can't play the autocrat forever, though. Most of us know and, broadly, trust Google products. But when I talk about the company with my friends and colleagues, I detect very little brand loyalty – none of the passion with which people defend Apple, nor even the better-the-devil-you-know Stockholm Syndrome that keeps most of us on Windows. I wouldn't be at all surprised if, in a month or a year, I get an email from Dan mentioning that he's decided to give Bing or Edge a try, or that he's switching to the iPhone – because why wouldn't he? The tipping point could be much closer than we realise.

I'm not saying I want to see Google laid low. All right, I admit, when I run up against another one of Google's infuriatingly careless user experience blunders, I do sometimes find myself wishing that someone would give the company a bloody nose. But as I've said, Google is far from the worst-behaved business in its industry, and its competition with the likes of Amazon, Apple and Microsoft drives things forward for all of us. I would much prefer to see it survive and thrive.

And there are encouraging signs. On the smartphone side of things, Google finally seems to be addressing one of the biggest frustrations of its platform: with Android One and Project Treble, we're on our way to a future where Android devices have a consistent look and feel, and receive timely updates, even after the manufacturer has lost interest in them. It's taken far too long to get here – can you believe it's eight years since Steve Jobs originally damned Android as "fragmented"? – but if Google can turn the same clear-headed customer focus to its apps and services, its next 20 years could be even better than the first.

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British Airways has failed to stick to its own script

In its rush to check its dubious check-in procedures, BA may have opened itself up to a huge attack

Barry Collins is co-editor of bigtechquestion.com and a former editor of PC Pro. And now a former member of BA's Executive Club, too.
@bazzacollins

The last time I flew British Airways – on New Year's Eve 2016 – I spent two hours in a queue at check-in because the airline's computer systems had collapsed. Was I overcome with shock when the company recently announced its website had leaked the credit card details from 380,000 transactions? I wasn't reaching for the smelling salts, no.

Another chap who didn't need a sweet tea and a sit down was Mustafa Al-Bassam. A PhD student from the Information Security Research Group of the Department of Computer Science at University College London, he doubtless knows more about internet security than your Average Joe. And your average journalist, for that matter.

Mustafa's been raising the alarm about BA's security for months. In July, he was attempting to check in online for his flight when he kept hitting a roadblock that wouldn't allow him to complete the process. Eventually, he figured out why. BA only lets you check in online after you disable your ad blocker, "so that they can leak your booking details to tons of third-party advertisers and trackers, including Twitter, LinkedIn and Google DoubleClick", he tweeted at the time. All those ads you see for the destination you've just booked a flight to? Well, this is one of the many ways they're generated.

Mustafa complained to BA's Twitter handlers, who came back with the least useful piece of advice since Jackie Kennedy said "it's a lovely day, let's take the convertible for the trip to Dallas". Check in at the airport, BA's Twitter team told Mustafa, or clear your history and cookies. As Mustafa

> **Hackers somehow managed to get hold of almost 400,000 transactions, including the three-digit security codes**

pointed out to them: "That's not how it works – third parties will already have my details, even after clearing history."

(By the way, and forgive me this little diversion, but this is by no means the worst of the technical howlers committed by BA on social media. As Mustafa himself has highlighted, BA's Twitter account routinely asks customers to send them details such as passport number and expiry date, the last four digits of their payment card, billing address, post code and email address, so that they can investigate tweeted complaints. What the BA account often fails to add is that those details should be sent via DM, not in public replies. Thus you'll find customers compromising their own security by posting public replies to BA with all this sensitive information included. BA is the master of inadvertently phishing its own customers!)

Anyway, back to the story. Mustafa wasn't chuffed with BA's response, so he decided to complain to the Information Commissioner. It's a breach of GDPR to pass his flight details to third-party advertisers without his express permission, Mustafa argued in his letter. The Data Protection Act gives a company a month to sort out any complaint before the Commissioner gets his hands dirty, so Mustafa sent his letter to BA and twiddled his thumbs for a month.

On the 20 August – 30 days later – Mustafa received a reply. It dismissed his claims that the check-in site didn't work with ad blockers and argued that by accepting the terms and conditions of its website, Mustafa had agreed to the processing of his data.

The letter made no admission of guilt or error on BA's behalf, but sometimes actions speak louder than carefully worded legal responses from BA's data protection officer, the marvellously named Jonathan Stiff. Because when Mustafa went back to check if BA was still using the offending advertising scripts on its website, they had mysteriously disappeared.

Fast forward a couple of weeks and Mr Stiff now needs a stiff drink. BA has put its hands up to an enormous data breach, where hackers somehow managed to get hold of almost 400,000 transactions, including everything right down to the three-digit security (CVV) code on the back of the card.

It's unlikely hackers would be able to fish such information out of BA's database, and BA's statement suggests it wasn't a database hack. The stolen details were taken during a very precise window: between 10.58pm on 21 August and 9.45pm on 5 September. As the CVV numbers were stolen, it suggests there was a rogue script running on the site.

"They [BA] changed their website to quietly remove the tracking scripts that were leaking booking reference information, although they didn't mention they did that in their response to me," Mustafa told me when I called him a few days after the hack was exposed. "The day after they replied to the complaint, they got hacked."

In its haste to remove potentially GDPR-breaching scripts from its website, is it possible that BA introduced a compromised script that was responsible for the attack? By rushing to fix one problem, had the company accidentally created a much bigger one? I wouldn't bet against it. Nor book a flight with BA again anytime soon.
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Snap to it phone makers, we need better cameras

Mid-range phones don't come with cameras that match flagships because we'll pay the ransom

Nicole Kobie is PC Pro's Futures editor. You can read about her next smartphone purchase in 18 months or so.
@njkobie

Smartphone makers are ruining our memories to make us spend more, and the first one to blink and give in will not only make millions but also have my eternal gratitude.

I've been forced by physical decay – my phone's, not mine – and the passage of time to buy a new smartphone. If you've been reading PC Pro for as long as I've been writing for it then you'll be aware that I find such shopping stressful. The range of Android devices on offer is overwhelming, and for some reason handset makers don't follow Apple's lead and simply improve their phones every year. I can't buy this year's version of what's currently in my pocket; every 18 months I need to start from square one.

Yet, my needs don't change. In return for a modest fee, I want three features in a smartphone: a small size so my tiny hands can grasp it; a solid battery life (just get me through the day); and a decent camera. My current Samsung Galaxy A5 was a compromise. At £250, the price was right, and its battery life has been okay, but the camera just isn't doing it for me. My sister shares snapshots from her equally old iPhone with delightful bokeh backgrounds; my husband takes snapshots in pubs that aren't smeared and blurry; I, meanwhile, have learned to keep my phone in my pocket. (These, by the way, are the photos I would like smartphone reviewers to include in their reviews. Forgo the artsy landscapes

for a portrait of a person, a selfie with a friend, an action shot of children running around and, most importantly, a low-light group shot of people in a bar. Those are the photos I'm desperately sad to miss, whereas I don't really care if the macro shot of a flower turns out or not.)

What hurts most is that photos I took a decade ago are often better than those snapped yesterday. I'm old enough that, when I went on holiday, it was the camera that travelled with me while my phone stayed at home. My SLR has long since become a DSLR – thankfully, I no longer need to pay Snappy Snaps to find out my photos are terrible – but its bulky size means it only makes rare outings. So I had a choice. Either restart lugging the beast in my carry-on or invest in a better smartphone shooter. The latter seemed the wiser choice and a Samsung Galaxy S8 is winging its way to my home.

That means I'm shelling out £400 this time just to ensure I can take decent photos. Samsung hasn't invested all that extra cash to supply me with a better camera lens – and, yes, I realise smartphone cameras aren't all about the hardware, with Apple snaps being lovely due to a combination of top-end components and the perfectly optimised software that requires a punchy processor. But, purely in hardware prices, the Galaxy S8 camera component cost $21. The iPhone 8's costs $30.

So I'm effectively paying £20 for a better camera and another £130 for all the extra whizzy features in the S8 that I don't care about. Things like fingerprint readers and curvy screens, which I'd rather were kept to £1,000 phones such as the aptly named iPhone XS. But paying an extra £20 isn't an option on the table – the good cameras are held back for the top-end phones.

Why? Most likely because smartphone manufacturers are perfectly aware that a good camera is a deal-breaker for many. Not everything we snap is important, and many photos won't be looked at twice – but some will become treasures.

People who can't afford a top-end phone are being left with shoddy photos, just so smartphone makers can push prices up. It's effectively holding people's memories hostage to drive upgrades. I appreciate that the margins on smartphones aren't always huge, but even on a cheaper model there's surely enough space in the budget for a better camera. The company that simply uses the best camera on the market for every smartphone it sells will win my credit card details – not for just the next time I buy a phone, but forever after.

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Please don't leave the future to tech billionaires

Elon Musk and Jeff Bezos are brilliant at building businesses, but we shouldn't let them take control
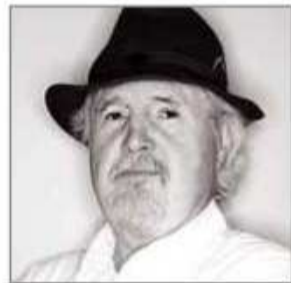
Dick Pountain is editorial fellow of *PC Pro*. He hopes to profit from apocalypse preppers by selling them baked beans in 18-carat gold cans.

For the sake of my health, I walk on beautiful Hampstead Heath at least once a week, and I get there via the revamped London Overground train service. It's clean, frequent and gets me there in less than 15 minutes. "So what?" you may be thinking; the significance is I get there by train rather than by flying car.

"Where's my flying car?" is a trope one sees regularly online, and like many such tropes it contains a kernel of truth. We don't have flying cars yet, and almost certainly never will, and the reason has little to do with tech. YouTube is crammed with videos of workable flying cars, many of them good-looking, all of them too expensive – but prices could crash if they ever went into mass production. The reason they don't go into mass production is, of course, social, which means also political. We live in a complex society in which many resources have to be

> **❝ High-tech entrepreneurs are prone to drawing their notions of invincibility from sci-fi, comics and video games ❞**

rationed and shared, urban space being one of them. On paper, flying cars ought to economise on that space, versus the ordinary motor car (or bus or train) which needs roads laid out on an almost-flat 2D surface.

Flying cars would bring the third dimension into use – except that the third dimension is already in use by airlines. In mass use it would also be impossible to police (traffic lights?). Fixed-wing or drone, a flying car is still subject to gravity and if two collide they're likely end up falling on someone's roof. The problems are endless, and flying cars could only ever be tolerable in small numbers. Of course they already are – they're

called helicopters, and mostly used by soldiers and billionaires. The rest of us must share flying trains called airliners.

"Futurists" often get things very wrong, not because they are stupid, but because their expertise and experience is narrow: they may be brilliant in one technical field but disconnected from normal society and ignorant of its basic requirements. A recent BBC Four retrospective covered 50 years of *Horizon* programmes, in which revered sci-fi authors Arthur C Clarke and Isaac Asimov made predictions about AI and robotics that now look quaintly naive, while Ray Kurzweil's "grey goo" warning looks frankly unhinged (even if Prince Charles did believe it). The tendency to overestimate the effect of new technologies is not itself new.

One futurist I do respect is Douglas Rushkoff, who recently wrote an inflammatory piece with the snappy title "How tech's richest plan to save themselves after the apocalypse" (**pcpro. link/290rich**). He was recently paid half his annual academic salary by five hedge-fund managers to talk about future tech, but it turned out they weren't really interested in tech per se, but in the coming apocalypse it promised. They realised that armed guards would be required to protect their New Zealand or Alaskan bunkers from the angry mobs "but how would they pay the guards once money was worthless? What would stop the guards from choosing their own leader? The billionaires considered using special combination locks on the food supply that only they knew."

Enormous riches tempt people to believe their possessor must be clever, but clever at what? Being clever at designing social networks no more qualifies you to redesign society than being clever at property speculation qualifies you to be president. Enormous riches frequently accumulated through what economists call "network effects": certain inventions, such as railways, telephones, gramophone records, television, took off only once enough people had the means to use them, so as much through luck as technical superiority. Yet riches tempt their possessors to believe themselves invincible, and high-tech entrepreneurs are prone to drawing their notions of invincibility from sci-fi, comics and video games. As Rushkoff put it, they consider human evolution to be "a video game that someone wins by finding the escape hatch and then letting a few of his BFFs come along for the ride. Will it be Musk, Bezos, Thiel … Zuckerberg?"

Transport For London (TfL) is might be dull compared to Elon Musk's plan to fire us at supersonic speed though vacuum tubes, but it satisfactorily moves a lot of people each day using little in the way of sci-fi magic except for the Oyster card system. I'd feel far happier if TfL were running the world than Rushkoff's humanicidal billionaires.

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Readers' comments

Are the numeric keypad's days numbered?

I read your product reviews in every issue and notice that all of the laptops you recommend seem to be devoid of a numeric keypad. I rely on the one on the HP ProBook 450 G1, which I've used for nearly five years, and when the time comes to replace it a numeric keypad will be at the top of my requirements list. **Matthew Marven**

PC Pro **editor-in-chief Tim Danton replies:** Numeric keypads appear to be a dying breed where laptops are concerned, as manufacturers concentrate on portability, even for corporate customers. Indeed, I can't recall a new laptop that includes one (other than gaming laptops). But there is hope: take a look at our roundup from IFA on p12 to see Asus' innovative solution, where it turns the touchpad into a second screen.

Self-patching routers

It just so happened that you tested 13 routers in *PC Pro* (*see issue 288, p76*) in the very same issue in which Davey Winder lamented "bad router hygiene" (*see issue 288, p118*). In his column, he noted that 72% of those contacted by researchers from Avast hadn't ever updated the firmware on their routers.

Sadly, we live in a world in which routers are increasingly coming under attack, because hackers know that even when their vulnerabilities are revealed, the majority of them will remain unpatched. It was, therefore, disappointing that the summary table comparing the features of the 13 tested routers, some of which cost over £200, didn't include details whether or not any of them could auto-update their

BELOW Avast found that 72% of people never update their router's firmware

Star letter

Listening to episode 442 of the *PC Pro* podcast, in which Darien Graham-Smith talked about a £1,000+ Nvidia graphics card, I was reminded how frustrating the mainstream gaming world can be. The drive for higher resolutions, a greater number of frames per second and other graphical effects are all great, but I wish games developers would spend as much time on original game play – or, if possible, more.

I'm in my 40s, so I'm lucky enough to have witnessed the entire life of video gaming to date, from the early arcades and first-generation home computers, through to the latest and greatest that 2018 has to offer. I didn't care too much about the graphics when I was a kid, but I can't help feeling I had more fun and enjoyed what I had more than my kids do today.

It's no surprise to me that the biggest games of recent times, *Minecraft* and *Fortnite*, don't depend on cutting edge-graphics but have instead used innovation to attract and keep their players coming back. Is that why so many of us are returning to retro gaming, where we can play games that are fun rather than visually stunning?

Maybe there's a bigger problem here than just games development, with the perpetual, seemingly annual obsession with releasing new hardware across the tech industry. It seems to be having the opposite effect to what the manufacturers will have wanted, with many people keeping their wallets closed and waiting for true innovation rather than just another annual incremental update. **Michael Webster**

PC Pro **editor-in-chief Tim Danton replies:** I think both can co-exist: to be fair to Nvidia, the advent of real-time ray tracing justifies the term game-changer, for once! That said, some of the most successful recent games eschew fancy graphics in favour of strategy and innovation simply because they're designed for the screens of a mobile phone.

firmware. I'm guessing that none of them had that feature, which is perhaps a sad reflection of the value we consumers give to convenience (yippee, it has a smartphone app!) over the less exciting topic of security. **Robert Coleman**

Chrome strikes gold

I enjoyed Nicole Kobie's article about moving over to Chrome OS (*see issue 287, p25*), as well as the increasing number of letters you publish from fellow readers complaining about Windows updates and the like. I've instigated Chromebooks where I work, initially as a tactical solution for a small number of users who needed something cheap and simple for home working. This tactical deployment has grown, both in the number of users and in the range of scenarios in which they're being used.

There are a few reasons for this, starting with the fact that our users like their Chromebooks. They're simple, offer great battery life, perform well and update in seconds. The organisation likes them as they offer great value, are secure, have no "build" and require no local support. We have grown from an initial rollout of 300 devices to more than 2,000 and I can manage them all remotely, via the cloud – and make changes to the entire estate in seconds no matter where the devices happen to be.

I came from a Windows background where creating builds, deploying updates and making changes required many people, took a long time and often delayed the business in bringing its products to market. I've been hugely impressed by the Chrome OS experience.

As organisations move towards a fully cloud ecosystem and looking at how huge Chrome OS is in the US education system, I do wonder whether Microsoft is on the cusp of once again not responding quickly enough to change. Chrome OS isn't perfect and can't yet replace every use-case that Windows or Mac users currently have. But that's becoming less and less true with every passing month – and for anyone frustrated by yet another Windows Update or strange compatibility issue, I would heartily recommend trying a Chromebook for their bread and

butter tasks. I think they'll be pleasantly surprised. **Name supplied, but withheld on request**

A point about fingers

In your article "The A-Z of security threats 2018" (*see issue 289, p102*), David Emm, principle security researcher at Kaspersky Lab is quoted as saying "If I choose a poor password and it's compromised, I can change it; if my fingerprint data is compromised, there's nothing I can do about it". Well, nothing, apart from using another finger that is. Surely Mr Emm knows that the vast majority of people have ten fingers? Unless, of course, you have registered all ten fingers, which is unlikely. **Adrian Mugridge**

Ohm no!

I'm prompted to wonder, after reading Jon Honeyball's column (*see issue 288, p130*), whether he was merely checking that his readers were actively thinking about his comments when he said "Higher voltage tends to lead to higher power dissipation (V=IR

> ❝ I do wonder whether Microsoft is on the cusp of once again not responding quickly enough to change ❞

for those who remember schoolbook physics)", or whether he was subtly proving he's human like the rest of us with an occasional slip.

Jon is correct with the first statement when taken individually, and I'm sure Jon knows full well that Power = Volts x Current or P=VI (or W=VA). The equation in brackets for Ohm's law is also correct when stated on its own, but I'm sure Jon will agree that the equation in brackets is not derived from the first statement and not the same as the first statement. **Barry Sunley**

Contributing editor Jon Honeyball replies: Mea culpa! You're quite right, of course, and clearly I should have consulted my old Horowitz & Hill. Mind you, if we say that R is constant – which it will be, near as dammit – then I hope it's obvious what I was driving at!

CORRECTION In our review of the new 15in MacBook Pro (*see issue 288, p48*), we stated that it was available with a four-core processor, but Apple only supplies it with six-core processors. Our apologies for the error.

Readers' poll

With the Chrome browser turning ten this month, we asked what you thought was the best thing about the world's most popular browser.

33% Its speed

17% Something else*

*see below

22% Its extensibility

23% The fact it's not Internet Explorer

5% The dinosaur game
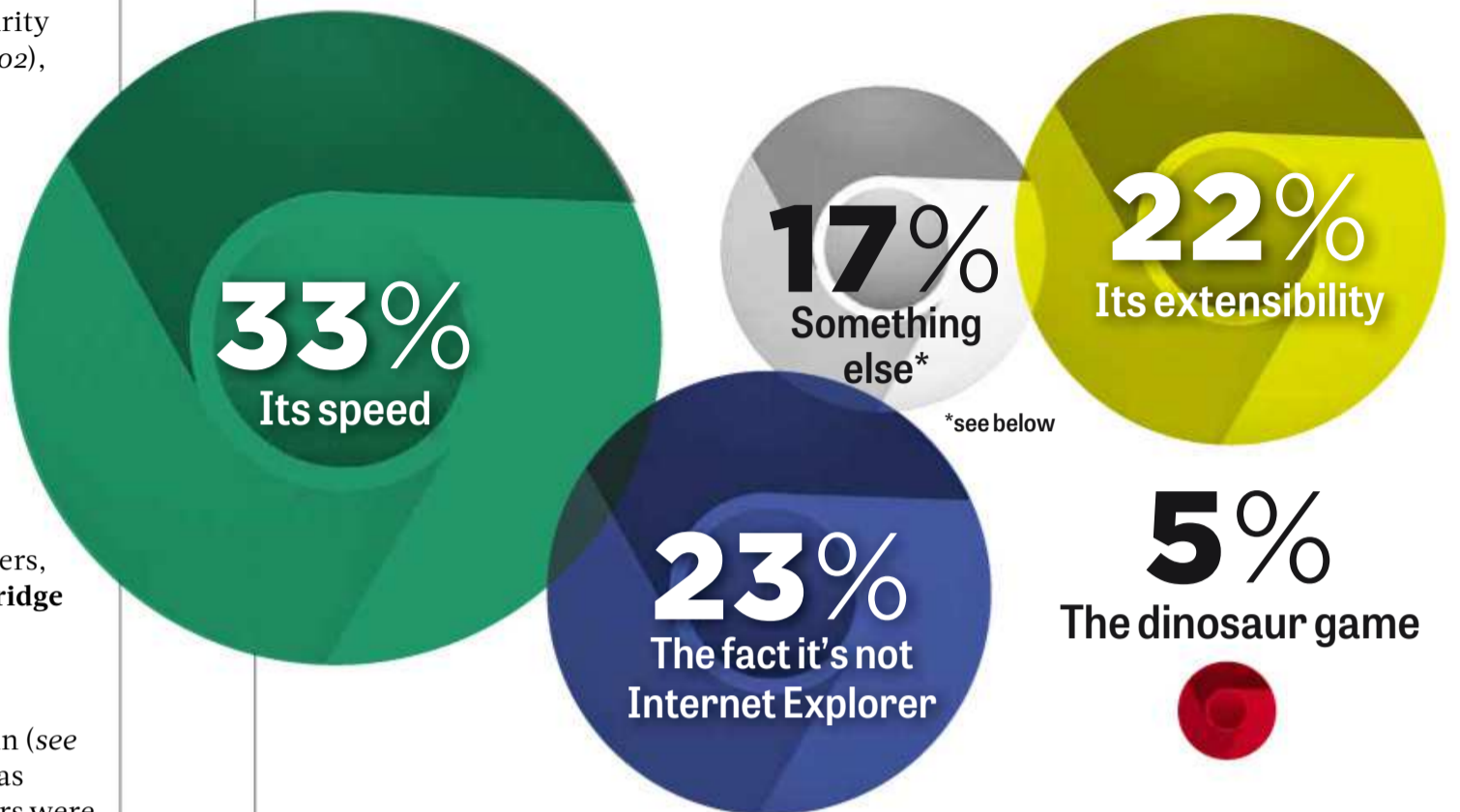
Of those who said it was something else, Jason Foster pointed out that "so much of my stuff is handled by Google that, as long as it stays fast and secure, it's just easier". Theo M-A feels the same: "It's part of Google's ecosystem, so my phone can sync its passwords and bookmarks more easily. I also like trying out the flags for a better and more customised user experience."

While Google may have destroyed Internet Explorer, it hasn't extinguished everyone's passion for Firefox. "I don't use Chrome any more, I've gone back to Firefox," wrote Dominic. "Chrome just hogs too much memory and isn't as fast as it used to be. Firefox isn't necessarily faster but is more customisable."

> ❝ I moved from Firefox to Chrome just before v59 was released, mainly due to poor stability and slow performance, even with all plugins disabled. Since using Chrome, I haven't looked back ❞
> **Richard Samson**

> ❝ I tend to use Firefox as it deletes cookies, websites visited and so on every time I close it ❞
> **Stewart**

> ❝ [I use] Firefox [as] the data harvesting of Chrome is off-putting, especially when signed in ❞
> **James C**

> ❝ My favourite extension is probably Ghostery, which preserves (at least a modicum of) my privacy online ❞
> **Julissa**

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VPN

WHICH ONE CAN YOU TRUST?

CONTRIBUTORS Stuart Andrews, Barry Collins and Darien Graham-Smith

VPN providers make great promises to protect and secure your connection. But can they be trusted? We investigate just how trustworthy and reliable VPN providers are and then review eight different services that meet specific needs

There's a multitude of reasons why you might want to use a VPN – and not just to cop a sneaky look at Netflix's US catalogue. You might want to throw ad trackers off the scent or reduce the risk of snooping when using a public Wi-Fi hotspot. You might have reasons for wanting to mask your identity (not necessarily criminal, of course) or to dodge traffic management by your ISP. You might just resent the idea that every site you visit, every download you make, every photo you look at is logged on an ISP's servers, accessible by heaven knows who.

But how do you know the VPN provider is any better? Can you be sure that your VPN is keeping your identity safe? Does it keep logs or records of its own? And is it subject to the same law enforcement requests as your ISP? In short, can you trust a VPN?

HOW DOES A VPN WORK?

To be clear, we're going to be talking about public VPN services – the kind that you can buy and install on your PC, phone or tablet – rather than a VPN your business might operate to tunnel into the company's servers, although many of the principles will be the same.

Typically, when you connect to the internet without a VPN, all your traffic passes through your broadband provider's servers, allowing it to log and potentially see everything you do online. Remember that under the UK's Investigatory Powers Bill, ISPs and phone companies are now obliged to store records of websites visited by every customer for a year, which can be accessed by the police or security services on production of a warrant. Companies such as BT even handed over customers' data to police without a warrant.

The VPN effectively makes the data collected by your ISP useless. It redirects your internet traffic to a remote server – potentially outside of the country or even the continent you're in. Your device will be assigned an IP address on the remote server, so when you make a request to a service such as Netflix or BBC iPlayer, it looks like you're in the country the server is hosted from, not the location of your computer.

All the data sent and received is encrypted, using a variety of protocols. All your ISP (or anyone inspecting the data) can see is that you accessed the VPN, not the sites you visited. Eavesdropping is futile. At least, that's the theory.

BELOW Don't be put off by the acronym – most VPNs, such as Avast SecureLine, are very easy to use

WHAT THE VPN PROVIDER SEES

In some ways, you're just transferring the problem from one organisation to another. Instead of routing traffic through your ISP's servers, you're routing it through the VPN company's – and those servers might be in the US, Russia, Panama or practically anywhere. Most of the VPNs we've reviewed in this feature have dozens or hundreds of servers dotted around the globe. What makes them any more secure or inscrutable than, say, BT's or Virgin's?

"You're right to assume that it's next to impossible to test whether your VPN is being shady or not, or to confirm that they are not recording your activity," said independent security expert Graham Cluley.

Many of the VPN providers will, therefore, publicly declare whether they do or don't retain logs on their users. Our choice of best overall VPN, NordVPN, states on its website that "we do not keep logs. If someone asks us about you, we have nothing to share."

OPERA'S BUILT-IN VPN – IS IT A SERIOUS CONTENDER?

Whilst all of the VPNs we've reviewed here come as separate apps, Opera has baked a VPN into its browser. Although even the use of the phrase VPN is pushing it somewhat.

Whereas all the others here will actually redirect your entire connection, the Opera VPN only deals with traffic going via the browser itself. Open your email client, Slack or another browser, for example, and the traffic will still flow as normal. It's more of an anonymising web proxy than a VPN in the conventional sense.

Still, if you're aware of those limitations, Opera will do a job for a short burst of surfing at a public Wi-Fi hotspot, for example. It's very simple to establish a "VPN" connection, too. Click on the little VPN icon in the address bar, choose your location from the dropdown menu and flick the switch to On.

The choice of locations is not so much helicopter-view as space station: you get to choose from Asia, Americas or Europe, or simply stick with the "optimal" location – presumably the one that delivers the fastest connection.

Still, Opera struggled to land us in the right continent. Firstly, Netflix was having none of our efforts to gain access to its US catalogue via Opera. Despite apparently lodging in the "Americas", we were still only offered UK content (a later security email revealed Netflix logged our location as Sweden). BBC iPlayer, however, barred us for being "outside of the UK". Worse still on YouTube, where despite still being in the Americas, we were presented with a Russian-language version.

Once set to optimal location, connection speeds absolutely flew – they were indiscernible from our regular fibre connection speeds, on both the up and the downlink. A switch to the Americas dropped download speeds to 11Mbits/sec and uploads to 2Mbits/sec, which is well below par when compared to the paid-for services.

With nothing else in the way of security features and no kill switch if the connection drops, it's hard to recommend Opera's built-in service for anything more than an extra layer of security for some Starbucks surfing.
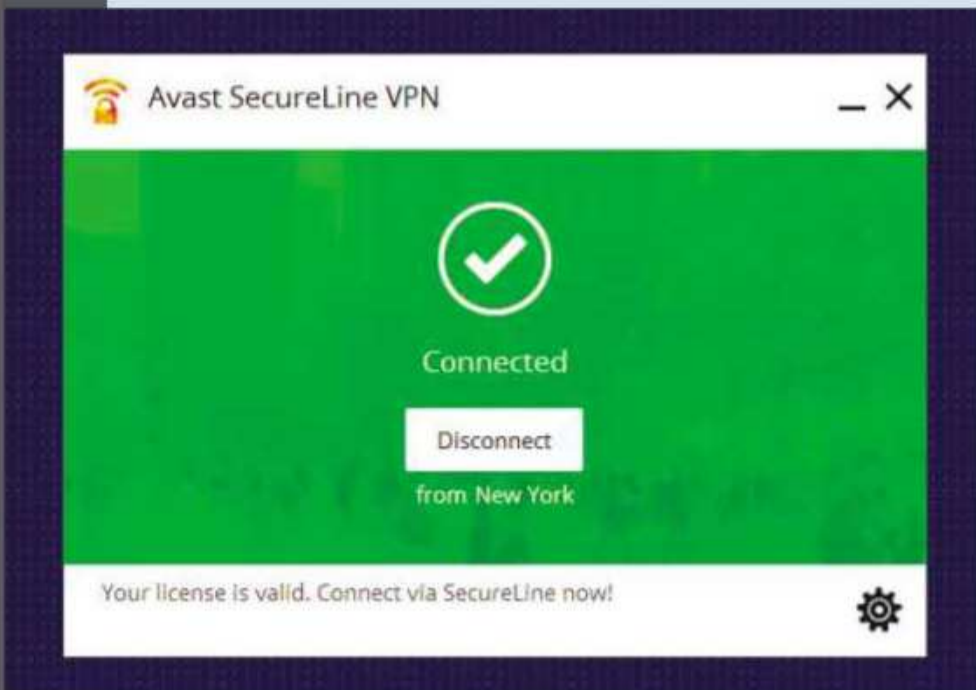
Hotspot Shield, which offers both free and paid-for versions of its service, declares that it does monitor which websites are visited by its users, but that it will "collect only anonymous, aggregate data". The firm insists it does "not attribute any specific website visits or app usage to any specific user".

Is there any independent or technical means to test such claims? Not really. You have to take their word for it.

THE LONG ARM OF THE LAW

It's fair to assume that it's not in the interest of the VPN provider to go poking around your data. If it were caught logging customers' web activity, for example, the reputational damage would likely be catastrophic. The same can't be said of law enforcement, who would very much like to see the data being passed across these servers. And, in this regard, it's important to check under which jurisdiction your VPN provider resides.

"Generally, I recommend that users purchase their VPN rather than use a free one (as they then have a vested interest in keeping you happy) and that the VPN is based in a country with tight privacy laws that is unlikely to bend over backwards if, say, the US authorities come knocking," said Graham Cluley.

How far do the US's tentacles reach? Or the UK's, for that matter? Well, now we need to start counting the eyes.

The so-called Five Eyes countries are part of the "UKUSA" agreement on intelligence sharing. You'll get no sticky bun for guessing who two of the members are, and they're joined by Australia, Canada and New Zealand. These countries share data via the highly secretive "STONEGHOST" network; Edward Snowden alleged that the five circumvent laws preventing spying on their own citizens by asking another member country to spy on them on their behalf. It's probably safe to assume that if a server resides in one of those five countries, it could be potentially accessed by the others.

The Nine Eyes network adds Denmark, France, the Netherlands and Norway. This is a looser collaboration, but involves intelligence co-operation and data sharing.

Then there's the Fourteen Eyes Network, which includes the previous nine and Germany, Belgium, Italy, Sweden and Spain. This group – known as SIGINT Seniors Europe (SSEUR) – is concerned with military intelligence, so less likely to be swapping citizens' surfing habits.

That said, groups such as **privacytools.io** warn against using a VPN based in the Fourteen Eyes and especially the US, because of the way the security services operate. "Services based in the United States are not recommended because of the country's surveillance programs, use of

National Security Letters (NSLs) and accompanying gag orders, which forbid the recipient from talking about the request," the privacy group's website states. "This combination allows the government to secretly force companies to grant complete access to customer data and transform the service into a tool of mass surveillance."

This is why you'll find many of the VPN providers based outside of the Fourteen Eyes nations. NordVPN is based in Panama, My Private Network is in Hong Kong, others are in the Seychelles, Hungary, the Czech Republic and other safe havens. Cluley recommends the table at **pcpro. link/290chart** to discover where a VPN provider is based, whether it's part of the Fourteen Eyes and whether it's logging DNS requests, web traffic and more.

That said, all the major VPN providers will have servers in the US, the UK and other nations on the Fourteen Eyes list. If your traffic is going through a server hosted in the US, it doesn't matter where the host has its headquarters. "Where that [server] is physically located could have an impact from a legal point of view," said David Emm, principal security researcher at Kaspersky Lab.

However, you can mitigate the risk. You could choose specific servers that are hosted outside of the Fourteen Eyes nations, for example, or choose a provider that isn't storing the type of data that would be of use to security services in the first place. "It's really important to find out what kind of logging they do," said Emm. "If all they are logging is stuff they need in terms of managing bandwidth usage, then what they're holding anyway isn't something you're going to be worried about them handing over. If on the other hand they're logging traffic and IP addresses, if they were required to hand that over to a legal authority, that is something you might be worried about."

LOOKING FOR LEAKS

No VPN will guarantee absolute anonymity, though. As the terms and conditions often state: if you're looking to mask illegal activity and think you're untraceable, think again.

But VPNs are partly designed to throw snoopers off the trail, to at least make it much more difficult for websites, advertisers, employers, governments or whoever to keep tabs on you. But they're not always infallible.

The **doileak.com** website is an excellent resource that shows the data that's capable of being harvested on your connection. It uncovers your IP address, the source of your DNS requests, whether there are any HTTP request leaks that might inadvertently give you away. If you're using a VPN, the service normally detects as much, giving you a thumbs up that you're unlikely to be easily traceable.

The Opera browser's VPN (*see p31*) is more worrying. Doileak.com reported that DNS requests could be leaking when we had the browser's VPN mode switched on. And despite setting the VPN to use servers in the Americas, the site reported that "the time zone of your browser settings and the time zone of your request IP location match" – which may explain why it failed to hoodwink Netflix.

Ensuring that your PC doesn't fall back on your regular connection if the VPN fails is another key requirement of anyone who's going to great lengths to secure their connection. The more advanced VPN providers offer a "kill switch". If your VPN connection drops, it kills the internet connection, ensuring you're not inadvertently leaving a trail. "If you have VPN loaded and for some reason it fails, what you don't want is a situation where it falls over to standard access," said Emm. "If my VPN fails, I want the connection to drop, because I don't want anything I'm doing to be visible to a third-party connection."

Even if your VPN provider advertises a kill switch, don't assume it's switched on automatically. Some need to have the feature switched on in settings, so fiddle around in the settings menu before you first use the software. As with all things VPN, it pays to be paranoid.

BEST OVERALL

NordVPN

nordvpn.com
£5.44 per month, if paid annually

SCORE ★★★★★

It's hard to get all that excited about VPN servers, but NordVPN's offering is undeniably impressive. As well as the normal global exit nodes, it offers a slew of specialist servers: P2P-friendly servers for torrent-sharing; Onion-over-VPN and double VPN servers for maximally robust anonymity; anti-DDoS servers; even servers that give you a unique, persistent IP address in the country of your choosing.

The double VPN option is the most interesting. Your traffic goes over a VPN to one server, which then connects to another VPN, through which your data emerges from a second server. This makes it even harder to link the websites and services you're using to your real identity and location. Onion-over-VPN works in a similar way, but using the TOR network.

The PC app also includes a range of optional security features to block ads and protect you from malware. Should your PC get infected with botnet malware or ransomware, it will cut communications with command and control servers.

The NordVPN app centres on a map-style interface, in which you click on a pin to connect to a server in that country. You can also click the Countries link at the top of the window, and switch between a list of locations, your favourite countries and the special server types we mentioned above.

It's fast to get connected. While some VPNs leave you hanging around for almost a minute when starting up, most connections we tried in NordVPN were up and running within ten to 15 seconds – and often less. Once you're online, you can switch smoothly from one location to another without having to disconnect first.

NordVPN's coverage is excellent, with more than 3,700 servers in 62 countries. In past tests, we haven't found NordVPN all that speedy, but it's catching up. Local VPN connection proved consistently good this time around, with UK-based servers giving us roughly 76% of our normal connection speed. And while it's a drag to lose half your bandwidth on a transatlantic hop to New York or Boston, 53% should still get you smooth browsing and streaming.

We were also able to stream video from Netflix US and Comedy Central without any warnings. Netflix keeps clamping down on VPN providers, but right now NordVPN seems to be ahead of the game.

NordVPN is an excellent service that's worth paying upfront for. It's fast and reliable, it offers solid privacy and security features and it's currently doing a great job of unblocking US streaming services. Some competitors may be cheaper – not to mention a little faster – but overall Nord represents the gold standard of VPNs.

BEST FOR PRIVACY

PureVPN

purevpn.com
£3.23 per month, if paid annually

SCORE ★★★★☆

The PureVPN app takes a goal-orientated approach. Instead of directly selecting an exit node location, you start by picking a usage mode. The modes cover all the main reasons why most people would want a VPN – streaming, censorship unblocking, security and peer-to-peer file sharing – and you can also choose a server that will assign you a dedicated IP address, for an additional $1.99 per month.

What happens next depends on the mode you choose. If you're looking for privacy, you'll still get a list of

BELOW The list of specialist servers that NordVPN offers is very impressive
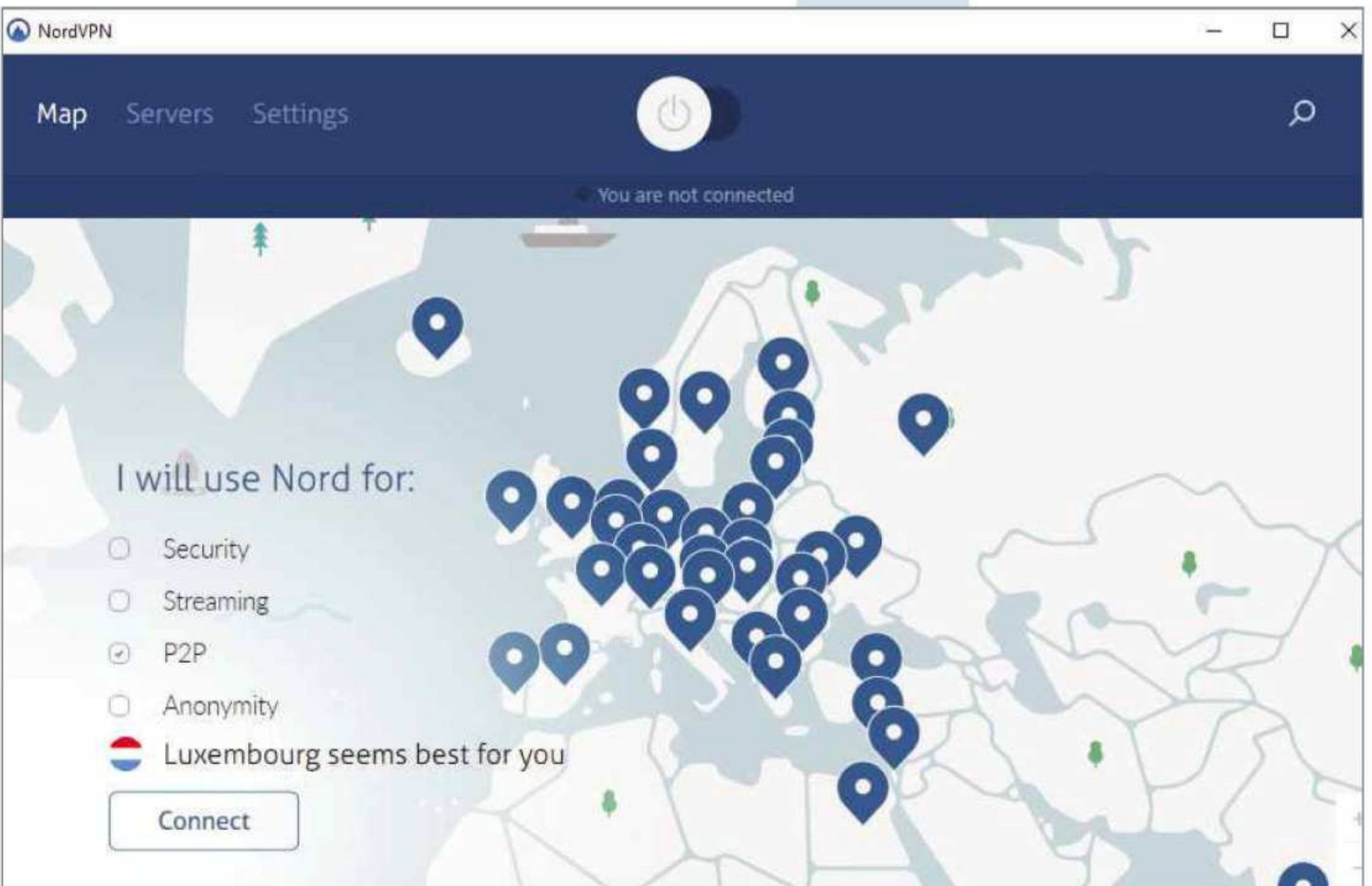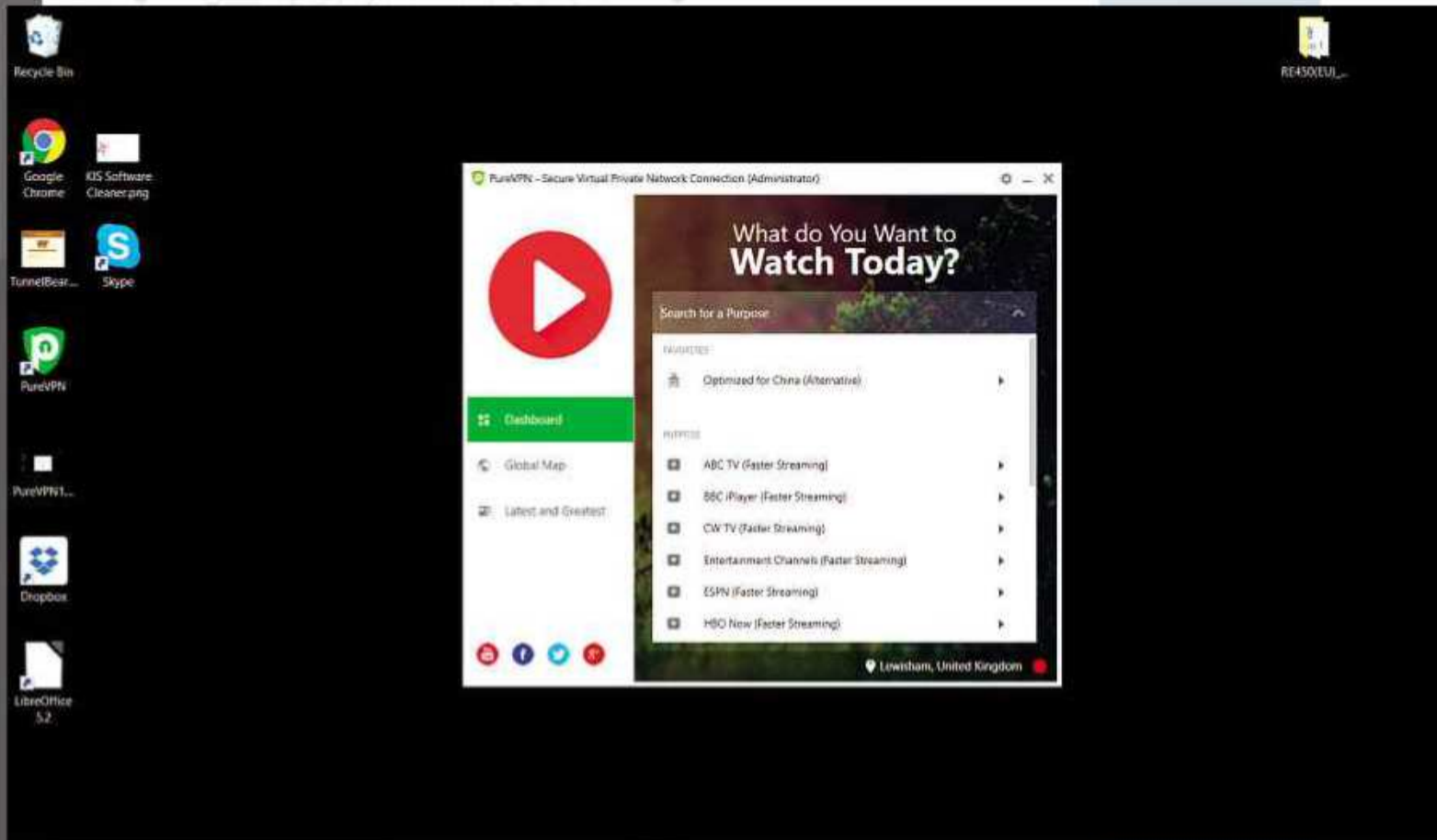
Hotspot Shield

£5.99 per month, if paid annually
hotspotshield.com

SCORE ★★★★☆

Hotspot Shield has a slick blue-and-white colour scheme that makes it one of the most polished-looking VPNs around. A friendly map shows how much bandwidth you have consumed and your virtual IP address.

There's little else to Hotspot Shield's interface. You can use the Settings panel to configure the VPN to start up with Windows, and to toggle the kill switch, plus there are options to turn on the VPN automatically when you connect to specific Wi-Fi hotspots, or unknown ones.

Installing Hotspot Shield can be a bit confusing, however. The Windows installer assumes that you want to activate the seven-day trial, even if you've already paid; to correct this, you need to counterintuitively click the Back button, then the Menu button and sign-in.

Hotspot Shield can't claim the most extensive server list on the market, but its 24 locations give you a decent range of options across the Americas, Asia, the Middle East, Australia, New Zealand and particularly Europe.

One of the best things about Hotspot Shield is that it's incredibly fast. Perhaps we were unusually

countries to connect to; choose the Stream mode, on the other hand, and you'll see a handy list of available streaming services – so you can, for example, open an optimised connection to Netflix US with just a single click.

PureVPN ticks all the privacy boxes and it helps that the operator is based in Hong Kong, far out of reach of even the Nine Eyes intelligence-sharing alliance, and not subject to any mandatory data-sharing or retention laws. PureVPN, therefore, maintains a strict no-logging-policy, collecting no data whatsoever on its users' online activities, including the websites they visit or the apps they use. This – combined with the app's built-in privacy mode – makes PureVPN well worthy of your consideration if privacy and anonymity are your main concerns.

There are plenty of configuration options, too. The kill switch can be configured to suspend all internet activity on a disconnection and then automatically reconnect; you can set up split tunnelling, meaning that only specified apps use the VPN; and you can even turn your own PC into a VPN hotspot, for other devices to connect through.

PureVPN also comes with a decent set of security features, such as the ability to block dating sites, piracy sites, drug-related pages and so on. Consequently, we could see it appealing to parents – although it is a little ironic that an app that's designed to bypass censorship can also be used to enforce your own.

PureVPN isn't short of servers, with exit nodes in over 14 countries. If you're looking to access blocked services from within a country with heavy censorship, PureVPN should be able to get you a fast, anonymous connection.

We used to rate PureVPN as the fastest VPN service on the market, but in our latest tests it didn't retain the crown. Connecting through the Netherlands, we registered respectable download speeds of 85% of our standard downstream connection speed, but performance on a UK VPN was way below the levels of other VPNs. US connections were perfectly usable, at 42% of our normal connection speed, but again we've seen faster from NordVPN and Hotspot Shield.

ABOVE Instead of offering a map of servers by country, PureVPN sorts them by "purpose"

BELOW The slick Hotspot Shield interface isn't much to look at, but this VPN is remarkably fast

lucky, but while connected through a UK-based server we enjoyed an amazing 98% of our regular downstream bandwidth – and when we switched to the Netherlands, that still held up to 97%. Even more remarkably, connection speeds via the US and Hong Kong were 89% and 94% respectively of our regular non-VPN speeds. That's exceptional.

The news isn't quite so good when it comes to streaming, however. Hotspot Shield didn't have any problems streaming video from

BEST FOR OCCASIONAL USE

TunnelBear
Free (for up to 500MB per month)
tunnelbear.com

SCORE ★★★★☆

There are many things to like about TunnelBear. For one, it's a fun, good-looking app with a stream of charming bear-related puns. And we can always bear more puns.

"Ghostbear" scrambles your VPN communications to make them look more like regular internet traffic, fooling the pesky packet-inspection tools that block some other VPNs. Sad to say, Ghostbear didn't manage to get us into Netflix US, but it worked with other region-locked streaming sites.

TunnelBear has a reasonable selection of exit nodes. Its 22 locations are mostly located in Europe and North America, but there are also servers in South and Central America, plus a handful in Asia and Australasia.

Comedy Central or NBC in the US, but Netflix's proxy-detection mechanisms spotted the VPN and refused to play.

There have been concerns that Hotspot Shield's free version shares data about your browsing habits with advertisers, and even the paid-for service collects anonymised and aggregated information about the sites and apps you use. This information can't be linked to you specifically, but it may still give you cause for concern.

If connection speed matters and you're prepared to pay up front, Hotspot Shield could be a superb choice. The lack of US Netflix will rule it out for some, and would-be whistleblowers and privacy advocates might prefer a service based in a more neutral jurisdiction. Overall, though, it's a fast and reliable VPN.

Then there's the service itself. When other VPNs offer a free tier, it's normally laden with pushy ads and nagging messages to upgrade, while functionality is limited. TunnelBear, by contrast, gives you the full set of features and locations: the only limit is a monthly bandwidth cap. It's set at 500MB by default, but you can get an extra 1GB for merely tweeting about the service.

TunnelBear lacks the built-in speed tests, streaming modes and extensive security features of some of the more high-end VPNs. However, it does have a couple of ursine extras to reassure you that your privacy and anonymity remain protected.

"VigilantBear" is effectively a kill switch, blocking all traffic in the event of a VPN failure until the connection is securely re-established, while

The UK and Netherlands nodes are particularly good if you just want a VPN for added security while on Wi-Fi networks, rather than to spoof a location.

Overall, TunnelBear is a mid-ranger in the speed tests. When connected to a UK server, we got 89% of our normal downstream connection speed, but routing our link via the Netherlands saw that drop to 44%. On occasion, we saw downstream speeds drop as low as 4.5Mbits/sec.

Since TunnelBear is based in Canada, it's subject to requests from the Canadian authorities which could be shared with other members of the Five Eyes intelligence alliance, including the US and UK. Don't panic too much, though: the company's privacy policy clearly states that it

doesn't record IP addresses or DNS queries while connected, nor any information about the applications, services and websites you access through its servers.

If you're an occasional VPN user who doesn't care about streaming, it's a great way to get a little extra privacy and security.

Avast SecureLine
£49.99 per year for one PC, £64.99 for five devices
avast.com/en-gb/secureline-vpn

SCORE ★★★★☆

Avast SecureLine does things differently from most VPNs. For a start, there's no monthly subscription – the company only offers annual licences, covering either a single PC or Mac, a single smartphone/tablet, or five mixed devices.

It's an unusually basic service, with precious little in the way of hand-holding or secondary features. There isn't even a kill switch, which could be a deal-breaker for those who genuinely need privacy. On the flipside, it makes SecureLine both very lightweight and straightforward to use. If, therefore, you're just looking for a VPN to protect your data when you're using public Wi-Fi, it could be all you need.

SecureLine's Windows app is simplicity itself. A dropdown menu lists available server locations and a few configuration options let you tell SecureLine what to do when you connect to an unsecured
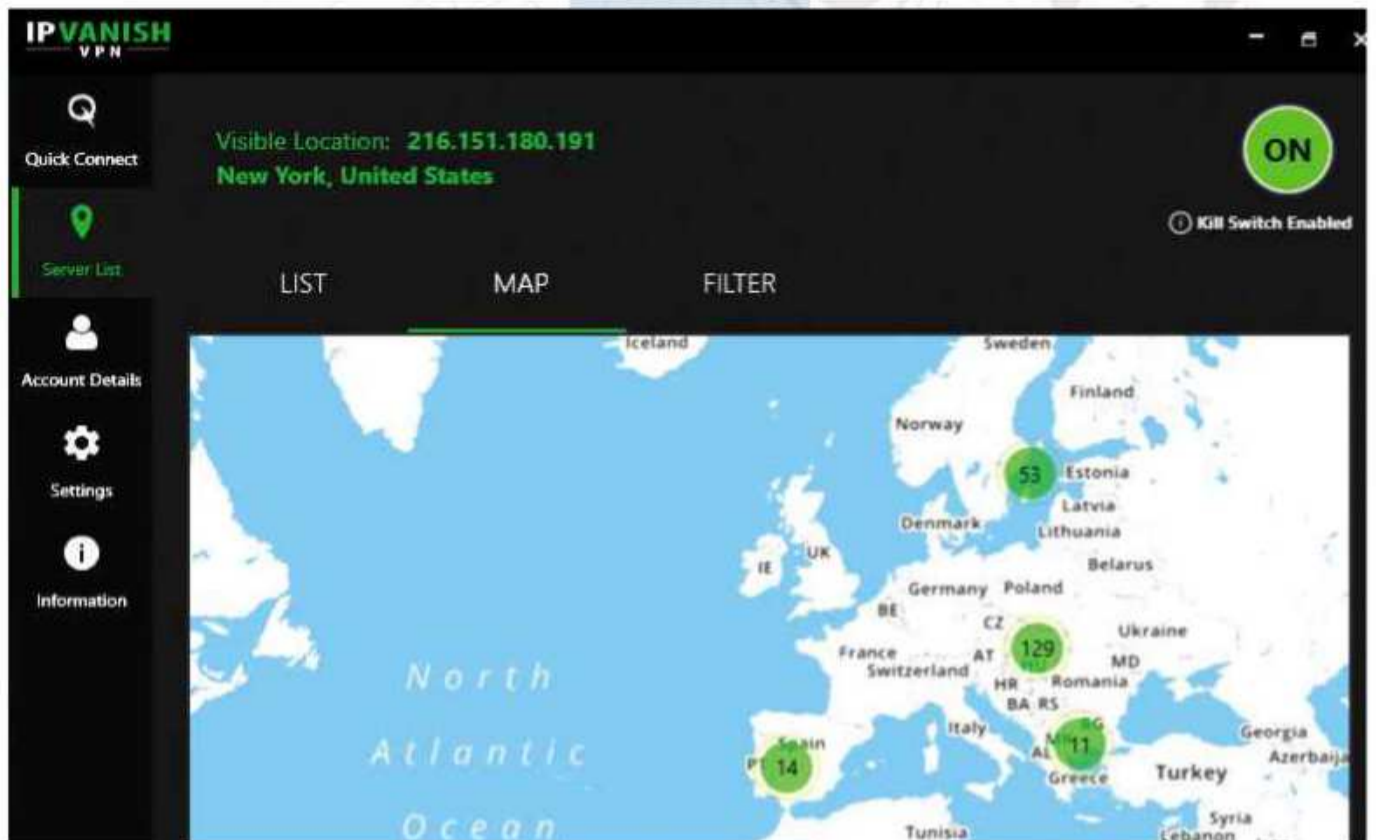
Wi-Fi hotspot, and set the interface language. That's it, though: if you're looking for a choice of protocols or a choice of server types, this isn't the VPN for you.

Still, SecureLine does a decent job. The initial VPN connection is quick and painless, and the service feels solid while browsing or streaming video. The only real stumble is that you need to manually disconnect before switching to a new server, which is something other VPNs handle in one step.

SecureLine offers 41 server locations in 33 countries around the world. Rival VPNs do far better when it comes to geographic diversity; if you're a regular traveller, we recommend you double-check that SecureLine meets your needs.

It isn't the speediest VPN, but it's reasonably nippy on UK-to-UK VPN connections, and (oddly enough) even faster when connecting through nearby European servers – a Netherlands connection gave us 95.5% of our regular download speed. It's also pretty good over longer distances, maintaining 52% of our normal download speed over a VPN connection to Boston in the US and a credible 37% when hooked up through Hong Kong.

Streaming capabilities are limited, however. We were able to watch NBC and Comedy Central via US servers, but SecureLine failed to get past Netflix's proxy-detection systems.

SecureLine uses the secure OpenVPN protocol, and it seems to do the job on the privacy front: doileak.com certainly didn't spot any DNS or IP leaks. Moreover, Avast SecureLine doesn't log the websites you visit, the data you transfer or which IP addresses are accessed.

Avast is a decent VPN that's very easy to use, but it doesn't stand out from the pack. It's a viable contender if you only want to secure a single laptop or desktop, but other VPNs give you more for a similar monthly fee.

IPVanish
£5.04 per month, if paid annually
ipvanish.com

SCORE ★★★★☆

IPVanish appeals to our inner nerd. Where some VPNs launch in a minimal, applet-style window, this one is a big, multi-tabbed affair full of bandwidth graphs and real-time info updates. Even the Quick Connect mode is more in-depth than usual, letting you select not only a country, but an individual server in a specific city. It's not difficult to use, but the emphasis is clearly on control rather than simplicity.

This makes it an ideal choice for advanced users who like to tinker. Want to change the VPN protocol or toggle different types of leak protection on and off? Go ahead. You can also choose to obfuscate OpenVPN traffic (to foil services that try to use deep packet inspection to detect VPN usage), automatically switch IP addresses periodically, or use IPVanish's own DNS servers for additional leak prevention. It's safe to say that, when it comes to privacy, IPVanish always goes the extra mile.

Despite its rich feature list, IPVanish is easy to navigate. The Quick Connect mode gets you protected in a few clicks, while the server list lets you browse a mass of useful information, with proper

search tools and options to sort the servers by country, response time or load. The map view that used to dominate the Windows app is no longer front and centre, but it's still there if you prefer to pick locations manually. And while we're not quite sure what purpose the real-time bandwidth graph actually serves, it looks pretty cool.

IPVanish boasts more than 1,000 servers across 60 countries, and while the vast majority of these are in North America or Europe, there are outposts in Brazil and South Africa, plus a decent selection in Asia – particularly in Hong Kong and Singapore.

Connection speeds are mixed. We found that short-distance connections, to servers in the UK and the Netherlands, retained between 83% and 86% of our regular connection speed, which is fine if not exceptional. Where IPVanish shines is in UK-to-US VPN connections: here we saw download speeds of over 22Mbits/sec. That makes IPVanish brilliant for US-based video-streaming services – aside from the unfortunate fact that the service was blocked by Netflix's ever-evolving anti-VPN measures.

IPVanish is a polished, well-designed VPN with an impressive and highly configurable set of privacy features. Other services may be cheaper or faster, and some customers may be put off by the idea of US jurisdiction, not to mention the lack of Netflix. If you're looking for control, however, you'll struggle to find another VPN that comes close.

CyberGhost 6
£10.99 for a six-month subscription
cyberghostvpn.com

SCORE ★★★★☆

CyberGhost cleverly installs as a seven-day trial of its paid-for service – then moves you down to the free service if you decide not to subscribe. You keep the same basic VPN features, but free users must live with in-app adverts and are automatically disconnected after three hours of usage. There's a smaller pool of servers too, so you might have to queue to get connected.

Still, CyberGhost has a slick interface and a strong feature set that's arguably worth paying for. Connection speeds could be faster, but overall it's not a bad Android VPN.

The CyberGhost app takes an unusual profile-based approach, with different VPN modes on offer to suit different needs. "Wi-Fi Auto-Protect" is designed to keep you safe on public networks, while "Secured Streaming" is for accessing international TV services, and the "Surf Anonymously" and catch-all "Choose My Server" options speak for themselves. Select one and the client will automatically connect you to the fastest and most suitable server.

It's an approach that can feel long-winded if you're experienced with VPNs. Once you're connected, though, there's little to complain

BELOW In CyberGhost, you are given a range of VPN "modes" to suit your needs

about. The basic VPN services are effective, and CyberGhost is – at the time of testing – one of the few Android VPNs that can successfully trick Netflix into streaming its US catalogue to UK-based customers.

CyberGhost has over 1,250 servers worldwide, across 60 countries. They're particularly concentrated in the most popular locations – such as the US, Germany, the Netherlands and the UK – but wherever you are, it shouldn't be hard to find a connection that's relatively nearby.

With all those servers to choose from, CyberGhost is extremely quick at making the initial connection (although it's a little slower on the free service). Once you've established the link, however, actual browsing speeds are nothing to write home about. Using a UK server nearly halved the bandwidth of our downstream connection, though upstream speeds were nearer the 70% mark.

There's a possible cause for concern when it comes to leak protection: doileak.com found that the same IP address was leaked through the WebRTC protocol whether the VPN was engaged or not. This won't be a major worry for most users, but if you want to be certain of your online anonymity, look elsewhere.

CyberGhost is based in Romania and Germany; the latter has strict data-retention laws, but the company has a policy of not tracking or logging any activity in the first place, and all customer info is anonymised wherever possible. ●

Time for ebooks to turn a new leaf?

Ebooks have largely failed to exploit the benefits of digital. But that's all set to change, finds Nicole Kobie
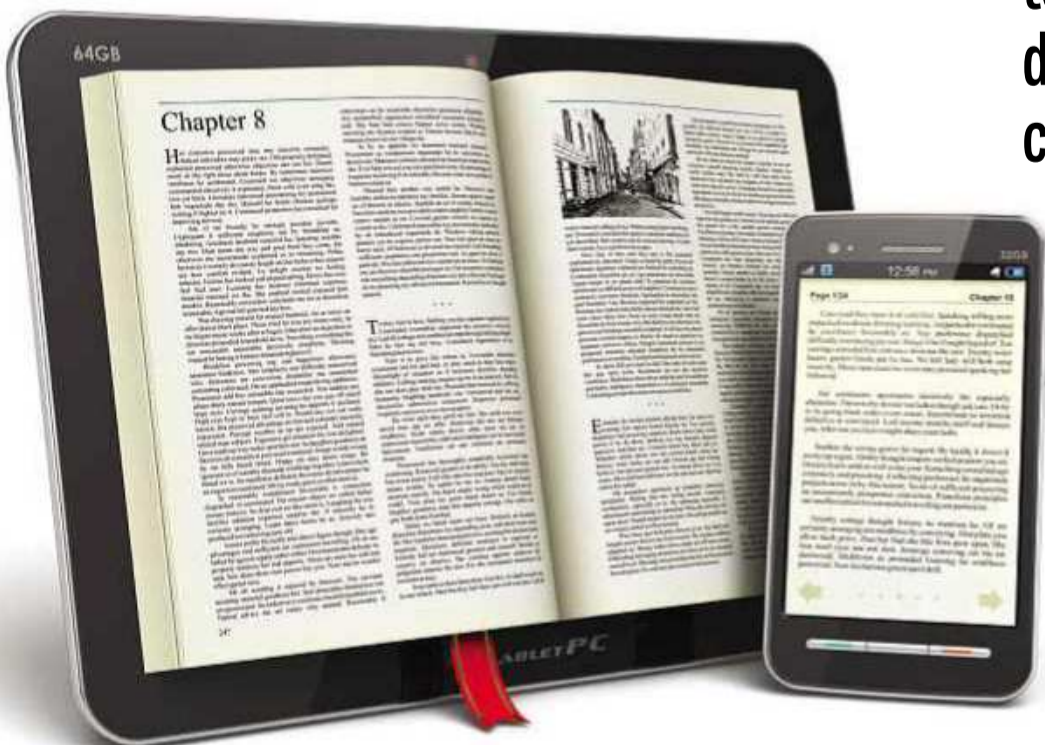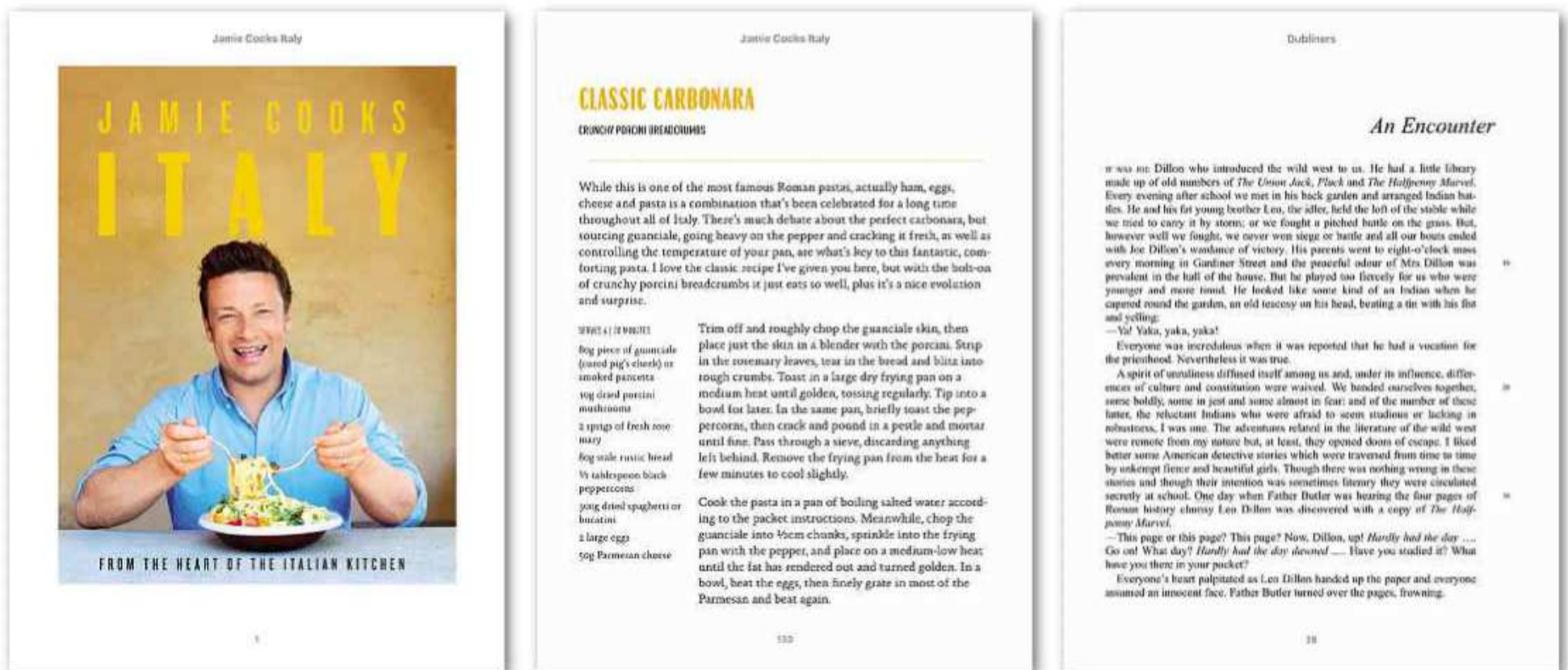
ABOVE Embedded fonts mean this Jamie Oliver cookbook has the same stylish design as the paper original, while the ebook of James Joyce's *Dubliners* has line numbers for students

Ebooks were the future once: e-readers were Hitchhiker's Guide-style wizardry holding thousands of books, accessible anywhere. Now paper is making a comeback. Despite smartphones letting us read almost any text, novel or magazine anywhere, ebook sales slid 10% in 2017, according to market research firm NPD Group.

No wonder publishers have resorted to name calling. "The ebook is a stupid product," Arnaud Nourry, chief executive of Hachette Livre, was reported as saying in a story in *The Guardian*. But it wasn't a childish tantrum: Nourry was criticising how poorly ebooks have been exploited by publishers. "It is exactly the same as print, except it's electronic. There is no creativity, no enhancement, no real digital experience," he said.

For the most part, that's true: ebooks are dumb. Most novels downloaded via Amazon to a Kindle are no more than digital versions of the same text that's on paper pages. "That precedent was set when the boom first happened," said Koko Ekong, technical and design manager for ebook production at Penguin Random House UK. Publishers in a rush to get ebooks to market simply released carbon copies of print books. "I think doing that, as well as lowering cost to get market saturation, set a precedent that's been hard to shake in public perception."

Ebooks don't have to be that way – and there's plenty of creative innovation on show from publishers that take a digital-first approach, such as giving would-be chefs video cooking lessons or translating between languages on the fly. "For ebooks to fully realise their potential, publishers will need to stop approaching it from a print-first workflow and look at it as its own entity, its own beast," Ekong added.

While such features are only starting to slip into ebooks, even the basic print replicas have their own clever uses of technology thanks to the hardware they're loaded onto, with innovations such as Amazon's audiobook syncing-tool Whispersync proving so smooth and simple it's indistinguishable from magic, as one famous sci-fi author once wrote. Here we uncover the clever tech that makes ebooks smarter than paper and what to expect next in the ebook evolution.

Basic text, big benefits

Paper has benefits. Many people find it easier on the eyes, and books on shelves aren't locked down with digital rights management (DRM) that prevent you from passing them on to your wife or the charity shop.

But ebooks have a few basic features that can change lives. Aside from the key selling point of carrying a library in a slim, light device, ebook

> Most novels downloaded via Amazon to a Kindle are no more than digital versions of the same text on paper

text can be reformatted with different text styles and sizes, a boon to those without perfect vision. Most ebooks are published in the EPUB file format – Amazon rejigs files into its own proprietary version, but it's how they start life – and the flexibility in that standard means ebooks are "inherently accessible", said Ekong, thanks to features such as changing text size and contrast, as well as text-to-speech. "That's one of the strengths of the reflowable version of the EPUB, because the content adapts to whatever container it's viewed in, you're not limited to screen size, aspect ratio and things like that," he explained. "The reader can adjust font sizes."

That may seem simple, but it's no easy task and depends on a robust file standard. You can't reflow text in a PDF, for example, if you'd like a larger font. But the EPUB format – formally known as "electronic publication" files – changed the game.

EPUB files are based on documents created with Extensible Markup Language (XML). Anthony Simnica, digital operations director at Hachette UK, notes that at the start of the digital revolution, publishers created ebooks from Word files or PDFs, unpicking formatting to make them work in EPUB. Using XML from the beginning now means books are perfectly tagged and formatted for print and digital.
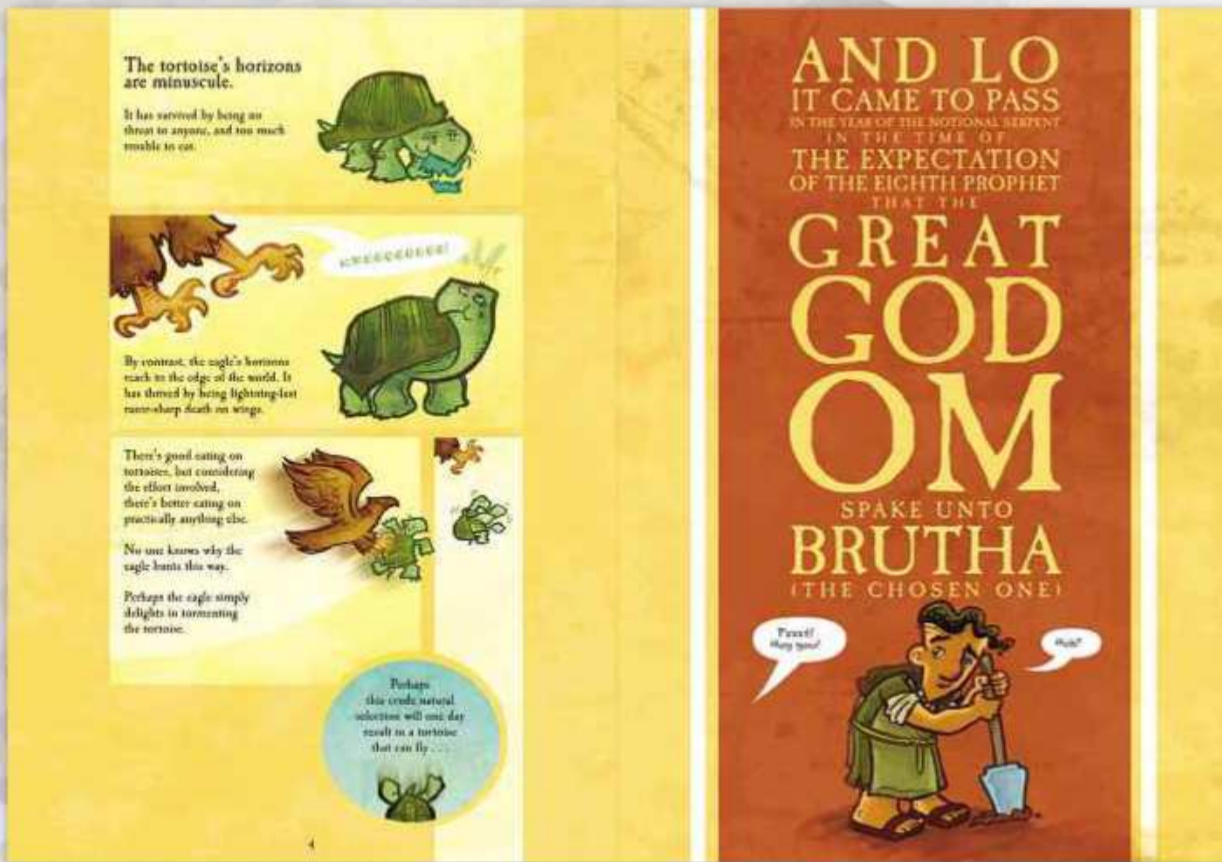
ABOVE The "Enhanced Edition" of Terry Pratchett's *Small Gods* sees the fantasy novel transformed into an immersive ebook

ABOVE The ebook version of *The Dinosaur That Pooped The Past!* includes animations, sound effects and a full audiobook read by the authors

That's what allows – and necessitates – features that tell you what percentage of a book is left and how much time it will take the average reader. Page numbers are no longer meaningful. "We have baked into the software locally a kind of baseline of how long it takes to read a certain number of words, and then we'll adjust those accordingly," explained Will Chaban, product owner at Rakuten Kobo, an ebook seller and e-reader maker. "We don't have to dial into a central server to analyse that, so if you're reading on vacation then you'll still get a reasonable estimate of how much time is left in your book."

Staying in sync

Ebooks are smarter than merely rejigging fonts or counting words, of course. Most e-readers or e-reading apps will let you look up words in a dictionary or perform basic foreign translations. On Kobo's system, there are two dozen dictionaries and translations embedded in every e-reader. "The dictionaries we automatically download [to your e-reader] are a subset based on which language you choose up front," said Chaban. "If I pick English, it'll automatically download the English dictionary and translations from English to each language we provide. But you can go and pick in the settings multiple dictionaries to download."

Basic ebook readers have other features we take for granted, notably bookmarking, notes and highlights. That's done by syncing locations in a book; the Kobo system can mark the beginning and end of each word.

One of the most impressive features is syncing audio versions with ebook text, so far only available via Amazon's Whispersync. Jeff Bezos' ecommerce giant bought audiobook company Audible in 2008 for $300 million, and in 2012 introduced Whispersync, which links the two formats. Listen to an audiobook on your walk to the train station and, if you have connectivity, you can pick up right where you left off in the ebook. Or, in "immersive" mode, you can read the text while listening to the audio version at the same time.

The magical thing about this is the narration matches the highlighted word on the page precisely. And that's a boon for people – especially children – with reading difficulties. It allows them to enjoy books without losing their place on their page. One parent we spoke to – who asked not to be named – said his dyslexic teenage daughter only started reading books again when they discovered Whispersync, as it helps her to read at the same pace as her peers.

Amazon wouldn't reveal the finer points of how that technology worked, but Kobo did explain why its ebooks don't yet support such a syncing system – in short, it's crazy difficult. "Some of it is due to how the books are licensed to us – the provider of the ebook and the provider of the audiobook aren't necessarily in harmony there," Chaban explained. While that explains why Amazon bought Audible to make Whispersync work, there's also the technical challenge. "If the underlying metadata to tell us this word in the book matches with this point in the audio isn't there, if we don't have that information, then it's a challenge to cross-reference both positions accurately."

Amazon's other magical ebook feature is a bit more mundane, though equally helpful to readers. X-Ray lets you hold down a word or phrase to find out more about it, pulling in information from Wikipedia or letting authors write their own entries. Like Whispersync, it's a tool added by Amazon, so only available on Kindle. Authors who publish their own books via Kindle Direct Publishing can enable the feature in their books simply by tapping a button in the publishing platform. The X-Ray system will automatically create X-Ray entries by pulling in information from Wikipedia and from elsewhere in the book, such as when the word being queried is a character, although the author can edit those to avoid spoilers.

The magical thing about this is the narration matches the highlighted word precisely

Some grannies are old, some grannies are great,
And Danny's was turning one thousand and eight.
He sang "HAPPY BIRTHDAY" with Dinosaur too,
Then asked to go out: there was playing to do!

Digital feedback

Ebooks collect data on how we read, using it to adjust "time left in chapter" updates as well as to keep our bookmarks and highlights. Kobo wouldn't reveal exactly what information is fed back to publishers, but it does have a data dashboard for independent authors. Writing Life, as the platform is called, gives self-published authors standard data about sales figures and estimated earnings, Kobo's Chaban reveals.

So far, that data isn't used to tweak books, such as telling writers when readers got bored or picked up the pace – but give it time. "It has been discussed for some time, and it'd be interesting to have access to that data," Hachette's Simnica said. "We haven't got that data, but it's sought after."

What could be done with such information? Simnica suggested multi-book series already help drive sales – finish the first book, and it's easy to buy the sequel. "I would suggest it's something in the minds of people when reading submissions," said Simnica, of publishers shifting through pitches.

Ebook sales already drive change in the publishing market. Amazon's Bezos said in an annual letter to shareholders that a thousand independent authors made more than $100,000 in royalties last year. And, thanks to that, Amazon has a lot of data on what we want to read, how far into a book we get, and so on.

What does all of that actually mean for publishing? We don't really know – although Amazon probably has a good guess.

Page-turning features

When you're sitting down to read a fabulous new novel, you don't necessarily want any on-page distractions – just the text – but there's more to ebooks than novels, and plenty of non-fiction could benefit from digital content.

Thanks to the EPUB format, there's not much that a webpage can do that ebooks can't, in theory at least. Imagine cookbooks with embedded video or children's picture books with animations to catch the attention of any youngster. Textbooks could come with 3D models, snippets of lectures, or video explainers.

Ekong revealed a few ebooks in the works at Penguin Random House, some that have yet to be published. One cookbook uses embedded fonts, meaning it has the same beautiful design as the paper version, and can reflow ingredient lists to best match the device you're using. On an ebook, they get a separate page; on a larger tablet, they're flowed into a neat sidebar, meaning all the information you need to start cooking is on-screen, meaning no flipping is necessary when your hands are mucky in the kitchen.

Children's books will have subtle animations, helping to boost immersion, said Ekong. A German classic lets you flip between the original text and the translation without leaving the page. A James Joyce edition has line numbering built-in – handy for those studying the text at school who need to reference specific sections.

Some are simple changes; others could revolutionise how we read. "That is the advantage of the EPUB format, technically there's no limit to what you can do," said Ekong.

The device you're using to read matters. If you're flipping digital pages on an e-ink reader, content-rich features such as video aren't available. Move the file to an app on a more robust device, such as an Android or Apple tablet, and you'll see them.

Of course, that's easier said than done. Because most ebook platforms are locked down, switching isn't easy. "If you're firmly entrenched in the Amazon ecosystem, and you upgrade from an older Kindle to a newer one ten years later, as long as you use the same system, no problem," said Ekong. "The problem is if you're in the Amazon system and you switch to Apple." But that's a market issue, not a technical challenge.

Competing with print

While sales figures suggest e-ink readers may be at saturation point, ebooks and print books aren't necessarily in competition. "We're competing for people's time," said Simnica, and the rivals aren't always other books but games, streaming video and everything else our smartphones and tablets offer. And that's why tech that makes reading

> That is the advantage of the EPUB format – technically there's no limit to what you can do

easier, be it line numbering, text reflowing or the dark magic of Whispersync, is the future of ebooks. "Making reading as convenient as possible is a high priority," Simnica said.

If such whizzy features appeal, you need not pass over Amazon for Apple. Plenty of such clever coding will work across Amazon's Fire tablets or even Fire TV. And, because the EPUB standard is open, ebooks are readable on almost every device that can support web technologies such as HTML and CSS. Indeed, support is already built into Microsoft's Edge Browser, while there are ebook extensions for Chrome.

The capabilities and support for EPUB is set to expand further. The standards body that currently manages the format, the International Digital Publishing Forum, last year merged with WC3, the web standards organisation. "EPUB, or something based on it, will become the de facto document format for the web," said Ekong.

"This is where a lot of people think this might be going. You can already see it starting to manifest in little ways, such as the Edge browser natively supporting EPUB now." Sales of ebooks may be sliding, but they could soon take over the web. Take that, print. ⬤

CSS3 tricks: Bring your website to life

Fed up with your flat, tired-looking website? Nik Rawlinson reveals some easy styling tricks that can transform the experience

I f you've dabbled in web design, you'll know about CSS – the styling language that's used to specify the layout and appearance of your pages. The latest major version is CSS3, but the standard is continually being updated, with the latest enhancements published as recently as June 2018.

This is both good and bad. It means that exciting new features are being added all the time, but if you embrace the latest and greatest features, there is a risk that not all of your visitors' browsers will support them.

Thankfully, you don't need to live on the bleeding edge to spruce up your site. There are plenty of mature and well-supported features of CSS3 that make it easy to create – and maintain – professional-looking websites. Here are some of our favourite tricks that you might not know about, from automatic text and table styling to simple animation.

How does CSS work?

First, let's recap how CSS works. Simply put, CSS is used to define "selectors", which can then be applied to various elements of your web page. These might typically include attributes such as font size and colour. The code can either be inserted directly into an individual page, or stored in a global style sheet that can then be linked to by every page on your site.

If you want, you can use selectors to apply specific attributes to standard HTML elements. For example, you can specify that all <p> elements will have text of a certain size, or that all <img> elements will have a particular border.

You can also create your own custom styles (or "classes"), which can be applied to any page element. To do this, simply declare a new selector, give it a name starting with a dot – ".mystyle", for example – and

invoke it in the HTML code for your chosen element, using syntax such as <p class=".mystyle">. You can also use a hash instead of a dot to specify that a style should only apply to an element with a specific name. For example, if you create a style called #mylayer, that will control the appearance of an HTML element with a matching ID, such as <div id="mylayer">.

The actual code that defines each selector is very simple: you simply write the name of the selector and then define the attributes you want between curly braces, with a semicolon after each one:

```
h1 {
    font-size: 2em;
    font-variant: small-caps;
    font-weight: bold;
}
```

The only difficult bit is knowing what attributes are available, what they do, and what arguments they take; a bit of Googling might be necessary to achieve the precise effect you want.

Smart styling

Basic CSS is simple, but in practice it can be a pain as you have to make sure that each element on your page is tagged with the correct selector. With CSS3, it's possible to be cleverer than this by defining styles that apply to elements of a particular type, and then letting the browser work out which elements those actually are.

To see how this works, let's imagine we want to publish the following table on our website:

```
<table class="mytable">
<tr><th>Name</th><th>Party</
th><th>Term</th></tr>
<tr><td>Tony Blair</td><td>Labour</
td><td>10 years</td></tr>
<tr><td>Gordon Brown</
td><td>Labour</td><td>2 years</td></
tr>
<tr><td>David Cameron</
td><td>Conservative</td><td>6 years</
td></tr>
</table>
```

There are plenty of mature and well-supported features of CSS3 that make it easy to create

```
=contents th { padding-top: 4px; padding-bottom: 4px; text-align: left; background-color: #808080;
color: gray; } body { font-family: 'lato', sans-serif; } .container { max-width: 1000px; margin-left: auto;
margin-right: auto; padding-left: 10px; padding-right: 10px; } h2 { font-size: 26px; margin: 20px 0; text-
align: center; small { font-size: 0.5em; } } .responsive-table { li { border-radius: 3px; padding: 25px 30px;
display: flex; justify-content: space-between; margin-bottom: 25px; } .table-header { background-color:
#95A5A6; font-size: 14px; text-transform: uppercase; letter-spacing: 0.03em; } .table-row { background-
color: #ffffff; box-shadow: 0px 0px 9px 0px rgba(0,0,0,0.1); } .col-1 { flex-basis: 10%; } .col-2 { flex-basis:
40%; } .col-3 { flex-basis: 25%; } .col-4 { flex-basis: 25% } } @media all and (max-width: 767px) { .table-header
{ display: none; } .table-row{ } li { display: block; } .col { flex-basis: 100%; } .col { display: flex; padding:
10px 0; &:before { color: #6C7A89; padding-right: 10px; content: attr(data-label); flex-basis: 50%; text-
align: right; } } } $bp-col5: 75em; { @include box-sizing(border-box); &:before, &:after { @include box-
sizing(border-box); } } body { font-family: $helvetica; color: rgba(94,93,82,1); } a { color: rgba(51,122,168,1);
&:hover, &:focus { color: rgba(75,138,178,1); } } .container { margin: 5% 3%; @media (min-width: $bp-col1)
{ margin: 2%; } @media (min-width: $bp-col5) { margin: 2em auto; max-width: $bp-col5; } } .responsive-
table { width: 100%; margin-bottom: 1.5em; @media (min-width: $bp-col1) { font-size: .9em; } @media
(min-width: $bp-col4) { font-size: 1em; } thead { position: absolute; clip: rect(1px 1px 1px 1px); /* IE6, IE7
clip: rect(1px, 1px, 1px, 1px); padding: 0; border: 0; height: 1px; width: 1px; overflow: hidden; @media (min-
width: $bp-col1) { position: relative; clip: auto; height: auto; width: auto; overflow: auto; } th { background-
color: rgba(29,150,178,1); border: 1px solid rgba(29,150,178,1); font-weight: normal; text-align: center;
color: white; &:first-of-type { text-align: left; } } } tbody, tr, th, td { display: block; padding: 0; text-align:
```

CSS lets you do the same thing on your web pages, again making it **terrifically quick** and easy to create

By default, this will look very flat – so let's use some CSS to highlight the header row, put dotted lines between each prime minister and add a solid underscore to denote that David Cameron was in power when it was put together:

.mytable {
    border-collapse: collapse;
}
.mytable tr {
    border-bottom: 1px dotted #000;
}
.mytable th {
    text-align: left;
    weight: bold;
    padding: 0.2em 0.5em;
    border-bottom: 2px solid black;
}
.mytable tr:last-of-type {
    border-bottom: 2px solid black;
}

We could have defined a custom style for the last row of the table, and edited the HTML accordingly – but you'll notice that instead we've used the CSS3 "last-of-type" selector. This means that David Cameron's entry will automatically be underlined, because it's the last table row. Even better, when we add Theresa May to the table, that new row will become the last one, and the formatting will update. With a line of CSS3, we've ensured that our table will be correct for as long as the British system of government prevails.

To simplify things further, we could also ditch the <th> tags, which currently define the appearance of the header cells, and instead use "first-of-type" to specify the format of the top row.

First, last – and using in-between

The ability to target specific on-page elements without knowing exactly which ones they are is one of the most powerful features of CSS3. You can even target, say, the second row of the table:

.mytable tr:nth-of-type(2) {
    border-bottom: 2px solid black;
}
...or every other row:
.mytable tr:nth-child(even) {
    background-color: #ccc;
}

You can also use "nth-child(odd)" to produce a table with alternating row styles, which looks nifty and makes it easier to read. And if you apply these tags to the "td" element rather than the "tr", you'll get alternating column styles instead:

.mytable tr td:nth-child(odd) { }
.mytable tr td:nth-child(even) { }

You're not limited to odd and even elements, either. If you were putting together a calendar of moon phases, you might want every fourth entry to stand out, to mark the full moon. You could achieve this by specifying:

.mytable tr:nth-child(4) { }

What if your table didn't conveniently start at the beginning of a four-week cycle, so you wanted to highlight the second row and every fourth row thereafter? You can add an offset to the number in brackets to specify its first instance, like this:

.mytable tr:nth-child(4+2) { }

Naturally, you'd change the modifier to +3 if the first full moon instead appeared on the third line, and so on. You can also use nth-last-child() to count backwards from the last element. If you want to apply a

style to the third-from-last row in your table, you can simply specify:

.mytable tr:nth-last-child(3) { }

Follow-on styles

If you've ever defined your own text styles in Word or a desktop publishing application, you'll know that when you define a paragraph style, you can also specify that a particular style should be automatically applied to the following paragraph – so, for example, when you type a headline and press return, the application automatically switches to body text.

CSS lets you do the same thing on your web pages, again making it terrifically quick and easy to create a look for your page that self-updates when you need to edit the content. This is one of those features that's been updated in CSS3, but it doesn't seem to be consistently implemented on the various browsers we've tried, so we'll use the older CSS2 syntax, which is universally supported.

The only catch with follow-on styles in CSS is that you need to think about them backwards, compared to the way they're implemented in Word. Rather than defining a style and then specifying which style should come next, in CSS you define your style in terms of which style it should follow. You do this by using a plus sign, like this:

h1 + p {
    font: bold 1.2em/1.5em Arial;
}

This tells the browser to apply the defined style to all <p> elements that come immediately after an <h1> element ("heading 1"). Any other paragraphs will get the default styling for a <p> element.

The effect is similar to using the "first-of-type" or "nth-child" selectors, but those definitions wouldn't work here because the heading and paragraph elements are of different types. You could however use "first-of-type" to set

the appearance of the first paragraph within a defined block.

CSS3 animation

Styling can go a long way towards keeping your website looking smart and professional – but if you really want to grab a visitor's attention, it's also worth looking at CSS3's arresting animation capabilities. We're not suggesting that you make your headlines and images bounce around the screen, but a tasteful bit of motion adds life to the page and helps draw the eye. For example, since GDPR remains a hot topic, we might use a simple colour-shifting effect to draw a visitor's attention to a cookie notice.

The HTML need be no more complex than this:

```
<div id="alert">
<p>
<a href="cookies.php">We'd like to use cookies to track your movements. Click here to view your options.</a>
</p>
</div>
```

The only thing that distinguishes this from basic, flat HTML is the fact that we've given the layer a name ("alert"). We can now use CSS to animate this specific element, without affecting anything else. Here's the style code we'll be using:

```
@keyframes cookies {
    from {
        background: salmon;
    }
    to {
        background: white;
    }
}
#alert {
    text-align: center;
    padding: 1em;
    border: 1px solid #333;
    animation-name: cookies;
    animation-duration: 2s;
    animation-iteration-count: infinite;
    animation-direction: alternate;
}
#alert a {
```

```
    text-decoration: none;
    color: black;
}
```

CSS animation is based on keyframes, meaning you don't have to define every step of a transformation: you just specify the desired start and end states of your element, and the transition between them is generated automatically. We've called our keyframe set "cookies" and used it to define two states, for the start and the end of the animation. In this instance, the background colour will fade from salmon pink to white.

You're not limited to defining two states within a keyframe set. You can set as many as you want, using percentages to indicate at what point in the animation the keyframe comes. For example, to run through red, green and blue you'd use:

```
@keyframes cookies {
    0% {
        background: red;
    }
    50% {
        background: green;
    }
    100% {
        background: blue;
    }
}
```

This moves through the colours at a regular speed – if you change the "50%" to "80%", the transition from red to green will take longer, and the transition to blue will be shorter. You get the idea.

Having defined our keyframes, the CSS below specifies that this code applies to the HTML element named "alert". Alongside familiar things like text alignment, padding and border, we simply include "animation-name: cookies" and specify how it should be played. In the example above, we've set the transition to last two seconds ("animation-duration: 2s;"), to repeat forever ("animation-iteration-count: infinite;"), and to play in reverse when it reaches the end so that it

doesn't suddenly jump back to salmon each time ("animation-direction: alternate;"). No doubt you can see how each of these could be tweaked to meet your own needs.

For the sake of neatness, these variables can all be specified on a single line:

animation: cookies 2s infinite alternate;

Obnoxious animation

Now, as a rule we suggest you don't make page elements move around while your visitor is trying to read the page. But it's certainly possible, using exactly the same techniques that we used above to change the colour of the alert. All we need to do is set up keyframes that specify the location of the element, rather than its appearance.

Let's finish up with some CSS that will cause a button with the name "evil" to move away from the mouse should anyone try to click it:

```
@keyframes evil {
    0% {
        margin-left: 0em;
    }
    1% {
        margin-left: 5em;
    }
    100% {
        margin-left: 5em;
    }
}
.evil:hover {
    animation-name: evil;
    animation-duration: 50s;
}
```

This is a fun example of what you can do with CSS3, but you probably shouldn't use this to link to your cookie policy. ●

Styling can go a long way towards keeping your website looking smart and professional

Click here to end this marriage

You can now complete a divorce from your smartphone, but what does it mean for the future of marriage? Theresa Harold vows to find out

"To have and to hold from this day forward, for better, for worse, for richer, for poorer, in sickness and in health, to love and to cherish, till death us do part…"

When couples utter those words, it's unlikely they're contemplating divorce, let alone thinking about applying for one online. This summer, as part of a £1 billion modernisation programme, the UK's Ministry of Justice rolled out digital divorce across England and Wales, meaning that couples can now apply for a divorce from the comfort of their living room.

The whole process is done with a few clicks on a screen, including payment and uploading of supporting evidence. For those who struggle to complete their tax returns online, the prospect of a DIY digital divorce might be daunting. But, rather promisingly, of the over 1,000 petitions that were issued through the new system during the testing phase, 91% of people said they were satisfied with the service.

"It was marvellous, pain-free and less stressful than the paper form which I tried several years ago to complete but got fed up of it being rejected," Elaine Everett, who was separated for more than two years before applying for her divorce (which she has now received), told the Ministry of Justice.
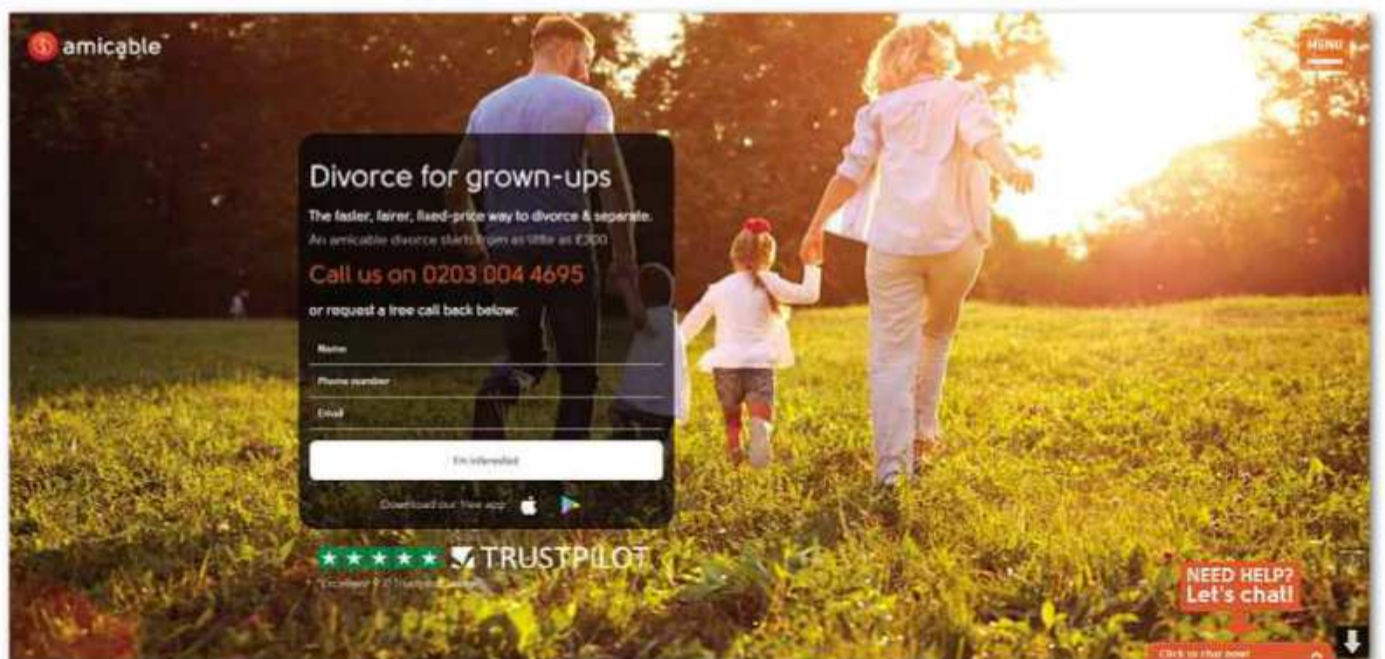
ABOVE Amicable's customers will be able to access the digital divorce forms directly through the app

In fact, by eschewing the legal jargon of the paper divorce forms, the simplified online service has led to a 95% drop in the number of applications being returned to their senders because of mistakes. And when you consider that court staff spend an estimated 13,000 hours per year dealing with complex divorce paperwork, this stands to be a huge cost-saver for overstretched courts.

"Allowing divorce applications to be made online will help make sure we are best supporting people going through an often difficult and painful time," said justice minister Lucy Frazer at the launch of the service. "More people will have the option of

moving from paper-based processes to online systems which will cut waste, speed up services which can be safely expedited, and otherwise better fit with modern day life."

Legal separation at your fingertips

But should something as serious as divorce be completed on your iPad while sitting on the sofa watching *Love Island*? In our world of instant gratification, might bringing the divorce process online make it seem more trivial?

"I don't think this is inevitable, but it certainly is possible," said Dr Sam Carr, director of studies for Education

DIVORCE

with Psychology at the University of Bath. "The convenience, ease, and at-your-fingertips nature of the digital world does have the potential to encourage and foster a sense that a divorce is 'just a click away'.

"Couples might pull out of marriages much more easily and quickly than they otherwise would. This could be good – but it could also be bad in the sense that if we simply have to click our fingers to end our marriages, then how can we learn about, appreciate, understand, and grow from the trials and tribulations that all marriages inevitably have to face from time to time?"

Indeed, it goes without saying that the emotional cost of divorce should be carefully considered. Barrister John Oxley, of law firm Vardags, is not convinced that digital divorces will lead to unhappy couples rushing to end their marriages. "Not at all. No one is dissuaded from ending their marriage because the form is difficult – they are simply inconvenienced whilst doing it," Oxley argued. "I also hope that this change helps pave the way towards no-fault divorce, as the overwhelming evidence shows our fault-based system is both unpopular and counter-productive, engendering heartache rather than protecting marriage.

"It is also worth remembering that this system does not do away with the

litigation which surrounds the ending of the marriage. Financial issues and child arrangements, where the real complications lie, will still be handled by the courts in the usual way."

Emotional support

The idea of instigating divorce proceedings online isn't new, as Kate Daly, who co-founded divorce app Amicable in 2016, will attest. Several online services already offer divorces, but Amicable's USP (claim its co-founders) is that it contains all the necessary legal information as well as the emotional support required to make the procedure as smooth as possible. Luckily for Amicable, the

MoJ's digital scheme is built using an open API, which means its customers access the forms through the app.

Speaking to *Courier* magazine about the digital divorce launch, Daly was enthused: "I think [adoption] will take an age in reality but any digitisation can't come soon enough. A simpler system will promote access to justice."

Access being the crucial word here. For many, the process of divorce can become – quite literally – an obstacle course. Rebecca, who did not want her last name to be used, received legal confirmation of her divorce 11 and a half weeks after submitting her application. "The service was a lot easier because I use a wheelchair and didn't have to go out, and I also found it very easy as an autistic person to get support from the team when I had questions," said Rebecca. In contrast, the paper process would have taken around six months.

Considering the number of relationships that now begin with people swiping right or 'liking' a

picture on Instagram, it seems only natural that the end of a marriage could also take place on screen.

Speaking at a lecture earlier this year, Sir James Munby, president of the Family Division of the High Court, said: "The online divorce pilot has been a triumphant success and shows, to my mind conclusively, that this is – must be – the way of the future." ●

Couples might pull out of marriages much more easily and quickly than they otherwise would

The headache-free guide to implementing a new VoIP system

Installing 3CX's software PBX is a slick process, but there are still some steps you should take if you want the smoothest possible migration

P icture the scenario. You've invested thousands of pounds into a new IT system with a features list that reads like a dream. This, you believe, is the big one. Happy end users. Happy finance director, because you have slashed your overall costs. Happy you, because maintenance will be almost zero. But we all know this doesn't happen by magic. For the best results, you need careful planning – and perhaps some outside expertise, from people who have done it all before.

While 3CX's PBX is a well-established service, there are things you can do before switchover day that will make your life easier. We speak to Nick Borg, product manager for 3CX, to find out the steps you can take to improve your life, as well as those of your employees'.

Choose a partner
First things first. Unless you're choosing the free version of 3CX, you'll need a 3CX partner. Fortunately, they are easy to find. Head to **www.3cx.com/ordering/find-reseller** and you can search by location, pick a nearby city or drill down into a region using the interactive map (England and Scotland only).

"As a 100% channel company we always recommend that customers use a 3CX partner," said Borg. "Our partners are trained on 3CX and can offer the customer the support, knowledge and expertise required regardless of installation size. Also, for troubleshooting issues, it's always good to have someone on call that knows the system like the back of their hand."

Even if you're choosing the free option, it makes sense to opt for a certified SIP trunk provider. Opposite, we provide a checklist to go through

BELOW Whether your employees are sitting at their desk or using their mobile phone, 3CX just works

before you decide who is right for you. "Using a certified SIP Trunk with 3CX makes setup and configuration a walk in the park," said Borg. "All you need to do is create an account with the SIP Trunk, log in to the 3CX Management Console, select your SIP Trunk from the drop down, fill in your SIP Trunk account details and voilà – all configuration is done automatically. 3CX also ensures that all certified SIP Trunk providers' templates are updated and tested against each new build and update."

So much for setup. Now to the big question: how do you make sure day one goes smoothly?

All in the planning
"I believe in training, I believe in demos, I believe in test runs," said Nick Borg. "Some people even buy refurbished phones to see how they work and what they can do before making a big investment in phones. After all, the price of the PBX that does all the work is so little compared to the phone on each desk."

So how does he recommend companies should plan? "I would create a demo group and I would make sure I knew the opinions of core people. What's the point in me choosing a

3CX Advertorial

phone for the receptionist? I need the receptionist's feedback – what features the phone should have – before I make the investment. You won't be changing phones every two years – you have one choice, so it should be done with as much precision as possible."

And what mistakes do companies make when they invest in new phones? "I'm very happy to answer that question!" said Borg. "Some users try to customise phones and create custom templates. This might make sense if you're a company with thousands of users and have a team of admins that know what they're doing. But even very technical teams can make mistakes sometimes.

"It's incredible what I see people do with phones. However, some phone models require XML provisioning and have thousands and thousands of entries." This, said Borg, could cause issues if the templates aren't updated at the same time as an upgrade to the software.

"As a result, we created a very safe provisioning system," explained Borg. "When a user switches on their phone and it doesn't appear in the management console or doesn't get an IP, it probably means there are some networking issues. Basically, 3CX is notifying the user: 'Hey, something here is not right. Something in your network is illegal' so don't expect to see this phone in your console before you fix this problem."

Secure your system
Worried about security? That's sensible, but Borg explains this is no longer a key issue when implementing 3CX. "Before, admins used to make the same crucial and very dangerous mistake of leaving the password of the phone as the manufacturer made it," he said. "So, if you have an attack, then the attacker knows how to access all the phones on your network! We have tightened that up completely, because an admin must, as part of the install procedure, change the default password of the phone."

Our previous guide covered how to choose your perfect phone (*see issue 288, p74*), but it's worth flagging why you should stick to the phones on 3CX's list. "I recommend that all administrators go to the list of supported IP phones on **www.3cx.com/sip-phones** and choose from it," said Borg.

"There's a guarantee behind that list that there are people – trained staff – who are checking for firmware, checking for vulnerabilities, checking for how the phone behaves, and making sure that your chosen phone, with that firmware and that bootloader, together with this version of 3CX, gives you the best user experience."

Train your staff
Choosing the right phone ties in to our final point: training your staff. "Some phones, if they aren't chosen correctly, can end up costing you more – not because of their price, but because of the time it takes to train your staff to use the new phone," said Borg. "Also, the way the phones work might not tie in to the way you run your business. For example, maybe it's complicated to make a call transfer to mobile phones. That means staff will have problems – they'll transfer calls to the wrong person, and some phones don't bounce back when a transfer fails. So you end up with lost calls and this can cause issues for your business."

What to ask from a SIP trunk provider

- Do they plug'n'play with your PBX? That means no manual configuration
- What's their pricing model? Dig into the details
- How reliable are they? What's their track record over the past six months?
- Security: what steps do they put in place to keep your details safe?
- Quality of support – can they prove it?
- Does their geographic coverage match your offices?
- What are their international rates? Check for gotchas
- Can they provide local numbers for your area?
- Can they scale to meet your demand?
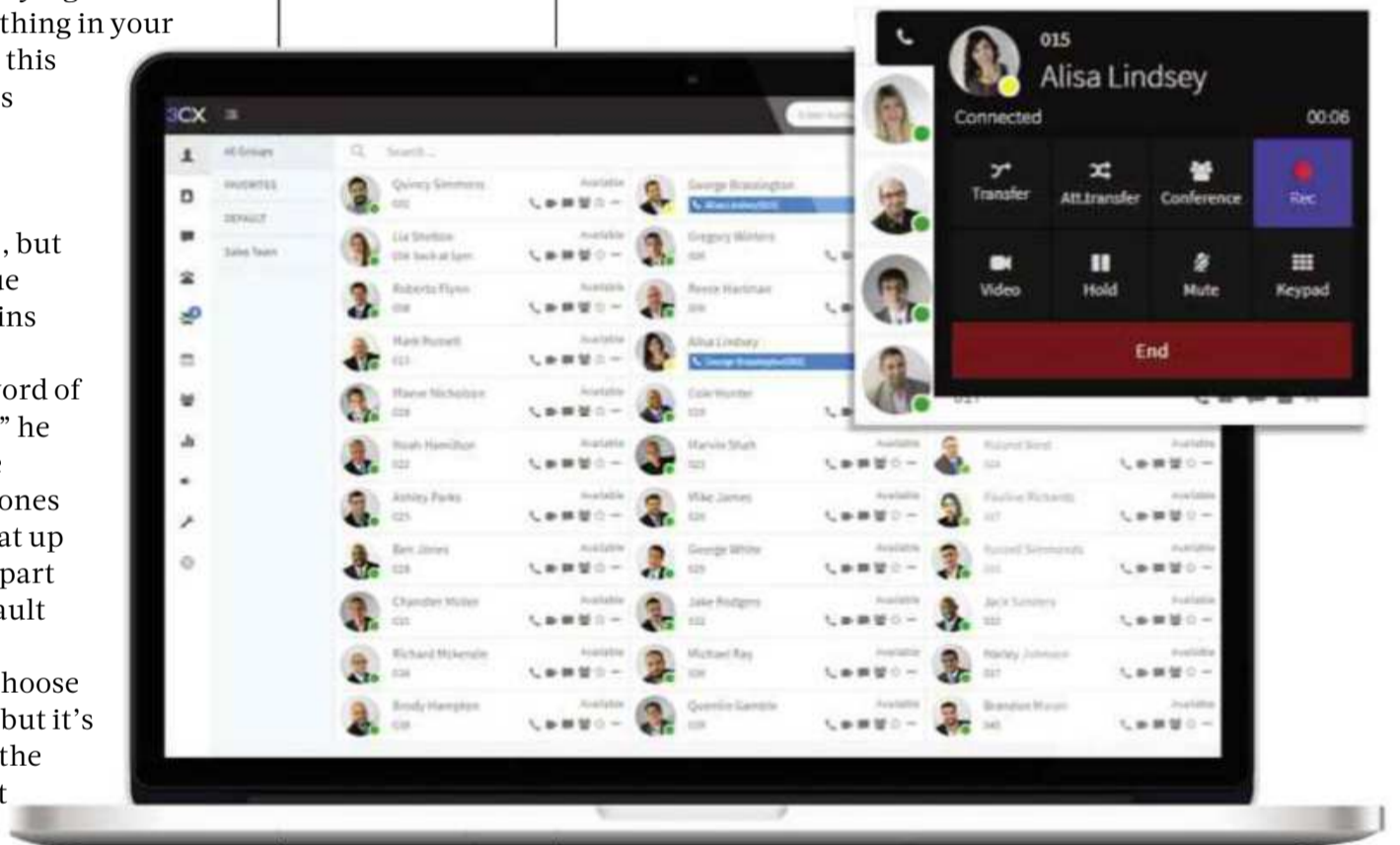
ABOVE 3CX in action on a laptop – note the many call-handling options and the handy presence information

Then there's the issue of choosing phones that are too complicated, or buying a brilliant system and not actually explaining what it can do to your team. "Let's say a receptionist has been working with a phone for 20 years, and one fine day, they're faced with a new phone," Borg said. "That can be a big challenge. So, they have to be educated. We need to give one-to-one education, one-to-one time, and it will involve patience."

This is one reason to seriously consider using software phones, whether apps on a mobile phone or on a computer. "On the IP phone you're constrained to the model, to the firmware – you cannot customise it in any way," said Borg.

"Apps, whether on your mobile device or desktop, are much easier to teach, because they're visual." In contrast, Borg points out, app developers can easily make updates and push them out instantly. "This means that if there's an improvement or a fix required this can happen on the spot – the user just needs to click the update button. This is one of the main reasons VoIP apps are becoming more and more popular."

Reviews

Samsung Galaxy Note9

A top-tier phablet with staggering battery life and excellent low-light camera performance, but the price is a big barrier even in the wake of the iPhone Xs

SCORE ★★★★☆

PRICE 128GB, £749 (£899 inc VAT)
from johnlewis.com

The Samsung Galaxy Note9 first appeared in July's unforgettable must-read page-turner: the press release accompanying the Samsung Electronics Second Quarter financial results. You didn't read it? Shame on you, because buried deep in the 2,109 words was our first confirmation of the Galaxy Note9. It would, Samsung assured us, offer "exceptional performance for a reasonable price".

Well, Samsung was bang on with the former. The Samsung Galaxy Note9 is the best smartphone you can buy right now, period. It doesn't put a foot wrong. The problem is that it isn't a huge amount better than its rivals, and that "reasonable price" turned out to be £30 more than last year's Note8 – a handset we previously described as "far too much for a phone".

This time around it's £899 for the 128GB model or £1,099 for the 512GB

Its beauty is even more impressive when you consider that Samsung hasn't bowed to pressure and used eye-catching design as an excuse to dump useful features. In fact, if you can name a top-end feature in a smartphone right now, the Note9 has it – as well as a few that its main rivals have jettisoned.

So not only do you get wireless charging and IP68 water resistance (it's resistant to 1.5m of freshwater for half an hour), but it keeps the 3.5mm headphone jack and ability to expand its capacity by 512GB with a microSD card. The last of these is particularly generous when the Note9 already has the biggest capacity we've seen in a smartphone: 128GB or 512GB.

And, of course, it finds room to house the new and improved S Pen. The Note's USP is back and better than ever, thanks to its added Bluetooth connectivity. It's a little thing, but being able to take selfies, control video playback and present slideshows with a click of the S Pen's button is genuinely useful. Not to mention that doodling and note-taking on the phone is an utter joy.

ABOVE You can now use the impressive Bluetooth S Pen to present slideshows and snap selfies

■ Screen star

Given Samsung makes some of the best smartphone panels in the business, it's no surprise that the Note9's screen is as good as it gets. The 6.4in Super AMOLED display keeps last year's 2,960 x 1,440 resolution and our colorimeter confirmed our eyes' glowing testimony. The screen is capable of producing the full 100% of the sRGB colour gamut, and because it's an AMOLED its contrast is effectively infinite.

To complete the hat trick of positive screen benchmarks, the display hits a searing 950cd/m² at maximum brightness, which would have been really handy with the recent sunny weather we've had in the UK. Suffice it to say, you'll always see what's on-screen, even in the brightest conditions. One final plus: it now supports HDR 10, too.

If I were to find one fault with the Note9's screen, it's that the colours – by default – are a little oversaturated and bright. But, as always, getting them down to something more natural is as easy as opening up the settings menu.

model. Sadly for Samsung, our perception of value hasn't changed. It's still too much, and if anything the world of phones has become even more competitive. However, if the Note9's unique attributes appeal, then step right up because this is as good as it gets.

■ Curvy design

The Note9 doesn't look hugely different from its predecessor. The plus-sized screen wraps about both curved edges on the front of the phone, and it's rounded off with mild bezels at the top. No Identikit notches in sight here.

Round the back, you'll find a horizontal dual-camera arrangement with a rectangular fingerprint reader underneath – although it's a shame that Samsung jettisoned plans for an in-screen fingerprint reader. Samsung is still pimping its Bixby assistant via a dedicated button on the left, but fortunately that can be disabled.

In short, the Galaxy Note9 is beautifully designed, but hardly revolutionary. With the exception of the S Pen's Bluetooth party trick and the crazy amount of storage, I could have written all of the above about the Note8 and it would still be true.

"If you can name a top-end feature in a smartphone right now, the Note9 has it – as well as a few that its main rivals have jettisoned"

■ Top-notch performance

It's a similar story on the inside: top-notch components everywhere you look. Powering the phone is Samsung's own Exynos 9810 chip, supported by a faintly silly 6GB of RAM in the 128GB model and a really silly 8GB RAM in the 512GB version. So buy a microSD card and you can carry 1TB of videos, music and photos in your pocket.

Performance is equally top drawer – but, damningly, that's actually not all that different from other, cheaper flagships when put through the

standard benchmarking tests. That's not surprising. Every flagship other than the iPhone uses the Snapdragon 845, and Android doesn't really know what to do with the extra RAM Samsung's generously provided. Not yet, at least.

Still, it is demonstrably faster than last year's Note8 – 37% better if you go by Geekbench's measurements. You may not notice the gap in practical terms now, but a year down the line and that could be the difference between a smooth experience and a laggy one in more demanding apps.

It performs brilliantly in games. Admittedly, the screen is something of an enemy here, as the WQHD+ resolution means that more demanding games struggle at top settings. Drop it down to Full HD+, however, and everything becomes buttery smooth – even the likes of *PUBG: Mobile*, *Asphalt 9* and *Real Racing 3*.

Notably, *Fortnite* played a big part during the launch announcement. Sure, the game can be downloaded on iOS devices and existing games consoles, but the Galaxy Note9 is – according to Samsung at least – the best place to play *Fortnite* if Android is your mobile OS of choice. You even get an exclusive in-game skin for free if you play a couple of games on your the device.

■ Battery life

One area where the Note9 has a convincing upper hand over its predecessor is stamina. As the Galaxy Note 7 proved to be slightly more flammable than is ideal for something that lives in your pocket, Samsung decided to play it safe with the battery in the Note8, dropping it to a 3,300mAh cell.

Convinced it has the problem licked, Samsung has now increased the battery life considerably, packing a 4,000mAh unit into the Note9. The results are suitably impressive.

In our looped video test, where the phone is set to Flight mode and 170cd/m² brightness, the Note9 went 19hrs 35mins before finally giving up: a chunky 19% improvement on the Note8. You'll get a day and a half out of this easily, and possibly more if you're a light user. Even the improved result from the iPhone Xs Max (*see p56*) can't come close.

■ Plus-size camera

The battle for best Android phone camera has become a three-way race between Samsung, Google and Huawei. While Google will be hoping to take back the crown with the launch of the Pixel 3, for now I'd give Samsung the edge. The bad news? It already had that edge, and the Note9's camera is no different to the S9 Plus' – although that is a step up from the regular S9, thanks to the added 2x optical lens that both phones share.

Both the S9 Plus and Note9 have the same dual-camera array: two 12-megapixel cameras, one with a f/1.5 aperture, and another f/2.4 telephoto lens for zooming without any distortion. Both lenses have optical image stabilisation (OIS) to ensure a steady shot, no matter how shaky your grip.

The f/1.5 aperture is key: that means it lets a lot more light in, brightening up shots and capturing more detail, particularly in tricky dark environments. It's a significantly wider aperture than the Note8's f/1.7 camera, and the best part is you don't need to do anything to benefit: if the Note9 is in bright conditions, the aperture narrows to f/2.4, and if it drops below 100 lux, it will widen to make the most of the limited light.

The results are brilliant. In our low-light still life test, in particular, the image is crisp and detailed, with perfectly captured colours, while the HDR system does an impressive job of lighting up dark, shadowy areas outdoors. Intricate wispy cloud layers, a notoriously tricky test for any smartphone camera, are captured exceptionally well, and are far better defined than on any other phone camera I've previously tested.

For now – and join in if you know the words – this is as good as it gets. Over to you, Google.

■ Buying notes

I really don't have a bad word to say about the Samsung Galaxy Note9. The design is spot on with no compromises on features, the screen is the best in the business, and the camera takes shots that will flatter your inner photographer. The S Pen is a joy to use, and it's more useful than before.

There's only one problem: cost. Most people would consider £899 a loopy price for a smartphone, and that's before we even get to the 512GB model, which sails past the four-figure mark. Yes, the even-more expensive iPhone Xs Max is one competitor, but Samsung's Android

Geekbench 4, multicore

Apple iPhone Xs Max	11,480
Samsung Galaxy Note9	9,089
OnePlus 6	8,783
Huawei P20 Pro	6,806
Samsung Galaxy Note8	6,614
Google Pixel 2 XL	6,263

HIGHER IS BETTER

Geekbench 4, single-core

Apple iPhone Xs Max	4,816
Samsung Galaxy Note9	3,728
OnePlus 6	2,422
Samsung Galaxy Note8	2,008
Huawei P20 Pro	1,919
Google Pixel 2 XL	1,895

HIGHER IS BETTER

GFXBench Manhattan, offscreen (1080p)

Apple iPhone Xs Max	111
OnePlus 6	80
Samsung Galaxy Note9	75
Huawei P20 Pro	65
Samsung Galaxy Note8	64
Google Pixel 2 XL	54

HIGHER IS BETTER

Battery life

Samsung Galaxy Note9	19hrs 35mins
OnePlus 6	17hrs 18mins
Samsung Galaxy Note8	16hrs 25mins
Google Pixel 2 XL	15hrs 9mins
Huawei P20 Pro	14hrs 36mins
Apple iPhone Xs Max	14hrs 18mins

HIGHER IS BETTER

ABOVE LEFT The Galaxy Note9's camera is the best you can buy

RIGHT Design-wise, little has changed since the Note8 – but we're not complaining

competition comes from Huawei's P20 Pro (typical price £700) and the Pixel 2 XL (£649).

The Note9 is better than those two rivals, but it's not that much better. The Huawei P20 Pro and Pixel 2 XL are both great phablets, and if you simply want a phone that matches the Note9 for speed, then the OnePlus 6 sells for just £469. Is it as good as the Note9? No, but it's sure as heck not 48% worse.

Most damningly of all, though, the Note9 isn't dramatically better than the Note8 – a phone that has been subject to traditional Samsung price depreciation and can now be bought for around £500 if you shop around.

Those looking nervously at their bank balances would do well to consider any of those options. For those who want the best of the best, though, it's right here. **ALAN MARTIN**

SPECIFICATIONS

Octa-core 2.7GHz/1.8GHz Exynos 9810 SoC ● 6GB RAM ● Mali-G72 MP18 graphics ● 6.4in AMOLED screen, 1,440 x 2,960 resolution ● 128GB storage ● dual SIM/microSD slot ● IP68 rating ● 12MP/12MP rear camera ● 8MP front camera ● 802.11ac Wi-Fi ● Bluetooth 5 ● NFC ● USB-C connector ● 4,000mAh battery ● stylus ● Android 8.1 ● 76.4 x 8.8 x 162mm (WDH) ● 201g ● 1yr warranty

How we test

Laptops and PCs

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

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

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

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

Screen quality

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

We also measure Delta E, which gives a guide as to how accurately the panel displays a colour. Anything under 1 is excellent and likely to be difficult for the human eye to distinguish; 1–2 is still strong; above this suggests a panel that you shouldn't trust for colour-accurate photo editing.
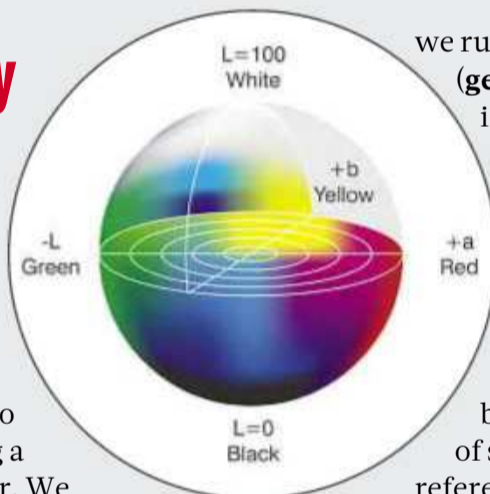
we run Geekbench 4 (**geekbench.com**). This is a good test of the processor and memory in particular, and includes both a test for single-core and multi-core performance. See below for a selection of scores to provide a reference of what's good… and what's not so good.

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

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

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

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

Geekbench 4, multicore

Apple iPhone X	10,390
Samsung Galaxy S8	8,804
Huawei P20 Pro	6,806
OnePlus 5T	6,658
LG G6	4,137
Honor 7X	3,457

Phones and tablets

We run a selection of publicly available benchmarks on all the phones and tablets we test. First,
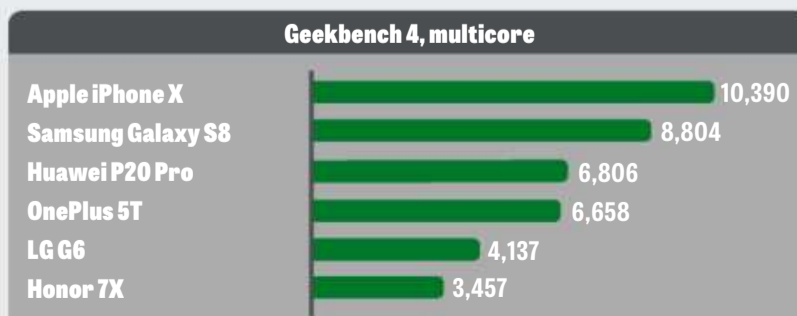
What our awards mean

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

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

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

The pcpro.link

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SCAN

Apple iPhone Xs Max

Apple's biggest phone yet is an absolute corker, but it's best if you ignore the price

PC PRO RECOMMENDED

PRICE 64GB, £916 (£1,099 inc VAT) from apple.com/uk

Forget its new features, its camera and its performance. Forget that this is the best phone Apple has ever produced. First, let's cover the topic everyone wants to talk about: the price. Buy the iPhone Xs or Xs Max and you'll be loved by the Apple accountants and directly contributing to its stupendous profit, because by every objective measure it's overpriced.

Even by modern standards, the cheapest version of the iPhone Xs Max is uncomfortably expensive: £1,099 for the model that comes with 64GB of storage and that price then rises to £1,249 and £1,449 for the 256GB and 512GB models.

Common sense
However, for many, the price will be a non-issue. For a lot of people, regardless of

whether they should make the sensible decision and move to Android, a new smartphone simply means a new iPhone. And that's why, having addressed the elephant in the room, I'm going to sidestep its trunk, steer clear of its tusks and step quietly outside.

The easiest way to think about the Apple iPhone Xs Max is to conjure a picture of the iPhone X in your mind – and then add a centimetre or so. If you're upgrading from an iPhone 8 Plus, it's roughly the same size but with a bigger, front-filling screen.

To be precise, the iPhone Xs (pronounced "ten-s") has a 6.5in display when measured from corner to corner. It measures 77 x 7.7 x 158mm, weighs 208g, runs iOS 12 and features improvements to the construction of the phone, the cameras, the

ABOVE The design isn't revolutionary, but the new gold colour gives the Xs Max a classy look

LEFT Sadly, the inelegant notch still dominates the top of the phone, but the OLED display is stunning

waterproofing and performance. It's the biggest and fastest iPhone yet.

Too big? Then you can choose the 5.8in iPhone Xs for £999, or wait for the £749 iPhone XR (due on sale in late October) with its more basic screen and camera.

Tweaked design
Don't expect much difference in design compared to the iPhone X. The iPhone Xs Max comes in a new, slightly refined gold colour that's best described as "foundation-beige", and it has a stainless-steel, gold-coloured chrome band running around the outside. I quite like the new colour; it's pretty and stylish but in an understated way. More Chanel than Jean-Paul Gaultier.

The volume buttons and do-not-disturb switch are still located on the left edge of the phone and the power button on the right. And there's still no 3.5mm headphone jack – Apple says the space saved by removing it is far too valuable to go back – and it's flanked bt two of rows of perforations that hide one of the phone's two stereo speakers. The other speaker sits behind the phone's earpiece.

At the rear, the phone's slightly protruding dual-camera module perches in the top-left corner, with the quad-LED True Tone flash flanked by the twin lenses of the 12-megapixel camera. On the front, the screen fills most of the front panel, with a broad notch eating into the top of the screen. It's a shame Apple couldn't find a way around this rather inelegant solution, but it seems we're stuck with it for now.

A handful of the design changes won't be immediately obvious, even on careful inspection. For instance, Apple says the chemical composition of the glass is improved and is currently the "most durable glass in the industry". Apple doesn't say – beyond the fact that it works with Corning to produce it – what type of glass this is, but anything that makes a phone more scratch- and breakage-resistant is good news.

Apple is more specific about the phone's dust- and water-resistance rating, which improves from IP67 to IP68 this year. The phone should now survive immersion to a maximum depth of 2m in fresh water for up to 30 minutes, which is 1m deeper than last year. More than this, Apple is now comfortable enough with the waterproofing to state that it will also shrug off a dousing in coffee, tea or even "soda".

You're also getting better speakers than on the iPhone X, with noticeably more volume and a wider soundstage; nice for the odd occasion when you've forgotten your headphones or don't have access to a Bluetooth speaker. For the first time in an iPhone, there's also dual-SIM capability thanks to the fact that you can add an eSIM to the phone's regular, physical nano-SIM card. And the phone has four microphones for positional stereo audio recording.

Brighter display

There are plenty of new features to get your teeth stuck into, then, but the screen is not one of them – aside from its bigger size of course. I can see why. After all, this is only the second year Apple has used OLED technology in its smartphones and it's tough to improve when the quality of its first effort was so good.

So, to the numbers: the iPhone Xs Max's 6.5in screen has a resolution of 1,242 x 2,688 and a pixel density of 458ppi. It peaks at 628cd/m², far brighter than the iPhone X, which could reach only 502cd/m². That's about the only significant improvement, though.

There's still support for HDR10 and Dolby Vision, meaning movies and TV shows supporting those standards look spectacular. Colour reproduction is excellent, with superb colour accuracy and sRGB colour coverage at 92.6%. Plus you still get Apple's wonderful True Tone screen, which monitors the colour temperature of the ambient light and adjusts the screen's white point to match, thus making it less of a chore for your eyes to re-adjust when you pull them away from the screen for a moment or two.

Faster than ever

So far it's been a case of "nothing to see here" with the iPhone Xs Max (if you ignore the extra size and price). When it comes to performance, however, that's absolutely not the case. That's because the A12 Bionic processor powering the phone is the first smartphone chip to go on sale that's built with a 7nm manufacturing process.

This means Apple has squeezed more transistors into the same space as its previous chip. That typically leads to faster speeds and more efficient running. The latter is the most interesting thing here, and contributes to significantly better battery life on the Xs Max than the X.

Having said that, there's nothing outlandish about the stamina of the iPhone Xs Max. In our video-rundown tests, conducted with the screen set to 170cd/m², it beat the iPhone 8 Plus, but not by much, and lasted about the same length of time as the Huawei P20 Pro (*see the graphs on p53*).

Speed-wise, there are no surprises. The iPhone Xs Max is a beast of a phone and is faster than any other smartphone you can buy. The quad-core GPU, octa-core "neural engine" and 7nm, six-core A12 chip all work together to deliver a phone that feels instantaneously responsive and that beats all comers in the benchmarks.

BELOW Larger pixels in the rear camera's sensor mean it performs better in poor light

" Speed-wise, there are no surprises – the iPhone Xs Max is a beast of a phone and is faster than any other smartphone you can buy"

BELOW The camera can capture gorgeous, stabilised 4K video footage at 60fps

The one disappointment is that game playback is limited to 60 frames per second due to the 60Hz refresh rate of the display. Despite much excitement at the mention of "120Hz" during the Apple press event, it turns out it was referring to the *touch* sample rate of the touchscreen rather than the refresh rate of the pixels on the screen. The Razer Phone remains the only smartphone with a 120Hz display.

Camera boost

It's a similarly impressive story with the cameras. The sensor for the main camera at the rear now has larger pixels (up from 1.22um to 1.4um here), which enhances its abilities in poor light, with the software having to work less hard to produce images and videos that are clean and sharp.

The rest of the Xs Max's camera hardware looks the same as last year. The resolution of both rear cameras is 12-megapixels, the apertures are f/1.8 on the main camera and f/2.4 on the 2x telephoto camera and the equivalent focal lengths remain at 28mm and 52mm. There's still optical image stabilisation (OIS) and phase-detect autofocus on both rear cameras and, at the front, the True Depth camera remains a seven-megapixel, f/2.2 unit with an equivalent focal length of 32mm.

Most of the headline improvements come courtesy of software and the A12 Bionic's beefed-up image signal processor (ISP), with Apple giving its computational photography engine a boost. The main improvement here is "Smart HDR". This doubles the

number of frames captured from four to eight (four underexposed, four overexposed) when you hit the shutter button, knitting them together to produce a photo with better balance between areas of shadow and light.

There's also greater dynamic range in video capture, video stabilisation has been added to the front camera for the first time and, in Portrait mode, it's now possible to adjust the intensity of the bokeh effect. Once you've captured your portrait photo, just hit Edit and you'll be presented with a dial you can drag to increase or decrease the blur.

How does this translate to quality in the real world? For stills, there is an improvement over the iPhone X, not only in low light, but across the board. Images are sharper, have less noise and more contrast, and the camera captures more subtle details than the X can. I'm also pleased to see the iPhone Xs Max's photographs look more natural than the photographs from the iPhone X.

It can't compete with the sheer detail the Huawei P20 Pro's 40-megapixel sensor, nor can it beat that phone's 3x and 5x zoom for capturing close-up detail, but its portrait mode is superior.

And it romps away for video quality. It's capable of capturing stabilised 4K footage at 60fps with greater dynamic range, smoothness and noticeably better detail than the iPhone X, but I was particularly impressed with how smoothly the Xs Max's camera adapts from bright to dark scenes.

As ever, Apple's stabilisation is incredible, and in combination with the improved quality, the results are simply stunning. It's really no overstatement to say this is the best video camera on a smartphone and a long way ahead of the rest. In fact, taken in combination with excellent but not-quite-class-leading stills quality, the iPhone Xs Max's camera is, on balance, the best all-round camera in the market.

■ Best ever

This is the fastest and biggest iPhone ever. The cameras are excellent, particularly for video, and the battery life is great. Again, it's not best in class, but it's the best battery life in an iPhone for a long, long while.

Indeed, of the iPhone XR, iPhone Xs and iPhone Xs Max, this is the model I would choose. That's mainly because of the size of the screen. I'm now used to using a phone with a 6in-plus screen and don't want to go back. Furthermore, it's a brilliant device to watch Netflix on, with support for HDR10 and exceptionally high peak brightness.

Is it worth the money? That's 100% down to you. There are plenty of other smartphones that are better in some respects than the iPhone Xs Max and cheaper. Just look at the Galaxy Note9 on p50. There are smartphones that have better cameras, longer battery life, more interesting design and more innovative features.

But buying a smartphone is about more than facts and figures. The iPhone Xs Max may be the most expensive mainstream phone money can buy, and I don't think it justifies its price. However, it's the best phone Apple has ever made and a device you'll still love to look at months after you've paid the initial bill.
JONATHAN BRAY

SPECIFICATIONS
Six-core Apple A12 Bionic processor ● 4GB RAM ● Mali-G72 MP18 graphics ● 6.5in AMOLED screen, 1,242 x 2,688 resolution ● 64GB storage ● IP68 rating ● 12MP/12MP rear camera ● 7MP front camera ● 802.11ac Wi-Fi ● Bluetooth 5 ● NFC ● Lightning connector ● 3,174mAh battery ● iOS 12 ● 77.4 x 7.7 x 157.5mm (WDH) ● 208g ● 1yr warranty

LEFT ARKit 2 allows developers to put together more immersive AR experiences

ABOVE iOS 12 brings four new Animoji and the divisive "Screen Time" tool

BELOW The price – and size – may be huge, but the Xs Max is Apple's best phone yet

What's new in iOS 12

A ton of new features arrived with the new iPhone Xs Max courtesy of the iOS 12 update. These include support for FaceTime conversations with 32 people (yes, 32) at once, four new Animoji and the arrival of ARKit 2 that allows developers to create – supposedly – even more "immersive" AR experiences. But there are a couple of more notable inclusions, too.

The first is that the iPhone's face-unlock feature can now recognise multiple faces. That's very handy if you find your main "face" data doesn't work when you're wearing sunglasses, a favourite hat or a motorcycle helmet, for instance.

Then there's the controversial "Screen Time". I thought I'd instantly disable this, mainly because I don't really want to be reminded how much time I spend staring at my smartphone screen on a daily basis. In reality, I've found its breakdown of how I use my smartphone absolutely fascinating and, weirdly, reassuring. It turns out that I'm not quite as much of an obsessive as I thought I was.

Given the exceptional quality of iPhone cameras, iOS 12 updates to photo sharing and photo search are welcome, too. There's a For You tab, which curates the best moments from your photo library and suggests sharing the snaps with the people in them. Searching for pictures has also become easier. Before you even start typing, there's a suggested page of recent events, people and places. You can also refine results by adding multiple keywords – "art", "beaches" and so on.

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SCORE ★★★★★

PRICE £2,000 (£2,400 inc VAT)
from scan.co.uk

Is this the future of gaming? Nvidia would certainly like us to believe so, stoking the GeForce RTX hype machine with such fury that by the time cards finally landed – in mid-September – it felt like the second coming. Scan was among the first to obtain this new generation of silicon, but ever the pragmatist, preferred the RTX 2080 over the speedier RTX 2080 Ti. Why? Because it has the marked advantage of actually being available to buy.

Not that you'll bump into an RTX 2080 card in the wild for a while, as Nvidia has kept the price at a premium – typically, cards cost £800, or you can buy its Founders Edition for £749 from **nvidia.com**. Want the full-blown power of an RTX 2080 Ti, with its 20 to 30% speed boost? Then expect to pay £1,250 for a third-party card, or wait for the Founders Edition version to become available for £1,099.

Here, Scan includes an Asus card that it overclocked by 150MHz from its default speed. All of which begs one important question…

■ How fast is it?

The answer is crazy fast. While RTX 2080 cards can only outgun GTX 1080 Ti cards by a few percent, this card will generally give you 60fps-plus speeds at 4K. Drop down to 1440p and you may well decide that a 144Hz G-Sync monitor would be an excellent idea, because such frame rates are well within its capability for the majority of games.

For instance, we test gaming PCs using *Metro: Last Light* at 4K and 1440p. (If you want to replicate our tests, push quality to Very High, switch SSAA and Advanced PhysX to off, set motion blur and tesselation

to Normal, and push texture filtering to AF 16x.) This is a tough test, with the fastest score we had previously seen coming from the Scan Vengeance Ti (*see issue 287, p56*) featuring an overclocked Core i7-8086K, 16GB of RAM and GeForce Ti graphics.

That's a handy baseline, too, because the only difference here is the graphics card. At 4K, *Metro: Last Light* scored 68fps, which is 3fps higher than its predecessor. Switching to 1440p, though, produced scores of 139ps, tantalisingly close to that 144fps barrier.

It should have been a similar story in *Rise of the Tomb Raider*, but an odd bug meant that the game refused to recognise either of our 4K test monitors. Tested at 1440p and Very High, it scored a suitably scorching 143fps, which is again a minor rise on the 1080 Ti.

You'll notice a theme here: right now, you're not going to receive a major boost in frame rates. As discussed in the *GeForce RTX: what's all the fuss about?* boxout opposite, your investment is in the future – unlike financial investments, though, frame rates can only stay steady or go up.

■ Silent but deadly?

One of the things I'm most impressed about with this system compared to the Scan 3XS Vengeance Ti is how quiet it is. Yes, there's always a hum

ABOVE It might not be the flashiest chassis, but the NZXT H500 is an understated beauty

"While RTX 2080 cards can only outgun GTX 1080 Ti cards by a few percent, this card will generally give you 60fps-plus speeds at 4K"

when the Vengeance RTX is switched on, but whereas this rose a couple of uncomfortable notches with the Vengeance TI, here it's like a car moving from fifth gear to fourth. With its predecessor, it was more like a fifth gear to third.

The gear shift is reflected in greater power consumption: in idle, it consumes around 70W, but that shifted to around 400W once I started benching games. That happened to tie in with a cold morning start, so I was grateful for the radiated heat, but come the summer you might want to shift the chassis away from your legs.

Not too far away, though, because it's gorgeous to look at. Scan preconfigured the RGB lighting on the Corsair memory, Asus motherboard and Asus graphics card to be plain white, and I see no reason to change it. It's almost soothing when gazed at through the window of the NZXT H500 chassis.

There's a respectable amount of room for upgrades. The Corsair TX550M power supply is hidden neatly away, with all the cables you might need ready for action but, for now, held firmly in place by cable ties. Your upgrade options include two empty 2.5in drive bays, two DIMM sockets and a sprinkling of PCIe slots.

Those with half an eye on the virtual reality future should also note the VirtualLink USB-C connector on the graphics card. This is a standard agreed by companies such as Nvidia, AMD, Valve, Oculus and Microsoft that should mean the current tangle of cables needed to feed VR headsets become only one. It's still early days, but we need hardware that supports the standard so kudos to Nvidia for making it part of the reference design.

Naturally, the present is catered for too. Three DisplayPort 1.4a outputs mean this card can handle 8K resolutions, with good old HDMI – here in its 2.0b incarnation – ready and waiting to connect up your current monitor.

■ Everyday speed

I've so far barely mentioned the Core i7-8086K chip that forms the centre of this system, or the Corsair Hydro H100i watercooling system, but note that Scan overclocks it to a safe 5GHz
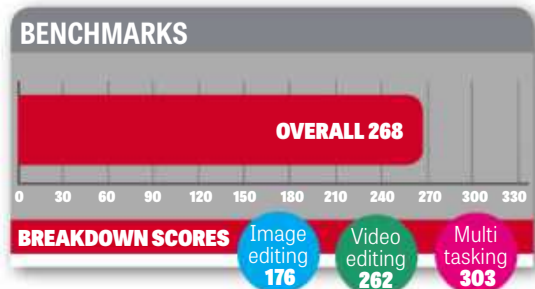
BENCHMARKS

OVERALL 268

0 30 60 90 120 150 180 210 240 270 300 330		

BREAKDOWN SCORES
Image editing **176** | Video editing **262** | Multi tasking **303**

across all six cores, as it did with the Vengeance Ti. With the same speedy 500GB Samsung 970 Evo NVMe SSD inside, and a 2TB Seagate hard disk tucked away for main storage duties, we expected a near-identical performance in our benchmarks.

It didn't quite work out that way, with a result of 268 being around 4% down on the 281 of the 1080 Ti-powered system. We're not too concerned by this drop, as it's most likely a minor driver issue (the RTX 2080 remains very new silicon), and we're confident that no one would spot this difference in practice anyway.

Of more import is what's coming over the hill. Normally we wouldn't worry about such things – there's always something new coming, and when exactly would you buy a machine if you were constantly waiting? – but, for once, it may be worth waiting a month.

Or just speaking to Scan at the time of ordering. One of its strengths is that you can customise its systems as much as you like, so once Intel has made its announcements, you can make a call whether you want to hold off or commit to this machine as specified.

For instance, if I was spending £2,400 on a PC then I would carefully consider whether it's worth spending another £300 on an upgrade to an RTX 2080 Ti card. This is likely to deliver a 20 to 30% speed boost over the RTX 2080 in most games at 4K, which could be the difference between 60fps and 45fps. Then again, when will Ti cards actually be available? Every day seems to bring more news of yet another manufacturing delay. Whether you wait or not is up to you, but one thing is certainly true: Scan has wrapped up the latest technology in a beautiful package. If you want the fastest machine on the block right now, buy the Vengeance RTX. **TIM DANTON**

LEFT Inside, the RGB lighting has been preconfigured to be plain white – and we're big fans

SPECIFICATIONS

4GHz Intel Core i7K-8086K processor overclocked to 5GHz ● Asus RoG STRIX Z370-F Gaming motherboard ● 16GB 3,000MHz Corsair Vengeance DDR4 RAM ● 8GB Nvidia GeForce GTX 2080 dual graphics ● Corsair H100i watercooling ● 500GB Samsung 970 Evo M.2 PCIe SSD ● 2TB hard disk ● Windows 10 Home ● NZXT H500 chassis ● 210 x 428 x 460mm (WDH) ● 3yr warranty (1yr on-site, 2yr RTB)

LEFT Buyer beware: you may find yourself gazing at Scan's neat internals through the side window

GeForce RTX: what's all the fuss about?

A good question. The headline feature is ray tracing, the rather brilliant technology that makes scenes more realistic (*see p128*), thanks to its advanced lighting effects. We're fans of the concept because it could make scenes look truly real, but we'll hold back our excitement for the moment. The demos look stunning, but let's wait until we see games that take advantage and try them out for ourselves.

Ray tracing isn't a nice new tickbox feature. To achieve it, Nvidia has introduced an architecture called Turing, which also supports a crucial new technology called DLSS. This stands for "deep learning super sampling", with the idea being that Nvidia will almost double frame rates (as we've seen, something that's still beneficial at 4K) with a minimal drop in quality.

Again, this needs support from developers, but judging by the few available demos, the promotional YouTube videos and what the games industry spokespeople have said on-stage at gaming conferences, they stand aligned behind Nvidia. The end result is that we should see multiple games appear in 2019 that support both DLSS and ray tracing, producing real-time scenes that look almost as good as animated Pixar films that have been rendered on hugely expensive professional workstations.
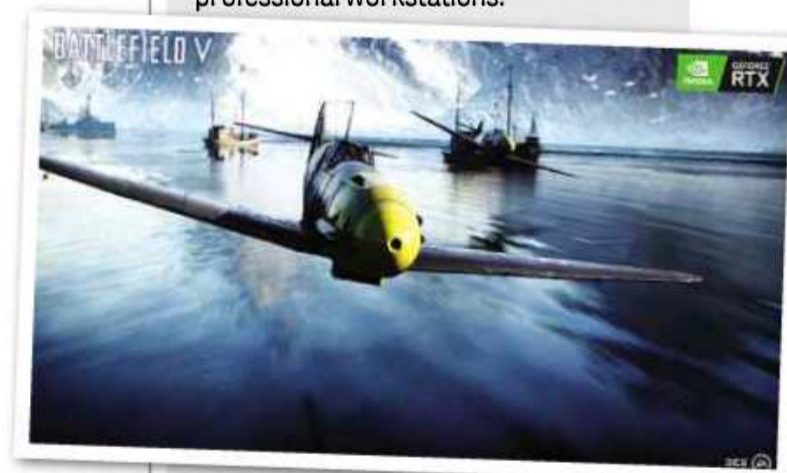
The big caveat to all this is that you will be wasting your money on an RTX card (including the RTX 2070, due out in late October) unless the games you love to play are supported. So don't rush in. Do your research first and make sure your bet on the future is based on the best available facts – and not Nvidia's hype machine.

HP Pavilion x360 14-cd0008na

A fast 14in convertible with a pretty design, but it's held back by the screen and keyboard

SCORE ★★★★☆

PRICE £583 (£699 inc VAT)
from pcpro.link/290hp

Whisper it, but budget laptops are getting better. Where you used to make a sacrifice on build quality, style and spec if you were spending less than a grand, it's now reasonable to demand all three. HP is at the forefront of this charge, with its latest addition to the Pavilion lineup an excellent exemplar.

To look at it, you might think the Pavilion x360 costs well over £1,000, with a sandblasted, metallic keyboard frame: it's not overstated, as HP's Spectre range can be, but subtle. The high-gloss black bezel and occasional chrome accents give it a premium look, even if the grey lid is a trifle dull. HP provides a literal twist, too, as that lid swivels back 360 degrees to turn the x360 into a tablet.

A big tablet, mind you. This machine weighs 1.59kg, so if you're scrawling on the screen – and note HP's Active Pen costs another £58 (**pcpro.link/290pen**) – you'll want to rest it on your lap or a table. That weight is manageable for a laptop, though, especially one like this that is mainly going to move from room to room rather than accompany a businessperson on their commute.

It's why I can forgive the mediocre battery life of 5hrs 27mins in our video rundown tests, which is with the screen set to what I would normally consider a low 170cd/m². The reason I caveat the brightness level is because, for this 14in display, that translates to around 85%: as with the HP Envy 13 (*see issue 289, p84*), HP compromises the maximum brightness.

Which is a shame, because otherwise this is a perfectly acceptable screen: sure, it can only cover 62% of the sRGB gamut and its average Delta E is 4.69, so anyone looking for colour accuracy should run for the hills, but thanks to a glossy finish, colours looks vivid. Again, though, you may not like it in an office situation: there's no evidence of clever anti-reflective coating here.

Then there's the keyboard, which clacks along in a way that your nearest and dearest won't fall in love with. I'm not a big fan of the way keys press down without any cushioning either, but at this price I don't want to be too critical. As long as you aren't typing away at a hundred words per minute, it's fine, and all the keys are sensibly laid out. I like the touchpad, too, which has a "widescreen" aspect to match the 16:9 of the 1,920 x 1,080 resolution screen.

HP makes no compromises at all to the components, with a Core i5-8250U processor, 8GB of RAM and a souped-up 256GB PCIe M.2 SSD (its sequential write speeds were 711MB/sec in AS SSD, while read speeds hit 1,240MB/sec). These pushed it to a commendable 84 in our own benchmarks, which are as fast as most people will ever need. It's less convincing for gamers, as reflected in a 10.5fps score in *Dirt: Showdown* at 720p Low settings.

There are nice design touches, too. Not just the contoured grille above the keyboard, which also contains the powerful-if-not-subtle speakers, but the fingerprint reader tucked onto the right-hand edge. There's a handy

ABOVE The Pavilion x360 has the premium, all-metal looks of more expensive rivals

"HP makes no compromises to the components, with a Core i5-8250U processor, 8GB of RAM and a souped-up 256GB PCIe M.2 SSD"

ABOVE The screen won't win any prizes for accuracy, but colours are vivid

BELOW The laptop sides feature a useful fingerprint reader – as well as a data-only USB-C port

volume rocker switch there too, along with an HDMI output, SD card reader, old-style USB-A port and new-fangled USB-C port. Note that the latter can't be used to power the HP (you'll need to pack the 292g power supply) or output video, with HP stating that it's for data only.

A second USB-A port is kept company by a 3.5mm combo headphone/mic jack on the left, with the only other physical inclusion of note being the basic HD webcam above the bezel. This doesn't support Windows Hello, so logging in will require the fingerprint reader or the stalwarts of PIN and password. If you live in a house with flaky Wi-Fi reception then also beware the 1x1 wireless chipset, which means the HP doesn't have the range or maximum download speeds of more expensive laptops with their 2x2 chips.

This pattern of "it's good, but" characterises the Pavilion x360. Overall, I do like it. However, I keep finding myself being drawn to the compromises. The truth is that I can live with them all, even the not-so-bright screen, and as long as you buy the Pavilion knowing about its shortcomings you should be happy. If you don't need its convertible trick, though, take a look at the Asus ZenBook UX410UA (*see issue 280, p68*) before you commit. **TIM DANTON**

SPECIFICATIONS

Quad-core 1.6GHz Core i5-8250U processor ● Intel UHD Graphics 620 ● 8GB RAM ● 14in IPS touchscreen display, 1,920 x 1,080 resolution ● 256GB M.2 PCIe SSD ● 1x1 802.11ac Wi-Fi ● Bluetooth 4.2 ● USB-C 3.1 (data only) ● 2 x Type-A USB 3.1 ● HDMI 1.4 ● SD card reader ● HD webcam ● 41Wh battery ● Windows 10 Home ● 324 x 224 x 19.7mm (WDH) ● 1.59kg ● 1yr limited warranty

BATTERY: video playback, 5hrs 27mins

BENCHMARKS

OVERALL 84

0 30 60 90 120 150 180 210 240 270 300 330

BREAKDOWN SCORES

Image editing	Video editing	Multi tasking
103	91	73

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Lenovo ThinkPad X1 Carbon (2018)

The sixth-gen ThinkPad X1 Carbon is a worthy business ultraportable, but you'll have to put up with some kinks

SCORE ★★★★☆

PRICE £1,564 (£1,877 inc VAT)
from uk.insight.com

This year sees the ThinkPad X1 Carbon series enter its sixth generation – and deservedly so. Few other business ultraportables have proven so consistently brilliant. There haven't been any big changes to this version, other than making the jump to eighth-generation Intel Kaby Lake chips. We tested the Core i7-8550U, non-touch Quad HD model (20KH007BUK), which sits in the upper-middle of the range.

The new ThinkPad X1 Carbon is built with a mix of carbon fibre, glass fibre, plastic and magnesium alloy. As well as giving it a pleasant soft-touch finish, this makes it impressively light at only 1.13kg. So it's a 14in laptop, with room for full-size USB and HDMI ports, but it only weighs as much as a super-slim 13in ultrabook. At 16mm, it's also rather svelte.

The ThinkPad X1 Carbon's ports are a cut above most ultraportables. Two USB 3.1 ports look after older peripherals, while there's HDMI and a USB-C 3.1 port that can be used for either data or charging, but it's the Thunderbolt 3 port that adds real flexibility. Also, hidden on the rear edge is a tiny compartment containing both a microSD slot and a micro SIM slot, which goes hand-in-hand with the integrated LTE-A receiver.

There's no Ethernet jack, but there is an Ethernet extension adapter for another, slimmer port next to the Thunderbolt 3 connector. However, the two are so close together that the adapter prevents an USB-C cable from being plugged in – an unfortunate oversight, especially if you've connected to a monitor and want to use a wired network connection at the same time. Another issue is heat. The base can get noticeably warm on light use and uncomfortably hot under heavy loads.

On a more positive note, Lenovo has updated the ThinkPad X1 Carbon's webcam with its "ThinkShutter", a fancy term for a small piece of plastic that can slide over the camera sensor, obscuring it. This is a nice win for the privacy-conscious, while there's also a fast-acting fingerprint reader on the right palm rest.

The keyboard has spacious, curved keys with plenty of travel, which makes for a comfy and quiet typing experience. In addition to the trackpad, Lenovo's signature red pointing stick makes another appearance. Oddly, after every restart, the trackpad would suffer bouts of sluggishness, with occasional delay between swiping and the cursor moving, and taps sometimes not registering as clicks. Even weirder is the fix: closing and opening the lid, sending the laptop to sleep just long enough to snap the pad out of its funk. It's not ruinous, but it is annoying.

You can equip the 14in ThinkPad X1 Carbon with either Full HD and Quad HD resolutions, as well as touch capability, but we were happy with our non-touch IPS panel running at a beautifully crisp 2,560 x 1,440. It's a massive improvement on the 2017 version, which only reached a peak brightness of 312cd/m² and covered 82% of the sRGB colour gamut. This time, brightness peaks at a searing 526.9cd/m², and sRGB coverage has shot up to a near-perfect 99%. Wide viewing angles and a high contrast ratio of 1,525:1 also contribute to the general loveliness of this screen. The only catch is accuracy: an average Delta E of 4.04 is far from ideal.

Our review unit had the same key internals as the Dell XPS 13: a quad-core Intel Core i7-8550U, 16GB of RAM (which is soldered on, preventing upgrades) and a 512GB PCIe SSD. But Dell's laptop does a better job of avoiding throttling – it scored 96 overall in our 4K application benchmarks, whereas Lenovo's scored 80. It's still not that slow by ultraportable standards, but we know the hardware is capable of better.

Battery life is middling. The ThinkPad lasted 7hrs 3mins in our video playback tests, which, again, isn't as impressive as the 10hrs 7mins achieved by the XPS 13.

This latest ThinkPad X1 Carbon is a more qualified success than its recent predecessors: it's hot, expensive and not as powerful as the XPS 13, despite having the same processor and RAM. And yet, it's still remarkably endearing. **JAMES ARCHER**

> **"It's a 14in laptop, with room for full-size USB and HDMI ports, but it only weighs as much as a super-slim 13in ultrabook"**

ABOVE At only 1.13kg the ThinkPad X1 Carbon is ideal for working on the move

ABOVE Lenovo's "ThinkShutter" slides over the webcam to give you peace of mind

BELOW Despite being a mere 16mm thick, the ThinkPad boasts an impressive array of ports

SPECIFICATIONS Quad-core 1.8GHz Intel Core i7-8550U processor ● Intel UHD Graphics 620 ● 16GB RAM ● 14in IPS display, 2,560 x 1,440 resolution ● 512GB M.2 PCIe SSD ● 2x2 802.11ac Wi-Fi ● Bluetooth 4.1 ● Thunderbolt 3 ● USB-C 3.1 ● 2 x Type-A USB 3.1 ● HDMI 2 ● microSD card reader ● micro SIM ● HD webcam ● 41Wh battery ● Windows 10 Pro ● 324 x 217 x 16mm (WDH) ● 1.13kg ● 3yr on-site warranty

BATTERY: video playback, 7hrs 3mins

BENCHMARKS

OVERALL 80

0 30 60 90 120 150 180 210 240 270 300 330

BREAKDOWN SCORES
Image editing 85
Video editing 67
Multi tasking 80
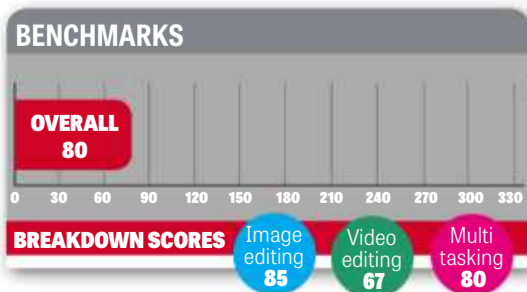
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REQUIRES Windows 7 or later; 30MB hard drive space; online registration

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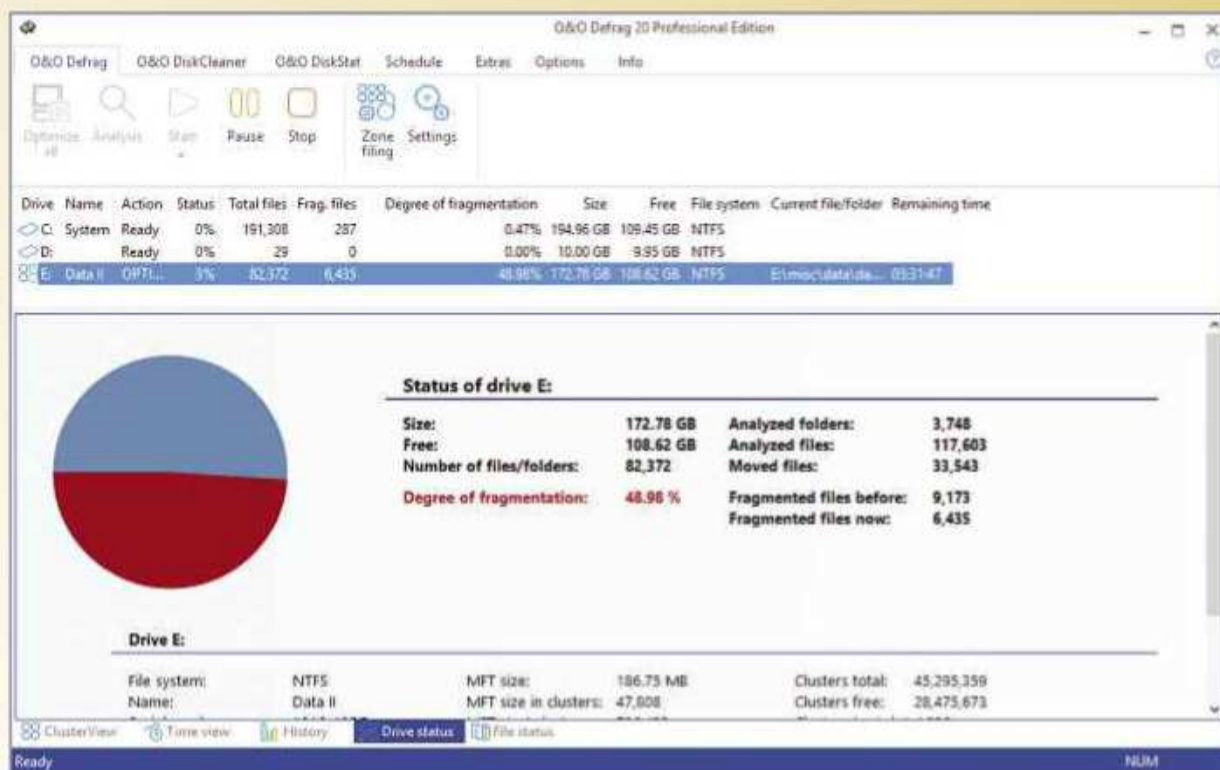
REQUIRES Windows Vista or later; 90MB hard drive space; online registration

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REQUIRES Windows 7 or later; 40MB hard drive space; online registration

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REQUIRES Windows XP or later; 10MB hard drive space; online registration

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Iolo System Mechanic 17.5

■ Full product **worth £20**
■ iolo.com

REQUIRES Windows XP or later; 50MB 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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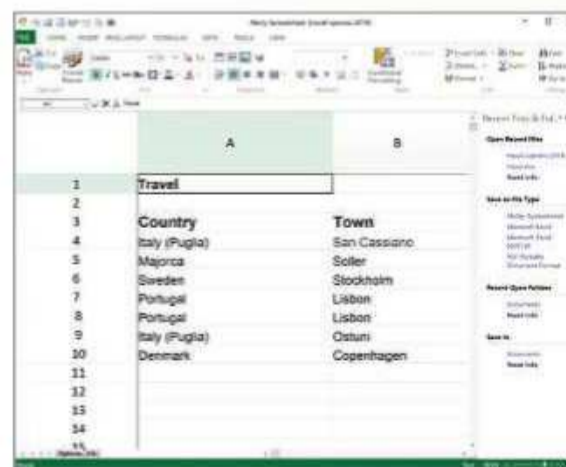
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REQUIRES Windows XP or later; 150MB hard drive space; online registration

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Google Home Max

The Google Home Max is a beast of a smart speaker, but far more expensive than it should be

SCORE ★★★★☆

PRICE £332 (£399 inc VAT)
from store.google.com

Big brother to the Google Home and Google Home Mini, the Google Home Max has taken almost a year to reach shops in the UK – so has it been worth the wait? It's certainly bigger, louder and much more expensive than its smaller siblings. Google hopes this hits the spot for customers who want a smart speaker, but don't want to compromise on sound quality.

The company's ambitions arguably go further than this: it wants the Max to be the smart speaker people use as their main home hi-fi speaker. It's not designed as portable speaker – there is no battery inside and it's not waterproof – but it's flexible in terms of how you connect to it, with voice control, Wi-Fi support, Bluetooth and a 3.5mm analogue jack.

■ Smart design

Build and design quality is every bit as good as you would expect for this sort of money. It's solidly put together and weighs a substantial 5.3kg. Give it a rap with your knuckles and it sounds satisfyingly tight and resonance-free, just like a top-quality speaker should.

In terms of appearance, the Max is pleasingly familiar – as if Google shot a Home Mini with a grow gun and flattened the sides – although not everyone will love its cutesy looks. Grey cloth covers the drivers, here facing forwards instead of up, while the rest of the body is made of tough, soft-touch plastic.

Four circular LED dots lurk beneath the cloth grille on the front of the speaker, indicating various statuses; they light up when the speaker is listening to you and show volume levels when you make adjustments. A touch-sensitive area on top of the speaker allows you to do just that, sliding your finger right and left to increase or reduce the volume and tapping it to pause and play.

At the rear, meanwhile, is a switch for muting the microphone and a small cutout hosting the speaker's various connections: a figure-of-eight mains port, a 3.5mm audio input and a USB-C socket. The latter is used not for audio, disappointingly, but for connecting an Ethernet adapter (not included) in case you're having problems with Wi-Fi connectivity.

To stream music using Bluetooth, you must first put the speaker into pairing mode via the Google Home app, which is a bit of a faff, and there's no support for the more advanced Bluetooth codec, aptX.

■ Smart features

Google Home Max's digital assistant features work much the same as on the Google Home and Home Mini. Via Google Assistant, you can use your voice to ask the Home Max to play music and radio; set up timers, reminders and calendar entries; and ask questions about the weather and various other trivia.

ABOVE The four LEDs light up when the speaker is listening and when you adjust the volume

"It's punchy, it's not overly bassy, and there's plenty of control at the low end – it's a great speaker for listening to Kraftwerk"

LEFT The Google Home Max's soft-touch plastic body feels sturdy and well-built

There's nothing new here, but Google Assistant remains an excellent resource. It's generally better than Amazon's Alexa or Apple's Siri at recognising the things you ask, and it's much more likely to give you a cogent response to a random trivia question. Assistant on the Home Max supports up to five different voices, meaning it can recognise who is asking it to play music and tailor recommendations accordingly. It's worth bearing in mind that Amazon's Alexa remains more widely supported by hardware manufacturers, however.

Google Assistant is pretty good, though, when it comes to the number of music and radio services it supports. It's on par with Alexa and beats the Apple HomePod roundly. With Apple's smart speaker, you're pretty much restricted to Apple Music if you want to search for music or podcasts by voice, while there's very little support for radio.

The Home Max supports voice search, control and playback via Google Play Music, Spotify (Premium and free), Deezer and YouTube Premium. Radio playback comes via TuneIn and iHeartRadio, while podcasts are played via Google's own library. There's no synchronisation between progress on the speaker and your phone, though, which is slightly annoying.

The Home Max isn't so hot on far-field voice detection. The speaker uses an array of six microphones to pick up voice instructions, and it's reasonably good at doing so across the room with moderate background noise. However, I found that I needed to raise my voice or any of the Echo speakers I've tested. With the music turned up beyond 60%, you

practically have to shout "OK Google" to get a response.

That's not the only thing the Max uses its microphones for, though. As with the Apple HomePod, Google Home Max uses them to sense its surroundings and adapt the sound output automatically. Called Smart Sound, the idea is to avoid the boomy bass caused by placing speakers close to walls and in corners, or the lean, bass-light sound you can get from a speaker in a large, open space.

With the HomePod, you can clearly hear this working as you move the speaker from location to location, but with the Google Home Max I couldn't hear any noticeable change. When I moved the speaker deep into a corner, the bass sounded stronger than with the speaker out in the open, although not overly so. Google's adaptations, assuming they're happening at all, are clearly more subtle than Apple's.

■ Sound quality

So, how does the Google Home Max sound? In a word: loud. This is one beefy speaker, capable of filling medium to large domestic spaces and

ABOVE At the rear, there's a USB-C port – but it can't be used for audio

pumping up the volume sufficiently to kick out house-party levels of volume without distorting.

Behind the grille at the front is a pair of 4.5in, high-excursion woofers accompanied by a pair of tweeters. This combination provides controlled, deep bass and a wonderfully rich lower-mid range. I like the sound this speaker produces. It's punchy, it's not overly bassy, and there's plenty of control at the low end. It's a great speaker for listening to Kraftwerk, which, in my book, can only be a very good thing.

Where the Home Max falls short, at least to my ears, is in the higher frequencies. Live tracks, where I'd expect to hear some kind of

atmosphere wrapping around the music, lack the presence you deserve from a speaker this expensive.

Whether you have the speaker laid on its side or up on end, it also suffers from a disturbing lack of width in the soundstage. Close your eyes and all sound appears to emanate from a narrow channel directly in front of you. In comparison, the Apple HomePod has a far wider, deeper soundstage that, while far from perfect, is more engaging and fun to listen to at quieter volume levels.

Things do improve if you add a second Home Max and set them up in stereo pairing mode – which is remarkably straightforward to do within the Google Home app – but that ups the price to a steep £800. For that sort of money, I would be thinking about buying a pair of decent active speakers and pairing with a Google Home Mini for smart features instead.

■ Sound decision

Despite these weaknesses, the Google Home Max is the best all-rounder of the smart speakers

produced by the big three brands: Google, Amazon and Apple. It's the most flexible in terms of its connectivity; its digital assistant works extremely effectively; and there's a good balance between the music services and devices it supports and its sound quality.

The Home Max is a great product, no doubt, but the problem here is the high price. At £400, it's also far and away the most expensive of the big three's smart speakers and Google doesn't do enough to justify that premium. **JONATHAN BRAY**

SPECIFICATIONS
2 x 114mm high-excursion woofers ● 2 x 18mm custom tweeters ● six-microphone array ● ambient light sensor ● orientation sensor ● 802.11ac Wi-Fi ● Bluetooth 4.2 ● 337 x 190 x 154mm (WDH) ● 5.3kg ● limited warranty

BenQ EX3203R

A tempting monitor if you want to enter the world of curved screens, HDR gaming and 144Hz refresh rates

SCORE ★★★★☆

PRICE £391 (£469 inc VAT)
from pcpro.link/290benq

We saw from last month's *PC Pro* Excellence Awards that BenQ is one of the most highly rated monitor brands, with 96% of its customers happy to buy from the company again. Indeed, it topped the charts for value for money, and you only need look at the price of the EX3203R to realise why: a 32in curved monitor, complete with 144Hz refresh rates and HDR support, is superb value at this price.

There are a couple of caveats. You don't get integrated speakers, just a 3.5mm headphone jack, and owners of Nvidia graphics cards should look away now – it supports AMD FreeSync 2, so you'll need to live with the overhead of VSync or suffer the occasional tear. If you consider yourself a serious gamer also note that its similarly priced HDR rival – the 27in Samsung CHG70 – has a 1ms response time to the BenQ's 4ms.

Most of us, though, will simply be distracted by the richness of HDR gaming. Initially, at least. I put the EX3203R to the test with *Forza Motorsport 7* on the Scan 3XS Vengeance RTX (*see p60*) and it looked suitably vivid.

Was it so great that I'll demand my next monitor must support HDR? In all honesty, no. Once you start playing games, it's the on-screen action that should grab your attention, and so far I've been more impressed by the added realism of ray tracing – admittedly, in demos, not real games – than HDR.

It doesn't help that Windows 10 looks washed out once you enable HDR, meaning I found myself only switching it on when it was time to play. It would have been nice if BenQ had made this easier, but it takes four button presses on the menu to switch between Standard mode and HDR. And then you have to activate it in Windows 10. That said, if you have this monitor hooked up to a PlayStation and a Windows PC, it's clever enough to remember which is the preferred mode.

There are plenty of inputs to choose from, too, with two HDMI 2 ports, a DisplayPort and a USB-C port. BenQ generously includes a cable for all of them in the box, but don't expect the USB-C to deliver power as well as a video signal – you'll need the bulky external power supply for that.

This isn't the world's most flexible stand either, with no pivot mode, a fixed stand (so no rotation) and the only flexibility coming via -5°/20° tilt and a height adjustment of 60mm. And if you're hoping to mount this monitor on an arm or wall then note that it doesn't come with the usual VESA fittings – BenQ sells a VESA Transfer Kit for £33 – but that's the price you pay for a sleek, curved screen.

Let's not forget that you're buying a 32in monitor with a 1440p resolution for this money – the equivalent from Samsung costs a similar amount but only offers a 27in diagonal. Those extra five inches offer an obvious advantage in games, and it's here where the curved design comes into its own. I also enjoyed having a curved display in Windows, but here those extra inches are arguably a disadvantage because they lead to a lower pixel

ABOVE The BenQ's colours are both rich and vivid when playing games

ABOVE The monitor sports a USB-C, DisplayPort and two HDMI 2 ports

> **"When I switched from Standard mode to sRGB, the BenQ EX3203R covered an excellent 95% of the sRGB gamut"**

LEFT Not the most flexible stand, but at least it looks good

density. In day-to-day use, that meant text looked jagged on occasion, and it didn't help that I switched to the BenQ straight from a 32in 4K monitor – to be precise, the Iiyama ProLite X3272UHS-B1 (*see issue 288, p72*), which costs £100 less.

I can't fault the quality of this panel, however. While BenQ only boasts about its movie-friendly DCI-P3 gamut coverage in its marketing materials – it claims 90% and it scored a creditable 88% in our tests – when I switched from Standard mode to sRGB it covered an excellent 95% of the sRGB gamut. What's more, its average Delta E was 1.41, so combine those two figures together and you have a colour-accurate panel. It's bright too, measuring 453cd/m² at its peak, with a 2,952:1 contrast ratio.

So where does this leave the EX3203R? While it falls just short of a Recommended award, it remains a great choice if you're looking for a monitor with its particular features: support for HDR and FreeSync 2, together with that 144Hz refresh rate, make it a terrific partner for an AMD-powered gaming PC. **TIM DANTON**

SPECIFICATIONS
31.5in 2,560 x 1,440 VA panel ● 8-bit panel ● 1440p at 144Hz ● 4ms response time ● HDR ● FreeSync 2 ● DisplayPort 1.4 ● 2 x HDMI 2 ● USB-C ● headphone jack ● -5° to 20° tilt ● 713 x 224 x 536mm (WDH) ● 8.1kg ● limited warranty

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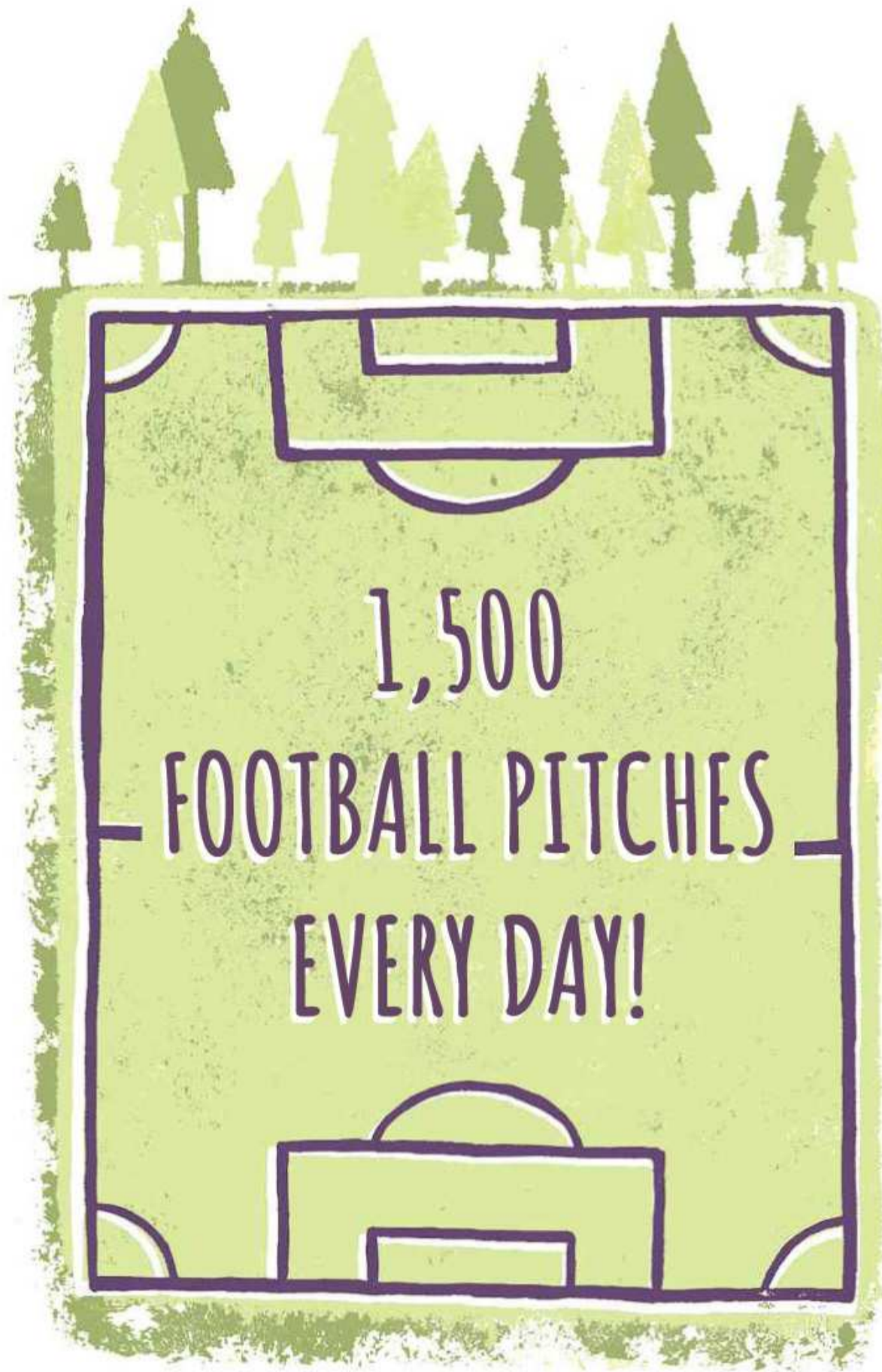
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UNFAO, Global Forest Resources Assessment 2005-2015

Two Sides is a global initiative promoting the responsible use of print and paper which, when sourced from certified or sustainably managed forests, is a uniquely powerful and natural communications medium.

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twosides.info

TWO SIDES

Android phones

Honor Play

SCORE ★★★★★
PRICE £233 (£280 inc VAT)
from hihonor.com/uk

"Crazy smart, crazy fast" is how Honor sums up the Honor Play, but there's much more to this phone than style and speed. Although it is undeniably a nice phone to look at – available in black or blue, its matte aluminium chassis with soft rounded edges gives it a premium look and feel.

The 6.3in IPS display only reinforces this impression. It reproduced 91.6% of the sRGB colour gamut on the phone's default "vibrant" colour mode and, while colours were a little too punchy for our taste, the phone's alternate "normal" display mode was much more reserved. A contrast ratio of 1,589:1 and maximum brightness of 465cd/m² is well suited to outdoor use, too.

But the big draw for the Honor Play is its flagship-beating levels of performance. Equipped with the same chipset as the £680 Huawei P20 Pro – an octa-core HiSilicon Kirin 970 processor, clocked at 2.4GHz – Geekbench found little to split the two phones when it boils down to raw speed.

The embedded Mali-G72 GPU produces playable frame rates in the latest Android games, including demanding titles such as *PUBG Mobile* and *Asphalt 9*. Fire up those games and you'll notice a feature that Honor calls "scenario-based shocks". This vibrates the phone depending on different scenarios, such as the explosion of a nearby grenade or revving the engine on your sports car.

You could be playing a game for a good chunk of time on a single charge, too. The Play reached 13hrs 9mins in our continuous video playback test, which places it in the middle of the battery life pack.

Honor pairs a 16-megapixel f/2.2 camera with a depth-sensing 2-megapixel f/2.4 camera to improve fancy bokeh-effect shots, while the main sensor adds detail and colour information. Shots in good light include plenty of detail and accurate colour reproduction, but the narrow aperture means photos suffer in lower light.

This disappointment aside, the Honor Play is a brilliant mid-range phone. Why pay more?

KEY SPECS & RESULTS Octa-core 2.4GHz/1.8GHz HiSilicon Kirin 970 ● 4GB RAM ● 64GB storage ● 6.3in 1,080 x 2,340 display ● Android 8.1 ● 16MP/2MP rear camera ● 16MP front camera ● 158 x 7.5 x 74mm (WDH) ● 176g ● Geekbench scores 1,868/6,542 ● Manhattan 3 off-screen 47fps ● 13hrs 9mins battery life

Motorola Moto E5 Plus

SCORE ★★★★★
PRICE £124 (£149 inc VAT)
from pcpro.link/290e5plus

Motorola – a Lenovo brand – proved itself the king of budget handsets with the £220 Moto G6 (*see issue 286, p70*), so why confuse things with this cheaper version?

It even looks nice, with a glossy plastic chassis complete with rear-mounted fingerprint reader. The 6in screen is protected by a layer of Corning Gorilla Glass, for added resilience against drops and scrapes, and the 5,000mAh battery – which helped it to a staggering 23hrs 2mins in our battery-life tests – only pushes its weight to 197g. The only obvious sacrifice is that it's chunky at 9.35mm.

One major difference between the E5 Plus and the G6 is that the phone is charged via micro-USB instead of USB-C, which limits the speed at which the battery is replenished.

As for the screen, the E5 Plus is 720 x 1,440 in resolution and employs an IPS panel. This is the first time Motorola has used an 18:9 all-display handset at such a low price, and it looks good. A pixel density of 268ppi is sharp enough to satisfy the most exacting eyes, and peak brightness hits a sunlight-friendly 511cd/m².

Even the internal specifications are generous for the price. Inside, Qualcomm's 1.4GHz quad-core Snapdragon 425 processor and 2GB of RAM helped it score 1,848 in Geekbench 4's multicore test to the 3,920 of the Moto G6. While 16GB of storage isn't great, this can be expanded by up to 256GB with a microSD card. Its gaming capabilities are mediocre at best, though, so expect frequent frame drops when running intensive titles such as *Asphalt 9*.

There's no Moto G6-like dual-camera arrangement; you'll have to make do with a single 12-megapixel unit with an aperture of f/2.0. It also has none of the G6's landmark recognition or depth editing skills. But, the quality of the photos are stunning. In low light, the Moto E5 Plus achieves the perfect balance of grain and noise suppression, with the camera capturing an excellent level of detail and accurate colours.

However, it matters little how quick the Moto E5 Plus is, how good its camera, or its limited feature count. What really distinguishes it is that huge 5,000mAh battery.

KEY SPECS & RESULTS Quad-core 1.4GHz Qualcomm Snapdragon 425 ● 3GB RAM ● 16GB storage ● 6in 720 x 1,440 display ● Android 8 ● 12MP rear camera ● 5MP front camera ● 161 x 9.4 x 75mm (WDH) ● 197g ● Geekbench scores 654/1,848 ● Manhattan 3 off-screen 3fps ● 23hrs 2mins battery life

> "The Honor Play has flagship-beating levels of performance, as it's based on the same chip as the £680 P20 Pro"

shootout

Autumn 2018 has seen a slew of budget Android phones hit shelves. **Tom Bruce, Christopher Minasians** and **Nathan Spendelow** deliver their verdicts

Motorola Moto E5 Play

SCORE ★★★★☆
PRICE £74 (£89 inc VAT)
from pcpro.link/290e5play

The Moto E5 Play has much in common with its more expensive sibling: the same Snapdragon 425 processor, the same 16GB of RAM, the same black, all-plastic design. It's more compact, though, with a 5.34in screen that has a 960 x 480 resolution. That's poor for a modern-day phone even at this price, with the year-old Vodafone Smart N8 sporting a 720p display. Nor is the screen easy on the eye. There's noticeable colour shift when tilting the phone, and it measured poorly for colour accuracy and contrast ratio in our tests.

It's also a shame that Motorola chose to provide only 1GB of RAM. Even an extra 512MB would have helped navigate Android 8 with more fluidity, with an annoying pause as you switch between apps. And, despite its name, this phone isn't cut out to play tough games. You can fire up *Candy Crush* or *Temple Run*, but forget *PUBG Mobile*.

At this point, you may be wondering how on earth it gains four stars, but there are two good reasons. The first is its battery life. It's no match for the bigger battery in the incredibly long-lasting E5 Plus, but a result of 10hrs 9mins in our video rundown test means that it should survive a day's use. And even if it doesn't, it has a secret weapon: you can swap out its battery. Add quick charging via the micro-USB socket and it's a solid choice.

The second reason is its camera, although our first impression of its talents were terrible. Fortunately, that's because we were viewing the results on the screen. On a computer display, it was a different story. Despite only having a rear 8-megapixel f/2.0 and front 5-megapixel single lens camera, the E5 Play captures plenty of light and detail. It even captures lifelike colours.

When you consider the third key factor, its price, the E5 Play suddenly starts to look like a contender. We're also fans of the forward-facing speaker and the fast fingerprint reader. If you aren't worried about taking photos then the Smart N8 is a better choice due to its superior screen, but this is still terrific value.

KEY SPECS & RESULTS Quad-core 1.4GHz Qualcomm Snapdragon 425 ● 1GB RAM ● 16GB storage ● 5.34in 480 x 960 display ● Android 8 ● 8MP rear camera ● 5MP front camera ● 148 x 9.2 x 71mm (WDH) ● 150g ● Geekbench scores 590/1,482 ● Manhattan 3 off-screen 3fps ● 10hrs 9mins battery life

Nuu Mobile G3

SCORE ★★★★☆
PRICE £167 (£200 inc VAT)
from uk.nuumobile.com

Founded in 2010, Chinese-born Nuu Mobile has worked quickly to launch an international operation with offices around the world, including the UK. It's still quite unknown, but the arrival of the superb Nuu Mobile G3 could soon change that.

This sleek, shiny beauty has a 5.7in, 720 x 1,440 IPS display, a MediaTek Helio P25 processor, 4GB RAM and 64GB of storage. The P25 nestles somewhere between the Qualcomm Snapdragon 435 and 450, and puts the G3 nearly up there with the Motorola Moto G6. It actually outperformed more expensive handsets in the GFXBench Manhattan on-screen test, with a 17fps result.

> "Nuu Mobile is still quite unknown outside of China, but the arrival of the superb G3 could soon change that"

Battery life isn't as impressive, crawling just over the nine-hour mark, and that will drop still further if you take advantage of the bright screen. It hit highs of 700cd/m², which – together with high contrast levels – helps to distract from its mediocre colour accuracy.

Selfie-snappers will enjoy the wide angle 13-megapixel front-facing camera, especially as you can allow the fingerprint sensor to serve as the shutter so you don't need to touch the screen to take a picture. The rear setup includes a 13-megapixel camera with a secondary 2-megapixel lens for depth-sensing and auto-focus. Sadly, in low-light conditions the camera struggles due to image noise. Even outdoors, in good light, photos were overexposed, with it struggling to pick up on the contrast between surfaces of a similar colour (such as bricks in a wall).

Another downside? This phone runs Android 7.1, which means a default maximum aspect ratio of 1.86:1 for all apps – so you can't take full advantage of the screen size. At least Nuu Mobile doesn't include undeletable preinstalled apps, so you get a clean home screen.

The efficient fingerprint reader is accompanied by less functional face recognition. A hilarious *The Matrix*-style graphic appears when you're scanning your face but, less amusingly, it doesn't let you enable both face and fingerprint recognition, just one or the other.

So this phone has its frustrations, but a decent spec and two-year warranty mean it remains a formidable budget handset.

KEY SPECS & RESULTS Octa-core 2.39GHz Helio P25 ● 4GB RAM ● 64GB storage ● 5.7in 720 x 1,440 display ● Android 7.1 ● 13MP/5MP rear camera ● 13MP front camera ● 153 x 9 x 70mm (WDH) ● 169g ● Geekbench scores 847/3,357 ● Manhattan 3 off-screen 10fps ● 9hrs 3mins battery life

Surface Go vs the world

We pitch Microsoft's new tablet against four iPads and ten rival Google tablets to reveal which are worthy of your investment

Whether it's catching up on emails or tweaking a PowerPoint presentation, watching your favourite box set or editing a 4K video for a client, the latest tablets can do it all. But with such a wide variety of prices and capabilities, which tablet is right for you?

To answer this question, we gathered together 15 tablets for this month's Labs – including the all-new Microsoft Surface Go, which we give an in-depth review on p80. Can it knock the iPad from its best-of-breed position?

To find out, we compared all these tablets' capabilities across a range of uses. We analysed their screen quality, tested for speed and battery life, compared them for design and usability. And, with devices ranging from the fun and colourful Amazon Fire 7 for £50 to premium devices such as the Samsung Galaxy Tab S4, we're certain there's a tablet to suit your needs and budget.

So, no matter if it's for Netflix, *Fortnite*, PowerPoint or Photoshop, read on to discover your perfect mobile companion.

CONTRIBUTOR: Gareth Odgen

Contents

7 mistakes to avoid when buying a tablet

Buy in haste, repent at leisure. It's all too easy to rush in and buy the wrong type of device, so take a moment to read our buying advice

It's tempting to rush the tablet buying decision. Many people blithely think that iPads are best, without considering whether they actually meet their needs. Instead, you should ask why you want a tablet and draw up a shortlist of criteria.

For example, are you simply looking for a device with which to browse the web and catch up with social media? Do you travel a lot and want to watch movies on the go, or in your bedroom? Are you looking for a travelling companion for business use that can handle productivity tasks, or even heavier workloads, such as video editing?

By analysing your needs and making a checklist, you'll be ideally placed to look through the models in this month's Labs test and compare them against your list. To help, we've covered the important features of modern tablets below.

1 Buy the right OS for you

The two main tablet operating systems are Apple's iOS and Google's Android, and if you've already bought into either software environment with your mobile phone, that's a major factor to consider. For example, if you have an iPhone, choosing an iPad will make it easier to share apps and data between the two different devices. The same is true for Android – sign in to your Google account and it's a simple task to update your apps and sync your cloud services so that switching between your phone and tablet becomes seamless.

Amazon's Fire OS is another option. This is a customised version of Android that surfaces Amazon's various services, such as Kindle ebooks, as well as Amazon Prime Music and Video, making them easy to access. If you subscribe to Amazon Prime, are a frequent user of Amazon Music and Video and perhaps have a few Echo devices around the home, Fire OS could make more sense than a standard Android tablet. However, Fire OS has limitations, such as forcing you to use Amazon's own app store rather than Google Play. As a
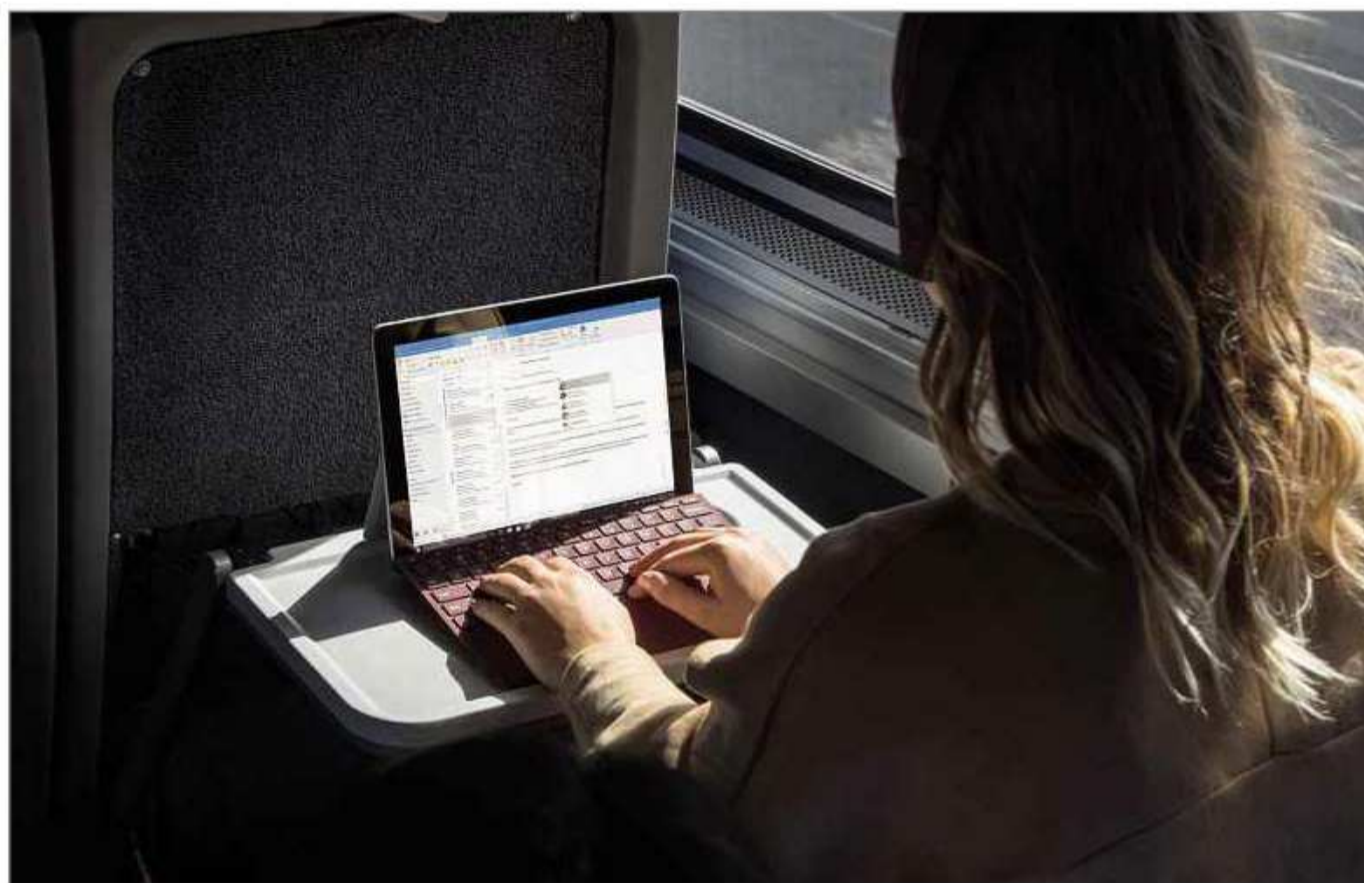
ABOVE Need to get work done on your daily commute? The Microsoft Surface Go might be the answer

BELOW If you're mainly going to use your tablet to watch films and TV, splash out on a larger display

result, Google's own apps, such as Gmail and Maps, are missing, and you're restricted to using Amazon's Silk browser too. If you really need the Google apps then it is possible to install the APK files, but this route is for more advanced users only.

Last year, these would have been your only choices, but there are now two more options. Google's Chrome OS is, so far, only found in the education-focused Chromebook Tab 10 (*see p82*), and still needs work to make it truly tablet-friendly. But support for Android apps and the desktop-class OS mean it's worth a look. Finally, there's Windows 10 in the form of the Surface Go. We explore its pros and cons in the review on p80.

2 Don't skimp on the display

When it comes to choosing a screen, again consider why you're buying the tablet in the first place. If it's more for productivity work or simple web browsing, a 4:3 screen, such as that found on the Apple iPad devices, may be better. But, if your primary intention is to play movies, consider a 16:9 or 16:10 aspect ratio instead.

Screen size is also important. The 10in or larger tablets look more cinematic, but are trickier to hold and weigh more. If being able to slip your tablet into a pocket or small bag is important, look at the 8in or smaller devices. Conversely, if you're a digital artist looking for a sketching tool then a bigger screen is better, and you need to ensure that the device supports (or includes) a stylus or pen.

Resolution matters for all tablet screens, but especially for the larger devices. The key feature to look at is the screen's pixel density, which is measured in pixels per inch (ppi). Anything below about 200ppi and small text will start to look fuzzy, though you need to drop below 150ppi for this to seriously affect readability. Apple settled on 264ppi as the optimal pixel density for super-sharp text, and we agree: more than this is fine, but it's difficult to see the difference.

Numbers don't tell you everything, however: the difference in screen quality between the premium and budget tablets is like night and day. Apple's colour-accurate 120Hz screens on the iPad Pro devices are perfect for content creation work, while Samsung's HDR-capable Super AMOLED display on the Galaxy Tab S4 is unmatched for watching or streaming videos. Again, decide what

you actually need the tablet for and choose accordingly.

3 Follow due processors

Don't worry if you haven't boned up on the various processors inside these tablets. What matters is ensuring you buy a tablet that offers the performance to meet your needs.

All the tablets in this test can handle basics such as web browsing, email and streaming video, but if you need to create your own videos then the basic chips in the budget tablets will run out of steam. Similarly, all the tablets on test could handle simple gaming, but to play the latest 3D games at their best, you'll need to step up to a premium model with a more powerful graphics chip.

To make it easy to see how each tablet in this month's test performed, we've run a set of benchmarks to provide a straightforward comparison (*see p93*). Tablets at the top of these charts can arguably replace a laptop for certain tasks, while those at the bottom should be considered as simple social media and web browsing devices. For most people, somewhere in the middle makes sense.

4 Avoid storage blues

Storage is an area where Android tablets have the Apple iPads licked, for one reason: almost all Android devices include a microSD or SD card slot. Insert one of these tiny memory cards and you can boost even a budget 8GB tablet with an additional 64GB or 128GB or storage for very little money. And, for those who need even more, stepping up to 512GB is possible (but not all tablets support larger cards).

The downside is that some SD cards are considerably slower than the tablet's on-board flash memory. That said, 50MB/sec read and write is fairly common for UHS (Ultra High Speed)

cards, and the higher-capacity SD cards, designed for professional use, can even reach 300MB/sec. While you don't need the top-speed cards, it's important to make sure the card you buy won't drag down the performance of your tablet. A Class 10 card would be the sensible minimum, but a UHS Class 1 card is a safer bet for high-res video playback; even a brand-name, 64GB UHS 1 card only costs between £20 and £30, if you shop around.

Apple, on the other hand, limits you to the storage embedded in the device, which means that if you run out of space, your only option is to delete apps or data. As such, only choose the base 32GB model iPads if you're sure you won't need more, bearing in mind that iOS already eats a sizable chunk of this space, even before you install any apps.

> "All the tablets could handle simple gaming, but to play the latest 3D games at their best, you'll need to step up to a premium model"

5 Consider the extras

If you're buying a tablet for email and social media use around the house, you needn't be overly concerned with what accessories are available, but if you want the device to double up as a mobile productivity tool then cases and accessories become important.

The standardisation of Apple devices means that a huge range of accessories are available for the iPads, from protective cases to headphones and more. The 2018 iPad and all iPad Pros support the Apple Pencil (£89) and for those looking to work on the move, Smart Keyboard accessories for the 10.5in and 12.9in iPad Pros are near-essential (if expensive).

The situation for Android tablets is more complicated. On one hand, the variety of Android-

based tablets is great for customer choice, but it makes it harder for third-party manufacturers to provide a comprehensive range of accessories. Also, the manufacturer's own accessories can often be hard to find. We found only one seller stocking the official Huawei keyboard for the MediaPad M10 Pro, for example, and couldn't find a single seller of Lenovo's Home Assistant dock.

That said, since all Android devices support Bluetooth, adding on a Bluetooth keyboard can be done cheaply.

6 Don't miss your connections

A standard feature on all but one of this month's tablets is the 3.5mm headphone jack, which means that your pair of stereo headphones will work fine, even with the iPads. Beyond this, the data connection ports vary according to price and whether you're Apple or Android.

Apple's Lightning connector will be familiar to anyone with an iPhone, and it's versatile enough to support a wide range of devices, in addition to carrying power and even video and audio data, if needed.

Cheaper or older Android tablets use the micro-USB socket for both charging and data/PC connections. This can also support USB flash drives and other peripherals, via a USB OTG (on-the-go) cable. You can pick these up from Amazon or eBay for less than a fiver. Newer Android tablets use the USB-C connector, which is considerably faster and supports Fast Charging.

7 Roam when in Rome?

If you anticipate spending a lot of time away from the home or office, check to see if your preferred tablet is also offered in a 4G (also known as LTE) variant. These are identical to the regular Wi-Fi-only models, but support cellular data connections, much the same as a smartphone. The SD card tray usually doubles as a SIM-card slot for the 4G-enabled models, so note you may not be able to have both.

You may think that 4G is an unnecessary feature, given the wide availability of Wi-Fi hotspots, but these public services are often atrocious. Plus, connecting into business services is more secure using a private 4G connection.

It's important to be clear on your need for 4G connectivity, as adding this can increase the cost of tablets. Apple, for example, asks a whopping £130 more for the 4G-enabled models. Instead, we'd be tempted to tether a phone and suck up some additional data charges.

	Acer Chromebook Tab 10	Acer Iconia One 7	Acer Iconia One 10	Amazon Fire 7	**RECOMMENDED** Amazon Fire HD 8	**LABS WINNER** Apple iPad	Apple iPad mini 4
Overall rating	★★★★☆	★★★★☆	★★★★☆	★★★★★	★★★★★	★★★★★	★★★★☆
Operating system	Chrome OS	Android 7	Android 7	Fire OS	Fire OS	iOS 10.3	iOS 10.3
Price (inc VAT)	£256 (£307)	£60 (£72)	£99 (£119)	£42 (£50)	£67 (£80)	£266 (£319)	£333 (£399)
Supplier	laptopsdirect.co.uk	pcpro.link/290acer7	pcpro.link/290acer10	pcpro.link/290fire7	pcpro.link/290fire8	apple.com/uk	apple.com/uk
Dimensions (WDH)	238 x 10 x 172mm	189 x 9.3 x 109mm	258 x 9 x 167mm	192 x 9.6 x 115mm	214 x 9.2 x 128mm	240 x 7.5 x 170mm	203 x 6.1 x 135mm
Weight	549g	270g	530g	295g	369g	469g	299g
Customer service							
Warranty	1yr RTB	1yr RTB	1yr RTB	1yr RTB	1yr RTB	1yr RTB	1yr RTB
Overall rating [2]	70%	70%	70%	81%	81%	87%	87%
Reliability rating [2]	74%	74%	74%	87%	87%	93%	93%
Core components							
Processor	Rockchip RK3399	MediaTek MT8163	MediaTek MT8167	MediaTek MT8127	MediaTek MT8163	Apple A10 Fusion	Apple A8
Clock speed	2GHz	1.3GHz	1.3GHz	1.3GHz	1.3GHz	2.34GHz	1.5GHz
Number of cores	6	4	4	4	4	4	2
Installed RAM	4GB	1GB	2GB	1GB	1.5GB	2GB	2GB
Connectivity							
Wi-Fi	802.11ac	802.11n	802.11ac	802.11n	802.11n	802.11ac	802.11ac
Bluetooth	4.1	4	4.1	4.1	4.1	4.2	4.2
GPS	✔	✔	✔	✘	✘	4G model only	4G model only
NFC	✘	✘	✘	✘	✘	✔	✔
4G option	✘	✘	✘	✘	✘	✔	✔
Physical connectors	USB-C, audio jack	micro-USB, audio jack	2 x micro-USB, audio jack, micro-HDMI	micro-USB, audio jack	micro-USB, audio jack	Lightning connector, audio jack	Lightning connector, audio jack
Display							
Screen size and type	9.7in IPS	7in IPS	10.1in IPS	7in IPS	8in IPS	9.7in IPS	7.9in IPS
Native resolution	2,048 x 1,536	1,280 x 720	1,280 x 800	1,024 x 600	1,280 x 800	2,048 x 1,536	2,048 x 1,536
Aspect ratio	4:3	16:9	8:5	4:3	8:5	4:3	4:3
Pixel density	264ppi	210ppi	149ppi	171ppi	189ppi	264ppi	324ppi
Max brightness (measured)	373cd/m²	300cd/m² [3]	298cd/m²	330cd/m²	455cd/m²	520cd/m²	450cd/m²
Contrast (measured)	1,113:1	1,000:1 [3]	1,254:1	959:1	968:1	861:1	967:1
Storage and battery							
Storage capacity (as reviewed)	32GB	16GB	32GB	8GB	16GB	32GB	128GB
Other options	✘	✘	N/A	16GB	32GB	128GB	✘
microSD slot	✔	✔	✘	✔	✔	✘	✘
Battery capacity	4,500mAh	2,780mAh	6,100mAh	2,950mAh	4,750mAh	8,827mAh	5,124mAh
Other features							
Front camera	2MP	0.3MP	2MP	640 x 480	640 x 480	1.2MP	1.2MP
Rear camera	5MP	2MP	5MP	2MP	2MP	8MP	8MP
Rear camera flash	✘	✘	✘	✘	✘	✘	✘
Notification/charge LED	✘	✘	Charge only	✘	✘	✘	✘
Stylus	✔	✘	✘	✘	✘	£89	✘
Fingerprint reader	✘	✘	✘	✘	✘	✔	✔
Physical controls	Power, volume	Power, volume, MediaMaster	Power, volume, MediaMaster	Power, volume	Power, volume	Power, volume, Home	Power, volume, Home
Colour options	Blue	Black, white	Black, white	Black, yellow, blue, red	Black, yellow, blue, red	Silver, grey, gold	Silver, grey, gold

1. Switch to Windows 10 Home for no charge via Microsoft Store. **2.** Based on *PC Pro* Excellence Awards survey, see issue 289, p30. N/A means not enough customers responded to give a reliable rating. **3.** Estimated results

	Apple iPad Pro 10.5in	Apple iPad Pro 12.9in	Huawei MediaPad M5	Huawei MediaPad M5 Pro	Lenovo Tab 4 8 Plus	Lenovo Tab 4 10 Plus	Microsoft Surface Go	Samsung Galaxy Tab S4
	RECOMMENDED		RECOMMENDED				RECOMMENDED	
Rating	★★★★★	★★★★☆	★★★★☆	★★★★☆	★★★★☆	★★★★★	★★★★☆	★★★★☆
OS	iOS 10.3	iOS 10.3	Android 8	Android 8	Android 7.1	Android 7.1	Windows 10 Home [1]	Android 8.1
Price	£516 (£619)	£641 (£769)	£249 (£299)	£407 (£488)	£223 (£267)	£269 (£323)	£424 (£509)	£423 (£507)
URL	apple.com/uk	apple.com/uk	pcpro.link/290hwm5	ebay.co.uk	pcpro.link/290tab8	pcpro.link/290tab10	pcpro.link/290surfgo	pcpro.link/290tab4
Dimensions	251 x 6.1 x 174mm	306 x 6.9 x 221mm	213 x 7.3 x 125mm	259 x 7.3 x 172mm	210 x 7 x 123mm	247 x 7 x 173mm	245 x 8.3 x 175mm	249 x 7.1 x 164mm
Weight	469g	677g	316g	498g	300g	475g	522g	482g
Warranty	1yr RTB	1yr RTB	2yr RTB	2yr RTB	1yr RTB	1yr RTB	1yr RTB	2yr RTB
	87%	87%	85%	85%	79%	79%	83%	83%
	93%	93%	91%	91%	86%	86%	88%	88%
CPU	Apple A10X Fusion	Apple A10X Fusion	Kirin 960S	Kirin 960S	Qualcomm Snapdragon 625	Qualcomm Snapdragon 625	Intel Pentium Gold 4415Y	Qualcomm Snapdragon 835
Clock	2.4GHz	2.4GHz	2.4GHz	2.4GHz	2GHz	2GHz	1.6GHz	2.35GHz / 1.9GHz
Cores	6	6	8	8	8	8	2 (4 threads)	8
RAM	4GB	4GB	4GB	4GB	4GB	4GB	8GB	4GB
Wi-Fi	802.11ac	802.11ac	802.11ac	802.11ac	802.11ac	802.11ac	802.11ac	802.11ac
Bluetooth	4.2	4.2	4.2	4.2	4.2	4.2	4.1	5.0
4G	4G model only	4G model only	4G model only	4G model only	✔	✔	✖	✔
	✔	✔	✔	✔	✖	✖	✖	✖
	✔	✔	✔	✔	✔	✔	✔	✔
Ports	Lightning connector, audio jack, Smart Connector	Lightning connector, audio jack, Smart Connector	USB-C	USB-C	USB-C, audio jack	USB-C, audio jack	USB-C, audio jack, Surface Connect	USB-C, audio jack
Display	10.5in IPS	12.9in IPS	8.4in IPS	10.8in IPS	8in IPS	10.1 IPS	10in IPS	10.5in Super AMOLED
Resolution	2,224 x 1,668	2,732 x 2,048	2,560 x 1,600	2,560 x 1,600	1,920 x 1,200	1,200 x 1,920	1,800 x 1,200	2,560 x 1,600
Aspect	4:3	4:3	16:9	16:9	16:9	16:9	3:2	16:9
PPI	264ppi	264ppi	359ppi	280ppi	283ppi	224ppi	217ppi	288ppi
Brightness	528cd/m²	512cd/m²	381cd/m²	381cd/m²	418cd/m²	430cd/m²	426cd/m²	485cd/m²
Contrast	1,504:1	1,421:1	1,482:1	1,482:1	729:1	1,230:1	1,379:1	N/A
Storage	64GB	64GB	32GB	64GB	64GB	64GB	128GB	64GB
	256GB, 512GB	256GB, 512GB	✖	✖	16GB	16GB	64GB eMMC	✖
microSD	✖	✖	✔	✔	✔	✔	✔	✔
Battery	8,134mAh	10,307mAh	5,100mAh	7,500mAh	4,850mAh	7,000mAh	3,400mAh	7,300mAh
Front camera	7MP	7MP	8MP	8MP	5MP	5MP	5MP	8MP
Rear camera	12MP	12MP	13MP	13MP	8MP	8MP	8MP	13MP
	✔	✔	✖	✖	✖	✖	✖	✔
	✖	✖	✔	✔	✔	✔	✖	✖
Stylus	£89	£89	✖	✔	✖	✖	Optional	Optional
	✔	✔	✔	✔	✔	✔	✖	Iris and face
Buttons	Power, volume, Home	Power, volume, Home	Power, volume	Power, volume	Power, volume	Power, volume	Power, volume	Power, volume
Colours	Silver, grey, gold, rose gold	Silver, grey, gold	Gold	Grey, gold	Black, white	Black, white	Silver	Black, grey

Microsoft Surface Go

A surprise hit, the Surface Go is a brilliant machine for those who seek a highly portable work companion

SCORE ★★★★☆

PRICE 128GB, £424 (£509 inc VAT)
from microsoft.co.uk

The Surface Go is a tablet like no other. Without the optional keyboard, it's a 10in Windows tablet and you might wonder why anyone would buy it. But add the keyboard and it's transformed – imagine a lazy Hollywood movie where the leading lady removes her glasses to reveal the beauty beneath and you won't be too far wrong.

Let's get some basics out of the way first. This is a 10in Windows tablet with a seventh-generation Pentium Gold 4415Y processor inside, and it comes in two configurations: one with 4GB of RAM and a 64GB eMMC drive, the other with 8GB of RAM and a 128GB SATA 3 SSD. These upgrades push the price from £379 to £509, but we wouldn't recommend the lesser specification: when you're running Windows 10, you need every ounce of performance you can get.

Even with the higher specs, it isn't going to win any awards for speed. It scored 2,050 in the single-core Geekbench 4 test, rising to 4,026 in the multicore portion. That appears embarrassingly slow when compared to Apple's iPad and iPad Pro devices, and is beaten by every comparable Android device, too. Nor did it shine in our Windows-based benchmarks, with an overall score of 20 being one of the slowest we've seen this year.

But benchmarks are just benchmarks. What we really care about is how well this machine performs in everyday use, and we have few complaints. Do web pages spring to life as quickly as on our main systems? No, but they're not far behind. Likewise, it's fine for tapping away in Word, rendering PDFs and editing the occasional photo. We wouldn't edit a movie on the Surface Go, but for daily tasks, it's fine.

■ Super screen

We should also mention that the 10in screen makes Windows feel cramped. Poking at icons on the taskbar is a little bit fiddly (you'll end up using the generously sized trackpad on the keyboard most of the time), and this is one consistent area of superiority

for iOS and Android: they're actually designed for fingers. Sure, you can tell Windows 10 to switch into Tablet mode, but it still feels like applying sticking plaster to a gaping wound.

Luckily, the screen is terrific. In terms of image quality, it's right up there with the iPad, even if it falls behind the iPad Pro and its 120Hz display. A resolution of 1,800 x 1,200 translates into a sharp 217ppi, and with a maximum brightness of 426cd/m² it's readable outside in all but the brightest conditions. We were pleasantly surprised by its colour accuracy, too: a respectable 90% sRGB gamut coverage was backed up by a superb average Delta E of 1.44.

Purely for academic reasons, we settled into a prolonged Netflix session. Here, we look for lost details in shadows and any other defects that might spoil viewing pleasure, but the Surface Go sailed through. It helps that the audio from the two speakers is surprisingly strong, with great handling of speech, but there's a 3.5mm jack built into the tablet if you want to plug in headphones.

■ Windows 10 in S mode

You might have noticed that so far we've talked about Windows 10 rather

"Luckily, the screen is terrific. In terms of image quality, it's right up there with the iPad, even if it falls behind the iPad Pro"

than Windows 10 in S mode. While the Surface Go is pre-supplied in S mode – which means you can only install apps from the Microsoft Store, adding a layer of security but also restricting you to Edge rather than Chrome – it's easy to switch to Windows 10 Home.

If other web browsers were included in S mode then we would be tempted to stick with it. We like the fundamental security it offers, even if Microsoft tells you to run antivirus software (whilst emphasising that Defender is absolutely fine). And the Microsoft Store is slowly improving, too. But if you're hoping to search for a beloved program then you'll likely be disappointed.

Note that previous versions of the Surface supplied in S mode upgraded to Windows 10 Pro, but that will be an extra £120 here. (And no, that's not a typo.)

Microsoft is also stingy with Office. Where previous Surface devices have come with a year's subscription to Office 365 Personal, here you get a 30-day trial. You can buy it for £20 as part of a bundle at time of purchase, but that still sticks in the craw.

than the ARM chips inside its rivals. To be fair to Intel, the gap is closing – the Pentium Gold 4415Y has a maximum TDP of 6W – but the Go still gets warm if you push it.

How does that translate into real-world battery life? Microsoft claims up to nine hours, but that's optimistic: it only lasted for 6hrs 44mins in our video rundown test. That looks bad compared to, say, the iPad Pro, but as ever it depends on your needs. If you're going to be in meetings all day and occasionally taking notes on the keyboard (or using the Surface Pen), that level of battery life is fine. If you're sitting in economy class and want to alternate between work and watching movies for that flight, you'll be a mite disappointed.

Should you Go or stay?

So where does this leave the Surface Go? In a unique position, which has its pluses and negatives. On the negative side, you will never get the same range of keenly priced tablet-focused apps as on iOS. The apps you can buy from Microsoft Store are mostly repackaged pieces of software designed for Windows with a mouse and keyboard, not to be used with touch.

You also can't buy the same range of third-party accessories, so you will be paying through the nose for the Surface Pen (£100), Surface Go Keyboard (£100 to £125) and Dial (£90). Likewise for power supplies, where a second Surface Go adapter costs £35.

We must also reiterate that we've reviewed the high-end model with 8GB of RAM and a 128GB SSD. We'd steer clear of the 4GB/64GB Surface Go for numerous reasons: our 128GB machine had around 110GB of usable storage, so you'd only get 45GB of space with the lesser spec. But even more annoying, it will feel much more sluggish in use – 4GB of RAM is right at the limit of Windows 10's usability, while an eMMC drive is a poor choice in a Windows machine.

With that caveat in place, there are numerous positives that earn the Surface Go *PC Pro*'s Recommended award. The keyboard is truly excellent, and turns this machine into a fully fledged laptop when you need it. The screen is among the very best, making this a great tablet for watching videos. And it's more versatile than any of its rivals – even the iPad Pro.

If you're the sort of person who has been frustrated by tablets before, because they can't do all the things you want, then we urge you to take a look at the Surface Go. It really is a tablet like no other.

The form factor

Microsoft doesn't supply the Surface Go with a keyboard, so your first choice is which one to buy. There are four different colours, with the "Signature" keyboards costing £125 and coming in blue, burgundy and silver. For most people, though, the £100 default keyboard is surely the way to go: it still looks stylish and matches the black bezels of the tablet.

It's also – to our surprise – extremely enjoyable to type on. The main keys are large enough that you shouldn't hit their neighbours by mistake, and while it is small compared to a "proper" keyboard, we had no difficulties hitting the same level of touch-typing speeds as normal. There's also a reasonable amount of travel on the keys and they don't make much noise when you type – always a positive for a machine designed for use on your travels.

Naturally, the Surface Go uses a kickstand to support the screen in laptop mode, but this is one area where its size helps: even if you have relatively short legs, you should find it possible to rest the Go on your lap and keep typing (although it's a more pleasant experience on a table). We're fans of the large, responsive touchpad,

while the backlit keys mean it's still usable in dark conditions.

Bereft of keyboard, there's nothing special about the Surface Go's design at all. At first glance, it's almost indistinguishable from an iPad, with chunky black bezels surrounding the screen. There's no Home button, though, with just a power button and volume up/down rockers on the right-hand side.

Microsoft again goes its own route with its choice of connectors. Along with the proprietary connector for the keyboard, there's a microSD slot, Surface Connect and USB-C port. Here, the USB-C port can be used as a display output or for storage, and as ever we recommend you consider stowing a third-party USB-C port replicator in your bag.

Sadly, you can't use the USB-C port to charge the Surface Go. That's a pain because it means you must sling the 170g proprietary power supply into your bag if think you'll run low on battery during your travels.

Nor should you expect miraculous battery life. Windows 10 is a more power-intensive OS to run than iOS or Android, and because you have a full x86 processor inside (rather than ARM) it consumes more electricity

ABOVE The extras turn the Surface Go into a fully fledged laptop – for a price

"While it is small compared to a 'proper' keyboard, we had no difficulties hitting the same level of touch-typing speeds as normal"

Acer Chromebook Tab 10

Great for schools and educators, but those seeking pure entertainment should look elsewhere

SCORE ★★★★☆
PRICE £256 (£307 inc VAT)
from laptopsdirect.co.uk

The Acer Chromebook Tab 10 is unique in this Labs: not only is it the sole tablet to use Google's Chrome OS, it's also been designed specifically for educational use. But, if you're familiar with iOS or Android, working with the Chromebook Tab 10 takes a little getting used to. There is a desktop-like taskbar interface, but Android apps – downloadable from Google Play – open full-screen rather than in windows. Split-screen mode works for some apps, though, which helps with multitasking.

It's not an entirely intuitive interface when used on a tablet as Chrome OS was designed as a desktop OS and isn't optimised for the tablet format. Not yet, anyway. Google is working on many enhancements and promises a better experience by the end of the year, so we'll just have to wait and see how it plays out.

Given the education focus, though, Chrome OS makes a lot of sense here. Many schools already use Google Classroom, so it will be a simple matter for school IT departments to deploy and manage another Chrome OS device. Even the battery life has school days in mind: the 4,500mAh battery is quite small for a tablet of this size, but our looping test video lasted for 8hrs 57mins – not great, but enough for a day's work before it gets shunted onto the charging station.

In terms of classroom devices, the main competitor to the Chromebook Tab 10 is Apple's 2018 iPad, and so it's no surprise that Acer has almost exactly matched the iPad's physical dimensions. The Chromebook Tab 10 is a little chunkier and heavier than the iPad, but it feels well built and the textured plastic case is comfortable to hold. It's also less slippery than the glass or smooth metal cases of rivals.

The 9.7in IPS panel has a 2,048 x 1,536-pixel resolution, which equates to a crisp 264ppi – exactly the same as the 9.7in iPad. The iPad is brighter and more vibrant, but the Chromebook Tab 10 still has a great screen.

We're more concerned that Acer hasn't matched the performance of the Apple device, with the 2GHz Rockchip RK3399 puny in comparison to the Fusion A10 CPU inside its rival. That pushed the Tab 10 to a single-core score of just 1,295 in Geekbench 4 and a multicore score of 3,176; that's enough for the sort of education and productivity tasks that it's designed for, but the iPad feels much snappier.

Gaming isn't the focus for a tablet such as this, which is a good thing as 10fps in GFXBench Manhattan is little better than most budget tablets can manage. But, it's good enough for light gaming… once you're away from the classroom, of course.

No sane person should consider taking photos with a tablet, but the cameras come in useful for taking pictures to include in school projects, or for AR apps such as Google Expeditions. The Chromebook Tab 10's cameras are fine for these tasks, but the five-megapixel rear and two-megapixel front cameras are basic offerings compared to the iPad. At least it will limit the amount of storage that is taken up with selfies.

Where the Chromebook Tab 10 scores over the iPad is with the included EMR stylus, which neatly stows into the lower-left corner in portrait mode. Apple charges an extra £89 for its Apple Pencil, but there's nowhere to stow it, which means it's easier to lose. Given how good children are at losing things, this could end up being costly for any school or parent going the Apple route. The Acer stylus is comfortable to hold and

note-taking was smooth and accurate using Squid, while doodling in Autodesk Sketchbook was great fun.

Elsewhere, Acer makes sensible decisions. A 3.5mm headphone jack, volume and power buttons, SD card slot and a USB-C port sit on the tablet's various edges. The USB-C port supports Fast Charging and could be very useful for educators who want to connect to a HDMI TV or projector, using a suitable adapter.

Shop around and you can find the Chromebook Tab 10 for around £300, placing it in competition with the 9.7in iPad. Factor in the £89 cost for the Apple Pencil, though, and the Chromebook Tab 10 represents good value. Schools would likely get a hefty discount on this price, depending on how many are purchased.

You could argue that a Chromebook laptop or 2-in-1 could be had for similar money, but that's missing the point. The Chomebook Tab 10 is designed to be used as a tablet, not as a cross-over device that is trying to be both. This is likely why there is no official keyboard accessory, and though any Bluetooth keyboard would work, that's again straying from its intended purpose.

Overall, those looking for a quality entertainment device would be better served with the 9.7in iPad or Huawei's 8.4in MediaPad M5, but if Chrome OS on a tablet is something you want or need, the Chromebook Tab 10 is a solid device.

Apple iPad

The latest iPad offers even stronger performance along with Apple Pencil support, making it our top choice

SCORE ★★★★★

PRICE 32GB, £266 (£319 inc VAT)
from apple.com/uk

Apple's iPad needs no introduction. As the device that created the tablet market, it's a brand so synonymous with digital slates that people use the word "iPad" to mean any tablet device. So, while the 2018 model of the 9.7in iPad keeps the same moniker, what has actually changed?

Not much. The chassis is the same as the 2017 model, so the dimensions, weight and battery capacity remain the same, and the Touch ID-enabled Home button still sits at the bottom of the frame. Besides this there are just the expected power and volume buttons, plus a SIM-card slot if you opt for the 4G version.

The colour options are also unchanged, so you can choose a black front with a "Space Grey" back, or the classic white front with a silver rear casing or gold. Using the same frame means the 3.5in headphone jack remains while the full breadth of accessories stays compatible, too.

It's a shame that Apple didn't choose to upgrade the cameras, though. While these aren't the most important features of a tablet, the eight-megapixel rear and especially 720p FaceTime camera are hardly what you would expect from a £319 Apple device.

Everything else lives up to expectations. This is a solidly built device but, at 469g, you won't feel fatigued after holding it for extended periods. At 7.5mm thick it's not the slimmest tablet in its class, but the difference between it and the wafer-like 6.1mm of the iPad Pro isn't that noticeable in use.

The 9.7in, 2,048 x 1,536 Retina display is the same as the 2017 model. This means it lacks the laminated, anti-reflective coating of the bigger iPad Pros, and we'd have loved to see a 120Hz panel, but huge compensation comes via Apple Pencil support. Besides, it's still a beautiful screen, with a crisp 264ppi resolution and enough brightness to make it viewable in sunny outdoors conditions.

The second notable upgrade over the 2017 model is the Apple A10 Fusion processor and embedded A10 co-processor, which Apple claims is twice as fast as the A8 processor in the 2017 model and iPad mini. It promises an almost threefold increase in graphics performance, too. The Geekbench 4 results don't bear this out, but a 40% increase in both CPU and GPU performance is still great to see – and it's hardly as if the 2017 iPad was a slouch.

The only devices that are faster, predictably, are the iPad Pro models with the Fusion A10X processor, which both offer amazing speed, especially in multithreaded environments. Given that the iPad is more of a consumption device than the iPad Pro models – with their keyboard attachments and desktop-level horsepower – it's debatable whether you need this much performance, but it should at least offer some future-proofing to account for OS upgrades and new apps.

If you're addicted to *Fortnite* or *PUBG*, the iPad remains a strong choice for gamers. The GFXBench Manhattan score of 40.1fps at the native panel resolution of 2,048 x 1,536 is again only bested by the iPad Pro devices, although Samsung's Galaxy Tab S4 comes close, with 36fps.

There will be plenty of time to rack up those Victory Royales too, because the iPad's battery life is strong. A single full-charge managed to last for 14hrs

ABOVE The physical design may not have changed, but it's still a stunning tablet

PC PRO LABS WINNER

BELOW Support for the Apple Pencil means the iPad is a great choice for kids
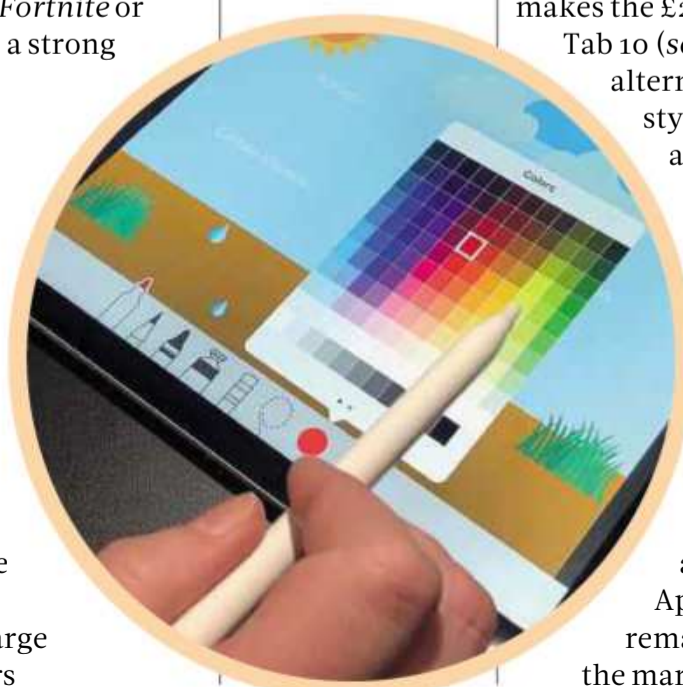
47mins of full-screen video playback, which is again amongst the best of all the tablets on test this month.

The processor upgrade alone would arguably justify a price hike over last year's model, so the fact Apple has actually lowered the asking price to £319 for the 32GB version is a welcome surprise. If you want more than 32GB of storage then the 128GB bumps this up to less appealing £409 (as if anyone needs reminding, there's no SD card slot on iPads) and once you add the £89 Apple Pencil it then enters the realm of premium-priced tablets. Compared to the 128GB iPad, the Samsung Tab S4 and Huawei MediaPad M5 are worthy alternatives, as they both offer premium build quality, great performance and pin-sharp screens.

Also, it's worth bearing in mind that if you're interested in the iPad for educational use then the Apple Pencil is almost a necessity, which then makes the £279 Acer Chromebook Tab 10 (*see opposite*) a strong alternative: this includes a stylus that stows neatly away, has a near-identical screen, and can be easily expanded thanks to the SD card slot.

Competition has certainly increased, but if you're just looking for a device on which to consume content and play games, and you're already invested in the Apple ecosystem, the iPad remains the best tablet on the market.

Apple iPad Pro 12.9in

Overkill for movie watching, but a compelling mobile sidekick to a desktop system for creative professionals

SCORE ★★★★☆

PRICE £641 (£769 inc VAT)
from apple.com/uk

If you were to apply the phrase "go big or go home" to tablets, the result would be the 12.9in iPad Pro. In fact, it's so big that we had to double-check our coffee mug didn't have the words "DRINK ME" written on the side. At 221 x 306mm, it's larger than a sheet of A4 and, at first, feels unwieldy in your hands. Thankfully, this lessens in time, in part because of its impressively light weight of 677g. It takes practice, but you can distribute this weight by resting the iPad on your arm.

You might be concerned that the large screen area, coupled with a thickness of only 6.9mm, would lead to some flex, but the robust metal chassis mean you don't need to handle it with kid gloves for fear of it breaking. In other respects, the 12.9in model feels just like an upsized iPad: the familiar Touch ID Home button, Lightning connector, volume rocker and headphone socket are all where you'd expect them to be.

The 12.9in display will also be familiar to those who have used the 10.5in iPad Pro, because it retains the same 264ppi pixel density. The screen size means that the 12.9in iPad Pro features a higher resolution of 2,732 x 2,048, with a dazzling maximum brightness of 512cd/m².

The best aspect of the iPad Pro's screen, however, isn't the resolution or brightness, but the enhancements to its refresh rate and colour accuracy. The display supports the DCI-P3 colour space, which is something that digital creatives will appreciate, and combined with the anti-reflective coating on the glass, colours look fantastic. Then there's the Pro Motion tech, which adds support for a 120Hz refresh rate. This not only enhances the fluidity of moving images, such as movies and games, but makes using the Apple Pencil (an £89 extra) feel even more natural.

Using the 12.9in iPad Pro purely as a content consumption device seems like overkill, but there's no denying that watching movies on this giant screen is a real joy. The experience is further enhanced by upgraded sound quality, thanks to an additional two woofer/bass drivers on top of the regular stereo pair. A 6.9mm thick chassis is never going to deliver cinematic audio, but the extra richness that these separate woofers deliver highlights just how tinny the audio from most other tablets sounds.
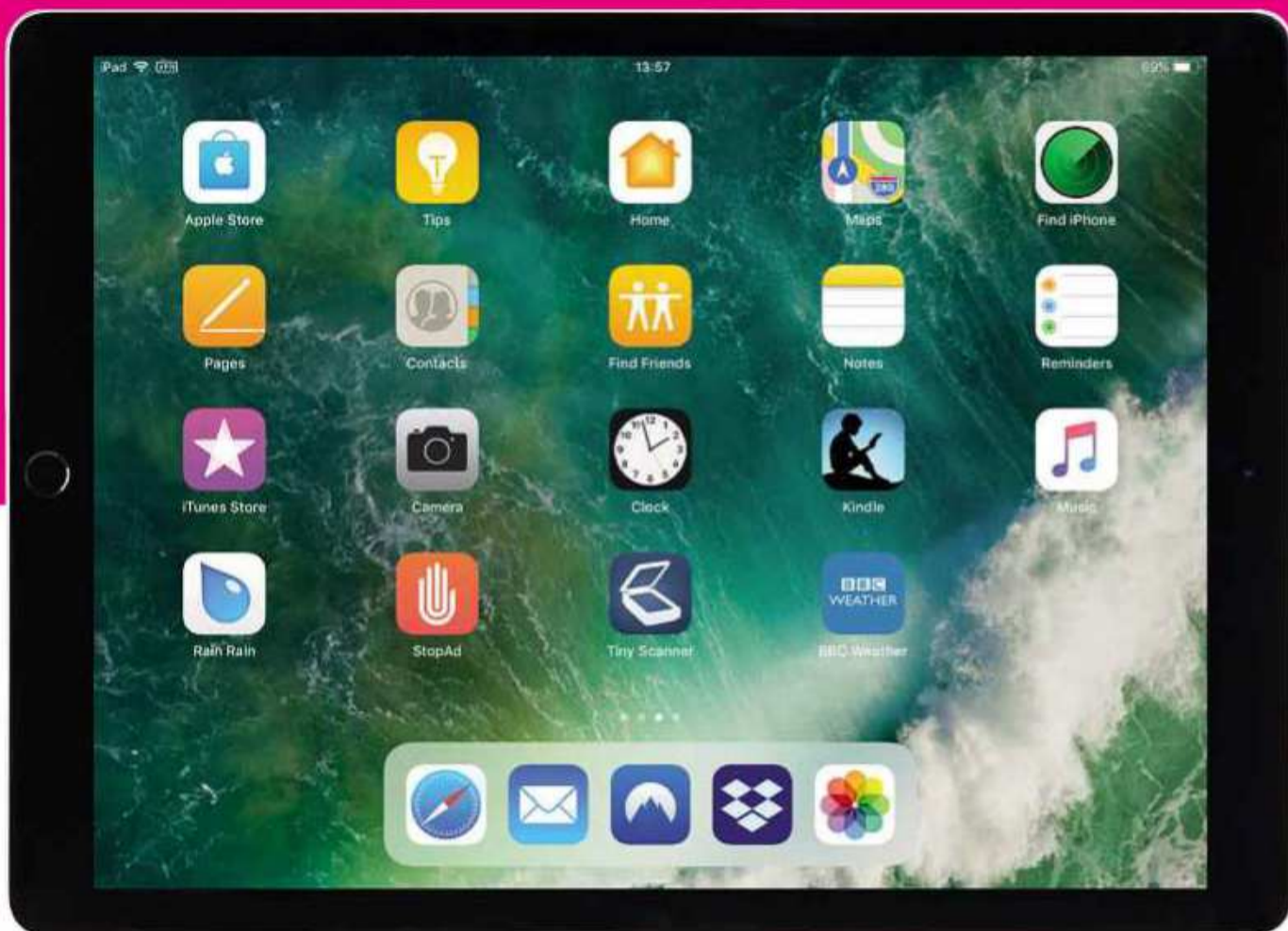
Pushing all of these pixels around is no easy task, so it's no surprise that Apple has outfitted the goliath iPad with a top-of-the-range A10X Fusion processor and M10 co-processor. This powered the GFXBench Manhattan test to a chart-topping score of 46fps, making the iPad Pro a superlative mobile gaming device. You also need not worry about the screen going blank in the middle of the action – the battery life of 12hrs 18mins, while not the best on test, is impressive given the size of the screen.

For those more focused on the serious business of productivity, the Geekbench 4 scores of 3,925 and 9,292 respectively should bring a stoic smile to your face. This would have been easily comparable to a high-end mobile Intel CPU 12 to 18 months ago, although it's now more in line with the current eighth-gen mid-range chips. For example, it's roughly comparable to the four-core (eight-thread) Intel Core-i5 8250U mobile CPU in the single-core test and about 25% slower in the multicore test. In short,

ABOVE The iPad Pro 12.9in is a behemoth, but it's a surprisingly light one at 677g

BELOW The Pro's sturdy metal chassis means that you don't have to worry about it bending or snapping

performance is good enough to justify Apple's "desktop level" claims.

This phraseology is perhaps the biggest hint as to the real purpose of this tablet: as a cross-over device that can work as hard as it can play. For digital creatives and artists, the huge screen, accurate colours and smooth interaction with the Apple Pencil make it a compelling creative platform, and it certainly has the performance to handle complex design work. For more productivity-based tasks, the optional Smart Keyboard (a significant £169 add-on) turns the 12.9in iPad into a viable laptop replacement. There are limitations with iOS that mean it can't entirely replace a desktop environment, but multitasking improvements in iOS 11 and 12 certainly bring it closer.

At £769 for the 64GB Wi-Fi model and a stomach-fluttering £1,119 for the 512GB version, the 12.9in iPad Pro is impossible to justify as a pure entertainment device. Add in the Apple Pencil and the Smart Keyboard and even the base model tops a grand. But for digital creatives looking for a companion to their desktop – that is a superb entertainment device too – it makes more sense. It's certainly not for everyone, but if you can make use of its many capabilities to the fullest then it will more than deliver its worth.

Samsung Galaxy Tab S4

An unbeatable entertainment device with some useful productivity capabilities thrown in

SCORE ★★★★☆

PRICE £423 (£507 inc VAT)
from pcpro.link/290tab4

The Samsung Galaxy Tab S4 easily rivals the premium looks of the Apple competition. Samsung has removed the Home button from the front panel, which results in thinner bezels and a larger screen size of 10.5in, up from the 9.7in panel of the Tab S3. We also didn't lament the lack of the physical buttons, or even the fingerprint reader, especially since the iris scanner worked so well – the bigger screen is ample compensation, too.

It's a fraction heavier than the 10.5in iPad Pro, but that's fine: it feels reassuringly substantial. Samsung neatly integrates volume and power buttons, USB-C for charging and an audio jack. The SD card slot is inside a concealed compartment, which maintains the sleek, rounded edges, so if you find the default 64GB of storage too limiting then you can expand the storage by up to 400GB.

There are still a couple of niggles with the design, though. The boxy 13-megapixel rear camera can make the Galaxy Tab S4 look like a giant smartphone, and the glass back is both slippery and seemingly designed explicitly to attract fingerprints.

Samsung knows a thing or two about displays, and the 10.5in Super AMOLED screen is easily the Tab S4's strongest feature. It is, quite simply, breathtakingly good. If content consumption is your primary reason for owning a tablet, the display is unbeatable. Watching Netflix in HDR, for example, looked so crisp that we found ourselves ogling the image quality and missing important moments in the story. The 2,560 x 1,600 resolution and 16:10 ratio is also better suited to video than the 10.5in iPad Pro's 4:3 ratio.

The Tab S4's 288ppi pixel density is again higher than the Apple device, although in practice it would be hard to tell the difference, since both are exceptionally sharp. Sure, the iPad Pro has the 120Hz Pro Motion display and DCI-P3 colour accuracy, but these are more beneficial for creative professionals than for binge-watching *The Walking Dead*.
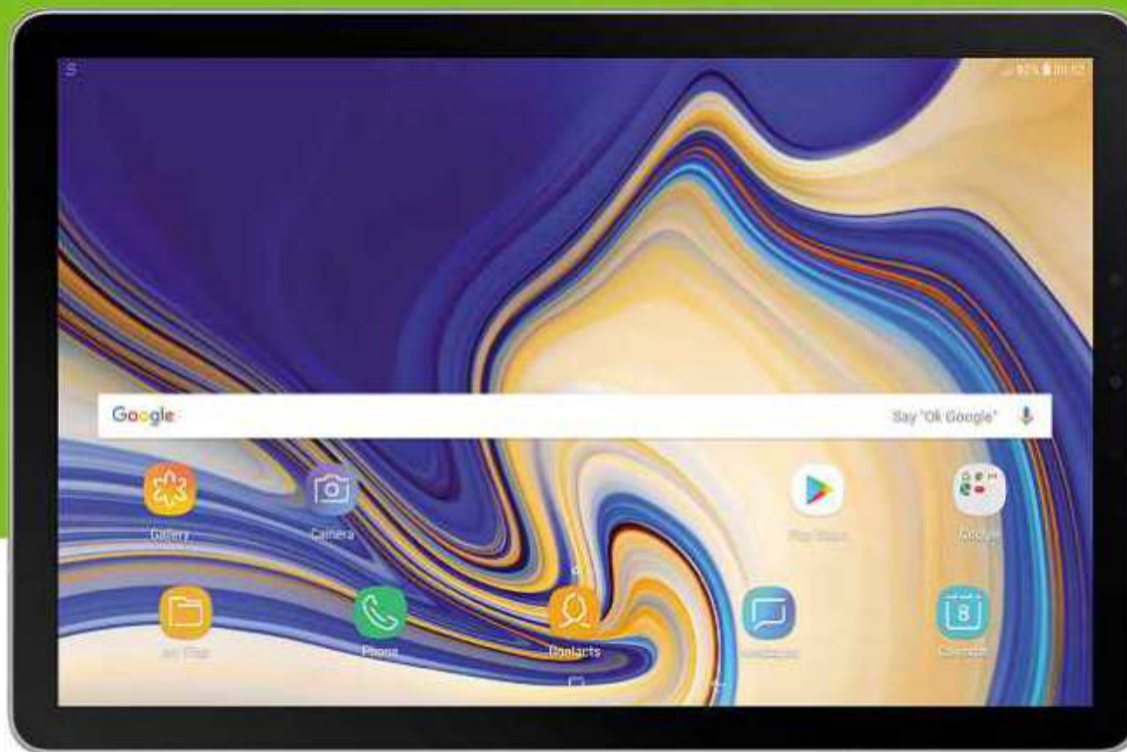
Unless you like to be antisocial, the headphone jack or Bluetooth transceiver will be the more likely method for delivering audio to your ears, but the quad-speakers are of surprisingly good quality. They're tuned by audio brand AKG – which is itself a subsidiary of Samsung – and support Dolby Atmos audio. However, to our ears the Huawei MediaPad M5 had more punch from its Harmon Kardon speakers.

It would have been nice to see a Snapdragon 845 processor inside rather than the 835, but paired with 4GB of RAM the performance is still strong enough to beat all the other Android tablets on test. The Geekbench 4 scores of 1,888 and 6,506 are way behind the Fusion A10X-powered Apple iPad Pro, so for heftier content creation work Apple has the advantage. The iPad Pro is also a stronger gaming device, but the Tab S4's score of 36fps in the GFXBench Manhattan test still makes it a powerful option.

There's more to the Galaxy Tab S4 than just being an incredible entertainment machine, though. Included in the box is Samsung's S-Pen, which offers 4,096 pressure levels and is great for taking notes or undertaking creative work in Photoshop Lightroom. That said, we still prefer Huawei's M-Pen.

Photoshop work is assisted greatly when switching to Samsung's DeX mode, which provides a Windows-like interface. Switch to DeX and apps run in dedicated windows, making it simple to multitask. With the

ABOVE Samsung has binned the Home button, resulting in even slimmer bezels

BELOW Samsung's sleek S-Pen is well-suited to note-taking

HDMI adapter, sold separately, the DeX interface can be displayed on a full-sized monitor, with the tablet acting as either a virtual keyboard or large touchpad.

A number of apps are optimised for DeX, including Lightroom, but there are still quirks. For instance, Amazon Prime Video only ran in a window, and the playback paused whenever the video window wasn't in the foreground. And, in general, the apps that aren't optimised for DeX can be hit-and-miss. So there's clearly still work to do in order to improve the DeX experience.

For working on the move, Samsung offers the Keyboard Book Cover for £119. This attaches via the Pogo interface and is good enough for light office work, and it also provides a handy stow for the S-Pen. We found that the 7,300mAh battery was excellent, looping our test video for 17hrs 50mins. There are more features and accessories too, such as the Pogo charging dock, which can turn the Tab S4 into a smart home display, similar to an Echo Spot.

All of this technology comes at a cost, however, and the 64GB Wi-Fi model weighs in at £599. This is £20 less than the 10.5in iPad Pro, though, and if you add the Apple Pencil then the Tab S4 is £119 less. If you're simply looking for a quality tablet with pen support, note the Huawei MediaPad M5 Pro is almost £100 less than the Tab S4. But, as a superlative entertainment device that can also double as a light productivity machine, the Samsung Galaxy Tab S4 is tough to beat.

Acer Iconia One 7

The decent screen and low price aren't enough to save this basic and cheap-feeling 7in tablet

SCORE ★★☆☆☆

PRICE **£60 (£72 inc VAT)**
from **pcpro.link/290acer7**

The Acer Iconia One 7 is one of two 7in tablets in this month's labs, but while the Iconia One 7 is smaller, thinner and lighter than the Fire 7, we prefer the feel of Amazon's device in the hand. Like its 10.1in brother, build quality isn't a strong point of the Iconia One 7, with a lot more flex in the chassis than we would wish for.

All the buttons and ports are where you might expect them to be, with a 3.5mm jack and SD card slot on the top to supplement the 16GB of on-board storage.

The phone-like dimensions make using the Iconia One 7 to take photos more sensible than most tablets, but – how can we put this without being cruel? – the 2MP rear camera and 0.2MP front camera are unlikely to help you win Wildlife Photographer of the Year.

Acer equips the Iconia One 7 with a quad-core MediaTek MT8163 CPU running at 1.3GHz, with a miserly 1GB of RAM in support. A Geekbench 4 single-core score of 623 and multicore result of 1,734 are similar to the other budget tablets on test this month, and mean that this tablet is okay for basic web browsing and content consumption, but nothing more. This isn't a machine you'll enjoy using.

A result of 7.6fps in GFXBench Manhattan means light gaming is just about okay, but one look at the graphs on p93 should make it clear where the

ABOVE The Iconia One 7 has a decent screen, but the chassis feels flimsy

Iconia One 7 stands in relation to other tablets. Only the Fire 7 performs worse.

Then we come to arguably the weakest area for the Iconia One 7 in our tests: battery life. The 2,780mAh cell gave up after only 6hrs 9mins of constant use when looping our test video, so if you're doing anything at all arduous then you can expect that figure to fall to around five hours.

There is one surprising area of strength for this device, though, and that's its screen. The display on the Iconia One 10 was a disappointment, but its little brother shines – in comparison at least. That's in part because they share the same 1,280 x 720 resolution, which is far better suited to the smaller screen. Indeed, the Iconia One 7's 210ppi pixel density is superior to the Amazon Fire 8 HD. The colours are also stronger than the Iconia One 10 and white balance is more accurate than the Fire 7.

So which to buy? Sadly for Acer, that question is easy to answer. While the Acer Iconia 7 offers better performance and a sharper screen than the Fire 7, Amazon's family services, more robust build quality and cheaper price (wait for deals and it's often just £40) still make the Fire 7 a better choice as a cheap tablet for your whole family.

Acer Iconia One 10

Highly affordable for a 10.1in tablet, but it looks and feels cheap – and the screen is terrible

SCORE ★★☆☆☆

PRICE **£99 (£119 inc VAT)**
from **pcpro.link/290acer10**

The Acer Iconia One 10 is tempting on paper. A 10.1in IPS screen for just £119? What's not to like? Hold the Iconia One 10 in your hands, though, and the cost savings are apparent. While the coarse plastic body feels unpleasant, it's the horrible silvery plastic that covers the stereo speakers that really makes the Acer tablet look like the budget offering it is – and these speakers don't redeem themselves by sounding good, either. Both of the Amazon Kindle Fire tablets on test manage to be cheap without feeling it.

Acer's logo placement suggests using the Iconia One 10 in landscape orientation by default, which makes the choice of placing the power and volume buttons on the top bezel a little odd. A flimsy plastic flap hides an SD card slot and the second of two micro-USB ports, so you can charge and add another storage device if needed. We would certainly advise using the SD card slot if you need to supplement the included 16GB of flash memory.

A 1.3GHz quad-core MediaTek MT8167 resulted in Geekbench 4 scores of 534 and 1,467, making it the slowest 10in tablet on test. Even the £80 Amazon Fire 8 HD is quicker, albeit not by much. The Iconia One 10 is fine for general web browsing and

ABOVE The Iconia 10 is okay for normal browsing and light gaming, but the design screams "cheap"

content consumption, though, and can even manage light gaming: it hit 9fps in GFXBench Manhattan, the same score as the Fire 8 HD.

There is a version of the Iconia One 10 with a Full HD screen, but sadly this isn't the model on test. As such, gaming is an uninspiring experience on the dull, 1,280 x 800 resolution panel, which – with a pixel density of 149ppi – makes text look fuzzy and indistinct. Movies fare a little better, but we preferred watching films and shows on the smaller Amazon Fire 8 HD.

Battery life is better but not stellar. Despite its 6,100mAh capacity, which is respectable for a 10.1in device, the Iconia One 10 gave up looping our test video after 9hrs 37mins.

A 10.1in tablet for such a low price will always mean compromises, but Amazon has shown that it's possible to design a low-cost tablet that doesn't feel cheap. Despite offering a larger screen than the Amazon Fire 8 HD, we'd much rather spend our time using Amazon's colourful device than the Iconia One 10.

Amazon Kindle Fire 7

Cheap, cheerful and fun, the Fire 7 is a great tablet for Prime families – just don't expect too much

SCORE ★★★☆☆
PRICE £42 (£50 inc VAT)
from pcpro.link/290fire7

It would be easy to be snobby about the Amazon Kindle Fire 7's chunky frame and modest specifications, but this would be missing the point. This is a tablet that's focused on having fun at the lowest price possible, and at £50 (often discounted lower), it's easily the most affordable tablet on test.

The Fire 7 certainly looks like a fun device. Our review unit featured the "Punch Red" back cover, but others include "Canary Yellow", "Marine Blue" and plain old black for those who don't like happiness.

The chunky frame feels durable too, which is an important consideration when the Fire 7 is likely to end up in the hands of younger family members. There's even a dedicated Kids Edition with protective cover and one-year subscription to Kids Unlimited for £100, often discounted to £80.

Don't ignore Kids Unlimited either: it's a handy service that bundles games, videos and books based on your child's age, with the added benefit that you're given more control over time spent on the device and what they can access. You don't need to buy the Kids Edition, though, as it's a £1.99-per-month add-on if you're already a Prime subscriber.

Fire OS places Amazon's services at the heart of the interface, which makes it easy to select from the wide range of music and video content

ABOVE The Kindle Fire 7 may not be glamorous, but it's great fun

available through Prime. Kindle ebooks and Audible audiobooks are also front and centre, and Alexa is supported, as you would expect. The compromise? You're forced to use Amazon's Silk browser and its more limited app store.

The more significant compromises are apparent when you look at the hardware specs. The 1.3GHz MediaTek MT8127 processor returned the lowest results in Geekbench here, and the GFXBench Manhattan test wouldn't even run. It was still nimble in general use, but things slow down quickly if you do too much at once. The 8GB of storage won't go far, either, and while there is a 16GB model, simply adding an SD card makes more sense.

The screen is another area where costs have been shaved. The 1,024 x 600 resolution means that smaller text looks fuzzy and finer details are lost. It's still an IPS panel, though, and it's bright enough when used indoors. The screen is fine for cartoons and kid's movies, and it managed to loop our test video for 8hrs 30mins, which is more than enough for a long journey.

Despite its shortcomings, this is a capable media player and simple gaming device. So long as you manage your expectations, the Fire 7 is a lot of fun for very little money.

Amazon Kindle Fire HD 8

An affordable and well-designed entertainment device, especially if you subscribe to Amazon Prime

SCORE ★★★★☆
PRICE £67 (£80 inc VAT)
from pcpro.link/290fire8

Where the Kindle Fire 7 is a no-frills entertainment device that's affordable enough to dish out to the whole family, the Fire HD 8 offers a slightly more grown-up alternative – but not too grown-up.

The Fire HD 8 looks much the same as the Fire 7 and is offered in the same fun and vibrant colours. We looked at the "Canary Yellow" version, which we liked far more than we expected to, but there's also "Marine Blue", "Punch Red" and boring old black. The button and camera placements are also the same as on the Fire 7, though the larger frame of the Fire HD 8 allows space for stereo speakers, which lack punch, but offer respectable volume.

The obvious and most important upgrade over the Fire 7 is the screen, and the 1,280 x 800 8in IPS panel is a distinct improvement. Text and icons look sharper, thanks to the 189ppi pixel density, but there is still a slight fuzziness around the edges of text, which isn't apparent on the more expensive Android competitors with their higher-density screens. Still, it's enough to allow Amazon Prime video content to stream in HD, something that many of the far more expensive devices fail to achieve due to inadequate DRM certifications.

The processor gets a bump too, though the MediaTek MT8163 is still far from a powerhouse, placing the Fire HD 8 third from bottom in the

ABOVE The larger screen means that you can stream HD video on the Fire HD 8

PC PRO RECOMMENDED

Geekbench 4 tests. That said, the single-core score of 644 and multicore score of 1,854 are dramatically faster than the Fire 7. It also managed to complete the GFXBench Manhattan test, albeit with an uninspiring score of 9fps, but this does at least mean that modest 3D gaming is possible. The 1.5GB of RAM helps when switching between apps, though there are still limits to what you can do.

With a bigger 4,750mAh battery capacity, the Fire HD 8 looped our test video for 13hrs 4mins, which is the best out of all the Android devices, bar the Samsung Galaxy Tab S4.

All Amazon tablets work best when partnered with a subscription to Amazon Prime, and the Fire OS interface makes it simple to reach all of your Prime content. It's a smooth experience and far more intuitive than having to open individual apps. Alexa is integrated too, so you can control your smart home devices and voice control your video and music choices.

Affordability is one of the strongest features of the Kindle Fire tablets, and at £80 for the 16GB model and £100 for the 32GB version, both of which are often discounted by £20, the Fire HD 8 is superb value for money. If you simply want a solid entertainment device, and have a Prime subscription, it's a great choice.
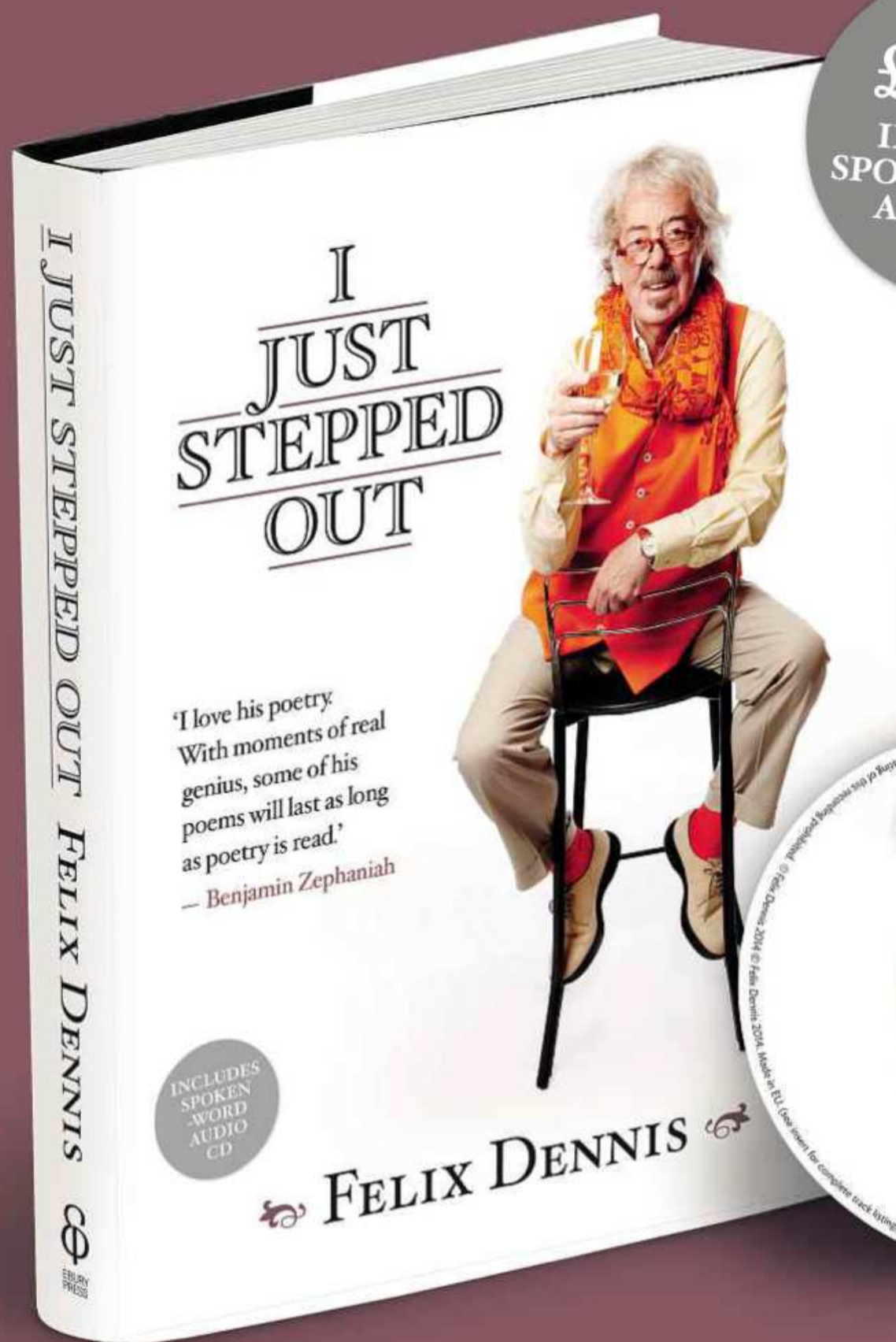
Apple iPad mini 4

Still a capable device, but £399 for three-year-old tech is hard to justify unless portability is your priority

SCORE ★★★☆☆

PRICE £333 (£399 inc VAT)
from apple.com/uk

Without wishing to sound ageist, the iPad mini 4 is now getting a little long in the tooth. You may be surprised to hear this model first appeared back in September 2015, back when Brexit was only a theoretical possibility. Can it really be worth almost £400 three years on?

In many ways, yes, because this was a high-quality product then and remains one now. In terms of screen quality, for example, the iPad 4 mini actually has an advantage over the latest version of the 9.7in iPad, as its Retina display is fully laminated and includes an anti-reflective coating, which helps to keep the display looking vibrant even in brighter outdoors conditions. The resolution of 2,048 x 1,536 equates to a super-sharp 326ppi too.

But while the screen hasn't dated, the hardware inside has. The new iPad features the upgraded Fusion A10 processor, while the mini 4 is left with the older Fusion A8. This is reflected in the Geekbench 4 score of 1,694 in the single-core test and 3,058 in the multicore test, while a score of 15fps in the Manhattan benchmark is in the realm of mid-range Android devices rather than a modern iPad. Still, this performance is perfectly good for a device that's geared around media consumption and light gaming.

The major benefit of the iPad mini 4, and the main reason to consider it

ABOVE The mini 4's screen is great, but the rest of the tablet is showing its age

over its larger siblings, is portability. It's far easier to place in a bag or pocket than the bigger devices, so if taking your iPad on the move, to play games, watch movies or read books is your primary concern then it may suit you better than a 10in or larger tablet. The smaller size doesn't mean lower build quality, either, because it still feels superbly engineered, despite the 6.1mm thickness and airy 299g weight.

The iPad mini 4 is now only available with 128GB of storage, which should be enough for most uses, but at £399 it sits in an awkward position. On one side, there's a crowd of Android devices with broadly comparable performance and equally good screens, with the £299 Huawei MediaPad M5 8.4in being our top choice. On the other side, iOS fans can choose the superior 2018 iPad, which is only £10 more for the 128GB model.

As such, the choice to buy the iPad mini 4 will come down to whether you specifically want the smaller screen and are so invested in the Apple ecosystem that you're willing to pay a premium for three-year old tech. Even then, it's tempting to wait and see if Apple releases a higher-spec version. For everyone else, a cheaper Android device offers better value.

Apple iPad Pro 10.5in

A brilliant entertainment device and ideal travelling companion for creative professionals

SCORE ★★★★★

PRICE 64GB, £516 (£619 inc VAT)
from apple.com/uk

The obvious question for anyone considering the 10.5in iPad Pro rather than the 12.9in edition is this: does the reduction in screen size lead to other compromises? The short answer is no. The 10.5in iPad Pro is essentially identical to its bigger brother. Despite being slightly thinner, at 6.1mm, it feels as robust.

Apple squeezes the same powerful six-core Fusion A10X processor inside, along with a generous 4GB of RAM. This pushed it to 3,930 in the single-core Geekbench 4 test and 9,380 in the multicore version, putting it on a par with an eighth-gen mobile Core i5. Gaming performance is even stronger than the 12.9in model: due to the lower screen resolution of 2,224 x 1,668, it scored a table-topping 58fps in the GFXBench Manhattan test. A smaller screen also contributes to its battery life of 12hrs 59mins, 41 minutes more than the 12.9in model.

As this is a "Pro" iPad, it benefits from a laminated, anti-reflective screen that supports the DCI-P3 wide-colour space and Pro Motion 120Hz technology. Despite a lower pixel resolution than the 12.9in model, this gorgeous screen has the same 264ppi pixel density, which ensures that the UI has a consistent appearance across all the iPad models except the mini 4.

ABOVE The Pro 10.5in may be smaller than its bigger sibling, but it's just as powerful

PC PRO RECOMMENDED

The laminated screen and Pro Motion tech also make the Apple Pencil a joy to use, which highlights the capabilities of this tablet as a tool for creatives. Its Smart Keyboard is fractionally cheaper than the 12.9in model's at £159, but the smaller screen makes this less viable as a laptop replacement. It's still capable for productivity tasks, aided by the multitasking enhancements in iOS 11 and 12, and so could conceivably still replace a laptop – although Windows users would be better served by the Surface Go.

It has other competition, too. If you seek a content consumption device with some creative aspirations, the Huawei MediaPad M5 Pro is worth a look. This includes a 4,096-layer pressure sensitive pen and costs a chunky £200 less, but lacks the iPad Pro's processing grunt and superlative screen. At £619 for the 64GB model, rising to £969 for 512GB, before you add the £89 Apple Pencil or £159 Smart Keyboard, the 10.5in iPad Pro is the domain of creative professionals and well-heeled consumers – but if you can afford it, it's a great bit of kit.

The future of tablets is… surprisingly bright

As smartphone screens become ever-larger and laptops become ever-lighter, can tablets survive in the combative middle ground?

In last year's Labs, we concluded that the doom and gloom surrounding the future of the tablet was unfounded. But what's the situation a year on? Are you a fool to be even considering a tablet?

Well, no. Tens of millions of tablets are still being sold each month, it's just that the manufacturers are having to fight harder to persuade people to upgrade. After all, if your three-year-old tablet is still going strong, why spend £400 on a new one?

Stats don't lie, though, and there's no hiding the fact that sales are falling. In the first quarter of 2018, according to market watchers (**pcpro.link/290tabs**), shipments were down 7%. Apple could only increase its sales by 2%, but the most notable figures came from Amazon and Huawei: both companies sold 15% more tablets in Q1 2018 than Q1 2017.

In the case of Huawei, its growth was put down to successes in the connected tablet markets (4G-enabled devices), while Amazon has focused attention on selling devices at lower costs to support its Amazon Prime Video service. Nevertheless, the market is still down overall, so why the positive spin in our headline?

Where's the growth?

According to the Global Tablet Devices Market Forecast to 2024, the decline should start to reverse from 2019. Admittedly, much of this growth is forecast to come from APAC countries, such as China, India and Vietnam, with lesser improvements in Western Europe and USA.

Many of those increased sales are expected to come via healthcare and retail as replacements for kiosk or POS systems. Then there's education. Despite the ongoing controversy about use of technology in schools, this remains a largely untapped market for tablets – we've seen a glimpse of this future in the form of the Acer Chromebook Tab 10. It's a tablet, Jim, but not as we know it: Google's Chrome OS is already well established in schools, so why not kill off those difficult-to-manage iPads and have one OS to rule them all?

So where does this leave the tablet as a home content consumption device? Manufacturers are having a tough time forcing people to retire a tablet that works well. As long as your existing iPad is still capable of handling movies, music, browsing and light gaming, why upgrade? Want and need are the key words. Need could mean a broken screen or one OS upgrade too far, while want comes in the form of some radical product innovation that you just must have.

Unfortunately, this Labs shows little in the way of real innovation. Apple may well launch a new tablet before the end of this year, but judging by recent history, this will be a minor upgrade – such as when it added support for the Pencil to the iPad – rather something new. Of the other manufacturers, Samsung is showing new thinking with its Galaxy Tab S4 and its DeX interface – to turn it into something closer to a fully fledged PC – but it must still iron out flaws.

ABOVE Children are watching more videos, browsing and playing more games than ever before…

BELOW …which Amazon is aiming to capitalise on with its range of rugged, kid-friendly tablets

Children are our future

Which brings us to one area of rapid growth: children's advertising marketing. Developments in this "kidtech" sector have been led by companies such as Super Awesome, whose services are used by brands to enable safe, digital engagement for the under-13 audience that meets the requirements of COPPA and GDPR-K. This includes so-called "zero-data" advertising, with no cookie-based ad targeting and no collection of personal data. It's big business and the market is growing at 25%, year-on-year.

PwC estimates that the children's digital advertising market will reach $1.2 billion globally in 2019, driven by the fact that children are spending far more time online, watching streaming video content or playing games. When you consider this, Amazon's strategy – offering solid devices at a low-cost, tied into its own digital services – begins to make a lot of sense. It's a case of selling the services, not the devices. And with a Fire 7 costing just £50 you can buy a family set of devices for less than an iPad.

So, it seems the future of tablets is looking quite bright. The shape of the market may be changing, and the top manufacturers are going to need to innovate at the high-end, or produce lower-cost devices with added value to continue to be successful. But, whether in the home or workplace, tablets aren't going anywhere soon.

Huawei MediaPad M5 8.4in

A superb media device and a alternative to the iPad mini 4 if you can live with Android's tablet shortcomings

SCORE ★★★★☆
PRICE £244 (£299 inc VAT)
from pcpro.link/290hwm5

ABOVE The MediaPad M5 has a sleek, iPad-like finish that its Android rivals lack

PC PRO RECOMMENDED

As soon as you remove this sleek tablet from its box, its iPad aspirations are obvious. At first glance, you might even mistake it for an iPad mini 4 – until you spot the Huawei logo at the top. Far East manufacturers still haven't got the memo about being subtle with their branding. It's forgivable, though, because the MediaPad M5 looks and feel fantastic. The smooth metal body gives it a premium feel that the Lenovo Tab 4 8 Plus distinctly lacks.

Held in portrait orientation, a fingerprint reader sits on the bottom bezel, which is more awkward to use than the Lenovo's side-mounted reader, with power and volume buttons on the right edge. The SD card slot is accessed via a SIM-like drawer that helps to maintain the smooth, seamless design. Huawei places the USB-C port on the bottom edge, but search as you might you won't find a 3.5mm headphone jack. At least Huawei provides an adapter in the box.

Turn on the MediaPad and the difference in screen quality compared to the Lenovo is apparent. The 8.4in IPS display has a superior 2K resolution of 2,560 x 1,600 and 359ppi pixel density – the highest on test. It's the best Android screen here, bar the incredible Samsung Galaxy Tab S4. Those users with Netflix subscriptions will be pleased to see that the M5 makes the list of devices certified for streaming HD content, while sound quality from the Harman Kardon speakers is fantastic.

Huawei chose to go with a Kirin 960 processor, which is a rung down from the 970 but still delivers strong performance compared to its Android rivals. Its Geekbench 4 single-core score of 1,882 is double that of the Lenovo and the same as the Samsung Galaxy Tab S4, while a multicore result of 6,194 beats even the 2018 iPad.

It's also a capable gaming device, reflected in its 27fps in the GFXBench Manhattan test, and there's plenty of gaming to be had, too: battery life is strong, looping our test video for 12hrs 49mins.

The MediaPad M5 is easily the best 8in Android tablet on test and a viable alternative to the iPad mini 4. It's £100 less than the iPad mini 4 too, and even with the added cost of an SD card to bulk up the 32GB storage, it's better value. The question then boils down to this: are you happy to live with Android instead of iOS, which also has a better selection of tablet apps? If so, the M5 8.4in is a great choice.

Huawei MediaPad M5 Pro 10.8in

A powerful tool for creative professionals, but it's still hindered by Google's more limited app store

SCORE ★★★★☆
PRICE £407 (£488 inc VAT)
from ebay.co.uk

ABOVE With its excellent display, sound and battery life, the MediaPad M5 Pro is a decent iPad rival

We're always a bit suspicious when the word "Pro" appears in the name of any product, because often the hardware doesn't match up to its professional aspirations. But can Huawei's "Pro" 10.8in tablet match the iPad Pro?

In terms of specification and performance, yes. The same Kirin 960 CPU found in the 8.4in M5 pushed it to similar strong results in Geekbench 4, even if the iPad Pro tablets proved stronger still. It's a capable gaming device, scoring 28fps in GFXBench Manhattan and sound quality is outstanding thanks to the Harmon Kardon speakers and hi-res audio certification. Battery life is also great, looping our video for 12hrs 59mins.

The screen is, again, superb. With a pixel density of 280ppi and native 2K resolution of 2,560 x 1,600, the raw specs compare favourably to the 10.5in iPad Pro. The iPad's wide colour gamut display, Pro Motion technology and laminated panel set it apart in a direct comparison, but the screen on the Huawei is still one of the best.

The Pro credentials become clearer when you find Huawei's M-Pen in the box. The stylus includes shortcuts and 4,096-layer pressure-sensitivity, with tilt and shading features in supported apps. The M-Pen requires charging, but Huawei suggests 50 days of battery life is possible.

Flip the MediaPad M5 Pro over and you'll see three circular connectors, which connect to Huawei's keyboard accessory. With the keyboard attached, you can use the Desktop mode – part of Huawei's EMUI 8 interface – to switch to a desktop-like interface. It works well for general office tasks; it's just a shame that the official smart keyboard is so hard to buy.

You'll have no problems buying accessories for an iPad, and the other killer factor in Apple's favour is the strength of its app ecosystem: for digital creatives and professionals, there's much more choice. This leaves value as Huawei's main weapon, and it certainly wins. Once you add the Apple Pencil to the 10.5in iPad Pro, the cost difference is £300 in Huawei's favour.

Apple might argue that the iPad is a closer competitor to the MediaPad M5 Pro and, once you add the Apple Pencil, the base 32GB iPad costs about the same. But, providing you can find it, the MediaPad M5 Pro has the option of a smart keyboard, something Apple reserves for its Pro range. If only the Google app store was stronger.

Lenovo Tab 4 8 Plus

An attractive 8in device with a good screen and solid performance, but there are better Android tablets

SCORE ★★★☆☆

PRICE £249 (£299 inc VAT)
from pcpro.link/290tab8

The Lenovo Tab 4 8 Plus is one of three 8in Android tablets on test this month, but unlike the budget-friendly Kindle Fire HD 8 this is a premium device. Indeed, at this price Lenovo no doubt hopes to tempt people away from the Apple iPad mini 4. Its squarer edges set it apart from the curvy iPad, and it's a good looking, well-built device.

Look around its silvery edges and you'll find an SD card slot hidden behind a Lenovo-branded flap on the left edge, and a volume rocker and combined power switch/fingerprint reader on the right edge. Power is supplied via a USB-C port on the top and, unlike the Huawei MediaPad M5, there's a 3.5mm headphone jack too.

The top and bottom edges house stereo, front-facing speakers. Although the Dolby Atmos-infused audio sounds good, the MediaPad M5 is more dynamic.

Screen quality is often what sets apart the premium tablets apart from cheaper devices, and the 8in IPS panel in the Tab 4 8 Plus is bright and detailed thanks to a 1,920 x 1,200 resolution and 283ppi pixel density. The Huawei MediaPad M5 has it licked again, though, thanks to a superior resolution, higher brightness and stronger colours.

Lenovo includes a Snapdragon 625 CPU, 4GB of RAM and 64GB of storage underneath the glass of this "Plus" tablet. (Be aware that the Tab 4 8

ABOVE The M5 Pro's sharp corners are a stylish departure from the iPad-inspired curves of its rivals

model more commonly available in the UK has 3GB of RAM and 16GB of storage, and costs £100 less, so check before you buy.) Its performance is solid, scoring 875 and 4,182 in Geekbench 4, but bad news Lenovo: again the MediaPad M5 is stronger, with its Kirin 960 CPU more than doubling the Tab 4's single-core result. Gaming performance is solid at 9.3fps in the GFXBench Manhattan test, which sounds okay until you see the MediaPad M5's score of 27.3fps.

But, while it may not have the greatest performance of the 8in devices on test, it does have a few other tricks. Like Amazon, Lenovo provides a Kid's Mode to provide a safe environment via age-appropriate apps and parental controls. There's also a Home Assistant Pack, an attachable speaker that turns the Tab 4 8 Plus into a screen-assisted Amazon Alexa, but this doesn't appear to be available in the UK.

The Lenovo Tab 4 8 Plus, as reviewed, costs £299, which undercuts the iPad mini 4 by £100. However, it's also the same price as the 8.4in Huawei MediaPad M5, which is a smarter choice for Android at this price. If you're willing to compromise on performance and storage space, though, check out its sibling with 3GB of RAM and 16GB of storage.

Lenovo Tab 4 10 Plus

A solid 10.1in Android tablet, but lack of Netflix HDR certification hampers its streaming credentials

SCORE ★★★★☆

PRICE £269 (£323 inc VAT)
from pcpro.link/290tab10

The 10in version of the Lenovo Tab 4 Plus has a chunkier and more angular look than its 8in sibling, with thick bezels that make it easier to hold but give it a clunky feel. To our eyes, it's nowhere near as sexy as the Huawei MediaPad M5, iPad or Galaxy Tab S4, but looks are in the eye of the beholder – and at 7mm thick and 475g, it's comfortable to hold.

If you intend to make use of Android's ability to create multiple accounts and loan it out to family members, though, consider investing in Lenovo's rubberized case. Part of its Kid's Pack, this also includes a blue light filter that sits on top of the glass.

From the placement of the fingerprint reader, it's clear that

Lenovo intends the Tab 4 10 Plus to be used in landscape mode. The fingerprint reader itself is a little picky and we found simply unlocking with a PIN to be much quicker. In landscape mode, the power and volume buttons sit on the left edge, with the headphone, SD card slot and USB-C port on the right edge. In this orientation, the stereo, front-facing speakers sit at the top and pump out respectable levels of Dolby Atmos-powered volume, although the Huawei MediaPad M5 has better sound quality.

The 10.1in IPS panel shares the same resolution as the 8in version,

ABOVE What the Tab 4 10 Plus lacks in looks it makes up for in portability at just 7mm thick

offering 1,920 x 1,200 resolution in landscape mode. Pixel density reduces to 224ppi, but everything still looks sharp. HD video content looks great, but note that the Tab 4 Plus isn't present on Netflix's list of certified devices that support HD content – both the 8.4in and 10.8in MediaPad M5 tablets are certified.

Lenovo supplied us with the 10 Plus that includes a Snapdragon 625 CPU, 4GB of RAM and 64GB of storage, but be aware that the model more commonly available in the UK has 3GB of RAM and 16GB of storage. Its performance was solid in all our benchmarks – see the graphs opposite – but still well behind the 10.8in Huawei and 9.7in iPad. Battery life also proved respectable and the tablet looped our test video for 10hrs 21mins, thanks to the larger chassis being able to accommodate a sizable 7,000mAh battery.

We found the Lenovo Tab 4 10 Plus available for £323, which puts it in a similar realm to the iPad – albeit that upgrading from 32GB to 128GB boosts the iPad's price to £409. Still, unless you're sold on Android, we'd pay the extra for the iPad's superior gaming and media-streaming abilities.

View from the Labs

Before you buy your tablet, make sure you know whether you're looking for something fun or a device with serious intent

Typically, a product can be defined by the function it's designed to perform. Laptops, for example, are all designed for productivity, and while such tasks can range from simple home organisation to complex 3D design, the role they play is fundamentally the same.

Tablets are different. You can buy a tablet for serious work or for viewing videos. Unlike laptops, not all tablets are capable of both sets of tasks – some tablets are geared so much towards entertainment that they should be classed as a different type of device.

Take the 12.9in iPad Pro, the pinnacle of tablet engineering with a price to match. With 512GB of storage it costs £1,119 even before you add any accessories, but for content creators and those who want a compact productivity tool, it truly can replace a laptop. Of course, you can watch *The Bodyguard* on it, and very good it will look too, but you'd be stark raving bonkers to buy an iPad Pro simply to catch up on your favourite shows.

Gareth Ogden is the founding editor of *Custom PC* **and prefers** *Pokémon Go* **to PowerPoint**

"Perhaps most curious of all was that, of all the tablets on test, the one I spent the most time with was the £89 Amazon Fire HD 8"

The Amazon Fire 7 sits at the opposite side of the scale; heck, you could buy two Fire 7 tablets for the price of a single Apple Pencil. Of course, the Fire 7 is hopeless for any sort of advanced productivity task: even if you want to send emails, the fuzzy text makes this an unpleasant experience. But the Fire 7 is designed to be cheap and cheerful, so you can dole them out to your children and slap on a Prime Kids account to keep them out of your hair while you do the hoovering.

I even found that higher-end devices, many of which can cross over between entertainment and work roles, are much more focused towards one rather than the other. The iPad Pro is the prime example, but the new Samsung Galaxy Tab S4 is another. With its DeX mode, pen and keyboard accessory it can, in theory, rival the iPad Pro as a laptop replacement, but in reality it just wants

to have fun. The gorgeous Super AMOLED screen in particular makes it an incredible entertainment device. Sure, you could use the Tab S4 to write emails and tinker with PowerPoint slides, but Fortnite and *The Walking Dead* rank higher on its list of priorities.

So, tablets are curious devices, and after spending time with the 15 machines on test, I could almost split them down the middle into devices that are geared towards entertainment and those that should really only be considered for more serious uses. The point is to be clear about why you need or want a tablet, so you don't end up disappointed by the limitations of a device, or spending too much on something you don't need.

Perhaps most curious of all was that, of all the tablets that littered my desk during this process, the one I spent the most time with was the £89 Amazon Fire HD 8. Hey, sometimes Labs writers just wanna have fun. ●

Test results

Geekbench 4 (single core)

Device	Score	
Apple iPad Pro 10.5in	Recommended 3,930	
Apple iPad Pro 12.9in	3,925	
Apple iPad	2,490	Labs Winner
Microsoft Surface Go	2,050	Recommended
Huawei MediaPad M5 Pro	1,904	
Samsung Galaxy Tab S4	1,888	
Huawei MediaPad M5	1,882	Recommended
Apple iPad mini 4	1,694	
Acer Chromebook Tab 10	1,295	
Lenovo Tab 4 8 Plus	875	
Lenovo Tab 4 10 Plus	862	
Amazon Fire HD 8	664	Recommended
Acer Iconia One 7	623	
Acer Iconia One 10	534	
Amazon Fire 7	356	

Geekbench 4 (multicore)

Device	Score	
Apple iPad Pro 10.5in	Recommended 9,380	
Apple iPad Pro 12.9in	9,262	
Samsung Galaxy Tab S4	6,506	
Huawei MediaPad M5	Recommended 6,194	
Huawei MediaPad M5 Pro	6,171	
Apple iPad	4,204	Labs Winner
Lenovo Tab 4 8 Plus	4,182	
Lenovo Tab 4 10 Plus	4,032	
Microsoft Surface Go	4,026	Recommended
Acer Chromebook Tab 10	3,176	
Apple iPad mini 4	3,058	
Amazon Fire HD 8	1,854	Recommended
Acer Iconia One 7	1,734	
Acer Iconia One 10	1,467	
Amazon Fire 7	1,143	

GFXBench Manhattan 3 (offscreen, fps)

Device	Score	
Apple iPad Pro 10.5in	Recommended 58	
Apple iPad Pro 12.9in	46	
Samsung Galaxy Tab S4	36	
Huawei MediaPad M5 Pro	28	
Huawei MediaPad M5	27	Recommended
Apple iPad	26	Labs Winner
Microsoft Surface Go	21	Recommended
Apple iPadmini 4	15	
Acer Chromebook Tab 10	10	
Lenovo Tab 4 8 Plus	9.3	
Lenovo Tab 4 10 Plus	9.2	
Acer Iconia One 10	9	
Acer Iconia One 7	7.6	
Amazon Fire HD 8	7	Recommended
Amazon Fire 7	Did not run	

Battery life (video rundown test)

Device	Time	
Samsung Galaxy Tab S4	17h 50m	
Apple iPad	Labs Winner 14h 47m	
Amazon Fire HD 8	Recommended 13h 4m	
Huawei MediaPad M5 Pro	12h 59m	
Apple iPad Pro 10.5in	Recommended 12h 59m	
Huawei MediaPad M5	Recommended 12h 49m	
Apple iPad Pro 12.9in	12h 18m	
Apple iPad mini 4	10h 42m	
Lenovo Tab 4 10 Plus	10h 21m	
Acer Iconia One 10	9h 37m	
Acer Chromebook Tab 10	8h 57m	
Lenovo Tab 4 8 Plus	8h 47m	
Amazon Fire 7	8h 30m	
Microsoft Surface Go	6h 44m	Recommended
Acer Iconi One 7	6h 9m	

The Network

Practical buying and strategic advice for IT managers and decision makers

BUSINESS FOCUS

How to choose the right remote support software

Dave Mitchell puts four market-leading remote support packages to the test, and explains what to look for before you buy

Anyone who's worked with an IT support team will know that diagnosing and resolving user issues is a never-ending endeavour. Unfortunately, manpower is limited and, unless you're a very small office, it's simply not practical to have staff making personal visits to everyone's desktop. The problem only gets worse when you're supporting staff who are based in branch or remote offices – or, increasingly, at home.

Unfortunately, telephone support is no substitute. It's frustrating and time-consuming for all parties as the poor non-technical user tries to explain their problem, and the support agent tries to guide them through the steps needed to diagnose and fix it.

The answer is remote support software, which allows technicians to connect to recalcitrant systems, see for themselves precisely what the problems are and fix them without leaving their desk. And the growing number of cloud-hosted solutions makes it easy to extend support beyond the local network, and out to remote offices and workers.

This month, we try out four remote support software products from some of the biggest names in the market – namely ConnectWise, ISL Online, Netop and NetSupport. We test on-premises, cloud-hosted and hybrid solutions to help you decide which one's right for your business. Believe us, your support department will thank you for it.
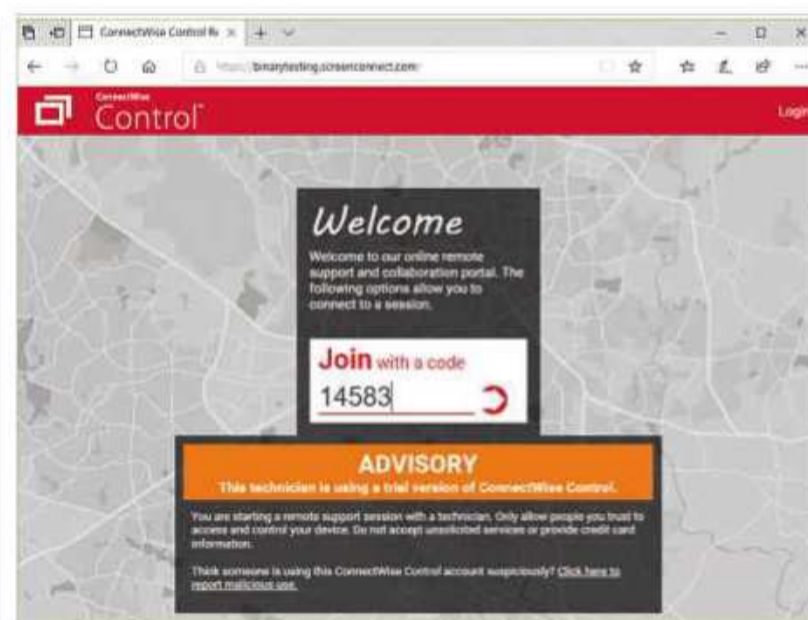
ABOVE Users must be wary of unsolicited connection requests

■ Play it safe

The big concern with remote support is security. If support agents are able to remotely access users' desktops, then so in theory could an intruder.

To ensure this doesn't happen, the products on review support multiple authentication methods, including unique access codes, password protection and support for Active

Directory. All communications between host and guest are secured with AES 256-bit encryption, to protect sensitive data from snoopers.

End users also need to play their part. Many remote access products allow the user to refuse an unexpected remote connection, or one where they can't verify the identity of the person requesting it.

For this reason, we'd advise against free remote access software such as Chrome Remote Desktop or Windows 10's built-in Quick Assist feature. These are fine for helping family members in times of trouble, but they have much more limited security and management features. Indeed, all such potential back doors should be blocked on your network.

■ Unattended access

All remote support products require an agent to be loaded on the client system, to receive connection requests from your support staff. This doesn't have to be permanently resident, however: in an "on-demand" remote support model, the user downloads a lightweight, temporary agent to give the technician access, which is then removed once the session has ended. This ensures there's no possibility of an intruder gaining illicit access.

One catch with this approach is that sometimes a technician will need to reboot the remote system – which results in the support software being unloaded, so they need the user to re-authorise the connection once the system has restarted. A number of products work around this by temporarily installing the agent as a service which automatically restarts with Windows.

The other problem with on-demand support is that the user needs to be present, so you can't use it for unattended maintenance: for this you need a permanently loaded agent. The majority of products offer separate on-demand and unattended agents, and the latter can normally be pushed directly to the client from the technician's console.

If you're going down this route, make sure that the permanent agent offers strong password protection – and check that the unattended agent can only be installed when a user is present to verify the requester's authenticity, to minimise the potential for abuse.

■ Cloud or on-premises?

For a small business with workers dotted about the country, cloud-hosted remote support is the perfect choice. You don't need to set up a central management server, and technicians can open remote sessions from anywhere on the internet.

This is often handled using a code system, where support agents get a unique code from the web portal, which a remote user must then enter to authorise the connection.

For larger businesses seeking total control over remote support, an on-premises software solution will be a better choice. Here you install the management software on your local network, and direct all operations from there.

The downside of on-premises support is that it may be more complicated to support remote workers. Hybrid support platforms let you combine local management with a cloud service that links multiple sites together – but check whether this capability is included as standard, as some products only offer it as a chargeable option.

■ Support tools

All remote support tools provide basic remote desktop access, but there's also a range of secondary tools that can be very helpful, such as chat services and drag-and-drop file copies between technician and user. Some products also offer a Registry editor, and the ability to capture a video of your session for later review.

One feature that's worth looking out for is a hardware and software inventory service, which allows technicians to see what's loaded on the user's PC prior to starting a support session. This can also be a good starting point for a more general audit of your network.

Consider platform support, too. We've focused mainly on Windows, but all four of the products on test this month also support Mac and Linux clients. Just be aware that they may not work identically on all platforms: for example, on macOS High Sierra all of this month's unattended access packages had to be manually installed, and one support client also had to be manually
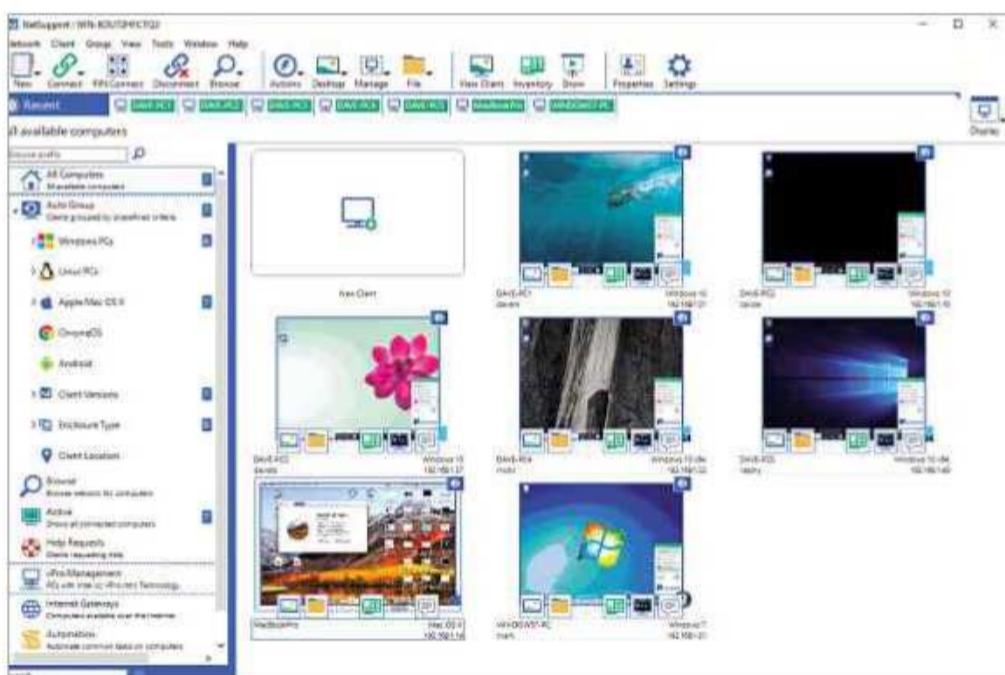
TOP Features may vary on different operating systems: read the small print

ABOVE On-premises software is great for hands-on IT support

BELOW Netop is a hybrid solution that offers both cloud and on-premises access

configured to connect to the provider's cloud service.

When it comes to iOS, remote access isn't possible, owing to Apple's security model. But many products include free iOS and Android apps that let you control remote systems from a smartphone or tablet.

The right remote support solution will speed up problem resolution and help your IT department do more with less. Read on to see which one's right for your business.
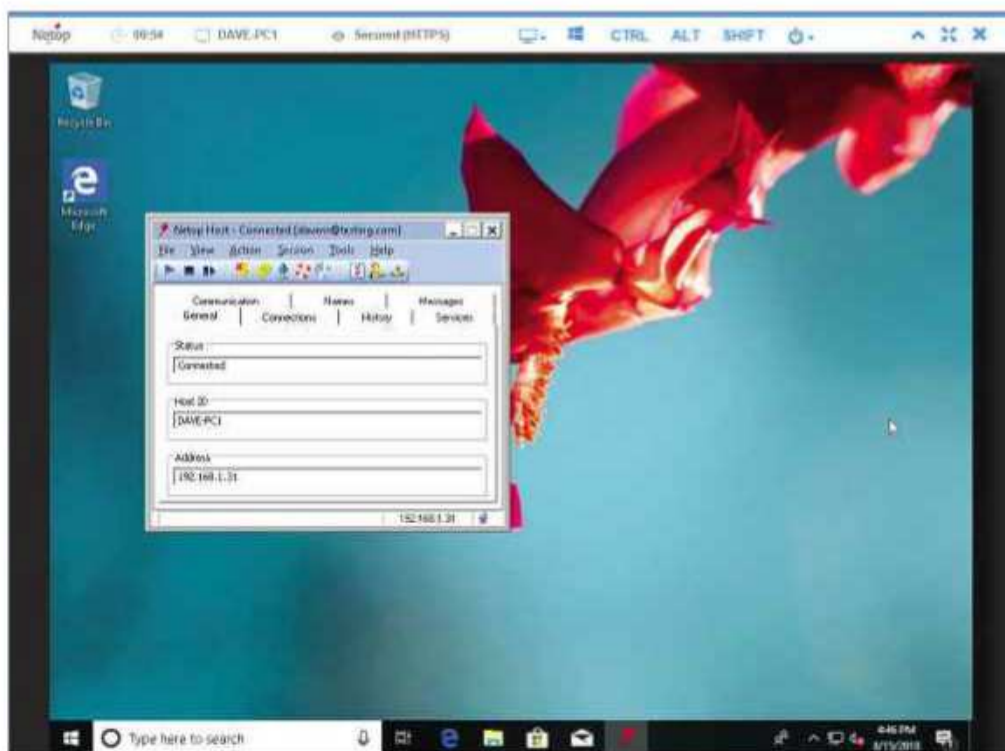
ConnectWise Control 6.7

A versatile cloud support solution, offering myriad branding options and a flexible licensing model

SCORE ★★★★☆

PRICE From £15 per month (exc VAT)
from connectwise.com

If you're not satisfied with a generic support solution, ConnectWise Connect will be right up your street. It offers a great range of features that can be customised with your own branding.

Licensing options are very flexible, with prices starting at around £15 per month for a "One" licence. As the name suggests, this allows one technician to open a single connection to up to ten unattended agents – and also gives you access to file transfers, web meetings and remote printing features. The next step up is a "Standard" licence; from around £28 per month, this permits up to three sessions per user and adds unlimited unattended agents, VoIP audio for meetings and support for the iOS and Android mobile guest clients.

Getting set up on the cloud portal requires no technical knowledge whatsoever. You simply need to provide an administrative email address and a company name, which then forms part of the URL your clients will use to access support.

Starting a remote session is quick: the portal's support page presents a connection URL and a five-digit code. You can directly email these to the user, copy them to the clipboard or, for session booking, save them as an ICS file for your calendar.

When the client enters the correct code, the Connect app loads up on the remote system and links with the portal. The technician will see when they have done this, and can then double-click to start a session.

Once connected, you get a complete interactive view of the user's desktop, along with a feature-packed toolbar. From here you can initiate file transfers, capture or annotate the client's screen, activate session recordings, start a voice or text chat and share your own screen. There's also a useful option to reboot the client and reconnect without having to install a permanent agent. We tested this on both Windows 10 and macOS High Sierra and found it worked perfectly every time.

If you want to set up unattended access, you can use the Build page of the portal to create a tailor-made agent installer for Windows, macOS and Linux. Once we'd installed these on our Windows 10 and MacBook clients, they promptly appeared in the portal's Access page ready for anytime connection.

ABOVE The ConnectWise portal offers plenty of technician tools

The portal also features a handy sidebar. By default, this shows a thumbnail of the client's screen, but you can switch it to show a basic hardware inventory, a list of messages exchanged or commands sent and a graph showing who last conn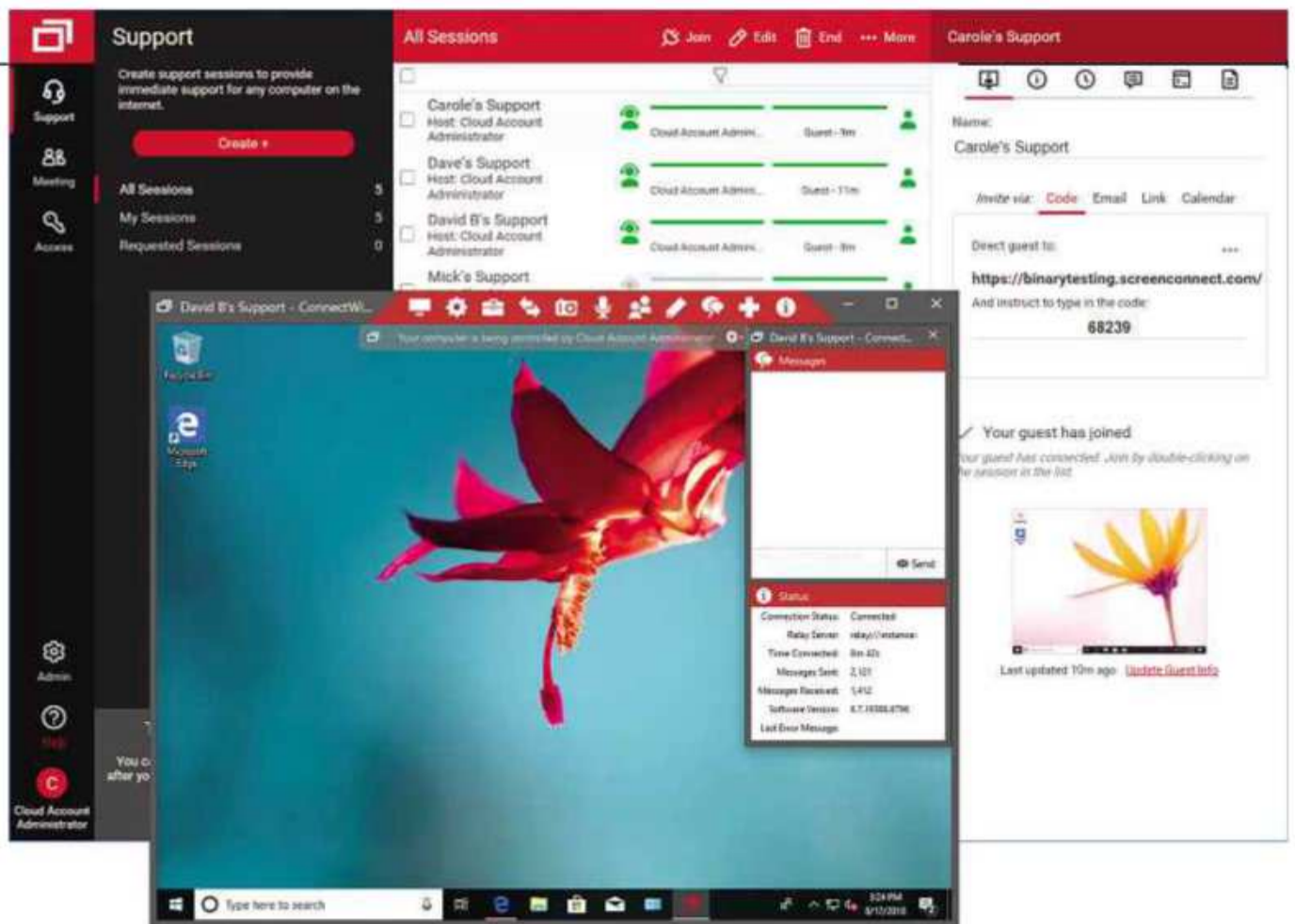ected and for how long. You can place selected clients in session groups for easier management, and there's a built-in web conference service, too. It's accessed using a custom company URL and meeting code, which brings up an interface for screen sharing, audio chats and messaging.

If the web portal isn't convenient, the native apps for iOS, Android and Chrome OS offer the same key features as the browser interface. Just be warned that the iOS client requires iOS 11 or later – so it wouldn't work on our fourth-generation iPad, which can't be updated past iOS 10.3.

ConnectWise's final distinctive feature is, as we've mentioned, its support for custom branding. Within the portal we were able to choose themes and modify any part of the front-end with our own company logos. We were even able to use our own favicons for the browser, and set a custom system tray icon for the agent.

ConnectWise Connect is a great choice for businesses seeking the simplicity of a remote support solution, while retaining a good set of features and control over their own branding. It's reassuringly secure, client connections can be made in double-quick time, and the pricing options mean it's accessible to organisations of all sizes.

> **"If you want to set up unattended access, you can create a tailor-made agent installer for Windows, macOS and Linux"**

REQUIREMENTS Windows 7/Server 2008 upwards ● macOS 10.8 upwards ● Linux ● Mobile apps: Android/iOS 11/Chrome OS

LEFT Custom agents are used to provide always-on access

ISL Online

A great-value cloud-hosted remote support solution that's easily managed, versatile and secure

SCORE ★★★★★

**PRICE** Cloud/1 licence, £259 per year (exc VAT) from islonline.com

ABOVE The portal provides easy access to support, chat and web conference tools

Managing costs is one of the key reasons for choosing a cloud service – and ISL's cloud-hosted remote support service offers a novel payment option that many smaller businesses will love. Rather than charging an annual fee for a set number of technicians or clients, ISL's basic pay-per-use offering grants you 500 minutes of unrestricted remote access for a one-off fee of £70.

Even if you step up to a full cloud licence, it's a flexible system. An annual subscription of £259 covers any number of support staff, but only allows one concurrent active session. To enable more technicians to connect at once, you simply need to buy additional licences. Or, if you want an individual technician to be able to open simultaneous sessions with multiple clients, you can upgrade a licence for an extra £89.

What you get for your money is a well-featured remote support solution, featuring remote desktop control, file transfer, text chat, voice and video calls, plus session recording for Windows, Mac and Linux clients. There are also free iOS and Android apps to help technicians offer remote support on the move.

The web portal is easy to use, with icons at the top for initiating on-demand remote sessions and opening unattended sessions. You can create any number of user accounts, place selected clients into groups and share access to them with other technicians.
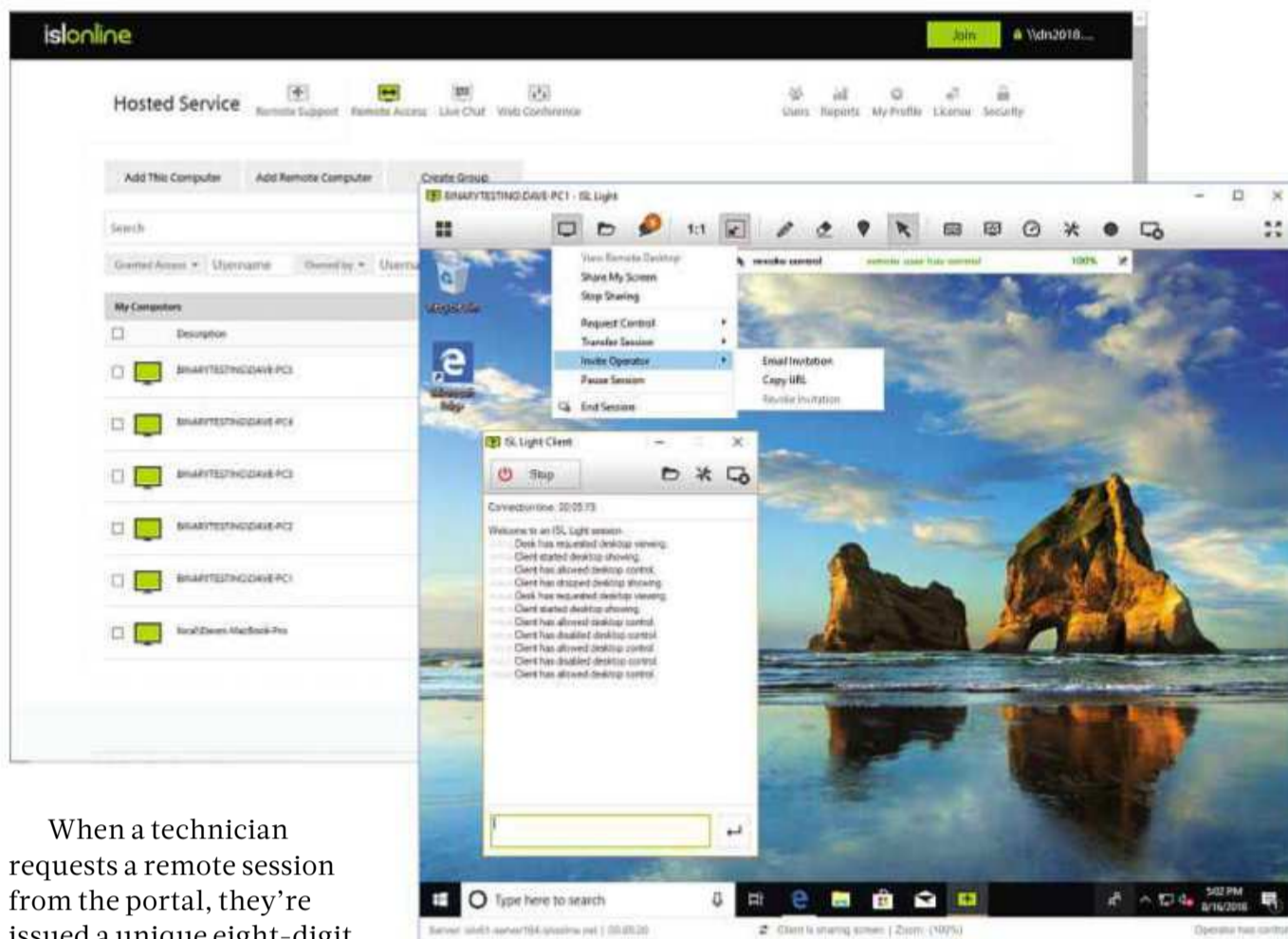
When a technician requests a remote session from the portal, they're issued a unique eight-digit code, and presented with a button that emails a web link directly to the client. When the user clicks the link and provides the code, the ISL Light app is installed on their system; this handles screen sharing and also provides a control bar allowing the user to close the session at any time.

The technician, meanwhile, gets their own view of the client's screen, including their own toolbar, which offers quick access icons for a range of tools. From here, they can share their screen with the client, ask to take control, transfer the session to another technician, invite others to join and start session recording. We particularly like the file transfer tool, which lets you send local files directly to a specified location on the remote machine, or pull specific files from it. Enabling administrative mode also gives the technician the ability to restart the machine and automatically resume the session, so they don't lose access if they make changes requiring a reboot.

For unattended access, you can install the ISL AlwaysOn app. We had no problems loading it on both Windows and macOS clients, and installation took only a matter of seconds. To ensure opportunist hackers can't use it as a back door, the app requires the client to configure a password, which the technician must enter to gain access. The installer comes preconfigured for a specific cloud account, and is only initially available to the technician that sent the installation request. And as a final layer of security, clients can switch remote access off at will, to ensure that unattended access is only available at pre-arranged times.

Live chat services are provided by the free ISL Pronto application, but keep in mind that this requires an on-premises Windows or Mac host. You can also run web conferences from the ISL web portal; when you click to join the meeting, the free ISL Groop app is downloaded, allowing users to converse and share screens or slide presentations.

ISL Online does everything most businesses could ask for from a remote support product, with excellent platform support and features. It will appeal particularly to smaller businesses that only need to make occasional use of its capabilities, since its licensing scheme allows them to tailor costings precisely to their needs.

PC PRO RECOMMENDED

"ISL's basic pay-per-use offering grants you 500 minutes of unrestricted remote access for a one-off fee of £70"

LEFT macOS clients are fully supported and there are tools for Android and iOS

REQUIREMENTS Windows 7/Server 2008 upwards ● macOS 10.8 upwards ● Linux ● Mobile apps: Android/iOS 9

Netop Remote Control 12.72

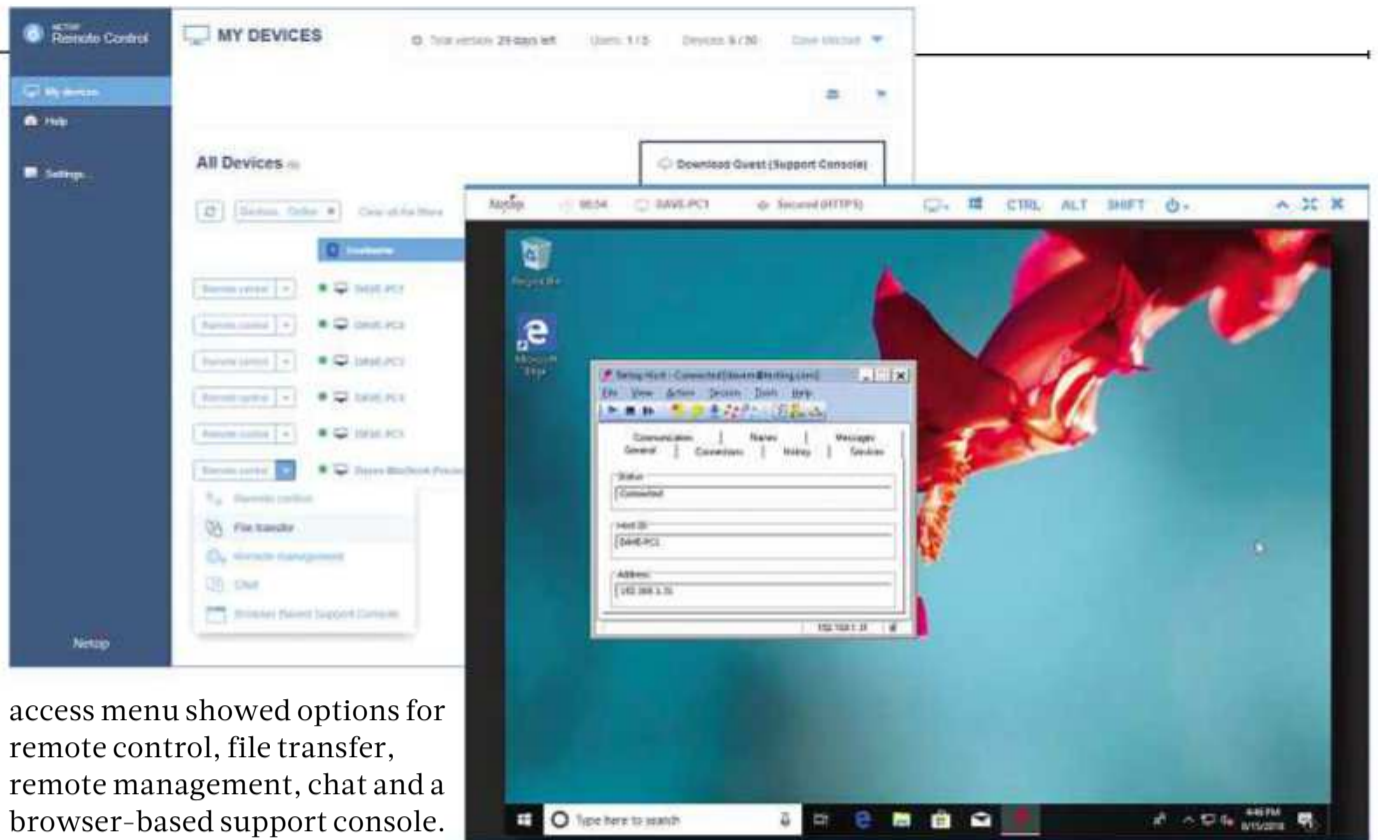An affordable hybrid solution offering handy in-browser support and great access controls for your team

SCORE ★★★★☆

PRICE Perpetual: 1 guest/10 hosts, £625 (exc VAT); Subscription: 100 Hosts, £1,075 per year (exc VAT) **from** netop.com

Netop's remote support product is a hybrid service that gives you the best of both worlds. Its web portal helps you reach remote clients and provide support from anywhere on the internet, while on-premises users get the benefit of additional management services and features such as a system inventory.

To get started, you simply need to install the host component on each workstation. Enrolment packages can be downloaded directly from the web portal, and to streamline the process they can be preconfigured with unique signatures and set up to link the host directly to your account. For extra security, you can also apply a hard-coded time-limit on how long the agent will work for, and how many times it can be used. Once you've enrolled your clients, you can also use custom packages to place them into support groups.

We installed the default package on a selection of Windows 10 hosts, all of which showed up in the web portal account as soon as the install had finished. Next to each one, a quick-access menu showed options for remote control, file transfer, remote management, chat and a browser-based support console.

Installing the host on our MacBook clients was a bit more time-consuming; the package comes down as a DMG disk image, which must be mounted prior to installation, and you have to manually enter your portal account details – this isn't complicated, just tedious.

Still, Netop Remote Control has some real plus points. As well as managing clients, you can manage the staff within your own support team, specifying what different technicians can do on a host: team members can receive full remote control or view-only access, and you can determine whether a support agent is allowed to use file transfer and chat.

A remote session can be launched by simply clicking next to a device in the web portal. This opens up a remote desktop session directly in your browser, offering simple remote control plus options to lock, restart or shut down the host.

There are buttons for launching file transfer, remote management and chat. These don't run in the browser, however, but rather launch the

> **"As well as managing clients, you can manage your own support team, specifying what different technicians can do"**

standalone Netop Guest app and trigger the requested function. If it's not already installed, this lightweight tool can be downloaded from the portal in a matter of minutes, and can be used independently of the online portal. We suggest you use the Guest app where possible, as not only does it offer many more functions than the web-based interface, it also has a much slicker remote control interface, with handy shortcuts for remotely running programs and accessing the host's Windows Management console.

If you're providing on-premises support, you can also use the Guest app to browse the network and see a list of supported hosts that are available to connect to over TCP/IP. Moreover, for convenience, you can set up a "phonebook" of shortcuts to selected hosts, which stores authentication, encryption and compression details.

As a final nice touch, the Guest console is also able to generate a hardware and software inventory of each remote system, and we found this to be impressively accurate. It correctly identified the CPUs, memory and hard disks in our diverse range of clients, got all the host OS versions right and provided a complete list of software applications.

Mac deployment could be smoother, but once it's up and running, Netop Remote Control delivers a versatile mix of cloud and on-premises remote support services. Its access controls are ideal for offices that rely on agency staff, and there's the option to buy either a perpetual licence or an annual subscription to suit your finances.

REQUIREMENTS Windows 7/Server 2008 upwards ● macOS 10.7 upwards ● Linux ● Mobile apps: Android 4 upwards

NetSupport Manager 12.5

A classy on-premises solution, packed with useful features and priced right for businesses of all sizes

SCORE ★★★★☆

PRICE 1-500 systems, £10 each (exc VAT)
from netsupportmanager.com

SMBs seeking a no-nonsense, on-premises remote support solution will struggle to do better than NetSupport Manager 12.5. It boasts an unparalleled suite of support tools, it works with almost every platform out there, and its perpetual licensing scheme means you have no ongoing subscription fees to worry about.

Needless to say, remote control, file transfer, chat and recording facilities are all present. There's also a detailed system inventory capability. And platform support is excellent, with clients available for all versions of Windows plus macOS, Linux, Google Chrome OS and Android.

For accessing remote sites, NSM doesn't use a web portal, but rather a bespoke gateway component, which links together technician and user when both enter the same unique PIN. Encryption options include 256-bit AES to ensure the connection is secure from end to end.

Getting set up is a swift process. We had the management software up and running on a Windows Server 2016 host in five minutes, and were then able to push the client out to selected systems and run discoveries on AD domains, workgroups and IP address ranges. We were impressed by how smoothly this went, with the client landing on each of our Windows 10 desktops in about 30 seconds. At this point you can also password-protect clients, apply Active Directory access policies and restrict what tools each technician can access.

The only disappointment is that you can't remotely deploy the NSM agent to macOS clients. For these systems, we had to download the client from the NetSupport website and install it manually on each Mac.

Still, once all our Windows and macOS clients had been deployed, the main control console made it a breeze to browse them, arrange them into custom groups and search for specific ones using all or part of their machine name. For larger organisations, the smart grouping function is likely to be very useful too, allowing you to instantly sort all your clients into lists

ABOVE The NSM Control console provides easy access to clients for remote control and many other support tasks

> **"Once all our Windows and macOS clients had been deployed, the main control console made it a breeze to browse them"**

BELOW We used the iOS Mobile Control app to remotely support our Windows and macOS clients

based on their OS version, physical location or other attributes.

The console shows a live thumbnail view of each client, and you can just double-click to connect. Icons below provide instant access to remote control, file transfer, command prompt, chat and inventory tools. Right-click on a client icon and you'll see additional options allowing you to reboot the computer, log out the user and remotely execute apps. Integration with Windows means you can also use File Explorer to browse the network and directly open a remote control session, initiate a chat or view a system's inventory.

The file transfer tool, meanwhile, appears in a separate window, showing the contents of the local and client machines for simple drag-and-drop file copies. It's partnered with a handy file distribution tool that allows you to send selected files to multiple clients in one go.

There's also a free control app for both iOS and Android devices, which can connect to any network device running the client. We tried this on our iPad and had no problem firing up remote control sessions, having a text chat and rebooting the system.

For some, a cloud-based service will make more sense, but if you want an on-premises solution, NetSupport Manager is the best on the market. It's easy to deploy, it delivers a wealth of features – and it's very competitively priced, too.

REQUIREMENTS Windows 7/Server 2008 upwards ● macOS 10.5 upwards ● Linux ● Mobile apps: Android, iOS
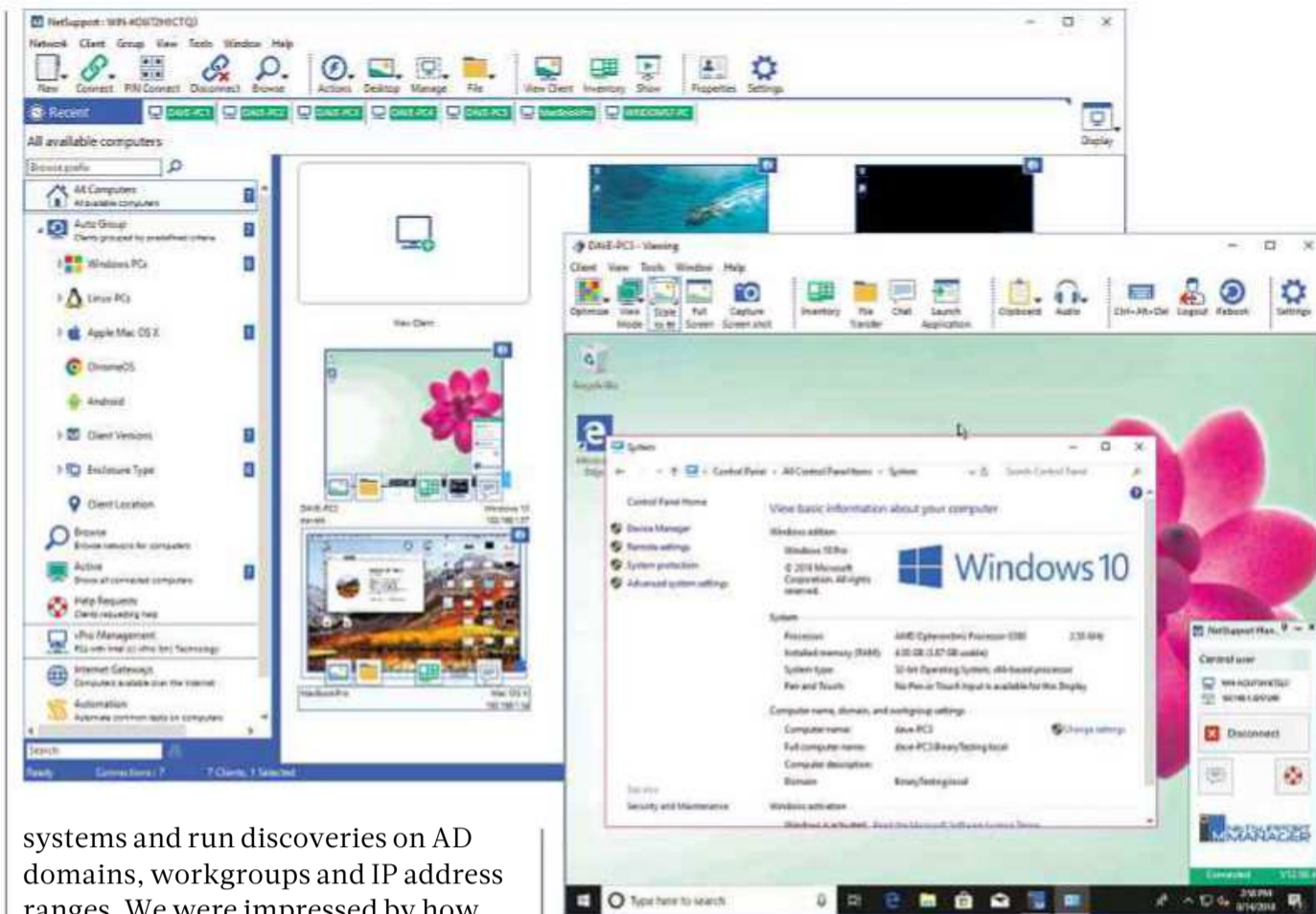
AdRem NetCrunch 10.4

A fast, affordable network monitoring suite that can keep an eye on a huge range of devices and services

SCORE ★★★★★

PRICE NetCrunch Suite, 250 nodes, £4,844 (exc VAT) from adremsoft.com

The latest version of NetCrunch may be only a point update, but AdRem certainly hasn't skimped on new features. The software's "monitoring packs" group together common sets of performance monitors, and version 10.4 adds no fewer than 32 new ones to the mix, bringing the total number of monitoring components to 187.

They're significant additions, too. The new monitors give NetCrunch the ability to keep watch over security devices from Cisco, Fortinet, Juniper and SonicWall, plus NAS appliances from Buffalo, Netgear, Qnap and Synology. Server monitoring sees big improvements too, thanks to added packs for Dell EMC iDRAC, Fujitsu iRMC, HPE iLO and Lenovo IMM remote management controllers.

One aspect of NetCrunch that's always impressed us is how quickly it gets to work monitoring your network. After installing the latest version on a Windows Server 2016 host, we followed the discovery wizard and were looking at a complete breakdown of our lab network in just 15 minutes.

It's no quick and dirty audit, either. NetCrunch found and correctly identified all our Windows Server 2012 R2 and 2016 servers, Windows 7 and 10 workstations, VMware ESXi hosts, printers and HPE network switches. It picked up our MacBooks too, correctly noting they were running macOS High Sierra, and even alerted us that one of them was running dangerously low on available memory.

To find other issues on your network, the Top Charts tab is the place to go, revealing systems with the highest CPU, memory and storage usage, plus those with the most pending alerts and any that have high levels of network traffic. If the default displays don't cover the issues you're concerned about, you can add your own dynamic charts, performance counters and device filters.

Or, if it's a complete overview of your network you're looking for, NetCrunch's "Atlas" view lists all your network devices, conveniently colour-coded so you can see at a glance which ones have problems or are unresponsive. The Smart Pages feature automatically updates your view based on the content selected in the left-hand pane: selecting a network segment brings up a Layer 2 map with real-time views of network traffic passing between each node.

If you want to single out an individual system, the console also provides full search facilities, making it easy to find a device of interest. We were quickly able to pull up details about each of our Windows, Mac and Linux systems, and NetCrunch was even able to provide full performance statistics for our ESXi servers, with

ABOVE NetCrunch provides a great set of server-monitoring components

> **"NetCrunch was even able to provide full performance statistics for our ESXi servers, with resource details for every VM"**

LEFT The dashboard shows network traffic passing between nodes in real-time

graphs on datastore usage and status and resource details for every VM. Note, though, that Hyper-V support isn't so comprehensive: NetCrunch will give you details of host CPU utilisation and Hyper-V Windows Management services, but it can't provide any information about the VMs themselves.

Regular readers will know we're fans of server management tools, and for us NetCrunch's new monitoring pack for HPE's iLO platform is another godsend, bringing alerts such as fan and power supply failures right into the NetCrunch console. The software can even access HPE's internal sensors, and show details on fan speeds, internal temperatures and overall power usage.

NetCrunch isn't just for passive reporting, either. You can set up actions to carry out commands in response to certain triggers, including sending an alert email, launching a script, restarting Windows services and even rebooting an entire system.

For large support departments the free GrafCrunch web server is a final plus point, as this can drive a big, highly visible display of whatever metrics you want to keep an eye on. We used it to show real-time graphs of CPU, disk, memory and network usage for our critical Windows servers, and we're pleased to note that the latest version fully supports Microsoft Edge.

AdRem's NetCrunch has long been one of our favourite network monitoring tools, and the new features make it more versatile than ever. Its node-based licensing scheme keeps things affordable for SMBs, deployment is a swift 15-minute task, and the highly visual management console means you never need to worry about missing a network problem again. **DAVE MITCHELL**

REQUIREMENTS

Windows Server 2008 R2 upwards ● Options: yearly maintenance, 33% of initial price
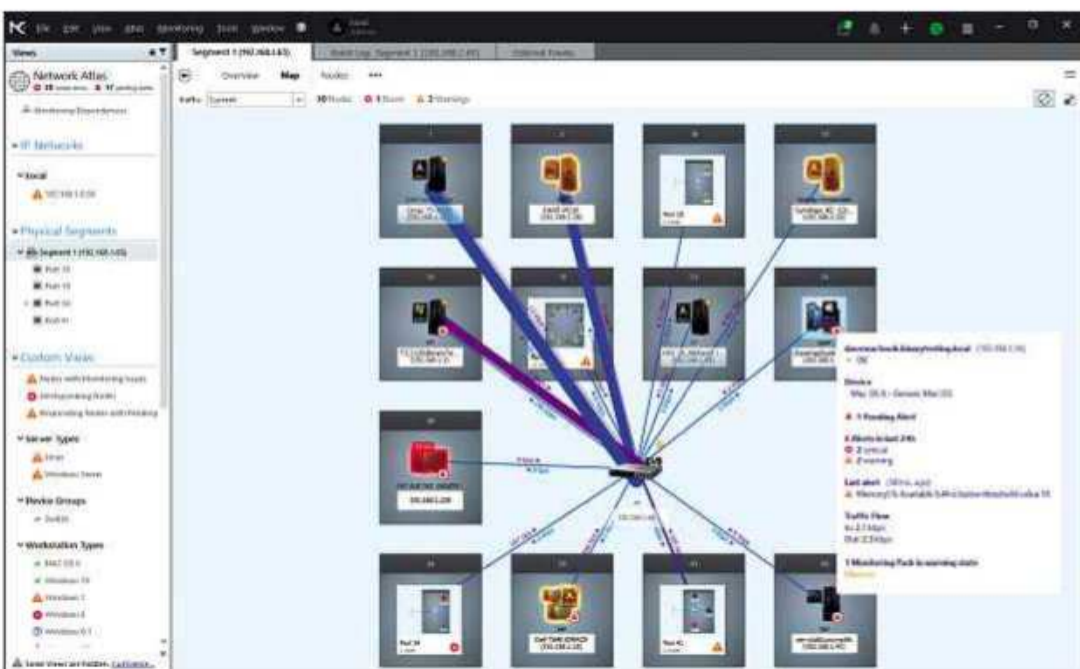
WatchGuard Firebox M270

A powerful security appliance that's chock-full of tough protection measures and priced right for SMBs

SCORE ★★★★★

PRICE With 1yr Total Security Suite, £2,743 exc VAT from watchguard-online.co.uk

Small and medium sized businesses are now the go-to place for cyber-criminals as they're seen as soft targets. They need to stiffen their network defences and WatchGuard has the perfect solution, as its Firebox M270 offers enterprise-class security and performance at a sensible price.

Recommended for businesses with around 60 users, this 1U rack appliance boasts a high raw firewall throughput of 4.9Gbits/sec. Enabling gateway AV drops this to 2.1Gbits/sec and activating all UTM services cuts this to a still very respectable 1.6Gbits/sec.

The price we've shown includes the appliance and a one–year subscription to every security feature you can imagine. It enables web content filtering, application controls, anti-spam, gateway AV, network discovery, IPS, data loss prevention (DLP), Dimension Command and an APT blocker.

There's more as you get WatchGuard's Reputation Enabled Defence (RED) service for tougher web protection. A Gold Support subscription tops it all off nicely , which includes a free remote setup and configuration session with a WatchGuard in-house engineer.

Not that the M270 is difficult to deploy. Far from it, as its web console runs a wizard-based setup routine that creates a base set of firewall policies for securing internet access.

The M270 employs proxies to control different traffic types and each one loads a wizard the first time you access them. Web content filtering takes two minutes to configure. We chose from 130 URL categories, added blocking actions for the HTTP and HTTPS proxies and watched the wizard add new firewall policy rules.

Gateway AV comes courtesy of the Bitdefender scanning engine and can be enabled on selected proxies. You now get double protection from malware as the new IntelligentAV feature in Fireware 12.2 uses the Cylance AI-based engine.

IntelligentAV doesn't rely on signatures and scans files such as Office documents, Windows portable executables and PDFs after they've passed through the Bitdefender engine. It's activated with one-click and applied to all proxies that have gateway AV enabled.

"The M270 is a great choice for securing large remote or branch offices as multiple appliances can be remotely managed in the cloud"

BELOW WatchGuard provides a wealth of security measures, including the new AI-based AV scanner

The new DNSWatch service adds even more web protection by monitoring client DNS requests and blocking access to known malicious domains. It's another service that's both easy to enable and can be applied to all or specific network ports on the appliance.

If you're worried about Facebook sneaking in to the workplace, the Firebox M270 has you covered. The Application Control service manages access to hundreds of predefined apps and its 11 entries for Facebook mean that you can block all usage or fine-tune access and decide, for example, whether staff can chat, like, comment, edit profiles or transfer files on the site.

Spam filtering is easy to apply as the spamBlocker wizard asked us to select incoming SMTP traffic and provide an internal mail server address or just activate IMAP or POP3. We chose the latter for transparent scanning where the POP3 proxy client was set to append the subject line of dubious messages with "Spam", "Bulk" or "Suspect" tags so we could filter them out using Outlook message rules.

The DLP service scans files and emails looking for keywords and can be applied to the HTTP, HTTPS, FTP and SMTP proxies. We created a DLP sensor looking for a group of phrases and when we tried to send Word documents containing these to our external FTP site, the service blocked the transfer.

The M270 is a great choice for securing large remote or branch offices as multiple appliances can be remotely managed in the cloud or via the free Dimension software. We run Dimension in the lab as a VMware VM and, after adding the M270, we could view global threat maps, an executive dashboard and see activities for all its security services.

The Firebox M270 dispels the notion that high UTM performance has to come at a high price. It offers a persuasive range of security measures and is perfect for SMBs that want the same protection as enterprises but at price they can actually afford.
DAVE MITCHELL

SPECIFICATIONS

1U rack appliance ● 4GB RAM ● 8 x Gigabit (WAN, 7 x LAN) ● 2 x USB 3, RJ-45 serial port ● web browser and Dimension Command
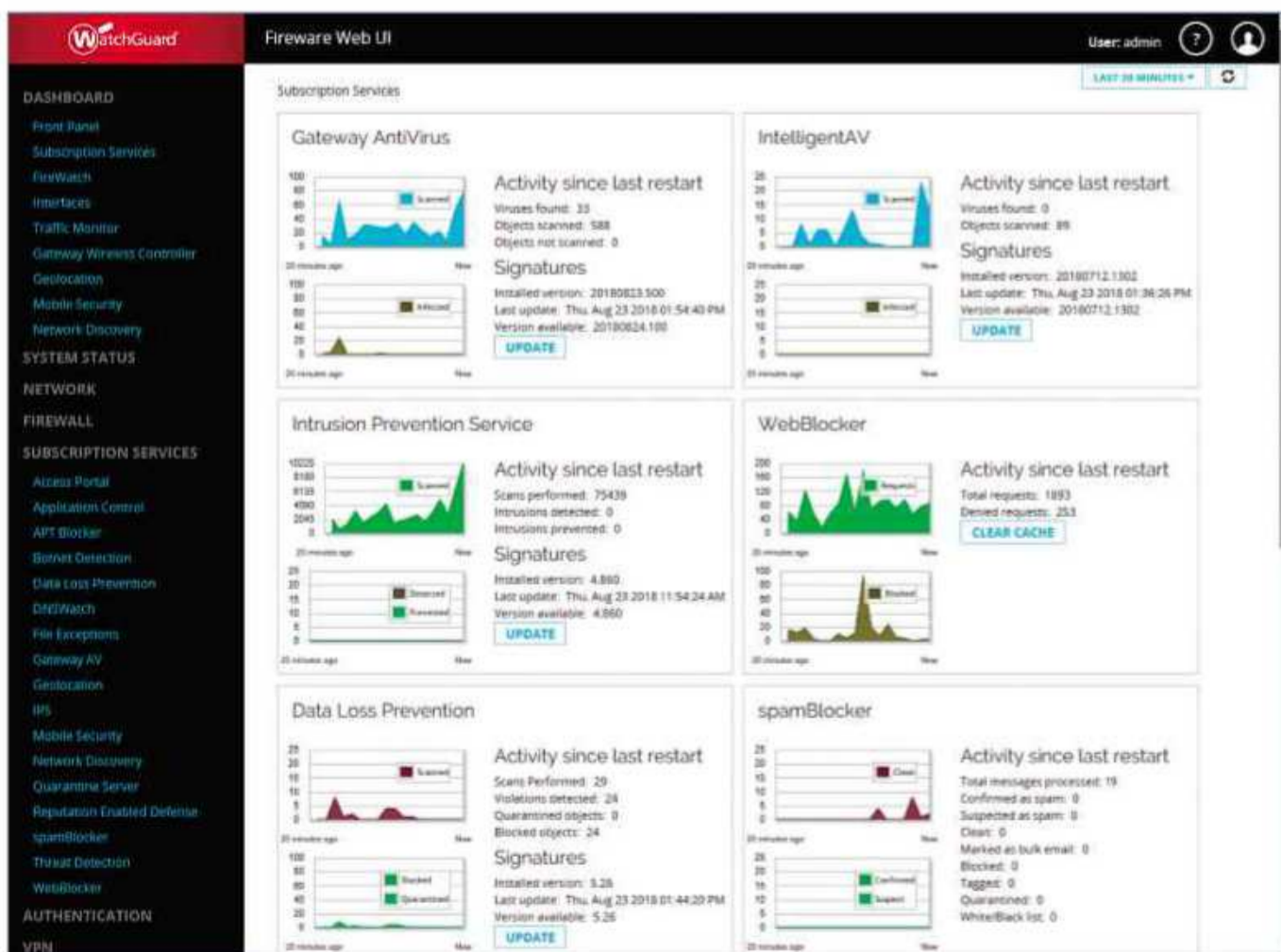
Is your website legal?

Many sites aren't fully compliant with online regulations – and the consequences could be serious. Nik Rawlinson lays down the law

We're sorry to have to tell you this, but you may be breaking the law. In fact, you've probably been doing so for some time.

The problem is your website. In creating and maintaining it, it's natural that you've prioritised design, content and SEO – all the things that bring visitors to your site and turn them into customers. But there are legal requirements that you need to attend to as well. If you've created the site yourself, you might well have failed to take them all into account – and if you've used an out-of-house developer or bought an off-the-shelf template, there's a chance that the issues haven't even been brought up.

So what are those requirements? They're mostly to do with the information that needs to be present on your site. The specifics will vary from business to business; below we'll discuss some of the major issues that affect almost all organisations, but if in doubt we recommend you take professional legal advice, to ensure you're following both the spirit and the letter of the law.

◼ Who are you?

Your website probably includes some sort of contact page, but does it contain all the information it should? Registered companies have a legal obligation to include certain official details on everything from their headed notepaper to their email footers – and their websites.

As a bare minimum, your company name and number, registered office and place of registration should be stated clearly on your website. Note that your registered office might not be your place of business: many companies are registered by accountants or solicitors on behalf of their clients, using their own addresses. If this is the case for you, make sure the distinction between the legal address where notices can be served (your registered address) and the correspondence address for customers is clear. If you're registered for VAT, include your VAT number.

If you're using a template site with a standard footer, consider including the information there so it appears on every page, not just your contact page.

"Your company name and number, registered office and place of registration should be stated clearly on your website"

◼ Collecting information

Is your website being used to collect data? If you have a contact form on your site, the answer is yes. You might assume that, when a visitor sends you a message, they understand it will be electronically stored in some way – even if that only means it sits in your inbox until you have a chance to deal with it. However, you need to make

it explicit at the point of collection that you're gathering potentially personal information.

This is a requirement of GDPR and, as the ICO points out, there are different ways to do it. For clarity, a "layered approach" is recommended, where next to the form you simply present "a short notice containing key information, such as the identity of your organisation and the way you use the personal data". This can then contain links that expand additional layers of information, or direct the reader to a page setting out your data protection details in full.

There's no formal template that you have to follow: in its guidance (**pcpro.link**/**29oico**), the ICO declares that "data controllers have a degree of discretion as to what information they consider needs to go within each layer, based on the data controller's own knowledge of their processing".

You don't need to overload the collection page with legal information – just make sure that the visitor knows where to find the information should they wish to review it. Another possible approach is to use a "just-in-time notice" that pops up when a visitor's cursor enters a particular form field. This again keeps the page clean and easy to navigate, while ensuring that the legally mandated information can't be missed.

Usage data and analytics
As well as accepting messages from your website visitors, you're probably recording information about activity on your site. This includes details of what pages people are visiting and what links they're following – and if you're using analytics plugins to

monitor your web traffic, you'll probably also be tracking their IP addresses, location data and more.

Be aware that GDPR counts this as "personal data". Even if you don't directly identify the visitor, what's collected may well be sufficient to distinguish an individual from other website users. Therefore, you must get consent before starting to track user activity – which is one reason why all those big intrusive overlays have started appearing on websites.

You also need to know that GDPR gives individuals the right to request that their information be deleted. This means you need to appoint both a data controller and a data processor, and make it easy for visitors to find contact details for at least the first of these. If you're not certain what the difference is, the data controller is the person in your business who determines what data needs to be gathered and how it is to be used. The data processor carries out the controller's instructions and

"If you're using cookies, you must alert visitors to the fact, explain what they do (and why) and get explicit consent"

keeps a record of what's been collected and how it's been processed. In organisations with more than 250 employees, it's also necessary to appoint a data protection officer.

Disclosing cookies
Whether or not you're using analytics, there's a good chance that some function of your website relies on cookies. The EU's Privacy and Electronic Communications Regulations state that if you're using cookies, you must alert visitors to the fact, explain what they do (and why) and get explicit consent for storing cookies on their device.

The good news is that you only need to do this the first time you set cookies, but it's important to get the form right. Those using WordPress can take advantage of a wide range of pre-built cookie compliance plugins – just search the repository for "cookie" – which will pop up cookie notices and provide a mechanism by which visitors can opt out.

If you're creating your own cookie consent form, you'll need to ensure that you're presenting all the required information. At the very least, link to a page detailing which cookies you're using, including any third-party cookies set by services such as YouTube when you embed a video, so that visitors can manually delete them, or block them through their browser settings. The same is true of local storage if you're accessing that, and cookies set by plugins such as Flash.

If you're not sure about exactly what information you need to put on your cookie information page, you can always model your own page after the ICO's (**pcpro.link**/**29ocookies**); since this is the body responsible for policing cookie compliance in the UK, it should be a pretty safe example to follow.

What about if embedded elements want to create and
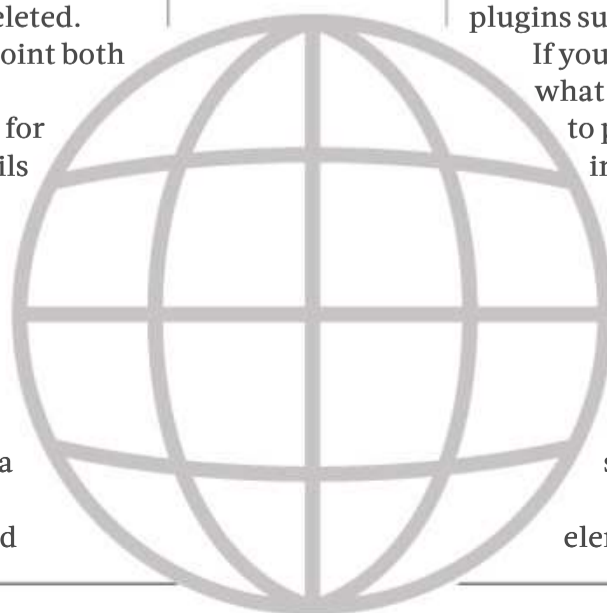
access cookies as soon as they're loaded, before the user has had a chance to give their consent? You're unlikely to get many complaints about this from users – in all likelihood, most will simply click to accept your cookies. However, the ICO warns that "setting cookies before users have had the opportunity to look at the information provided about cookies, and make a choice about those cookies, is likely to lead to compliance problems".

The practice isn't banned outright: the guidance states only that "wherever possible" cookies shouldn't be stored until users have had the opportunity to understand what cookies are being used and make their choice. However, the ICO continues: "Where this is not possible

Protection Act 1988. Lately the requirement has been reaffirmed by the Data Protection Act 2018, which supplements GDPR in advance of the UK's planned exit from the European Union.

Similar to your cookie policy, your privacy policy statement must contain details of the kind of information you're collecting and how long you're going to retain it, who you're going to share it with and how you plan to use it. It should also include contact details for queries,

LEFT You must publish details of all cookies used by your website

BELOW Using a text-based browser can quickly expose any accessibility problems

find the privacy policy statement for **gov.uk**, the website of the UK government – which ought to be pretty reliable blueprint.

Equality Act compliance

The Equality Act 2010 protects people from discrimination, wherever it occurs. When it comes to websites, the bit that you need to pay attention to is Section 20, which concerns itself with what it calls a "duty to make adjustments". This stipulates that your site must not "put a disabled person at a substantial disadvantage […] in comparison with persons who are not disabled".

What does this mean in practice? You might assume that a website would be equally accessible to all, but think about people with mobility restrictions or impaired vision. You might well need to re-engineer some of the workings of your site to ensure it's accessible to such visitors. For example, consider implementing keyboard shortcuts to aid navigation for those who have difficulty using a mouse or trackpad – you'll find a guide at **pcpro.link/290kb**.

Visitors with impaired vision, meanwhile, often rely on screen-reading software – so you should label every element you can, at the very least providing alt tags for images and title tags for links. Using relative rather than absolute sizes in your HTML code will ensure that the page can be magnified gracefully, and using standard HTML elements such as H1 and H2 rather than bespoke styles will help screen readers understand the structure of your page. As a side benefit, it will also help web crawlers parse your site, which could give you a boost in the search engine ratings.

If you don't already know how accessible your website is, try visiting it with a text-based browser such as Lynx. This will give you a demonstration of how easy it is to navigate with a keyboard, and whether you've correctly labelled all the important elements. ●

at present websites should be able to demonstrate that they are doing as much as possible to reduce the amount of time before the user receives information about cookies and is provided with options. A key point here is ensuring that the information you provide is not just clear and comprehensive but also readily available." You can download the complete set of guidance notes from **pcpro.link/290cookies2**.

Your privacy policy

It's been a legal requirement to publish a privacy policy on your website since the passing of the Data

including the name of your data protection officer if you have 250 or more employees, and information on how individuals can withdraw consent for your handling and processing of their personal information. All of this must be written in plain English and be easy to find.

If you're not sure how to draft a privacy policy, again a good starting point is to find an existing policy from a trustworthy source and use it as a template for your own. For example, at **pcpro.link/290privacy** you'll
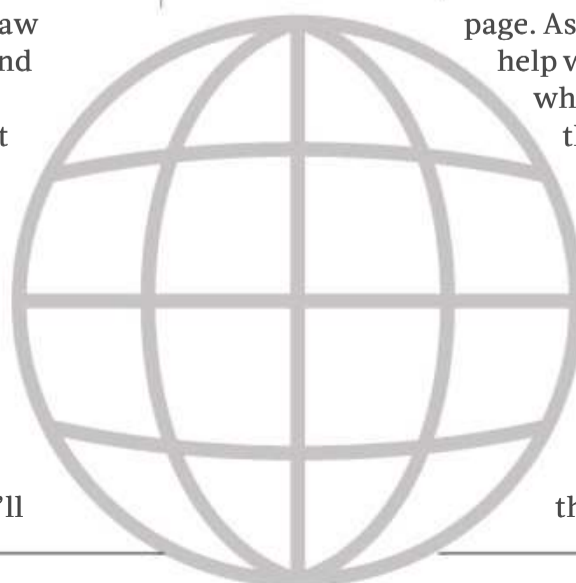
DevSecOps

Davey Winder explains how software development teams can benefit from a culture of security

■ **Even by normal IT jargon standards, "DevSecOps" sounds pretty impenetrable. What gives?**
Well, you may have already heard of DevOps. Short for "development and operations", it's an idea that aims to streamline software development through tight integration between the teams that create the code and those who deploy and manage it.

No surprise, then, that DevSecOps is DevOps with security added in. The DevSecOps mindset calls for security to be a core consideration throughout the development process, rather than something that's left to specialists and only tested at the end phase. If your business has an in-house development team, it's an evolution that's well worth pursuing.

■ **Shouldn't developers already be thinking about security?**
You'd certainly hope so, wouldn't you? However, the DevOps mantra is all about delivering applications at high velocity and minimum cost, and security concerns tend to pull in the opposite direction on both fronts. No surprise they often get sidelined, or relegated to a retrospective exercise in box-ticking.

DevSecOps seeks to ensure that security is built into every stage of development and deployment, by cementing secure thinking into the framework itself. It thus becomes the responsibility of the many and not the few – and more eyes means better security.

■ **So we're talking about a complete change of mindset for both development and operational teams?**
It doesn't have to be that drastic. DevOps is already founded on understanding and collaboration across different functions, so it's not a huge step to add one more perspective into the mix. Ideally, security should quickly become just another part of the process. Gartner, in a recent report, neatly suggested that the goal should be to make "the Sec in DevSecOps silent". And this isn't as difficult to

achieve as you might imagine: the key, as with so much of DevOps, is automation.

■ **Surely trying to automate security processes is asking for trouble?**
Not necessarily. When you think about it, most businesses already rely to a large degree on automated security testing and tools to protect their systems and data. There are plenty of similar automated tools for testing code functionality, so that holes and potential exploits can be identified and flagged up long before a project hits the production stage – helping to minimise the impact on costs and schedules. Automation can help towards the end of the process too, by using scripted tools to analyse and attack a deployment candidate running on a virtual machine.

■ **So will DevSecOps allow us to lay off our in-house security staff?**
In a sense, it will greatly increase the size of your security team, by bringing everyone involved in DevOps into it. Of course, you can't really train every developer to be a security specialist, but given the right tools and the right mindset, security vulnerabilities become just another bug that needs to be detected and corrected.

■ **And how costly will it be to adopt this new philosophy?**
There's a cost in moving to any DevOps system, but progressing from there to a fully integrated DevSecOps model shouldn't be a major upheaval. Most medium-sized businesses will already have the requisite security expertise on hand, and the automated tools don't have to be expensive: there are plenty of open-source packages that are tailor-made to promote a secure software development lifecycle. ●

> **"Given the right mindset, security vulnerabilities become just another bug that needs to be detected and corrected"**

Putting the "Sec" into DevOps

1. Don't expect developers to adapt their workflows to meet the needs of your security tools. Rather, seek to choose and adapt your testing and compliance processes so as to integrate with the existing DevOps toolchain as much as possible. Remember, it's all about making "Sec" invisible: happy developers are productive developers.

2. Test your tools, just as you would your output. That starts with knowing where the components originate, and what the potential pitfalls are: an open-source tool

may well have an impeccable reputation, but it could still be susceptible to vulnerabilities and configuration errors. Apply the same levels of code assurance to your testing regime as you do to your development cycle.

3. Don't rely too much on your own tests: if there's one part of the process worth outsourcing, it's validating security. An audit might confirm that your processes are working as intended, or it might reveal problems within them. Either way, it's a security win.

Should I use a VPN to connect my remote offices?

A virtual private network isn't your only choice when linking remote workers and offices. Nik Rawlinson explores the options

Even in the consumer space, VPN providers are seeing an uptick in interest. Perhaps that's not surprising as the Snowden files detailing widespread online surveillance, on both sides of the Atlantic, have caused many users to look for ways to cloak their online activity. It's more a matter of principle than anything else.

As each new user logs on, they become part of the provider's WAN, in much the same way that businesses have been using VPN for years: to connect their remote offices to centralised resources.

Implementing a corporate VPN needn't be complicated. Neither is there any requirement for its users to understand how it works – or even that they're using one.

"[It lets you] store your files, intranet servers, authentication servers and so on at the head office, and connect to them via the VPN," said Dan Harris of business ISP, Beaming. "You'd have a router with a VPN server at the head office and routers in the branches with specific configurations that allow them to connect back to it… You can do other things like fibre between buildings,

which will work, but it's debatable whether this is secure, and it's certainly expensive."

What Harris describes is one of the most common VPN implementations within a disparate business. Called hub and spoke, the corporate HQ or data centre sits at the centre and its remote sites call in. For a long time, this was the only viable infrastructure, but it's latterly been joined by the mesh-configured VPN.

"These have got redundancy built in," explained IT security manager Daniel Prendergast. "If the primary connection back to the hub goes down, the remote offices will refer back to their routing tables to find an alternative track to the resources they need, often through their sister offices. Basically, it's how the internet works, but on a much smaller scale."

■ Beyond VPN

VPNs may be grabbing the headlines at the moment, but they're not the only option. "Traditionally, you'd have opted for MPLS because it guaranteed you a set bandwidth when the internet was still fairly slow," said Prendergast. "That's no longer the case, of course, when broadband

frequently tops 500Mbits/sec on fibre, but it remains an option."

Yet MPLS has its detractors. It doesn't offer the flexibility of a VPN, setup costs are higher to reflect the more involved process, and contracts are often longer.

"[It's] really about stitching together a lot of different network protocols," explained Bob Hendy of Cerberus Networks. "When you had multinational companies, they might have a frame relay in one country, an ATM network somewhere else, but now everything is IP everywhere."

IP traffic can just as easily be routed over a VPN, which can be set up in a few hours, taken down instantly and reconfigured whenever business needs change. "You could easily buy another office anywhere in the world, get your connectivity and set up a VPN," said Harris. "You can immediately give your customers peace of mind that their data is being handled securely, which a business might like to use to market itself."

The only downside is that speed isn't guaranteed because the

> **"Implementing a corporate VPN needn't be complicated. Neither is there any requirement for its users to understand how it works"**

connection passes over the internet, and is thus contended.

A managed solution

Larger businesses with in-house IT will naturally oversee their own VPN, but there's no reason why VPNs can't be handed off to a third-party and hosted in the cloud, effectively making the head office just another node on the WAN.

Cerberus Networks offers this with its hosted firewall product. As far as its users are concerned, they're paying for a virtual gateway in exactly the same way they'd rent a virtual server. It can be scaled up or down as required and managed entirely from one central point, rather than requiring IT support at each office, or for a technician to travel between sites. As the hub is already cloud-based, additional services, such as online backup and PBX, can be added at the same point.

"It's exactly the same as an MPLS service provider would do, but without all that additional kit that's there to support MPLS networks," Hendy said. "We just do it as an Ethernet VPN. The net effect is the same but it's cheaper and more flexible, and we can deploy a lot of VLANs across our network."

Moving the firewall to the cloud and using that as the hub of a virtual spoke-based network consolidates the organisation's out-facing nodes to a single egress point and centralises its security configuration. There are also fewer variables to consider when diagnosing problems as there isn't a separate firewall or authentication server at each remote site.

Partnering VPN

In many cases, it won't be an either/or decision. VPN's flexibility, simplicity and affordability mean that it's easily combined with complementary tech.

"Larger businesses – and particularly those that don't want to consider contention on a daily basis – might opt for MPLS for their primary WAN infrastructure," said Prendergast. "But this could be backed up by an inexpensive VPN, which remains dormant until and unless the MPLS connection goes down. It would be up to the business to decide whether all of its services are available across both connections, but it could offer just a subset over the VPN, perhaps cutting external internet access or bandwidth-hungry applications."

It's a policy that works both ways. Beaming's ProtectNet Plus offering, aimed at the security sector, connects remote sites using a secure VPN backed up by a 4G connection. Monitoring devices, such as cameras and alarms, feed a central monitoring point across the VPN, which is configured to restrict access to only authorised users. Should an outside agent bring it down, service continues via the failover connection which, because it's physically distinct, offers a second level of defence.

Making the right choice

VPN, MPLS and rival technologies such as ATM, Frame Relay and GRE are, ultimately, delivering a single end result: binding multiple remote LANs to act as a single WAN. In each case, the choice of technology deployed will be determined by its use.

For insurance brokers accessing databases on a provider's network, VPN would be ideal. A research institute sharing data between remote labs may opt for MPLS, reasoning that

the additional cost would be offset by the faster iterations and shorter time to market that the guaranteed speed and security could deliver.

As Prendergast advises, it's a matter of evaluating your use and picking a technology to fit. "Do you want secure internet access? Do you need to expose your services to the internet, in which case you'll have to consider authentication? Maybe that poses a security risk, and you need to offer remote access without an internet front end. There are many possibilities, all of which VPNs can address, but it's not the only choice, and won't always be the right choice, either."

Certainly, VPN remains the most flexible option, giving organisations of all sizes the freedom to scale as required, and even move the infrastructure from site to site simply by boxing their pre-configured routers and shifting them to the new location.

However, as Harris explained, minimising the number of third-party providers involved is good practice, where both security and complexity are concerned.

"We could provide a VPN service as an add-on to an existing connectivity package," he said, "[but] we wouldn't recommend it. It's still better to be dealing with a single provider who's handling the encryption and the VPN-based stuff because then it's going across [a single] network. That way we're aware of everything, including any attempted breaches, and it's fully encrypted as it traverses our secure network." ●

> **"Certainly, VPN remains the most flexible option, giving organisations of all sizes the freedom to scale as required"**

ABOVE As more employees slip into a work-anywhere mentality, VPNs come into their own

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The expert view Steve Cassidy

Business VPN provision is a giant, *Game of Thrones*-style epic battle between different providers. Not just different in their brand, but different in their entire concept. MPLS and its rather lumpen successors are about a third of the VPNs I see; another third are using SSL, while the last third are experimenting with IPv6.

Of these three, the smoothest implementations are in the SSL group, which is why firewalls that work this way are expensively licenced. Businesses that have lots of roaming users love SSL, because it travels in the same socket and format as HTTPS sessions – which means that connection suppliers, dodgy hotels, convention centres and Jon

Honeyball's airline seat in the mid-Atlantic don't stop your VPN traffic dead in its tracks. SSL also means you can extend your VPN to tablets and phones – something you'll find much more difficult with MPLS and later equivalent technologies.

Beware, also, handshakes that happen out of sight. Connection providers can tell you they have coverage where your offices sit, and then achieve that by subcontracting with a local supplier. Their traffic - and yours - looks like it's just the same as back at head office, but actually it's hiding the subcontractor's infrastructure. Incredibly, some suppliers I've dealt with in Europe are amateurish, verging on irresponsible, about connections they don't "own", most often because they feel denied

the chance of some local sell-through or bundled telephony deal.

With all that said, VPNs are worth the bother. Having a completely reachable, open address space across all your locations makes the support and troubleshooting process so much easier: certainly easier than relying on traffic crossing the public internet to get work done. These days, most cloud services require you to make a secure link before you can do anything, which turns your cloud portfolio of servers into a virtual branch when looked at from the perspective of a hub and spoke VPN. And nobody's cloud data centre is going to accept a connection over MPLS. Ring them and ask, and you might hear a little bit of laughter.

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JON HONEYBALL

"Although we have a more capable platform in Windows 10 today, I don't believe we're more productive"

Jon looks back wistfully on Windows 95, turns any HDMI source into a webcam, and attempts to resurrect his aunt's coffee-soaked Vista laptop

I came across the following while browsing the intertubes, and my interest was immediately piqued. A developer called Felix Rieseberg (@felixrieseberg) spotted an OS virtualisation project and used it to create a standalone Windows 95 app.

It uses a technology called Electron and a whole bunch of Javascript. I confess this is a technology that's passed me by, probably for the very simple reason that hypervisors are a far more robust solution to the problem. Indeed, Felix himself says: "It's a terrible idea that works shockingly well. I'm so sorry." The whole project is available on GitHub, and there are packages for macOS, Windows and Linux. I downloaded the zipped file for macOS, which revealed a standard application. Firing it up gave me a window running Windows 95.

It was one of those moments similar to looking at old family photographs. It was both familiar and alien at the same time. The chiselled 3D look and feel worked so well, and is arguably better than the flat-screen views we have today. The usual icons were in place, with My Computer, Network Neighborhood, Recycle Bin, C:, Control Panel, System and so forth. The Start menu worked fine, and it was a full installation of Windows 95B. I searched for a TCP/IP stack but nothing was found, which was a pity. Nevertheless, this is the real thing and it works.

Of course, the first thing I did was to look up the Calculator app to see which version it was. During the original beta testing period, I became ballistically angry with the Microsoft developers when I discovered that the Calculator app managed to give "2.11-2.01 = 0.00". This version of Calculator appears to be the fixed version, which is a relief.

I confess that the flashback brought with it a wave of memories. Remember that, at the time, you had two choices for Windows: first, the Windows 95 platform for both the low-power desktops plus the laptops that were around at the time. Indeed, I just dug out our lab test results for PC testing in 1995. A typical laptop had an 80486DX processor running at 66MHz, 8MB of RAM, a 3.5in floppy drive, a 340MB hard disk and a 640 x 480-pixel, 256-colour display. Power users were into the world of Windows NT 3.51 and NT 4. And those who were super-extreme, like myself, had multi-CPU NT4 workstations and even the Digital Alpha processor.

Things were simple back then. Windows 95 was a small, low-power OS designed to bring GUI consistency to the masses. That meant a meaningful printer driver model and graphics card adapters that could scale the dizzy heights of 1,024 x 768 pixels. Word and Excel were well established and very usable. Web browsers were in their infancy, and NetBEUI was the preferred networking protocol to TCP/IP.

Was this simplicity a good thing? Yes, I think it was. Although we have a hugely more capable platform in Windows 10 today, I don't believe we're actually more productive. The only exception to that rule for the home user is the power of the web browser, and the world-changing services it has brought with it. But the underlying capabilities of the desktop operating system? I'm far from sure that we've made much progress for most people, which is a somewhat sobering thought. Indeed, the power for most people has moved to their smartphone in their pocket.

Turn any HDMI source into a webcam

Here's a really cute piece of tech. I love the stuff that Blackmagic does, and its boxes are fairly priced to the point of often being surprisingly cheap.

Its Web Presenter box (**pcpro.link/ 290magic**) takes any SDI or HDMI video/audio feed and turns it into a USB source that you can use for high-quality streaming on the internet. If you're a heavy user of Skype, YouTube Live or any other of this type of service, then the built-in camera on your laptop or desktop might be woefully inadequate. You could spend money on a better webcam. Or you could do the job properly and get a decent camera, and use this interface box to convert from SDI to USB.

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@jonhoneyball

BELOW The good old days, when life was simpler

SDI, or serial digital interface, is a widely used format used in the professional video and audio world. It was first defined by the SMPTE (Society of Motion Picture & Television Engineers) in 1989 and has been extended since then. 3G-SDI is a 2.97Gbits/sec link, and there are 6G and 12G versions too. In essence, 6G will do 4K video at 30fps. 12G will do 4K video at 60fps – and all of them will carry audio and control data, too. It uses a single BNC-plugged cable and you can run long distances.

Anyway, one defining mark of a superb-quality video camera is that it outputs on SDI. And now you can use them for web-presenting roles by use of this Blackmagic box. You can pick it up for under £400, which, considering what it does, isn't expensive. For example, the Blackmagic Pocket Cinema Camera 4K is an astonishingly good piece of kit and costs just £925 plus VAT. And it comes with a full licence for Blackmagic DaVinci Resolve Studio.

Talking of which, DaVinci Resolve 15 has now shipped. You can download the free version if you want, or stump up £239 for the full power. Frankly, most anyone of sub-Hollywood intentions will be fine with the free version, although the paid-for software extends the reach to quite stupendous levels.

Blackmagic is really stirring up the market here, causing major worries to the incumbent players. If I was working, or studying, in the audio video world, then DaVinci Resolve is a skillset that's going to be well worth having.

On the subject of competitors, I've been trying very hard to get to like Adobe Lightroom CC. I've been using it for real work for some months now, processing the photos from the D800 in our professional-grade photo studio here in the lab. But I confess it really isn't gelling well with me.

It certainly doesn't help that on attempting to print out some images taken outside on our DJI Mavic Pro, I discovered that there's no printing feature within Lightroom CC. Maybe I've been looking in the wrong places, but I can't find a print function at all. Which strikes me as somewhat stupid and unnecessarily fiddly, because I then have to transfer out to another program just to print. This is 2018, for goodness sake.

iStat Menus

I used to use iStat Menus frequently – it gave a really strong view of what was going on inside my Mac. For some reason, it fell by the wayside. My interest was re-ignited by the recent news about CPU core and clock speeds, so I went to reinstall it. Naturally, there was an upgrade. So, once that was sorted, I had the package up and running.

It really does provide a deep insight into the inner machinations of your computer, and packs an enormous amount of information into a compact user interface. This

ABOVE Blackmagic's Web Presenter box really is, well, magic!

"iStat Menus provides a deep insight into the machinations of your computer; it packs a lot of info into its UI"

BELOW Working or studying in the audio video world? Then DaVinci is a must-have

is a cleverly designed app, and there's much to like about it. Indeed, having had it back on one machine, I've installed it onto my MacBook Pro and Mac Pro as well, which for me is a sure-fire indicator that I need its capabilities on a day-to-day basis. Let's see how long it lasts this time.

Parallels universe

In the world of hypervisors, there are two big players if you're on the macOS platform: VMware's Fusion and Parallels. Of course, on Windows you could go for VMware, or use the built-in Windows Hyper-V capabilities. And there are others, too, especially if you're using a Linux base platform. Or you can just boot a raw hypervisor and not really have any "desktop" capabilities at all.

Parallels 14 has now been released, and I've been slowly moving over to it, away from VMware Fusion. There are many reasons for this.

First, I don't tend to run VMware on servers anymore, so the ability to move VMs from desktop to server and back isn't really functionality that I need. Second, you might recall the PR disaster a few years ago, when VMware appeared to indicate that Fusion development was ceasing and that the development team had been laid off. A more PR-friendly version of that news was that the development work was sent from California to India. Nevertheless, it impacted my choices at the time.

I like Parallels. It's a modern, robust, clever and well-implemented hypervisor environment. It isn't scary for beginners, and you can get going with it very quickly. It supports all the usual things, such as downloading prebuilt images containing Linux builds. But you can also pull down the Windows 10 Development Environment and the Microsoft Edge and IE Test environments from Microsoft, or get Windows 10.

So what are the main improvements? Well, there's been

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sending myself a specially configured email. It would be useful if Access monitored that account and enabled itself when it saw the incoming code. That way, I could ensure that Access was disabled when I didn't need it, but it could be enabled when I did. I have emailed this suggestion to Parallels, so let's see what the company has to say.

As I said, a product such as Parallels brings huge capability to macOS, and there's a veritable chocolate box of things to try out here.

A rescue package

One of my aunts managed to throw coffee over the keyboard of her Dell laptop. It's an elderly machine and runs Windows Vista, with a whole pile of apps that she likes to use. She maintains that she doesn't want it updated to Windows 10, that she's used to Vista just like a pair of well-worn slippers. And that the apps she uses aren't so good in their later, more current versions.

I'm pretty sure I can migrate everything over to Windows 10, and we shouldn't ignore that Windows has many compatibility settings to help run older applications on the current version of the operating system. A comprehensive Program Compatibility Troubleshooter allows you to choose an ill-behaved app and apply settings to help nurse it into life.

However, that wouldn't be good enough. I suspect that change is going to be hard to manage – and, to be honest, it's hard to disagree with her. She has an external keyboard that works fine. However, the built-in keyboard has started to suffer from significant "coffee rot", spitting out random keystrokes. The only way to calm it down is to run your hand over the keyboard and attempt to unstick all the keys.

This seemed like an ideal job for Parallels Transporter, which can suck the brains out of your Windows computer and turn it into a Parallels virtual machine file.

I downloaded the tool, fired it up, pointed it at

a lot of tuning work so things run smoother and use less resources – both CPU and RAM. And disk space utilisation has been tweaked, too. Driver model improvements mean you can now support 4K video cameras within a VM, and there's support for pressure sensitivity within Windows 10 sessions; Microsoft has said that pressure sensitivity is coming into the next version of Office. Plus, there's support for Mojave, the next version of macOS, which will be useful.

The MacBook Pro Touch Bar is now supported, even in Windows virtual machines and Windows applications. Indeed, you can use the Touch Bar wizard to build custom actions for virtualised applications. For the power hungry, you can take this further with XML coding to do almost anything you might want.

The suite of add-on tools, called Parallels Toolbox, has been improved with a raft of small but useful additions. One I use often is the ability to turn a long scrolling web page into a single screengrab.

For me, Parallels is an essential add-on to any decently specified macOS computer. It hugely increases the range of capabilities of the

platform, without compromising the underlying operating system. It renders Boot Camp irrelevant for almost all users, and the ability to seamlessly integrate Windows applications onto the macOS desktop is extremely useful.

It has even greater capabilities than those mentioned above, however. I installed the Parallels Access tool onto my iMac 5K, and set up an account with Parallels. Then I installed the client onto my iPhone, and logged in. All of a sudden, I had full access to the Mac desktop from my phone, from anywhere in the world. It isn't just a screen scraper – it's cleverer than that. It does some very cute predictive operations based around objects on-screen, so it snaps correctly to Windows borders, for example. If I wanted a bigger experience, I could use an iPad. Or point any decent modern browser at the Parallels login server.

I'm not a big fan of remote access applications because of the obvious potential security worries. I'd be happier if I could keep the Access tool in disabled mode on my desktop, and maybe wake it up by

some external storage, and left it to do its cranial surgery. After a few hours, I had a fully formed Parallels virtual machine ready to fire up on my MacBook Pro.

As you might expect, there was quite a bit of whinging from the Windows Vista OS running in the VM. This was because the underlying Dell hardware had vanished. It even had the temerity to demand that it was re-authorised with Microsoft, but this went through without a hitch.

Overall, then, it works a treat. I now have my aunt's entire working life running in a VM under Parallels, and it's properly backed up. There are just two small problems. First, can I really ask her to buy a MacBook Pro on which to run Parallels so she can continue to run this Vista environment into the future? It would be more expensive than a new Dell laptop, that's for sure, but getting her existing Vista-based computing world onto a new laptop would be an exercise in extreme personal torture.

The other downside? I had to do some serious Registry editing on the resultant Vista installation. Nothing to do with Microsoft, or Parallels, I hasten to add. Just that the idiots at Dell who wrote the utility apps decided that they wouldn't run if you tried to execute them on a machine that wasn't a Dell.

While I can accept this parochial thinking, I can't work out why anyone would want to do so. What I did want to do, however, was to uninstall these now redundant utilities. But I couldn't, because the app said it wasn't running on a Dell, and immediately shut down, causing the uninstaller to fail.

Dear software engineers of Dell, it takes a particularly strong form of stupid to code things like this. I hope you don't do it anymore.

In case you're wondering…

… if I've ordered a juicy new Apple iPhone Xs Max (*see p56 for our full review*) with half a terabyte of storage and the Apple Watch Series 4 with a built-in electrocardiogram, the answer is "nope". My iPhone 8 Plus and Series 2 watch will do just fine for the moment, thanks. And I suspect I'm not alone.

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PAUL OCKENDEN

"It's great to see a company still supporting and continuing to develop a five-year-old product"

Paul finds that trying to go paperless involves lots of paper, and looks at an innovative single-board computer

There's a very good chance that you're reading this column in a paper copy of *PC Pro* magazine. I've been told that some people with electronic subscriptions will even print out these Real World columns in particular, in order to read them. There's just something about paper, isn't there? And it isn't going away. Tech companies have tried to replicate paper with E Ink displays, and some of these are very good indeed, yet the postman still shoves a pile of paper through my letterbox every day.

We were supposed to be getting away from this, weren't we? Letters were going to be replaced by email. Websites were going to replace catalogues. And e-readers would mean that nobody would ever buy books again. Okay, some of this has happened to an extent, but most of us are still receiving letters and catalogues in the post. And every high street still has a couple of book stores.

Paper just feels "right" for so many things. Even for traditional on-screen tasks such as programming, which normally involves typing code into a window within an IDE, I find that if I'm stuck trying to fix an obscure bug then I'm much more likely to find it if I print out the offending chunk of code and study it using the paper copy, scribbling on it using coloured

Paul owns an agency that helps businesses exploit the web, from sales to marketing and everything in between

@PaulOckenden

> **"There's just something about paper. And it isn't going away"**

BELOW Achieved the "paperless" dream? No, neither have I…

pencils. And I'm pretty sure that this isn't an age thing – I've seen many a young whippersnapper coder doing exactly the same.

In reality, the term "paperless office" seems to have been a joke foisted on the world in 1975 by an article in *Businessweek* magazine. That article, "The Office of the Future", is usually cited as the first use of the term, and it's been trotted out routinely ever since. But the concept hasn't come to fruition, and I can't see it happening any time soon.

There's a problem with paper, however: storing the stuff. There's the ecological problem, too, but that's taken as read – if you'll excuse the pun. When it comes to paper documents, it's possible to chuck some of it into the recycling bin (or the shredder), but others, such as receipts, are important to keep. I also tend to hang on to bank statements, which might seem odd in an age of online banking. However, banking IT systems don't have a great reliability record of late, and there's a chance that when I come to do my tax return at 10pm on 31 January, my bank's online systems might not be available.

So, most of us will have a stack of paperwork sitting somewhere in the house. Some of it will need to be kept (contracts, house deeds, warranties), some can be thrown out, but there will be items that are time-sensitive, too. For example, bank statements are important for a year or so, but can be disposed of thereafter.

The problem is, for those who aren't particularly organised (and I include myself in this group), the mountain of old documents just gets ever bigger. And I suspect I'm not alone in this.

So a while back I started looking for technology to help me get things in order.

What I needed was a scanner, but not just any old scanner. A flatbed would be useless for this task, as it would take ages to scan all my old documents. What I needed was a sheet-fed scanner that would take a bundle of documents at a time. I also wanted something that would help me to automatically sort the documents the device had scanned, perhaps by doing an OCR pass on them. And then maybe shunt the resulting scans off to one of the many cloud storage providers.

There are a few products that will do that, but it usually involves running software on a local PC for the grunt work of document processing, and then sending the files off into the cloud. In an ideal world, I wanted something that would run standalone. A scanner that I could take into the junk room where all my old filing is kept, feed a load of papers in, and then, without any other intervention, it would all arrive neatly filed in Dropbox (other cloud storage providers are available), sorted into different folders depending on the document type.

I did much searching for such a product but couldn't find a scanner that did exactly that. However, I did find something that comes pretty close, in the form of the Fujitsu ScanSnap iX500. It looks like many other sheet-fed desktop scanners, and it scans very quickly even in duplex mode (no need to turn the paper round to scan the other side). It isn't a new device, by any means – I think it's been on sale for at least five years – but it's a reliable workhorse.

The iX500 isn't sold as a photo scanner, but it does a great job here too. And, being a duplex scanner, you get a copy of anything scribbled on the back of the print – or, with some old photo labs, the processing date. I'm sure some of you are screaming that I should be writing "full duplex" here, but "duplex scanning" seems to be one of those industry standard terms that are almost deliberately designed to annoy us pedants!

I haven't measured the speed of the scanner – Fujitsu rates it at 25 pages per minute, and I have no reason to doubt that figure – but it's certainly very quick. And you can stack around 50 sheets in the hopper. I've found the

paper feed to be reliable, and it has an ultrasonic sensor that detects double feeds – it somehow senses the air-gap between the two sheets. It also uses separate feed and brake rollers to minimise double-feeds. I can't remember the last time I had a misfeed, and the scans usually come out dead square, too. Although it's primarily an A4 scanner, there's a carrier sheet you can use to scan folded A3 documents, which it will stitch back into a single document.

The rollers inside the iX500 are apparently good for around 200,000 scans. A sheet of A4 weighs around 5g, so 200,000 scans is, quite literally, a tonne of paper. Replacement rollers are available, which tells you that Fujitsu expects the iX500 to be a serious workhorse, despite being a relatively small desktop device.

You can scan to a PC (Windows or Mac) via either USB or Wi-Fi, and to mobile, too, which is pretty neat. You pop in a document, and a few seconds later it appears on your phone. For me, the killer feature is being able to scan directly to the cloud, with no intermediate PC required. As long as

ABOVE Fujitsu's iX500 is a solid workhorse of a scanner

> **"If the iX500 has a Wi-Fi connection, it will magically squirt things out onto the internet"**

BELOW ScanSnap Cloud sends documents from the scanner straight to your cloud storage accounts

the scanner has a Wi-Fi connection available, it will magically squirt things out onto the internet. The system currently supports Box, Dropbox, Evernote, Expensify, Google Drive, Google Photos, OneDrive, Shoeboxed, Concur Expense and QuickBooks Online.

You can even set different endpoints for various types of documents. So you can despatch receipts to Expensify, photos to Google Photos, business cards to Evernote, and general documents to a Dropbox folder. You don't have to pre-sort the pages before scanning them – this all happens automatically and in real-time. Just occasionally documents will get mis-recognised. On occasion I've found taxi receipts appearing with my photos, but this doesn't happen often.

Documents saved to cloud services as PDF get the full OCR treatment, too, making them fully searchable. You'll find many online reviews complaining that this is missing, but it's a new feature that Fujitsu quietly enabled last year. It made an already very usable workflow considerably better. There's been a number of similar improvements over the years – it's great to see a company still supporting and continuing to develop a five-year-old product!

The OCRing of documents is also used to determine the filename of the scanned documents. You can, if you want to, use the date that you scanned the document, but it's far better to allow the software to extract the date from the document itself. It makes the storing of items such as bank statements and letters much easier.

Business cards

Documents

Receipts

Photos

iX500

iX100

The only thing missing from my wish-list is the ability to identify particular types of documents and place them in separate folders. But that's a job that's pretty easy to do manually, based on the file name.

There's a bundle of PC and Mac software supplied with the scanner, but apart from at initial setup, I never use it. I just press the button on the scanner and, a few seconds later, the documents appear in my Dropbox. It really is that simple, and the whole process is super-reliable.

I even ended up buying the iX500's little brother, the iX100. It's a portable A4 scanner – a tiny little thing. It runs off a built-in rechargeable battery, and only scans single-sided. It's significantly slower than the iX500, but the scanning quality is just as good.

The only problem I've had with mine is that, sometimes, when just switched on, it won't register on my Wi-Fi network. As such, I have to flick the network switch on the scanner a couple of times before it sorts itself out. I've never had that problem with the iX500.

Despite that little quibble, the smaller scanner is great. I have the iX500 in my office and the iX100 in a kitchen drawer, in the vicinity where I open my post. I can quickly scan anything interesting before putting it in the bin. The iX500 is used more for big scanning runs, large documents such as contracts, and slowly trying to reduce the pile of ancient documents I have in storage.

Of course, after scanning in all of my old documents I can then begin the fun job of shredding them!

On display

I know that a lot of you like to play with various single-board computers. In the past I've written about various flavours of Raspberry Pi, its rival Orange Pi, Arduino boards, plus ESP8266-based kit. There's so much choice out there. Some are great for low-power uses; others have built-in

Wi-Fi and Bluetooth. Most also have various add-on boards available – there's a whole industry out there creating such items. They tend to be cheap, too. Just take a look at some of the kit sold by the likes of Pimoroni (**shop.pimoroni.com**), which is one of my favourite sellers.

An item that Pimoroni doesn't (currently) sell but which I've been using a lot recently is the WIFI Kit 8 from Chinese company Heltec Automation (**pcpro.link/290heltec**).

It's a tiny thing, much smaller than many other single-board computers. Very cheap, it includes an ESP8266 CPU and a USB port (driven by a CP2104, so no problem finding drivers). There's onboard 802.11bgn Wi-Fi (no 5GHz, which is a shame), and plenty of usable I/O ports including analog, digital and serial. So far, so ordinary. What sets this particular board apart is that it has a built-in 128 x 32-pixel OLED display.

Like many such boards, the easiest way to program it is by using the Arduino IDE. You'll find everything you need to extend the IDE to cope with ESP8266 boards at **github.com/esp8266/Arduino**. Just follow the "Installing with Boards Manager" instructions. You'll need to select Generic ESP8266 Module, then set the CPU to 80MHz, 40MHz flash, DIO flash mode, 921600 baud, 4M (3M SPIFFS) flash size, and set the Reset Method to nodemcu. With that done you can upload sketches to the board.

A good one to start with is the Wi-Fi scan sketch. Open File | Examples | ESP8266WiFi | WifiScan, and upload it to the WIFI Kit 8 board. You'll see the output from the sketch if you open the serial monitor within

> "What sets the WIFI Kit 8 apart from other boards is its built-in OLED display"

the IDE. At this point, you won't see anything useful on the display. Incidentally, you might find specific WIFI Kit 8 support available if you do a search within Boards Manager, but I've always found using the Generic ESP8266 Module is more reliable.

You can use any SSD1306 library to drive the OLED panel, but U8g2 (which you'll find at **github.com/olikraus/u8g2**) is particularly versatile. When you install U8g2 into the Arduino IDE, you also get a copy of U8x8. The latter is text-only, using a fixed-width 8 x 8-pixel font, but it uses hardly any resources. U8g2 is much fancier, with a choice of fonts and drawing lines, boxes and circles. However, it uses some of the board's RAM as a buffer, plus you'll notice that it can seem slightly sluggish compared to U8x8.

U8x8 may appear compromised with its 8-pixel fonts, but there's actually a choice of several available – see **pcpro.link/290U8x8** for the current list. The library uses the drawString function to write to the screen, but there's also draw2x2String that draws double-sized characters, while draw1x2String produces tall, narrow text.

So, despite the cut-down nature of the library, it remains pretty flexible. Many people instantly reach for U8g2 without even considering its lower-footprint cousin. But if you do use U8g2, you'll need to set the clock pin to 5, the data pin to 4, and the reset pin to 16 in your code.

So what's the WIFI Kit 8 board like in use? Well, when it works, it works well. There are some rough edges that cause it to crash with certain sketches, but these crashes are repeatable and happen straight away. When you get a sketch working, it will run for weeks without any problems.

There's much you can do with this board. One thing I haven't touched on is that it can run FreeRTOS, the Amazon-backed real-time operating system that has deep integration into the company's cloud infrastructure, including AWS IoT core and AWS Greengrass. But that's a topic for a future column.

@PaulOckenden

MARK NEWTON

"We almost gave up, believing this data wouldn't convert for 3D prints. But our perseverance paid off"

Mark Newton shares the story of how he went from 3D printing novice to producing a half-metre-square rendition of Orkney's Ness of Brodgar dig

For my first foray into 3D printing, I decided on a printer that was as close to "plug and play" as possible. I was drawn to the British-made Robox printer (**cel-robox.com**), with its custom reels of filament that tell the printer what settings it needs. I also liked its unique print heads with shut-off valves to stop the flow of plastic, rather than the conventional method of retracting the filament.

3D printing uses FDM (fused deposition modelling), which pushes a thin plastic filament through a heated nozzle at between 160°C and 300°C. This nozzle is usually 0.4mm in diameter but can range between 0.2mm and 0.8mm, creating layers of plastic as thin as 0.01mm.

One of your first tasks is to decide upon the material you're going to use. The two main types are biodegradable PLA and the rather smelly ABS, but there are dozens of others – including nylon and wood.

Initially, PLA seems the obvious choice since it's easy to print with, but it deteriorates in UV and has a "glass point" (the temperature at which it becomes flexible) of 60°C, which renders it useless for many applications. While PLA doesn't need a heated bed to print on, other plastics do. If a plastic is allowed to cool too rapidly whilst the print is going on, serious warping can occur.

This caused me huge grief in the early days, as I experimented with materials and different print-bed surfaces. On

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BELOW The Robox printer on top of the Raise3D beast!

one occasion, the combination of print bed and the plastic chosen bonded so well that I had to remove the bed and use a thin knife to release the print job from it – but at least it didn't warp away from the print bed!

One thing I've learnt while experimenting with lots of different materials is that this can bring its own problems. When you change materials, you have to purge the old material out of the nozzles. If you change from one temperature plastic to a different one, carbonisation can result in a blocked nozzle, which isn't easy to remedy.

Once you've chosen your material, you need to set the temperature of the print head, the print bed, the rate of flow of the filament, and a variety of other parameters. With the Robox all this worry is handled by "smart spools", whose embedded chip will detect the type of plastic and set the above accordingly. All printers use printing software, complete with preset profiles for their materials. You can tweak these to your liking, but for 3D printing to become mainstream, it needs to be much easier to set up. Even valiant efforts by firms such as Robox have some way to go, as a read of the support forums confirms.

If a print job is to go wrong, it will most likely be on the first layer. If this layer doesn't stick to the print bed then the subsequent layers won't adhere and the printer will attempt to print the entire job in mid-air, resulting in an effect similar to the output of a spider on acid!

Placement of the printer is also an issue. The garage isn't ideal, because of dust and

moisture. The plastic filament itself can absorb moisture that will ruin a print run, so if you aren't using the printer for a while then you should unload the material and store it in dry containers or de-humidify the print room. Then there's the noise whilst printing: the Robox makes such a racket that it has to be operated at the other end of the house, behind closed doors, and even then I'm aware when the printing stops!

To remedy this, increase print volumes and boost speeds, I decided to buy a beast of a printer in the form of a Raise3D Pro2 Plus (**raise3d.eu**). Thankfully, it's almost silent.

So what do you print? There are lots of 3D models available on the web for you to download. Some are simple, but others require removable supports to be added to the print job by the software. After printing some of these downloaded models, it won't be long before you'll want to either alter them or create your own. There are plenty of programs available, but after much trial and error, I've found that Autodesk's Fusion 360 (**pcpro. link**/**290fusion**) is rather excellent, and this normally very expensive software has a free hobbyist licence.

It's a full 3D design tool with much more functionality than you'll ever need, and it will export your design as an STL file that the printer software requires. Meanwhile, Autodesk's versatile Meshmixer (**meshmixer. com**) is also free. This enables you to edit and repair STL files ready for printing. The final piece of software I've found invaluable is Simplify3D (**simplify3d.com**). This emulates the printer by converting your model into the "slices" – one per layer – that the printer requires. You can then "single step" through each layer and see what's going on, and hopefully detect any trouble spots. It costs $149, but can save you plenty of time, frustration and materials if trying to print badly formed STL files.

All this done, load your model into your printer's supplied software. This produces a series of instructions that the printer understands known as "G-codes". The file containing these G-code instructions can be transferred to the printer via an SD card, USB drive or USB lead, but since the printer will often be hidden away due to its noise – and print times are measured in hours and sometimes days – that isn't always practical. I prefer to use a network connection, either cable or Wi-Fi. My original Robox didn't have this capacity, but I added it via a

Raspberry Pi box connected to the printer via USB.

Ness of Brodgar

Archaeologist Jim Bright (**sketchfab. com**/**jimbright**) and I originally planned to 3D print some of the 5,000-year-old buildings that make up the world-important Ness of Brodgar dig in Orkney (**nessof brodgar.co.uk**). This dig has been going on through the summer for eight weeks each year since 2005. My initial tests were done on the data model of a single wall of Structure One. We showed it to the site director, Nick Card, who suggested that it would be good to see a 1m x 1m square model of the largest part of the site. Sure, we said, no problem.

This model would have to be made up of several pieces, as the printer I had at the time had a build volume of only 210 x 150 x 100mm. The data we had access to was generated in 2016 and generously provided by Dr Hugo Anderson-Whymark (**sketchfab.com/ hugoandersonwhymark**).

Before you attempt to print this type of data, I recommend examining the model without its overlay of colour from the photos. This colouration convinces the eye that there's more detail than is actually there. Examining it without gives you a better idea of what your finished 3D print might look like.

You can't just take this data and throw it at your printer, you'll get a mess – as my first tests demonstrated. One of the issues is that the data will often consist of just a top "skin" of zero or very small thickness. The printer will see this and print nothing, since it's too thin for it to reproduce. Our first job was to thicken this first layer using the Solidify function in Blender. We then extruded the model down about 100mm using Meshmixer, which was then sliced at a suitable depth to make a flat base to the model.

Any model you attempt to print should have a complete manifold. This means that the mesh of triangles it consists of is complete, with no holes or broken triangles. If it isn't complete, the results can be unpredictable, and if you start slicing up then things can go a little crazy. Many programs have options to "fix" a broken manifold, but often they'll make a dreadful attempt and you'll
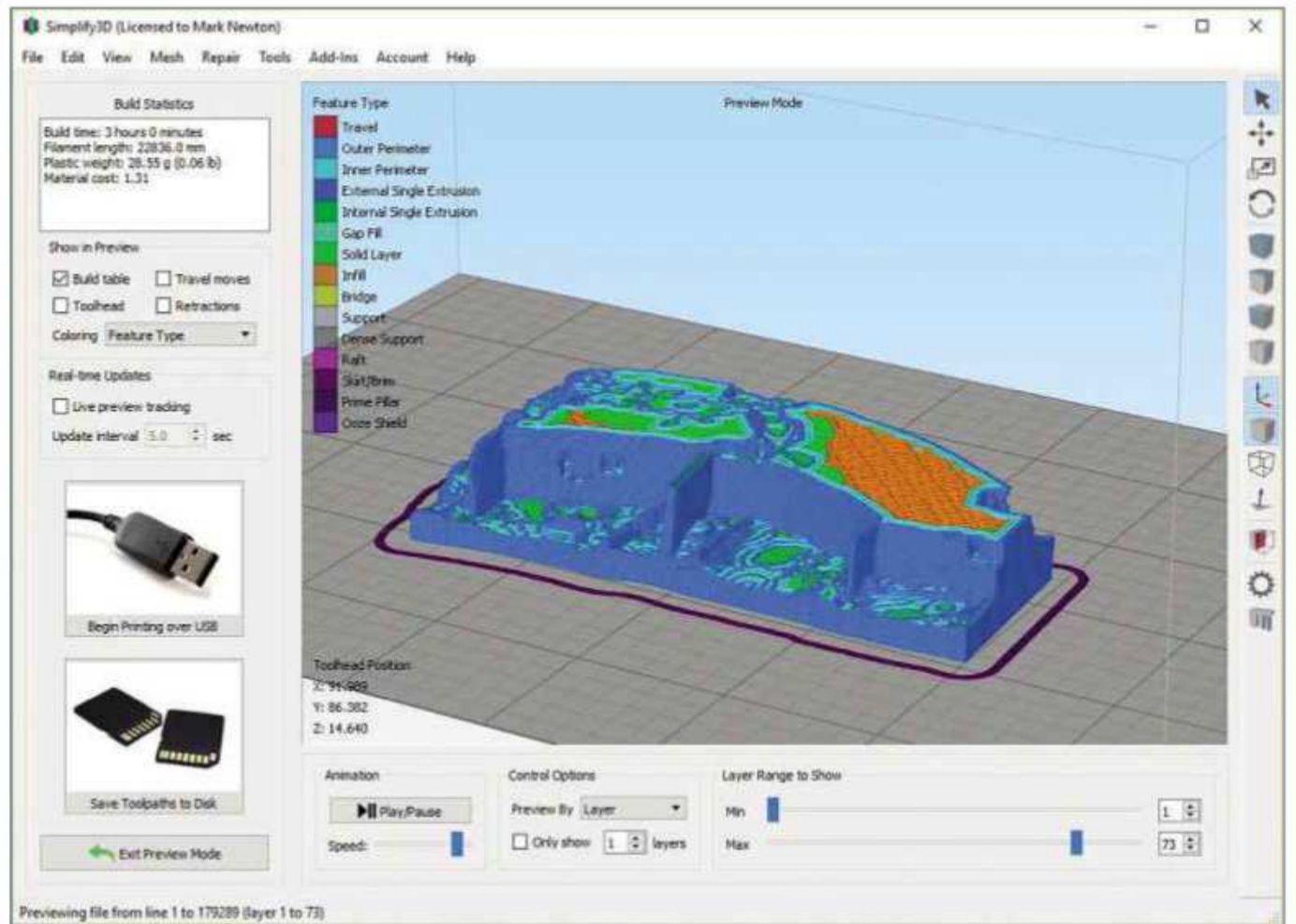
end up with large areas that are lacking in detail.

I wish I could offer a definitive way of avoiding this, but I can't. Experimentation with different methods is the only way forward, since each model is different – but, again, Meshmixer is a handy tool. When we were running our tests, Jim and I almost gave up after about three weeks; we started to think that this particular data wouldn't convert for 3D printing. But our perseverance paid off, with some tests successfully printed.

We were sensibly just testing with a small segment of the model. Now was the time to put what we had learnt and apply it to the full set of data. This data was generated using

photogrammetry, combining some 600 photos to produce a 3D model made up of over 4 million triangles. The complexity of the information nearly brought our machines to their knees!

The next task was to slice the full model into the pieces we intended to print. At this point, I thought it would be sensible to check how much plastic material it would use – and my heart sank when I calculated a price of £600. I should point out that all this was unfunded! But all was not lost: if we halved the length of the sides to a still reasonable 500cm, the volume would reduce by a factor of eight, bringing the material cost to a more reasonable £75.

The total print time ended up being 14 days and nights, but in reality it took longer because the print was done in 11 sections with removal and setup times added. Although 3D printers don't use a lot of power (about 200W), the extended period of printing can make a significant impression on your electricity bill!

The segments were finally glued together in time for the final public open day at the Ness (*see left*). This might be the first time such a thing has been attempted on an active archaeology dig.

We now intend to use these techniques to produce more models of such data, but using the larger print volume of the Raise3D printer. The ability to visualise an object on the computer and then produce a physical version is a fascinating process. But it isn't easy – far from it.

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DAVEY WINDER

"Software-only AI assistant? It's more likely the social media giant wants a slice of the hardware pie"

Davey fans the rumours around a Facebook rival to the Echo, celebrates the latest version of Chrome, and explains why ransomware isn't dead

Around a year ago, reports first surfaced about Facebook working on Aloha. This video chat/AI assistant device was rumoured to be launching in May this year, or July, depending upon the rumour you believed. Obviously, neither date turned out to be accurate. However, according to someone who has reverse-engineered the Android Facebook and Messenger apps, it could be ready to roll soon now.

That's because the app hacker, Jane Manchun Wong, managed to dig a working UI and basic speech-to-text functionality out of the codebases. Posting to Twitter as @wongmjane, she threw some images of the "Aloha" app icon and voice-assistant UI into the ether. This has kicked off some speculation that Facebook is taking a software-only approach to an AI assistant. However, it seems much more likely that the social media giant would want a slice of the hardware pie currently divvied up between Amazon and Google, and to a lesser extent Apple and Alibaba.

Indeed, some evidence of this can be found in the UI. A screenshot from @wongmjane shows a dialogue that states "Your mobile device is now connected to Portal". It advises improving accuracy by turning on Bluetooth and ensuring Portal and the smartphone are using the same Wi-Fi network. So, we can reasonably expect the rumoured Facebook AI video-chat assistant to be both a reality and called Portal.

Why so confident? Well, Facebook has a patent filing for a cube-shaped "ornamental design for a speaker device" that throws some more interesting pointers into the mix. The speaker device in the filing refers to it being invented by Baback Elmieh, and his business Nascent Objects was

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acquired by Facebook at the end of 2016. Elmieh now works for the Facebook Building 8 lab as technical lead on a hardware project, and he also has patents for modular cameras developed at the company. If you ask me, speakers, cameras and intelligent voice recognition all add up to Portal. And given we're coming up to the perfect time to release such a product – namely, the months before Christmas – I'd say watch this space…

Chrome brings site isolation to the masses

While web browser client choice remains a personal preference, Google has made some changes to Chrome that help make that decision a little easier. Although users of the browser have been able to implement site isolation by way of an experimental enterprise policy option for a while, with the latest updates to Chrome 67, it's come to the masses as a default.

So, what is site isolation and why should you care? Let me try to explain. The update has come in response to the threat from Spectre, which I'm not going to go into here beyond saying that it's a speculative execution side-channel attack that

BELOW Proof of Facebook's new "Portal" AI voice assistant

Jane Manchun Wong @wongmjane · Aug 21
Facebook's unreleased home device "Portal" can be paired using Bluetooth LE or WiFi

previously: twitter.com/wongmjane/stat...

✅

Your mobile device is now connected to Portal.
@wongmjane
You can improve your home accuracy by turning on Bluetooth and making sure Portal and your phone use the same Wi-Fi Network.

could expose values stored in parts of memory that would otherwise be closed to the attacker. Google it for more information; add my name to your search and you'll find I've written plenty on the subject.

The relevant thing here is that browser clients run what could be malicious JavaScript from multiple sites within the same process, and, theoretically, this leaves the door open for a Spectre exploit to expose data from other sites. There's been precious little evidence that anyone is actively exploiting Spectre, but it would be hard to tell if they were. All the major browsers have already implemented exploit mitigation by way of tweaking JavaScript code compilers, for example.

However, that doesn't mean that more shouldn't be done, and Google has done it by using the site-isolation approach. This has involved changes to the Chrome architecture so that each renderer process is now limited to documents from a single site, rather than multiple ones. In other words, it uses the OS itself (Windows, Mac, Linux and Chrome OS) to prevent attacks between processes.

This is quite a big change for Google, since Chrome has until now always used a multi-process architecture; this allowed cross-site iframes and cross-site popups to remain in the same process as the page that created them. Which answers the "why you should care?" question, funnily enough, as a successful Spectre exploit could therefore read passwords and cookies belonging to other iframes or popups in its own process.

The Chrome site-isolation implementation also features Cross-Origin Read Blocking (CORB). This transparently blocks, or at least attempts to block, cross-site HTML, XML and JSON responses from the renderer process. This is to mitigate against a Spectre attack that might attempt to access data from cross-site URLs by requesting them as subresources such as scripts or images, even with the renderer process limited to documents from one site.

As with all Spectre mitigation, the additional security comes with a cost to performance. The very processes that Spectre exploits are part of the CPU architecture precisely because they speed things up, so mitigation inevitably slows them down. That said, it isn't a huge hit. Google reckons that the creation of more renderer processes using site isolation adds a 10% to 13% memory overhead in the
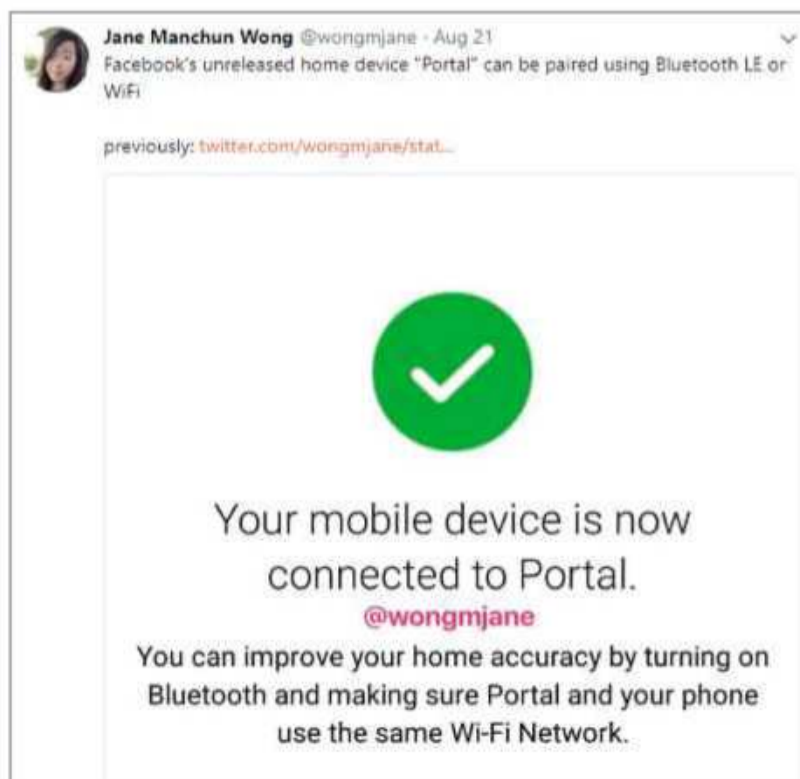
real world. Future updates should further reduce this as Google engineers work to optimise the function. Talking of future updates, Google tells me that site isolation in Chrome is just the opening phase of a broader site-isolation project. Forthcoming security updates will add attack mitigation beyond Spectre; for example, to protect against fully compromised renderer processes.

Lost insecure property?

A recent bit of research entitled Identity Crisis caught my eye (**pcpro. link/290ident**). This Parliament Street paper, carried out in conjunction with Transport for London, gave figures for the number of mobile devices lost on public transport in London during the 2017/2018 financial year. The total was 25,690 mobile devices, which broke down as 23,453 phones, 1,155 laptops, 1,055 tablets, 568 e-readers, ten drones and four Amazon Echos.

Let's not worry too much about the Echos and drones, and concentrate instead on the phones, tablets and laptops. That's a total of 25,663 devices lost – and those are just the ones handed in to lost property. You can bet there were a whole load that went no further than the pocket or backpack of the finder. I mention this as it ties in nicely with an insecurity bugbear of mine: mobile devices with inadequate owner authentication.

There are certain categories of insecure thinking that I tend to file under "banging head on wall" and "convenience uber alles" sits well within that remit. The convenience argument is one I hear too often, and there's rarely any merit to it. I can't empathise with those who complain that securing a service login with an additional factor such as an authentication code makes it a hassle to use, given the hassle they'd face were that service to be compromised.

I quite happily sacrifice a few seconds – and that's all we're talking about, even if the code-delivery mechanism is of my least favourite by-text-message variety – in the knowledge that I'm making it harder for someone to access my data. Sadly, not everyone believes the same.

Secure thinking needs to be hammered home in every business, regardless of size, and that same thought needs to carry over into the home as well. While BYOD may no longer be a buzzword bingo high scorer, it has never been a bigger security risk. Personal smartphones and tablets are as ubiquitous in the workplace as they are potentially

dangerous. Not so much from the being locked down on the corporate network perspective, but rather from the access to the user, their data and their trusted contacts one.

If every device came with forced fingerprint unlocking and data encryption out of the box, I'd be less concerned – but they don't. My concern isn't lessened by the convenience argument, either. If I had a pound for everyone whose idea of login security is a four-digit PIN at best, I'd be laughing. Although it isn't funny, and nor are the number of folk who don't even bother with a PIN.

Should that device be lost, it isn't just the potential of international roaming charges or someone seeing your risqué photos that should concern. If the device were to get into the hands of someone other than your casual chancer, someone who has a bit of criminal knowledge when it comes to cyber for example, then it can make life very difficult for the owner and their employer as well.
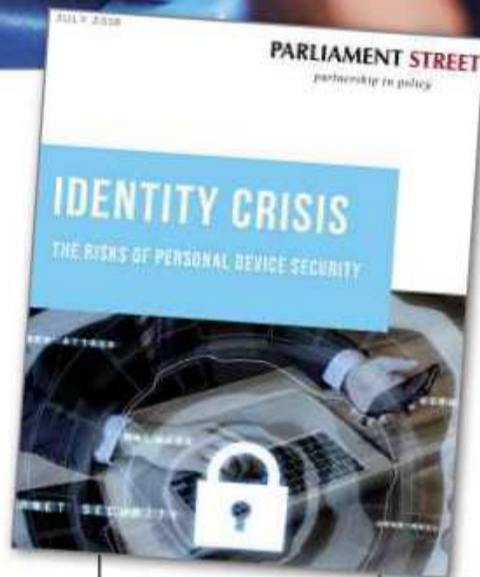
ABOVE The *Identity Crisis* paper reveals worrying numbers of phones left behind on public transport

BELOW "No More Ransom!" The place to go for advice if you've been hit by ransomware

It's all too easy to get all the personal data from your average smartphone that's needed to reset passwords for valuable accounts such as email and social media. Being in possession of the device itself circumvents the "something I own" side of the security equation and enables identity validation. Armed with access to such accounts, not only can personal assets be targeted – including online banking – but corporate ones as well. The average social engineer would have a party when presented with a genuine email account from which to start the spearphishing of a company.

Ransomware isn't dead

With all the Trumpian inspired "fake news" hysteria, it's easy to forget that real news can be equally disruptive – especially when it comes to cybersecurity postures. Take, for example, the fact that ransomware has been on a rapid downwards curve since WannaCry hit the NHS, quickly followed by NotPetya.

Research from CyberEdge shows that, for the first time in five years, the number of organisations hit by a successful ransomware attack is on the slide. 61% of organisations questioned had experienced a ransomware attack in 2016, while it was only 55% in 2017. The latest Kaspersky Labs research, based on data collected by the Kaspersky Security Network,

reveals this slide continues: the total number of customers encountering ransomware dropped from just over 2.5 million in 2016/17 to just over 800,000 in 2017/18.

This is the reason headlines have proclaimed that ransomware is dead, and as far as column inches go, this is certainly the case. Over the past 18 months, I've read more about the cryptomining threat. Yet while cryptomining is problematical on many levels (including the security holes that allow it to take place within your organisation), it isn't as damaging to your business as ransomware. Damaging in the short-term with loss of access to data and resources, and damaging long-term due to loss of reputation that you need to recover.

Take the emergence of Ryuk (**pcpro.link**/**29oryuk**), which has extracted ransoms in excess of $600,000 in just a few weeks. By targeting specific firms with advanced encryption methodologies, Ryuk has managed to extract "an exceptionally large ransom" from a handful of enterprises in order to regain control of their data.

Here's the thing: if you were to base your security posturing around the perceived declining threat from ransomware and the more current trend towards cryptomining, then you'd actually increase your risk of falling victim to both. A mature security posture should be threat-agnostic and concentrate on protecting data and networks from anything that might cause harm. By continuing to install patches in a timely fashion, applying the principles of network segmentation, using application whitelisting techniques and so on, you can build a layered approach to your security that covers most bases. The same goes for having a tried-and-tested, preferably air-gapped, data recovery plan.

This isn't something you should just abandon because ransomware is less of a problem than it was a couple of years ago. That's just common sense, and so is most secure thinking. If you've been hit by ransomware or want further advice, head to **nomoreransom.org**.

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STEVE CASSIDY

"We're told that heavier encryption equates to longer intervals between attacks. This isn't always the case"

Steve laments the process of choosing remote access software, and uncovers a web page that was disrupting a small business' net connection

The remote access business has been presenting itself as an extra layer of security for quite a while, with heavy emphasis on the short time between availability and successful attack. I find such claims overwrought, although I did come across one customer who loved the idea of using shortcuts to start RDP sessions so much that he left a shortcut on a machine in an internet cafe somewhere in Spain. On that occasion, the interval between availability and attack was about as short as the security gurus expect. That is, 20 minutes after the customer finished his latte and walked away.

So, there's a heavy emphasis on security. People are told to protect their remote connections, and that heavier encryption equates to longer intervals between successful attacks. In practice, this isn't always the case. Either your machines are infected and the hackers find that your resources aren't valuable, or you're simply hiding in an unfashionable corner of the remote access marketplace, where the mainstream, fashionable hackers don't go.

I can remember back in the days when we went years between RDP attempts, with the rather sad observation that when the attack traffic came from countries in South America, the passwords they'd be trying for the administrator account had distinctly Latin American roots. Yes, it's smart to try breaking in using girlfriends' first names; it isn't smart to choose those names from a list in your native language rather than that of the country you're targeting.

Back to remote access security. You have the choice of a separate login password, and then an

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BELOW If you're using a remote connection in an internet cafe, make sure you don't leave any RDP sessions open...

admin password to get into the servers supplied by the server OS, if you want to work on the assumption that neither single password is enough. Everyone believes this is a good idea – except Microsoft. While the independent players have been adding on layers of auxiliary capabilities, such as inter-machine text chat, file transfer and even support for smartphone access, Microsoft has been meddling in the market. And not in a useful way.

Of course, it takes two to tango. For every genuinely dangerous security hole in the OS, there are a million ill-informed experts who blether on about imaginary or misheard vulnerabilities, all of which add up to decades of screaming that the sky is falling when nothing of the sort is happening. Nonetheless, there's obvious discord between the Microsoft insiders, who point to the proven rates of infection, and the outsiders, who point to standards-compliant VPNs and networks that don't get infected much.

That said, it was Microsoft that blew up a broad range of small-to-medium-business-sized VPNs. Not once but many times with the
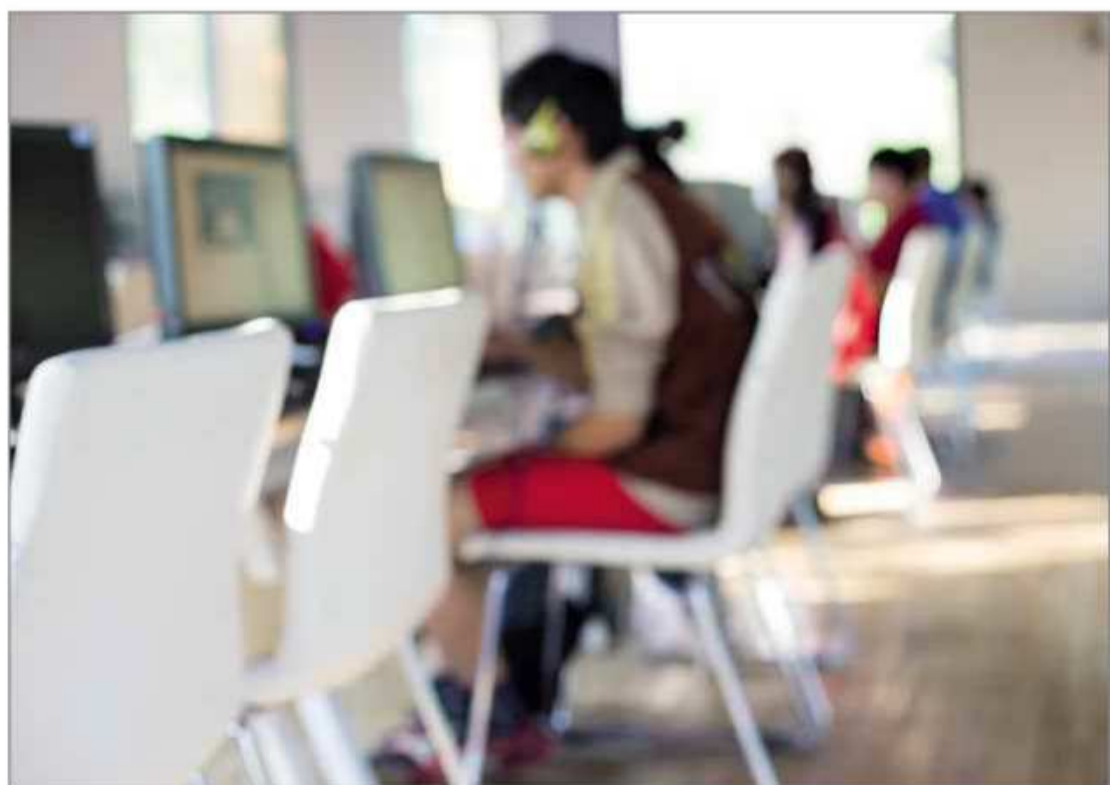
approach to security taken by Windows 10, interfering with the little add-on apps responsible for connecting the roaming device to the VPN's gateway. It's also Microsoft that rolled out IPv6 quietly, and then made its DirectAccess server remote access product depend on it.

If it ain't brokered, don't fix it

DirectAccess is nearly perfect. It certainly shows signs of having been designed by someone familiar with IPv6, although I wish one could say the same for the team writing the implementation wizard!

If you and your laptop want to be part of a wider DirectAccess implementation, and be findable by all the (appropriately authorised) corporate support resources to boot, then someone running the DA setup wizard needs to factor that possibility in up front. Why? Because by default the wizard uses an IPv4 DNS record format. Manual editing becomes necessary, just at the point when those who are setting this up for the first time are at the limit of their expertise. This isn't something you just do at 4pm on a Friday.

The difficulty is, how do you make a connection to anything in IPv6, when your laptop is propped up on the wet bar at Mar-a-Lago? The Wi-Fi is IPv4. It's like an uncrossable chasm: all that IPv4 hardware between you and your distant server doesn't have the capability to understand an IPv6 address, and your PC can't take part in your corporate setup without login information, policies, profiles and DNS configurations – all of which Microsoft would like you to be keeping these days in IPv6. Deadlock, surely.

Not quite. There are network standards that allow you to package up your IPv6 traffic and send it to an IPv4 address, where a broker process unpacks it and sends it on to the identified target. That's the job of a tunnel broker, and you can buy a membership for one of those services off the shelf.

If you went shopping with Microsoft for such a thing, then first you'd become lost in the swamp of over-extended product names, long implementation delays and half-hidden documentation. That sounds depressing, I know – but did you know that Microsoft only made IPv6 available within Azure in late 2016/early 2017? So any prospect of an all-DirectAccess environment would
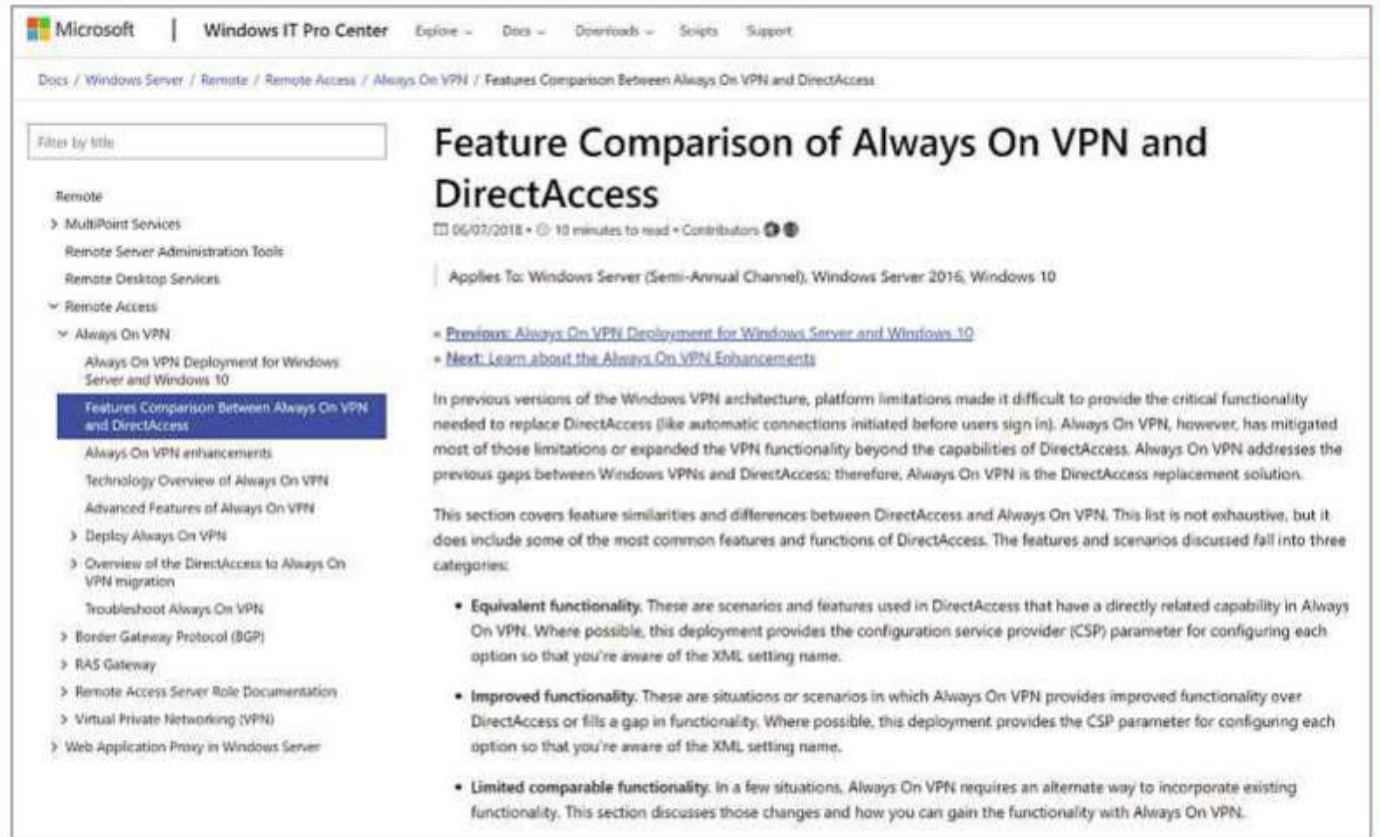
be a bit of a configuration challenge, to say the least.

The most famous tunnel broker is probably Hurricane Electric. It's been offering single users such capability, for free, for over a decade. It gives you global capability to jump from IPv4 to IPv6. But here's the oddity: it isn't an encrypted connection.

Let's mull that one over. Not only do you have to log into a tunnel broker with some credentials, you've then got to open up a firewall link to the public-facing side of your server farm (cloudy or on-premises) and then give that a username and password. This then traverses an unencrypted link before your firewall VPN session (assuming you can find such a thing running in IPv6 without breaking the bank) starts up and lets you in to your servers… which then want you to log in with a username and password.

Even if you manage to combine the firewall authentication with the server login, you're still asking users to run twice the regular password count – and the middle one (of the actual three in use, just to keep things confused) is transmitted in clear text.

Just to make sure I had this right, I called on Alex Bloor, CTO at Andrews & Arnold, a UK ISP that seems to live very happily in IPv6 world. He confirmed that he had a product that works in a similar way, making an L2TP tunnel and then allowing traffic out into the IPv6 traffic stream. He doesn't encrypt that initial channel either, because to him it makes no sense. Any encryption, he said, is handled further up the protocol stack – say, in the HTTPS connection to the various login portals. It isn't automatically the

responsibility of the lowest-level protocol. Besides, it might break other uses of port 443 in the connection.

Even though the logical case for tunnel brokering in mixed IPv6/v4 deployments remains as strong as ever, and can only go in one direction as IPv4 addresses become harder to come by, there's no reason to assume that the style of connection offered by DirectAccess is the last word in VPN connectivity. As we'll see, because Microsoft has pretty much left DA alone ever since the release of Server 2012. Even though DA's roots go back to Server 2008, one would have expected such a system component to have been updated and improved in a decade of use. Instead, it's all change.

Always-on VPN muscles in

Incidentally, everything everyone does with IPv6 always seems to be on the quiet. Did you know that Facebook's public IP address block includes ":face:booc:"? A legitimate hexadecimal address, to be sure, but quite literally many universes worth of grains of sand away from just taking the next available /48 off the top of the pile.

I'm sure there are some Easter egg addresses in the Microsoft address allocation, too – but these offer only a glimmer of reassurance in the fog of confusion surrounding all these topics. It looks as if Microsoft can't settle on the role it would like to occupy when it comes to roaming devices. If you had DirectAccess all set up, with the right accompanying external public DNS naming and SSL certificates, then you could get to the roaming laptop easily. It could call home to

ABOVE So long DirectAccess, it was lovely knowing you

> "It looks as if Microsoft can't settle on the role it would like to occupy when it comes to roaming devices"

BELOW Is Always On the VPN answer? Microsoft certainly thinks so
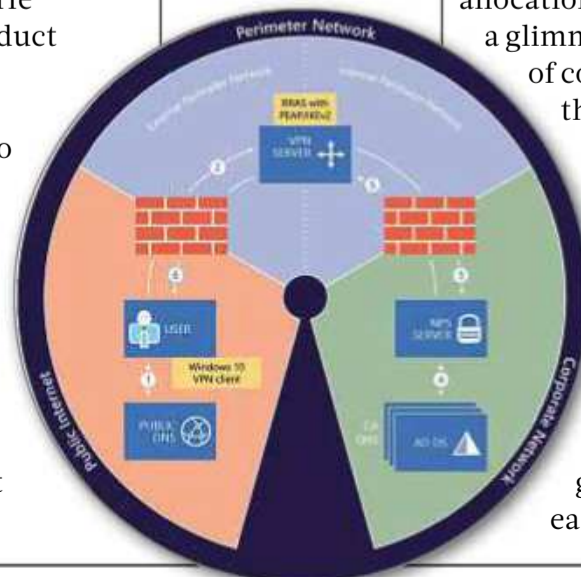
you; so long as the link was up, you could make a connection and fix whatever it is you need to fix. This completely distinguished DA from the other "remote server control" tools, being one architecture to rule them all.

It's rather early days to make sense of Always-on VPN in this context. It's a replacement in Microsoft's eyes mostly because it overcomes problems around what a company laptop should actually log into, when it's far from home. The local network? The service provider? The LTE cell? Corporate home base? It's a huge set of choices, each after gatekeeper responsibility. So you have to pay up before you get logged in – a nightmare for travellers and those who support them.

Microsoft's answer is to say that the machines are always on the VPN. The structures are operational right from the instant of boot-up, with policy-delivered constraints and permissions telling the VPN connection how to wait, what to look for, who to pass through, and even how long to stay on once connected.

Some of these tricks mimic the strange experiments done to Skype over the past few years, in which certain Wi-Fi and cellular providers negotiated unpaid, unmetered pass-through arrangements so that Skype users could pay for the connection through Skype, rather then having to negotiate the strange logic and peculiar charging preferences of small-town internet connection providers (yes, GANAG of Germany, I'm thinking of you).

This old and now apparently obsolete trick required an open back-channel, so that the traveller's machine could be sure it had credit on Skype, then wait for Skype to communicate with the back-end of the distant provider, which then pushed credentials or a "voucher" forward to your specific session. This then completed a single-purpose connection just for making that all-important evening video call at the end of a hard day.

This strikes me as an astonishing bit of overdesign, in pursuit of a usage model with as many opportunities for mischarging, ripping off and not working, as were found in the now dreadfully deprecated DirectAccess. Of the small number of people I know

who are obliged to use DirectAccess by a mix of configuration and hardware vendors, I don't know any who have made plans to move over to Always-on VPN as their daily bread remote compute connection provider. Not a good situation!

Watch out for cloud backups

My client was very puzzled. His firm had endured a bad internet week, right at the end of the hot summer. He was sure that the link speed had dropped in the preceding weeks, too, and the line behaviour looked as if it was due to poor-quality connections on the DSL side of the router. Much shrugging ensued.

No way to get BT Openreach to retest a line like that, and precious room in the surrounding wiring to ask for another route into the building. The firm's new CEO arrived, and things got embarrassing: glitches in pictures on web pages, difficulty logging in, jittery VoIP service. Eventually, I had to go take a look.

When faced with what looks like a hopeless case, with the solution out of my reach (in this case, DSL wiring standards not being upheld), I fall back on simply mooching about. Just looking at the usual suspects to see whether any evidence pops up unexpectedly. And I got some!

This network has four VM servers on two physical hosts. It's small. There's a large group working remotely; they mostly want to access a database server, which isn't terribly cutting-edge when it comes to the actual database. Nor yet are the developers, who have never been prescriptive when it comes to cloud-based backup programs, leaving final choice to the user.

On this particular day, when in mid-mooch, I jumped to the database

> "When faced with a hopeless case, with the solution out of my reach, I fall back on simply mooching about"

server VM and found it laggy. In fact, testing another part of the update and talking from it to the Quad9 DNS server, I was seeing 25% packet loss. An idle look around in Task Manager and I could see there was a web page sitting minimised in the taskbar that was taking more CPU and network than the rest of the VM put together.

This was being comprehensively hidden by the dynamic load features of VMware, because these VMs are on fast, quite new servers. The web page in question was the dashboard of a new cloud-resident intelligent backup product. No current job was running. Nonetheless, just leaving the dashboard open wasn't just eating the DSL line, it was messing up almost all the other services on the network.

Closing the page and rebooting that server as a precaution brought everything else back up to speed. Packets stopped dropping, collisions dropped away. I was flabbergasted that a mere web page could exert that much influence over an otherwise respectable network.

Okay, so it was running on a very fast machine in a clean configuration, and could therefore have produced far more mess if it had been so minded. But the simple fact remains that this devil wasn't backing anything up at the time. It had been left idle for a few days: a situation in which most corporate cloud resources will politely log themselves out and disappear. This was doing the opposite.

The lesson is simple. You can't have a sufficiently separated test environment in a small business. If you're going to test at home, make sure you define a start and an end to the test process, and a recovery path if things seem to be going wrong.
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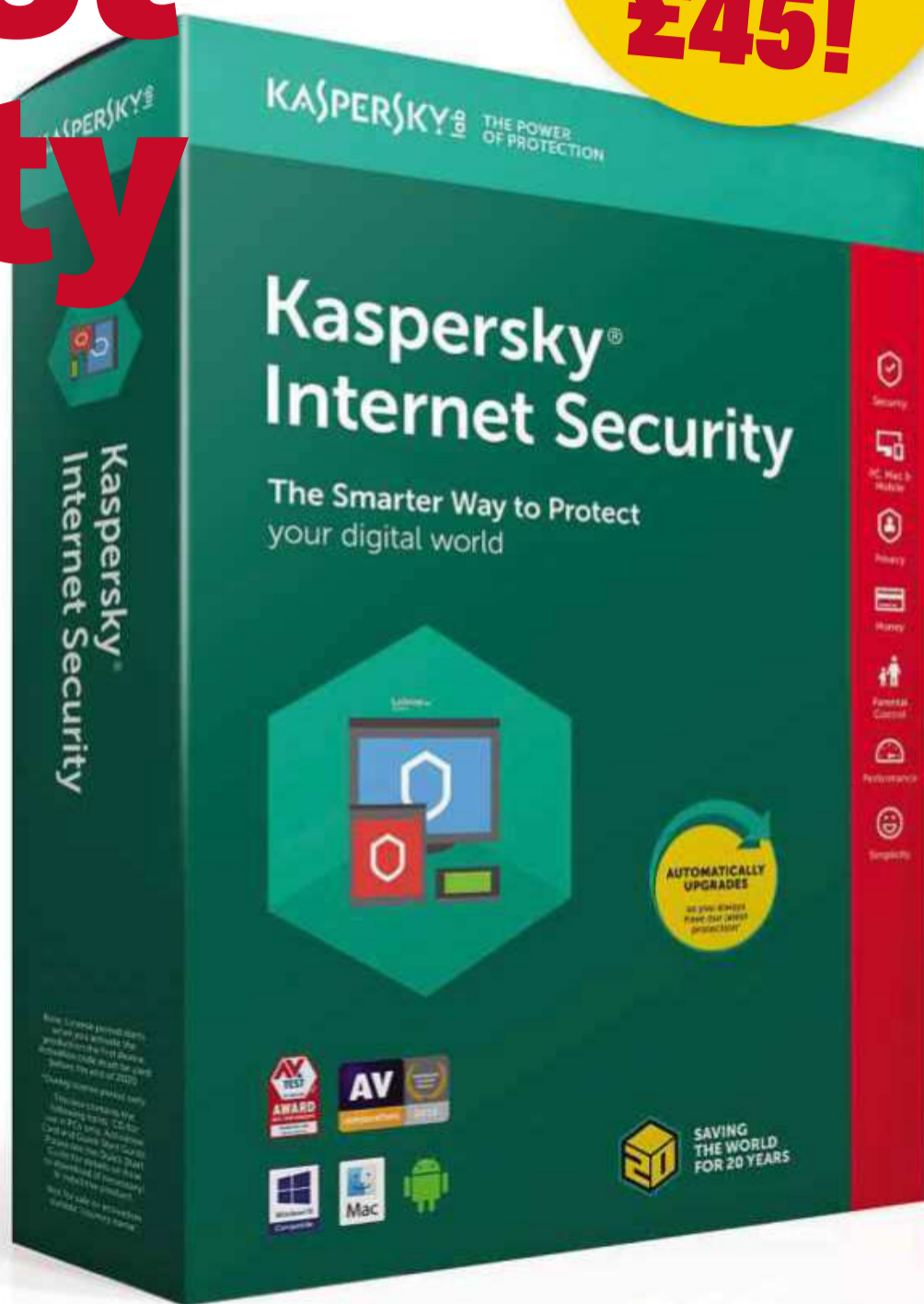
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Futures

Don't be stupid
AI is arriving for your business right now

Yes, artificial intelligence is a buzzword, but dismiss it at your peril:
it's already becoming a useful tool for businesses, automating small tasks
that eat up employee time
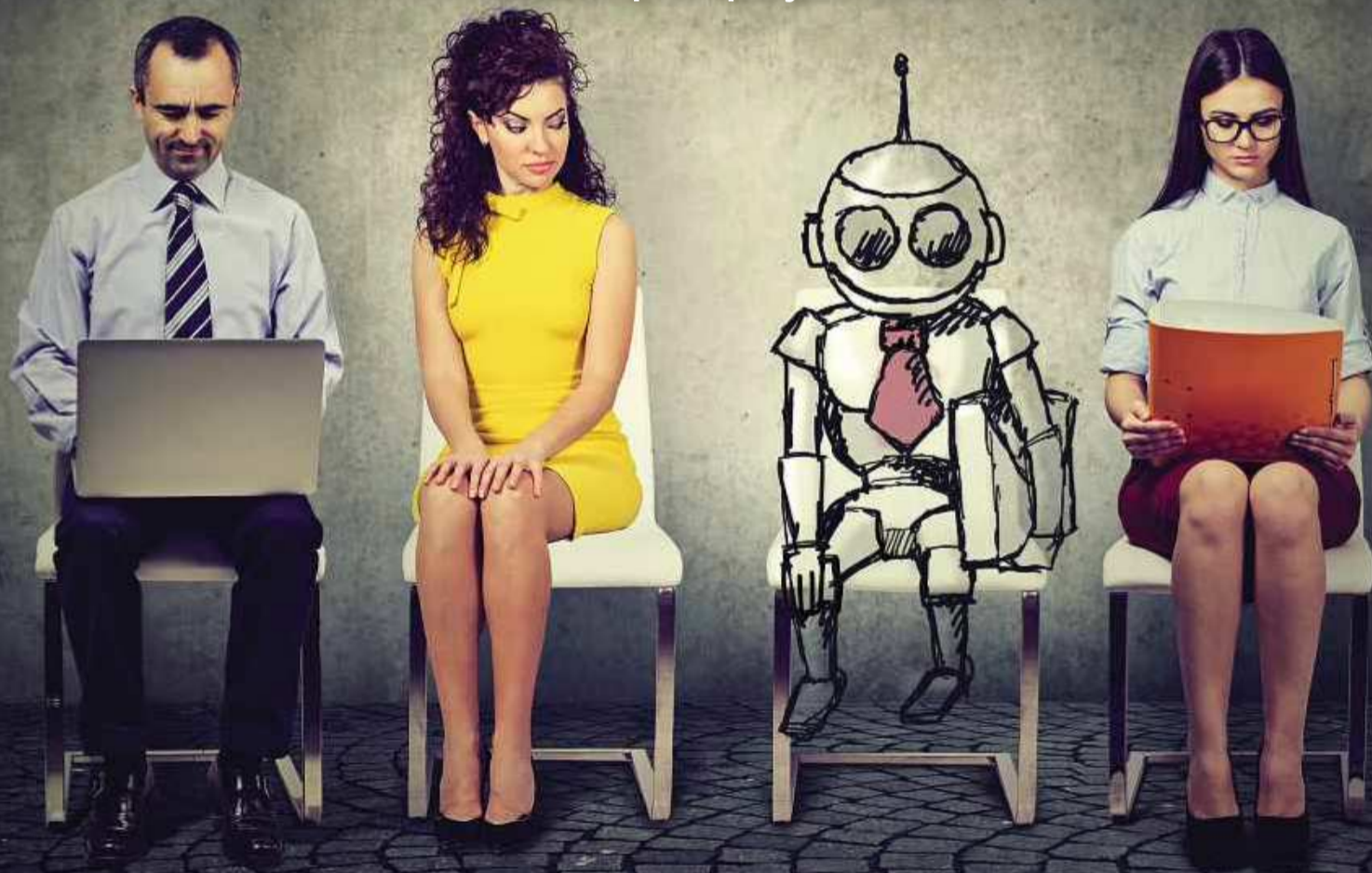
Artificial intelligence isn't limited to cutting-edge healthcare and driverless cars – it can power your business, too.

There's more to AI, be it machine-learning or neural networks, than chatbots of questionable use. Instead, the software you already use is slowly letting AI-powered tools and features trickle into their systems, be it Microsoft, Box or Slack. Businesses know this: a report from Boston Consulting Group and MIT at the end of last year revealed that eight in ten respondents said AI will help their company gain a competitive advantage and is a strategic priority for their businesses. An EY survey suggested one in three businesses are already piloting AI tools, with the aim of improving or developing new products or services, cutting costs and accelerating decision-making.

So what is this AI technology doing? Plotting a future war against humanity? Coming over here to take our jobs? The reality is rather more mundane: it's often automating basic tasks, says Angela Eager, research director at TechMarketView. "It's tempting to look for the most headline-grabbing developments but some of the most useful AI – and specifically machine learning – uses within the business arena are more down to earth," she said.

Eager points to invoice processing and filing expenses, such as Abacus and CumulusPro, along with service desks and customer services where automated tools can handily sift through content. Sales departments

are already using machine learning to predict and forecast fraud detection, via AI-powered services such as Kount. And HR and recruitment are being helped with intelligent matching that far surpasses keyword association – Textio even examines ads for gender bias.

Behind the scenes

"In the business environment, many of the use cases are almost behind the scenes in that only the output is seen by the user, be that a recommendation for action, a decision point or a completed expenses claim – and that's precisely how it should be, now and in the future," said Eager. "Algorithms don't help users do their jobs but the output does. These technologies are increasingly being embedded within applications and some sort of capability is rapidly becoming a baseline requirement – whether the business has immediate plans to deploy it or not."

Such technologies aren't going to replace office workers, or at least not anytime soon. Instead they will take over or assist with repetitive tasks, which will make them welcomed by staff tired of such dull jobs. "Today's business use cases are also driven by levels of capability – machine learning is at home with repeatable patterns, narrowly defined tasks and large amounts of data, but is not capable of general purpose machine learning," she said. "'Comfortable' use cases – ones that help rather than replace the user such as invoice processing – are finding traction."

For that reason, chatbots aren't necessarily a silly piece of technology – they could help your business make contact with customers and gather data on what they're looking for, as well as help staff run queries and research. "Voice-based chatbots in an office or a noisy environment are unlikely to be appropriate but can be well suited to front line customer service triage," Eager said. "Text-based chatbots potentially have more widespread potential within business – it's about the right technology in the right environment."

Growing complexity

So far, then, the use of AI in business is limited to chatbots, automating expenses and other simple tasks. However, as the Microsoft and other announcements reveal (*see "Three ways you can use AI at your company now", below*), there are more complex jobs that such technologies can help with, in particular those that help sift through data quickly, such as for sentiment analysis, data discovery and image recognition and transcription, as in the OneDrive features. Such technologies will be embedded into existing software, as with Microsoft and Box, but it will also be available as machine-learning-as-a-service for more specific use cases, Eager said.

While AI is becoming easier to use and addressing more in-office tasks, challenges remain. No machine-learning system works without quality data – as the IT adage goes: garbage in, garbage out. So none of us should necessarily trust AI output – instead, it must be auditable.

"The tech will take over or assist with repetitive tasks, which will mean it's welcomed by staff tired of such dull jobs"

"Businesses need to have a specific and well-defined task in mind, a known output and ways of measuring the impact," said Eager. "They need to be able to select the 'right' data for the task – which assumes they know what the 'right' data is. They also need to know what a 'good' result looks like and be ready to question output to prove its validity and build trust. Beyond that, the issue of auditable AI/machine learning is becoming more important – understanding the how and why behind a recommendation, particularly in highly regulated industries – and that's not easy to determine." In other words, AI can work for business, but let's take the effort to make sure it works. ●

Three ways you can use AI at your company now

Artificial intelligence is a wide-ranging set of technologies that are complicated to understand, let alone build. But it's starting to work its way into existing software, which you may well already use in your office or business. Here are three products with AI-enabled features available now or soon.

OneDrive for Business and SharePoint

If you're a Microsoft 365 user, AI is about to make your work a whole lot less annoying. Starting later this year, any video or audio files stored in either OneDrive for Business or SharePoint will use AI-based transcription, making it easy to search for the specific content you need – and ensuring you never need to type up notes yourself again. That comes alongside text recognition that means you will be able to search screenshots and snapshots of receipts or other documents by the text in the image – handy if you went to Nandos for a cheeky working lunch that you're hoping to expense. The aim with all these tools is to make it easier to find untagged, unstructured data without hunting endlessly.

Box Skills

Box has been slowly adding AI-powered "skills" to its cloud-storage systems. At the end of last year, the company unveiled "Box Skills" with automated transcription for easier searching, similar to Microsoft's plans for OneDrive. This summer, it revealed plans to expand that via IBM Watson, using that AI platform to analyse image data and automatically tag documents with concepts and keywords to make it all more searchable. "For lawyers working on time-sensitive matters, this could be the difference between making a court filing deadline and needing to file for a costly extension," the company said at the time. It's also automating translation of documents, handy for those working globally.

Zoho Zia

The cloud-based office suite rolled out a set of updates to its core package, Zoho One, that includes a new set of analytics tools as well as integration with its AI-based assistant, Zia. Zoho fans will know that Zia isn't new, but it's now moving away from its sales-assistant role – as part of the company's CRM tool – to all of Zoho One. The key idea is that it will pull in data across apps to make

suggestions. For example, it could mash together information from Zoho CRM and Zoho Desk, combining it to reveal how many customers are looking for support, or examine the Zoho Books and Zoho People apps to reveal revenue-per-employee. The company is also planning to open up the Zia platform so businesses can build their own customer skills for the assistant.

The tech startups cleaning up the air

Air pollution is a dirty business in the UK, leading to early deaths and damaging our brains. Nicole Kobie reveals the startups helping us breathe easier

That haze in the air, the smell when a diesel truck passes by – it's not only killing us, but air pollution makes us more stupid, too. Thankfully, tech startups are working on solutions.

Air pollution causes 40,000 premature deaths each year in the UK – or so claimed the Royal College of Physicians in a 2016 report – and causes asthma in children. It may even increase dementia rates for those living by the busiest roads. Researchers at the Yale School of Public Health in the US suggested long-term exposure to air pollution causes reduction in cognitive function equivalent to a year of education at school. With London roads surpassing EU healthy air limits for the year just a few days into January 2018, cleaning it up is a serious challenge.

"A single number tells the story: 91% of the globe's population is exposed to air pollution levels exceeding the World Health Organisation's recommended limits," said Tyler Knowlton, communications director at Plume Labs. "The long-term consequences are shortened life expectancy, increased risk of heart disease, lung disease, and the unhealthy growth of our children."

Solving the problem at the source is a key step, and electric cars and buses have the potential to reduce the rate of pollution. But while we wait for drivers to flip from petrol to batteries – or for cities to ban polluting cars from roads, as some have started to do – startups are offering temporary solutions to this serious public health issue.

■ Streetside cleanup: Pluvo

A trio of students out of the Royal Academy and University

College London have started their careers in headline-winning fashion with Pluvo.

Designed as part of their Masters programme, these 3m-tall glass lava lamp-esque tubes are installed on pavements alongside busy roadways. They suck in dirty air and use a mist to remove polluting materials. At the same time, the integrated display shows advertising, meaning that councils or local governments that install the Pluvo tubes should make back the money it costs to install the air-scrubbing machines.

The designers say that air is 50% cleaner after being through the Pluvo wash cycle. "What we wanted to do was clean the actual air that people were breathing," explained the co-creator of Pluvo, Lewis Hornby. "That was why we started to look at roadside air cleaning."

The team, which also included Claudia Arnold and Nick Hooton, considered a wide range of possible technologies, settling on a method called "web scrubbing" that's used in power plants for waste streams. "It's one of the only
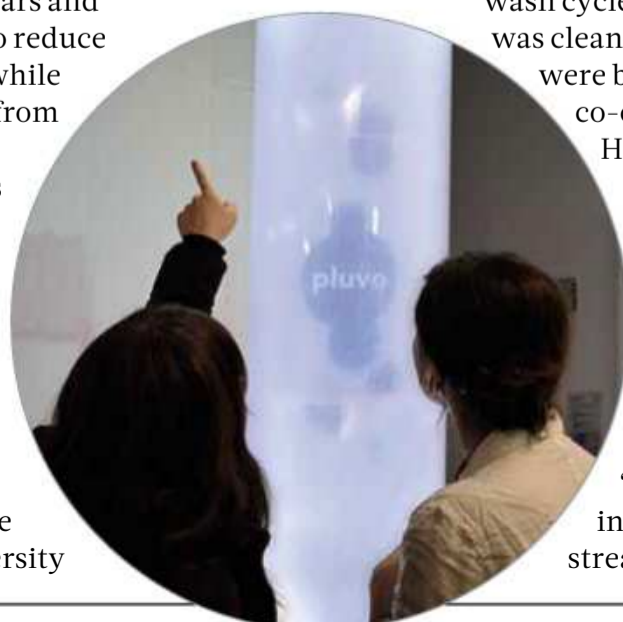
methods that can actually tackle both particulates and gases," said Hornby.

Getting the tech right in a pavement-ready format was only the first challenge. The second was finding a business model. "If you're going to have a meaningful impact on the quality of the air then it needs to be a scalable product, and that means it needs to have a financial incentive for its rollout, as councils don't have the money to spend on anything," he said. That's why the Pluvo was designed to support advertising. And it's worked: Hornby says he's had requests for trials from most London councils, and will be installing them at an unnamed Northern line train station in 2019.

■ Tracking emissions: Emsol

Emsol, meanwhile, is more on the preventative end. The London-based startup calls itself an emissions-as-a-service provider, but what it's actually doing is monitoring the cars and lorries that are already on our roads, particularly around construction sites.

Air sensors will be sited where lorries and trucks wait or drop off, meaning they can track "poor driver behaviour" such as idling. "The vehicles, if you sign up with Emsol, will be tagged and once they pass the sensor the data is collected," said Makeda Seaton, community manager at Emsol. That data is passed up to a real-time dashboard so companies can track the level of emissions, such as CO_2 and particulate matter, on their sites to meet regulatory limits. "They can then contact the fleet manager and say how much emissions were being emitted, and advise them to do something about it."

She stressed Emsol doesn't directly enforce air pollution laws, but gives companies the data they need to ensure they keep within limits. So far, the connected sensor system is only being trialled at a few construction sites in London, but the aim is to expand into any industries that involve fleet management, such as couriers and delivery firms. "You'll be able to say [to couriers] I don't want this parcel delivered to me if it's impacting my air quality," she said.

■ Fighting back: Flow

Plume Labs is also keen to help us track air quality, offering the Flow detection system for individuals. It's a 5in sensor that connects to your smartphone to track pollution wherever you go – indoors and out. "The device itself is made up of several custom components that measure, in real-time, the most important pollutants to avoid in relation to human health: NO_2, PM2.5, PM10,

RIGHT The £129 Flow sensor measures the amount of air pollution where you are – and is surprisingly stylish

BELOW The accompanying app gives an at-a-glance view of the pollution you've breathed in
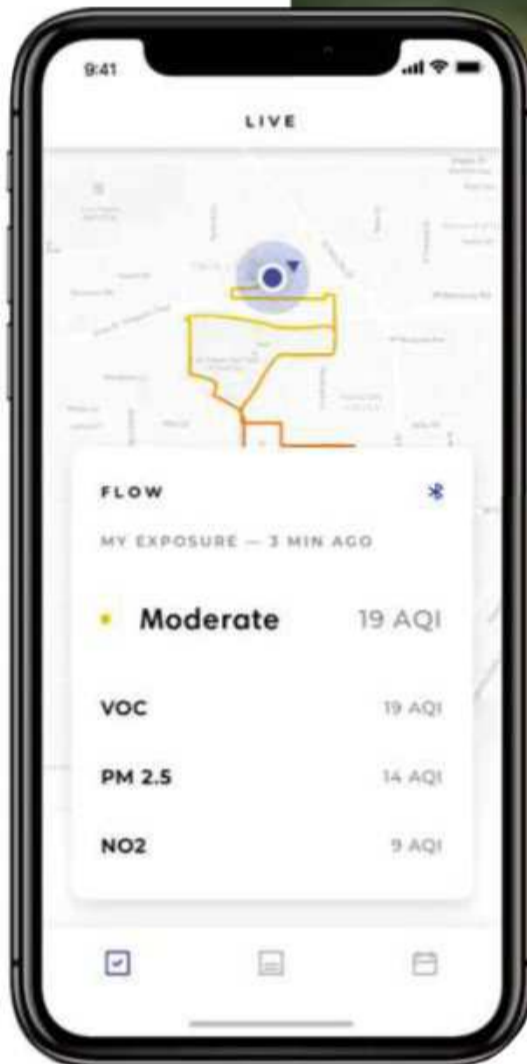
and VOCs," said Knowlton. That data is churned through a machine-learning platform that spits out "actionable advice to reduce personal exposure to air pollution".

Is knowing about air pollution levels enough to help us avoid them? Knowlton says a recent study by King's College London suggests that, informed with the right data, small changes to routine can cut pollution exposure by half. If you want to go

with the Flow, it's now on sale for £129 at **flow.plumelabs.com**.

However, it's not only about changing our behaviour, but the behaviour of those in power, too. "Beyond individual health and wellness, we believe that we cannot tackle air pollution and climate change without the world's governments and institutions," explained Knowlton. "We know that governments of all levels, all around the world, are facing protests and lawsuits related to a lack of transparency and action as air-quality awareness increases.

"Increased access to air pollution data and monitoring technology, at the citizen and NGO level, is driving a shift in power. Data collection agencies are being challenged where there is information and, where there is none, individuals are stepping in to fill the gaps." That should make all us breathe easier. ●

> **"Increased access to air pollution data and monitoring technology, at the citizen and NGO level, is driving a shift in power"**

Mapping the problem

Air pollution is the ultimate local problem. London is full of dangerous places to take a deep breath, but if you live on a quiet street alongside a park, your air quality is likely fine. You may feel safe from health woes if you live in a smaller town, but every minute you spend in bumper-to-bumper traffic is dangerous.

You can't simply look out the window and know if the air out there is safe. To help, there are plenty of projects that tie together open mapping, such as Google Maps, with open data, using either live sensors or modelling to predict the worst pollution hotspots.

Clean Air Walking Routes (**pcpro.link/290clean**) is a project by King's College London that combines pollution models with live data from the London Air

Quality Network to map the best routes to walk through London. It includes air quality levels, helping pedestrians find the side streets with better air to make their morning commute less dangerous and helping runners get training in without choking on fumes. The City Air app does a similar job and there's a version for your phone (**cityairapp.com**).

There are other sources of air-quality data, too. DEFRA's air pollution forecast (**uk-air.defra.gov.uk**) lets you see predictions for future dates, while Air Quality England lets you search your local area to find air quality alerts (**airqualityengland.co.uk**). Thinking global? The World Air Quality Index map reveals pollution levels in 101 countries (**aqicn.org**).

What is...Ray tracing?

Nvidia's latest GPUs support this graphics technology, creating frighteningly realistic games. Here's how it works – and what it means for digital content


Computer graphics are set for a perfectly lit leap forward thanks to Nvidia's latest GPUs, which finally support real-time ray tracing.

What is ray tracing? It's the latest rendering technique, which raises the eminently reasonable question: what is rendering? It's the process by which a computer builds an image, using a model of lighting, texture and more to create a scene from nothing more than an algorithm and data points. It's how computer graphics are built. Ray tracing rendering behaves just like real light would, allowing for more realistic images.

The current technique for lighting rendering is called rasterisation, and while it looks fine in certain circumstances, the way the information is layered means it doesn't work well for reflections or other instances where light is actively interacting with the scene. Ray tracing traces every single ray of light, letting the light behave naturally in reflections, creating realistic shadows and interacting with moving objects.

We couldn't do this before? Movie makers already use ray tracing. Animation house Pixar first used it in *Monsters University*, which was released back in 2013, and it's also been used by Industrial Light & Magic in the *Iron Man* films. But filmmakers have time to leave a scene to render, letting their racks of servers do the work overnight. Games developers need it to work in real-time – no one wants to take a bullet because the sunlight stalled the game. But real-time ray tracing is rather computing intensive, so it hasn't been possible.

Until now? Until now. In August, Nvidia revealed its next-gen graphics cards at Gamescom in Germany, powered by an architecture dubbed "Turing". The GeForce lineup has ditched the GTX designation for RTX, reflecting the ray tracing capabilities. The GeForce RTX 2080 Ti, 2080 and 2070 GPUs feature RT cores that are optimised for ray tracing, alongside cores designed for neural network processing – which means developers can use a different technology, deep learning super sampling, to improve frame rates. The end result? Nvidia – and the whole games industry – is promising smoother, cleaner graphics.
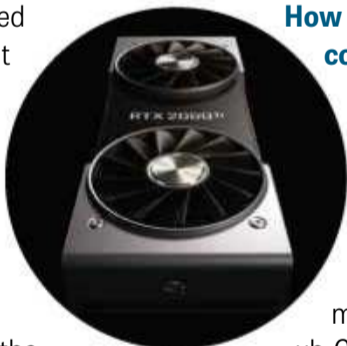
How much will these GPUs cost? The lower end RTX 2070 will cost around £500, offering six GigaRays/sec of tracing – a measurement invented by Nvidia, but we assume that's enough for most of us. If you want more, uh, GigaRays, you can upgrade to the RTX 2080 or RTX 2090 Ti, with the top end model topping out at £1,200. The top-end models landed in September, albeit not in high volumes, with the 2070 arriving in October. See our review of the RTX 2080-based Scan Vengeance on p60.

So gaming will finally look truly realistic? Not so fast: the tech exists and there's hardware to process it all in real time, but game developers still need to use it. Nvidia announced that top games – including *Battlefield V* from EA and the next *Tomb Raider* – will feature real-time ray tracing, but they're yet to be released. The arrival of the RTX products may well encourage other developers to turn to ray tracing, but it'll be some time before games that use the natural light system arrive.

OPINION
Nicole Kobie

Keep the pilot – but ditch the petrol

Flying cars are a trope of futures writing, a sci-fi classic that never seems to arrive (*see Dick Pountain's column on p32*). Last issue, one of the stories in this section described Rolls Royce's part-electric flying car – a helicopter that turns into a small plane, kind of. In September, Bristol startup Vertical Aerospace revealed a video clip of its own version, a quadcopter that it hopes will be zipping passengers between cities within four years. The companies naturally eschew the term flying car, although they might have to find a sexier term than VTOL, or "vertical take-off and landing" vehicle.

What's fascinating isn't the idea of flying from London to Cambridge in a tiny drone copter – let's face it, the prices will likely be sky-high versus even Britain's pricy train fares – but what's powering these machines. Rolls Royce has a part electric, part gas turbine system, while Vertical Aerospace is entirely electric. If you can fly a five-seater quadcopter hundreds of kilometres on a battery, you can definitely power a runaround car.

Forget driverless cars and VTOLs (see, told you it needs a better name). It's electric-powered vehicles that actually matter. The sooner we ditch petrol, the better – not least because of that whole looming climate change disaster and the air pollution choking our cities. Once we've got batteries parked in our driveways and on our streets, it's a whole lot easier to make use of renewable energy sources that are intermittent in power generation, such as solar or wind. When paired with smart grids, batteries can draw down power when it's cheap and clean to recharge, and even supply it back to our homes to power our appliances, which will hopefully help wean us off dirtier energy sources. Flying cars and autonomous runarounds may remain dreams of the future for the time being, but electric transport means that we get a better chance at having that future.

Besides, who wants to fly around in an autonomous, airborne taxi if you can't see out of the windows because of all the smog?

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FEATURES

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Join the podcast revolution
The barriers to podcasting just keep on falling away. We reveal how to join in the fun and take your podcast to pro levels.

Bring your own broadband
We meet the broadband exiles who got fed up of waiting for BT to pull its finger out and installed their own fibre.

Jon Honeyball takes a nostalgic trip down memory Tottenham Court Road

What better way to start a wet Saturday morning than driving up Tottenham Court Road in London? This used to be the centre of my technological world: as a teenager, the street was lined with hi-fi shops. Some had aspirations to quality. Others, like Lasky's, took on the "pile 'em high" approach, and often featured a "wall of sound", which was a whole wall piled floor to ceiling with loudspeakers. And there was the comparator switch box, which allowed the shop assistant to quickly switch between pairs of speakers, ensuring that the most profitable had the longest play in your brief deluge of noise.

Every vendor could be found somewhere on Tottenham Court Road. Need a particular widget or adapter? Someone stocked it. You might have to walk up and down, diving into shops and doing your best to avoid the onslaught of the hungry sales assistants, but your hunt would be rewarded.

Sometime in the late 1980s, the hi-fi boom passed and the baton was handed over to computing. This was an even richer vein to be mined. I often visited just to see what was on sale. I discovered all sorts of odd utilities on the shelves of Micro Anvika. I loved that shop, and was well known by the staff because I dropped in so often and they were always up for a chat.

Best of all, you could haggle. Find something that you liked, then hem and haw for a few minutes before going next door or the shop further down to see what price they would do. If you were prepared to walk and be firm but polite, there were significant discounts to be had. Remember, this was the era where high-street computer retailing had meaningful margins. Competition was real, alive and right next door. And if your favoured shop, Micro Anvika in my case, didn't have what I wanted in stock, they would send a van to collect it from one of their other stores.

As you might expect, Tottenham Court Road was also hugely influential in the photography world. Window after window was filled with gorgeous camera bodies, lenses, flash guns and endless other widgets. It wasn't really obvious what each thing did, or how you might use them, but the lust value was still immeasurable to a geeky teenage lad.

Today, it's like walking through a war zone. Shop after shop is shuttered, with tired and tatty display boards over the doors. An endless array of anodyne cookie-cutter chains selling vastly overpriced coffee. A bright sign reassuring me that McDonalds is just three minutes away going north. A road layout designed by a maniac with a fetish for making it as nasty as possible to drive along. A road surface that would make me fear for my life if I were on a motorbike.

In short, the place has died. The charm has gone, the wit and humour, the banter and barter, washed away in a wave of redevelopment and the endless onslaught of the internet.

It's not hard to see why. On Thursday, I needed to buy a small Bluetooth speaker for a lab test. A couple of mouse clicks in my browser, and it appeared the following morning. I didn't even need to get out of my seat in Huntingdon. A process that would once have required waiting till the weekend when I would next be in London, a tube train to Tottenham Court Road, a wander along the street, a purchase followed by the trip home, has been replaced by a ten-second finger twitch.

In every conceivable way, the new is better than the old. Faster, cheaper, less effort, easier, larger range, better stock holding, and feet that don't ache. You don't have to engage with a spotty 19 year-old with a heroic Clearasil habit, and a level of knowledge that would embarrass a turnip.

Indeed, no one even buys cameras any more unless you are really serious. The world of photography has sunk into a swamp of AI-enhanced "selfies" and the truly mind-numbing view that if you don't have a photo of you at a particular place, you can't have been there. Cartier-Bresson would be rotating in his grave.

And yet something has gone. We are social animals, and this monster we call internet shopping is dehumanising us at a rate that is both subtle and terrifying. I get no pleasure from my one-click shopping experience, and that is most certainly a downward step. Maybe I shouldn't expect to enjoy it, and maybe I really had no right to relish the shopping experience when I was younger.

As Joni Mitchell sang, there's something lost and something found. I'm just not sure the something found is all it's cracked up to be. To quote another great musician, Roger Waters famously wrote "is there anybody out there?" Sometimes it's hard to be sure.

> **This monster we call internet shopping is dehumanising us at a rate that's both subtle and terrifying**

■ Jon Honeyball is a contributing editor to *PC Pro* and a geek in the very truest sense of the word. He will never give in to Amazon's one-click buying button. Email jon@jonhoneyball.com

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