MAKE MONEY BY SELLING YOUR SKILLS ONLINE p30

PC PRO

DESKTOP PCs
From £399 bargains to £1,500 monsters p76

BACKUP SOFTWARE WORTH £36
Claim your bonus software: see p66

2021's MOST
DANGEROUS
SCAMS

☠ **Smartphone attacks**
☠ **The Office 365 lure**
☠ **Dodgy online forms**
And many more: see p24

How much RAM do you need?
Why it may not be as much as you think p40

The quantum internet
What is it and how will it work? p126

HIGHLIGHTS THIS MONTH

Full contents overleaf

REVIEW OF THE MONTH
p44
Porsche Design Acer Book RS I7
Is this the most stylish laptop we've ever tested? We'll let you judge from the photos, but it's certainly one of the most striking. With Acer and Intel's help, there's power to match the panache courtesy of an 11th-generation Core i7 processor, and it's wrapped up in a compact 1.2kg package. Read our in-depth verdict from p44 to discover if it's worth £1,900.
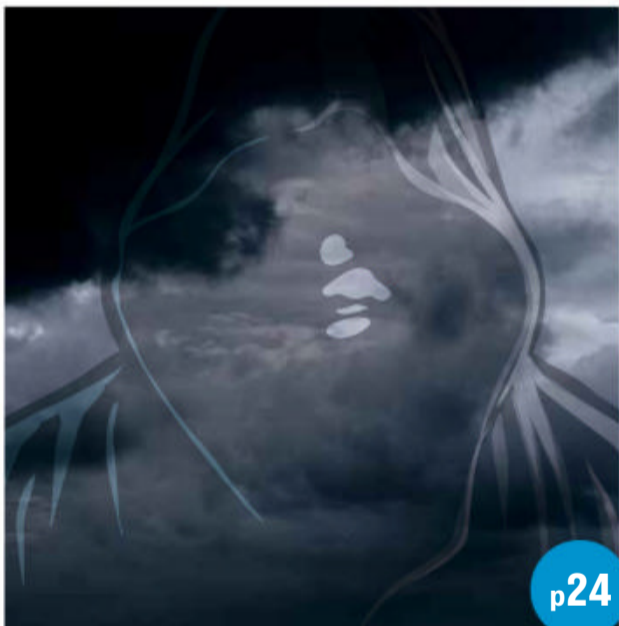
p24
SCARE STORY OF THE MONTH
As Monty Python almost said, scam, scam, scam, scam, scam. They're simply not going away, so Davey Winder explains how to spot scams and what action you can take.

p30
MONEY MAKER OF THE MONTH
We interview three impressive individuals who have managed to turn a side interest into money. If you fancy turning your talents into cash, head to p30.
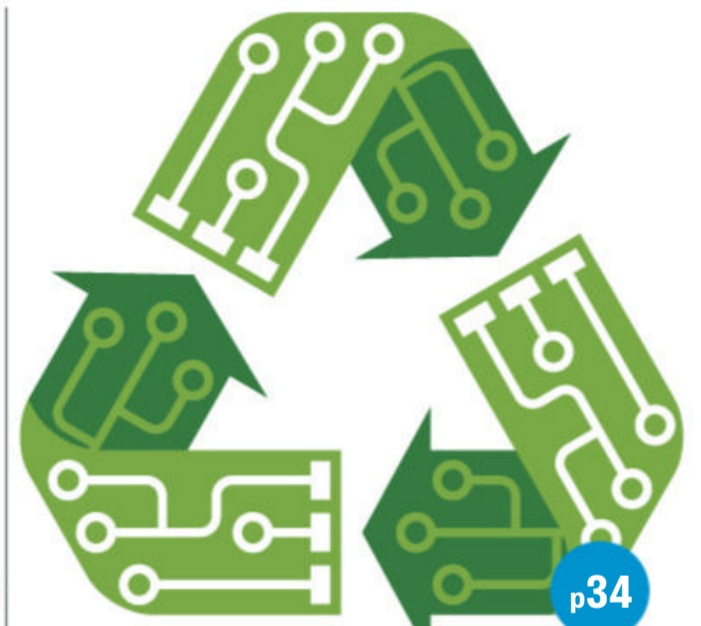
p34
MONEY SAVER OF THE MONTH
Even if your old laptops refuse to run Windows 10, there are many ways you can breathe new life into them – and not just the obvious routes. Nik Rawlinson reveals all on p34.

CONCEPT OF THE MONTH
p126
The quantum internet may sound like the stuff of fiction, but academics believe it has hugely practical applications that could make the world a safer place.

THE LABS IN ONE NUMBER
p76
That's how many practical tests we put each PC in our group test through, from rendering speed to 4K gaming, to discover which of the dozen on parade deserves your money.

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→ **THE PC PRO PODCAST**
Listen live to the *PC Pro* podcast every Thursday at 1pm. Visit **mixlr.com/pcpro** to join us

BELOW We performed a rigorous set of tests to see what can gobble up your RAM

p62 The Huawei Mate 40 Pro looks great, but comes with a colossal downside

DESKTOP PCs for every budget

p76 We put 12 PCs up against a bevy of benchmarks to find the right one for you

THE NETWORK

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Editor's letter

Don't just save your money – make some too

YOU'RE NO FOOL. How could you be? You're holding a copy of *PC Pro* in your hands. Wherever you turn, though, I guarantee people are trying to part you from your money.

For some prime examples, look no further than Davey Winder's eye-opening feature about scams on p24. You'll notice that this isn't a list of tricks such as the old ruse of "Microsoft" calling about a problem with Windows. The new breed of scammers are smarter than that. Among many other devious tactics, they tailor their message for topicality, whether that's mysterious delivery firms calling to expedite your parcel – a popular scam call in the lead-up to Christmas when this was a big concern – or the promise of a January sale deal.

The biggest danger may be thinking that you're too clever, too educated, to fall for a scam. The trouble is that the telltale signs we used to rely on no longer apply, with scammers growing ever more sophisticated. As Davey reveals, one popular tactic is to pretend – convincingly – to be your boss sending you an email. The email looks right, the language sounds right – so, as requested by the person who signs your pay cheque each month, you give them a ring on the number listed. It just so happens to be a premium number, and soon your bank account just so happens to be a few pounds lighter.

No matter how smart you are, you owe it to yourself to learn the tactics being employed, because the trend is clear: scamming became a bigger deal in 2020 and is likely to get worse in 2021.

You may already have fallen for another trick, which is to buy more RAM than you need. This is not down to scams as such, but rather human fallibility when it comes to wanting the best we can afford. For years, the beat of the marketing drum told us that we need as much memory as we can squeeze into our computers, but it isn't so. Some people will take full advantage of 16GB, 32GB or even 64GB of RAM, but turn to p40 and you'll discover why there's every chance that 8GB is enough. Even 4GB (no, really). And I write this as a person who bought a laptop with 32GB of RAM only a few months ago.

Consider also how much you really need to spend on a phone. Sadly for Huawei, I can't see many takers for its £1,100 Mate 40 Pro (*see p62*), due in large part to the continued absence of Google apps and services, but what benefits are you really getting from spending £799 on the Sony Xperia 5II (*see p64*) rather than the £329 OnePlus Nord 10 (*see p65*)? It's a question that repeatedly comes up on the *PC Pro* podcast, with Barry Collins making the argument in favour of bargain phones with the passion of a reformed smoker. (He replaced his top-end Samsung Galaxy S phones with a £230 Galaxy M31 and boy doesn't he love to tell you about it.)

Fortunately, Barry is also here to help you make money. This month, he shares the story of three people who have turned their talents and interests into cash, via newsletters, YouTube channels and even talent spotting for a football video game. To find your own side hustle, head to p30.

Tim Danton
Editor-in-chief

CONTRIBUTORS

Jon Honeyball
On top of his usual contributions – including the tale of his final Windows 7 migration on p110 – Jon delivers his verdict on the £549 Apple AirPods Max on **p59**

Dave Mitchell
Sharing files in the cloud doesn't only mean using Dropbox, Google and Microsoft. Dave explains what to look for and puts four alternatives through their paces from **p94**

Lee Grant
As someone who has to deal with grieving families trying to unlock a loved one's technology, Lee provides a unique insight on the steps we can all take. See **p116**

Nicole Kobie
What does the quantum internet actually do? And when will it appear? In this month's Futures section on **p126**, Nicole reveals two big recent breakthroughs that change everything

From a technology point of view, what was your highlight of 2020?

"I was taken aback by how well things continued to work. China effectively shut down for weeks, yet we've still seen innovations from AMD, Apple and Nvidia that will mark 2020 as one of the most important years in technology history."

"Streaming live music, most often via YouTube: from Wigmore Hall chamber recitals to Bill Frisell playing in his Brooklyn backyard."

"It has to be the Apple M1 processor, an era-defining shift that we'll still be talking about in 20 years."

"I know this is a soporifically dull answer, but the way the broadband network held up under the strain of a sudden switch to homeworking was impressive and vital."

"Singers. People performing from home have redefined popular singing. Listen to the House Gospel Choir perform *Red Alert* on YouTube or *Sophie Ellis-Bextor's Kitchen Disco*."

"Throw together the continued ascension of Ryzen, the emergence of Apple's M1 and the sobbing in the corner of Intel and 2020 brought the smell of change into the air…"

"The Apple M1. It broke the assumptions that we had been led to assume were unbreakable."

"My highlights were the social media posts advising people to switch off the 5G on their wireless router so they didn't get coronavirus. I haven't stopped laughing."

abc ppa The Professional Publishers Association Member

CERTIFIED DISTRIBUTION
20,301 (Jan-Dec 2019)

Want Wi-Fi in every room? You'll need a subscription

Broadband providers under fire for expensive upsell tactics

Broadband providers are facing criticism for the way they sell Wi-Fi upgrades, with consumers and industry experts claiming people are being locked into overpriced, additional subscriptions.

Wi-Fi can be a bottleneck in houses – increasingly so as broadband speeds into homes improve – and providers are selling equipment that claims to offer home-wide coverage. However, there's frustration that consumers are not always free to use their own kit if they want to avoid ongoing charges.

The issue was flagged by a reader who switched to Sky Broadband only to find that he was unable to use the home networking equipment he had previously purchased to spread the broadband into the deeper recesses of his house. "I had used a fibre modem connected to the line and Google Wi-Fi for internal connectivity," IT professional Mark Walsham told us, something he says he asked about being able to continue at the time of ordering and was told that it would be "fine".

"Sky sent the router out but I left it in the box because most ISP modems are poor and I assumed that I'd be able to use my existing Wi-Fi network equipment, which I'd had confirmed on the phone when I placed the order," he said.

However, Sky uses an unusual authentication process that meant his previous setup wouldn't work, and there are few routers for sale that are compatible with Sky's connection hardware. "Sky is the only ISP that I am aware of that requires a special form of IP allocation via something called MER and my Google routers do not support this," Walsham said, a situation confirmed by a broadband expert we consulted.

In order to get broadband into the house, Walsham eventually plugged in the supplied Sky Q Hub, but was unimpressed with the results. "I only had coverage of about 20% of my house, so I phoned to ask what could

be done to provide decent coverage with the equipment Sky had supplied," Walsham said. "When asked for help, the only option they offered was upselling to more Sky kit at an extra £4.99/month.

"I hate to think how many consumers have the wool pulled over their eyes and just pony up the extra cash to effectively lock themselves into Sky," he said.

> **❝ I hate to think how many consumers have the wool pulled over their eyes and just pony up the extra cash ❞**

Walsham was offered the guaranteed Sky Broadband Boost service for free and installed the equipment, only to send it back again two weeks later when the £4.99 was added to his Sky bill. Sky declined to comment on the case, and said there was a variety of well-documented reasons that Wi-Fi connections might be weaker than expected.

According to a broadband expert, ISPs are increasingly keen on

The true cost of "whole home" Wi-Fi

Deals that guarantee Wi-Fi coverage across the entire home are becoming increasingly common, from both big providers and smaller ISPs. Here are three examples of what these offers entail – and how it might be cheaper to source the equipment provided yourself in the long run.

BROADBAND PROVIDER	WHAT YOU GET	HOW MUCH IT COSTS	COULD YOU GET IT CHEAPER?
BT Broadband with Complete Wi-Fi	BT "guarantees a strong Wi-Fi signal in every room of your home". Customers are given the Smart Hub 2 and a Wi-Fi Disc to "get you started". It will send up to two extra discs for free if speeds are too slow	£10 per month on top of the normal fibre broadband package	A single BT Complete Wi-Fi Disc costs £140 from **amazon.co.uk** – the cost of 14 months of service
Sky Broadband with Broadband Boost	"Wi-Fi in every room or your money back" – although that's heavily caveated, with only the Boost money returned. You also get daily "health checks" on the broadband line	£5 per month on top of the normal fibre broadband package	Not easily, as Sky makes it difficult to install your own equipment
Zen Internet EveryRoom	Guaranteed signal in every room for homes that are smaller than 170m² (excluding outbuildings), using Fritz! Repeater 3000	£7.99 per month on top of the normal fibre broadband package	A single Fritz! Repeater 3000 costs £120 from **onbuy.com** – the cost of 15 months of service

for extras they don't need. "Over the phone, it's probably one of those things that upsells quite well for ISPs, which is one reason they offer this," said Ferguson.

"I do have some concerns that people who probably would have quite reasonable coverage from the router without this could easily be upsold when they don't really need it. They might be told 'you have a three-floor house, you'd probably be better to have something in the middle'."

Given the price of wireless extenders, £10 per month might sound expensive, but according to Ferguson, the BT equipment does provide a good service, even if the Complete Wi-Fi guarantee is underwhelming. "It does link neatly with the router and it's a proper meshed wireless network, but it's worth noting that the actual speed BT is guaranteeing is only 20Mbits/sec, so it's not mega-speed anyway," he said.

Ferguson added that it might be "cheaper to buy the kit outright and set it up yourself".

A BT spokesperson said that the upgraded service came with a 14-day cooling-off period in case it wasn't required. ●

deploying their own kit – in part because it simplifies networks, which means lower support costs. "Sky is an unusual one with the authentication issue and the Sky Q equipment is designed to make things work together as simply as possible," said Andrew Ferguson, a network specialist with ThinkBroadband.

"While the inflexibility is incredibly annoying if you want to use your own kit, it does not seem to be stopping Sky selling to lots of people."

BT's confusing proposition

Sky isn't alone in offering an upgraded Wi-Fi service, and in the case of BT the charge is £10 month, which is a significant slice of a monthly broadband charge.

When ordering a package online, potential BT customers are assured that their broadband connection package will include the company's Smart Hubs, which it says "are *Which?* Best Buys, giving you strong and powerful Wi-Fi".

Yet, going through the ordering process, BT suggests adding its "Complete Wi-Fi for a strong signal in every room". For customers, paying £27.99 per month for a 24-month Fibre 1 contract, that would entail a 36% increase on the total bill over two years to include "Complete Wi-Fi".

Selling an upgrade before users have tried the basic service has led to concerns that people may be paying

In memory of Adam Banks
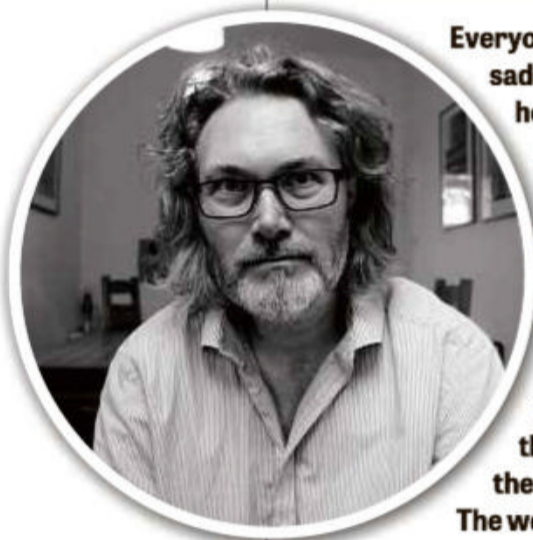
Everyone at *PC Pro* was saddened and shocked to hear of the death of Adam Banks.

Adam, who had written for *PC Pro* many times over the years, was best known as the editor of our sister title *MacUser*, taking the helm twice during the magazine's lifespan. The word "editor" doesn't even come close to describing the scale of Adam's input, however: he was a writer, columnist, art director and editor all wrapped into one supremely talented human being.

It was one of Adam's many moments of inspiration that won *MacUser* national acclaim, when a 2012 magazine cover was chosen as one of the PPA's Covers of the Century. In truth, the PPA could have chosen from a dozen or more equally strong contenders.

Adam would probably have squirmed at such praise, and at the many tributes paid by friends and colleagues at **adambanks.com**. In an industry where talent often comes at the cost of modesty, Adam could barely have been more self-effacing, nor more generous with his time or consideration for colleagues. A tendency to treat hard print deadlines as mere staging posts was his only notable flaw.

Fortunately for Adam, his work was always worth waiting for. He will be greatly missed.
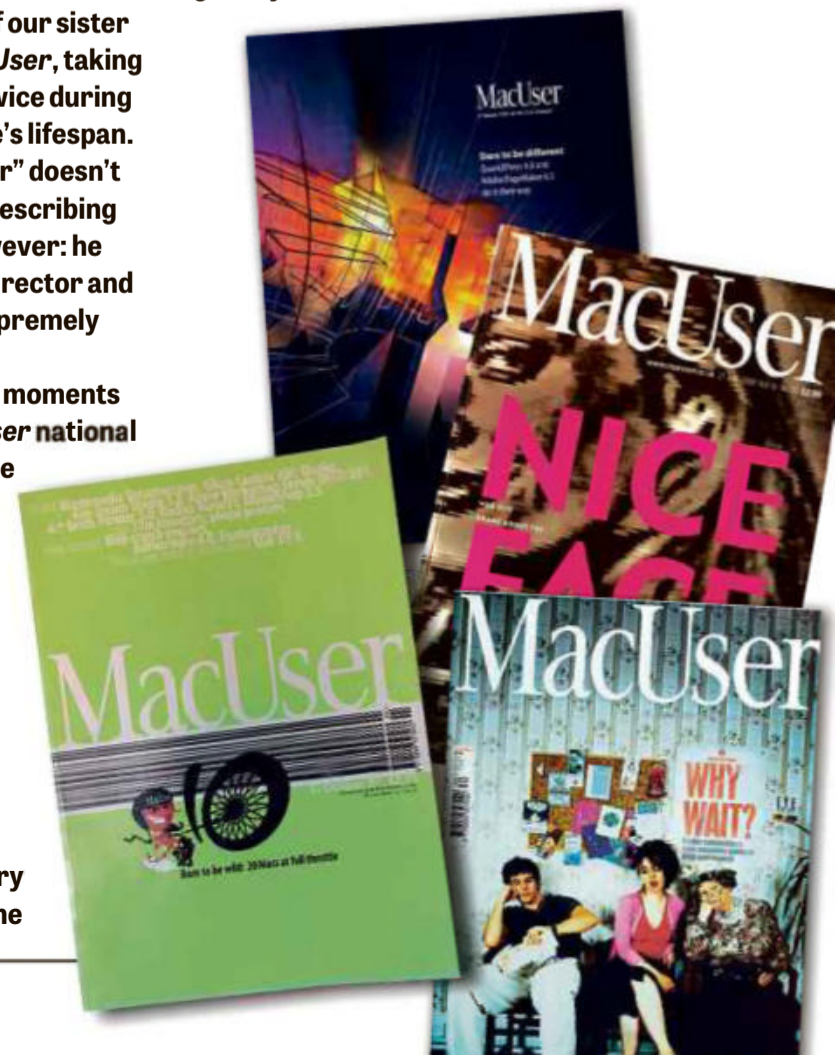
Ipsos MORI internet survey stokes security fears

Research company under spotlight over privacy-busting survey, Stewart Mitchell discovers

If you were approached to take part in a study, run by a household name, to better understand the nation's internet habits, would you take part? Well, maybe. Throw in £10 per month in rewards and it might seem more attractive.

But what if, in return, the company installed software that could theoretically give it unencrypted access to traffic passing between your devices and the web? Suddenly, the offer doesn't seem quite so appealing.

Research company Ipsos MORI has been sending out letters seeking participants for its Iris web usage research programme, which urges potential panellists to override system warnings and install apps and software that include its own VPN and root certificate.

"The idea that you should be downloading another root certificate and VPN – to anyone who knows what they are – should be an immediate worry," explained Hannah Smethurst, a privacy law trainer and researcher in surveillance law.

"If you got a phone call from your granny asking if she should do that, you'd drive round and smack the phone from their hands, it's such a bad idea," she said. "That's what they are asking you to do – turn off every single piece of security protocol or safeguarding app that you have on your phone in order to allow you to install it."

Ipsos MORI has stressed that it doesn't abuse the permissions granted to the apps it installs across user platforms, but that hasn't stopped criticism, with security experts expressing incredulity at the damage that could be done if Ipsos MORI's security was compromised.

"Ipsos might only use the data for what it says, but it seems to know what it's doing by the instructions for installation [*see boxout below*], and it's trying to man-in-the-middle all of your comms – it's a really shocking display," said Javvad Malik, a security analyst at anti-phishing platform KnowBe4. "Ipsos might not be reading it, but it's still going to get all the network traffic if you've installed the VPN."

Ipsos insists that (using SDKs from market research partner RealityMine) it has written the apps in a way that it can't collect data such as message content or bank security codes, saying that it only collects information related to market research purposes.

"The software monitors internet access on the device that it's installed on and allows Ipsos MORI to build a picture of how people use the internet," the company told *PC Pro* in a statement. "None of the software used will ever

> **❝ Ipsos MORI might not be reading it, but it's still going to get all the network traffic if you've installed the VPN ❞**

How project Iris works

Installing Ipsos iris orange on Windows

Using the App ▾

Using the ipsos iris orange app is really simple!
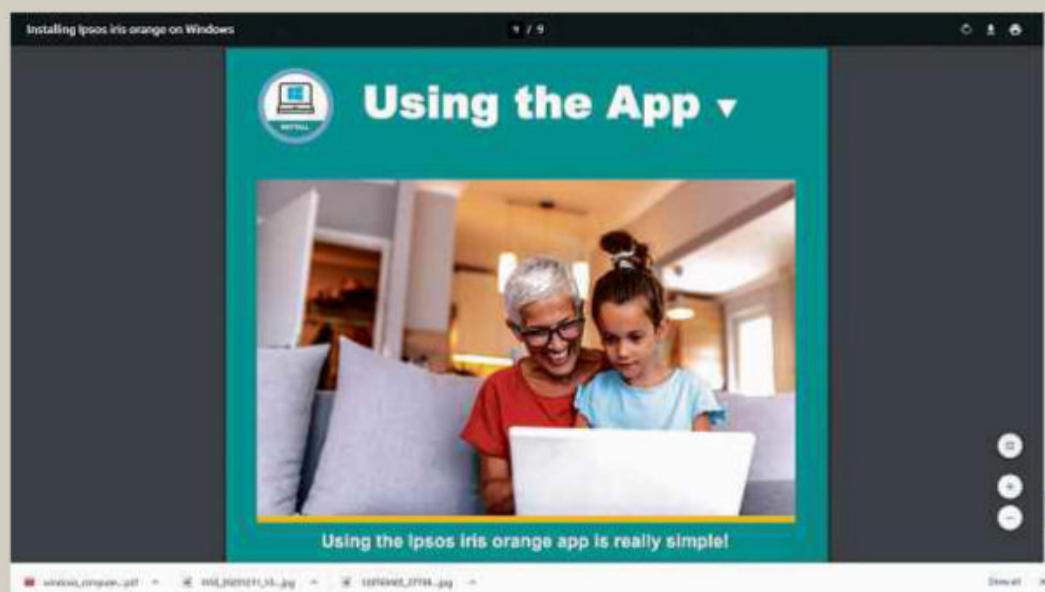
Under the Ipsos MORI Iris programme, 10,000 participants are invited to share details of their browsing habits in return for a signing-on fee of points that Ipsos values at £20. There are additional rewards of between £5 and £10 in points per month, depending on how many devices users make available.

To earn these benefits, users must download software or apps – sometimes from a valid app store, Google Play in the case of Android phones, or direct from Ipsos. Once installed via Google Play, for example, Ipsos Iris Blue also installs a VPN.

For Apple products, users are asked to download and install a piece of software from Ipsos and are guided through the process to implant it in iOS – Ipsos hasn't answered the question of why it's not in the Apple App Store.

The company says that on Macs and PCs it uses software called Ipsos Iris Orange, which is installed alongside browser extensions on each browser on the computer, but installation privacy issues quickly arise.

During installation, Ipsos explains in detail how to override or ignore operating system warnings that advise against proceeding with the download and granting permissions. "Please Note:

capture any secure or sensitive data such as phone calls, the content of messaging apps, passwords or bank details – this is not collected."

But critics remain concerned that allowing a company to install a VPN and root certificate is a risky leap of faith as it's impossible for users to check that the company is not overreaching. "It's hard to see any justification, ever, for giving away keys to our devices – how do we know that's all they're looking at? It's hard," said Malik.

"The VPN will capture all of your outbound traffic and there's no way of knowing what is flowing," he said. "Once installed, the only way of connecting to the internet is through Ipsos' VPN, which will take you to Ipsos' data centre and, from there, will take you to whatever you're trying to visit."

■ Root canals

If installing a VPN is a problem, letting a company outside a small trusted circle of firms install a root certificate on equipment rings alarm bells with security experts.

you may see a message that pops up when you install the browser extension," Ipsos explains. "It is a default message generated by the operating system to explain what some extensions of this nature are technically capable of capturing, such as passwords."

The software also warns users to switch off parental control software, which according to experts is another warning flag in terms of the apps security. "It seems to be that the requirement to turn off parental controls is because what they are asking you to download would

immediately be caught by parental controls," said Smethurst. "And it's not just parental controls you have to turn off."

In a statement sent to *PC Pro*, Ipsos MORI said: "During tests it was found that some users had parental controls which restricted the downloading of either the application, the VPN profile, or in some instances blocked the internet connection for the application. As a result of this, the installation instructions were updated accordingly to allow those users to participate in Ipsos Iris if they do so wish."

"With root certificates, there's an encryption certificate that has a private key and a public key," explained Christoph Hebeisen, head of research at mobile security company Lookout. "The public key is sent to you by the website and the private key stays on the website – so you know you are talking to the website rather than someone else in the middle.

"The reason you would want to install a root certificate, if you're Ipsos or somebody like that, is that you would want to get into the middle of that traffic, read it in the middle, decrypt it and pass it on," Hebeisen said.

"If you install that root certificate that certificate has been added to the list of trusted certificates, so it becomes its own signing authority. You've handed Ipsos the master key to all your encrypted traffic on your device if they can get in the middle of the traffic."

Ipsos positions the Iris project as a way of monitoring internet usage, which has led to questions over why it might also need to intermittently activate a device's microphone and location.

In its installation instructions, Ipsos says it needs the microphone "to periodically wake itself every few hours to listen for encoded radio/television stations/ broadcasts only", which, given its working with audience monitoring service UKOM, makes sense.

However, critics say it's not overtly clear that a listening function will be installed, and they're concerned over the privacy implications, in the same way that Amazon has been questioned over Alexa recordings. "With the smart speakers, they are in your home only, and you can unplug them," said Smethurst. "I don't go anywhere without my phone – it's always near. How many people keep their phone in their bedroom overnight? At intervals you can't control, it [Ipsos MORI] is turning on a microphone to just record sounds – not ideal."

Ipsos MORI said in a statement sent to *PC Pro* that "this function is switched off by default, however the mic will switch on occasionally to keep the app running. No conversations or personal information will ever by recorded or stored." ●

> ❝ **At intervals you can't control, Ipsos MORI is turning on a microphone to just record sounds – not ideal** ❞

The A-List

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

PREMIUM LAPTOPS

Apple MacBook Air

Affordable Apple M1 ultraportable from £999

from apple.com/uk

Apple's ARM-based M1 chip is blasting away its AMD and Intel x86 opposition with truly extraordinary speeds. Even the low-end model with 8GB of RAM is ludicrously fast. Apple makes few changes to the Air's design, but it looks fabulous and now supports both USB 4 and Wi-Fi 6. Add battery life into the teens and its only real threat comes from the updated MacBook Pro 13in. **REVIEW Issue 316, p40**

ALTERNATIVES

Dell XPS 17 (2020)
An excellent alternative to the 16in MacBook Pro thanks to a 17in IPS screen, bags of power, all-round quality and a great range of specs. **From £1,799 from dell.co.uk**
REVIEW Issue 315, p48

Apple MacBook Pro 13in (M1)
Apple replaces Intel's Core processors with its own M1 chip and the results are sensational: brilliantly fast with an incredibly long battery life. **From £1,299 from apple.com/uk**
REVIEW Issue 316, p44

Huawei Matebook X Pro
This laptop packs a 13.9in screen with a 3,000 x 2,000 resolution and powerful components. It might not be flawless, but it's very desirable. **£999 from johnlewis.com**
REVIEW Issue 312, p86

TABLETS

Apple iPad Pro 12.9in (2020)

Laptop-killing tablet from £969

from apple.com/uk

This tablet rises above the category thanks to its ability to swing between laptop, tablet and – courtesy of a Lidar sensor – augmented reality dream machine. Make sure you budget for the £349 keyboard, though. And a storage upgrade. And the cellular option… **REVIEW Issue 316, p82**

ALTERNATIVES

Amazon Fire HD 8 (2020)
Amazon continues to amaze with how much it packs in, with a 1,280 x 800 IPS screen and 32GB of storage the stars. **£90 from amazon.co.uk**
REVIEW Issue 316, p80

Apple iPad (2020)
While we yearn for thinner bezels, the boost in power courtesy of Apple's A12 Bionic chip means this is the obvious choice for under £400. **From £329 from apple.com/uk**
REVIEW Issue 316, p88

Samsung Galaxy Tab S7
Superb value (note the 4G option for £100 more), this powerful Android 10 tablet also looks the part in a metal chassis. **£619 from currys.co.uk**
REVIEW Issue 316, p85

SMARTPHONES

OnePlus 8T

Android 11 phone, 128GB, £549

from oneplus.com/uk

The OnePlus 8T knocks its more expensive brother, the OnePlus 8 Pro, off the A-List thanks to its far better value for money. For a surprisingly low price, you'll still benefit from a battery that lasts for two or three days of modest use – and recharges in 39 minutes – plus a 120Hz wide-gamut screen, bags of power via the Snapdragon 865 processor, 5G support and a fine set of cameras for good measure. **REVIEW Issue 315, p63**

ALTERNATIVES

Moto G 5G Plus
The cheapest 5G phone you can buy and it's stunning value: great screen, decent speed, fine cameras and a long battery life. **£280 from johnlewis.com**
REVIEW Issue 312, p68

Apple iPhone 12
Apple tempts with 5G, an AMOLED screen (60Hz), chart-topping performance and super cameras. But battery life could be better. **64GB, £799 from apple.com/uk**
REVIEW Issue 315, p58

Samsung Galaxy Note 20 Ultra
In a crowd of expensive Android phones, the Note 20 Ultra stands out due to its huge screen and integrated S Pen. **£1,279 from johnlewis.com**
REVIEW Issue 313, p58

EVERYDAY LAPTOPS & CHROMEBOOKS

Huawei MateBook 14

Ryzen 4800H laptop, £950

from consumer.huawei.com/uk

If you need power on the move, and have nearly a grand to spend, this is the obvious choice: with an eight-core Ryzen 4800H inside, the MateBook 14 is as fast as Intel-powered laptops twice the price. Combine that with a high-quality metal chassis and a sharp 2,160 x 1,440 screen, and you have a winner. **REVIEW Issue 315, p53**

ALTERNATIVES

Honor MagicBook Pro
A metal-bodied 16in laptop for £850? One that's fast and has excellent battery life? The screen is only 1080p, but the MagicBook Pro is a bargain. **£850 from hihonor.com**
REVIEW Issue 314, p72

Honor MagicBook 14
It's astonishing how much Honor crams into the 1.38kg chassis, from the Ryzen 3500U processor to a 256GB SSD. A huge battery life is the cherry on top. **£550 from hihonor.com**
REVIEW Issue 311, p65

Google Pixelbook Go
Striking a perfect balance between performance, portability and usability, Google's Pixelbook Go is the best Chromebook around. **Core i5, £829 from store.google.com**
REVIEW Issue 307, p50

ENTHUSIAST PCs

Scan 3XS Gamer RTX

RTX 3080 PC, £2,000

from pcpro.link/314scan

Scan gives the stunning Nvidia RTX 3080 its dream debut in this system, which creeps in at £2,000 by judiciously mixing an Intel Core i7-10700, 16GB of RAM and a 1TB SSD. But the graphics card is the star.
REVIEW Issue 314, p56

NEW ENTRY

HP Omen 25L

HP packs a surprising amount of gaming power into this beautifully constructed PC, with the RTX 2060 graphics card being the pick of the crop. It may be last year's card, but it's till superb at 1440p gaming. With bags of quality, this is a great PC (part code GT12-0045na). **£999 from currys.co.uk**
REVIEW Issue 317, p87

NEW ENTRY

Chillblast Fusion Commando 3060Ti Gaming PC

Chillblast's naming structure leaves you in no doubt as to this PC's key ingredient, and it's backed with an eight-core Ryzen 5800X processor, 32GB of RAM and a fast PCIe 4 M.2 SSD. **£1,500 from chillblast.com**
REVIEW Issue 317, p89

WORKSTATIONS

Scan 3XS RTX Studio Pro G132R

GeForce RTX 3090 workstation, £4,000

from scan.co.uk

AMD's Ryzen 5950X and Nvidia's RTX 3090 make their debuts in this dazzling, whisper-quiet workstation. Unless your workloads will take advantage of a 32-core Threadripper, or you need ISV certification, it's an obvious choice for creative professionals.
REVIEW Issue 316, p52

Armari Magnetar X64T-G3 FWL

It might be far pricier than the Scan, but in return you get AMD's 32-core Ryzen Threadripper 3970X combined with Quadro RTX 5000 graphics. The result is a machine that's fast at modelling and absolutely flies when rendering. **£6,351 from armari.com**
REVIEW Issue 307, p84

Chillblast Fusion Ryzen Render RTX 4000

A saving is always welcome, and you can trim a chunk off Scan's cost by choosing the almost identically specified Fusion from Chillblast. Its looks are a bit more enthusiast PC than workstation, but it's a great system. **£3,220 from chillblast.com**
REVIEW Issue 307, p85

MONITORS

LG UltraWide 38WN95C

38in widescreen, £1,600

from laptopsdirect.co.uk

That high price buys you a stunning 144Hz curved IPS monitor with 3,840 x 1,600 pixels, and it's equally at home playing games as it is displaying HDR films – or a spreadsheet.
REVIEW Issue 313, p90
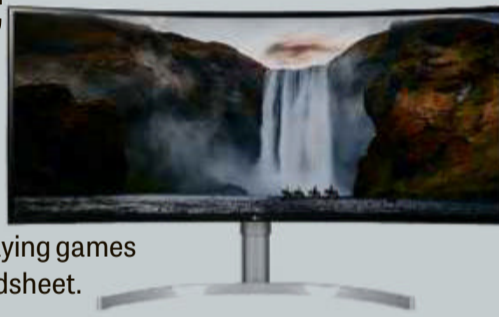
Philips Brilliance 328P6

If your budget can't stretch to the top-ranked LG, this 4K 32in screen (or Philips' curved 34in 346P1) comes ex close to matching it for quality, while also including a 60W USB-C connection and DisplayHDR 600 certification. **£455 from amazon.co.uk**
REVIEW Issue 313, p85

Iiyama ProLite XUB2792QSU-B1

It might lack frills such as USB-C docking, but this is a high-quality 27in screen with a 1440p resolution that looks sharp from normal distances. Quality is staggering for the price. **£250 from scan.co.uk**
REVIEW Issue 313, p79

NAS SERVERS

Synology DS218+

Two-bay NAS, £318

from scan.co.uk

The best two-bay NAS server around, thanks to a dual-core Celeron to give it some added grunt, a smart design that makes adding disks a piece of cake and the most wide-ranging spread of apps.
REVIEW Issue 305, p87

Asustor Nimbustor AS5304T

A hugely powerful four-bay NAS that's overkill for most people – not just due to its speed but also its slightly intimidating user interface – but techies and gamers should investigate the Nimbustor for its speed and flexibility. **£480 from amazon.co.uk**
REVIEW Issue 305, p82

Synology DS1019+

This five-bay NAS includes many of the features that makes the DS218+ an attractive buy: a superb selection of apps, elegant hardware design and bags of power. And those five bays make it ideal for RAID5 configurations, or Synology's own Hybrid RAID. **£634 from pcpro.link/305synology**
REVIEW Issue 305, p88

WIRELESS NETWORKING

Netgear Orbi RBK50

Mesh extender, £290

from pcpro.link/309orb1

The perfect all-round mesh extender, with speedy performance (despite using the 802.11ac standard), a user-friendly interface, plenty of security features and even parental controls for broad appeal.
REVIEW Issue 308, p80

Asus RT-AX88U

This 802.11ax router's performance proved even better than we dared hope: it provided blazingly fast speeds throughout even the trickiest areas. The design is surprisingly understated too – only the gold cutouts hint at this router's sparkling performance. **£297 from pcpro.link/300ax**
REVIEW Issue 300, p62

Honor Router 3

This astonishingly cheap Wi-Fi 6 router delivers consistently fast wireless speeds, broad coverage and a modest speed boost for newer hardware – and it's cute too. And, if you need more range, you can buy a second until to use as an extender. **£80 from hihonor.com**
REVIEW Issue 315, p71

WORKGROUP PRINTERS

Brother MFC-L9570CDW
Colour laser, £899 exc VAT

from brother.co.uk

Designed for workgroups of up to ten users, this flexible colour laser MFP is packed with features and extremely well connected. Print and scan quality are both top-notch – as are its speeds.
REVIEW Issue 308, p98

Kyocera Ecosys M6635cidn
It's the excellent apps that mark the Kyocera Ecosys M6635cidn out from the crowd, even if some cost upwards of £100. But they round out this brilliant all-in-one with a true 1,200dpi print engine and 35ppm print speeds. **£858 exc VAT from box.co.uk**
REVIEW Issue 308, p100

Brother X-Series MFC-J6947DW
This MFP thinks big, with an A3 colour flatbed scanner, a duplex ADF and three A3-sized 250-page trays. While it isn't the fastest, great printing quality and surprisingly low running costs make it a versatile choice. **£544 exc VAT from uk.insight.com**
REVIEW Issue 309, p99

HOME OFFICE PRINTERS

Canon Pixma TS8350
Multifunction inkjet, £140

from store.canon.co.uk

While its cartridges still need replacing – costs work out at 9.5p per colour page, 3.4p for mono – this is a feature-packed MFP that produces excellent printouts, scans and copies. We like the huge LCD screen too.
REVIEW Issue 310, p85

Canon Pixma G5050
The bottle-fed Pixma G5050 is brilliant value if you intend to print in large volume, with super-low running costs of 2.7p per colour page. While it lacks features – there's no scanner, for instance – its print quality is great. **£200 from argos.co.uk**
REVIEW Issue 310, p84

HP Neverstop Laser 1202nw
We love this simple mono laser MFP, and it's all thanks to high-quality results matched to stupidly low running costs – dropping to 0.75p per page after you've drained the supplied 5,000-page toner, thanks to its refill tank. **£260 from store.hp.com**
REVIEW Issue 310, p90

VIDEOCONFERENCING

Lifesize Icon 500 and Phone HD
4K meeting room solution, £4,750 exc VAT

from voipon.co.uk

A videoconference room solution that's easy to deploy, is blessed with highly intuitive controls, has a fine range of client apps and delivers great call quality.
REVIEW Issue 313, p98

Logitech Room Solution for Microsoft Teams
If you've settled on a supported videoconferencing service, and you need to cover a decent-sized meeting space, Logitech's Large Room Solution for Microsoft Teams has everything you could ask for. **£5,000 exc VAT from onedirect.co.uk**
REVIEW Issue 313, p99

Poly Studio X30 with TC8
Designed for small meeting rooms with up to six participants, the Poly Studio X30 brings together a 4K camera, loudspeaker and beamforming quad-microphone array in a single lightweight bar. **£1,700 exc VAT from onedirect.co.uk**
REVIEW Issue 313, p100

BUSINESS WI-FI

Aruba Instant On AP12
802.11ac access point, £93 exc VAT

from ebuyer.com

If you're worried about the complexity of wireless network management, Aruba's Instant On is a brilliant solution. This Wave 2 dual-band access point offers an excellent range of features for a reasonable price, and the slick app will have you up and running in no time.
REVIEW Issue 315, p96

DrayTek VigorAP 1000C
This tri-band Wi-Fi 5 access point is a great choice for small businesses, with both good performance and a wide range. Its mesh option is also impressively powerful for the price and makes it easy to manage and expand your wireless network. **£167 exc VAT from broadbandbuyer.co.uk**
REVIEW Issue 315, p97

Zyxel Unified Pro WAX650S
A Wi-Fi 6 access point with excellent performance, classy cloud management and a fine set of features. It's not the cheapest around, but it has double the throughput of rivals while still undercutting blue-chip rivals. **£515 exc VAT from broadbandbuyer.com**
REVIEW Issue 311, p103

SCANNERS

Brother ADS-3600W
Network scanner, £495 exc VAT

from printerbase.co.uk

As a networked office scanner, the ADS-3600W is hard to beat. It offers wireless networking, as well as excellent cloud service support, a great software bundle, 50ppm scan speeds and top output quality.
REVIEW Issue 310, p98

Canon imageFormula DR-S150
This neat little scanner still finds room for 60 sheets, a 4.3in LCD colour touchscreen and 802.11n wireless. It falls behind Brother for cloud service support, but hit its promised 45ppm speed without a problem. **£432 exc VAT from uk.insight.com**
REVIEW Issue 310, p99

Kodak Scan Station 730EX Plus
If your digitising demands require a dedicated PC, you should consider this smarter alternative from Kodak: the Scan Station 730EX Plus offers great speed, quality and security in a single and easily managed appliance. **£1,097 exc VAT from misco.co.uk**
REVIEW Issue 314, p105

SECURITY SOFTWARE

Bitdefender Internet Security 2020

Bitdefender demands few resources while also offering advanced features to tackle ransomware and an ultra-secure browser. And it's excellent value. **1yr, 3 devices, £20 from pcpro.link/306bit**
REVIEW Issue 306, p83

Kaspersky Internet Security 2020

Fast, affordable and accurate, but more than anything else, Kaspersky is reliable: it has won awards for more years than we can count. **1yr, 3 devices, £20 from pcpro.link/306kas**
REVIEW Issue 306, p84

Avast Free Antivirus

If you're looking for a free alternative to Windows Defender, and don't mind in-product advertising then Avast offers the broadest protection of any free antivirus product.
Free from avast.com
REVIEW Issue 306, p82

BACKUP SUITES

IDrive Personal

For families seeking set-and-forget protection, IDrive could be just the thing: it's very easy to set up, supports multi-computer installations and comes at a very reasonable price. **$52 per year from idrive.com**
REVIEW Issue 315, p81

Acronis True Image 2021

The most comprehensive personal backup system out there, and its user-friendly interface, strong performance and decent set of secondary tools don't hurt at all. Only its price counts against it.
£42 from acronis.com
REVIEW Issue 315, p80

Paragon Backup & Recovery 17 CE

If you merely need a low-key backup agent that makes periodic duplicates of your most important files, this is a persuasive solution that outshines much of the paid-for competition. **Free from paragon-software.com**
REVIEW Issue 315, p83

LINUX DISTRIBUTIONS

Ubuntu

While there may be younger distros on the block, Ubuntu is an elegant, mature option. It doesn't have the familiarity of Windows, but you may learn to love its logical structure, ease of use and great support. **Free from ubuntu.com**
REVIEW Issue 308, p92

Manjaro

It wasn't as speedy as Ubuntu in our tests, but this Linux distro is straightforward to set up, looks great and is eminently tweakable. It also worked surprisingly well on our current-generation laptop. **Free from manjaro.org**
REVIEW Issue 308, p88

Linux Mint

If you're looking for a drop-in replacement for Windows 7, Linux Mint is about as close as you'll get. For instance, the app launcher opens on pressing the Windows key, and Alt+Tab cycles through open apps. **Free from linuxmint.com**
REVIEW Issue 308, p86

SERVERS

Dell EMC PowerEdge T140

An ideal candidate for smaller offices that want an affordable on-site server with plenty of room to expand. It packs a powerful hardware package into a space-saving chassis and has top-tier remote management features.
£1,133 exc VAT from dell.co.uk
REVIEW Issue 314, p104

Dell EMC PowerEdge R340

A Xeon E rack server with good upgrade potential, plenty of storage choices and the best management features. This price also includes the iDRAC9 Enterprise upgrade. **£890 exc VAT from dell.co.uk**
REVIEW Issue 298, p97

NAS APPLIANCES

Synology RackStation RS1619xs+

One of the best-performing 1U rack NAS appliances, offering a superb range of data-protection and storage features – and a five-year warranty. **Diskless, £1,662 exc VAT from broadbandbuyer.com**
REVIEW Issue 309, p97

Asustor Lockerstor 8 AS6508T

You won't find any other vendor offering dual 10GBase-T and 2.5GbE at this price. Factor in easy deployment, plus useful data-protection apps, and the AS6508T is an attractive option. **Diskless, £833 exc VAT from span.com**
REVIEW Issue 309, p94

SECURITY

WatchGuard Firebox T20-W

Crams a great set of security services into a neat and affordable little box. With a superb set of deployment options, it's perfect for small businesses seeking all-in-one protection, and for larger companies looking to keep their remote workers secure. **Appliance with 1yr Total Security Suite, £697 exc VAT from watchguardonline.co.uk**
REVIEW Issue 313, p102
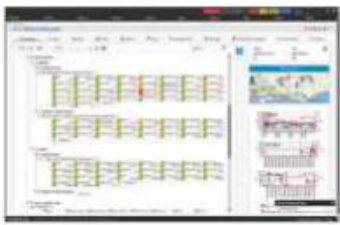
Sophos XG 135w Rev.3

Sophos delivers stunningly good wired and wireless security, teamed up with great performance.
Appliance with 1yr TotalProtect Plus subscription, £1,405 exc VAT from broadbandbuyer.com
REVIEW Issue 306, p97

REMOTE SUPPORT

IDrive RemotePC Team

SMBs seeking an affordable cloud-hosted support solution will find RemotePC Team a great choice. The core services are easy to deploy and use, while the free Vision and Meeting apps add versatility to your offering.
Team, first year, 50 computers, £145 exc VAT from remotepc.com
REVIEW Issue 312, p96

NetSupport Manager 12.8

If you want the full spectrum of support options, this is a fine choice, thanks to a wealth of features and perpetual licensing model. **1 to 500 systems, perpetual licence, £10 each exc VAT from netsupportmanager.com**
REVIEW Issue 312, p98

NETWORK MONITORING

Paessler PRTG Network Monitor 20.3

A great choice for businesses that want to keep an eye on their network devices and services. It's easy to deploy and provides a sophisticated set of monitoring tools in an informative web console.
2,500 sensors, 1yr maintenance, £4,433 exc VAT from paessler.com
REVIEW Issue 316, p97

ManageEngine Op Manager Plus 12.5

OpManager Plus delivers an impressive range of network monitoring tools at a sensible price. Its architecture allows it to scale easily with demand too. **50 pack, perpetual, £2,875 exc VAT from manageengine.com**
REVIEW Issue 316, p96

VoIP SERVICES

3CX Phone System Pro 16

If you're prepared to host your own IP PBX, 3CX's Phone System is simply the best thanks to easy deployment, plenty of call features and pricing to suit organisations of all sizes. **16SC Pro edition, £554 exc VAT from 3cx.com**
REVIEW Issue 307, p96

Voip Unlimited Voip Exchange

Voip Exchange is purpose-built as a complete cloud-hosted SMB service that can be rolled out with minimal training, and includes a strong set of features. **From £9 exc VAT per user per month from voip-unlimited.net**
REVIEW Issue 307, p99

Remember, remember the 2020 November

This time the gunpowder, treason and plot are breakthrough vaccines, a DeepMind revelation and the arrival of Apple's M1 chip
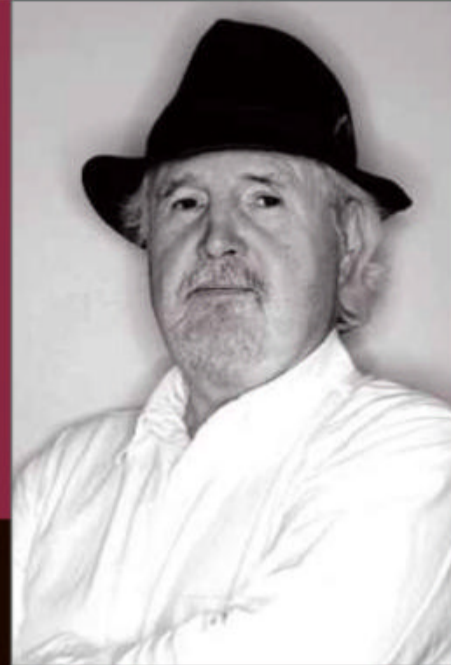
Dick Pountain is editorial fellow of *PC Pro*. For Christmas 2021, he'll be asking Apple for an M1-powered Chromebook.

World-changing innovations are like London buses: you wait for years and then three come along at once. The recent wait has been particularly irksome, as virology and epidemiology felt like the only relevant sciences in lockdown – apart from rocket science, with our tech leaders evidently desperate to get off this pestilential planet and to Mars. Then, blam, three breakthroughs arrive in the same month.

By far the most heralded were the three coronavirus vaccines, all produced in record-breaking time. While their speed of development, testing and approval is remarkable, that's not the best part: the real innovation is that two of those vaccines are totally synthetic.

Until now, most vaccines have required the target virus to be cultured in animal cells, then deactivated or broken apart and bits injected into live animals to generate antibodies. The Pfizer and Moderna vaccines are purely chemical: strings of messenger RNA assembled from scratch by those sophisticated gene-sequencing and nucleotide-assembling machines that have been invented in recent decades by harnessing powerful computers to robotic chemical processing. Injected into your arm, this mRNA tells your cells to start making one harmless spike-protein of the coronavirus, a sort of pretend infection that generates antibodies against the real one.

The second innovation relates to a breakthrough in solving the "protein-folding problem". All the biological processes that animate living things are driven by enzymes, which are proteins – long chains made up from 20 or so amino acid units. These chains don't just flap around like pieces of string but fold into compact lumps whose *exact* 3D shape, their cavities and crevices, enable them to work by fitting the molecules they work upon in lock-and-key fashion. These lumps are held together by bonds between amino acids from different points in the chain. To design artificial enzymes, or drugs that alter the action of natural enzymes by fitting their slots, you must simulate the way a chain of amino acids will fold itself. As every part of the chain can rotate freely, this is a crushingly difficult computational task if the chain is thousands of links long.

In October 2002, PC owners were asked to donate their spare CPU cycles to a worldwide distributed network for solving protein-folding problems run by Stanford University. 30,000 donors helped crack the protein structures of around 50 amino acids, but to get to 100 amino acids would need another 270,000. On 30 November 2020, an article in *Nature* related how Google's AI subsidiary DeepMind had made a similar breakthrough in protein-folding simulation all on its own.

DeepMind's program AlphaFold 2 had outperformed around 100 other teams in a biennial protein-structure prediction challenge called Critical Assessment of Structure Prediction (CASP). The performance of folding-prediction programs is measured against evidence of a protein's structure from X-ray diffraction crystallography, or cryo-electron microscopy, which pictures each atom: AlphaFold 2 scored close to a 90% match in this challenge.

> ## **As every part of the chain can rotate freely, this is a crushingly difficult computational task if the chain is thousands of links long**

> ## **The implications for the study of biochemistry, treatment of disease and future drug design are potentially world-changing**

An earlier version of AlphaFold worked entirely by deep learning, that is by examining amino acid sequences versus 3D structures of many proteins, which enabled 60% to 70% accuracy. For AlphaFold 2, the team added an extra level of constraint-solving. Consider any pair of amino acids linked together and physical chemistry will tell you how they can rotate about that bond and what resistance will be encountered; similar data is available for the close approach of active groups on remote amino acids. Applying such constraints to a purely learned prediction can boost accuracy to 90%. The implications for the study of biochemistry, treatment of disease and future drug design are potentially world-changing.

The third innovation unveiled in November relates tangentially to the other two: Apple released its M1 chip, which has two of its own world-changing virtues.

First, it breaks Apple's 14-year dependency upon Intel and in doing so elevates the ARM architecture to desktop PC status, threatening Intel's x86 hold there. Second, the M1 chipset contains not only eight general-purpose ARM cores and an eight-core graphics unit, but also a 16-core "neural engine" capable of performing up to 11 trillion deep-learning operations a second.

Alongside those gene-sequencing and nucleotide assembling machines, M1-powered computers running AlphaFold-style software promise a new era of computer-aided biology, a sort of Lego with living cells.

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Give me back my nastiness-free filter bubble

Oh for the good old days of constructive comments: there are advantages to not trying to talk to everyone in the world at once

Nicole Kobie is *PC Pro*'s Futures editor. Please don't prove her wrong by finding her on Twitter and hurling abuse, or she's going to have to start a newsletter. No one wants that.
@njkobie

Social media isn't very nice. Twitter is full of people taking offence where none was meant, whilst others seek to offend as many as possible. Facebook is no better, not least because the trolls are often your own family and friends.

There's an easy solution, of course: don't use such sites. That's easier said than done, but I'm certainly spending less and less time on social media, despite the lockdown-induced need for conversation sources external to my own living room/office.

And I have it better than many. Study after study shows that women get the worst abuse online, with the most intense and foul harassment saved for black women. I have been lucky enough to avoid death threats and doxxing, probably because I'm not particularly controversial with what I say online. That's not some chilling effect of the threat of abuse; I just don't see the point in arguing with strangers as surely no one's opinion has ever progressed that way.

That said, I'm glad others do fill social media with opinions counter to the majority, as much of it needs to be heard. If someone's a racist, Nazi, sexist jerk, they should be noted as such, but save the abuse for those who actually earn it.

Here's a ridiculous example: I live in Tottenham in London, and there's a new development going up diagonally opposite to our flat. On the Facebook ads for that housing block, which are inexplicably targeted at me, people leave the most foul comments about the neighbourhood I live in: it's dirty, full of scummy people, crime-ridden

– none of which is true. And even if it were, if you've got nothing nice to say, as the adage goes, shut your face.

That's the problem with Twitter, Facebook and the hellscape beneath online newspaper articles: anyone can comment. While such inclusion seems on the face of it a good thing, free-for-alls rarely are. I miss forums dedicated to specific topics used by smaller groups of like-minded individuals; most of all, I miss the *PC Pro* online forum and comments section.

I'm not sure there's ever been a more decent place online. I still remember the worst insult thrown at me in years of writing for the website: someone called me "Harriet Harman light". That is a delightful criticism, and I assure you my feminism – as that's what was being commented on – far exceeds Harman's, so I wasn't hurt but tickled.

And while I hardly needed defending from that lightweight lob, the subsequent comments did just that, not only backing me up but engaging with the argument in the article. It was a nice conversation, regardless of which side you came down on. And that was the norm.

That allowed me the distinct privilege of learning on the job. If I made a mistake or failed to include an interesting fact, the comments section would pitch in, giving me the benefit of the doubt that my intent was always accuracy, without abusing me. It gave me the space to explore new areas in my writing, knowing that I had a safety net of experts improving my work, rather than tearing me down.

Part of the success of the online community that constituted the *PC Pro* forums was that it

"Your comments gave me space to explore new areas in my writing, knowing that I had a safety net of experts improving my work"

belonged to the reader, and you decided to make it a nice place. Perhaps we need more smaller spaces, and a bit more self-selection.

To cite a famous example: many of my friends in Canada are into knitting and there's a website called Ravelry that, in 2019, banned any patterns referencing Trump. This sparked an exodus of Republican knitters.

"It's more like a house party: you invite people you like, not people you don't, and certainly not a bunch of random people off the street"

On one hand, that sounds exclusionary. Why have the internet connecting everyone, only to disconnect from those we disagree with? But if we accept that some people will always disagree and that we don't always want to argue, perhaps sometimes it's nice to have a space for people who think vaguely the same as you.

Ten years ago, this was dubbed a "filter bubble", and we worried we would never be able to broaden our minds by only listening to people who reinforced what we already think. But I'd argue it's more like a house party: you invite people you like, not people you don't, and certainly not a bunch of random people off the street who may or may not be Russian trolls.

Perhaps this is why so many journalists are opting to share their unedited thoughts via newsletters, a one-way broadcast with no clear route for readers to lob back their own opinions. I still want to know what you think – but only you, not every single person with an internet connection, misinformed opinion and an abusive attitude.

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Don't game a child's education – let them do it

Barry Collins was once editor of *PC Pro*, but he didn't run enough sensationalist scoops to keep the job. Some people never learn.
🐦 @bazzacollins

Parents, guardians and grandparents, please step aside. Children will find games that deliver valuable life lessons all by themselves

One of the reasons I'm here today, bashing out words that good people like yourselves pay to read, is because of a computer game called *Front Page*.

You probably won't remember *Front Page*, the most niche of titles for the Commodore 64. I bought it for 20p in Oxfam, mainly because it came in such a big box that eight-year-old me decided it must be good. You played a newspaper baron in a right-wing dictatorship and had to select the stories that went into the paper each week, balancing the need to run rag-selling sensationalist scoops with not upsetting the government so badly that it stormed in and took over your title. It was like editing the *Daily Express*, but with less Diana.

By today's standards, *Front Page* was a ridiculously primitive game. For example, you were given a sum of money at the start to buy newspapers with, but you had to keep track of your purchases on pen and paper – the game not being sophisticated enough to keep a tally by itself. Still, I played it so much I almost wore the tape out. I learned about left-wing and right-wing politics, the value of an exclusive, matching stories to an audience.

The key thing was it taught me stuff without me knowing it. My mum and dad, no doubt worried about how much time I spent in my bedroom looking at a screen, made speculative attempts to upgrade my games library with "educational games", but these were quickly discarded.

They needn't have worried, because I was getting a secret education. My love for football manager games introduced me to concepts such as budgeting and tax. I know for a fact that my grasp of dealing with big numbers was vastly improved by working out how much of my transfer kitty I had left to spend on a new striker, for instance.

In one game, *Football Director*, I didn't have enough money for a new player so I took out a loan. I looked at the budget carefully and worked out that I could afford the repayments, but I'd forgotten to take the interest – a new concept to me – into account. I won the league but I was sacked at the end of the season because I'd driven the club deep into the red. I was absolutely furious: there's probably still a joystick-sized dent in the wall of my mum's back bedroom to this day. But it taught me a harsh lesson in economics, one I didn't forget.

Why am I recounting these stories of a well-spent youth now? Because I'm peering over the shoulders of my kids, looking at the games they're playing and hoping that they're as beneficial to their upbringing as those Commodore 64 titles were to mine.

My eldest is faintly obsessed with *The Sims*, spending hours locked away in her bedroom recreating our home in the game so that she can redecorate her bedroom without having to tidy her actual one. I don't get it myself, but I can see that she's picking up things: a primitive form of CAD, structural awareness, the benefits of drafting and redrafting until you get the desired result.

The youngest, meanwhile, is a stone-cold capitalist. She plays *Roblox* online with her friends; I recently overheard a session in which she and her young business partner had set up a café in the game. They were preparing meals, greeting customers as they came through the door so they didn't leave, before deciding how much to charge them for a virtual latte. They were even being pestered by customers who wanted a job in the café so they could

> ❝ **Without any real involvement from me, my two daughters are picking up life skills through computer games** ❞

earn some Robux (the game's virtual currency), but my budding Ruth Rogers had worked out they couldn't afford to hire staff – though not before she'd relieved the jobseeker of a few bux for a plate of virtual chips, of course. That's my girl.

Again, without any real involvement from me, the girls are picking up life skills through computer games. The youngest's mental arithmetic skills have come on in leaps and bounds in the past year, partly because we're hammering the times tables into her, but partly because she needs those skills to scalp other kids by running her virtual Starbucks.

The moral of this tale? Yes, hour upon hour spent shooting other players in *Fortnite* might not offer much educational nourishment, but there are plenty of games out there that do – often in quite unexpected ways. Just hope that your kids or grandchildren find the beneficial games by themselves, because nothing is more likely to make them switch off than an "educational" game being handed to them.

📧 barry@mediabc.co.uk

> ❝ **I was absolutely furious: there's probably still a joystick-sized dent in the wall of my mum's back bedroom to this day** ❞

Readers' comments

Do no evil, promise

Are all tech companies evil? Is it ever worth using a free service? The announcements that Google was killing Google Music and that Google Photos will count towards its 15GB space limit after June 2021 had me annoyed, but the announcement of Yahoo stopping free email forwarding on 1 Jan 2021 has me fuming. "Security" reasons do not stack up if they can do this in the Pro version. It looks like a cash grab.

One view is that this is fair enough; the services cost money and therefore these loss-leading free offers were only going to last so long and I should be happy to pay. However, this fails to take into account Google's data mining for its search business and increase of Android mobile market share because of these services, or its track record of killing products that wouldn't force you to use the services (such as Picasa). In Yahoo's case, I don't believe forwarding ten emails a day costs it a great deal of money and email forwarding has been ubiquitous for a long time.

I have both Gmail and Yahoo addresses forwarding to Google. I have 250 logons for websites with a Yahoo address and 150 accounts with a Gmail address in my KeePass database. While I probably will have to bite the bullet and pay for Yahoo Plus, my mum, dad and aunt, all pensioners who aren't technically minded, also have Yahoo/Gmail accounts set up by me. Who knows how many website logons they have for each service? Do I now have to either explain to them that they need to pay Yahoo because they once had a Yahoo email account, or change all

BELOW Yahoo has decided to end its free email forwarding from January 2021

Star letter

Recently, *PC Pro* stated the death of the desktop, with the laptop winning over people to that form factor due in part to its portability. However, the desktop strikes back.

With the current pandemic situation that we all find ourselves in and the sharp increase in homeworking, people are finding that laptops are okay for a quick email or Zoom call but for heavy keyboard work you start to need extras to get proper work done – so do you start down the road of laptop docks, extra keyboards, mice, screens? Not to mention a proper desk to fit in all on, instead of a kitchen countertop. You soon get to the point where a desktop PC starts to make sense, one that can be placed on a dedicated desk for proper work, instead of risking cake mix (banana bread, naturally) on your laptop.

Once you have a desktop PC, you will find that you can use if for proper business work but you can start to use if for other things like games. So, as your partner settles in to watch yet another Netflix boxset, you can fire up an AAA title. That's why 2021 will be the year of the desktop. Long live the king. **Michael Ashworth**

Editor-in-chief Tim Danton replies: It's almost like you can read our minds: this month's group test is dedicated to the desktop PC. Take a look at our 12 contenders from p76 – and if you still have a copy of issue 312, read Barry Collins' column on p22 where he covers exactly this topic!

their logons on every website they've ever used?

My final point is that these services have been pulled without sufficient replacements in place and the tech firms don't seem to care. YouTube Music's interface is awful and it still doesn't play local playlists to my Google Home device. In Yahoo's case, the lower-cost $12 "Access and Forwarding" option isn't available in the UK, just the US – why not? Do people in the rest of the world not need to forward email?

In conclusion, I'll have to start paying for services, but after this none of those services will be with Google and Yahoo. **Pete Mitchell**

God bless the USO

Living rurally, my VDSL broadband download speed hovered around the Universal Service Obligation (USO) minimum of 10Mbits/sec download, 1Mbit/sec upload. This was fine for streaming on-demand TV and video, but lockdown has brought into focus the inadequacy of a 1Mbit/sec upload speed for videoconferencing. Zoom states a minimum 600Kbits/sec for a one-to-one call, but for a Gallery View of more than one other person, 1.5Mbits/sec both ways is required and it's just not possible using my line.

The BT USO page tells me that I'm not eligible for an upgrade to meet the standard as I already have "over 10Mbits/sec available at my location". If I put in a dummy order, it then tells me that 5-13Mbits/sec is possible with a guaranteed minimum of 7Mbits/sec – far lower than the USO requirement!

I have a 4G mast in direct line of sight, so I cancelled the landline and

VDSL broadband and I now get 60Mbits/sec down, 30Mbit/sec up, and at half the cost of the fixed line service. Sadly, many rural residents aren't so lucky, and it seems to me that Ofcom is doing absolutely nothing to help them. **Martin Pendlebury**

Globetrotting support

Just looking at Barry's column (*see issue 316, p22*), the problem with "low-paid support staff in foreign call centres" vanishes if you're lucky enough to live in a country where not everybody speaks English and you can get an address or chat function with writing in the local language.

The test here (which isn't difficult to pass) is that they respond quickly in better Finnish than mine. Once they're off-script, they're clearly not low-paid or in a foreign call centre.

The thing to avoid is thinking "my own language is English so I should contact the English language support service of my local supplier".

I had the same useless exchanges with the Indian subcontinent when I contacted (the Finnish company) F-Secure's support function.

In the end, I got them to switch me to their Stockholm office and, as I've worked for several years in Sweden, I could solve the problem with them in Swedish (although I suspect, once I had finally been forwarded to them, English would have done just as well).

I'm in Finland so not far away from F-Secure HQ, yet the support function *for Finland* was, it seems, outsourced to India. However, their Sweden support seems to have been in Sweden hence my being transferred there. Simply odd. **Mike Walsh via Twitter**

Dell, meet Dell

Further to your excellent monitors Labs in the November 2020 edition of *PC Pro* (*see issue 313, p68*), I have to report that my expectations and yours have not been met with regard to the Dell U2720Q monitor.

I decided to go for the Dell U2720Q, ironically as it has turned out, to ensure compatibility with my Dell XPS 13 (9350) laptop. This was not to be. On connecting the monitor to the computer using the USB-C to USB-C lead, I get the error message "No USB-C signal from your device".

I can drive the monitor by using an HDMI cable with a Dell Adaptor DA200. But, of course, this means that the docking functionality is lost and I can only drive the monitor at 2,048 x 1,152. As my laptop is then connected to the monitor via HDMI, it won't notice anything I plug into the monitor's USB ports.

I contacted Dell and they recommended I use a Dell D300 Docking Station, but this also

wouldn't facilitate USB-C to USB-C connectivity. Judging by the activity online (for instance, the exchange at **pcpro.link**/**317dell**), this issue appears to be known by Dell but no solutions are offered.

I bring this issue to your notice because there may be other readers of *PC Pro* who are experiencing the same problems. **Len Hobson**

Editor-in-chief Tim Danton replies: Thanks, Len. We were amazed by this and got in touch with Dell, who responded with the following statement: "This incompatibility issue has been brought to our attention. The possible solution can be found on our support site [visit **pcpro.link/317dell2** for details]. This issue should not be present in the newer Dell laptops with USB-C connectivity when paired with the new USB-C monitors."

However, following the link reveals that Dell's solution is to buy a Dell dock. And we're still none the wiser why the problem occurs over what should be a standardised USB-C connection. Our thanks to Len for bringing this to our attention so we can share it with a wider audience.

Readers' poll

Davey Winder provides an exposé on 2021's biggest scams from p24 and how to spot them, so we asked *PC Pro* readers what scams they had recently experienced. The results are clear.

Ransomware threat to business **9**%

Email scam **60**%

No scam at all **4**%

Telephone scam **75**%

SMS-based scam **47**%

SCAM ALERT

One thing's evident from our poll: scams show no signs of abating. "In spite of me telling mum that Microsoft doesn't ring you, she fell for one of those calls," Tanya told us. "It took many friends trying to assist before we found out why her PC was buggered. Luckily, her cards weren't scammed, but it was a close one."

However, there are occasional victories. "A friend was on the phone to a scammer for an hour," wrote Darren Davies. "She said she was completely useless so he didn't get anywhere, but he was very patient. The 'nice' man from BT sounded like he was after her login details when she described what had happened. She said 'he probably lost the will to live, poor chap'."

Join the debate

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❝My mother paid someone claiming to be from Amazon Prime membership. £199!❞ **Peter Sherriff**

❝A family member paid around £100 to a 'BT' cold caller for a free PC maintenance tool. I know people who were tricked into paying over £1,000❞ **Paul Roberts**

❝I ordered a CPU from a site that seemed legit. It never arrived and I'm struggling to get my money back❞ **Dylan Taylor**

❝I pretend to play dumb and keep them on the phone for a long as possible so they rack up expensive bills❞ **Dave Milner**

2021'S MOST DANGEROUS SCAMS

Davey Winder reveals the security threats you need to watch out for – and how to avoid them

Take one pandemic, add a nationwide dollop of homeworking and a rich helping of ever-hungry cybercriminals and you've got the perfect recipe for an upswing in online crime. Recent research published by the Ponemon Institute found that in the UK 79% of respondents have seen an increase in social engineering attacks since the start of the pandemic. In contrast, just 43% of organisations in the UK were found to have any policy on security requirements for those working from home. The scammers have never had it so good.

Whether you're a business owner, IT manager, employee or simply looking after the home network, it pays to be aware of the dangers that are out there. With that in mind, these are the most dangerous scams to watch for in 2021, with tips on how to mitigate against them.

■ PHISHING, SMISHING AND VISHING

There are many definitions of phishing – by far and away the most common social-engineering threat facing businesses and consumers today. Wikipedia calls it a "fraudulent attempt to obtain sensitive information or data… by disguising oneself as a trustworthy entity in an electronic communication".

While we tend to think of phishing as just an email scam, there are variants that employ text messaging known ("smishing") and voice calls ("vishing"). I'll come back to vishing shortly, as this is a scam methodology that matured during 2020 and one particular exploit is well worth being on your 2021 threat radar. But as for phishing and smishing, the goal largely remains the same: con the user into clicking a link that leads to malicious activity.

What happens when you click that link is worthy of a deeper dive (*see "What happens when you click on a phishing link?" on p27*). As for the nature of the scams themselves, these will be both ever-changing and the same tired attacks. Just look through your email spam folder and you'll see a mix of bogus invoices and emerging threats. Unfortunately, not all phishing attacks are filtered out, so you need to remain vigilant.

According to Maor Hizkiev, CTO at BitDam, a fifth of the phishing emails directed at businesses are currently using an Office 365 lure. "Some emails claim that your Office 365 password has expired and you have to reactivate it," Hizkiev said, and the scammers are getting more sophisticated in their attempts to get you to give up your credentials. If you click through, you're likely to find yourself at a page that looks like a genuine Office 365 login. Your organisation's logo can be injected into the page, with the correct business address at the start of the URL and even background branding for extra credibility. Hizkiev also warns that the phishers are getting better at evading detection, using tricks such as only enabling malicious websites to load on mobile browsers (less likely to be as secure as a desktop), and adding timed delays and even CAPTCHA codes to the faked pages to prevent security software from detecting the scam.

The best mitigation advice is also the hardest to follow: never click a link in any email and always browse to the website manually, or verify the communication with a known and trusted contact using a new email rather than hitting reply. This advice is just as relevant to smishing scams where URL shorteners are the business norm; the scammers love using obfuscated URLs and benefit from their increasing popularity for legitimate purposes.

What about vishing? Paul Ducklin, principal research scientist at Sophos, says that vishing is still popular with scammers as "more people are reliant on landlines due to the Covid-19 crisis with SMEs taking orders on the phone, people supporting family members who are self-isolating and so on". A growing problem is something known as "reverse phishing", according to Angel Grant, director of digital risk solutions at RSA Security, who says that lures of banking and social media accounts being locked are among the most recent examples.

Vishing itself requires the scammer to have your phone number and, often using caller ID spoofing, impersonating a trusted organisation in an unsolicited call. Reverse vishing, unsurprisingly, takes a backside-about-face approach: instead of calling the victim, the victim calls the scammer. It sounds like it can't possibly work, but it does. It's harder to pull off, but for the fraudster prepared to put in the effort, the results can be worth it.

Using keywords known to generate traffic, the scammers will poison the SEO of genuine support services by seeding legitimate social media support threads with deceptive responses. Some scammers will just scan genuine support threads and respond as a customer service rep, asking to be called back. Done successfully, the victim calls a fake customer service number and, because they initiated the call, will hand over pretty much whatever credentials are requested without suspicion of fraud. As with link-clicking, the mitigation advice is simple: only call support numbers you know to be genuine and perform due diligence to ensure they are.

■ FORMJACKING

While there are plenty of convincing phishing scams, at least you have a chance of spotting them. The same can't be said for all online fraud. "Card skimming and formjacking malware like Magecart will continue to be a major problem for online retailers and their customers," warned Paul Bischoff, a privacy advocate at Comparitech. "Shoppers can't detect the malware because it runs on the server side, with no discernible difference from a legitimate transaction on the client side."

Although bigger businesses are by no means immune to the threat, Chris Hauk, consumer privacy champion at Pixel Privacy, told *PC Pro* that the

SOME EMAILS CLAIM THAT YOUR OFFICE 365 PASSWORD HAS EXPIRED AND YOU HAVE TO REACTIVATE IT

Privacy Badger

English   Español

Privacy Badger automatically learns to block invisible trackers.

INSTALL PRIVACY BADGER
AND ENABLE DO NOT TRACK

v2020.10.7

Install for Chrome   Install for Firefox   Install for Firefox on Android   Install for Opera

ABOVE The EFF's Privacy Badger can stop malicious ads being served up

ABOVE **A typical channel-switching scam**
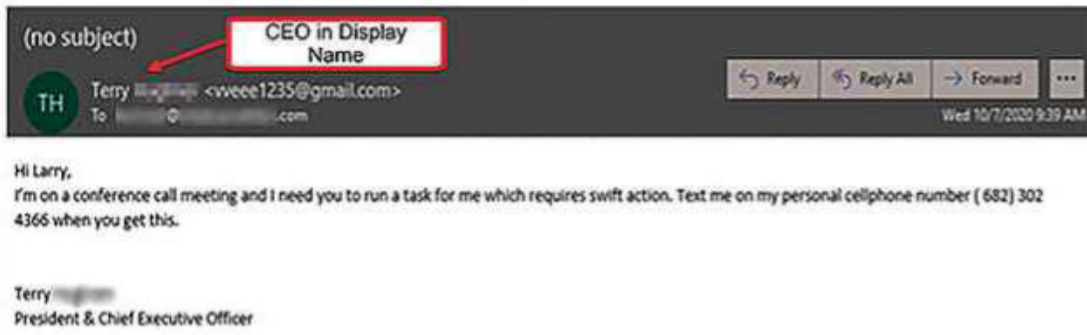
scammers will be particularly "looking to inject their nasty payloads into the websites used by small businesses, as they may not be as hardened against such threats as larger merchants are".

So, what is formjacking and how can it catch you out? From the scammer's perspective, an online form is targeted so that, when the user fills it in, the information they input is also sent to the attacker. Think of it like the petrol station card-skimming scams whereby a secondary reader is added to the genuine card reader so that any card swiped is also copying all the payment data needed for fraud.

Technically, it's a bit more involved than that, though. "Hackers are deploying a malicious JavaScript code that will capture secure data directly from the HTML and JavaScript on the page before it's sent to the website server," said Hadar Blutrich, CTO at Source Defense. "In the past we saw hackers trying to hide their tools in servers and domains that had names such as Gocgle.com [note the 'c' replacing an 'o']. Today, they are using legit tools to avoid detection. We are seeing them use CSP [content security policy] whitelisted solutions to deploy JavaScript code and then collect the information with other solutions and analytics tools. This way they don't need to use a server or a domain that is detectable."

In other words, the scammers attack a third-party JavaScript vendor used across multiple sites so there's no need to target specific sites. "In 2021 we are going to see hackers use tools like tag managers and analytics solutions to activate malicious code and capture data," Blutrich predicts. As for mitigation, that's the hard part.

Sticking to larger, more mainstream, online shops reduces the threat, but ultimately the mitigation has to sit with the online service itself.

■ **SCAREWARE**
Like phishing, scareware is something of a catch-all label. For a long time, it was associated with pop-ups informing a user their computer had been infected and offering a free antivirus scan that, should you have accepted, turned out to not only install malware on your device but charge you a fee for supposedly removing what wasn't there in the first place. Sadly, that scam still remains in various guises, but the broader threat has evolved.

"The latest variations find other ways to cash in on fake alerts, using them as the entry point to technical-support scams or prompting their victims to purchase fraudulent apps or fleeceware from a mobile app store," warned Sophos senior threat researcher, Sean Gallagher.

These fake pop-up notifications are not limited to desktop operating systems. In fact, fake Android notifications have become an all too common danger. And no, that's not hyperbole: scammers are combining two mobile attack modes to deliver one very convincing threat that's seemingly impossible to escape from. It all starts with social engineering to get the victim to download a seemingly legitimate app onto their Android phone. This is then used to deliver a ransomware-derived attack, which doesn't actually encrypt or hold any data to ransom, but it looks like it does. That's courtesy of
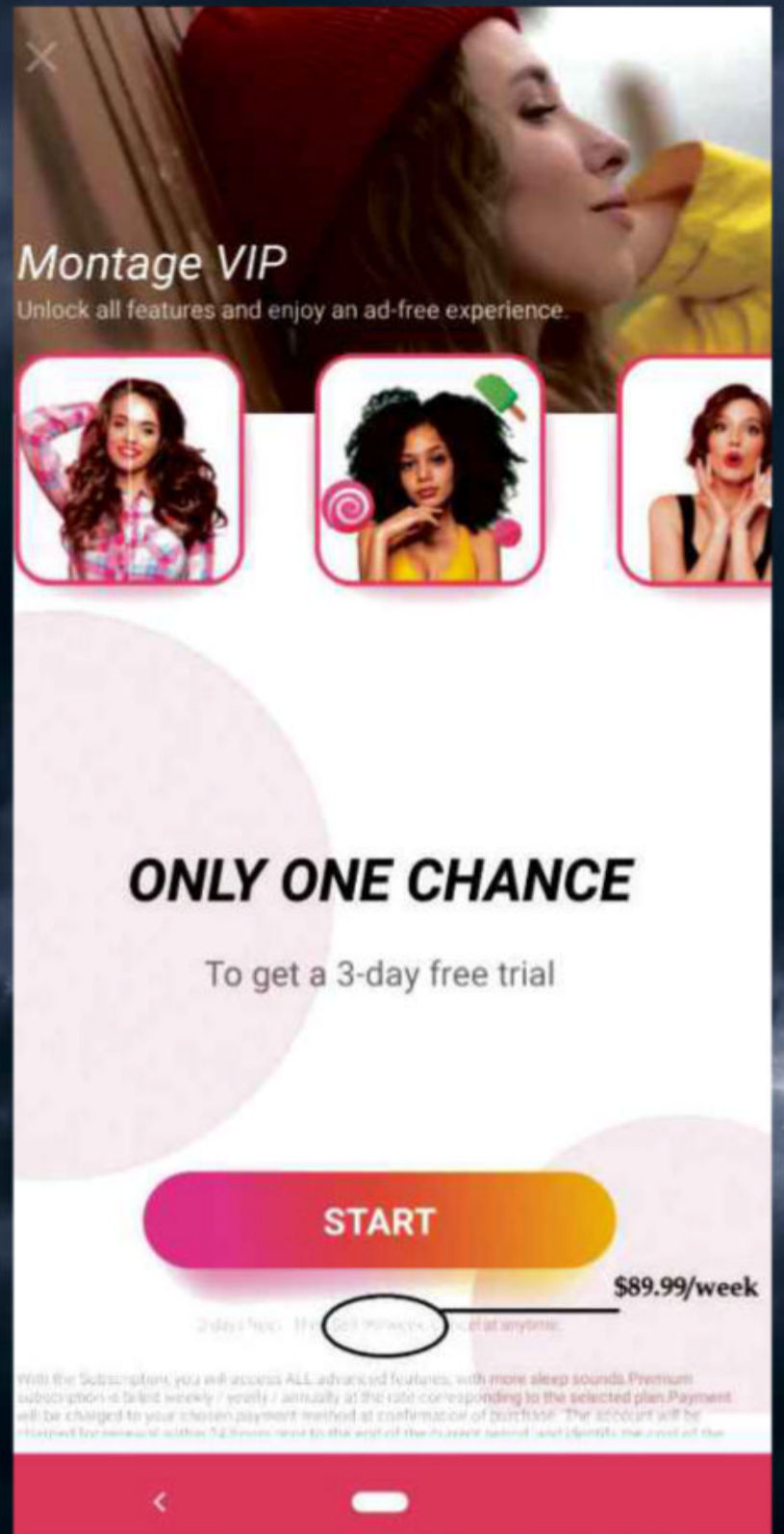
something called a screen overlay attack as part of the threat delivery. "Screen overlay attacks have been a common way for attackers to execute such ransomware attacks," explained Hank Schless, a senior manager of security solutions at Lookout. "Because it allows them to lock the user out of the device until the ransom is met."

One such recent threat is MalLocker.B, identified by Microsoft security researchers, which abuses incoming phone call notifications. In practice, the attack looks like an incoming phone call, but when the user presses the answer button it invokes a persistent screen overlay demanding a ransom and preventing access to anything else, including your homescreen. That threat evolution is far from over as Microsoft also found an as yet inactivated machine-learning module in the MalLocker.B code that, once used,

SCREEN OVERLAYS ALLOW ATTACKERS TO LOCK THE USER OUT OF THE DEVICE UNTIL THE RANSOM IS MET

Live GO Trackerr

| Map | Map2 | Pokedex | IV Calc |

Update to Radar Map PRO

Find more rare pokemon

Free Trial 3 Days.

Q: Why Google Play ID needs to add payment method for free trial?

A: In fact free trial is a in-app purchase,but it only pay for $0! (Pay $0=Free Trial) in Android programming language.So that application identifies you get a free trial period. Since it is so,you need add a payment method.

LEFT & ABOVE An example of a subscription trap scam

COMPANIES NEED TO TAKE RANSOM DDoS SERIOUSLY AND WORK CLOSELY WITH THEIR SECURITY PROVIDERS

WHAT HAPPENS WHEN YOU CLICK A PHISHING LINK?

Everyone will tell you not to click an unverified link in your email, but there are only a few people who can tell you the reason from a technical perspective. Liam Follin, a web application security tester at Pentest People, is one of them.

"Cross-site request forgery (CSRF) is that reason. Clicking on that link means that an attacker can fake any user-supplied input on a site and make it indistinguishable from a user doing it themselves. CSRF arises because of a problem with how browsers treat cross-origin requests.

"Take the following example: a user logs into site1.com and the application sets a cookie called 'auth_cookie'. A user then visits site2.com. If site2.com makes a request to site1.com, the browser sends the auth_cookie along with it. Normally this doesn't matter. If it's a GET request then the page is served, and the same-origin policy stops any funny business. But what if site2.com makes a POST request instead? That request came from the same computer as the valid session and uses the correct authentication cookie. There's no way to tell the difference, and any state-changing operation can be performed.

"The start of any CSRF attack is always the payload. The first thing to note here is that when an iframe loads, it sends a GET request to whatever is specified in the 'src' parameter. Normally this is a standard page, and the content is displayed. But what if you framed a 'log-off' page which invalidated your authentication cookie and then redirected you back to 'index.html'? Well, turns out it does exactly what it says on the tin, but, importantly, it doesn't redirect the entire page, only the contents of the iframe.

"So how would an attacker get the payload to fill the whole page? Well, they can interact with the height and width properties of iframes using JavaScript. More importantly, they're able to rewrite the whole page. What an attacker really wants are the keys to the kingdom: an admin username and password. In our pen test we had already fiddled around with JavaScript a bit to get to this point, so we took it a stage further, just as a real attacker would. The 'onload' property of an iframe would come in handy to an attacker: by checking what the current source of the iframe is set to when it loads, they could then rewrite it to the admin login portal."
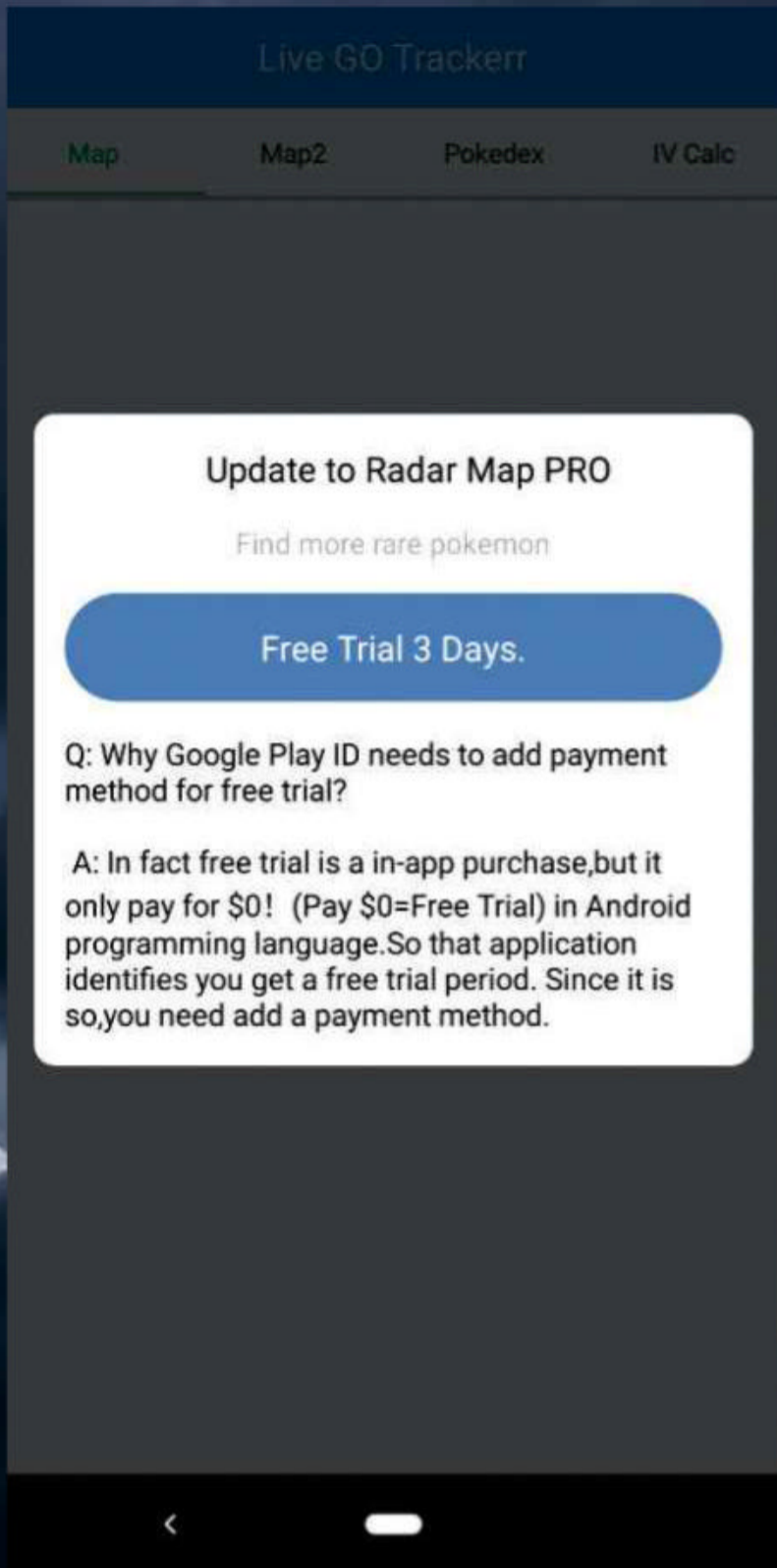
would ensure the overlay screen matches the device screen resolution perfectly to make it as believable as possible across all phones.

Mitigation comes down to not installing malicious apps in the first place. Don't download from unofficial app stores and don't install "cracked" apps. Gallagher recommends using privacy tools such as the Electronic Frontier Foundation's Privacy Badger (**privacybadger.org**) browser add-on for Firefox on Android to "block trackers used by less reputable ad networks". Malicious adverts are a major scam distribution method in this case, so an ad-blocking plugin that blocks known dodgy ad-dealing domains will help.

■ RANSOM DDoS

Sticking with the ransomware theme, Pascal Geenens, the director of threat intelligence at Radware, told *PC Pro* that readers should be warned about

the continuing rise in "extortion using ransom DDoS". This is another of those mashed-up threats, combining distributed denial-of-service with ransomware. "We have seen groups posing as 'Fancy Bear', 'Armada Collective' or 'Lazarus Group' become more active in recent weeks and it shows no sign of abating into 2021," Geenens said, adding that the main targets currently seem to be financial institutions and manufacturing businesses. As with all such threats, the attackers will go where the money is, so the targets will likely change in the coming months.

The scam itself is about as simple as it gets, and that's what makes it all the more dangerous. Emails sent by ransom DDoS groups warn that "the recipient's network will be subject to a DDoS attack starting about a week from the date of the letter," Geenens said, and at the same time a small attack is launched to "prove" the

legitimacy of the threat. Truth be told, such attacks can be rented online at a very low cost for a few minutes at a time. Of course, the threat is there, but it's a method of scaring potential victims into paying "insurance" so an attack doesn't happen that probably wouldn't anyway.

If the scammer really thought they could take down your business and get a payday out of it, they would go straight for the jugular. That said, Geenens warned: "All research into the source of the letters and the sophistication of the scams suggests companies need to take ransom DDoS campaigns seriously and work closely with their security providers to continually monitor the risks and adapt their strategy to mitigate against them accordingly."

DDoS protection is the best way to reduce the threat surface and dilute the ransom. Paying the ransom is never recommended, just as much

Subject: DDoS Attack

We are the Lazarus Group and we have chosen ▇▇▇▇▇ as target for our next DDoS attack.

Please perform a google search for " Lazarus Group" to have a look at some of our previous work. Also, perform a search for "▇▇▇▇▇" or "▇▇▇▇▇" in the news. You don't want to be like them, do you?

Your whole network will be subject to a DDoS attack starting ▇▇▇▇▇ next week. (This is not a hoax, and to prove it right now we will start a small attack on a few of your IPs from AS▇▇▇ block that will last for about 60 minutes. It will not be heavy attack, and will not cause you any damage, so don't worry at this moment.) There's no counter measure to this, because we will be attacking your IPs directly and our attacks are extremely powerful (peak over 2 Tbps)

This means that your websites and other connected services will be unavailable for everyone. Please also note that this will severely damage your reputation among your customers who use online services.

Worst of all for you, you will lose Internet access in your offices too!

We will refrain from attacking your network for a small fee. The current fee is 20 Bitcoin (BTC). It's a small price for what will happen when your whole network goes down. Is it worth it? You decide!

LEFT An actual ransom DDoS scam email

BELOW A smishing scam text message

with traditional ransomware, because there are no guarantees they won't come back for another go or attack your business anyway.

■ SUBSCRIPTION TRAPS

Subscription traps are a time-tested scam that have been boosted into the spotlight by the pandemic and the promise of coronavirus cures. As the name suggests, these rely upon misleading advertising scams that promise a free or heavily discounted trial, but deliver a costly and recurring subscription instead.

Fabian Libeau, EMEA vice president at RiskIQ, says his company undertook an investigation that "connected hundreds of similar content-farm sites to ads leading to subscription traps, pointing to a symbiosis between purveyors of fake content and subscription trap schemers".

However, it's not only Covid-19 cures that are used as bait when it comes to subscription traps, explained Satnam Narang, a staff research engineer at security firm Tenable. "Similar to the sale and supply of questionable goods, there has been a resurgence in diet pill spammers," Narang said. "In these instances, fake celebrity endorsements and spliced-up video content or edited images are used to promote diet pills that claim to help people lose weight. The latest fad is promoting diet pills that use the term 'keto' to capitalise on the craze surrounding the keto diet – there is no relationship between the keto diet and a keto pill."

Both Narang and Libeau offer the same mitigation advice to counter these subscription traps: scepticism. "If you find a piece of web content is engaging you at a highly emotive level, and especially if there is a call to action that involves the wallet, then you must question if you are being manipulated," Libeau said.

■ CHANNEL SWITCHING

Last but not least on our scams watchlist: channel switching. This is the scam that leans most heavily on homeworking. "Business email compromise attacks are continuing to be heavily distributed and are well positioned with many organisations working from home, which creates more physical separation which the attackers can benefit from," said Troy Gill, manager of security research at Zix.

With increasing amounts of publicly available data concerning employers and employees easily obtained from social media and business-oriented networks such as LinkedIn, open-source intelligence (OSINT) is the starting point for a channel-switching scam. Once the OSINT has been garnered, a scammer may pose as the CEO of the company the victim works for, or a known business associate, and initiates the attack with an email from a spoofed address. "The emails are often targeted at members of the finance team as they have access to company finances," Gill warned.

The scammer will quickly request that the conversation is moved to text message – a channel switch to SMS to escape any email security solutions that may be in place. That the switch is made is confirmation that the victim is hooked and the payload is usually, well, a payload: a request for a wire transfer that can be justified by a myriad of business reasons your boss might use.

Mitigation is a combination of awareness that such scams exist and tech buffers, such as two-factor authentication (2FA) being a standard operating procedure for any wire transfer. "Something as simple as a phone call for confirmation can go a long way to thwart these attacks," Gill concluded. "Just be sure not to use the phone number listed in the email." ●
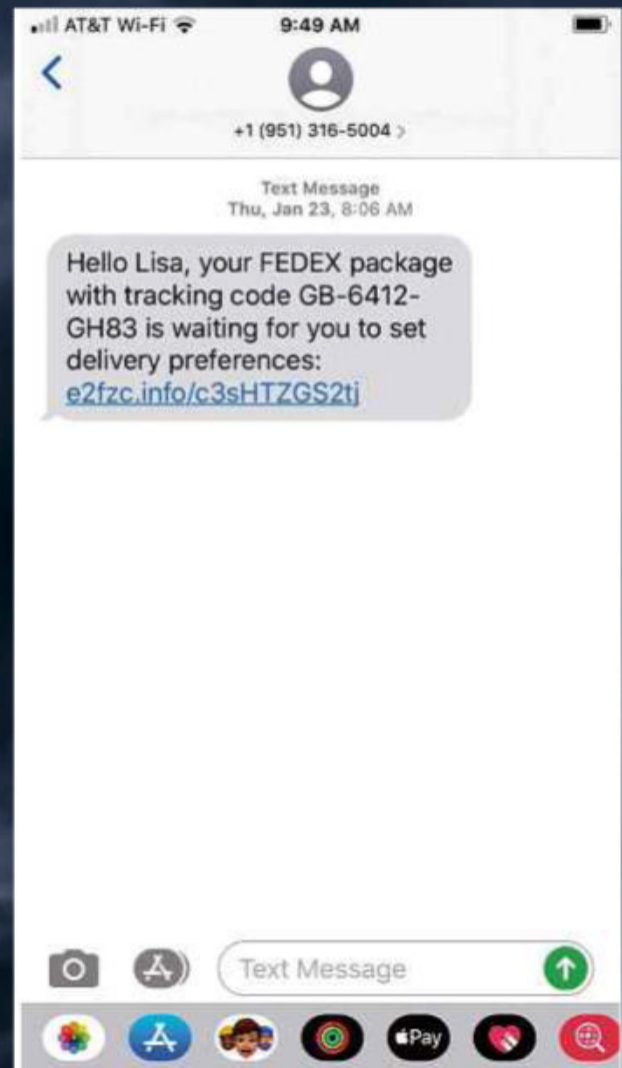
A SCAMMER MAY POSE AS THE CEO OF THE COMPANY THE VICTIM WORKS FOR

THE SCAM CHECKLIST

Here's a checklist of things to do and watch for, which might prevent you and your colleagues becoming victims of fraud:

■ Know what you're looking for – keep up to date with the latest threats by reading IT security news and magazines such as this one!

■ Adopt basic security hygiene. In the same vein as "hands, space, face", you and your team must follow the IT security basics, especially with staff working from home. Don't idly click on email links, don't respond to unusual requests without checking and don't install random apps.

■ Take care on every device: apply caution with your personal devices as well as your work ones, as these will likely be the weak links in your security posture.

■ Don't put off updates: keep up to date with OS and app updates to ensure you're not exposed to already fixed threats.

■ Get passwords out of your head: use a password manager to take better control of the credentials you use and ensure two-factor authentication is enabled everywhere possible.

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SIDE HUSTLE

HOW TO MAKE EXTRA MONEY FROM YOUR SKILLS

Barry Collins profiles three people who used tech to turn an interest into an income stream

Let's face it, the economy is looking pretty grim. The worst decline in GDP since dinosaurs were lolling about in swamps, public sector pay freezes and double-digit unemployment levels: these are our "new normal".

In treacherous times such as these, it makes more sense than ever to look for extra ways to earn money, which is why we've sought inspiration from three people who have used tech to convert their interests and hobbies into a regular income.

Be warned: there are no get-rich-quick schemes here. All three of our case studies put in years of hard work before they saw any return on their time and passion. And I'm sure all three wouldn't mind me saying that none of them will have Bill Gates looking over their shoulders on the rich list.

However, they've all found a way to convert something they love into extra income. They'll each explain how they did it and maybe give you the inspiration you need to find your own tech-related side hustle.

THE DATA TUTOR

Kevin Markham claims he became something of an accidental YouTube hit. "I created the *Data School* blog and YouTube channel simply because I wanted to share things that I was learning about data science," Markham told *PC Pro*. "Every time I found a data science topic that seemed to be lacking a high-quality tutorial, I wrote a blog post or created a video to explain that topic in a thorough yet accessible manner."

That recipe certainly worked. Markham's *Data School* channel on YouTube (**youtube.com/user/dataschool**) now has 165,000 subscribers, with tutorials covering topics such as setting up Python for machine learning, web scraping and setting up GitHub. The *Data School* videos aren't particularly flash: for instance, there are no animated introduction sequences or 30 seconds of begging to subscribe, as you get with many big channels. Instead, it's just an enthusiast sharing his passion for coding in a straightforward, approachable manner.

"I never intended for *Data School* to be a business," Markham explained. "I just loved sharing what I was learning, and it turned out that my posts and videos resonated with a large audience."

It would be wrong to think *Data School* was an overnight hit, however. It took years of effort before Markham began to realise that his hobby might generate an income. "The first time that *Data School* earned any meaningful revenue was when I sold my first online course, which was roughly two years after I started *Data School*, and one year after I began teaching data science in the classroom," he said. "The online course sold out quickly, which is when I realised that *Data School* could be a real business rather than just a hobby."

Markham is also one of a growing number of content creators who now monetises their expertise through Patreon. He's kept the fees modest. A donation of only £1 per month (exc VAT) gets access to the lowest tier of Patreon membership, which includes rewards such as alerts every time there's a new tutorial. The £17-per-month top tier, called Business School, grants access to a private forum where you can ask Markham questions and get a behind-the-scenes look at how his videos are created. He says that the income from Patreon is a "small, but meaningful" part of his overall revenue, with the bulk of his earnings coming from "selling online courses directly to my audience, as well as licensing courses to other platforms".

Markham says there are no shortcuts for technology experts who might be considering a stint in front of the camera. He didn't buy his way to success with paid-for adverts or promotions, he just relied on the strength of the content he produced – and that was a serious amount of upfront labour. "From the beginning, my strategy for audience growth has simply been to create free, high-

TOP Markham sells his courses directly and licenses them to other platforms

ABOVE He then supplements this with a range of Patreon levels

quality content and share it in the right communities, so that it can reach people who might benefit from it," he said. "I trust that when my content is great, the people who love it will share it with their friends and search engines will surface it to their users.

"My business is successful because I've invested thousands of hours over six years creating free content and building a brand and community around that content," he added. "Duplicating this type of business is a long-term strategy with no guarantee of success, so I only advise it if you are truly passionate about a particular topic and willing to be patient."

THE NEWSLETTER QUEEN

Creatives aren't keen on the word "no". It was when Sian Meades-Williams was stymied in her attempts to liven up her company's newsletter that she decided she'd be better off going it alone.

Setting up Python for machine learning: scikit-learn and IPython Notebook

From the video series: Introduction to machine learning with scikit-learn

Agenda
- What are the benefits and drawbacks of scikit-learn?
- How do I install scikit-learn?
- How do I use the IPython Notebook?
- What are some good resources for learning Python?

classification
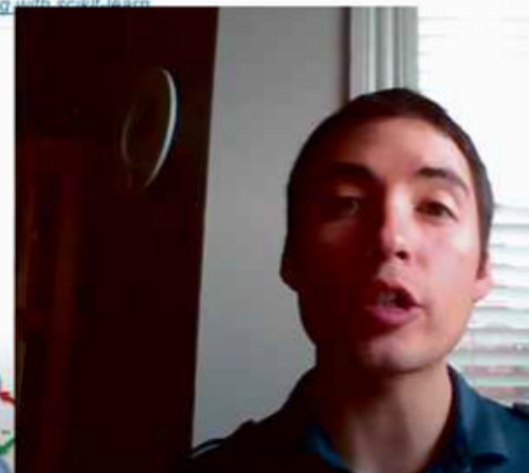
data school INSIDERS

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Kevin Markham
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"I started writing a shopping newsletter on my lunch break one day, because I hated my job and I wanted to do something creative, and I was working for a company that wouldn't let me write original content in the newsletter," she said. Original content? That will never catch on.

Instead, she set up her own shopping newsletter called *The Friday Wishlist* in 2016, and was soon surprised how she could earn a decent income without having millions of subscribers. "It was so successful through affiliate links and open rates that it paid for the first year of my MA," said Meades-Williams. "I loved it and I got the bug."

Those affiliate links mean shopping sites can track who send customers their way and pass on a commission for each sale. It's an income model that normally relies on huge amounts of traffic as most people don't end up buying. *The Friday Wishlist* only had around 500 subscribers, but it had a 75% open rate – which is phenomenal for an email newsletter – and that led to engaged readers clicking on the recommendations.

"You can have all the subscribers in the world, but if they don't care, you're just shouting into the void," she said. "It's all about engagement, and it's the engagement I talk about when I speak to advertisers as well."

The success of *The Friday Wishlist* prompted Meades-Williams to set up further newsletters with her business partner. She relaunched her *Domestic Sluttery* blog as a daily newsletter. "We thought we could absolutely keep up with that level of content, and it turned out that we couldn't for various reasons."

ABOVE Meades-Williams and Laura Brown's weekly lifestyle newsletter

LEFT Meades-Williams has also published a guide for freelancers

Photo: ©David Hobby

However, it was six months spent as a freelance writer that convinced Meades-Williams there was another newsletter in her. "I realised there wasn't a platform for just freelance writing jobs and I knew this because I kept on having to sift through either jobs boards that had dozens of unpaid jobs, or worse, sift through hundreds of full-time writing jobs just to find the one that was suitable for me.

"I knew it was a good idea and I knew the newsletter was the right format for it, because of the temporary element of freelance jobs."

The reason why many email newsletters go unopened is because they add nothing to the pile of noise in your inbox. Quality of writing and delivering desirable content – be it shopping recommendations, tech tips or job openings – is everything. "I firmly believe that we don't necessarily want more email," said Meades-Williams. "We want better email and when you get emails that are really great and do exactly what

they're supposed to, it's great. And it makes your inbox a much nicer place."

When you nail the content, the promotion starts to look after itself too, because word of mouth becomes your greatest marketing tool. Meades-Williams promotes *Freelance Writing Jobs* via her Twitter account (**@SianySianySiany**), but doesn't even have a website to showcase the newsletter. "I still don't have a proper website [for *Freelance Writing Jobs*]. It's mainly laziness but also I don't need to because of the amount of subscribers and the traffic is doing fine," said Sian. "By the time I'd set up the [newsletter] landing page for *Freelance Writing Jobs*, I went to make a cup of tea and I came back and there were 300 subscribers."

Freelance Writing Jobs has led to a spin-off book, *The Pyjama Myth: The Freelance Writer's Survival Guide*, which hit its crowdfunding target with a little to spare earlier this year. Meades-Williams admitted that it needed a lot more self-promotion to get over the line, though – something that doesn't come naturally to her. "Because of having the immediate and direct audience [from *Freelance Writing Jobs*], it made it a lot easier, but I think everybody hopes that their project will get crowdfunded quickly and when that doesn't happen, it's a real slog," she said.

"There was a bit halfway through the funding, which took about nine months, when I genuinely didn't think it would happen. It was harder than I thought it would be, but the support has been great and the enthusiasm has never waned."

THE SUPER SCOUT

In 1994, West Ham were playing a pre-season friendly at Oxford City when one of the fans started shouting abuse at misfiring striker Lee Chapman in earshot of West Ham manager Harry Redknapp. Redknapp turned to the abusive skinhead in the crowd, asked him if he "could play as good as you talk" and sent him on as a 70th minute substitute. Unlike Chapman, the fan scored.

Stuart Milne got his break in the virtual football business in much the same manner. "I got *Championship Manager 97/98* and the Dundee United data wasn't particularly good," said Milne. "So I emailed Sports Interactive [the game's developer] and got given the role of being the Dundee United assistant researcher."

BY THE TIME I'D SET UP THE LANDING PAGE, I WENT TO MAKE A CUP OF TEA AND I CAME BACK AND THERE WERE 300 SUBSCRIBERS

BACK IN THE DAY, IT WAS SORT OF LIKE PEN AND PAPER AND, YOU KNOW, ASK THE CLUB FOR INFORMATION AND GET TOLD TO GET LOST

Championship Manager subsequently became *Football Manager*, now one of the biggest selling computer games in the world, and the chippy young Scot who told the developers that their Dundee United data wasn't up to scratch is now leading the game's team of Scottish league researchers – all whilst holding down a day job as a business advisor.

For *Football Manager*, Milne's job is part football scout, part data scientist. He still takes charge of compiling the statistics for his beloved Dundee United, rating the club's players in a vast range of categories that put a precise figure on their ability to pass, shoot, tackle and make decisions, as well as less tangible skills including composure and leadership.

"Nowadays, it's a lot easier to do the job because there's so much information available on club websites and online – all these different stats and analytics you get," admitted Milne. "Back in the day, it was sort of like pen and paper and, you know, ask the club for information and get told to get lost."

Players are given overall rating out of 200. Pelé would be a 200, Lee Chapman closer to a one. To prevent the devoted fans who rate their own team's players from succumbing to bias and awarding players ratings that are better than they deserve, the leagues are standardised, so that Scotland isn't suddenly overpopulated with a crop of world-class players. "We know that players in the Scottish Premiership maybe go from 90 to 120 if they're not playing for Rangers and Celtic [consistently the two best teams in Scotland], and then we work down from there," said Milne, explaining the balancing system.

The Scottish research team shares an online forum where the ratings awarded to certain players are discussed, working together to create a consensus and erode supporter bias as far as possible. Not that the millions of *Football Manager* players are shy about venting their opinion if they feel the research team has got a player or entire team marked down too low. "If any major issues come up, people will tell you about it," Milne said. "Traditionally, Rangers and Celtic fans are the most difficult ones to appeal to. They are always competing against each other. This year, for example, we've had a lot of Rangers fans complaining 'we're underrated

because we're above Celtic in the [actual] league'."

The stats for all of the players were, until relatively recently, compiled in Microsoft Access databases, which had to be checked, double-checked and then sent to Sports Interactive just ahead of the game's release for inclusion in the game. Now, the researchers have moved to an online database, which makes it far easier for the research teams to collaborate and check each other's work.

With first team, under-23 and under-18 players to rate for every club, compiling and checking all that data is no mean effort, which is why the game has hundreds of researchers all over the globe. The period just ahead of the game's release every autumn (slightly delayed this year because of Covid-19) is the busiest for

Milne and his colleagues. "In that August/September time, doing that [data research] on top of a full-time job can be pretty hectic," said Milne, who estimates he spends six or seven hours a day on the research role at peak times. Research continues through the year, with data updates released throughout the season as players move clubs or dip in and out of form.

Does that mean he's sick to death of *Football Manager* by the time the game actually comes out? "I always try to, but it's difficult to have enough time to play it," Milne confessed. Besides, his knowledge has already sucked some of the enjoyment out of the game. "I know how the sausage is made," he said. "So, I would know exactly what players to sign, which almost takes the fun away." ●

BELOW Milne helps to compile a rating out of 200 for each virtual player…

BOTTOM …and as can be seen, there's a huge amount of data to compile
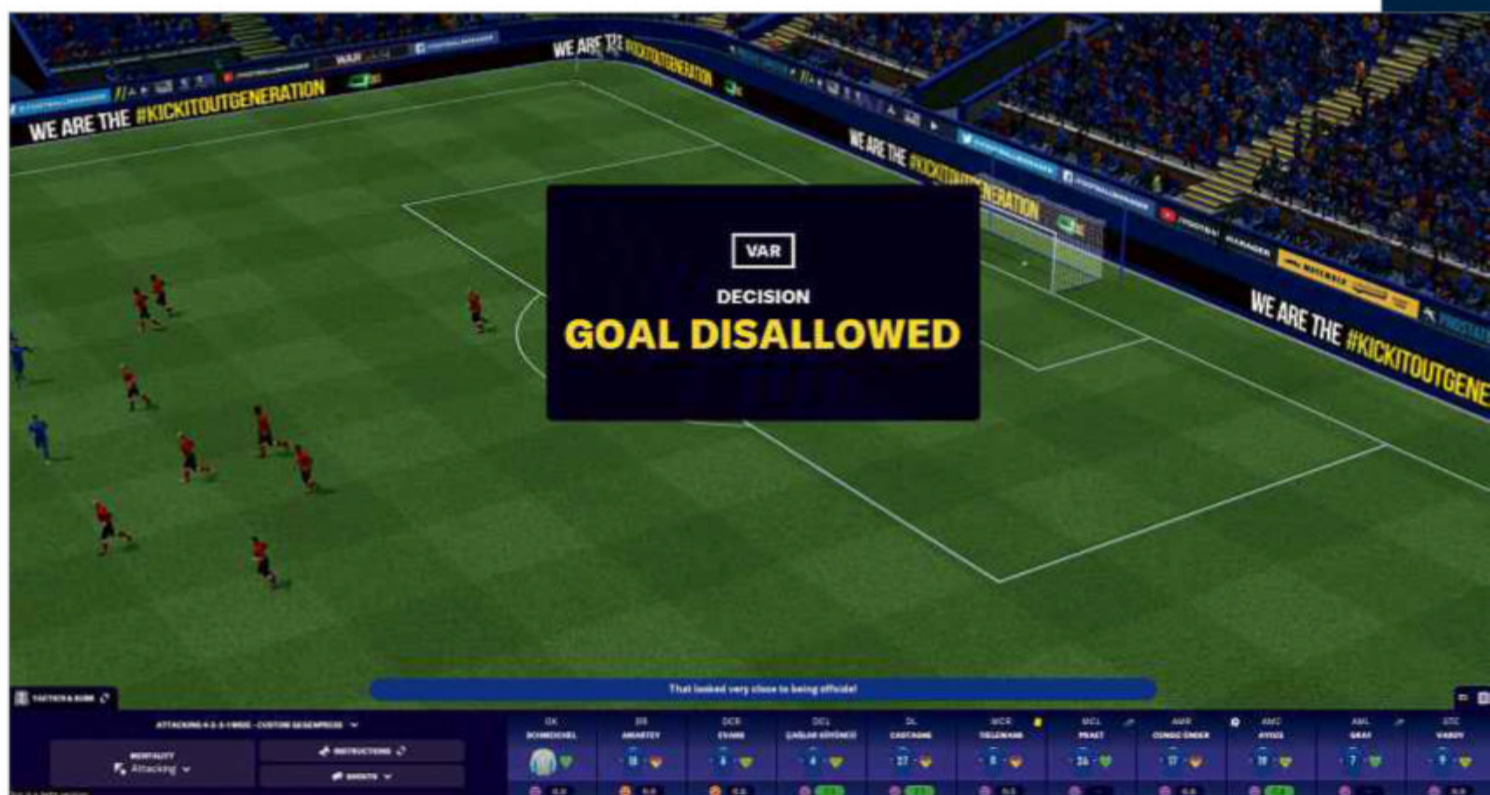
WHAT CAN YOU DO

Don't throw out old hardware: **Nik Rawlinson** finds out how to breathe new life into a disused computer

with an OLD LAPTOP?

These upgrades could boost the performance of your laptop, giving it an extended life as a spare machine or as a lightweight system for a family member

Nobody likes clutter, but the very worst thing you can do with an old laptop is throw it away: that's both wasteful and bad for the environment. If you genuinely want to get shot of a computer you no longer need, see if you can pass it on to a friend or donate it to a charity shop. Note, though, that not all shops will accept used consumer electronics, as reselling them requires full safety testing, so it's best to check online before turning up on the doorstep with an armful of obsolete kit.

Don't be in a rush to discard your ageing technology, however, as there are plenty of productive and even potentially profitable uses that it can be turned to.

Bring it back to life with an upgrade

If you've already replaced your old laptop, you may not be eager to spend money improving its performance. Yet it can be handy to have a second machine that's powerful enough to be genuinely useful. Granted, it's more difficult to upgrade a laptop than a desktop machine: the casing may be sealed shut in quite ingenious ways and, even if you can get in, modern laptops tend not to have many replaceable parts.

Older systems, however, often have hatches to allow you to add extra memory, and if your laptop is old enough to use a mechanical hard disk, it's likely that you'll be able to access this and replace it with a cheap 2.5in SATA SSD. Either of these upgrades

could boost the performance of your ageing laptop, giving it an extended life as a spare machine for you or as a lightweight system for a family member. Don't be put off by the cost: when you bought your old laptop it might have cost hundreds of pounds to add 8GB of RAM and a 250GB SSD, but these upgrades can now be had for under £30.

Installing new components will mean you need to get handy with a screwdriver, and we're assuming that a retired laptop is long out of warranty. If you're stuck with a slow hard disk, therefore, you might prefer to enable ReadyBoost, which has been a feature

ABOVE Linux distro Zorin OS has one of the best-looking interfaces around

of the operating system since Windows 7. This won't speed up every operation, but it caches frequently used data so that it can be retrieved more quickly, which can make computers without SSDs run more smoothly. If your laptop has an SD card slot, all you need is a fast card; alternatively, you can use an external SSD, ideally connected to a USB 3 socket if you have one.

To set up your storage device for ReadyBoost, simply right-click it in the Windows File Explorer and pick Properties from the menu. Switch to the ReadyBoost tab and click the button labelled "Use this device".
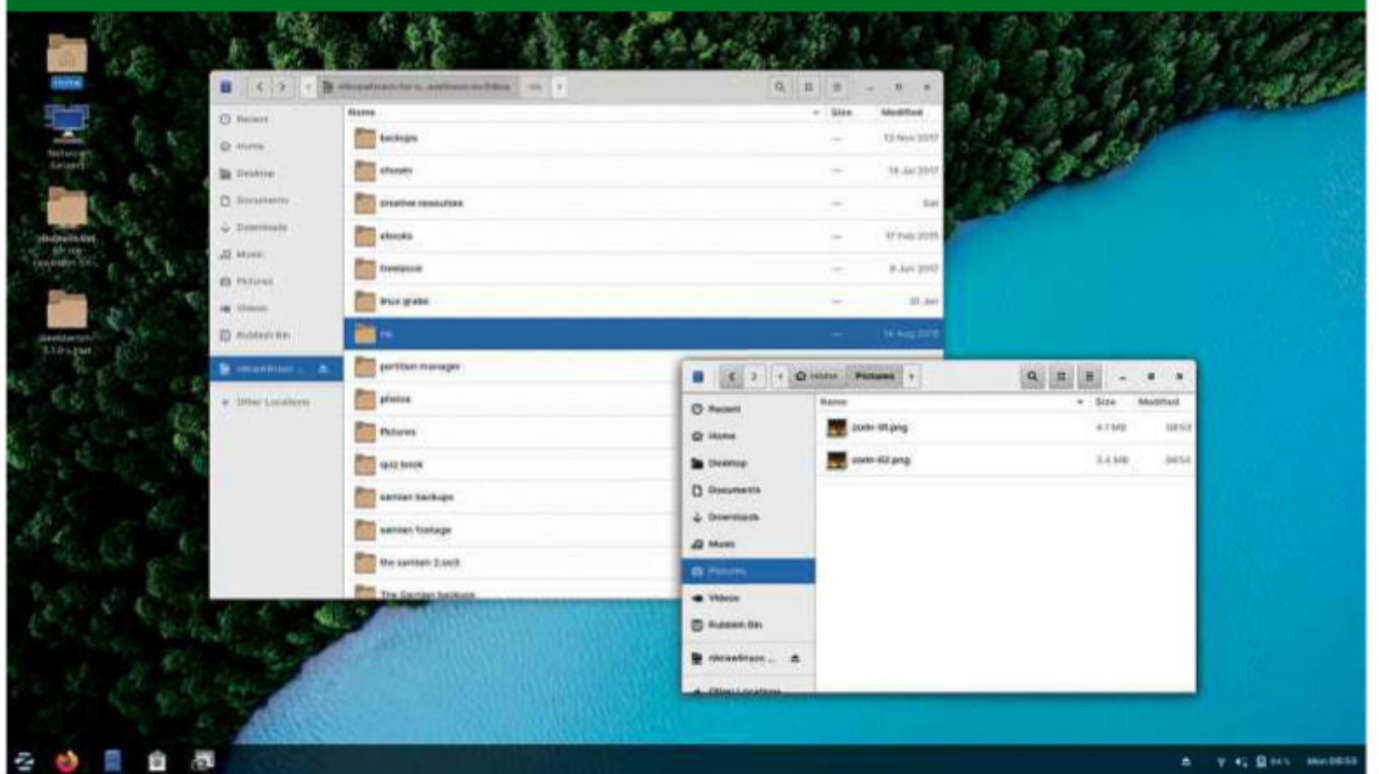
Replace the OS

Windows is more nimble than it used to be, but Linux almost always feels snappier on older hardware – so switching OS can be a free and very effective way to turn a sluggish old system into something more usable. One popular option is Ubuntu MATE (**ubuntu-mate.org**): this edition of Linux lacks the familiar GNOME desktop, but it will run on anything from a 32-bit 386 PC up, and there are versions for Macs and the Raspberry Pi. The 386 version is based on Ubuntu build 18.04, Bionic Beaver, and will be supported until at least April 2021.

If you don't get on with Ubuntu MATE, you can check out Zorin OS, which has – in our view – one of the slickest interfaces around. For really lightweight computers, there's also a Lite version of Zorin that uses the Xfce desktop environment: the 32-bit build requires only a 700MHz single-core processor, 512MB of RAM and 8GB of storage, and will work with any display with a resolution of 640 x 480 and upwards.

If you don't fancy the idea of installing a new OS on your old hard disk, you could alternatively try a USB-hosted alternative. Slax Linux is Debian-based, like Ubuntu and Zorin, but it can be run directly from a USB flash drive (or even a DVD): check out **slax.org**/**starting.php** for instructions on getting set up.

Ventoy is another USB-based option. This is a boot environment that lets you set up multiple Oses on the same USB drive, and switch between them at boot. As well as the major Linux distributions, it supports Windows 7 and later. You can download it for free from **ventoy.net**.

Bear in mind that booting from an external USB-connected device may require you to make changes to your PC's BIOS or UEFI configuration, and you might need to disable Secure Boot, which by default prevents your PC from launching unauthorised OSes. The shortcut for accessing the BIOS or UEFI interface is sometimes displayed during the boot process; if it isn't, check the manufacturer's website. Failing that, Delete, F1, F2, F10 and F12 are all good bets

Turn it into a Chromebook

If you don't fancy the idea of setting up and learning a new computing platform, another option is to convert your old laptop into a Chromebook by installing the open-source Chromium OS. This way, you can use familiar websites and online apps in a secure, lightweight environment.

There are several ways to install Chromium OS: techies may like to compile it from source code or download precompiled builds from a source such as ArnoldTheBats World of Whimsy (**arnoldthebat.co.uk**). The easiest option, though, is to use the free Home edition of CloudReady from Neverware (**neverware.com**). This comes with a friendly graphical installer that sets up the Chromium OS environment for you and includes automatic updates.

If you're lucky, your laptop will appear on Neverware's list of 350 certified models, which should deliver the smoothest experience – but even if it doesn't, you needn't rule it out. CloudReady's only strict requirement is 2GB of RAM, but Neverware also recommends at least 16GB of storage (your files will almost all be hosted in the cloud) and a processor from 2007 or later. You aren't able to dual-boot CloudReady alongside another OS, but you can run it directly from a USB drive, so you can try it out for as long as you like before you jump in with both feet and wipe your internal drive.

Aside from these requirements, the only thing you need is a free Google Account for logging on once you've installed the OS. You're not committed to using Google apps from that point forward, however: anything that works in a Chrome browser should also work in CloudReady. Note that the Home edition doesn't include compatibility with the Google Admin Console, nor standard technical support: if you need these, you can pay $20 per device per year for an

BELOW You can install multiple operating systems on a single USB stick with Ventoy

Converting your laptop into a Chromebook means you can use familiar websites and online apps in a secure, lightweight environment

Education install or, for $49 per device per year, the Enterprise tier adds deployment and configuration support as well.

Build a NAS

If your household has multiple laptops and desktops, network-attached storage is a convenient way to keep shared files safely in one place – and you can easily turn an old computer to this purpose. Before you set off down this road, though, be warned that while dedicated NAS appliances invariably use multiple hard disks for RAID mirroring, most laptops only have a single drive, and if that fails you're likely to lose all the data that's stored on it. We'd recommend you never rely on a single-drive system as your sole repository of backups or shared data, and always thoroughly check the internal drive for faults before you start.

To do this, press Start and type "cmd" to show the command prompt icon, then right-click on it and select "Run as Administrator". When the prompt appears, enter **chkdsk c:** and, when it's finished running, check the line beside **bad sectors**. You want this to be zero: if it's anything else, run the **chkdsk** command again with either **/f** or **/r** appended to the end. **/f** tells it to fix errors, while **/r** tells it to both fix them and recover their data where possible. The disk needs to be locked to perform either of these operations, so you may be given the option to run them at the next reboot.
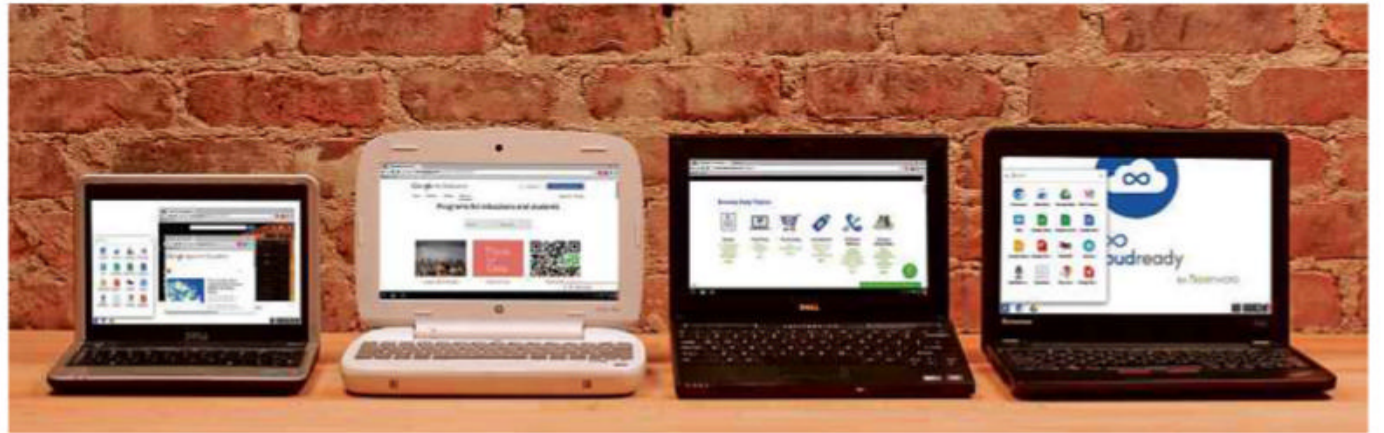
Once you're happy with the state of your disk you have several software options for setting up your NAS. The open-source TrueNAS (previously FreeNAS) platform is one of the most popular. It comes with a web interface and file-sharing tools built in, so it's ready to use right away, and it also supports plugins, letting you run apps such as Plex across your network.

TrueNAS installs as a standalone OS (it's based on the Unix-like FreeBSD system), so by installing it you'll be replacing Windows and giving over your old hardware entirely to running the NAS. The advantage is that this allows it to offer a wide range of features and protocols – including SMB, AFP, SSH and FTP access – without any need for you to worry about configuring a host operating system. It also supports full disk encryption, has built in SMART diagnostics and offers multi-factor authentication to keep your data secure. You can download it for free from **truenas.com**.

Host your own website

It's not normally necessary to run your own website. There are plenty of hosting services that will give you free webspace with a domain registration, or even offer an ongoing gratis tier. Hostinger (**hostinger.co.uk**) is one provider that offers free hosting in the UK, with support for WordPress, PHP and MySQL – and no adverts. Using a dedicated hosting service also means your website will always be available: you don't need to keep your own computer online 24/7 to serve up content, and visitors won't be eating up bandwidth on your personal broadband connection.

Even so, there are reasons to roll your own. It's a great way to learn about web technologies and hosting, and you have complete hands-on control over your content and the software you run, meaning you can use whichever languages and add-ons you like. It's easy too: all you need to do is set up port forwarding on your router and sign up for a free domain

If you're happy to leave your old laptop running all the time, you can play a role in researching treatments for diseases such as Covid-19

forwarding account (like the free tier at **noip.com**), which allows people to reach your home network by simply typing in your chosen web address. Just check the terms and conditions of your broadband contract to make sure this doesn't contravene your agreement and bear in mind that if you're on a metered connection a popular site hosted at home could end up costing you more than a dedicated remote-hosting deal.

When it comes to the actual web server software, you have several options. Microsoft's own Internet Information Services (IIS) is built into Windows 10: to enable it, click Start, search for "Turn windows features on or off", open the dialog, tick the box beside Internet Information Services and hit "OK".

We prefer the free XAMPP package (**xampp.org**) because it bundles the Apache web server, MariaDB database (which is compatible with MySQL), PHP and Perl, giving you everything you need to host either a static website or a database-driven one using platforms such as WordPress, Joomla, Drupal and MediaWiki. It's a breeze to use: you simply need to place your web-facing files in your site's home folder at c:\xampp\htdocs, and its various add-on features can be enabled with a click from the XAMPP control panel.

Dedicate it to research

If you're happy to leave your old laptop running all the time, you can play a role in researching treatments for diseases, including Covid-19. Foldingathome (**foldingathome.org**) allows you to contribute to massively distributed calculation projects that could lead to medical breakthroughs. Although you're not paid for your contribution, recent lockdowns have shown how important it is for everyone to play their part. This isn't something you have to dedicate your computer to: the software only makes use of spare processor cycles, so you can run it alongside tasks such as hosting web pages – the only cost is a tiny hit to your electricity bill.

To get started, download the Windows build of the Foldingathome client from **foldingathome.org/ start-folding** (or the Linux build if you've followed the steps above to replace Windows on your machine).

Destroy or donate it

If you really need to get rid of an old computer, consider donating your unneeded hardware, rather than dumping it. As we mentioned earlier,

ABOVE Windows comes equipped with its own built-in web server: IIS

not all charity shops will accept computers, but there are dedicated IT recycling options in the UK.

Revive IT (**reviveit.co.uk**) will collect unwanted IT gear and recycle what it can, while guaranteeing 100% destruction of any confidential data. That's a good guarantee to have: data security isn't just a consideration for businesses, but is key for personal computers too, which may have been used for online shopping, banking and so on. The service doesn't only accept laptops, but also phones, monitors, printers and more.

Another option is the Restart Project, a nationwide organisation that finds new homes for unneeded computer kit with students, refugees, job seekers, families in need and others. You can find a list of locations at **pcpro.link/317restart**, along with details of the kind of hardware and peripherals they can take.

Finally, if you have a school nearby, consider making a direct call. With children increasingly being home-educated due to both local and national lockdowns, and many care givers out of work for similar reasons, there's never been a more pressing need for donations.

If you're going to hand over a computer yourself, make sure you have removed any licenced software from it, along with any personal data. If possible, use a certified data removal tool such as Blancco Drive Eraser (**pcpro.link/317blancco**). ●

How much
RAM
do you
really need?

Is it worth springing for the maximum memory allocation? **Darien Graham-Smith** explains how to understand Windows' memory usage and work out your personal requirements

When it comes to RAM, the traditional advice is to buy as much as you can afford. These days, though, paying for the largest available memory option could mean wasting a lot of money.

To be fair, a typical PC running Windows XP might have shipped with just 256MB of RAM, so switching between applications often meant a tedious and noisy wait while Windows shunted the active program's dataset onto your hard disk and loaded the information required for the incoming one into memory. Increasing the RAM was a quick way to make your system more responsive – you could easily quadruple the base allocation before experiencing diminishing returns.

Thankfully, we're not in that world any more. Most modern systems come with at least 8GB of memory, plus fast SSDs that make virtual memory access far swifter. Even so, the suspicion that more RAM is always better persists.

There are a few reasons for this. One is the simple fact that many laptops are offered in both 8GB and 16GB variants. The mere existence of a larger option sparks a certain anxiety as to whether the smaller allocation will be enough – and that's heightened by the fact that it's almost never possible to add extra memory to a laptop after purchase, should you subsequently find yourself wishing for more headroom.

Then there's good old human pride. Some computers are bought explicitly for a lightweight role, but those of us who dabble in fields such as photo or video-editing often like to think of ourselves as power users, whose technical demands must naturally exceed those of the average computer user – even though, in reality, we may see very little benefit from investing in extravagant amounts of memory.

If you fall into that category, however, it's forgivable. It can be hard to know how much memory you really need, not least because various technologies in Windows make the question rather more complicated than looking at a single number.

Memory management

Whether you're swimming in RAM or getting by on a minimal provision, Windows uses a few clever techniques to make the most of whatever resources are available. We've already mentioned virtual memory, but it's worth being clear that the OS doesn't necessarily move entire applications around each time you press Alt+Tab. Components and libraries that aren't immediately needed may be left on the disk until they're called for; this means that even when an application is nominally in the foreground, part of it could still be residing in virtual memory, freeing up physical memory for other tasks to run at the same time.

Then there's memory compression, which basically works like file compression. If a program loads in a data file that consists of a billion zeroes, Windows is smart enough

THE MERE EXISTENCE OF A LARGER RAM OPTION SPARKS A CERTAIN ANXIETY
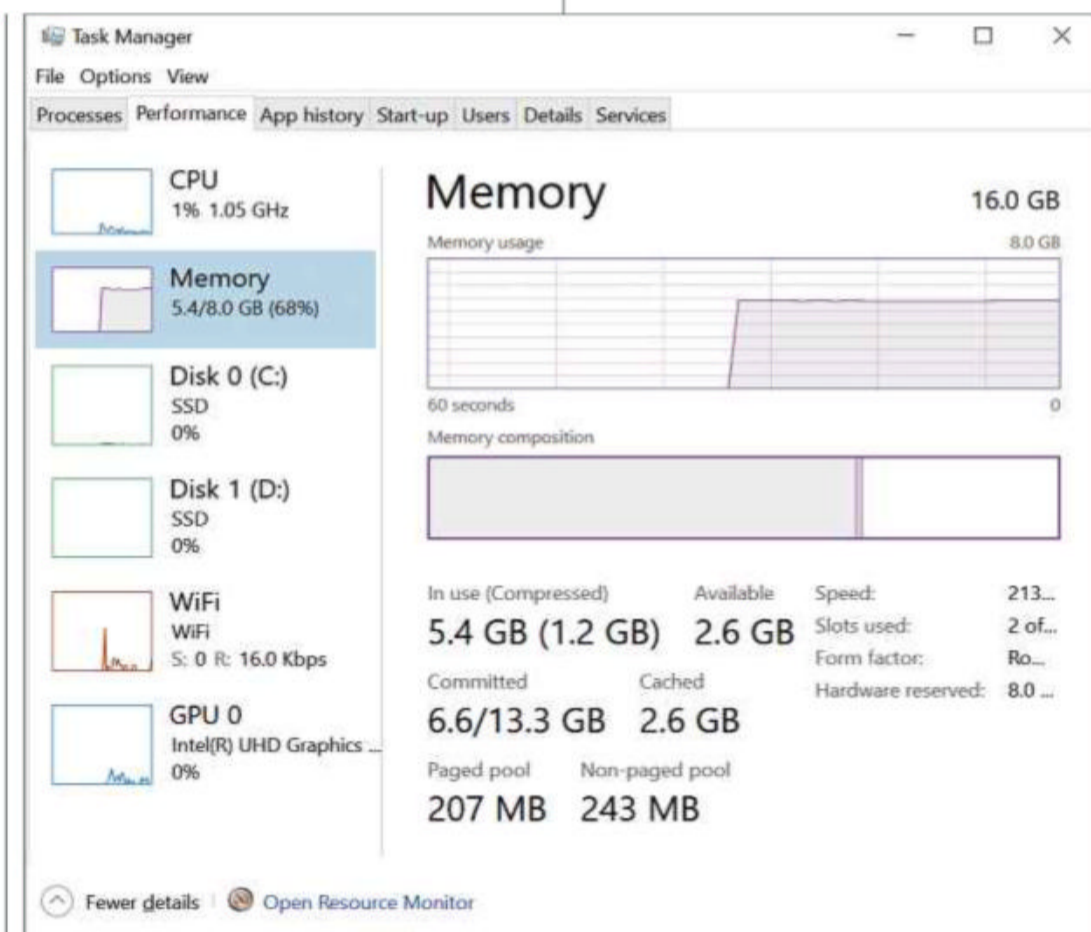
not to dedicate a gigabyte of physical RAM to storing it: it can use simple mathematical techniques to squeeze a quart into a pint pot.

A third technology that muddies the question of memory usage is SysMain – known until 2018 by the jazzier name SuperFetch. This Windows service runs in the background and uses spare RAM to cache frequently used files and system components, so there's no need to wait for them to load in from the hard disk when they're needed. Memory used in this way isn't normally counted against your available RAM, as it's instantly ceded to any foreground application that needs it.

How is my RAM being used?

To check your own current memory situation, open the Windows 10 Task Manager and switch to the Performance tab. You'll see a little Memory graph on the left-hand side with a usage readout; on an 8GB laptop, this might say something like "6.6/7.8 GB (85%)". The available total is always slightly lower than the amount of RAM physically installed because some will be reserved for the graphics hardware and other devices.

Click on this graph and the main pane switches to show more memory statistics. A live graph shows what proportion of your physical RAM has been in use over the past 60 seconds, while the memory composition graph below gives an overview of what it's being used for. The purple bar at the left represents RAM that's currently in use by applications or the OS; to the right of that you may see a little bar that represents modified items in memory that need to be written back to disk before that part of memory can be flushed. Beyond that, a white block represents memory that's being used for caching items that aren't currently in use, and if there's any RAM left completely free, that appears at the right-hand end of the graph.

Below, you'll also see raw figures for how much RAM is actively in use, and how much is available; the figure in brackets represents how much of that memory is compressed, and if you hover your mouse pointer over the "In use" section of the memory composition graph, a tooltip will appear telling you how much space compression has saved you.

The "Committed" indicator, in the second row of figures, refers to the total amount of memory allocated to all your various running processes and applications. It appears as a pair

of numbers, such as the "6.6/13.3 GB" in our example screenshot on the previous page. The first figure tells you that 6.6GB has been committed; it's normal for this to exceed the amount of physical RAM installed as Windows will automatically swap things into and out of virtual memory as needed. The second number, 13.3GB, is the commit limit, which represents the combined total amount of physical and virtual memory that's available for programs. You don't normally have to worry about this because, by default, Windows will automatically expand the size of your on-disk virtual memory file as needed.

To the right of this you'll see a readout of "Cached" gigabytes – that is, storage in use by SysMain – and below are details about the paged and non-paged pool, which concern OS components that need to be kept in RAM and can't be moved into virtual memory. Unless you're a kernel developer, you can ignore these numbers. Finally, to the right, you'll see some information about the physical configuration of your RAM chips such as their form factor.

What's using my RAM?

You now know the total amount of RAM you're using, how much use you're making of virtual memory and how much spare RAM is being used to cache files and speed up your PC. What we haven't yet discovered is how much RAM your individual applications account for.

To get an instant overview of which programs are using the most memory, switch to the Processes tab and click on the header of the Memory column. This handily sorts the most demanding applications and tasks to the top of the list. However, while it shows current memory usage, that's only part of the story: as we've noted, the full commit size of an application could be much larger, depending on your virtual memory usage.

You can see the total memory committed to each process by switching to the Details view and enabling the Commit size column. This view has its own shortcoming, though, as it doesn't group processes together hierarchically – all your Chrome browser tabs appear as separate items, for example, making it a pain to work out the total amount of memory allocated to the application.

We recommend that you instead download the free Process Explorer tool, developed by Sysinternals, from **pcpro.link/317sys**. This presents a grouped Task Manager-like list of

your running processes, and includes a column called "Private Bytes" that shows the total size of each program's footprint in both physical RAM and the page file.

How much RAM is enough?

Finally, we come to… well, it's not quite a million-dollar question, but memory isn't free. While an 8GB DIMM kit for a desktop costs around £40, you can easily pay £100 or more to upgrade a standard laptop specification to 16GB. Is it really worth the investment?

This isn't the first time I've tackled this issue. Way back in 2011, I confidently stated in these very pages that, based on my own tests and experiments, 4GB of RAM was enough for Windows and your everyday applications to run smoothly. And I'm here today to tell you that, believe it or not, that remains true. The official system requirements for the 64-bit edition of Windows 10 call for just

2GB of memory, the same as Windows 7 required in its day, and typical desktop programs such as Word and Chrome don't normally add a huge amount on top.

I confirmed this by repeatedly running our standard desktop benchmark suite on an HP Elite Dragonfly laptop, and progressively reducing the amount of system RAM for each run. Happily, I was able to do this without physically prising the chips from the motherboard: you can artificially "remove memory" from a system using the **bcdedit** command – see **pcpro.link/317mem** for a guide. Don't use the old MSConfig tool, though: this is still built into Windows

RELATIVE PERFORMANCE IN PC PRO BENCHMARKS

Image editing (seconds) — LOWER IS BETTER

RAM	Value
16GB	95
8GB	95
4GB	97
3GB	100
2GB	108

Video editing (seconds) — LOWER IS BETTER

RAM	Value
16GB	1,331
8GB	1,342
3GB	1,346
4GB	1,348
2GB	2,008

Multitasking (seconds) — LOWER IS BETTER

RAM	Value
16GB	2,126
8GB	2,187
4GB	2,214
3GB	2,309
2GB	5,624

Overall benchmark score — HIGHER IS BETTER

RAM	Value
16GB	79
8GB	78
4GB	77
3GB	75
2GB	46

FOR THIS TYPE OF JOB, THERE'S LITTLE DIFFERENCE BETWEEN A 4GB SYSTEM AND A 16GB ONE

10, but it behaves erratically and could even leave your system unbootable.

Our benchmarks comprise three tasks: converting a folder full of 35-megapixel TIFF images to JPEG, transcoding a 12-minute 4K video to 1080p while applying various filters, and then doing both at once while playing a 4K video in VLC. The results (in seconds) are shown in the graph above, and the conclusion couldn't be clearer. For this type of job, there's little difference between a 4GB system and a 16GB one. In fact, you could go as low as 3GB without a major impact on performance.

Only when I dropped down to 2GB did Windows start to struggle.

Process	CPU	Private Bytes	Peak Private Bytes	PID	Description	Company Name
Lightroom.exe	0.69	3,405,668 K	9,157,904 K	9516	Adobe Photoshop Lightroom	Adobe Systems
MsMpEng.exe	0.06	263,192 K	711,592 K	6380	Antimalware Service Executa…	Microsoft Corporation
svchost.exe		172,420 K	197,512 K	4840	Host Process for Windows S…	Microsoft Corporation
SearchApp.exe	Suspended	129,800 K	144,748 K	8740	Search application	Microsoft Corporation
chrome.exe		88,804 K	123,872 K	7596	Google Chrome	Google LLC
chrome.exe		82,812 K	131,632 K	9416	Google Chrome	Google LLC
dwm.exe	0.10	64,432 K	81,140 K	1388		
TouchpointAnalyticsClientService…		55,924 K	56,268 K	2916	HP Touchpoint Analytics Clie…	HP Inc.
explorer.exe	0.03	55,132 K	64,092 K	5980	Windows Explorer	Microsoft Corporation
WinStore.App.exe	Suspended	50,408 K	68,308 K	2268	Store	Microsoft Corporation
SearchIndexer.exe		43,516 K	51,916 K	7780	Microsoft Windows Search In…	Microsoft Corporation
Microsoft.Photos.exe	Suspended	39,888 K	40,728 K	5792		
chrome.exe	0.02	35,508 K	63,688 K	7180	Google Chrome	Google LLC
dynamiclinkmediaserver.exe		35,152 K	35,916 K	8124	dynamiclinkmediaserver.exe	Adobe Systems, Incorporat…
chrome.exe		34,392 K	63,172 K	6020	Google Chrome	Google LLC
chrome.exe		33,856 K	42,140 K	684	Google Chrome	Google LLC

CPU Usage: 2.32% Commit Charge: 49.62% Processes: 182 Physical Usage: 67.51%
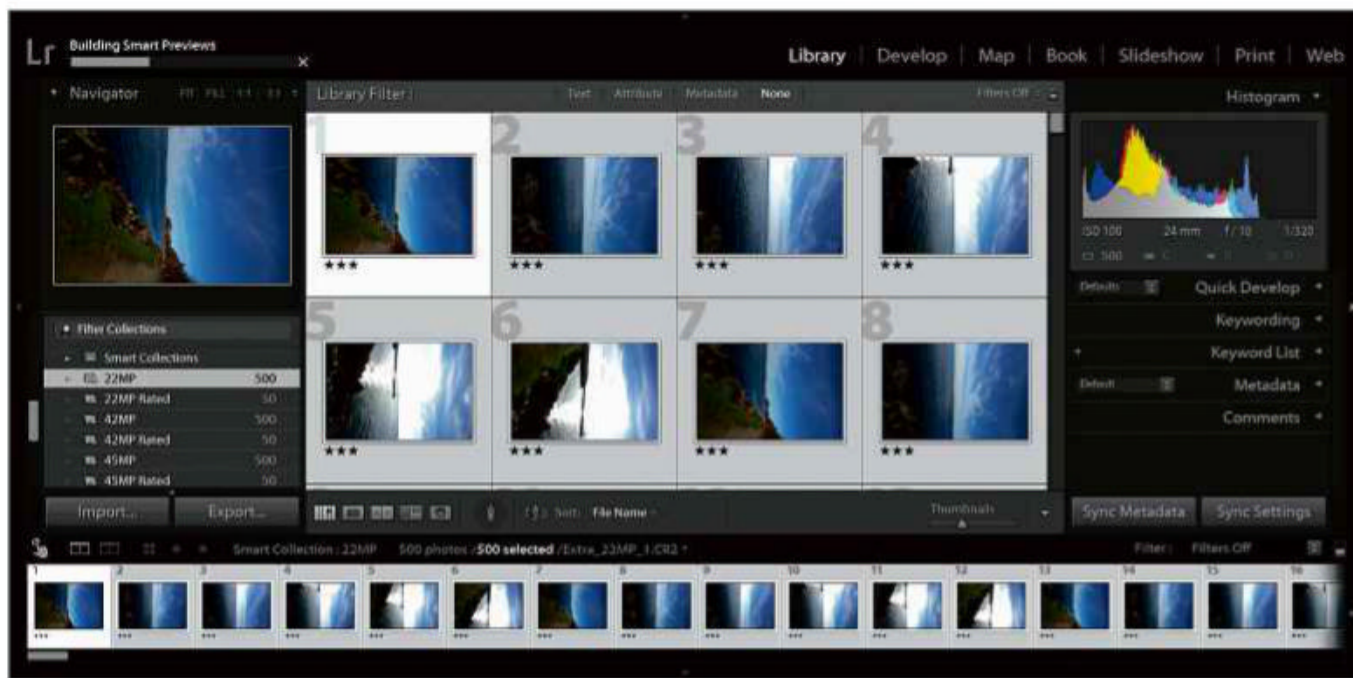
ABOVE **We tested RAM usage with the infamously greedy Lightroom Classic**

PUGETBENCH ADOBE LIGHTROOM CLASSIC BENCHMARK

Build 500 smart previews (seconds) — LOWER IS BETTER
- 16GB: 380 (784)
- 8GB: 914
- 4GB: 1,358

Create panorama (seconds) — LOWER IS BETTER
- 16GB: 62 (784)
- 8GB: 267
- 4GB: 358

Create HDR image (seconds) — LOWER IS BETTER
- 16GB: 42 (784)
- 8GB: 95
- 4GB: 108

Overall benchmark score — HIGHER IS BETTER
- 16GB: 586 (784)
- 8GB: 465
- 4GB: 433

Image-editing speed wasn't badly affected, but evidently at this point the system can't keep a big enough chunk of video data in memory at once to work on efficiently. It's also apparent that virtual memory, while less painful than it used to be, still has a big impact on performance. That shouldn't be surprising: according to the AS SSD benchmark tool, the NVMe SSD inside the HP Elite Dragonfly can read data at around 1.4GB/sec – which is a far cry from the 17GB/sec of its DDR4-2133 memory modules.

So don't panic if you're still using an 8GB system. With a clean install of Windows 10, that still leaves around 5GB of headroom for applications before performance significantly suffers. Indeed, if you mostly use your computer for typical productivity tasks, there's no urgent need for your next laptop to be a pricey 16GB model.

When more is more

This isn't to suggest that the extra RAM is never useful, however. One application that's frequently mentioned in this context is Adobe Lightroom Classic, which experienced photographers describe as notoriously memory-hungry.

To test this, I turned to a dedicated Lightroom benchmark created by workstation specialist Puget Systems (**puget.systems/go/154165**). This test loads 1,500 RAW image files and then carries out a range of procedures, including batch colour correction, HDR processing and exporting entire libraries of pictures in JPEG format. Officially, Lightroom Classic requires 8GB of RAM just to run, and 16GB is recommended; in practice, I found that the application worked with allocations as low as 2GB, although a minimum of 4GB was required to complete the tasks that involved merging multiple images together.

The first three graphs above show how long the benchmark took, in seconds, to complete a selection of photo-editing tasks with differing amounts of RAM available. I've focused on memory-intensive jobs – building smart previews for 500 freshly imported 42-megapixel RAW images, merging six of those images into a panorama and stacking six of them to create an HDR image. The final graph is for the overall PugetBench score, which shows the aggregate performance differential across the test.

Since each of the test images occupies no more than 100MB on disk, you might wonder whether these processes really require more than a few gigabytes of memory. In fact, I saw a clear benefit when moving up from 4GB to 8GB, and stepping up to 16GB had a significant impact on performance too. The speed boost is so transformative that Lightroom aficionados might well consider the upgrade worthwhile, even if it means paying several hundred pounds extra for a laptop.

The follow-up question is obvious: would you see a further benefit if you moved up to 32GB, as some systems allow? The only way to be 100% certain would be to get hold of such a laptop and try it out – but we can get a clue by looking at Lightroom's maximum commit size while running

THERE'S NO URGENT NEED FOR YOUR NEXT LAPTOP TO BE A PRICEY 16GB MODEL

the benchmark. This gives us an indication of whether all of the program's activity would have fit within the physical RAM available (assuming no other task pre-empted it) or whether it had to spill over into slower virtual memory.

The information we seek is helpfully exposed by Process Explorer in a column entitled Peak Private Bytes (*see the screenshot opposite*). This isn't visible by default, but you can activate it by right-clicking in the column header area, selecting the Process Memory tab in the dialog that appears and ticking the relevant box.
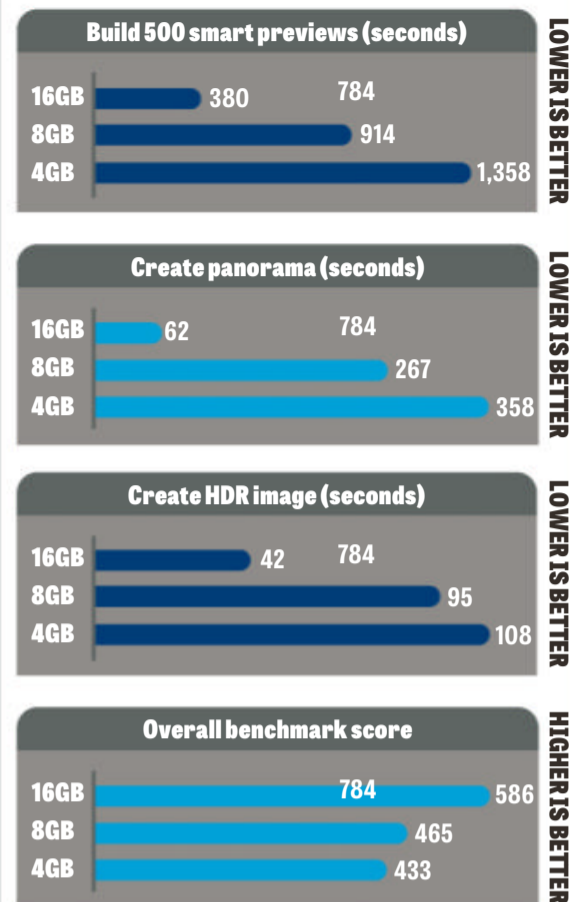
With my HP Dragonfly system restricted to 8GB of system memory, I found the peak charge shown for Lightroom was around 9.1GB, confirming some reliance on virtual memory. Enabling the full 16GB, however, gave the software enough space to stretch its legs: the peak commit size grew, but only to 12.6GB, which the hardware was comfortably able to accommodate. This suggests that, while adding further memory beyond 16GB might allow SysMain to speed things up a bit, it probably wouldn't yield another major performance jump.

Of course, this information only specifically applies to Lightroom, and to this particular workload – but if you're reliant on any demanding program then you can use the same technique to work out whether your own processes could benefit from a RAM upgrade.

You can also check the peak commit value of your entire system, which can be helpful if you frequently use lots of applications at once, or switch back and forth, and want to see if overall system performance could benefit from more RAM. To find this value, click on one of the graphs at the top of the Process Explorer window to open the System Information window, then switch to the Memory tab, which will show Current, Limit and Peak commit values in bytes. ●

Porsche Design Acer Book RS I7

A beautiful and compact laptop that packs a punch thanks to the new Intel Core i7, but you pay a big premium for the name

SCORE ★★★★☆

PRICE £1,583 (£1,900 inc VAT) from store.acer.com

This is a laptop of firsts. It's the first Porsche Design laptop we've reviewed, and the first machine that Porsche's design wing has produced in partnership with Acer. It's the first laptop we've seen with an 11th-generation Core i7 processor. And it's also the first outing for Nvidia's GeForce MX350 graphics.

However, what's most unusual about this laptop is its look. A carbon fibre finish on the lid is striking enough to gain stolen glances from across the train aisle and across the boardroom, with a honeycomb effect that looks far better in the flesh than words can describe or photos show.

BATTERY: video rundown, 9hrs 56mins

BENCHMARKS

OVERALL 135

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

BREAKDOWN SCORES
Image editing **170** | Video editing **127** | Multi tasking **128**
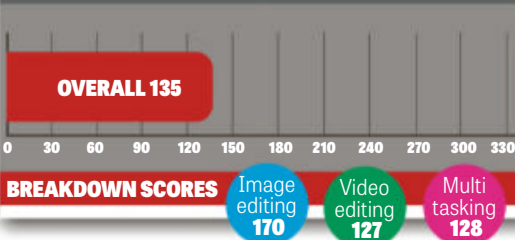
The rest of the design is more practical, with a magnesium alloy body that – a little unfortunately – resembles grey plastic from a distance. The fact that it's metal is obvious once you're hands on, with a sturdiness and coolness to the touch that emphasises the quality shown throughout the laptop.

Design isn't all about looks, though, and Porsche Design has nailed portability. A 90% screen-to-body ratio contributes to a compact design, measuring only 209mm from front to back when closed. With an 18mm thickness and 1.2kg weight, this laptop is tailor-made for life on the road. It helps that battery life is equally strong, surviving 9hrs 56mins in our video-rundown test. Naturally, you can charge via the USB-C port, although a more mundane proprietary charger comes in the box.

■ Quality throughout

Porsche Design plays it safe with the display, which is a high-quality 14in IPS touchscreen with a 1,980 x 1,020

ABOVE The all-metal construction gets the Porsche Design off to the perfect start

"It measures 209mm from front to back when closed. Add an 18mm thickness and this 1.2kg laptop is tailor-made for life on the road"

resolution; at this price, I hoped for at least 2,560 x 1,440. A glossy, anti-reflective coating diffuses overhead lights effectively, and a peak brightness of just over 400cd/m² means it can cope with every lighting condition other than direct sunlight.

A contrast ratio of 1,651:1 adds further punch, and it covers 99% of the sRGB colour gamut with excellent accuracy: an average of 0.3 and maximum of 1.02 means no human eye will spot any issues. The screen isn't designed for more adventurous colour spaces such as Adobe RGB or DCI-P3, covering 70% of them both, but films still look impactful.

The quality extends to the keyboard, which is both quiet and pleasant to type on. There's enough travel to make each keypress substantial, while the "feel" of the buttons is dampened so you don't have the impression of typing on jelly. I have only one bone to pick and that's

CPU COMPARISON

PC Pro benchmarks (overall) — HIGHER IS BETTER

	Score
AMD Ryzen 4750U	231
Intel Core i7-1165G7	135
Apple M1*	125
Intel Core i7-1065G7	100

Geekbench 5 (single-core) — HIGHER IS BETTER

	Score
Apple M1	1,704
Intel Core i7-1165G7	1,536
Intel Core i7-1065G7	1,215
AMD Ryzen 4750U	1,120

Geekbench 5 (multicore) — HIGHER IS BETTER

	Score
Apple M1	7,343
AMD Ryzen 4750U	6,449
Intel Core i7-1165G7	5,773
Intel Core i7-1065G7	4,121

Cinebench R23 (single-core) — HIGHER IS BETTER

	Score
Intel Core i7-1165G7	1,492
Apple M1	1,491
AMD Ryzen 4750U	1,207
Intel Core i7-1065G7	1,120

Cinebench R23 (multicore) — HIGHER IS BETTER

	Score
AMD Ryzen 4750U	8,108
Apple M1	7,087
Intel Core i7-1165G7	5,322
Intel Core i7-1065G7	3,488

*Apple M1 score in *PC Pro* benchmarks under Rosetta 2 emulation. AMD Ryzen 4750U tested in HP EliteBook 845; Intel Core i7-1065G7 in HP EliteBook x360; Apple M1 in MacBook Pro.

the placement of the PgUp and PgDn keys right next to the cursors. Hitting the key you want involves precision worthy of Lewis Hamilton.

My bigger complaint regards the touchpad. The main surface is smooth and responsive, but when buying a premium laptop such as this I expect the click of mouse buttons (built into the bottom of the trackpad) to sound and feel classy; instead, you're rewarded with an echoey click more reminiscent of a Fiat Uno than a Porsche Boxster.

Perhaps this is one reason Porsche Design is pushing a bundle of the RS I7 with its three-piece travel set (£2,100 inc VAT direct from **porsche**-**design.com**), which includes an elegant two-button mouse. This mouse carries through the laptop's carbon fibre design, which covers the left-click button, and is light and compact enough to sling into a bag. To nitpick once more, however, there's no off button, so it may accidentally activate your laptop during travel.

The other key element of the travel set is as curious as it is useful. Not the mesh fabric sleeve, which looks suitably professional and offers plenty of protection, but a magnetically attaching top that doubles up as a slim leather mouse mat. There's even a separate leather travel bag for the mouse and charger, which again clips on to the carry case magnetically. It's all very clever.

■ Power within

The real brains behind this operation is an 11th-generation Core i7 processor. While still based on a 10nm process, like the tenth-generation Core chips, a number of enhancements mean that these "Tiger Lake" processors can run all cores faster, and for longer, than their Comet Lake predecessors – and single-threaded performance has been hugely improved too.

For an instant comparison, the Porsche Design laptop scored 135 in our benchmarks compared to 100 for the HP EliteBook x360 on p48 – despite their processors having

ABOVE LEFT The keyboard has a quiet, satisfying feel, but the touchpad falls flat

LEFT The lid's carbon fibre finish wouldn't look out of place on a supercar's dashboard

similar on-paper specifications. That's an unprecedented jump. We saw a similar leap in Geekbench 5, from 4,121 in the multicore test to 5,773. And in Cinebench R23: from 3,488 to 5,322.

The same applies to single-core speed. The image-editing portion of *PC Pro*'s benchmarks best illustrate this, with the Porsche Design taking 61 seconds to complete this task compared to 76 seconds for the HP. In Geekbench 5's single-core test, the advantage was 1,536 against 1,215. And once more Cinebench R23 hammered home Tiger Lake's speed, with a score of 1,492 versus 1,120. Wherever you look, the new chip is 30% to 40% faster than its predecessor.

Comparing Tiger Lake to AMD's Ryzen 4000 series of processors tells a similarly positive, if more nuanced, story. In single-core tests, Intel holds a clear advantage. For instance, the HP EliteBook 845 powered by a Ryzen 7 4750U processor scored 1,128 in the single-core Geekbench 5, so around 20% slower than the Porsche Design. However, that AMD-powered EliteBook completed our photo-

editing test in 59 seconds, which is two seconds quicker. What's more, with eight cores and 16 threads to call upon, it scored 231 overall in our benchmarks and blasted to 6,279 in the multicore part of Geekbench 5.

Finally, for the sake of completeness, I should mention the Apple M1 chip, which was faster than them all in Geekbench 5 (1,724 and 7,476) and Cinebench R23 (1,491 and 7,087). The M1 isn't yet compatible with our benchmarks, so we don't have a true comparison here.

■ 3D speed

As mentioned at the start, this is our first chance to test Nvidia's GeForce MX350 graphics. The direct successor of the GeForce MX250, which we last saw in the Huawei MateBook 13 (*see issue 310, p62*), it has numbers in all the right places thanks to 640 shaders – compared to 384 for the MX250 and 448 for AMD's Radeon RX Vega 7.

Nvidia claims the MX350 is 2.5x faster than the UHD 630 integrated graphics found in an Intel Core i7-1065G7, but in this incarnation Nvidia's chip proved disappointing. In fact, in many tests it was slower than the MX250-powered MateBook: this averaged 45fps in *Metro: Last Light* at 1080p, while the Porsche Book only scored 36fps. And where the MateBook managed a paltry 11fps in *Metro Exodus*, the Porsche spluttered to a mere 8.5fps.

The MX350 was a modest 5fps faster than the MX250 in GFXBench's offscreen Car Chase test, 83fps against 78fps, but even after checking and rechecking for driver updates – and resetting the PC, just in case there was a hidden software problem – the inescapable conclusion is that this implementation of the MX350 is currently below par. I hope (and

GPU COMPARISON

GFXBench Car Chase (1080p offscreen, fps)

Intel Iris Xe	143
Nvidia GeForce MX350*	83
Nvidia GeForce MX250	78
AMD Radeon Vega 7	61
Intel UHD Graphics 630	36

HIGHER IS BETTER

F1 2020 (1080p, High, fps)

Intel Iris Xe	53
Nvidia GeForce MX250	50
Nvidia GeForce MX350*	47
AMD Radeon Vega 7	42
Intel UHD Graphics 630	12

HIGHER IS BETTER

Metro: Last Light (1080p, High, fps)

Intel Iris Xe	59
Nvidia GeForce MX250	45
AMD Radeon Vega 7	37
Nvidia GeForce MX350*	36
Intel UHD Graphics 630	16

HIGHER IS BETTER

Metro Exodus (1080p, High, fps)

Intel Iris Xe	14
AMD Radeon Vega 7	11
Nvidia GeForce MX250	11
Nvidia GeForce MX350*	9
Intel UHD Graphics 630	5

HIGHER IS BETTER

*GeForce MX350 results are probably not representative of this chip's performance, but are based on the results from the Porsche Design laptop. AMD Radeon Vega 7 tested in HP EliteBook 845; Intel UHD Graphics 630 in HP EliteBook x360; Nvidia GeForce MX250 in Huawei MateBook 13 (2020); Nvidia GeForce MX350 and Intel Iris Xe graphics in Porsche Design Acer Book.

expect) that it's a temporary problem that will be solved via an update, but it's still disappointing.

There is a crumb of comfort, however, and that's the quality of the Intel Xe graphics. Indeed, these are so good that it's questionable just how big a boost Nvidia's MX350 will be

once it starts working like it should. The graphs to the left should tell most of the story, but for the first point of evidence note the GFXBench Car Chase scores: a 143fps result is four times faster than the UHD 630 graphics found in previous mobile Core i7 processors, and almost double that of the GeForce MX250 – a discrete graphics processor, note.

I'm also impressed by its results in real games at 1080p. It's true that *F1 2020* and *Metro: Last Light* aren't the most demanding games, but results of 53fps and 59fps respectively show just how smooth you can expect gaming to be. That's a clear 11fps and 17fps better than the Radeon graphics found in AMD's Ryzen 4750 Pro processor, which I tested in the HP EliteBook 845 G7 last month (*see issue 316, p50*).

Metro Exodus proved a stretch too far (14fps), while *Shadow of the Tomb Raider* refused to run, but for the first time in many years, Intel's mobile processors have taken the 3D speed lead from AMD.

■ Final stretch

While Intel's newly discovered turn of pace is great news for the company, the 11th-generation Core processors are hardly unique to the Porsche Book – and I'm struggling to find convincing reasons to spend this much money on a laptop that only has design to make it stand out.

There are plus points: the 1TB SSD isn't just big but also fast, returning sequential read speeds of 2,213MB/sec and writes of 1,958MB/sec. The single USB-C port is similarly speedy, supporting Thunderbolt 4, and both USB-A ports support the fastest USB 3.2 standard. Add Wi-Fi 6, Bluetooth 5.1 and 16GB of RAM, and this machine ticks all the speed boxes.

Porsche Design and Acer could have further justified the price if the discrete graphics were meatier, with a GeForce GTX 1650 perhaps, and the laptop feels well-built enough to cope with the extra heat this produces. As it stands, though, the Porsche Design Acer Book RS I7 doesn't have a big enough engine to win the premium ultraportable race. **TIM DANTON**

> "I'm struggling to find convincing reasons to spend this much money on a laptop that only has design to make it stand out"

LEFT Lift the lid and the Porsche Design looks little different to many modern laptops

SPECIFICATIONS

Four-core 2.1GHz Intel Core i7-1165G7 processor ● 16GB DDR4-2133 RAM ● 2GB Nvidia GeForce MX350 graphics/Intel Iris Xe graphics ● 14in IPS touchscreen, 1,920 x 1,080 resolution ● 1TB M.2 PCIe SSD ● 2x2 Wi-Fi 6 ● Bluetooth 5.1 ● Thunderbolt 4 USB-C ● 2 x USB-A 3.2 ● HDMI ● 3.5mm jack ● 56Wh battery ● Windows 10 Home ● 319 x 209 x 18mm (WDH) ● 1.2kg ● 1yr RTB 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 our intensive set of benchmarks

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 one is excellent and likely to be difficult for the human eye to distinguish; between one and two is still strong; above this suggests a panel that you shouldn't trust for colour-accurate photo editing.
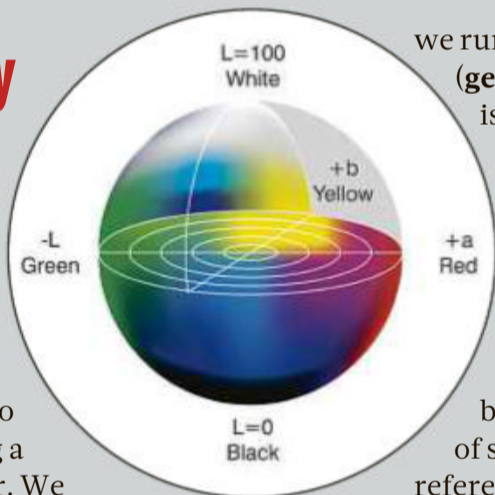
we run Geekbench 5 (**geekbench.com**). This is a good test of the processor and memory in particular, and includes both a test for single-core and multicore performance. See below for a selection of scores to provide a reference of what's good… and what's not so good.

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 with the device in Flight mode. We set the screen brightness to as close to 170cd/m² as we can get in its settings.

LEFT We use a Display i1 colorimeter to measure sRGB gamut coverage and Delta E

BELOW We play a video with the screen set to 170cd/m² to test battery life

Phones and tablets

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

Geekbench 5 (multicore)

		HIGHER IS BETTER
Apple iPhone 12 Pro		4,028
Apple iPhone 12 mini		3,736
Apple iPhone 11		3,417
Apple iPhone SE		3,291
OnePlus 8T		3,217
Google Pixel 4a	1,591	
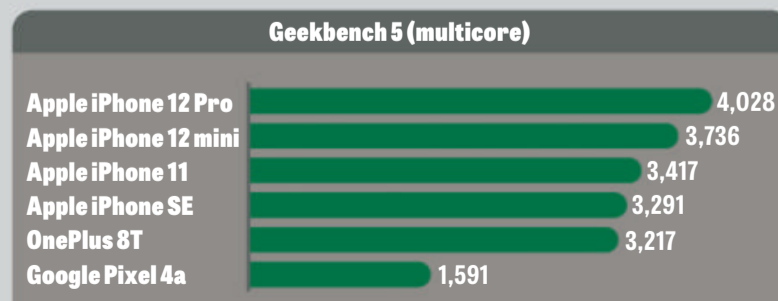
What our awards mean

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 p14. It's updated each month.

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

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

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

HP EliteBook x360 1030 G7

This flexible business laptop benefits from rock-solid construction, but you certainly pay a premium

SCORE ★★★★☆

PRICE Core i5/16GB/256GB, £1,389 (£1,667 inc VAT) from store.hp.com

If you can look past the branding, the HP EliteBook x360 has a surprising amount in common with the Porsche Design Acer Book on p44. They have an almost identical set of compact physical dimensions – right down to their 1.2kg weight – and feel similarly well built in the hand, thanks to an all-metal construction that should prove durable.

While the HP doesn't aim for style in the same way as the Porsche Design, it has an understated chic. An aggressive bezelled edge at the front makes it look slimmer than even a 16.1mm measurement would suggest, while the grilles on either side of the keyboard break up the monotony of silver.

The "sacrifice" compared to the Porsche Design is a 13.3in screen rather than 14in, with thicker bezels around its 1,920 x 1,080 pixels. Does this matter? In practice, no. It means the dot pitch is 0.1534mm rather than 0.1614mm, but I challenge anyone to notice this in general use.

What does affect readability is HP's Sure View technology. This is a clever way to stop people snooping on your screen – press F2 and it effectively becomes unreadable from the side – but it comes with a sacrifice to general

viewing angles too. You have to look at the screen perfectly head-on to enjoy a clear image.

One way to counter this is to push the screen to full brightness, in this case a spectacular 607cd/m² if you switch off the ambient light sensor. I found the most practical choice was to keep it at 100% brightness (using the Windows setting) but let the sensor take control. It proved to be a sound judge, keeping the screen at roughly 400cd/m² in my well-lit office.

Technically, it's an excellent screen, covering 95% of the sRGB gamut. With an average Delta E of 0.56 and 2,216:1 contrast ratio, it's punchy and accurate – but with that proviso of looking at it head-on.

The screen's other notable feature is its support for touch, and HP sent an Active Pen G3 (£55 exc VAT) for testing. This magnetically clamps to the side of the chassis with the same ferocity as a toddler to his mum on the first day of nursery, which means you can shove the x360 into a bag, with pen attached, and not worry about it disconnecting.

While the stylus works well, in tablet mode the x360 won't give Apple any cause for concern. Not only is 1.2kg heavy for anything you hold in one hand, but there's always the presence of the keys under fingers, while a 16:9 aspect ratio feels unnatural in tablet mode. It's too tall and narrow. Instead, the x360 works best in "tent" mode, either for displaying a presentation (the pen doubles as a remote control) or watching a film and enjoying the power from the speakers. These are

> "The stylus magnetically clamps to the chassis with the same ferocity as a toddler to his mum on the first day of nursery"

capable enough to set music going in the background too.

The mics built into the chassis pick up the spoken voice well (albeit with some reverb). What I fail to understand is why HP doesn't supply a better front-facing camera for video calls, with noise and a lack of detail both obvious when compared to a half-decent phone or tablet. HP has hinted that the next generation of its business laptops will include a far superior 5MP webcam, so this might be worth waiting for.

The processor is also likely to be improved, with the 1030 G7 featuring tenth-generation Core processors. My review unit included a four-core Core i7-10610U, 16GB of RAM and 512GB SSD, but this configuration isn't currently available for sale in the UK. Instead, there's a Core i5-10310U version with 16GB of RAM and a 256GB SSD for £1,389 exc VAT. It will be a smidgen slower than the Core i7 machine I tested, but I'm more concerned by the smaller SSD.

3D acceleration comes from the same built-in graphics chip whether you buy the Core i5 or Core i7, so you can expect similar performance here: a 33fps average in GFXBench's onscreen Car Chase test, with 29fps in *Dirt: Showdown* and 16fps in *Metro: Last Light*. A gaming system this is not.

In fairness, that's what you should expect from a business laptop, and with a battery life of 9hrs 53mins in our video-rundown test, support for Intel's vPro and an excellent three-year warranty for parts and labour – upgradeable to on-site for £79 exc VAT – it will fit neatly into any fleet of managed laptops. Before you buy, though, make sure the intended users will make use of the privacy screen on their travels or you'll be wasting money on a feature that in day-to-day use is a negative. **TIM DANTON**

SPECIFICATIONS (AS TESTED)

4-core 1.8GHz (4.9GHz burst) Intel Core i7-10610U processor ● Intel UHD graphics ● 16GB RAM ● 13.3in IPS touchscreen with HP Sure View, 1,920 x 1,080 resolution ● 512GB M.2 PCIe SSD ● 2x2 Wi-Fi 6 ● Bluetooth 5 ● 2 x Thunderbolt 3 (USB-C) ● 2 x USB-A 3.1 ● HDMI ● SIM slot ● 720p webcam ● 54Wh battery ● Windows 10 Pro ● 304 x 194 x 16.1mm (WDH) ● 1.2kg ● 3yr RTB warranty

BATTERY: video rundown, 9hrs 53mins

OVERALL 100

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

BREAKDOWN SCORES

Image editing	Video editing	Multitasking
137	93	92
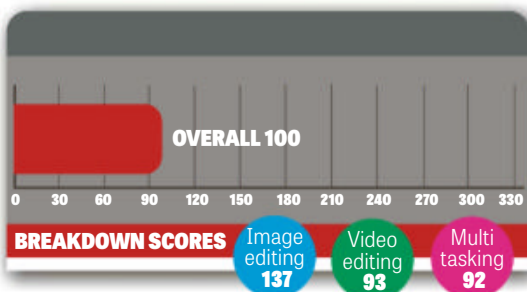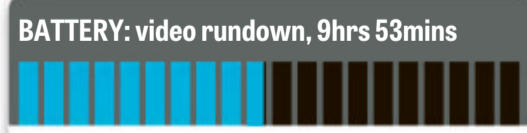
Avita Liber V 14in

A stylish laptop for an equally attractive price, but it's lacking the punch necessary to convince

SCORE ★★★☆☆

PRICE Ryzen 5, **£417 (£500 inc VAT)** from box.co.uk

Avita evidently believes th don't need to sacrifice de and build quality just because you don't have thousand of pounds to spend on a laptop, with this budget machine making a great first impression It isn't another cookie-cutter version of the MacBook, either, with a jet-black finish that gives it a style all of its own (it also comes in red or grey).

Avita describes the 1.3kg chassis as "mainly metallic" due to its plastic base, but there's more flex in the lid than is ideal. If you intend to take the Liber V on your travels, we'd advise buying a protective cover; Avita does include a lightweight pouch in the box, but it's there to protect against scratches rather than knocks.

One other design curiosity is the webcam module above the screen, but this is disappointing even by the low standards set by Windows laptops, with clipped highlights, fuzzy focus and poor colour accuracy.

That iffy colour accuracy extends to the 14in IPS screen. We measured an average Delta E of 5.15, which is an alarming result even for a budget laptop. Consider that its maximum Delta E was 22.3 and you'll realise just how off some of its colours are. Maybe this shouldn't be surprising when it can cover only 57% of the sRGB gamut. It's bright enough, hitting a 290cd/m² peak, but even a solid 1,076:1 contrast can't give photos or films any "pop".

If all you're looking for is a typing machine, though, you'll be happy with the display's clean whites, and the keyboard is surprisingly good for a budget laptop. There's plenty of travel

BATTERY: video rundown, 4hrs 57mins

BENCHMARKS

OVERALL 72

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

BREAKDOWN SCORES Image editing **104** Video editing **76** Multi tasking **58**

to each keypress with no hint of sponginess, and it's dampened enough to use in a train's quiet carriage without earning accusatory stares.

What's more, the huge touchpad is a bonus for anyone who has mastered Windows' gesture controls. It doesn't have the smooth glass finish of the best touchpads, but that's one of those things that you'll only miss if you've become used to it. Far more important is that it handles palm rejection perfectly, and if you connect a mouse via one of the two Type-A USB ports then you can switch the touchpad off via a shortcut in the taskbar.

Avita also squeezes in a USB-C port, HDMI output, microSD card slot and 3.5mm jack into the Liber V's slim frame, which is a solid selection. There's a fingerprint reader next to the Esc button too. Note that it's a generation behind the times for both Wi-Fi and Bluetooth, though, offering Wi-Fi 5 and Bluetooth 4.1.

The Ryzen 3500U is also one generation behind the latest AMD mobile processors, but this isn't an issue for a budget laptop. After all, the £550 Honor MagicBook 14 (*see issue 311, p65*) offers a near-identical spec and we judged its performance to be excellent for the price. Sadly, I can't say the same for Liber V as it proved to be slower in almost every test, and that's because it clamps down to 2.4GHz when pushed; the Honor's cooling system lets it go closer to the chip's 3.7GHz boost speed.

In Avita's defence, this is only notable after it has been pushed for a

ABOVE The keyboard and rugby pitch-sized touchpad are both a pleasure to use

> "Keep your expectations low and you should be satisfied with the Avita's performance. Never happy, perhaps, but satisfied"

BELOW There's a solid lineup of connections, including an HDMI and USB-C port

test and 3,019 in the multicore test, so within a whisker of its rival. But, when I immediately ran the test again, the multicore result dropped to 2,687. The difference was more marked in the longer and more intense *PC Pro* benchmarks, with the Avita's 72 score made to look paltry next to the Honor's total of 109.

Another reason for the gap is that Avita uses a SATA SSD while the Honor benefits from a significantly faster NVMe SSD: compare their scores in the AS SSD benchmark, where the Avita managed sequential reads of 510MB/sec and the Honor scored 2,456MB/sec. All this contributes to the Avita feeling occasionally sluggish in Windows 10, but I don't want to overplay this: keep your expectations low and you should be satisfied with its performance. Never happy, perhaps, but satisfied.

This laptop can play undemanding games too, thanks to AMD's capable integrated Radeon Vega 8 graphics. *Dirt: Showdown* is just about playable at 1080p, averaging 35fps, and the likes of *F1 2020* and *Metro: Last Light* reach the same mid-30s range if you drop down to 720p. Again, the better-cooled Honor is typically 10fps faster with the same graphics chip.

The final area where the Honor outscores the Avita Liber is perhaps the most important: battery life. There was a time when 4hrs 57mins of video playback would have earned a laptop praise, bu that was back when Tony Blair was in power. Now we expect eight hours or more, which the Honor duly delivers.

All these disappointing results mean that this Avita laptop falls short of a recommendation; when you can buy the Honor MagicBook for £50 more, the only obvious reasons to choose the Liber V are its styling and the lovely keyboard. **TIM DANTON**

SPECIFICATIONS

4-core 2.1GHz (3.7GHz boost) AMD Ryzen 5 3500U processor • 8GB DDR4 RAM • Radeon RX Vega 8 graphics • 14in non-touch IPS display, 1,920 x 1,080 resolution • 256GB SATA SSD • 1MP webcam • 2x2 802.11ac Wi-Fi • Bluetooth 4.2 • USB-C 3 • 2 x USB-A 3 • HDMI • microSD card reader • 3.5mm jack • 36.7Wh battery • Windows 10 Home • 318 x 218 x 17.4mm (WDH) • 1.3kg • 1yr limited warranty
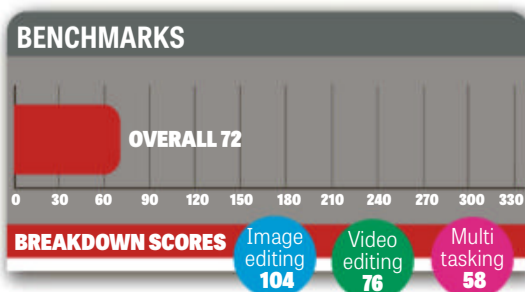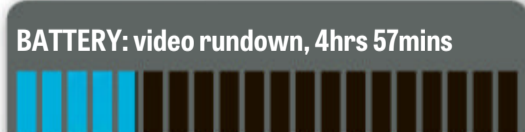
Dell XPS 13 (9310)

Hardly groundbreaking, but a solid update to the Dell XPS 13 thanks to Intel's 11th-generation silicon

PC PRO RECOMMENDED
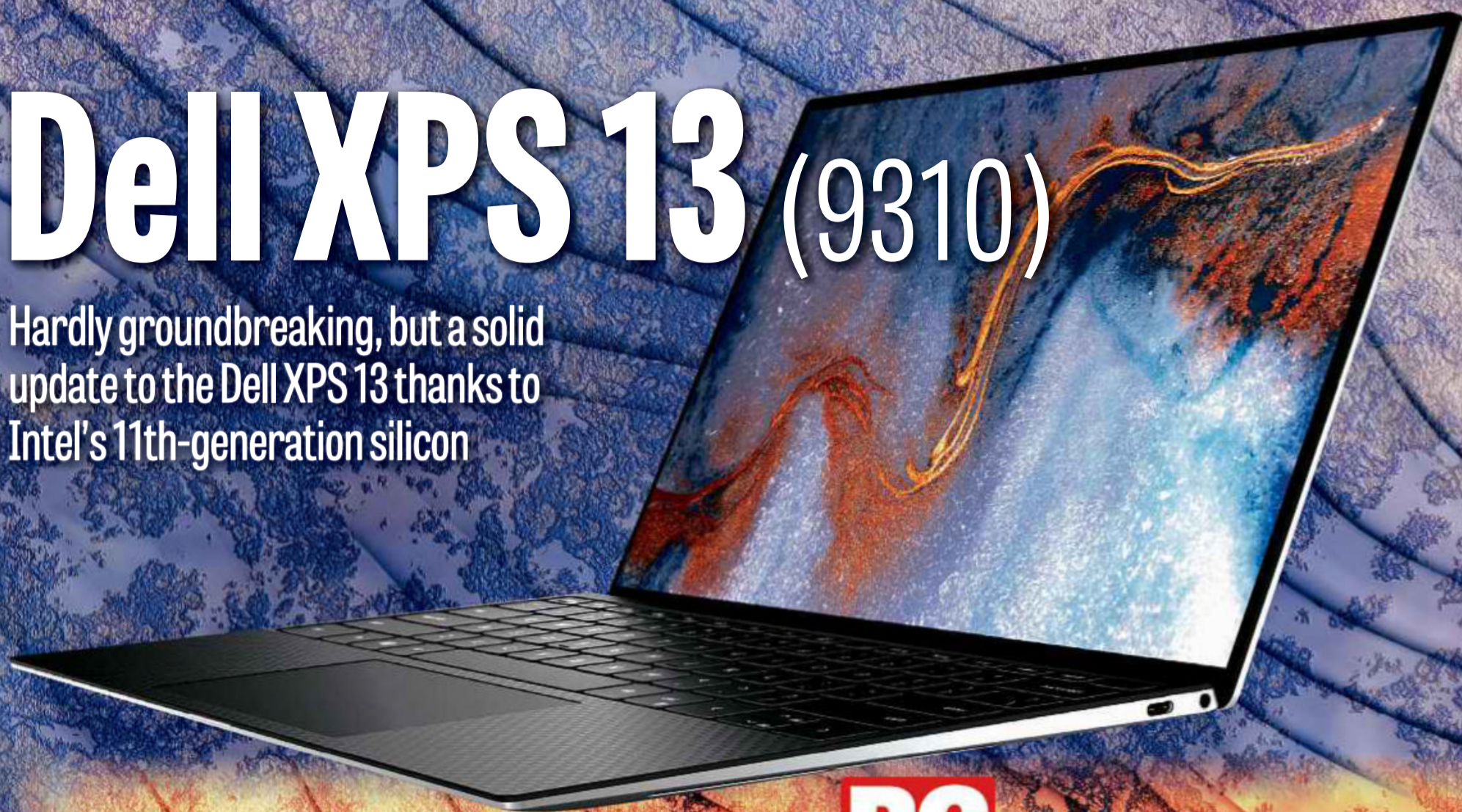
SCORE ★★★★☆

PRICE From £1,166 (£1,399 inc VAT) from dell.co.uk

The Dell XPS 13 needs no introduction. A stalwart of the ultraportable laptop scene, its appeal is simple: it's well-made, well-priced and comes in a wide range of configurations to suit people's needs and budgets.

Dell is also quick to update its flagship laptop whenever new Intel silicon comes along, and this latest XPS 13 is a reflection of that strategy: inside, you'll find 11th-generation "Tiger Lake" Intel CPUs.

What would otherwise have been a fairly unremarkable update has been cast in a more dramatic light by developments elsewhere. The debut

of Apple's first M1-based MacBooks makes this one of the most important updates to the venerable XPS 13 yet: can it defend itself from the combined might of the MacBook Air and Pro?

Choice upgrades

As the configuration table opposite reveals, the new XPS 13 is based around three different versions of the Tiger Lake processor. All include four cores with Hyper-Threading support, and all are based on the enhanced 10nm architecture discussed in the Porsche Design review (*see p44*).

The Core i5-1135G7 boosts from a 2.4GHz base up to 4.2GHz and has 8MB of Level 3 cache; the i7-1165G7 goes from 2.8GHz to 4.7GHz and has 12MB of L3 cache; and the i7-1185G7 includes the same amount of cache but boosts from 3GHz to 4.8GHz. All come with the Intel Iris Xe integrated graphics that so impressed us in the Porsche Design laptop.

Otherwise, it's familiar territory for XPS 13 fans. The laptops come with 8GB, 16GB or 32GB of LPDDR4x RAM, either a 512GB or a 1TB PCIe SSD, and a choice of 13.4in IPS screens: the non-touch 1,920 x 1,200 display or a 3,840 x 2,400 touchscreen.

ABOVE The design hasn't changed from the previous iteration, but it's still a winner

"The Dell XPS 13 remains one of the most attractive, well-built, usable and portable Windows laptops on the market"

BELOW As before, there's a Thunderbolt 4 USB-C port on both sides of the XPS 13

Nor does Dell attempt to gouge you on upgrades. Moving from 16GB to 32GB costs £150, which is the same as shifting from 512GB to 1TB of storage. The most expensive upgrade is the touchscreen, which costs £200 and isn't available on the Core i5 model.

Despite this flexibility, I can't ignore the M1 MacBook Air (*see issue 316, p40*). The 8GB model with a 512GB SSD costs £1,249, which is £150 cheaper than the similarly specified XPS 13, and while the MacBook can't offer 32GB of memory or a touchscreen, the 16GB/1TB option costs a competitive £1,649.

Static design

I can summarise the physical changes between this XPS 13 and the previous edition in one word: zero. But I don't think this matters. The XPS 13 remains one of the most attractive, well-built, usable and portable Windows laptops on the market.

The lid and base are covered with unyielding, attractive aluminium while the interior is clad in soft-to-the-touch carbon fibre. Given how stiff the chassis is, I've no complaints

BATTERY: video rundown, 11hrs 57mins

BENCHMARKS

OVERALL 120

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

BREAKDOWN SCORES

Image editing	Video editing	Multi tasking
163	118	107

Dell XPS 13	**Apple M1 MacBook Air**	**Apple M1 MacBook Pro 13in**
296mm	304mm	304mm
199mm — 14.8mm	212mm — 16.1mm	212mm — 15.6mm
1.2kg	1.29kg	1.4kg
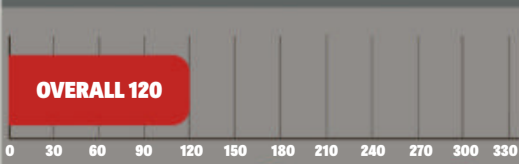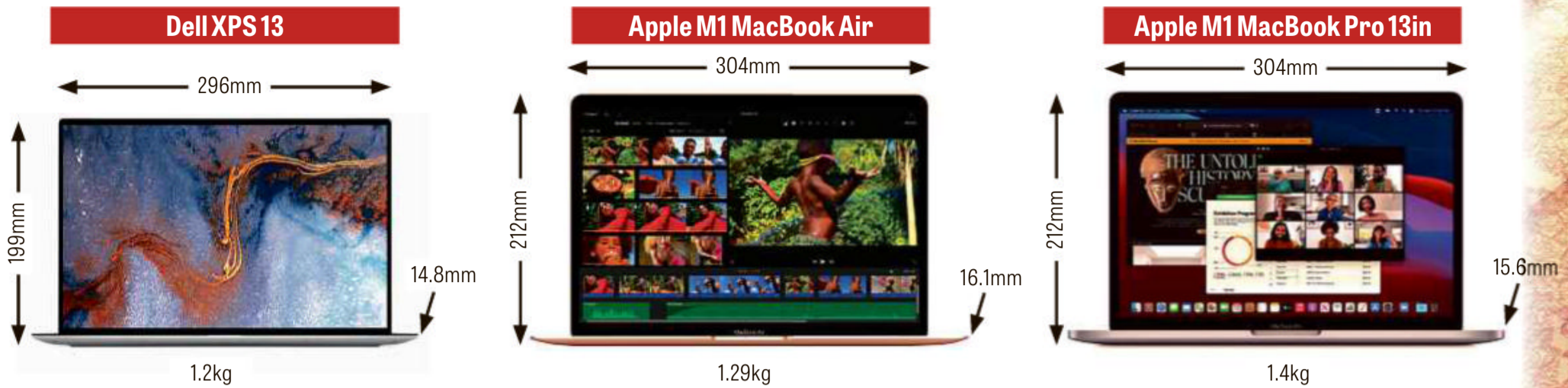
about its 1.2kg weight (1.27kg with the touchscreen) and it's as slim and compact as you could reasonably hope for, with the thinnest sliver of bezel surrounding the 13.4in display.

For reference, the XPS 13 beats the M1 MacBook Pro and MacBook Air here on all counts, although not by huge margins.

The XPS 13's keyboard is one of the best of any laptop. It has a German car door thunk to the keystrokes that feels just right. The layout is mostly perfect too, save for the fingerprint reader/power button in the top-right corner that shunts the Delete key left from its usual position.

The touchpad also works superbly, even if the MacBook Air and Pro offer more luxury than the mechanical diving board affair of the XPS 13.

Other physical attributes match the previous version of this laptop. There's a pair of Thunderbolt 4 USB-C ports, one on each side, plus a 3.5mm headset jack and a Kensington lock slot. Wireless connectivity comes via a Killer Wi-Fi 6 AX500-DBS adapter and Bluetooth 5. As with the M1 MacBook Air and Pro, there are no cellular options.

Good display
Our test model featured the non-touch 1,920 x 1,200 screen. I missed being able to tap buttons on a touchscreen, but this is more than enough resolution for a 13.4in panel. I like the 16:10 aspect ratio too: that extra squareness makes it more pleasant to work with than 16:9 displays, especially when you place two windows side by side.

The screen reaches a sunlight-friendly peak of 566cd/m², while a contrast ratio of 1,849:1 gives images real punch. It can't match the DCI-P3

colour coverage of the M1 MacBook Air, but it covers 98% of the sRGB colour space with excellent accuracy. Just make sure you fire up the Intel Graphics Command Center and turn off the various auto-contrast features for the best colour performance.

New generation
The Porsche Design laptop has stolen the XPS 13's thunder when it comes to the 11th-gen Intel Core processor, and as Dell sent us the mid-range model with a Core i7-1165G7 CPU and 16GB of RAM, I expected similar levels of performance.

While it didn't quite hit the same heights as the Porsche Design, scoring 120 overall in the *PC Pro* benchmarks compared to 130, that's still a big improvement over the 103 we saw from an XPS 13 with a tenth-gen Core i7-1065G7. And with an otherwise identical spec, the scores are directly comparable. In Geekbench 5's CPU tests, the improvement was 18% for single-core and 7% for multicore operations.

Intel's Iris Xe Graphics put in an even more impressive showing. In the GFXBench OpenGL graphics tests, it was 49% better than the Intel Iris Plus graphics in the previous-generation XPS 13 and not far off the much-lauded M1 MacBook Pro 13in.

It's just a shame that Dell hasn't squeezed an AMD Ryzen 4000 Series CPU into this laptop, as we'd love to see how fast the XPS 13 could push, say, the eight-core Ryzen 4700U.

Finally, Dell and Intel both deserve praise for improving battery life

"The XPS 13's 16:10 aspect ratio adds that extra bit of squareness that makes it more pleasant to work with than 16:9 displays"

compared to the previous generation of XPS 13, up from just shy of 11 hours to almost 12 hours in our video-rundown test. That pesky MacBook Air is still ahead, lasting for 12hrs 15mins, but it's a noteworthy step forwards nonetheless.

Final marks
As my regular allusions to the M1 MacBooks in this review make clear, the new XPS 13 – like all Windows laptops – has been put in the shade by its Apple rivals, which offer faster performance and superior battery life for less money.

Nevertheless, it's clear that Intel is fighting back. Its 11th-generation Core processors show obvious signs of progress and, as a result, this XPS 13 is a good notch better than its predecessor.

That doesn't change my overall thinking, though: if you don't mind which platform you operate on then you should switch to one of the new MacBooks. However, if you need to run Windows, the new Dell XPS 13 is a superb laptop on which to do so.
JONATHAN BRAY

SPECIFICATIONS
Four-core 2.1GHz (4.7GHz burst) Intel Core i7-1165G7 processor • 16GB 4,267MHz LPDDR4X RAM • Intel Iris Xe graphics • 13.4in 1,920 x 1,200 non-touch IPS display • 512GB M.2 NVMe SSD • 720p webcam • 2x2 Wi-Fi 6 • Bluetooth 5.1 • 2 x Thunderbolt 4 (DisplayPort and power delivery) • microSD card slot • 3.5mm jack • 52Whr battery • Windows 10 Home • 296 x 199 x 14.8mm (WDH) • 1.2kg • 1yr on-site warranty

THREE EXAMPLE CONFIGURATIONS

Processor	Memory	Storage	Display	Price*
Core i5-1135G7	8GB	512GB	1,920 x 1,200 non-touch	£1,399
Core i7-1165G7	16GB	512GB	1,920 x 1,200 non-touch	£1,649
Core i7-1185G7	32GB	1TB	3,840 x 2,400 touchscreen	£2,099

*Prices inc VAT and Windows 10 Home from **dell.co.uk**

3XS Studio Pro G124R

- AMD Ryzen 9 5900X
- 32GB Corsair DDR4
- 10GB NVIDIA GeForce RTX 3080
- 1TB M.2 SSD & 2TB HDD
- Microsoft Windows 10 Pro

From

£2,599.99 INC VAT

3XS Studio Pro G124R

- AMD Ryzen 9 5900X
- 64GB Corsair DDR4
- 24GB NVIDIA GeForce RTX 3090
- 2TB M.2 SSD & 4TB HDD
- Microsoft Windows 10 Pro

From

£3,699.99 INC VAT

3XS Studio Pro G132R

- AMD Ryzen 9 5950X
- 64GB Corsair DDR4
- 24GB NVIDIA GeForce RTX 3090
- 1TB M.2 SSD & 2TB M.2 SSD
- Microsoft Windows 10 Pro

From

£4,099.99 INC VAT

PC PRO ★★★★★ A-LIST

AMD RYZEN

SCAN S

HP EliteOne 800 G5

This tidy all-in-one packs a lot into its slim dimensions, with the added benefit of easy management

SCORE ★★★★☆

PRICE £882 (£1,058 inc VAT) from uk.insight.com (part code: 7AB90ET)

As anyone who has struggled with a laptop while working from home will agree, there are obvious advantages to an all-in-one PC. The screen is much larger and easier on the eye; a separate keyboard and mouse mean typing and navigation are both more accurate and less tiring; and you're also far more likely to have a superior webcam and speakers due to space no longer being at a premium.

HP delivers on this latter feature with a pop-up webcam that is indeed far better than that of an average laptop. Don't expect extraordinary detail, but video captured at its default 1080p setting looks crisp while offering natural colours. My only criticism is that you'll need to move closer to the screen than feels natural to fit fully into the frame, as its wide angle isn't best suited to solo videoconferencing. Also forget about using the camera to capture images, with detail sacrificed at the altar of compression.

The built-in microphones are more than good enough for calls, and while the speakers are heavy on treble I found them excellent for listening to music – equivalent to a sub-£50 Bluetooth speaker. Bass comes through more clearly than on most laptops too.

I was more disappointed by the keyboard and mouse. It's convenient that they're wireless (RF, rather than Bluetooth), but when you're paying more than £1,000 for a business PC to give to your staff you should expect better quality than the "HP Wireless Business Slim". I've seen more action in a monastery. The mouse, while lacking shortcut buttons, feels much better in the hand and has the advantage of being suitable for both left and right-handers.
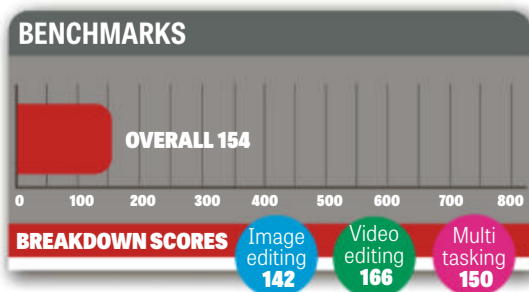
The final notable plus point of an all-in-one versus a laptop is the screen, and here you have a vista stretching over 23.8in. Again, you might think you deserve more than 1,920 x 1,080 pixels when paying this much, but you can still work side by side on documents; text simply looks fuzzier than it would with, say, a 1440p display. I suspect the supplied 1080p panel won't be a big issue for most people.

Many of the HP EliteOne G5 models on sale include a touchscreen, but the PC on test here (part code: 7AB90ET) uses a non-touch panel. This shouldn't be a problem, but for reasons best known to HP, only the touchscreen models of the EliteOne 800 G5 feature Windows Hello infrared webcams and Wi-Fi 6.

HP quotes identical specifications for both the touch and non-touch displays, including a peak brightness of 250cd/m². That's not great, but it seems that HP is being cautious here: the panel I tested hit 380cd/m².

It also performed well in our technical tests, covering 90% of the sRGB gamut with a contrast ratio of 1,156:1 and an average Delta E of 1.29. Delta E is a measure of colour accuracy, and anything less than two is a fine result – but note that its maximum of 3.25 is enough to push this all-in-one into dodgy territory for anyone who does creative work where colours matter.

Surprisingly, you have the option to pivot the screen 90°, and note that its height is adjustable: its bottom-most position is roughly a centimetre from the base, but it stretches

up 100mm to cater for varying heights and desk setups.

HP uses ninth-gen Core processors in the EliteOne, with the model on test featuring a Core i5 chip with six cores. You can buy eight-core Core i7 versions, but even with 8GB of RAM this PC rattles through office tasks. An overall score of 154 in *PC Pro*'s benchmarks is strong for a business system, even if it – along with a Geekbench multicore score of 4,579 – pales in comparison with the similarly priced desktop PCs in this month's Labs (*see p76*). There's little flexibility for after-hours gaming, as emphasised by a 12fps rate in *F1 2020*, but the high-quality panel and speakers ensure that films look and sound great.

This version of the EliteOne only includes a 256GB SSD, but at least there's a DVD writer built into the left-hand side for archiving and backups. You can also hook up external drives, with the fast USB-C 3.2 port on the panel's underside of particular note. USB-A ports abound too, while a wired Gigabit Ethernet port complements the Wi-Fi.

So where does this leave the EliteOne 800 G5? It's certainly no bargain, as you can buy the PC Specialist Aurora Mini (*see p83*) for £417 exc VAT and then a far superior 27in screen to go with it. However, a dedicated business all-in-one PC such as the EliteOne 800 is easier for businesses to manage – note the presence of a TPM 2 module and HP's "self-healing" BIOS – and it's backed by a three-year warranty that covers parts, labour and on-site repair.

If your priorities are ease of mind, ease of deployment and ease of use then the HP EliteOne 800 G5 is a solid choice. Anyone who has been crouched over a laptop for the past nine months will be delighted by the improvement to their working day.
TIM DANTON

ABOVE There's a lot to love here, including an excellent display and a pop-up webcam

> "You can buy eight-core Core i7 versions, but even with 8GB of RAM the HP EliteOne 800 G5 will rattle through office tasks"

BELOW The wireless mouse is pleasant to use – the shallow, slim keyboard less so

SPECIFICATIONS

6-core 3GHz (4.4GHz burst) Intel Core i5-9500 ● Intel UHD Graphics 630 ● 23.8in non-touch 1,920 x 1,080 IPS display ● 8GB of 2,666MHz DDR4 RAM ● 256GB SSD ● DVD writer ● 4 x USB 3.2 ● 2 x USB 3.1 ● USB-C 3.2 ● Gigabit Ethernet ● Wi-Fi 5 ● Bluetooth 5 ● 2MP webcam ● Windows 10 Pro ● HP Wireless Business Slim Keyboard ● HP Wireless Mouse ● 3yr on-site warranty ● 540 x 54 x 367-467mm (WDH) ● 6.1kg

BENCHMARKS

OVERALL 154

BREAKDOWN SCORES
Image editing 142 | Video editing 166 | Multi tasking 150
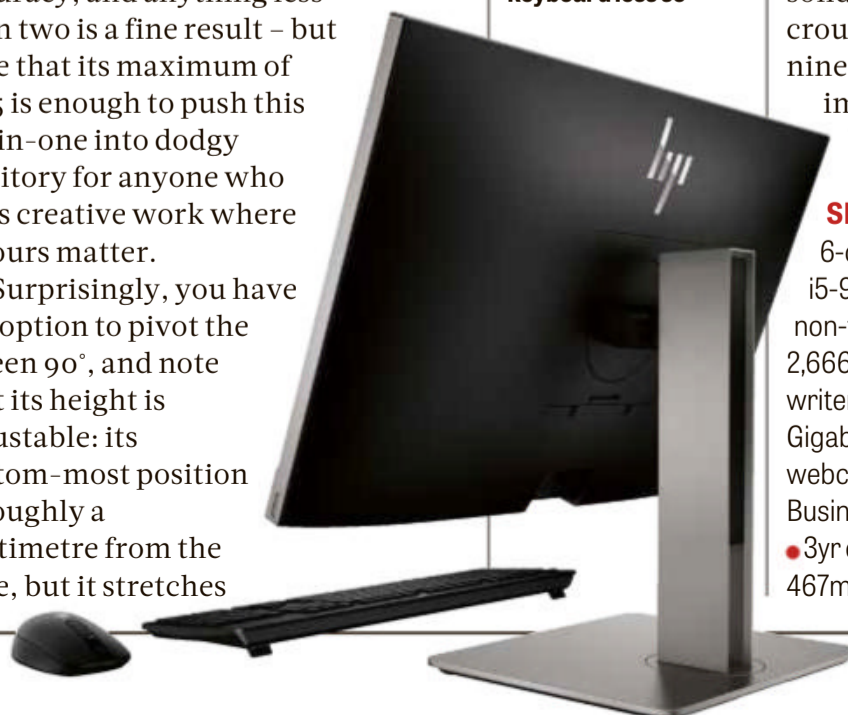
EXCLUSIVE OFFER:
Bitdefender Family Pack 2021

2YR/15 LICENCES

PC PRO ★★★★★ A-LIST

GET TWO YEARS OF PROTECTION FOR UP TO 15 FAMILY DEVICES FOR JUST £29.99, SAVING 80% ON THE RRP

2YR/15 LICENCES £29.99

THANKS TO BITDEFENDER, keeping all the computers and mobiles in your home secure just became a lot easier. The aptly titled Bitdefender Family Pack 2021 includes 15 licences, providing protection for you and your loved ones' devices – and we've got a great deal that will give you two yea of protection for just £29.99, saving £120 on the current RRP!

This deal – available for a limited period only – isn't made at the expense of security, either. Bitdefender is a renowned security product that won the 2019 AV Comparatives "Product of the Year Award" and a *PC Pro* Labs (*see issue 306, p76*).

What sets Bitdefender Family Pack 2021 apart is its flexibility in allocating slots to different users. You set yourself up as the master account holder, then add family members through email invitations, allowing them to set up their own private accounts and keeping them out of yours.

Not only does Bitdefender Family Pack 2021 allow you to allocate slo individuals via their own accounts, it supports up to 15 devices – far mor generous than the competition – including Windows and Mac com plus Android and iOS mobile devices.

Bitdefender Family Pack 2021 is underpinned by all the o award-winning protection that Bitdefender is rightly re ow d . Windows users get access to Total Security 2021, with its core components such as antivirus, firewall and anti-spam, as well as proactive tools that offer protection against everything from ransomware and rootkits to online threats and zero-day exploits.

There are also tools for maintaining privacy, including an anti-tracker, a password manager, file encryption, VPN and parental controls. And if that wasn't enough, Bitdefender Family Pack 2021 includes a collection of tools to help optimise your PC's performance, including Startup Optimizer and Disk Cleanup.

Bitdefender Family Pack 2021 normally costs £149.99 for two years of protection for your entire household, but we've got a stunning time-limited deal that will cost you just £29.99 for the full two-year licence – that's 80% off the RRP.

Buy from the *PC Pro* store at pcpro.link/bitdefender

LG UltraGear 27GN950

A stunning 4K screen with all the RGB trimmings, but you'll need a colorimeter to take full advantage of its talents

SCORE ★★★★☆

PRICE £624 (£749 inc VAT)
from currys.co.uk

In a world where Nvidia charges £1,500 for a consumer graphics card, LG's £749 asking price for a 27in gaming screen doesn't seem so crazy. Especially when that monitor offers a 4K resolution, refresh rates up to 144Hz and compatibility with AMD FreeSync Premium Pro and Nvidia G-Sync. For the occasions when you want to watch films rather than play games, there's VESA DisplayHDR 600 certification.

But it's gaming where this screen excels, with a vividness that's a world apart from everyday IPS monitors. There's a richness to colours that will make futuristic, neon-lit worlds look exactly like their creators intended. Naturally, LG adds some RGB bling for good measure, but unlike MSI's curved 34in Optix MPG341CQR (*see issue 313, p87*), which included a strip of lights on the front, the LG supplies its LEDs as a colour ring at the rear.

There are plenty more features for gamers, including a choice of crosshairs, four colour presets and extra control over response times: Normal, Fast and Faster. This screen also supports LG's Black Stabilizer technology to lift details in dark corners, as well as its answer to input lag: Dynamic Action Sync (DAS) mode. DAS mode can only be switched on and off, but you can take fine control over Black Stabilizer and may find it more useful than adjusting contrast or brightness.

You access all these controls from a nippy OSD controlled by a mini joystick built into the underside of the screen. It reminds me of an old-style IBM TrackPoint, complete with the option of pressing to select – which you need to do once you've settled on an option. There's also a scroll wheel

to the right of the joystick that you can use to switch between presets for the LED colour ring, but LG offers its Control Center software if you want to take full control.

That software is a nice-to-have. What's vital to download, if you happen to own a colorimeter such as the X-Rite i1 Display Pro, is LG's Calibration Studio. With both software and hardware in place, you can calibrate the monitor to colour spaces such as sRGB and Rec.709. And it's well worth doing: in the monitor's preset sRGB mode, it covered 98% of the sRGB gamut with 126% volume, while the average Delta E was 1.73 and the maximum was a poor 5.14. Ideally, you want Delta E to be under one and the volume percentage to match the coverage or the display will show colours outside of the designated gamut.

After I'd calibrated to sRGB mode, it covered 95% of the gamut with 95% volume, while average Delta E dropped to 0.45 and the maximum to 1.32. Those are stunningly accurate results. What's more, it almost perfectly hit the target colour temperature of 6500K with a 6513K measurement.

You can also calibrate to the panel's "native" colour gamut, which is essentially DCI-P3. Here, it covered 96% of that space with a volume of 100%, while Delta E

ABOVE Colorimeter or no colorimeter, this is an exceptional monitor for gaming

LEFT A scroll wheel underneath the panel lets you play with the *Tron*-style colour ring

LEFT There isn't tons of tilt, but you can adjust the height by 110mm

"There's a richness to colours that will make futuristic, neon-lit worlds look exactly like their creators intended"

stayed low with an average of 0.52 and maximum of 1.34. Again, that's an exceptional set of figures.

While it's annoying that you need a colorimeter to get the most out of this panel – LG should really be doing the hard work at the factory, even allowing for the fact that colours drift over time – it shows the quality of both the panel and the electronics that power it. And for anyone who doesn't care about colour accuracy, it won't matter a jot: they'll simply switch on this monitor and admire the rich colours.

Add a TV stick with HDR support and you can also enjoy the benefits of VESA DisplayHDR 600 certification. In theory, at least. While series such as *Our Planet* look superb on the LG, the HDR effect isn't as retina-searing as the VESA certification may lead you to believe. Despite LG's best efforts, the IPS technology inside this monitor is still no match for OLED when it comes to viewing high-contrast content.

Whilst in picky mode, I should point out that the HDMI ports are limited to 2 rather than 2.1. HDMI 2's more limited bandwidth means frame rates can't go beyond 60fps in 4K mode (at 8-bit colour), which is why you'll need to connect over DisplayPort to enjoy this panel's 144Hz refresh rate at 4K. Also note there's no USB-C connection, which reduces the usefulness of the two-port USB hub, although one will prove handy for powering a TV stick.

My final criticism will be less important to most buyers, but anyone who likes a flexible stand should note the lack of swivel on offer. I also like to see more tilt than the -10° and +15° here, but at least there's a respectable 110mm of height adjustment.

So the 27GN950 has its flaws, and you should note them all before spending this much money. That said, this is a high-quality and fast panel that makes games look gorgeous. From a gamer's point of view, it's far better to have that than a lesser 4K panel with HDMI 2.1, a USB-C connection and the world's most flexible stand. **TIM DANTON**

SPECIFICATIONS
27in 3,840 x 2,160 IPS panel ● up to 144Hz refresh rate ● 10-bit panel (1.07 billion colours) ● 1ms response time ● AMD FreeSync Premium Pro ● Nvidia G-Sync compatible ● HDR 10 ● VESA DisplayHDR 600 certified ● DisplayPort (HDCP 1.4) ● 2 x HDMI (HDCP 2.0) ● 2-port USB hub ● pivot ● -10° to 15° tilt (approx) ● 110mm height adjustment ● 609 x 291 x 461-571mm (WDH) ● 7.7kg ● 2yr warranty
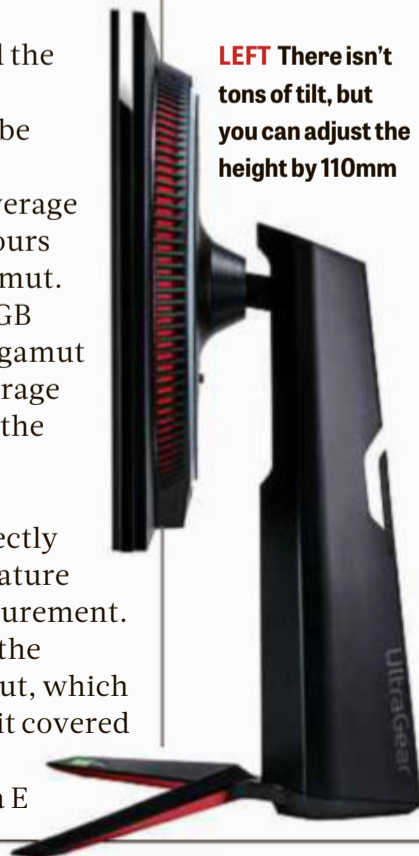
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Apple AirPods Max

With stunning audio quality and noise cancelling, these stylish headphones more than justify their price

SCORE ★★★★★

PRICE £458 (£549 inc VAT)
from apple.com/uk

When it comes to making great headphones, you have two basic design routes: straightforward analogue engineering, where you build miracles of precision constructio with only the best materials, or y take the digital route and rely on h power of digital signal processin (DSP) to work miracles.

Apple does both, combining a precision analogue build with a computational DSP for each headphone. They also tap into an array of mics (both inside and outside the cups) that use adaptive frequency response shaping of the in-ear soundfield to best match the incoming signal. It's a technological *tour de force* unlike any I've seen in my decades of testing headphones.

Each ear has ten cores of CPU power for all the processing work required, implemented on custom Apple H1 CPUs. But that's not all – imagine watching a movie on an iPad or iPhone, and having a 5.1 or Atmos soundtrack. Then let the headphone "binauralise" this to surround sound in the headphones itself. Then add in accelerometers to work out how your head is moving relative to the iPhone/iPad and then calculate the soundfield that tracks the screen as you move it around. The AirPods do all of that too.

Apple's next trick is to make all this work with zero input and twiddling from the user. (Heck, if you own more than one Apple device, switching between sources is seamless and automatic.) A typical pair of Bluetooth headphones comes with an app that offers a wide range of adjustment tools: EQ labelled Jazz, Voice, Smooth, Classical, as if good sound was defined by the genre.

Apple is having none of that. There are no adjustments aside from control over noise cancellation. There isn't even a power switch. Slide the headphones into the curiously shaped case that goes over the ear cups and magnets tell the headphones to switch down to an ultra-low consumption mode. Even this seems overkill when you consider that you will get around 20 hours of listening time. Plus, five minutes of charging delivers 1.5 hours of listening.

Such longevity is good news because all this quality means you'll want to wear them the whole day, and they're comfortable even over long periods; my ears didn't get too hot despite the fully-encased design of the ear cup. The build quality is beautiful, although time will tell how the matte paint will survive daily wear and tear. The ear pads detach and are held on by magnets; I'm sure some users will mix and match.

ABOVE The AirPods Max are comfortable, last roughly 20 hours and sound sublime

ABOVE Switching between (Apple) audio sources is a walk in the park

"Put on the AirPods Max and, after a second or two of the computers listening to the mics, the outside world just disappears"

What of sound quality? It's superb. t up there with the multi-thousand und Sennheiser HD800 or Stax l ctrostatics I use as my reference h adphones in the lab, but music is ar, clean and full of detail. Balance xcellent, without any of the h adache-inducing bass boost that me vendors impose.

Then we come to active noise ncellation (ANC). Cheaper adphones achieve effective results ng basic techniques, but truly ellent cancellation allows you to ten even at low volumes. ew things wreck hearing faster han hours of daily exposure to music played at 10/10 on a phone, ying to overcome the noise of the b s, train or underground.

With the AirPods Max, noise ncellation is staggering – class-l ding at over 50dB around 150Hz, ending usefully up to about 2kHz. them on and, after a second or two he computers listening to the ernal and external mics then doing t eir sums, the outside world just disappears. As in a nothingness where you can only hear your heartbeat. You need to turn Ambient mode on if you want to listen to someone shouting at you from 3ft away.

You must spend another £35 for the Lightning-to-3.5mm cable if you want to plug the AirPods Max into legacy sources – all the functionality works just as if it was on Bluetooth. There's a lot of technology in this cable, but when you're spending £549 for a pair of headphones it really should be in the box. Android users? They can connect to the AirPods Max as a normal set of Bluetooth headphones and enjoy all the onboard noise-cancelling technology, but spatial audio tricks are reserved for Apple owners only.

The Apple AirPods Max is the absolute cutting edge of headphone design and implementation. The only downside is the £549 cost, and whilst that is an undeniably robust price they are worth every penny. Their sound quality, active noise cancelling and utter simplicity form an intoxicating combination that sets new standards.
JON HONEYBALL

LEFT Want to make a statement with your headphones? There's a range of bold hues

SPECIFICATIONS
2 x Apple H1 headphone chips (one per cup) ● Apple dynamic driver ● active noise cancellation ● Adaptive EQ ● spatial audio with dynamic head tracking ● 9 x mics ● Bluetooth 5 ● up to 20 hours battery life ● Smart Case ● 169 x 83 x 187mm (WDH) ● 385g ● 1yr warranty ● requires Apple devices with latest OS
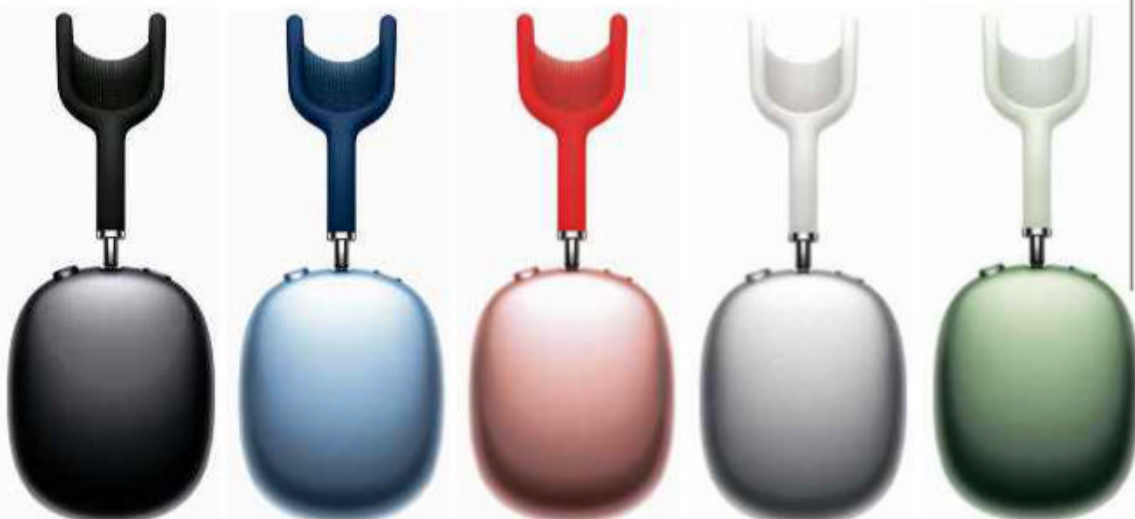
HP USB-C Dock G5
A hefty and useful hub that has a definite place on modern desks

PRICE £109 (£131 inc VAT)
from store.hp.com

To be as clear as Dominic Cummings' diary, this is not a portable hub. It's designed to sit permanently on your desk, with a chunky power supply that you should ideally keep hidden from view. After all, one of the benefits of a dock such as this is to keep your workspace clear of cable clutter.

One cable the Dock G5 should immediately replace is your laptop's power supply, providing a charge of up to 100W – although the company's specifications say that its maximum is 75W on non-HP machines. Either way, that's enough for all but the most powerful laptops, and note that HP emphasises the hub's suitability for a "mixed PC environment" (including most MacBooks).

With a compact footprint, all you then need worry about in terms of cable management are the connections from the rear of the dock. In theory, that could be quite a few. There are two DisplayPorts and one HDMI output, with the single missing video output being USB-C; there's a USB-C connector, but that's only for data and power out (up to 15W). The dock can output to two monitors simultaneously, giving you the potential for a three-display setup if you include your laptop screen. One caveat, however: the dock can only drive one external monitor if you're using a MacBook.

I won't run through all of the connections, as that's covered in the specifications list below and the pictures tell the story, but note that the four Type-A USB ports – two of

ABOVE The G5 dishes out 75W – enough for all but the greediest non-HP laptops

BELOW Plentiful video ports mean you can output to two displays at the same time

which are on the side – support USB 3, rather than USB 3.1 or 3.2. Data transfers are still quick – I copied across a 3GB file in 10.7 seconds, compared to 4.8 seconds over USB 3.2 – but this nonetheless feels like a missed opportunity.

With companies having a nasty habit of charging £200 or more for their docking solutions, I was pleasantly surprised to see HP settling on a more realistic £109 exc VAT for this versatile USB-C dock. There's also much to please IT managers, with the ability to push firmware updates to laptops via the dock and integrated asset management. With so much to please end users as well, this is one of those rare cases where win-win seems an apt phrase. **TIM DANTON**

SPECIFICATIONS
USB-C (front) ● 4 x USB-A 3 ● 2 x DisplayPort ● HDMI 2 ● RJ-45 ● 3.5mm combo jack ● 122 x 122 x 45mm (WDH) ● 680g ● 1yr warranty ● supports Windows 7, Windows 10 and macOS

Logitech Ergo M575 Wireless Trackball
A welcome update to Logitech's ergonomic range with quality in the right areas

PRICE £38 (£45 inc VAT)
from store.hp.com

Let's hope that users of wireless trackball mice are patient sorts, as they've had a ten-year wait for this successor to the M570. This isn't to say Logitech has left people who desire ergonomic mice in the lurch for a decade, as it's released the MX Vertical mouse and the MX Ergo Wireless in the meantime, but both of those cost north of £90.

This, then, is a more affordable option, and it's true that it doesn't have the "deluxe" feel of an MX mouse; it's robust but plasticky. Logitech even boasts about its use of recycled plastic in the M575, with 50% of the graphite-coloured option

and 21% for the white version. It's also unashamedly designed for use with the right hand, with the whole point being that your hand wraps around it in a secure and supported manner. What's clever about this design is that it doesn't matter what size your hand is: your fingers will always rest naturally over the left and right mouse buttons, with your thumb over the trackball. It feels as natural as holding a ball in your hand, and Logitech is right to suggest that the way it supports your palm – making it comfortable to use for extended periods – is one of the biggest improvements over the M570.

If you're shifting from a regular mouse, the biggest change will be to your thumb movement, particularly when you're scrolling sharply downwards, where you lose accuracy at first. With practice comes greater control, however, and you may soon find yourself spinning away without even thinking about it. While there should be less gunk to clean off this ball than an old-style mouse rolling across a desk, you can wholly remove it from its socket. Try not to think about eyes as you do so.

BELOW The natural feel makes the M575 comfortable during long mousing sessions

LEFT Eco-clickers, rejoice: the black version is made from 50% recycled plastic

> **"It doesn't matter what size your hand is: your fingers will always rest naturally over the left and right mouse buttons"**

There are two programmable shortcut buttons, and the scroll wheel is clickable, but that's it for features. Connectivity is equally simple, with a choice of Bluetooth or the supplied Logitech USB receiver, but unlike the MX series you can't switch between different devices with the click of a button and there's no support for "Flow" (where you drag the mouse from one PC's screen to another if they both have Logitech Options software installed). Nor is this mouse rechargeable, instead relying on an AA battery that Logitech reckons will last for 18 months of typical use.

Compared to the likes of the MX Ergo Wireless, the Ergo M575 is basic, but it does the job it sets out to do well with no obvious flaws. Whether the improvements were worth a ten-year wait is a different matter. **TIM DANTON**

SPECIFICATIONS
Logitech Advanced Optical Tracking (up to 2,000dpi) ● 5 buttons ● supports Bluetooth LE and 2.4GHz RF ● 100 x 134 x 48mm (WDH) ● 145g ● 2yr warranty ● Logitech Options supports Windows 7, 8, 10 and macOS 10.14 and later

The secret to homeworking success

Give your work life a boost – and clear the clutter from your desk – with a dedicated screen

Less is not always more, particularly when it refers to homeworkers staring at their laptop screens all day. After all, laptops were developed for work on the move, not to be a permanent replacement for the carefully selected office setup they've replaced.

The irony is that we've seen all this before, when we shifted from fuzzy CRT monitors to sharp, high-resolution flat-screen displays. Academic papers from the turn of the century only confirmed what workers already knew by instinct: that they could achieve more by switching to a bigger, better display.

This is even more true in today's multitasking world, where we have become used to working on multiple documents side by side and reaping time-saving benefits as a result. Investing in a second screen to plug into a laptop makes yet more sense, as the homeworker can keep information always to hand on the smaller laptop screen and focus their main attention on a bigger screen with a higher resolution.

The move is made even more attractive thanks to the growing number of USB docking monitors, which means that many laptops no longer need to have a separate power source: simply connect the monitor to the laptop via a USB-C cable and it can charge the laptop and take advantage of the monitor's built-in resources, such as USB ports.

This means you can plug all the devices you need directly into the screen, effectively creating a docking station. You could attach your printer, keyboard and mouse – and then share these resources with any computer you attach to the monitor. You can even charge your phone via a USB port built into the screen and transfer data.

Many USB-C Philips monitors have an extra secret weapon: a pop-up retractable webcam. This can be tucked into the body of the monitor when not needed, removing privacy fears, but be always ready for the next video call.

Privacy isn't the only advantage of building a webcam into the top of a desktop screen rather than a laptop: it also provides a more natural shooting position. After all, capturing images from a position roughly level with your forehead provides a more pleasant view than a laptop's natural inclination to shoot upwards towards your chin and nose.

There are time-saving advantages too, as the webcams built into Philips' monitors support Windows Hello. That means you can automatically lock the screen when you walk away (using Windows 10's Dynamic Lock tool) and set it to unlock when it recognises your face.

The big question then becomes not whether to invest in a new screen, but how big should it be? Philips' range of USB-connected monitors now stretches to 13 monitors, with sizes up to 49in. The curved 32:9 display pictured above offers all the advantages of having two full-size monitors side by side without a bezel in the middle, and makes shifting between windows through minimising, resizing and moving a thing of the past.

Whatever size of screen you decide upon, whether you simply want USB docking or any of the rich features discussed above, Philips has a screen for you. From 24in to 49in, from flat to curved, they all come with the Philips guarantee of quality with a price that's right. To find the perfect screen for your needs, head to **www.philips.com/monitors**.

BELOW The pop-up webcams in Philips monitors will allay any privacy concerns

Huawei Mate 40 Pro

A mighty fine handset, but the lack of Google Play Services remains a critical stumbling block

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

Before you even think about adding the Huawei Mate 40 Pro to your shopping basket, it's almost impossible to ignore the warning signs. Carphone Warehouse, the sole UK supplier outside of Huawei's own stores, has placed not one, not two, but three bright-yellow warning notices on the Mate 40 Pro's buying page. You have some light reading to do before spending over £1,000 for one of these.

For, just like the P40 Pro (*see issue 309, p62*) and Mate 30 Pro (*see issue 302, p74*) before it, the Mate 40 Pro doesn't come with the same suite of Google apps as the rest of its Android-based stablemates. The Google Play store is missing in action too, again replaced by Huawei's own rather limited AppGallery.

So, why even consider buying it? First, due to the sheer impressiveness of the hardware on offer; and second, it gives you a chance to live a Google and Apple-free life.

■ Fancy your Mate

While the Mate 40 Pro only comes in a "Mystic Silver" paint job, unlike the variety of colours frequently offered by its competitors, it looks just as stylish as any phone on the market. As it should for this price.

Kicking things off, the gigantic 6.76in display curves dramatically around the left and right edges of the handset at an 88° angle. These curved edges also serve a practical purpose since they can be used to access a list of your most-used apps by swiping your finger from the edge into the centre of the screen.

In more good news, despite using the same screen curvature as last year's Mate 30 Pro, Huawei has also reintroduced the physical volume rocker on the right edge of the handset, which sits above the phone's red power button. The Mate 30 Pro's speaker

ABOVE The edges not only look good; you can also swipe them to access popular apps

BELOW Stopping to snap the roses? The cameras can over-brighten colours

volume could only be adjusted via a fiddly onscreen slider.

The selfie cutout at the top of the display is another welcome step forward. Ditching the obtrusive notch of the previous model, the Mate 40 Pro's dual-camera array is now neatly embedded in a horizontal cutout in the top-left corner of the screen.

On that note, should you decide to flip the phone over, not only will you be treated to a reflective mirrored surface but a view of the phone's three Leica cameras neatly arranged within a large circular disc.

■ Snappy dresser

While the cameras look similar to the Mate 30 Pro's camera arrangement, in practical terms they're more akin to the P40 Pro. It consists of a primary 50MP (f/1.9) camera, 12MP (f/3.4) 5x telephoto zoom camera and a 20MP

(f/1.8) ultrawide unit with a 100° field of view.

As ever, this busy arrangement of cameras creates a well-rounded shooting experience. No matter what you're photographing, you're able to switch between a large variety of zoom lengths on the fly, moving all the way up to a 50x hybrid zoom if you wish – although this isn't quite as effective as the "Space Zoom" found in the Samsung Galaxy S20 Ultra (*see issue 308, p60*).

It also helps that these are among some of the best pictures I've taken on a phone. In particular, the ultrawide and zoom lenses (at 5x optical magnification) are rich with detail, and I was especially impressed with how the Mate 40 Pro picked up the finer details in the image of a friendly coot swimming in the nearby canal (*see above*).

My only major criticism stems from the way in which the Huawei Mate 40 Pro handles colours. On more than one occasion, I would take a picture of the same scene twice, only to find that one image had more of a magenta tint than the other. I'm also not a huge fan of the Mate 40 Pro's auto exposure, which has a tendency to over-brighten the image.

The Mate 40 Pro's video credentials remain unchanged from the previous year's Mate 30 Pro, which means superb, fully stabilised 4K footage at 60fps. As a bonus, Huawei has fixed the frame-skipping issues that plagued its predecessor.

There's little to say about the dual selfie array, other than that it consists of a 12MP (f/2.4) main lens paired with a time-of-flight (ToF) sensor to create fancy blurred-background selfies.

Screen test
It will come as no surprise that the Mate 40 Pro's display is among the best in the business. It's a 6.76in OLED panel with a 1,344 x 2,722 resolution and 90Hz refresh rate. It also supports HDR10 playback on Netflix, Amazon Prime Video and YouTube.

But it's colour performance where the Mate 40 Pro really shines. You have a choice of two colour modes, but I recommend switching to the "Normal" profile: this targets the sRGB colour space and delivers a 0.9 Delta E colour accuracy average.

My only gripe is that the Mate 40 Pro's screen can't match for the iPhone 12 Pro for maximum brightness. Peaking at 455cd/m² in auto mode, it fails to reach the same levels of luminosity offered by the iPhone 12 Pro, and the differences between the two are noticeable when viewing darker scenes in *The Queen's Gambit*, say, on Netflix.

How fast?
The Mate series has always been the first to use Huawei's latest and fastest mobile chipsets, and the Mate 40 Pro is no different. Here, it's the new Kirin 9000, which is Huawei's first 5nm CPU – built using the same fabrication process as the Apple A14 and Samsung's upcoming Exynos 1080 – and consists of eight cores with a maximum clock speed of 3.13GHz. There's also 8GB of RAM and 256GB of fast UFS 3.1 storage, which can be expanded with one of Huawei's SIM-sized Nano Memory cards.

Unfortunately, and frustratingly, I was unable to run *PC Pro*'s usual selection of benchmarking tests. The combination of Huawei's limited app store and a locked-down handset (I was blocked from installing the Geekbench 5 and GFXBench APKs) meant

that I can't provide final figures in this review.

However, the good news is that the Huawei Mate 40 Pro is, based on real-life usage, blisteringly fast. It unlocks even before you blink that blink of an eye, juggles multiple applications with ease and runs the (admittedly lacking) selection of AppGallery games at fluid frame rates – without any noticeable dips in overall performance.

I can be more definitive about battery life and, once again, it's excellent news. Setting the screen's brightness to 170cd/m² with Flight mode engaged, the Mate 40 Pro's huge 4,400mAh battery lasted for 24hrs 51mins. This comfortably brings Huawei's flagship into the upper echelons when it comes to battery life, and no matter how hard or how often you use it during the day it should last the course.

Mate for life?
A day might come when I don't have to regurgitate Huawei's software failings in every single review of one of its phones, but in the case of the Mate 40 Pro, today is not that day. Huawei is trying its best to encourage app developers to move to its own storefront, but the current UK-specific list is sorely limited; for example, you won't find Facebook, Twitter or Instagram available for download.

Until such apps make an appearance, most people should heed those Carphone Warehouse warnings and give the Mate 40 Pro a miss. Especially when it costs this much money: if you don't want to spend £1,100 upfront, EE is currently the only UK network provider offering Mate 40 Pro contracts, and that will cost you £100 and £66 per month for unlimited data.

The Huawei Mate 40 Pro excels in numerous areas, but where it matters most – namely usability and access to familiar apps – it falls flat on its face. Still, at least it manages to perform a most spectacular cartwheel on the way.
NATHAN SPENDELOW

> **"The Huawei Mate 40 Pro unlocks even before you blink that blink of an eye and juggles multiple applications with ease"**

SPECIFICATIONS
8-core 3.13GHz/2.54GHz/2.05GHz HiSilicon Kirin 9000 5G SoC ● 8GB RAM ● Mali-G78 graphics ● 6.76in 90Hz AMOLED screen, 1,344 x 2,772 resolution ● 256GB storage ● Nano Memory slot ● triple 50MP/12MP/20MP rear camera ● dual 13MP/ToF 3D front camera ● Wi-Fi 6 ● Bluetooth 5.2 ● NFC ● USB-C connector ● 4,400mAh battery ● Android 10 (EMUI 11) ● 76 x 9.1 x 163mm (WDH) ● 212g ● 1yr warranty

Sony Xperia 5II

This "budget" version of Sony's Xperia 1 flagship loses a couple of features but emerges as the better phone

SCORE ★★★★★

PRICE £666 (£799 inc VAT)
from pcpro.link/317sony

Sony made a problem for itself by naming its main flagship the Xperia 1 and its mid-range model the Xperia 5. So, to differentiate this second generation of releases, the company has decided to add Roman numerals – confusingly, you're meant to pronounce them as "Mark 2".

The Xperia 5II, then, is the cut-down version of the Xperia 1II, which was launched in early 2020. What separates the pair is size and price, with the 5II considerably reduced in both. It also doesn't have wireless charging or the 4K screen, but that's all you miss out on while saving £300.

The 5II has an aluminium chassis pleasingly wrapped in Gorilla Glass 6. Sony continues its insistence on a 21:9 aspect ratio: it's 158mm tall and only 68mm wide, which is ideal if you like to use your phone with one hand but less ideal if you have short pockets (I found it poked out the top of mine).

The UK is only privy to the blue and black models of Xperia 5II, but I'm not complaining: the glass body catches the light superbly. It highlights lots of understated design elements, such as the sleek oval camera module or the Sony logo. As with most all-glass smartphones, it's as slippery as an eel and likely to slide off anything with a slight gradient. Thankfully, the Gorilla Glass 6 has so far proved resistant to cracks.

The 5II has a 6.1in OLED display with a 1,080 x 2,520 resolution, but its big draw is the cinematic Brava tech that runs through it. These are great for streaming not so much for regular TV shows where the thinner aspect ratio means that you end up with a truncated square of a screen.

Aside from that gripe, you get a vibrant and crisp display, particularly with its 120Hz refresh rate; scrolling through apps and pages is smoother than Angel Delight. The 21:9 ratio also works well for split-screen mode, where you get decent-sized sections for two different apps. If you still need to be convinced of the quality here, we can point to our calibrator tests. The 5II registered 100% sRGB gamut colour coverage, 119% colour volume and a peak brightness of 352 cd/m². Others are brighter, but that's still a cracking set of results.

Qualcomm's Snapdragon 865 SoC and 8GB of RAM ensures top-level performance – for example, it scored 3,409 in Geekbench 5's multicore test – but more importantly its 4,000mAh battery lasted for 22hrs 11mins in our looped video tests. Few phones can match that stamina, and even when I put it through a thrasher of a working day it lasted beyond 24 hours. When it came time to recharge, the 21W fast charge put 50% back in within half an hour.

Security isn't so impressive. There's a fingerprint sensor in the home button on the side of the device that works fine when you place your finger just so, but it's not as quick as other flagship phones. Just below it is something even more frustrating: a Google Assistant button sounds like a fine idea, but I accidentally pressed it almost every time I pulled this phone out of my pocket.

On paper, the Xperia 5II's three primary cameras look low spec as they're all 12MP, but they're actually quite brilliant. The setup features wide, ultrawide and telephoto lenses – plus an 8MP selfie camera – and while the numbers sound better on OnePlus or Samsung phones, the Xperia 5II can match them.

The 3x optical zoom is effective, the low-light shots are amazing, and neither show much graininess. Shots with a moving subject are also excellent, thanks to Sony's stabilising technology. All of which leads me to the Cinema Pro mode that uses all three lenses and offers a wide range of filters and enhancements for perfect videos.

Perhaps the best part of the 5II is the "Photography Pro" mode, which is an app that imports DSLR-like features. If you want full control over your shots, this is for you. You choose which lens you want, select brightness levels, shutter speed and more, just like you would with an actual DSLR.

Aside from its confusing name, there's little to dislike about the Sony Xperia 5II. I'd argue that Sony has built a "budget" version that's better than the original. You miss out on the wireless charging and 4K screen of the Xperia 1II, but in return you enjoy better battery life whilst still enjoying the Xperia's excellent video and photography modes.
BOBBY HELLARD

ABOVE The Xperia 5II's statuesque 21:9 aspect ratio makes it ideal for movies

"You get a crisp display, particularly with its 120Hz refresh rate; scrolling through apps is smoother than Angel Delight"

LEFT A dedicated button summons the Google Assistant – often by accident

BELOW Sony's Game Enhancer app lets you make the most of the cinematic screen

SPECIFICATIONS

8-core 2.84GHz/2.42GHz/1.8GHz Qualcomm Snapdragon 865 ● 8GB RAM ● Adreno 650 graphics ● 5G ● 6.1in 120Hz OLED screen, 1,080 x 2,520 resolution ● 128GB storage ● microSD slot ● triple 12MP/12MP/12MP rear camera ● 8MP front camera ● Wi-Fi 6 ● Bluetooth 5.1 ● NFC ● USB-C connector ● 4,000mAh battery ● Android 10 ● 68 x 8 x 158mm (WDH) ● 163g ● 1yr warranty
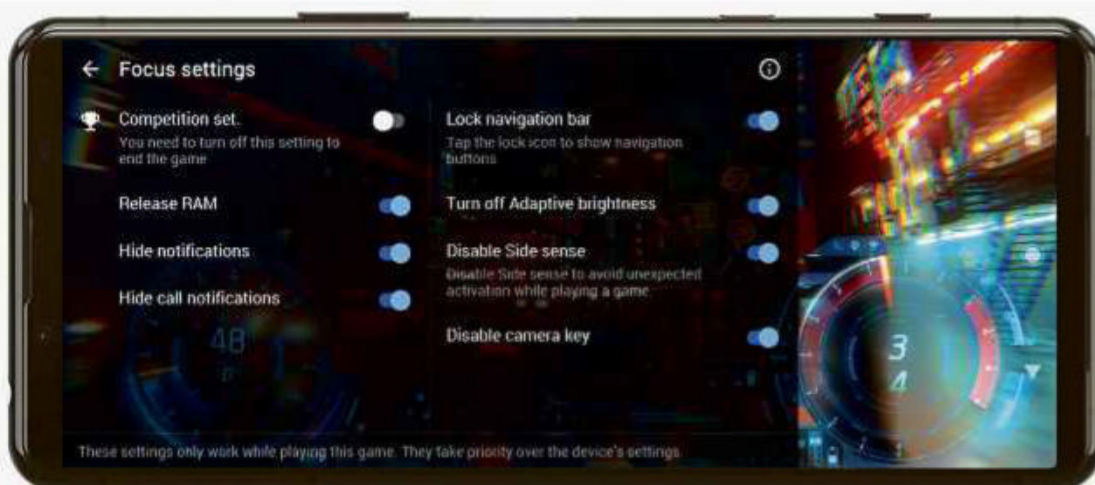
OnePlus Nord N10 5G

The second OnePlus Nord phone is a little cheaper but sacrifices too many of its predecessor's strengths

SCORE ★★★☆☆

PRICE £274 (£329 inc VAT)
from oneplus.com/uk

The first OnePlus Nord (*see issue 313, p62*) was OnePlus' attempt to recapture the mid-range ground it lost by focusing on more expensive flagship phones. The Nord N10 is its follow-up, costing £50 less with, it hopes, minimal sacrifices.

Externally, it's a struggle to find a difference between the two, although this new model is a millimetre or two larger than its sibling in width and height. However, below the surface, OnePlus has shaved its specification in several places.

Most notably, the N10 uses a Snapdragon 690 processor where the original had a Snapdragon 765. It also reduces the RAM to 6GB. Despite this, there's nothing between the two phones for day-to-day speed: the N10 scored 605 in Geekbench 5's single-core test compared to the original Nord's 606, and 1,866 in the multicore test versus 1,945. That's notably faster than the Google Pixel 4a (*see issue 313, p60*), which scored 1,591.

The difference in graphical performance is more pronounced. In GFXBench, the N10 recorded 33fps in the onscreen Manhattan 3 test and 37fps offscreen, which compares to 50fps and 56fps for the true Nord. In these tests, the N10 is neck and neck with the Pixel 4a.

per, the N10 also makes a big sacrifice by using an IPS panel rather than the AMOLED of the Nord. In practice, this isn't much of a sacrifice at all. A 1,668:1 contrast and peak brightness of 477cd/m² lend images instant impact, and it covered 98% of the sRGB gamut with an average Delta E of below 1.5. With a 90Hz

refresh rate, it's just as smooth an operator too.

In a marked transition from the norm, the Nord N10 only comes in one colour, "Midnight Ice": think dark, glossy grey; think plastic; think fingerprints. Still, the back curves gently to the sides, balancing nicely in the hand.

There are only two buttons around the edge: a power button on the left you can easily reach with your finger, and a volume rocker on the right for your thumb. The rear-mounted fingerprint reader is well positioned below the bank of cameras, which has been squashed into a squatter, more rectangular arrangement than the vertical column on the original Nord.

The front is mostly taken up by the screen, although its bezels are significant. The top bezel is a little thicker than the sides, and the bottom is bigger again. This gives the phone a lopsided look, but you can distract detractors by showing them the 3.5mm headphone socket, which its sibling lacks. The front camera occupies a hole in the top-left corner of the screen, nestled within the icons in the system tray.

OnePlus rates the Nord N10's battery at 4,300mAh so we hoped for more than 17hrs 53mins in our video-rundown test. That's notably short of the original Nord, which beat the 20-hour mark, and almost half the life of the Samsung Galaxy A31 (*see issue 312, p70*). Thankfully, OnePlus has still included its 30W Warp Charge technology, which the company claims will take your phone's battery from completely

empty to a day's worth of charge in only 30 minutes.

Perhaps not if you use the four rear cameras, and they will tempt you. The main camera unit is a 64MP sensor with an aperture of f/1.79, alongside an 8MP wide-angle camera with a 119° field of view and a f/2.25 aperture. Its macro lens is a 2MP model (f/2.4) and it also has a monochrome camera with the same 2MP (f/2.4) specification.

Taking a landscape shot in standard mode, the camera performed well: there's plenty of detail and the images are sharp with rich-looking colours. I'd say it's a match for the Google Pixel 4a here.

Switching between the main camera's 16MP and 64MP modes is achieved with a single button, which is located in the middle of the top menu. Tapping this reminds you of the limits of each mode, with the lower-resolution images supposedly offering improved high dynamic range to counter the benefits of higher resolution. The only difference I could discern between the two settings was an increase in detail in the 64MP images. When taking the same shot on the wide-angle setting, the results looked smudgy. Google wins for consistency, then, and also for selfies, capturing more texture than the N10's 16MP unit.

The original OnePlus Nord forged a brave path through tough mid-range competition, and it's still battling on. This makes the Nord N10 5G's job doubly tough, because it's only £50 cheaper, but has suffered a few minor cuts that start to stack up.

To make matters worse, it faces tough competition at every turn. If you're in the market for a better camera, for example, you might consider the Google Pixel 4a. For longer battery life, look to the Samsung Galaxy M31 instead.

None of this makes the Nord N10 a terrible phone, but it simply doesn't push hard enough against the boundaries of what we've come to expect from a mid-range phone to make it a must-have. **ANDY SHAW**

ABOVE The "Midnight Ice" colour wins full marks for poetry, but it loves fingerprints

> "In standard mode, the camera performed well: there's plenty of detail and the images are sharp with rich-looking colours"

ABOVE A discreet hole-punch selfie camera sits quietly in the top-left corner

LEFT The panel is IPS rather than AMOLED, but it's still a vivid and accurate performer

SPECIFICATIONS

8-core 2GHz/1.7GHz Qualcomm Snapdragon 690G ● 5G ● Adreno 619L graphics ● 6GB RAM ● 128GB storage ● microSD slot ● 6.49in IPS screen, 1,080 x 2,400 resolution ● quad 64MP/8MP/2MP/2MP rear camera ● 16MP front camera ● 802.11ac Wi-Fi ● Bluetooth 5.1 ● NFC ● 3.5mm jack ● USB-C ● 4,300mAh battery ● Android 10 ● 75 x 9 x 163mm (WDH) ● 190g ● 1yr warranty

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

Total value this month £107

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DiskImage also makes it a breeze to recover precisely the data you need. You can restore entire images, select individual files and folders, or mount an image in Windows and browse its contents as if it were a regular drive.
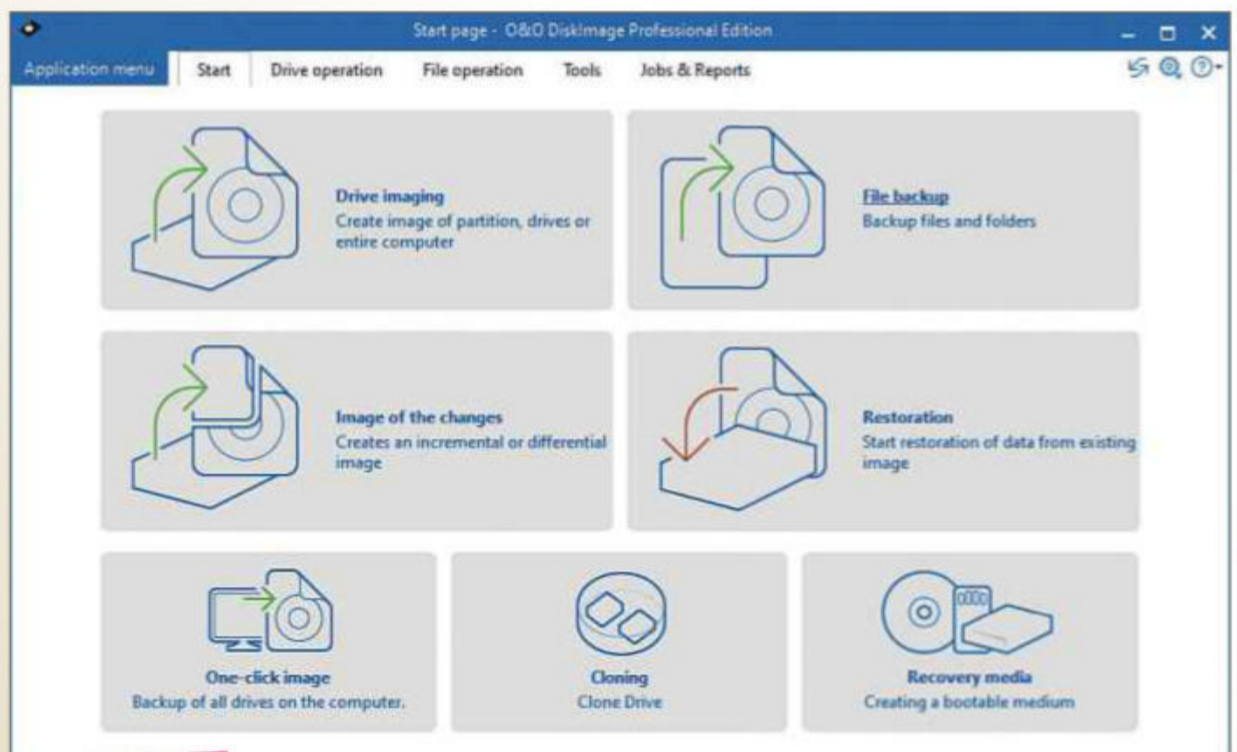
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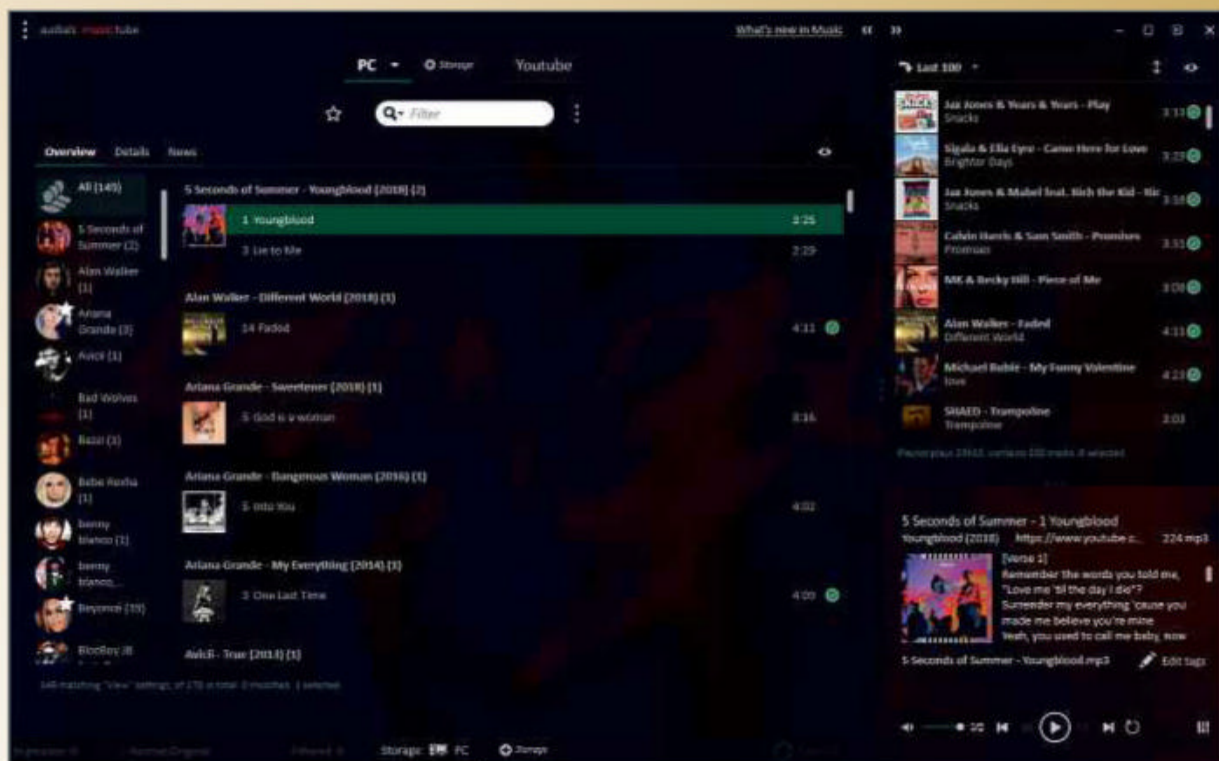
REQUIRES Windows 7 or later; 100MB hard drive space; in-application registration

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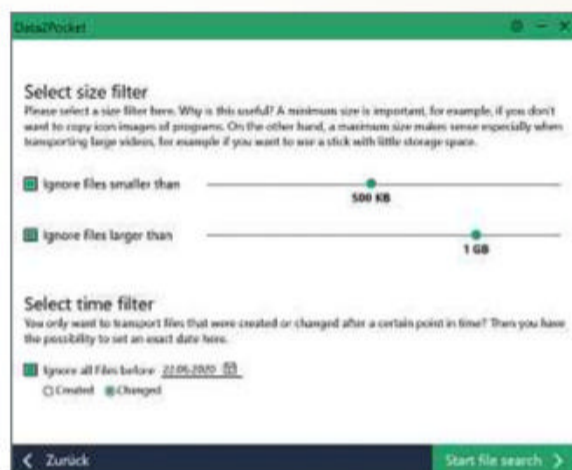
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■ **abelssoft.net**

REQUIRES Windows 7 or later; 50MB hard drive space; in-application registration

■ Make portable, external drives behave like cloud storage by quickly copying music, documents and more.
■ Configure the drives you want it to watch and it will copy matching files automatically.
■ Can also be used as a backup tool or when transferring data from one computer to another.

Ashampoo Backup 2021
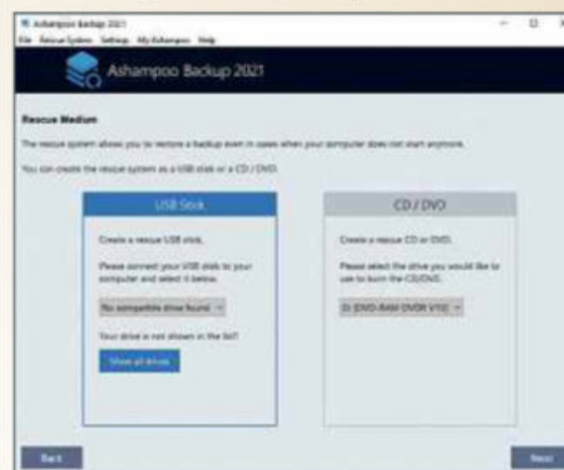
■ **Full product worth £10**
■ **ashampoo.com**

REQUIRES Windows 7 or later; 100MB hard drive space; in-application registration

■ Create a backup of your entire system – or individual files or folders – that can be restored whenever required.
■ Incremental backups help balance disk use and performance; scheduling keeps your backups up to date.
■ Light on resources, backups are updated in the background; supports disks larger than 2TB.

Iobit Uninstaller 10
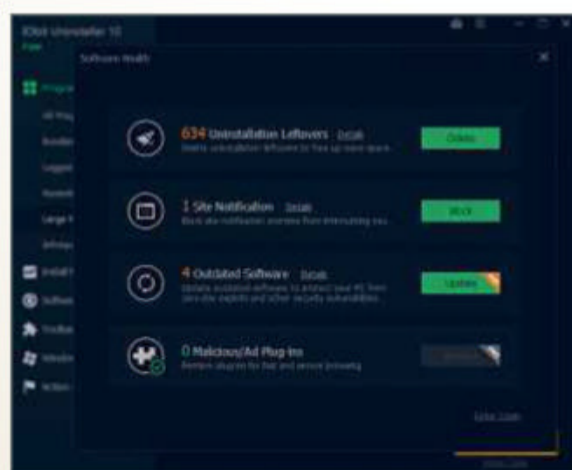
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■ **iobit.com**

REQUIRES Windows XP or later; 60MB hard drive space; online registration

■ Completely remove applications from your hard drive without leaving behind clutter and Registry entries.
■ Powerful scanning module goes beyond what applications' own uninstaller apps can target.
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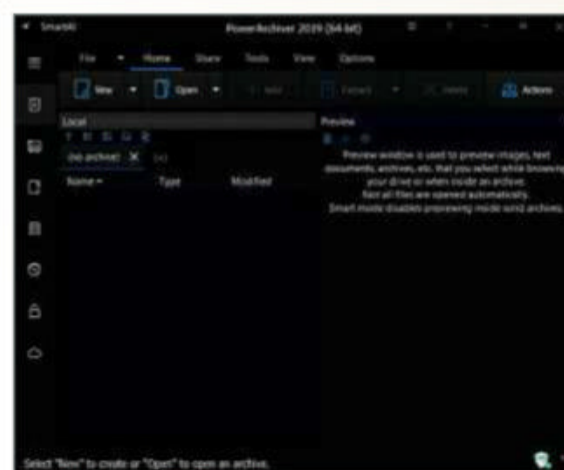
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■ **powerarchiver.com**

REQUIRES Windows Vista or later; 100MB hard drive space; online registration

■ This dedicated archiving tool handles a wider range of compression formats than native OS tools.
■ Supports high levels of encryption, with multiple methods for Adobe PDF and Microsoft Office documents.
■ Compresses files even when in use, and includes tools to repair archives and convert between formats.

D-Link DIR-X1860

There are faster and cheaper Wi-Fi 6 options, but don't rule out this solid and versatile router

SCORE ★★★★☆

PRICE £88 (£105 inc VAT)
from amazon.co.uk

Imposing, hefty, ostentatious… the D-Link DIR-X1860 is none of these things. This Wi-Fi 6 router occupies a modest 224 x 166mm footprint whilst weighing an insubstantial 525g. The case design isn't exactly boring, but with its simple curved shape and matte black finish it's no conversation piece. At the front, the only visual decoration is four LEDs that glow white to indicate the power is on, the internet connected and your 2.4GHz and 5GHz radios are up and running.

Simplicity also rules the day at the rear: four Gigabit Ethernet sockets are joined by a yellow WAN port that connects to your modem. (Note that, as reflected by its price, no modem is supplied.) Beside that WAN port lurks

a WPS button, and a recess at the other end houses the reset button. That's it for connectors: if you were hoping for USB, you're out of luck.

Also keep in mind that this is a dual-band router, promising Wi-Fi connections of up to 574Mbits/sec on the 2.4GHz band and 1.2Gbits/sec on the 5GHz band when used with compatible Wi-Fi 6 devices. Naturally, it works with slower 802.11ac (Wi-Fi 5) clients too, so it makes an affordable drop-in replacement for an ageing

last-generation router (although, again, there's no built-in modem).

The dual-band design means that bandwidth could get bottlenecked when large numbers of Wi-Fi 5 clients are connected, but that's mitigated by support for 4x4 MU-MIMO.

■ Generous features

Considering the price, D-Link has been generous with software features. The web portal offers everything you'd expect and more, including a simple firewall that you can use to

enforce global blocks and filters for all connected devices, as well as support for L2TP over IPsec, allowing you to route all internet traffic over a compatible VPN.

I'm also a fan of D-Link's visual QoS management widget, which enables you to assign priorities to different devices by simply dragging their icons from a list into a priority table. And if you register with the D-Link Cloud service, you can use either Alexa or Google Assistant to

ABOVE It's not exactly subtle, but the design doesn't draw the eye like other routers

BELOW D-Link's clean web portal makes managing connected clients a breeze

control the guest network and reboot the router.

A basic parental control module is included too, which lets you block selected devices according to a weekly schedule. There's neither logging nor custom web filtering, but for a free feature we can't complain too much. The only slight irritation is that while parental controls are applied to clients from the homepage of the web portal, the access schedules have to be defined under the management tab. I found it easier to configure using the D-Link Wi-Fi app for Android and iOS instead, which puts everything in the one place.

■ Speed surprise

The few low-cost Wi-Fi 6 routers that *PC Pro* has tested so far have put in respectable performances, but they haven't been able to match the speeds of their high-end brethren. The £105 question, therefore, is whether the D-Link DIR-X1860 can punch above its price.

I tested this by setting up the router in the usual spot in my living room, then walking around my home with a laptop, copying a series of files to and from a NAS appliance (connected to the router via Ethernet) to measure file-transfer speeds in different locations. To be strictly accurate, I used two laptops: one with an Intel AC9560 160MHz Wi-Fi 5 adapter and one with an integrated Wi-Fi 6 Intel AX200 2x2 160MHz card.

The top table opposite shows the speeds I experienced over Wi-Fi 6 in four key areas of my home. For context, I've also provided the speeds I obtained from the Honor Router 3, the £140 Netgear Nighthawk AX4 (*see issue 301, p64*) and the top-performing but £250 Asus RT-AX88U (*see issue 300, p62*).

> **"The D-Link DIR-X1860's performance over Wi-Fi 5 was excellent, which isn't something you can take for granted"**

Downloads over 5GHz Wi-Fi 6 (MB/sec)	D-Link DIR-X1860	Honor Router 3	Netgear Nighthawk AX4	Asus RT-AX88U
Living room	60.5	48.4	59.5	70.5
Rear terrace	23.6	24.7	24.5	51.6
Bedroom	35.2	27.2	27.2	56.8
Bathroom	10.6	10.2	13.5	32.6

Downloads over 5GHz Wi-Fi 5 (MB/sec)	D-Link DIR-X1860	Honor Router 3	Netgear Nighthawk AX4	Asus RT-AX88U
Living room	51.9	52.8	39.2	32.2
Rear terrace	16.5	18.2	8.7	8
Bedroom	17.6	20.9	10.4	16.9
Bathroom	11.2	11	8.4	10.8

While close-range performance was nothing to sniff at, the signal dropped off sharply in other parts of the house, with speeds falling well behind the best-in-class Asus. For sure, the D-Link showed strengths too – notably an encouraging 35.2MB/sec in the bedroom – but its overall performance over Wi-Fi 6 was merely in line with what we've come to expect from a sub-£150 router.

On the positive side, performance over Wi-Fi 5 was excellent, which isn't something you can take for granted – even from a router that delivers great Wi-Fi 6 speeds. That's amply demonstrated by the Asus, which was shown a clean pair of heels by much cheaper hardware.

Taking into account the element of chaos that's inherent to wireless networking, we'd go so far as to say that the Honor and D-Link gave functionally identical performances over Wi-Fi 5, while the Asus and Netgear models brought up the rear.

■ Tough decision

If you're looking for Wi-Fi 6 at the lowest possible price, there's no buying decision to make. The Honor Router 3 costs much less than the DIR-X1860, and provides similar performance over both Wi-Fi 5 and Wi-Fi 6 connections. It would be a mistake, however, to think of the DIR-X1860 simply as a more expensive alternative. It does things that the Honor Router 3 won't; the firewall and VPN support are excellent touches, and I haven't even mentioned D-Link's open-ended dynamic DNS support.

On top of that, the DIR-X1860 offers 4x4 MU-MIMO, while the Honor Router 3 is limited to 2x2. The difference is marginal, but Wi-Fi 5 devices will undoubtedly be with us for some time to come, so anything that helps manage contention on a dual-band router is to be welcomed.

My one caveat is that, despite the fact it's a new release, the DIR-X1860's price fluctuates. At one point I saw it on sale for £82, but it's now stabilised at a less tempting £105. Even at this higher price, the D-Link DIR-X1860 provides something we've been missing for too long: a low-cost Wi-Fi 6 router option that combines credible performance with a strong feature set. If that sounds appealing, there's no reason to wait any longer – unless, of course, you're holding out in hope that the price will go back down. **DARIEN GRAHAM-SMITH**

SPECIFICATIONS

Dual-band 802.11ax 2.4GHz/5GHz Wi-Fi router ● 4x4 MIMO radio ● 4 x Gigabit Ethernet ● Gigabit WAN port ● 4 x external antennae ● WPS ● 224 x 166 x 65mm (WDH) ● 525g ● 2yr warranty
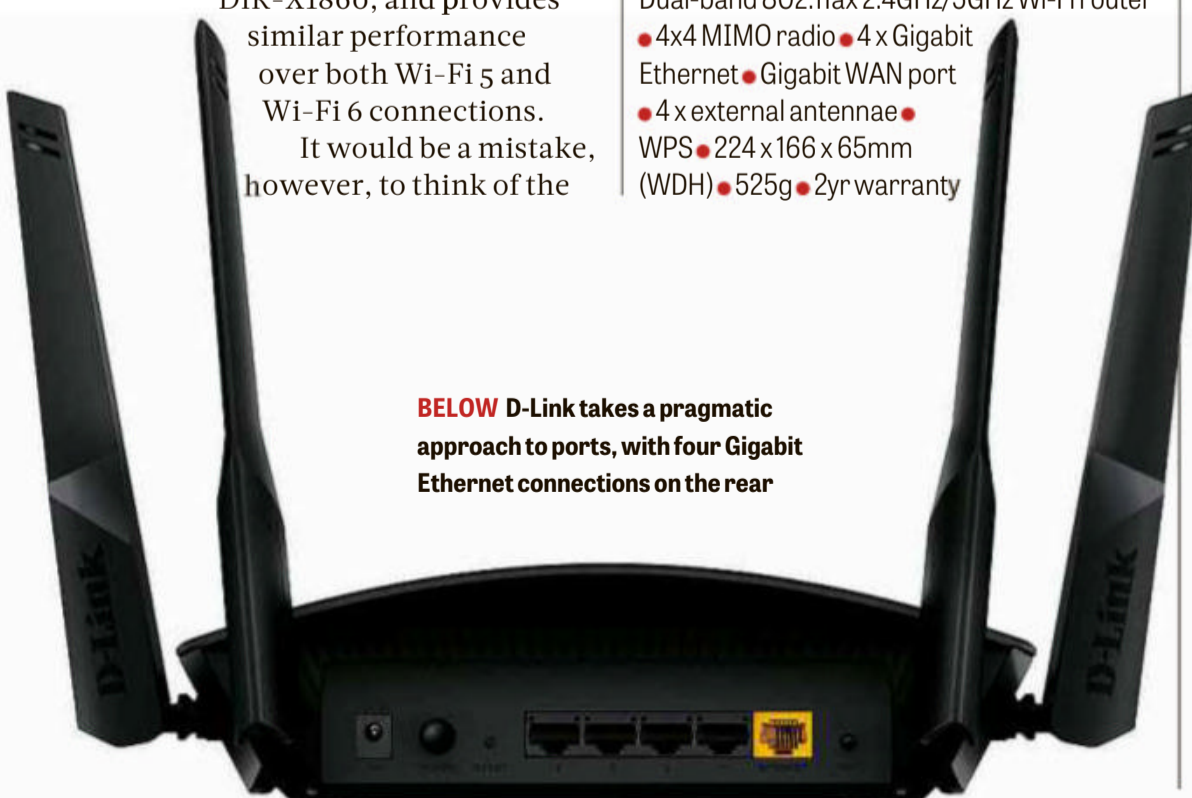
BELOW D-Link takes a pragmatic approach to ports, with four Gigabit Ethernet connections on the rear

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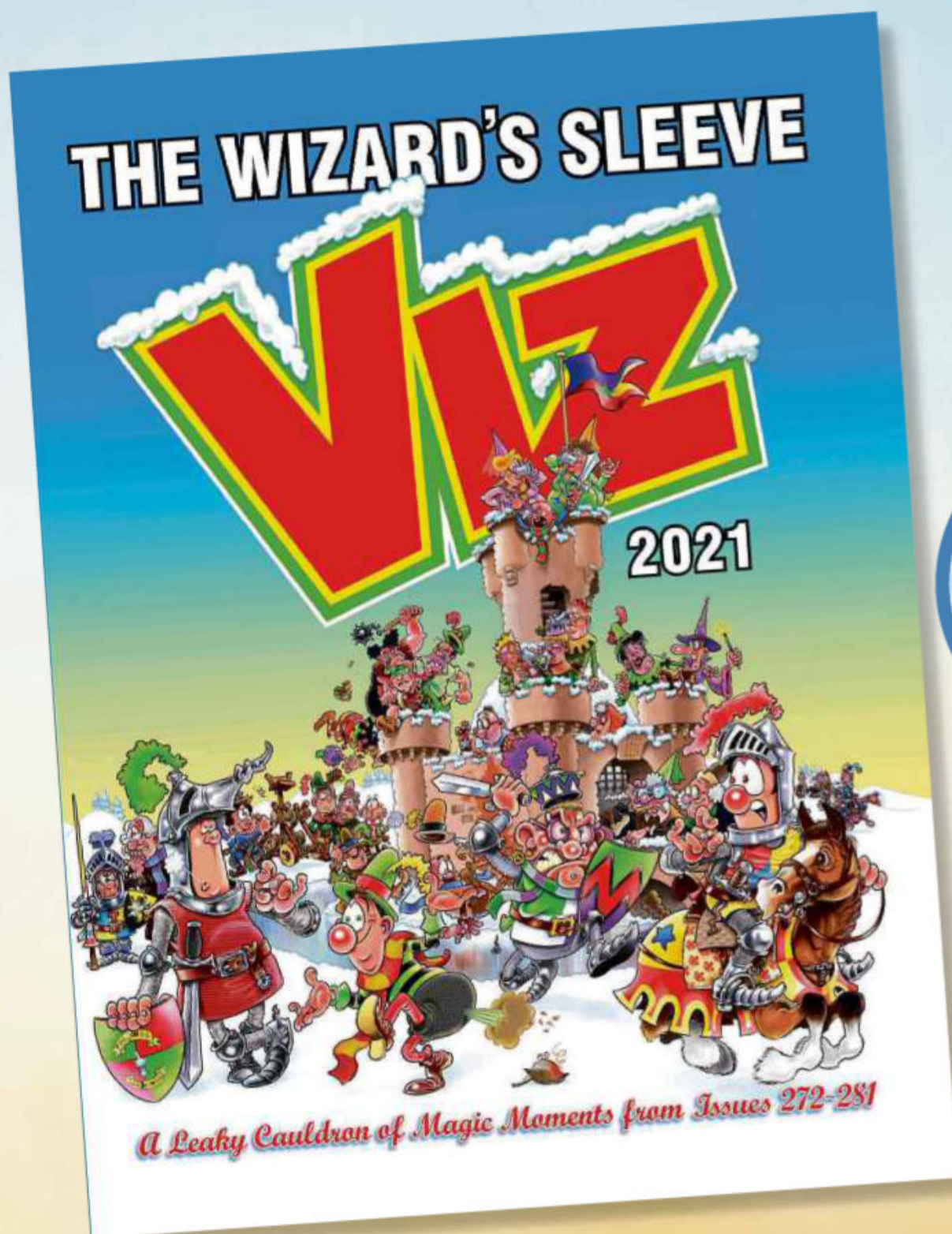
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**Source: ABC figure experienced during a dream after eating a large amount of cheese

Labs mini
SMART SPEAKERS

Welcome to our new (occasional) section: Labs mini. Here, we pitch four smart speakers against one another for quality and features

CONTRIBUTORS: Jonathan Bray, Alan Martin

	Amazon Echo (4th gen)	RECOMMENDED Amazon Echo Dot (4th gen)	Apple HomePod mini	RECOMMENDED Google Nest Audio
Overall rating	★★★★☆	★★★★★	★★★★☆	★★★★★
Price	£75 (£90 inc VAT)	£43 (£50 inc VAT)	£83 (£99 inc VAT)	£75 (£90 inc VAT)
Supplier	amazon.co.uk	amazon.co.uk	apple.com/uk	store.google.com
Warranty	1yr RTB	1yr RTB	1yr RTB	2yr RTB
Smarts				
Assistant	Alexa	Alexa	Siri	Google Assistant
Wi-Fi	Wi-Fi 5	Wi-Fi 5	802.11n	Wi-Fi 5
Bluetooth	A2DP, AVRCP	A2DP, AVRCP	Bluetooth 5	Bluetooth 5
Spotify?	✔	✔	✘	✔
Other	Zigbee smart home hub	✘	Real-time tuning	Ambient EQ, Chromecast, Media EQ
Physicality				
Audio jack?	✔	✘	✘	✘
Dimensions (WDH)	144 x 144 x 133mm	100 x 100 x 89mm	98 x 98 x 84mm	124 x 78 x 175mm
Weight	970g	328g	345g	1.2kg

CONTENTS

Amazon Echo (4th gen)

Amazon's new-look smart speaker provides a host of improvements in all the right places, including Zigbee

SCORE ★★★★☆

PRICE £75 (£90 inc VAT)
from amazon.co.uk

This is the most dramatic change in design since Amazon first started making smart speakers. The first Echo was a tall, industrial-looking cylinder with a twistable top for adjusting the volume. This became a shorter, stubbier fabric-covered cylinder for the second and third generations. Now, cylindrical is out and the spherical is in.

The fabric remains, although it now only covers two-thirds of the device, with matte plastic on the rest The ring of light that activates when you say the "Alexa" wake word has relocated to the bottom, and we're fans of the warm glow it casts onto the surface it's sitting on. It could look even more fetching if wall-mounted via the screw hole in the bottom.

All that said, it feels as if Amazon doesn't know what to do with the buttons. The plastic mute, action, volume up and volume down keys all sit adrift on the fabric, spoiling its minimalism. We're not advocating that Amazon gets rid of the buttons – anybody who's struggled to be heard shouting "Alexa, turn the volume down" over a loud track will know that's asking for trouble – but they're an afterthought rather than an integral part of the design.

Like previous Echo devices, the fourth-generation speaker includes a 3.5mm line in/out jack. That's welcome but increasingly less necessary: there are cheaper ways of adding Alexa to your dumb speaker, and the sound quality is good enough at this point that you don't need to outsource audio playback.

And, for a £90 speaker, it sounds excellent. The previous generation had a 3in woofer and a 0.8in tweeter, and the new Echo adds a second 0.8in tweeter. While this sounds like a straightforward upgrade, it's a trade-off: previous Echo devices deliberately stuck to a single tweeter to provide 360˚ sound. With two tweeters, the Echo is more directional, but it comes with an important improvement: like the Nest Audio (*see p75*) and Apple HomePod, the

Echo will now adapt to the room's acoustics for a better listening experience without the need to tinker.

While the distance between the two tweeters doesn't allow for proper stereo separation, it's still far better than what we've heard in past Echo devices, especially in multi-channel audio tracks.

We placed the third-generation Echo next to the 2020 model, alternating the same tracks between them on Spotify Connect. The newer model sounds noticeably richer to the extent that, if you put the two side by side, nobody would pick the older model – itself no pauper in terms of sound quality. This can be improved further if you pair it with the £120 Echo Sub.

The sticking point is that, to our ears, the Nest Audio has the edge. It's fuller at the bottom end and more

> **"Getting all of these features in for the already competitive £90 price was always going to result in a five-star review"**

balanced, making the Echo sound reedy by comparison. Both are very good, but if sound quality is paramount then you'll want to back Google this time around.

Another reason to back Google is the smarts of the virtual assistant. Alexa has become more intelligent, but it's still not up there with Google Assistant, both in terms of understanding what you want and providing an appropriate answer to your questions. Even Google Assistant's jokes are better.

Still, if you only want a smart speaker to play music and answer basic questions about the weather and your daily schedule, it's much of a muchness. And remember that the new Echo has an ace up its figurative sleeve: Zigbee.

Zigbee is a wireless communication protocol designed for smart homes. If your smart home kit – be it a light bulb or a thermostat – supports Zigbee, you can ditch the hub it comes with and have it talk directly to your Echo instead. The one hassle worth noting if you own a bunch of such devices is that you'll need to reset them all to get them to pair with Alexa. There's also a real risk that you won't get the full functionality of a compatible device if you don't use the hub it comes with, so it pays to check before you jump through the setup hoops.

With all its first-party hardware, Amazon has a history of making small quality-of-life improvements with each generation, and the fourth is no exception. It sounds better than ever, the new design is stylish and Zigbee – which was a formerly premium feature for the Echo Plus – now comes as standard. Getting all of these features in for the already competitive £90 price only adds to the Echo's value for money.

But if you're looking to buy your first smart speaker and aren't already wedded to the Amazon "Echosystem", you owe it to yourself to investigate the Nest Audio first. The sound quality is a touch better, and Google Assistant is more likely to wow you with its smart capabilities.

Amazon Echo Dot (4th gen)

This redesigned Dot offers improved sound for the same great price, making it the new sub-£50 king

SCORE ★★★★★

PRICE £43 (£50 inc VAT)
from amazon.co.uk

It's not only the full-sized Amazon Echo (*see opposite*) that enjoys a fresh look. While most would accept a year with a full-blown pandemic as a valid excuse for an iterative update, Amazon has found time to revamp the Echo Dot too.

Gone is the plastic hockey puck of the first two generations and the slightly fatter fabric look of the third: in its place, a sphere slightly larger than a cricket ball. Like the full-sized Echo, it's about two-thirds covered in fabric, with the remaining third a hard matte plastic. It is, of course, flat on one side, to prevent it rolling around.

As with the full-size Echo, we're keen on the trademark ring of blue light that appears when the wake word "Alexa" is uttered. While on previous generations this appeared at the top of the device, it's now on the bottom, meaning it reflects softly against whatever surface the Echo is sitting on. It's a strong look.

However, we're less keen on the plastic volume control, mute and action buttons that sit on top of the device and ruin an otherwise delightful minimalist look. It's always a sensible move to include such buttons, but we wish that Amazon had found a way to make them more discreet. As it is, they look like they've been stuck on by a toddler.

The final physical feature of note is a 3.5mm jack, which means you can both plug your phone in with a cable to output to the speaker or transfer the Dot's output to a better-sounding device. This is one of the Dot's key advantages over the £50 Google Nest Mini, which hasn't been updated at the same time as the Google Nest Audio (*see p75*).

So, how does the Echo Dot perform? Well, the bizarre thing is that, despite having the same internal speaker specs as the third-generation Echo Dot, the 2020 version sounds markedly better. Perhaps that's due to the new round design, or maybe it's down to clever acoustic tweaks

from Amazon's engineers. Either way, the new model makes its predecessor sound murky: the new Dot is crisper and clearer, with more distinction between each instrument on a track. It can also reach louder volumes without distortion, although it's still not a speaker you'll routinely want to push past 5/10 on the volume dial. Both are superior to the Nest Mini.

I don't want to overstate this, though: there are limits to the kind of sound a £50 speaker can push out. The point is that Amazon has once again made us revise our opinion of what those limits can be: it's truly excellent for the price, and while it clearly misses the full-sized Echo's 3in woofer, most non-audiophiles will be happy with the sound it produces. And even audiophiles will be satisfied with it in a smaller room, we suspect.

Plus, you can always pair it with a second Echo Dot for stereo sound, and an Echo Sub to provide the missing bass – although at that point you're looking at a bill of £220, and you might wonder why you didn't just buy a £190 Echo Studio instead.

Where the Echo Dot still falls down compared to its Nest rival is in its

ABOVE The ring has moved to the bottom, adding a pleasing glow underneath the Dot

PC PRO RECOMMENDED

> "The new Dot makes its predecessor sound murky: it's crisper, with more distinction between each instrument on a track"

BELOW An extra tenner buys you a handy LED display on the front of the Dot

smart capabilities. While Alexa is streets ahead of Apple's Siri digital assistant, Google Assistant makes it look like a dunce, both in terms of understanding the questions you ask and the quality of answers it delivers.

Whether that matters to you is a different question. If you're like us and tend to only use Alexa to play music, get the weather and hear the occasional joke, the Echo Dot is fine. If, on the other hand, you want your virtual assistant to be a surrogate encyclopedia, you're far better off getting a Nest-branded device instead – but we suggest that you step up to the Nest Audio.

Before you rush out to buy the Echo Dot, you should think about spending an extra £10 on the Echo Dot with Clock. It's essentially the same device except Amazon builds an LED into the fabric. This generally just shows the time, but has a couple of context-sensitive functions too: it can flash up the temperature outside if you ask Alexa the weather, shows the volume number when you make adjustments, and displays the time left on any timer you set. You can also cancel alarms with a tap on the top, in a call back to the old snooze buttons on alarm clocks, which is a nice touch.

Aside from this, there's no difference (aside from a few grams in weight) between the Dot and the Dot with Clock, and both devices are bargains. The third-generation Amazon Echo Dot was already our favourite small smart speaker, and now it looks nicer, produces a better sound and comes at the same low price. It's another winner.

Apple HomePod mini

Excellent audio quality for the price and the size, but for Apple owners only – and there's no Spotify support

SCORE ★★★★☆

PRICE £83 (£99 inc VAT)
from apple.com/uk

Just like its rivals, the HomePod mini is a low-cost smart speaker that can be controlled by voice, but here you're being served by Siri instead of Alexa or Google Assistant. While those rivals can be used on whichever phone you fancy, the HomePod mini is only designed for users of Apple devices.

It's absolutely tiny, measuring 84mm tall and 98mm in diameter. That's around half the height of the Nest Audio and significantly smaller than the fourth-generation Echo. It's also fractionally smaller than the new Echo Dot. It's wrapped in smart-looking textured fabric, available in white or grey. A rubber base stops the speaker sliding around surfaces while a captive, braided power cable emerges from the rear of the speaker. This is terminated with a USB-C plug so you could plug it into a power bank to provide power (assuming it can output 20W), but Apple does provide a mains adapter with this device.

A circular, backlit touch-sensitive control surface sits on the top of the speaker. This is illuminated by multicoloured LEDs, which move and change colour depending on what the speaker is doing. Tap the plus and minus symbols on either side to adjust volume up and down. A single tap plays or pauses, a double-tap skips tracks, a triple-tap skips back and a long press activates Siri. It's all very straightforward.

The HomePod mini is also blissfully easy to set up. Plug it in, bring an iPhone or iPad close by and up pops a setup window. You'll be ready to go in a couple of minutes. Stereo-pairing two HomePod mini speakers is just as simple, while controls are neatly built into the fabric of iOS and iPadOS.

Siri proves a smart choice too. As well as the usual trivia and music

playback requests, if you ask for directions they will be synchronised as a suggestion the next time you open Apple Maps on your phone. You can transcribe notes, which later appear in the Notes app on your iPhone, add reminders and tasks, get news updates and call or send messages to contacts.

It's also possible to use multiple HomePod speakers in an intercom-like system. This is similar to Google's one-way Broadcast feature, but you can send messages to specific devices here, while Google's speakers simply blanket broadcast. But you can't carry out a two-way conversation as you can with a pair of Amazon Echo speakers.

We also like the "proximity" features enabled by the HomePod mini's U1 ultra-wideband chip. Leaving the house? Bring your phone close to the speaker and it will offer to move that music from the speaker to your phone, and the same happens in reverse if you're listening on your phone and want to continue to listen on the speaker.

Alas, support for audio content platforms isn't so impressive. While you can add a selection of commercial radio stations thanks to TuneIn integration, if you ask the HomePod

> **"From Stevie Nicks' husky tones on *Landslide* to Chris Stapleton's drawl, the HomePod mini delivered a poised, involving listen"**

mini to play something from Spotify then Siri will reply that the app hasn't added support – yet. The same holds true for Audible, BBC Sounds and Tidal. While it's possible to stream radio and music from Spotify on your phone to the speakers via AirPlay 2, that's not the point of a smart speaker.

Inside the Apple HomePod mini, a single, downward-firing full-range driver is mounted above an acoustic waveguide, which disperses sound waves around the room for full 360˚ audio. Apple couples this with a pair of passive radiators to strengthen bass. Meanwhile, Apple's S5 processor and four microphones work in tandem to listen out for voice commands.

The HomePod mini doesn't support automatic room EQ like its larger sibling, but it does analyse the type of content that's playing in real-time and adjust its output accordingly. This results in astonishingly high-quality audio, with the mini able to deliver a strong, detailed and balanced sound, whatever you feed it.

It's particularly accomplished with vocals. From Stevie Nicks' husky tones on *Landslide* to Chris Stapleton's crackling country and western drawl, the HomePod mini delivered a poised, involving listen. Classical tracks are served up with a light touch too, with a gorgeous sense of space to Chopin's *Nocturnes*. The HomePod mini even copes with more complex, multi-layered compositions such as Mozart's *Requiem*.

Where it falls down is heavier, more industrial music, which can sound harsh and brittle, especially at louder volumes. Don't expect room-shaking levels of bass, either: what's there is well-controlled but it doesn't dig deep.

Overall, though, the HomePod mini puts in a remarkably composed performance given its size. The reason it doesn't walk away with a *PC Pro* Recommended award is the current lack of Spotify and BBC Sounds, and clearly if you aren't an iPhone or iPad owner then you should look elsewhere. However, if you're wedded to Apple then the HomePod mini is a fantastic little speaker, works beautifully and should open itself up to the wonders of the biggest third-party streaming services in time.
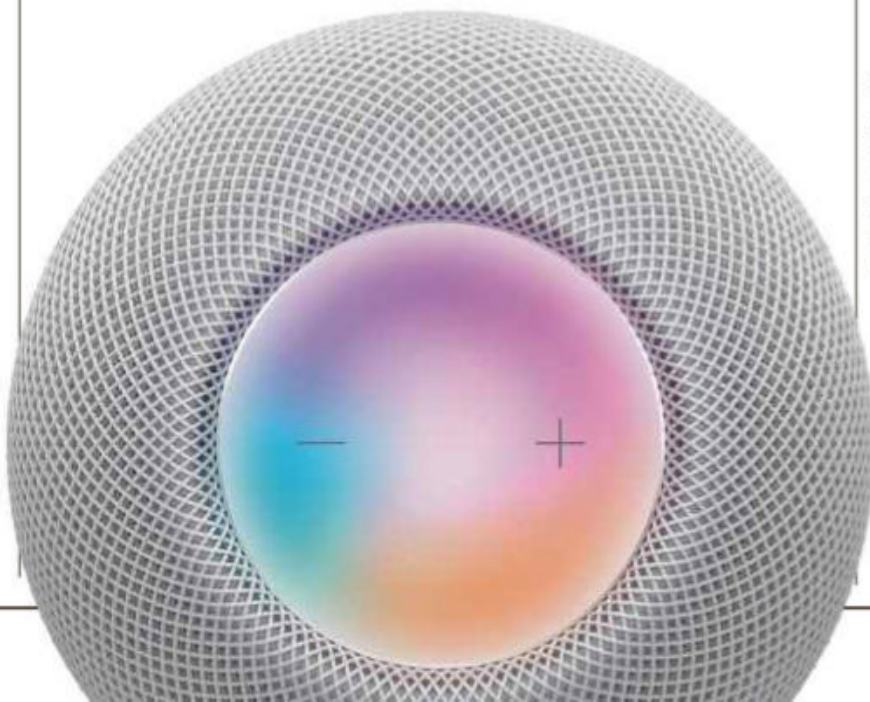
Google Nest Audio

Google's renewed focus on audio quality pays off – the Nest Audio is a fabulous smart speaker

SCORE ★★★★★

PRICE £75 (£90 inc VAT)
from store.google.com

It's happened: Google has *finally* released the Google Nest Audio, an update to its very first smart speaker, the Google Home. And, after a four-year wait, plenty has changed. The design has been revamped, inside and out, the price is lower and there's a renewed focus on audio quality. The best news, though? The Nest Audio is a crackerjack of a smart speaker.

It's a very different beast to the speaker it replaces, both in terms of the way it looks and the way it's constructed. It's covered head-to-toe in tough-feeling recycled fabric. It no longer has multicoloured LEDs on top; instead, there are four LEDs across the front. It now has a physical mute switch on the rear for those times when you want a little privacy, and its Wi-Fi connectivity is complemented by Bluetooth, which the Home lacked.

Beneath its fabric covering – which Google proudly claims is made from 70% recycled plastic bottles – are two drivers: a 75mm (2.95in) woofer and one 19mm tweeter. That's a huge step up from the single 50mm full-range driver and twin passive radiators in the original Google Home speaker, and with the whole lot nestled within a rigid housing this speaker is a huge step up in quality.

Not only does it deliver a richer, fuller sound, but it does so across genres. We first fired up our favourite "lo-fi beats" playlist on Spotify for chilled background music to work to. We were immediately impressed with how solid and meaty the low-end sounded. Moving to vocal-focused material – Gregory Porter's album *All Rise* – the Nest Audio coped admirably, delivering Porter's powerful baritone with a drive and richness that belied its size.

But it's not all about the low-end: there's also plenty of articulation here with drums, cymbals and hi-hats all easy to pick out above Porter's vocals. There's good separation between other instruments as well. The sound doesn't have much width, but you can get stereo imaging by purchasing a second speaker and setting up stereo in the Google Home app.
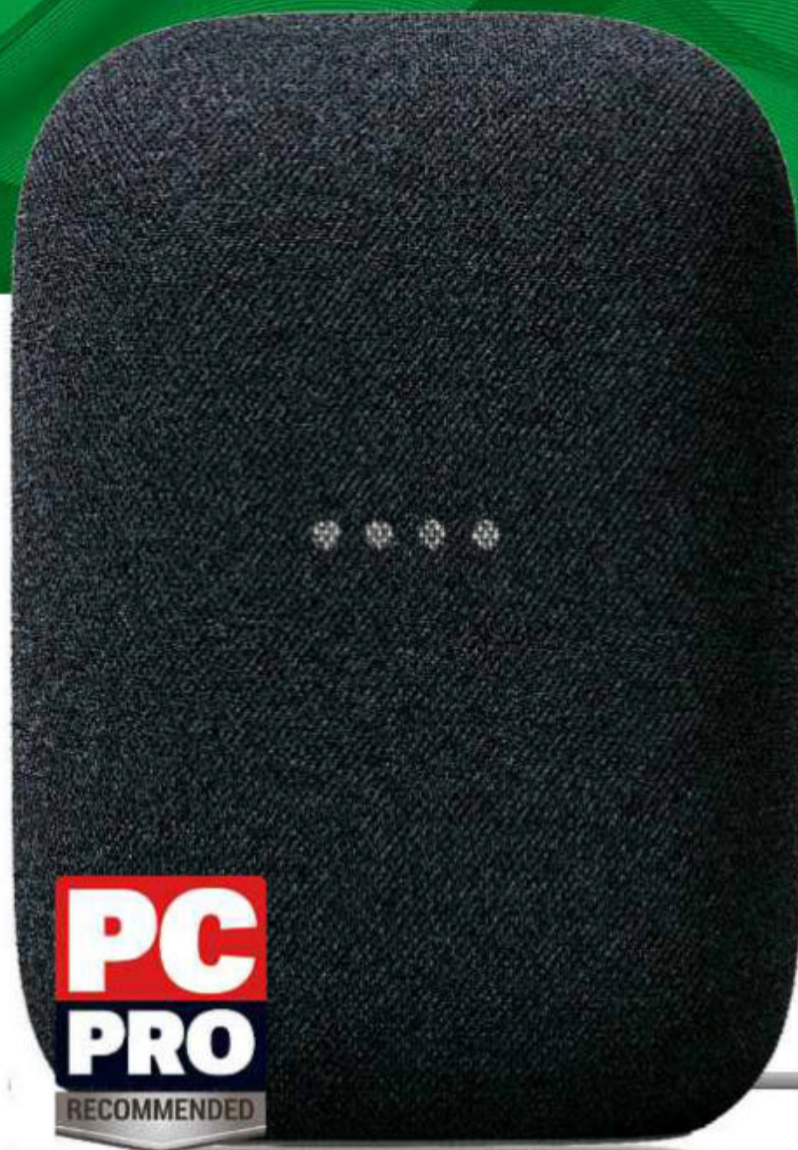
The only time the Nest Audio begins to get out of shape is when you crank the volume up to maximum and cue up something raucous. A few minutes of listening to System of a Down and Rammstein at maximum click quickly had us reaching for the touch-sensitive volume buttons; at high volumes, it sounds strained and runs out of puff.

We're also unconvinced by Google's Media EQ technology, which is meant to automatically adapt the Nest's tuning to the content that's being played through it. We couldn't hear obvious evidence of this occurring except during one football podcast, where the Nest Audio mitigated the deep tones of one of the presenters, making them easier to understand.

One of Google's pre-existing audio technologies, Ambient IQ, is more useful. This adjusts the volume and equalisation (EQ) of the spoken word

ABOVE A quartet of LEDs graces the front, while the fabric is 70% recycled bottles

"There's plenty to shout about here: the long-awaited Google Nest Audio is the successor the Google Home has long deserved"

BELOW Ambient IQ cleverly adjusts the volume depending on the background noise

to make it more audible depending on the background noise. We fired up a hair dryer right next to the speaker while it was playing another podcast and immediately the Nest Audio raised the volume level and shifted the EQ towards the treble end of the audio spectrum, making it easier to hear over the background roar. It's subtle, so most of the time you probably won't notice it, but the result is that you don't end up tweaking the volume all the time. All very clever.

The same can be said of Google Assistant. Grab the speaker's attention with "Okay Google" or "Hey Google" and you can ask the Nest to play music, listen to radio, control smart home devices, set timers and alarms, or even answer general questions such as "Hey, Google, when did the original Google Home come out?" The new triple microphone array is excellent at picking up your voice over background noise too, while Google Assistant did its usual brilliant job of interpreting our various requests.

In that respect, it's superior to Echo speakers. Although there's more third-party hardware and software support for Alexa, Google Assistant is less frustrating to use and feels more reliable. It also gives you more "thinking time" than Alexa after you've activated the assistant, which is nice if you're fumbling around for what to say.

We're less enamoured by this speaker's touch-sensitive controls. These are split into three zones, arrayed across the top of the speaker, just in front of the fabric seam that runs around the circumference. You tap the speaker's right shoulder to turn up the volume, tap the left to turn down the volume and tap in the centre to pause or play. Sounds simple, doesn't it? Unfortunately, there are no markings to indicate where the zones start and finish, and We ended up adjusting the volume when we'd intended to pause on more than one occasion.

Aside from this, there's plenty to shout about here: the long-awaited Google Nest Audio is the successor the Google Home has long deserved. It sounds great, looks great and works just beautifully. The only missing piece of the puzzle is the lack of 3.5mm audio input, but for £90 you simply can't go wrong. ●

SUB-£500

SUB-£1,000

SUB-£2,000

DESKTOP PCs
for every budget

We test a dozen PCs ranging from £399 to £1,859. Read on to find the right one for your needs

One of the great joys of producing a Labs is that you see the whole market in a cross-section. Especially in a Labs such as this one, where prices start from a humble £399 and steadily rise to almost £2,000.

In the space of 18 pages, you can see a clear picture of what your money buys you – and thanks to our comprehensive graphs starting on p92, you can also see exactly what difference that makes in terms of speed. If you weren't sure what your budget should be for that new PC before this test, you should be after.

It may well be that one of the dozen computers on test here perfectly matches your needs, but the continuing beauty of desktop PCs is their customisability. For the likes of Acer and HP, you may find a different model in their range that suits you better. With the other companies, a change in component is often just a dropdown menu away – or even that most old-fashioned of things, a phone call.

All of which gives us reason to celebrate the desktop PC in 2021, some 40 years after IBM announced the Personal Computer that started it all. There's life in the old dog yet.

CONTRIBUTOR: Tim Danton

Contents

Seven steps to choosing your perfect computer

Before you dive into the reviews, we recommend that you take a quick refresher course in what to look for when buying

We're going to start this buyer's guide with one monster assumption: that you're looking to buy a Windows 10 PC, rather than a Mac or a Linux system. While much of our advice applies equally to Linux, Apple's control over its hardware makes that buying process an entirely different set of decision trees.

With that out of the way, we'll cover the broader question first, followed by some nitty-gritty specifics. Even if none of the dozen PCs we review here appeals to you, hopefully this guide will help you make your final decision.

1 What do you want to do?

If all you're looking for is a simple system for email, web browsing and Microsoft Office, we can save you both money and time: buy the PC Specialist Aurora Mini. It's more than powerful for all those tasks, whilst being small, quiet and cheap to run.

At the other end of the scale, for those who want to play the world's most demanding games on Ultra HD monitors, it's a simple matter of working out your budget and buying the best combination of processor and graphics card you can.

Except it's never that easy in the real world. Even for gamers, there are more considerations to bear in mind (which we cover below), so our best advice is to carefully consider what software you want your computer to run and make sure your chosen spec meets the recommendations. Ideally, give yourself some headroom for the next version too because it's bound to want more.

2 The processor

The Intel or AMD question is now almost moot: both companies produce fast and efficient processors. The more important question is how many cores the processor contains and whether these support multiple threads (Intel calls this Hyper-Threading).

As a rule of thumb, a processor with six cores and 12 threads will tackle tasks such as

ABOVE Are you a snap-happy photo editor? Make sure the spec is up to the task

video editing – where the software is designed with multithreading in mind – much more quickly than a processor with four cores and eight threads (or a six-core processor that doesn't supporting multithreading). You can see this play out in benchmarks such as *PC Pro*'s own, Cinebench and Geekbench, as detailed on p92.

"The more important question is how many cores the processor contains and whether these support multiple threads"

Both Intel and AMD use model numbers that indicate where they sit in the hierarchy. Core i3 and Ryzen 3 are at the low end, Core i5 and Ryzen 5 are in the middle, Core i7 and Ryzen 7 are near the top, and Core i9 and Ryzen 9 are reserved for enthusiasts with deep pockets.

It's also worth noting the generation of processor. The clue is again in the model name, with Intel's Core chips starting with the relevant number – so the Core i5-10400 is a tenth-generation processor. AMD's naming isn't as straightforward, but its latest desktop chips are worth seeking out (they begin with five, such as the AMD Ryzen 7 5800X). It's always worth putting the model name into a search engine to double check such information.

BELOW AMD makes stellar desktop chips, but watch out for any naming banana skins
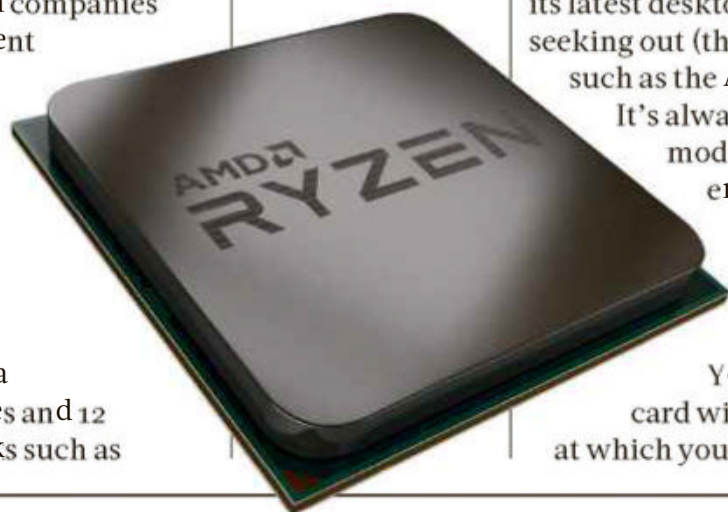
3 Graphics cards

Your choice of graphics card will dictate the resolution at which you can play demanding games. We've tried to illustrate this in the graphs by giving an average frame rate across all of our gaming tests at the different resolutions, so you can see the results you're likely to get from each PC. You can also use the 3DMark result to roughly calculate how well each PC will play popular games such as *Fortnite* and *Apex Legends* at 2,560 x 1,440 (1440p) by visiting **pcpro.link/317fortnite**.

While Nvidia remains the dominant force in desktop graphics cards, that doesn't mean you should ignore AMD's cards. As the Alienware PC shows, cards based on its RX 5000 range can compete with Nvidia's GeForce series – and AMD has just released RX 6000 cards that promise even greater acceleration.

Nevertheless, Nvidia cards offer gamers a range of options depending on their budget. Just note that buying a GTX rather than RTX card means you'll miss out on Nvidia's ray tracing cores – these can help lift a scene due to their handling of light – and its frame rate-boosting Deep Learning Super Sampling (DLSS) technology. AMD is at the start of its ray tracing journey, having only just added this capability to its RX 6000 series.

Finally, note that cheaper PCs usually rely on graphics integrated with the processor. These provide basic 3D acceleration that can be good enough to run undemanding games, but the 1080p, 1440p and 4K gaming graphs on p92 tell no lies. For these

BELOW Nvidia offers a range of graphics cards to cover the spectrum of gaming budgets

graphs, we used a weighted average of frame rates across all our real-world gaming benchmarks to provide an at-a-glance indication of what frame rates you'll experience. We recommend looking for 40fps or above for smooth play.

4 How much memory?

Windows 10 is perfectly happy with 8GB of memory, but if you afford 16GB then it's worth doubling down: some software chews up memory (*see "How much RAM do you really need?" on p40*) and having more to hand simply makes life smoother. Gamers in particular will want 16GB of memory, especially if you intend to run other tasks in the background. Unless you're working with huge files, such as

BELOW M.2 storage is preferable to older alternatives and we'd advise getting 500GB
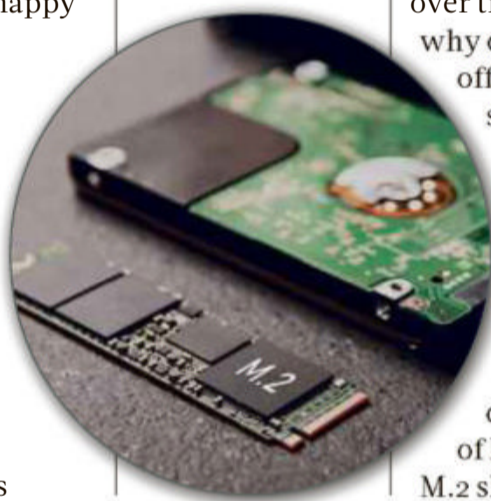
high-resolution photos and videos, few people will push their computer so hard that they need 32GB or 64GB.

5 Storage principles

Instead of worrying about memory, then, we suggest you focus on storage. Solid-state drives (SSDs) offer tremendous speed advantages over traditional hard disks, which is why only the cheapest machines offer hard disks as their primary storage devices. SSDs not only make Windows run more smoothly and boost faster, but they're also quieter.

Yet, again, things are never quite that simple. Ideally, you should look for an M.2 NVMe SSD: M.2 indicates the format of the drive, resembling a stick of RAM and stuck straight into a M.2 slot in the motherboard, while

NVMe unglamorously stands for Non-Volatile Memory Express – but what really matters is that it's many times faster than SATA SSDs.

We recommend you choose a 500GB SSD or larger, as otherwise you'll soon find space running out and you'll want most applications (and particularly games) to be stored on the SSD for quick loading. That said, a secondary storage drive is always useful for space-hogging data such as music, videos and photos, and a hard disk makes sense here as you get so much more storage space for your money than with an SSD.

6 Encased in silence

So far, all our advice can be applied to an online purchase; there's no need to get your hands on the PC before you buy. What an online retailer will never tell you, however, is how noisy a PC is. And they vary hugely. Indeed, it's the main reason we wouldn't recommend the Alienware Aurora Ryzen Edition. In each review, therefore, we provide a sentence or two about fan noise or, ideally, its absence.

Likewise, a flattering photo can deceive, so take a note of the case your intended PC comes in. Some are gorgeous to behold; others less so. Again, we share our thoughts in each review, and this is where (trusted) online reviews of individual cases can also be useful.

The choice of case, and the motherboard, will also dictate how easy it will be for you to upgrade or add components later in the PC's life. However, most PCs offer plenty of space and ports for extra memory and drives, with only two here (the Acer Aspire and PC Specialist Aurora Mini) having notable limitations due to their compact designs.

7 A question of support

PC Pro is in the fortunate position of running an annual survey that provides a breakdown of our readers' experiences with computer manufacturers, with the most recent results printed in issue 314. We summarise these results (for customer service, reliability and one overall rating, with a higher number being better) on the feature table overleaf.

You should also check what's covered by the warranty and whether it includes return-to-base cover – where you are responsible for shipping it back to the manufacturer or retailer – or collect-and-return, where the company will bear the cost and organise the collection. The best cover is on-site, where the company will send out an engineer to fix the problem, but always check the small print to see what is and isn't covered.

How we test

First, we run the *PC Pro* suite of benchmarks to test image editing, video editing and multitasking capabilities. This provides an overall score we show in the graph on p92. We also run the single-core and multicore tests found in Geekbench 5 and Cinebench R23. Together, these results give an at-a-glance indication of how quick the machine will be in everyday use.

Along with 3DMark's Time Spy test, we run a series of gaming benchmarks at 1080p (1,920 x 1,080 resolution), 1440p (2,560 x 1,440) and 4K (3,840 x 2,160). The games range from the undemanding *Metro: Last Light* and *F1 2020* to the graphically intense *Metro Exodus* and *Shadow of the Tomb Raider*. We also punish the systems in *Hitman 2* at demanding settings, including super sampling at 2x.

Rather than drown people in numbers, we use a weighted average of these results on p92 to give a single frame rate for each of the three resolutions.

Desktop PCs can be power-hungry beasts, so to give an idea of annual running costs we measure the
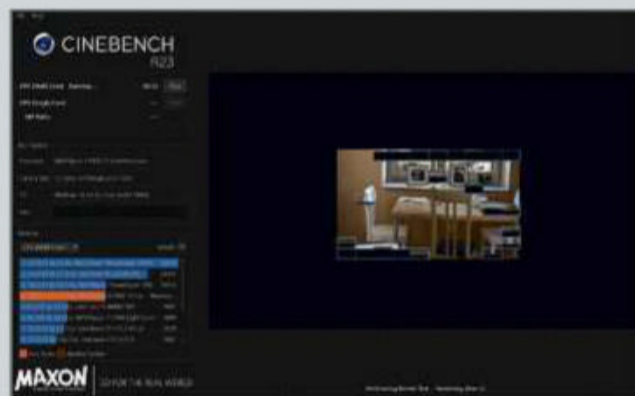
ABOVE Cinebench's multicore test separates the big boys from the rest

idle and peak power draw of all the systems. We model a year's usage based on an eight-hour day where two hours would be spent of intense usage and six hours closer to the idle rate. Assuming a charge of 13p per kWh, the UK average, we translate that into a simplified annual running cost on p93. Clearly, these results are illustrative only!

	SUB-£500 PCs			SUB-£1,000 PCs		
	Acer Aspire XC-895	Chillblast Versato Family PC	PC Specialist Aurora Mini	Acer Nitro 50-610	Chillblast Fusion Marine 1660 Super Gaming PC	HP Omen 25L
			RECOMMENDED		RECOMMENDED	LABS WINNER
Overall rating	★★★★☆	★★★★★	★★★★★	★★★★★	★★★★★	★★★★★
Information						
Price (inc VAT) [1]	£333 (£399 inc VAT)	£417 (£500 inc VAT)	£416 (£499 inc VAT)	£583 (£699 inc VAT)	£833 (£1,000 inc VAT)	£832 (£999 inc VAT)
Supplier website	currys.co.uk	chillblast.com	pcspecialist.co.uk/reviews	currys.co.uk	chillblast.com	currys.co.uk
Part code	DT.BEWEK.004	N/A	N/A	DG.E1ZEK.002	N/A	GT12-0045na
Service and support						
Warranty [2]	1yr RTB	5yr (2yr C&R, 3yr RTB labour-only)	3yr (1mth C&R, 11mth RTB parts & labour, 2yr RTB labour-only)	1yr RTB	5yr (2yr C&R, 3yr RTB labour-only)	1yr C&R
Customer support rating [3]	86%	92%	93%	86%	92%	78%
Reliability rating [3]	89%	92%	93%	89%	92%	84%
Overall rating [3]	87%	93%	93%	87%	93%	81%
Processor & memory						
Processor	Intel Core i5-10400	AMD Ryzen 5 3400G	AMD Ryzen 5 4500U	Intel Core i5-10400F	Intel Core i5-10600K	Intel Core i5-10400F
Architecture	Comet Lake	Zen 2	Zen 2	Comet Lake	Comet Lake	Comet Lake
Base/turbo frequency	2.9GHz/4.3GHz	3.7GHz/4.2GHz	2.3GHz/4GHz	2.9GHz/4.3GHz	4.1GHz/4.8GHz	2.9GHz/4.3GHz
Cores/threads	6/12	4/8	6/6	6/12	6/12	6/12
CPU cooler	Unbranded air cooler	AMD air cooler	N/A	90mm air cooler	Chillblast 120 CPU water cooler	90mm air cooler
Supplied RAM	8GB 3,200MHz DDR4	16GB 3,200MHz DDR4	8GB 2,400MHz DDR4	8GB 2,666MHz DDR4	32GB 3,200MHz DDR4	16GB 2,666MHz DDR4
RAM slots (free/total)	1/2	2/4	1/2	2/4	2/4	2/4
Motherboard						
Model	Acer B46H5-AD	Asus TUF B450M-Plus	Asus PN50 Ultra Small Form Factor	Acer custom	Asus TUF B460M-Plus Wi-Fi	HP Dorado_4L
PCI Express x8 or x16 slots (spare/total)	x16 (1/1)	x16 (1/2)	✘	x16 (0/1)	x16 (0/1)	x16 (0/1)
PCI Express x1 ox x4 slots (spare/total)	x1 (1/1)	x1 (1/1)	✘	✘	x1 (1/1), x4 (1/1)	✘
M.2 slots (spare/total)	✘	1/1	0/1	0/1	1/2	0/1
USB-A slots	6 (4 x USB 3.1, 2 x USB 2)	5 (USB 3.1, 2 x USB 3, 2 x USB 2)	2 (2 x USB 3.1)	6 (4 x USB 3.1, 2 x USB 2)	6 (4 x USB 3.1, 2 x USB 2)	6 (2 x USB 3.1, 2 x USB 3, 2 x USB 2)
USB-C slots	✘	1 (USB 3)	1 (USB 3.2)	✘	1 (USB 3)	1 (USB 3.1)
Ethernet	Gigabit	Gigabit	Gigabit	Gigabit	Gigabit	Gigabit
Graphics						
Make and model	Intel UHD Graphics 630	AMD Radeon RX Vega 11	AMD Radeon RX Vega 6	Nvidia GeForce GTX 1660 Super	Nvidia GeForce GTX 1660 Super	Nvidia GeForce RTX 2060
Video memory	Shared	Shared	Shared	6GB GDDR6	6GB GDDR6	6GB GDDR6
Outputs	2 x HDMI	DVI-D, HDMI, USB-C	DisplayPort, HDMI, USB-C	DVI-D, HDMI	DVI-D, HDMI, USB-C	DisplayPort, DVI-D, HDMI
Storage						
Primary drive	Toshiba DT01ACA100	WD Blue 3D NAND	Intel 660p	Kingston U-SNS8154P3	Samsung 970 Evo Plus	WD PC SN520
Drive technology and interface	7,200rpm SATA hard disk	M.2 SATA SSD	M.2 NVMe Gen 3 SSD	M.2 NVMe Gen 3 SSD	M.2 NVMe Gen 3 SSD	M.2 NVMe Gen 3 SSD
Nominal capacity	1TB	500GB	512GB	256GB	500GB	256GB
Secondary drive	✘	✘	✘	WD Blue	Seagate BarraCuda	WD Blue
Drive technology and interface	N/A	N/A	N/A	7,200rpm SATA hard disk	7,200rpm SATA hard disk	7,200rpm SATA hard disk
Nominal capacity	N/A	N/A	N/A	1TB	2TB	1TB
Optical drive	✘	✘	✘	✘	✘	✘
Wireless						
Wi-Fi	Wi-Fi 6	802.11n	Wi-Fi 6	Wi-Fi 6	Wi-Fi 6	Wi-Fi 6
Bluetooth	Bluetooth 5.1	✘	Bluetooth 5	Bluetooth 5	✘	Bluetooth 5
Chassis						
Model name	Acer Aspire XC-895	Chillblast Blizzard M-ATX Gaming Case	Asus PN50-BBR048MD	Acer Nitro 50-610	Chillblast Monolith M-ATX Gaming Case	HP Open 25L
Glass side?	✘	✔	✘	✘	✔	✔
Size (WDH)	100 x 330 x 295mm	210 x 397 x 425mm	115 x 115 x 49mm	175 x 386 x 392mm	210 x 397 x 425mm	165 x 369 x 433mm
Front/top ports	2 x 3.5mm, SD card, USB-A, USB-C	2 x 3.5mm, 3 x USB-A	3.5mm, infrared, microSD card, USB-A, USB-C	2 x 3.5mm, USB-A, USB-C	2 x 3.5mm, 3 x USB-A	2 x 3.5mm, 2 x USB-A
Power supply						
Model	Acer custom	Unbranded	External	Acer custom	Fractal Design Essence	HP custom
Wattage	180W	500W	65W	500W	600W	500W
80 Plus rating	Not stated	✔	✘	Not stated	✔	✔
Software						
Operating system	Windows 10 Home	Windows 10 Home	Windows 10 Home	Windows 10 Home	Windows 10 Home	Windows 10 Home
Bundled software	1yr 100GB Dropbox, CyberLink PhotoDirector 8 LE, CyberLink PowerDirector 14 LE	✘	✘	✘	✘	1yr 25GB Dropbox
Bundled hardware and extras	RF wireless keyboard and mouse	802.11n Wi-Fi card	✘	✘	✘	✘

		SUB-£2,000 PCs			
HP Pavilion Pro TP01	**PC Specialist Studio Supreme**	**Alienware Aurora Ryzen Edition**	**Chillblast Fusion Commando 3060Ti Gaming PC** RECOMMENDED	**Cyberpower Ultra 7 RTX Elite**	**PC Specialist Fusion X**
★★★★☆	★★★★★	★★★☆☆	★★★★★	★★★★★	★★★★☆
£583 (£699 inc VAT)	£832 (£999 inc VAT)	£1,549 (£1,859 inc VAT)	£1,250 (£1,500 inc VAT)	£1,333 (£1,599 inc VAT)	£1,249 (£1,499 inc VAT)
currys.co.uk	pcspecialist.co.uk/reviews	dell.co.uk	chillblast.com	cyberpowersystem.co.uk	pcspecialist.co.uk/reviews
TP01-1023na	N/A	d00awr1006	N/A	N/A	N/A
1yr C&R	3yr (1mth C&R, 11mth RTB parts & labour, 2yr RTB labour-only)	1yr on-site	5yr (2yr C&R, 3yr RTB labour-only)	3yr (6mth C&R, 18mth RTB parts & labour, 1yr RTB labour-only)	3yr (1mth C&R, 11mth RTB parts & labour, 2yr RTB labour-only)
78%	93%	76%	92%	87%	93%
84%	93%	83%	92%	90%	93%
81%	93%	81%	93%	86%	93%
Intel Core i5-10400F	AMD Ryzen 5 5600X	AMD Ryzen 9 3900X	AMD Ryzen 7 5800X	AMD Ryzen 7 5800X	AMD Ryzen 7 5800X
Comet Lake	Zen 3	Zen 2	Zen 3	Zen 3	Zen 3
2.9GHz/4.3GHz	3.7GHz/4.6GHz	3.8GHz/4.6GHz	3.8GHz/4.7GHz	3.8GHz/4.7GHz	3.8GHz/4.7GHz
6/12	6/12	12/24	8/16	8/16	8/16
80mm air cooler	PCS FrostFlow 100 V2	80mm air cooler	Chillblast 120 CPU water cooler	Cooler Master MasterLiquid Lite 240	PCS FrostFlow 240 Series
16GB 2,666MHz DDR4	16GB 3,200MHz DDR4	16GB 2,933MHz DDR4	32GB 3,200MHz DDR4	16GB 3,200MHz DDR4	16GB 3,200MHz DDR4
1/2	2/4	2/4	2/4	2/4	2/4
HP Baker	Asus Prime B550-Plus	Dell custom	Asus Prime B550M-A Wi-Fi	MSI X570-A Pro	Asus Strix B550-F Gaming
x16 (0/1)	x16 (1/2)	x8 (1/1)	x16 (0/1)	x16 (1/2)	x16 (1/2)
x1 (1/1)	x1 (2/3)	x4 (1/1)	x1 (1/2)	x1 (1/3)	x1 (1/3)
0/1	1/2	0/1	1/2	1/2	1/2
4 x USB 2	7 (USB 3.2, 4 x USB 3.1, 2 x USB 2)	10 (USB 3.1, 3 x USB 3, 6 x USB 2)	6 (2 x USB 3.2, 4 x USB 3.1)	7 (USB 3.2, 4 x USB 3.1, 2 x USB 2)	7 (USB 3.2, 4 x USB 3.1, 2 x USB 2)
✘	1 (USB 3.2)	1 (USB 3.1)	✘	1 (USB 3.2)	1 (USB 3.2)
Gigabit	Gigabit	Gigabit	Gigabit	Gigabit	2.5 Gigabit
Nvidia GeForce GTX 1650 Super	Nvidia GeForce GTX 1660 Super	AMD Radeon RX 5700 XT	Nvidia GeForce RTX 3060 Ti	Nvidia GeForce RTX 3060 Ti	Nvidia GeForce RTX 3070
4GB GDDR6	6GB GDDR6	8GB GDDR6	8GB GDDR6	8GB GDDR6	8GB GDDR6
DisplayPort, DVI-D, HDMI	3 x DisplayPort, HDMI	3 x DisplayPort, HDMI	2 x DisplayPort, 2 x HDMI	3 x DisplayPort, HDMI	2 x DisplayPort, 2 x HDMI
Intel Optane H10	Seagate FireCuda 520	Toshiba XG6	Seagate FireCuda 520	WD Blue SN550	Seagate FireCuda 520
M.2 NVMe Gen 3 SSD	M.2 NVMe PCIe Gen 4	M.2 NVMe PCIe Gen 3	M.2 NVMe PCIe Gen 4	M.2 NVMe PCIe Gen 3	M.2 NVMe PCIe Gen 4
512GB	500GB	256GB	500GB	1TB	500GB
✘	Seagate BarraCuda	WD Blue	Seagate BarraCuda	Seagate BarraCuda	Seagate BarraCuda
N/A	7,200rpm SATA hard disk	7,200rpm SATA hard disk	7,200rpm SATA hard disk	7,200rpm SATA hard disk	7,200rpm SATA hard disk
N/A	2TB	1TB	4TB	2TB	2TB
HP Slim SuperMulti DVD writer	✘	✘	✘	✘	✘
Wi-Fi 5	802.11n	Wi-Fi 5	Wi-Fi 6	Wi-Fi 6	802.11n
Bluetooth 5	✘	Bluetooth 4.2	✘	Bluetooth 5.1	✘
HP Pavilion Pro TP01	Corsair Carbide Series 275Q	Alienware Aurora Ryzen Edition	Chillblast Crystal M-ATX Gaming Case	Cyberpower Onyxia II	Lian Li Lancool II Gaming Case
✘	✘	✘	✔	✔	✔
155 x 303 x 337mm	211 x 460 x 455mm	223 x 432 x 482mm	210 x 397 x 425mm	206 x 474 x 471mm	229 x 478 x 494mm
3.5mm, SD card reader, 4 x USB-A, USB-C	2 x 3.5mm, 2 x USB-A	2 x 3.5mm, 3 x USB-A, USB-C	2 x 3.5mm, 3 x USB-A	2 x 3.5mm, 2 x USB-A	3.5mm, 2 x USB-A
HP custom	Corsair 550W CV Series	Dell custom	Chillblast 700W 80+ Bronze PSU	Corsair RM750x	Corsair TX650M
310W	550W	550W	700W	750W	650W
✔	✔	Not stated	✔	✔	✔
Windows 10 Home	Windows 10 Home	Windows 10 Home	Windows 10 Home	Windows 10 Home	Windows 10 Home
1yr 25GB Dropbox	✘	✘	✘	✘	✘
Bluetooth mouse and keyboard	✘	Alienware AW510M mouse and 510K mechanical keyboard	✘	✘	✘

Acer Aspire XC-895

The cheapest PC here lacks excitement, but it's a solid machine that's more than capable of routine tasks

SCORE ★★★★☆

PRICE £333 (£399 inc VAT)
from currys.co.uk

There are two obvious types of buyer for the Acer Aspire XC-895: first, someone with a tight budget; second, someone who's tight on space. The Aspire still consumes 100 x 330mm on your desk and it isn't designed for a monitor to sit on top of it, but its faux brushed aluminium front gives it Habitat catalogue flair.

There's practicality here too, with a full-size SD card on the front along with USB-C, USB-A and two 3.5mm jacks. You could add a slimline optical drive – there's a cutout on the front and the bay behind sits free – but you'll need to be both patient and handy with a screwdriver.

This is one of the drawbacks of such a small chassis, but there are more practical upgrade options. The most obvious is to add a second stick of RAM to upgrade the supplied 8GB DIMM, and there's an x1 PCIe slot, but if you're feeling more adventurous then a half-height graphics card will provide a substantial upgrade over the Intel HD 630 graphics. The 180W power supply will limit your choices, but, with a 111W maximum power draw as supplied, there's headroom.

As it stands, this isn't a gaming system: it refused to run most of our benchmarks and stuttered to 24fps in GFXBench's undemanding Car Chase test at 1080p. Bearing in mind this

ABOVE The Acer's clean-cut case Aspires to a style worthy of pricier machines

lack of speed and the minimal power draw, we were surprised by the fact fan noise that became noticeable whenever the CPU was pushed beyond a mundane task.

Nevertheless, a six-core Intel Core i5-10400 processor ensures there's enough power to sail through everyday life with ease, and although the hard disk makes this system more sluggish than rivals that use an SSD, at least it provides 1TB of space. Note that more experienced PC builders can always use that optical drive bay to house a 2.5in SSD at some point, with one SATA connector tucked away ready for action.

With Bluetooth and Wi-Fi 6 built in, plus a respectable RF wireless keyboard and mouse, not to mention a year's subscription to Dropbox with 100GB of storage, the Acer feels like more of a package than the £500 PCs from Chillblast and PC Specialist. If it fulfils all your needs, we see no need to spend more.

Chillblast Versato Family PC

A basic system that offers room to expand in the future, but there's little to thrill today

SCORE ★★★☆☆

PRICE £417 (£500 inc VAT)
from chillblast.com

Compared to PC Specialist, Chillblast takes the traditional route to PC building here. The Versato Family PC has a capacious case that offers one huge advantage: expandability. Based around a high-quality Asus TUF B450M-Plus motherboard, an x16 PCIe slot lies temptingly empty – so if you discover the integrated Radeon RX Vega 11 graphics aren't enough to play games, it's easy to add a dedicated card.

For now, you'll be limited to undemanding titles at 1080p, so think *Fornite* and *Minecraft* rather than *Hitman 2*. Note that Chillblast saves money by opting for an older Ryzen 5

3400G processor, a quad-core CPU that supports multithreading but uses Zen 2 rather than Zen 3 architecture. Even with a generous 16GB of RAM, it came bottom or thereabouts in many of our tests, but it feels faster than the Acer Aspire due to an SSD rather than a hard disk. That's despite Chillblast again saving money by choosing a SATA drive rather than NVMe.

Note that Chillblast provides only one mount for a 2.5in SATA drive, but there are two 3.5in drive bays for adding more storage so this isn't a big problem. The chassis is more Tesco

ABOVE There's a cathedral-sized cavity for upgrades further down the line

Value than Finest, but there's a tinted glass side if you want to see what's happening – which isn't much, unless you choose to supplement the motherboard's basic backlighting with some LED strips.

You'll notice this machine's presence when it's pushed into action, with fan noise ramping up to distracting levels from its usual steady hum. That's despite a low 31W idle power draw and a peak of 129W, which are among the lowest results here, but note the power supply has plenty of headroom.

Your final expansion routes are to add more RAM, with two sockets free, and to fill the spare PCIe x1 slot. Chillblast fills one PCIe slot with an 802.11n Wi-Fi card, illustrating the tight budget constraints, but doesn't hold back on the warranty with five years of cover – and it will cover the courier costs for the first two. And that sums up this PC. It offers a solid foundation for the future, but lacks much excitement today.

PC Specialist Aurora Mini

A miniature PC that stands tall next to its rivals thanks to its pace, even if gamers should look elsewhere

SCORE ★★★★★

PRICE £416 (£499 inc VAT)
from pcspecialist.co.uk/reviews

PC Specialist takes an intriguing approach for this sub-£500 PC. Based around the Asus PN50 barebones chassis we reviewed two months ago (*see issue 315, p47*), it packs a surprising amount of power into a tiny box – and in doing so makes both the Acer Aspire and Chillblast Versato seem bulky, loud and simply overkill for their intended purposes.

Let's tackle its obvious weakness first: this isn't a computer designed for gamers. It relies on integrated Radeon RX Vega 6 graphics, with the "6" in its title referring to the number of graphics cores it has to play with. Compare that to the Chillblast with its RX Vega 11 graphics and the difference in games is predictable, with the far bigger Versato Family PC capable of frame rates twice as high.

Still, the Aurora Mini can cope with undemanding games. Drop *Fortnite* to low settings at 1080p and you'll see smooth results, while the aged *Dirt: Showdown* produced an average 36fps at 1080p and High settings. It's also worth dropping the resolution to 720p, with *F1 2020* improving from its 23fps average at 1080p to 35fps, while *Metro: Last Light* turned an 18fps average into 33fps (all at High presets).

While this PC doesn't threaten the big hitters in our other benchmarks, we think you'll be surprised by just how quick the six-core Ryzen 5 4500U is. It doesn't support multithreading, but a result of 132 in the *PC Pro* benchmarks remains strong enough for many years of life. Note that its single-core power is right up there with far more expensive systems, which is all the more impressive when you consider that the 4500U is part of AMD's mobile processor range.

This provides two advantages, one of which manifests itself in the estimated running cost graph on p93. The Aurora Mini is by far the cheapest runner here, pulling in 48W at its most greedy – that's lower than almost all the other PCs in idle. The CPU still needs the aid of a fan to keep it cool when pushed, but it never rises above

a quiet hum, and most of the time you won't hear any fan noise at all.

One factor to consider is that the power supply is external, but it's a compact unit that will be easy to hide away. As will the Mini itself – you can even use the provided VESA mounting kit to tuck it behind a monitor. The bigger hassle will be to find a cable short enough to avoid a tangle, with a choice of DisplayPort, HDMI and USB-C video outputs.

Considering the Aurora Mini's size, there's quite a selection of ports. Round the back you'll find two USB-A ports and Gigabit along with the video outputs (the USB-C connector can be used for connecting external drives too), while the front is home to a further USB-A and USB-C port, plus a microSD slot, 3.5mm jack and infrared ports. There are also two mics built in.

While internal expansion is largely off the cards, the Asus PN50 sensibly bakes in Wi-Fi 6 and Bluetooth, and because PC Specialist opts for an M.2 storage device you can easily add your own 2.5in SATA SSD at a later point. There's also a spare SO-DIMM socket, with the 2,400MHz Corsair Vengeance DDR4 stick

ABOVE PC Specialist has taken the five-star Asus PN50 and made it even more tempting

PC PRO RECOMMENDED

BELOW The Aurora Mini packs a port punch that belies its diminutive size

that PC Specialist opts for costing around £35 – an affordable upgrade.

We also think PC Specialist chose wisely with the 512GB Intel 660p NVMe SSD, which isn't the fastest M.2 SSD in benchmarks – a 1,609MB/sec sequential read is great, a 900MB/sec sequential write less so – but destroys the hard disk that Acer chooses for the Aspire's primary storage and the slower SATA SSD in Chillblast's sub-£500 system. We're particularly glad that PC Specialist chose a 512GB drive rather than 256GB, as that should be enough for a PC that isn't designed for gaming, video editing or other data-hogging tasks.

Clearly, the Aurora Mini has its drawbacks due to its small size, but overall its many merits make it a great choice for people on a more limited budget. We were similarly impressed by the Asus PN50 as a barebones chassis, but PC Specialist has added a bundle of value with its sensible choice of supporting components – and saves you the worry and cost of installing Windows 10. When you consider that PC Specialist provides three years of cover, the Aurora Mini is a compelling package.

Acer Nitro 50-610

This may not be a dream machine, especially for upgraders, but it's a great all-rounder for the price

SCORE ★★★★☆

PRICE £583 (£699 inc VAT)
from currys.co.uk

When we first set eyes on the Acer Nitro 50-610 four months ago (*see issue 313, p47*), it cost £899. That outing earned the Nitro a three-star review, but with a £200 price drop we're minded to be more charitable about its shortcomings.

The biggest one is a 256GB SSD primary drive. While it's great that this uses PCIe technology rather than SATA, it will quickly fill up if you install games. You will soon have to resort to the 1TB hard disk instead, which is both a pain and means slower load times.

Acer also applies a minor handbrake to the Intel Core i5-10400F processor by only supplying 8GB of

ABOVE The case has a *Robot Wars* glower, while inside space is at a premium

RAM, but this is easy to remedy via the two spare DIMM sockets. Nor is it strictly necessary, as the Nitro still speeds along: its 227 score in our benchmarks beat the identically priced HP Pavilion Pro, which uses the same processor but has 16GB of RAM. The roles would have been reversed had HP chosen a faster SSD, but you're more likely to notice the Acer's limited storage capacity than software running a fraction quicker.

Where Acer indisputably wins is its graphics card, which is a GeForce GTX 1660 Super to the 1650 in the HP. Both cards are better suited to 1080p gaming than 1440p, and the 1660

typically scored 10fps more than the 1650 in our tests at this resolution – for example, in *Metro Exodus* at 1080p the Acer Nitro averaged 58fps to the 46fps of the HP Pavilion. In some games, it will be the difference between playable and not playable.

If you intend to upgrade components, we suggest you look elsewhere. There's a spare 3.5in disk bay, but a compact chassis leads inexorably to tight innards. Despite the lack of a glass side, Acer includes a sprinkling of red LEDs inside the chassis to give the innards a demonic charm. This lighting is visible through holes cut into the metal side, and we recommend you keep this in place as it isn't a pretty machine to gaze at with the side off; wires abound. While the triangular front with a slashed red "V" makes a good first impression, ultimately this is an insubstantial chassis that does little to dampen the buzz from the fans.

Despite its shortcomings, we're drawn to the Nitro's slashed price and all-round speed. It's simply great value for money.

HP Pavilion Pro TP01

A classy and versatile system with the bonus of a good-quality wireless mouse and keyboard

SCORE ★★★★☆

PRICE £583 (£699 inc VAT)
from currys.co.uk

The Acer Nitro and HP Pavilion have more in common than their £699 price, with both machines in lockstep in much of our testing due to their shared processor: the six-core, 12-thread Intel Core i5-10400F. Ignore the colouring and even their chassis have much in column, with a much more compact design than the likes of Chillblast and PC Specialist.

At first sight, there's little room for upgrades, but hunt out HP's maintenance guide for this machine and you'll find that by removing two screws you reach a 3.5in drive bay and get easy access to the single spare DIMM socket. That's because HP only fills one, which is an odd choice when two would have taken advantage of

ABOVE There's a generous supply of ports on the front and even an optical drive

the Intel chipset's support for dual-channel memory. This is one reason why it proved slower than the Acer Nitro, despite having twice the RAM.

The HP also has a slower SSD than the Nitro, but it benefits from 512GB of storage – again, twice that of its Acer rival. Even this will quickly be swallowed by games and video, so you may find that extra storage bay useful for upgrades. Uniquely in this Labs, HP also provides an optical drive, which offers a way of archiving data to recordable DVDs.

Gaming capability comes from a GeForce GTX 1650 Super graphics

card, which is a solid choice that will deliver playable frame rates at 1080p – even 1440p at a stretch – in most games. It's older and slower than the 1660 Super in the Acer Nitro and the more expensive Chillblast and PC Specialist systems, which is why it was consistently 10fps or so slower in tests. If you want the insurance of faster performance, this alone is a reason to choose the Acer.

However, the HP is a more refined system than the Acer, and not simply because it's finished in more stylish silver. The fans are less noticeable during operation, rarely troubling us even during the tougher tests, and we like the generous number of ports on the front: one 3.5mm jack, four USB-As, a full-size SD card slot and a USB-C. What's more, HP rounds off this edition of the Pavilion Pro (code: TP01-1023na) with a stylish wireless mouse and keyboard set.

If you value style, and peace and quiet, more than outright speed, the HP Pavilion Pro TP01 is a better choice than the Acer Nitro.

PC Specialist Studio Supreme

Great if you're after workstation levels of power for £999, but the HP Omen provides tough competition

SCORE ★★★★☆

PRICE £832 (£999 inc VAT)
from pcspecialist.co.uk/reviews

One component takes centre stage in this PC: the AMD Ryzen 5 5600X. As with all the Ryzen 5000 series processors we've tested, based as they are on AMD's superb Zen 3 architecture, it's blisteringly quick. This is one of the fastest computers you can buy for under £1,000, offering workstation levels of power for a relative pittance.

It underlines this point by breaking the 300-point barrier in the *PC Pro* benchmarks, a clear 53 points ahead of its nearest sub-£1,000 rival, which is a remarkable score for a six-core processor. It showed a similar turn of pace in Geekbench and Cinebench,

rivalling the £1,500 PCs for single-core speed. And it does all this without raising much more than a murmur from the PCS FrostFlow 100 air cooler.

PC Specialist provides fine support via 16GB of Corsair 3,200MHz DDR4 RAM, with a Seagate FireCuda M.2 SSD taking advantage of the PCIe 4 interface. We were disappointed that it didn't produce even faster results than 2,782MB/sec sequential reads in AS SSD, but a 1,944MB/sec write speed underlines how fast it is. There's room for another M.2 SSD on the Asus Prime B550-Plus motherboard – or you can add to the 2TB Seagate hard disk via the spare 3.5in bay.

ABOVE Despite all of that Supreme speed, the PC Specialist never raises its voice

The Asus Prime motherboard isn't one of the company's flashiest offerings, but if you remove the solid metal side from the Corsair Carbide case – built with soundproofing in mind rather than beauty – then you'll see occasional streaks of light playing across the board. But that's it for decoration, with function and easy access the order of the day. You won't find a case that's roomier than the Corsair Carbide 275Q, so if you want to add more drives or use one of the three PCIe spare slots, it's simple to do so.

If anything, the inside of the chassis looks bare, which is in part due to the compact GTX 1660 Super graphics card. As we cover in the Chillblast review, in this incarnation it proved around 3fps slower in our slew of test games than in its Intel-powered rival – although this feels like crumbs of comfort when you compare the systems' speed in all the other tests.

If all you seek is the thrill of a multicore monster, the Studio Supreme answers this call with gusto. But for our money, and particularly for £999, the HP Omen 25L is a more rounded machine.

Prices and lead times

A turbulent year like no other has created uncertainty around desktop PC prices and delivery times

It was the email we never want to receive: "Transportation and component costs have increased – in the case of logistics the costs are now ridiculous and increasing all the time." The end result was that the manufacturer in question could no longer honour the price they had originally quoted for the PC they had sent into the Labs, and it would have to rise by £100.

Another manufacturer only had a limited number of slots with its preferred courier and decided to personally drive its systems to us rather than deny a customer their delivery. Through a combination of Brexit and Covid-19, we live in uncertain times – and with

BELOW Covid-19 has meant delivery slots have often been like gold dust

uncertain times come uncertain prices, uncertain logistics and uncertain stock levels.

Considering the turmoil that 2020 brought, we've been pleasantly surprised by the likes of AMD and Nvidia continuing to bring exciting new products to market. We haven't been so pleasantly surprised by how long it often took for those products' announcements to turn into a ready supply. We suspect that one of the reasons why Intel has made an unexpected resurgence in this Labs is because its tenth-generation chips are easier to source than AMD's Ryzen.

All this means that we are cutting manufacturers more slack than we would normally, both on lead

times and prices. While we'll still crack down on any sign of what we consider to be profiteering, if we feel that a price rise from the date of publication is reasonable then we'll officially sanction it via our social media channels.

We also advise you to have more patience when ordering a bespoke PC. Delays aren't just affecting British manufacturers: when we checked with Dell, it had a five-week lead time for its Aurora Ryzen systems.

We are now crossing all available fingers that normal service will resume once 2021 gets into its stride and the pandemic is waning both in the UK and throughout the world. Even if it takes a little longer than we'd hope for these PCs to arrive in your homes and offices, we're confident that they'll be worth the wait.

Chillblast Fusion Marine 1660 Super

A top-quality and well-rounded PC, this Chillblast is a tempting alternative to the HP Omen

SCORE ★★★★★
PRICE £833 (£1,000 inc VAT)
from chillblast.com

From the moment we removed the Chillblast Fusion Marine from its box, one word sprang to mind: class. This PC not only looks gorgeous through the tempered glass, but it's whisper quiet and lit with a degree of taste that would have even Jean Paul Gaultier muttering an appreciative "*bien*". If you want a PC that lights up like a Christmas tree, look elsewhere.

Naturally, good looks will only get you so far, but Chillblast provides a set of high-class components in support. Does the Intel Core i5-10600K really need watercooling? Probably not, but the "K" indicates there's potential for overclocking and Chillblast backs this up with the capable Asus TUF B460M-Plus motherboard. What's more, there's a whopping 32GB of memory supplied across two DIMMs, with a further two spare in the unlikely event that you decide you need more.

While this seems excessive in a £1,000 PC, perhaps Chillblast was aware that even the six-core and 12-thread Core i5-10600K would be made to look humble next to the Ryzen 5 5600X, as found in the PC Specialist Studio Extreme. And it's true: whichever non-gaming test you choose, the Fusion Marine is made to look second best, with the difference in *PC Pro*'s own benchmarks proving particularly bad reading: 249 versus 302 is quite some gulf (*see the results on p92*).

Nevertheless, unless you'll be using this system for tasks that will consistently take advantage of several threads, the difference is almost impossible to discern. You're far more likely to appreciate how quiet the Fusion Marine is during everyday use: sure, there's a continuous low whirr from the 120mm fan connected to the cooler, but it's quiet and stable enough that it soon fades into the background.

You should also notice how quick the primary storage is, whether that's due to the speed of transferring files from an external drive attached to the

USB-C port on the rear or loading a pile of images into your photo editor of choice. Impressively, the M.2 Samsung 970 Evo Plus SSD proved the fastest drive here for writing – which is quite an achievement when two rival £1,500 systems include a PCIe 4 FireCuda drive.

Chillblast also makes the wise choice of investing in a 500GB SSD, which means you can install far more applications on the primary drive than the otherwise brilliant HP Omen with its 256GB unit. There's a spare M.2 slot on the Asus motherboard too, but you'll need to remove the graphics card to access this; not a difficult job, but fiddly. For a simpler life, you may prefer to remove the right-hand panel (kept in place by two easy-to-turn thumbscrews) and use the supplied mounting for a 2.5in SATA drive, or add a second 3.5in drive to accompany the pre-fitted 2TB Seagate hard disk.

In time, you may also choose to replace the GeForce GTX 1660 Super graphics card Chillblast supplies, and with a Fractal Design 600W power supply in place there's plenty of spare capacity

ABOVE The Marine Fusion bests the HP on storage with a 500GB SSD and extra M.2 slot

PC PRO RECOMMENDED

BELOW Chillblast has shunned attention-grabbing LEDs for classy minimalism

from a power consumption point of view: as supplied, the Fusion Marine consumes 50W at idle and peaks at 284W.

This is reflected in mid-table results when it comes to gaming, but across the board we noticed that this Intel-powered system had an advantage of roughly 3fps compared to the AMD-powered PC Specialist Studio Supreme (which also included a GTX Super 1660 card). Admittedly, this won't be enough to make a tangible difference in games, and the Fusion Marine 1660 Super is best thought of as a smooth performer in 1080p with the ability to stretch to 1440p in less demanding titles.

To put that into concrete figures, this PC managed 102fps at 1440p (High settings) in *F1 2020* but dropped down to 61fps in *Shadow of the Tomb Raider* and 44fps in *Metro Exodus*. Switch to 1080p and those figures jump to 149fps, 91fps and 59fps.

The one problem for Chillblast is that the HP Omen 25L costs the same and was substantially faster in games due to its GeForce RTX 2060 graphics card. And for games that support ray tracing and Deep Learning Super Sampling (DLSS), its typical 10fps advantage can jump to 20fps with superior image quality.

As such, the HP Omen is the better choice if your priority is 1440p gaming. Nevertheless, there are still many reasons to buy the Chillblast: note the superior warranty, better expansion options and more storage. Plus the HP is only available in a limited selection of configurations, while you can call up Chillblast and tweak almost any option. Even though the stylish HP Omen earns our top accolade of Labs Winner, they're both brilliant systems that we're happy to recommend.
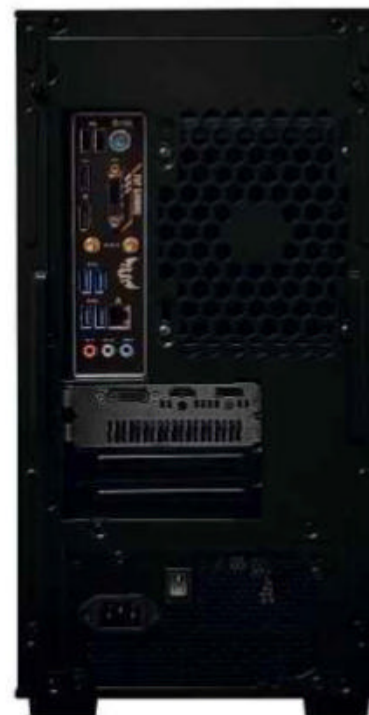
HP Omen 25L

The surprise package of this Labs, this is a top-quality gaming PC complete with Nvidia RTX graphics

SCORE ★★★★★

PRICE £832 (£999 inc VAT)
from currys.co.uk

If you had preconceptions about HP's PCs, perhaps considering Hewlett-Packard's biggest talent being to churn out printers and boring corporate computers, set them aside. The HP Omen is a high-class affair with a degree of industrial chic that other manufacturers could – and should – learn from.

The first sign of this is when you switch the Omen on. Rather than be hit with an array of multicoloured LED lights, the inside of the case lights up like a display case in a jewellers, except rather than glistening gold your eyes are treated to a combination of understated black and white. HP doesn't attempt to hide away the cables, placing them front and centre as they snake around the inside of the case. It's a striking combination of form and function.

In this particular configuration, we were also struck by the backlit "GEFORCE RTX" across the centre of the graphics card. HP is wise to draw attention to this, as the inclusion of an RTX card is the big advantage it holds over both Chillblast and PC Specialist at this price point. Where the British PC makers opt for the GTX 1660 Super cards, HP offers an RTX 2060.

As any gamer will be aware, the RTX 2060 is now officially old hat due to Nvidia releasing its swathe of RTX 3000 series cards – but we've only seen those cards in systems costing four figures. And it's not as if the RTX 2060 has become slow just because its successor has appeared. Not only did this card prove a cut above the GTX 1660 Super in all our gaming tests, it also supports ray tracing – and games are now taking advantage.

Away from ray tracing, you can expect a solid 10fps boost over GTX 1660 Super cards at both 1080p and 1440p resolutions. For example, in *Metro Exodus* at 1440p the Omen averaged 54fps to the 44fps of the Chillblast Fusion Marine, while it returned 72fps in *Shadow of the Tomb Raider* to 61fps for the Chillblast. And because the RTX 2060 supports Deep Learning Super Sampling (DLSS), it could reach 78fps with this switched

on. Perhaps even more tellingly, it hit 49fps at 4K in *Shadow of the Tomb Raider* with DLSS, while the Chillblast was stuck on a stuttery 33fps.

Both the Chillblast and PC Specialist systems have greater straight-line speed thanks to superior processors. HP sticks with the Core i5-10400F found in the much cheaper Pavilion Pro, and while this is a fast processor in isolation it's made to look positively turgid by the i5-10600F in the Chillblast and the shiny new Ryzen 5 5600X in the PC Specialist.

Turn to the first five graphs on p92 and you'll see what we mean. Whether it's Cinebench, Geekbench or the *PC Pro* benchmarks, the Omen falls well behind its similarly priced rivals – especially the Ryzen-powered Studio Supreme. Thankfully, HP provides two sticks of 8GB memory here to pull out a lead over the Pavilion Pro, hampered by a single DIMM and therefore not using the bandwidth provided by dual-channel memory, and we noticed that this was the only component where HP opted for a brand: you'll find heatsink-equipped HyperX Fury DIMMs in

BELOW A glowing white diamond gives the front of the case a sci-fi feel

place. Two sockets are empty if you want to add more at a later point.

Elsewhere, it's HP all the way, including a custom motherboard and 500W 80 Plus Bronze power supply. It's a power-efficient system, idling at 40W and hitting a peak of 270W, and this is reflected by the low whirr of its fans. They're audible in a quiet room but never annoying, and by the time the fans kick up a gear you probably won't notice as you'll be so ensconced in the game pushing it.

It's a shame that HP doesn't provide more excuses to open the case, because it uses an elegant solution where you press a button marked "INTERNAL ACCESS" and the glass side is released from its catch. Aside from the two DIMM sockets, there's a 3.5in hard disk bay complete with toolless caddy – and that's it. No PCIe slots, no spare M.2 sockets. It's a good thing the motherboard includes every feature you need, from a USB-C port at the rear to built-in Wi-Fi 6 and Bluetooth.

HP also flexes its muscles when it comes to the utilities and Omen Gaming Hub. For instance, if you aren't a fan of the clear white lighting theme the Omen ships with (which includes a backlit diamond on the front of the chassis), you can create your own lighting setup or choose another of HP's presets. For more prosaic housekeeping, such as keeping drivers up to date, HP provides everything you need via its JumpStart utility.

All of this, together with the high quality of the chassis and superb gaming performance, marks the Omen 25L out from the £1,000 crowd. For the first time in many years, this earns HP a Labs Winner award for one of its non-business desktop PCs. Some might call it a good Omen…

Alienware Aurora Ryzen Edition

The new Aurora Ryzen Edition adds a splash of style, but it can't match cheaper and faster machines

SCORE ★★★☆☆

PRICE £1,549 (£1,859 inc VAT)
from dell.co.uk

It's been some time since Dell entered one of our desktop PCs Labs so we were delighted when it agreed to send in its new Alienware Aurora Ryzen Edition, even if it inadvertently broke our maximum guide price of £1,500 inc VAT and forced us to raise the bar to £2,000. Still, one of the best things about buying from Dell is that you can tweak the components to fit your budget, and there really is nothing else like the Aurora in terms of design.

If you decide you want to buy this exact specification then enter "d00awr1006" into the search box at **dell.co.uk**, select the £1,749 option and upgrade the Ryzen 3900 to the 3900X we tested. Now you can start upgrading and downgrading as you please, and there are two obvious upgrades you can make: to double the boot drive's size from 256GB to 512GB for £50 and upgrade the Wi-Fi 5 to Wi-Fi 6 for £20.

Note that as part of the bundle you'll also receive an excellent mechanical keyboard, the Alienware 510K. Dell sells this standalone for £143, with Cherry MX Red switches that offer crisp responses with the minimum of pressure. The Alienware 510M mouse doesn't exude the same level of quality, with a lightweight plastic construction, but there's still everything that gamers need here – including a 16,000dpi sensor and six programmable buttons that sit under your left thumb.

Naturally, RGB lighting comes as part of the deal, and the annoyingly spelt Alienware Command Center is where you take control. Dell shipped the Aurora with an understated neon blue glow, but you're free to make it as garish as you like – or switch everything off.

If nothing else, the lighting on the front makes it easier to find the front-mounted ports in a dark room, with three Type-A USB slots and one USB-C connector (along with 3.5mm jacks for a headphone and mic). Things get more interesting when you open up the side panel, with Dell's approach in stark contrast to other vendors.

It starts simply enough: lift up a catch and the side pops away for easy removal. This done, you're faced with a wall of metal that includes the power supply. At this point, we strongly recommend you switch the computer off. You then have to locate two locks on the rear of the machine before taking your life in your hands and swinging the structure that contains the power supply out of the way, to reveal the motherboard. Unless you're careful, it yanks the graphics card out of its socket in the process; remove its power connectors and the metal arm swings completely out of the way.

Having hacked your way to victory, there's a sense of anticlimax when you realise the only upgrades available are via two empty PCIe slots (one x1, one x8) and two spare DIMM sockets. Also note that despite the size of the chassis, it's cramped inside and you'll have

to remove the graphics card if you want to access those PCIe slots. The good news? Adding more storage is simplicity itself, with two 2.5in bays sitting empty and in easy reach the moment you undo the side.

Dell provided a standard air cooler in this configuration, but you can upgrade to liquid cooling for another £60. That's well worth consideration because Dell clearly feels the need to aggressively cool the CPU by upping the fans at the slightest prompt – and with it the already substantial fan noise. We prefer the PC Specialist Fusion X's approach of being noisy all the time. The ramped-up fan is particularly noticeable when you're playing games, but even when idling it will accelerate for no obvious reason.

Another reason for Dell's aggressive cooling is this machine's choice of components, with the 12-core Ryzen 9 3900X one powerful beast. However, this CPU has now been usurped by the 5950X, and the improvement between the 3900X's Zen 2 architecture and the Zen 3 design found in the Ryzen 5000 series processors is hammered home by the £1,500 Chillblast and PC Specialist machines being frequently faster in our benchmarks – despite having fewer cores.

Dell also gives us our sole look at an AMD graphics card, but, as its results in our gaming tests show, the Radeon RX 5700 XT is no match for the RTX 3060 Ti. It's still fast, averaging 98fps across our tests at 1440p, but here a high of 187fps in the undemanding *F1 2020* masks a more disappointing 67fps in *Metro Exodus*.

Still, as we said at the start, the glory of Dell's approach is that you can mix and match as you see fit, with prices starting from £979. One final note: it's always worth firing up the chat service on the Dell website, as deals can often be struck.

Chillblast Fusion Commando 3060Ti Gaming PC

Quite simply a brilliant PC that keeps the noise down while delivering some of the best results we've ever seen

SCORE ★★★★★
PRICE £1,250 (£1,500 inc VAT)
from chillblast.com

One of the advantages of a single manufacturer supplying a £500, £1,000 and £1,500 PC is that you can see the evolution of a great PC. The Fusion Commando started from humble beginnings in the Versato (*see p82*), with its handful of basic components rattling around a case. It grew into a proper mid-range gaming system in the Fusion Marine (*see p86*), before blossoming into this: a well-rounded, high-quality PC that can turn its hand to anything.

It helps that Chillblast effectively uses the same case design for all three systems, with the dimensions staying the same but the quality of the materials increasing at every step. Here, we reach the top of the line with tempered glass not only on the left-hand side of the system but also at the front: Chillblast takes advantage by fitting three 100mm RGB fans, with one further RGB fan mounted at the top and a 120mm fan at the rear. The result is a constant hum, but unlike other powerful systems on test the fans don't ramp up and down in an irritating fashion; once you start working or playing games, the noise fades into the background.

The 120mm fan we mention above is part of the Chillblast 120 liquid cooler system, which is there to keep the Ryzen 7 5800X operating at its maximum potential. And it succeeds: the Fusion Commando lived up to its aggressive name with top scores in several of our tests, including our benchmarks, where it was the only system to break the 400 barrier. This lift was due in part to the 32GB of memory whilst its rivals only supplied 16GB, but there's still room to add more via two empty DIMM sockets.

While it's true that 32GB of RAM is overkill for most applications, and certainly not necessary for games, if you're manipulating huge files (think 4K video editing, for example), it does make a difference. It's no coincidence that the Chillblast topped the single-core Cinebench R23 rendering test, and only narrowly fell behind the 16-core-equipped Alienware in the multicore version of that same task.

If you're after all-out gaming power, the noisier PC Specialist Fusion X has the upper hand courtesy of Nvidia's GeForce RTX 3070 card, but we think few people will complain about the RTX 3060 Ti that Chillblast chooses. Remarkably, this mid-range card (it costs just under £400) is as fast as an RTX 2080 Super, which underlines yet again what an amazing job Nvidia has done with the RTX 3000 series. Our one concern is about availability as this is a new card and it's in scarce supply at the moment.

So, how fast is it? The first glimpse of its power comes in 3DMark Time Spy, with a stunning result of 11,577. Our weighted graphs on p92 further develop the story, which is that this card is brilliant at 1440p – averaging 127fps – and that it's no slouch in 4K with an average of 84fps. However, you may need to tone down settings at 4K for smooth running.

Take *Shadow of the Tomb Raider*. At 1440p (High settings), it averaged 112fps without DLSS, and still hit an average of 65fps at 4K. Activating DLSS lifted that to 74fps. In *Metro Exodus* at High presets, it

managed 82fps at 1440p and 50fps at 4K, while *Hitman 2* (with super sampling set to 2x and our usual mix of high/ strong settings) struggled to 42fps at 1440p and 18fps at 4K. But *Hitman 2* is made instantly playable by changing super sampling to 1x, with 4K jumping to 68fps and 1440p to 121fps.

As we explain in the PC Specialist Fusion X review, the RTX 3070 is notably faster – typically giving you 10fps more – and that can be the difference between playable and non-playable games. But you have to make a decision at some point; after all, the RTX 3080 is faster still, delivering 125fps in *Shadow of the Tomb Raider* at 4K with DLSS.

For the vast majority of people, even ardent gamers, we think the RTX 3060 Ti delivers an excellent balance between value, speed and power consumption. Its 200W thermal design power means Chillblast can include a 700W power supply in this PC without fear of overload, and an idle 60W consumption and 395W peak are surprisingly reasonable considering all the speed this PC packs.

Nor do we think you'll need to make any upgrades in the near future. Yes, a 1TB SSD would have been more roomy than the 500GB FireCuda PCIe 4 drive that Chillblast provides, but this proved to be a top performer in AS SSD with 4,035MB/sec sequential reads and 2,565MB/sec writes. Plus there's 4TB of hard disk storage when you need it, and a spare M.2 slot on the Asus Prime B550M-A motherboard. The only features we miss are Bluetooth and USB-C, but the former is easy enough to add via a USB dongle and the latter via the spare PCIe x1 slot.

With Chillblast backing up this PC with a far more generous warranty than its rivals – including two years of collect-and-return cover that also includes the cost of parts – the Commando is nothing short of a bargain. Place your order early to avoid disappointment.

ABOVE With this much grunt at hand, you won't need to upgrade any time soon

PC PRO RECOMMENDED

BELOW The Fusion Commando's case and performance both trip the light fantastic

Cyberpower Ultra 7 RTX Elite

A powerhouse of a PC that somehow stays quiet even when pushed and is packed with quality components

SCORE ★★★★☆

PRICE £1,333 (£1,599 inc VAT)
from cyberpowersystem.co.uk

W e've been consistently impressed with the speed and quality of Cyberpower's PCs, but we confess that we have criticised its systems in the past for fan noise. Well, we have no such worries with the Ultra 7 RTX Elite. This isn't to suggest it's silent, which is too much to expect of a system packed with this much power, but Cyberpower's judicious use of large fans and a liquid cooler ensure that it's never irritating. The only sound that interrupted our thoughts when using this PC was the occasional cute gurgle from the Cooler Master MasterLiquid Lite 240.

By contrast, the light display that appears when you switch on the Ultra 7 RTX Elite for the first time can be described as many things, but "quiet" isn't one of them. Think 1980s disco, with five LED fans contributing to the party – including three that shine through the tempered glass front of the case. Fortunately, you have full control over the lights via a remote control, so whether you want crazy colours, classy white or to switch the whole lot off, you have the choice.

As its name suggests, the Cyberpower Onyxia II case is of the company's own design; note that Cyberpower UK is the British arm of the US company. Although it's large and heavy, we like this case both for its quality of construction and its ease of use. Add Cyberpower's neat cabling and it couldn't be easier to work inside, or to admire through the tempered glass side window.

There's a lot of substance to back up the style, with Cyberpower investing in an MSI motherboard based around AMD's top-end X570 chipset. This means support for PCIe 4 for all expansion ports, not just the graphics card and M.2 storage ports, which in turn means greater storage expansion if you'll take advantage. In fairness, that's a big "if", but it's still nice to have the option.

Technically, the MSI X570-A Pro board offers four PCIe ports, but with one blocked by the graphics card and

one used by an Intel Wi-Fi 6 AX200 card only two remain free for you to use. You may want to upgrade the Gigabit Ethernet at some point, for example, or introduce more USB-C ports to complement the single such connector at the rear.

There's also an empty M.2 slot, but Cyberpower fits a generous 1TB NVMe SSD in the primary slot. Other SSDs proved faster, but few people will complain about the Ultra 7 RTX Elite's 2,232MB/sec read rate or its sequential write speed of 1,927MB/sec – the third fastest score here. A 2TB Seagate hard disk sits at the ready for storing data, and there are many routes for expanding this storage: Cyberpower provides two mounts for 2.5in SATA drives in the main body of the case, and there's space (just) for a second 3.5in hard disk that's accessible once you remove the case's right-hand side.

Adding to the 16GB of RAM is much easier, but as ever we doubt that you'll find any immediate reason to do so. Whatever task you care to throw a this system, powered as it is by AMD's new Ryzen 7 5800X processor, it will complete in next to no time. That's the beauty

of having eight cores and 16 threads, and with all the enhancements to AMD's Zen 3 architecture it's no surprise at all that it often beats the older Ryzen 9 3900X in our tests – despite the 3900X having 12 cores.

The new generation of Ryzen chips also have an advantage in games, which Cyberpower fully exploits by including Nvidia's RTX 3060 Ti graphics. We cover this card's abilities in the Chillblast Fusion Commando review, but it's worth emphasising once again that it matches the RTX 2080 Super for speed. For 3DMark aficionados, a Time Spy result of 11,559 says everything you need to know about this PC's gaming credentials. Only *Hitman 2* and *Metro Exodus* forced it below 100fps at 1440p, and even then *Hitman 2* reached 112fps once we reduced super sampling from 2x to 1x.

Let there be no doubt, then, that this is a terrific PC. If it weren't for the pesky Chillblast Fusion Commando, which offers the same dizzying levels of performance at £100 less (albeit with a smaller M.2 SSD), the Cyberpower Ultra 7 RTX Elite would have been challenging for our top awards this month.

PC Specialist Fusion X

Big, noisy and a whole lot of fun, the Fusion X proved to be the most potent PC in this highly competitive Labs

SCORE ★★★★☆
PRICE £1,249 (£1,499 inc VAT)
from pcspecialist.co.uk/reviews

We suspect that PC Specialist's engineers referred to this one as "The Beast" in the privacy of their labs. Not just due to the size of the Lian Li Lancool II case, a giant at 229 x 478 x 494mm, but because of the roar it makes when it's switched on: there's no hiding from the sound of the six 120mm fans that collectively aim to keep the Fusion X cool.

It's the kind of unapologetic noise we expect from workstations, and in terms of horsepower that's what you can expect to enjoy. The Ryzen 7 5800X's eight cores and 16 threads sliced their way through Cinebench R23's multicore test scene in no time, finishing with a result of 15,457. Only the 12-core Alienware was faster, and even then by a handful of points. It's the kind of task this PC relishes, with the fans kicking up yet one further gear to hammer home the point.

We continued to see this turn of pace throughout our tests. The Fusion X came second only to the Chillblast Fusion Commando in the *PC Pro* benchmarks, slashing its way to 398 and this time beating the Alienware Aurora Ryzen Edition on its way, and stormed to the top of the charts in Geekbench 5's single-core benchmark – it's notable that all of the PCs powered by AMD's latest Ryzen 5000 series chips dominated here.

But it was games where the Fusion X truly showed its speed supremacy. PC Specialist finds room in its budget for a GeForce RTX 3070 graphics card, and true to form it had a clear lead in every test. Let's start with the one synthetic gaming benchmark we use: 3DMark Time Spy. Here the Fusion X romped to 13,507, a full 2,000 points clear of its rivals and pushing it into true 4K gaming territory.

For the sake of simplicity, we use a weighted average to show each PC's gaming performance *(see overleaf)*, and this again shows how fast the Fusion X was compared to the rest. It averaged 100fps across all the games, 16fps in front of the Chillblast with its still excellent GeForce RTX 3060 Ti graphics card.

If we were to choose a 4K highlights reel, we would point to 211fps in *F1 2020* and 130fps in *Metro: Last Light*, but also find space for 60fps in *Metro Exodus* and 75fps in *Shadow of the Tomb Raider.* That improved to 86fps with DLSS activated. It was only our traditional torture test of *Hitman 2* at 4K, with a collection of "High/Strong" settings and super sampling at 2x, that this PC shifted into unplayable territory with 23fps. But even the RTX 3080 in the £4,100 Scan 3XS RTX Studio Pro G132R *(see issue 316, p52)* could only manage 36fps in that test.

These stellar results couldn't have been achieved without the help of a high-quality cooler, and that pivotal role is played by the PCS FrostFlow 240 Series liquid cooler. The liquid is cooled via two 120mm ceiling-mounted fans, which is why you shouldn't be tempted to use the top of the case for storage no matter how tempting its vast expanse of space is.

The pipes that draw the liquid away are the only obstacles in your way if you want to make any upgrades, because this is a ludicrously easy case to work in. You don't even need to undo any screws: pull down the metal flap at the bottom of the case and you reveal the Corsair

ABOVE Liquid cooling pipes aside, this beast of a case is incredibly easy to navigate

BELOW The lights are positively understated, but the performance certainly isn't

TX650M power supply and a three-bay caddy for adding more hard disks (PC Specialist supplies a single 2TB Seagate drive). This then frees the tempered glass panel, which is on a hinge and swings out of the way.

With this open, you're free to access every aspect of the Asus Strix B550-F Gaming motherboard. And then – well, there isn't much to improve. You might want to increase the memory, with two 8GB Corsair Vengeance modules currently in place and two spare DIMM sockets, but there's little else to add. The only obvious candidate is to upgrade the 802.11n Wi-Fi card that currently sits in one of the two accessible PCIe x1 slots.

We would also consider buying a second M.2 card at some point, as you may find the 500GB Seagate FireCuda 520 doesn't have quite enough storage for your ambitions. Again, this is a relatively straightforward upgrade, although you'll have to dig out a crosshead screwdriver to first remove the heatsink that covers the slot. Note the FireCuda is a PCIe 4 drive, with theoretically much greater bandwidth than a Gen 3 device, but this wasn't borne out in our tests using AS SSD: a sequential read of 2,782MB/sec is on a par with previous fast NVMe SSDs, as are sequential write speeds of 1,914MB/sec. Still, let's not forget that those are still extremely fast results.

Of more concern to people who watch their pennies is this PC's running costs: at 75W even when idling these will rack up, and with a peak draw of 434W we extrapolated a "typical" user could spend £63 per year keeping this PC on. That's the most expensive system on test. Still, we have a funny feeling that PC Specialist won't mind this accolade: it's only fitting for a machine that was also the fastest performer.

Test results

PC Pro benchmarks (overall)

PC	Score	Note
Chillblast Fusion Commando	406	Recommended
PC Specialist Fusion X	398	
Alienware Aurora Ryzen	394	
Cyberpower Ultra 7 RTX Elite	347	
PC Specialist Studio Supreme	302	
Chillblast Fusion Marine	249	Recommended
Acer Nitro 50-610	227	
HP Omen 25L	226	Labs Winner
HP Pavilion Pro TP01	206	
Chillblast Versato Family PC	151	
PC Specialist Aurora Mini	132	Recommended
Acer Aspire XC-895	117	

Geekbench 5 (single-core)

PC	Score	Note
PC Specialist Fusion X	1,636	
Chillblast Fusion Commando	1,633	Recommended
Cyberpower Ultra 7 RTX Elite	1,608	
PC Specialist Studio Supreme	1,580	
Chillblast Fusion Marine	1,291	Recommended
Alienware Aurora Ryzen	1,230	
HP Omen 25L	1,140	Labs Winner
HP Pavilion Pro TP01	1,102	
PC Specialist Aurora Mini	1,077	Recommended
Acer Nitro 50-610	1,065	
Acer Aspire XC-895	1,054	
Chillblast Versato Family PC	933	

Geekbench 5 (multicore)

PC	Score	Note
Cyberpower Ultra 7 RTX Elite	10,137	
Alienware Aurora Ryzen	10,130	
Chillblast Fusion Commando	10,013	Recommended
PC Specialist Fusion X	9,969	
PC Specialist Studio Supreme	8,106	
Chillblast Fusion Marine	6,633	Recommended
HP Omen 25L	6,082	Labs Winner
Acer Nitro 50-610	5,822	
HP Pavilion Pro TP01	5,209	
PC Specialist Aurora Mini	4,128	Recommended
Acer Aspire XC-895	4,090	
Chillblast Versato Family PC	3,749	

Cinebench R23 (single-core)

PC	Score	Note
Chillblast Fusion Commando	1,614	Recommended
Cyberpower Ultra 7 RTX Elite	1,604	
PC Specialist Fusion X	1,592	
PC Specialist Studio Supreme	1,534	
Chillblast Fusion Marine	1,273	Recommended
Alienware Aurora Ryzen	1,228	
PC Specialist Aurora Mini	1,153	Recommended
Acer Aspire XC-895	1,150	
HP Omen 25L	1,133	Labs Winner
Acer Nitro 50-610	1,127	
Chillblast Versato Family PC	1,066	
HP Pavilion Pro TP01	1,063	

Cinebench R23 (multicore)

PC	Score	Note
Alienware Aurora Ryzen	15,668	
PC Specialist Fusion X	15,457	
Chillblast Fusion Commando	15,253	Recommended
Cyberpower Ultra 7 RTX Elite	14,936	
PC Specialist Studio Supreme	10,516	
Chillblast Fusion Marine	9,276	Recommended
HP Omen 25L	8,147	Labs Winner
Acer Aspire XC-895	7,604	
HP Pavilion Pro TP01	7,420	
Acer Nitro 50-610	7,319	
PC Specialist Aurora Mini	4,904	Recommended
Chillblast Versato Family PC	4,873	

3DMark Time Spy (overall)

PC	Score	Note
PC Specialist Fusion X	13,507	
Chillblast Fusion Commando	11,577	Recommended
Cyberpower Ultra 7 RTX Elite	11,559	
Alienware Aurora Ryzen	9,417	
HP Omen 25L	7,088	Labs Winner
Chillblast Fusion Marine	6,112	Recommended
Acer Nitro 50-610	5,954	
PC Specialist Studio Supreme	5,923	
HP Pavilion Pro TP01	4,753	
Chillblast Versato Family PC	1,396	
PC Specialist Aurora Mini	602	Recommended
Acer Aspire XC-895	376	

1080p gaming (weighted average, fps)

PC	fps	Note
PC Specialist Fusion X	182	
Chillblast Fusion Commando	168	Recommended
Cyberpower Ultra 7 RTX Elite	168	
Alienware Aurora Ryzen	125	
HP Omen 25L	102	Labs Winner
Chillblast Fusion Marine	93	Recommended
Acer Nitro 50-610	92	
PC Specialist Studio Supreme	90	
HP Pavilion Pro TP01	79	
Chillblast Versato Family PC	19	
PC Specialist Aurora Mini	8	Recommended
Acer Aspire XC-895	0	

1440p gaming (weighted average, fps)

PC	fps	Note
PC Specialist Fusion X	148	
Chillblast Fusion Commando	127	Recommended
Cyberpower Ultra 7 RTX Elite	125	
Alienware Aurora Ryzen	98	
HP Omen 25L	74	Labs Winner
Chillblast Fusion Marine	61	Recommended
Acer Nitro 50-610	60	
PC Specialist Studio Supreme	58	
HP Pavilion Pro TP01	54	
Chillblast Versato Family PC	12	
PC Specialist Aurora Mini	5	Recommended
Acer Aspire XC-895	0	

4K gaming (weighted average, fps)

PC	fps	Note
PC Specialist Fusion X	100	
Chillblast Fusion Commando	84	Recommended
Cyberpower Ultra 7 RTX Elite	83	
Alienware Aurora Ryzen	60	
HP Omen 25L	42	Labs Winner
Chillblast Fusion Marine	34	Recommended
Acer Nitro 50-610	33	
PC Specialist Studio Supreme	32	
HP Pavilion Pro TP01	32	
Chillblast Versato Family PC	8	
PC Specialist Aurora Mini	3	Recommended
Acer Aspire XC-895	0	

View from the Labs

When choosing a winning desktop PC, the raw numbers only provide part of the picture

There were times when I lost track of the day, the month, even the year. When you're buried in testing, things blend into one. Your life is a constant battle against benchmarks that misbehave, computers that run out of storage space and reams of identical sheets of paper with something scrawled on them that's probably, definitely, maybe a three. Or an eight. Not sure? Time to rerun the benchmark.

In a fog of results such as this, it's easy to be distracted by the siren call of numbers rather than the factors that will genuinely make a difference if someone buys the computer on test. And trust me, I take this responsibility seriously: 99 times out of a 100 the people who write into *PC Pro* after buying something we recommend do so to say thank you, but there's always one out of 100 who is left unhappy with the purchase. Was it something I said? Something I didn't say? A test I didn't run?

This isn't the same thing as the cynics I occasionally meet who, after finding out what I do for a living, declare that it's all paid-for and that they don't trust magazines. I've grown used to that over my 22 years of testing kit, and now know that nothing I tell them will change their minds – even when I point out that, if our reviews were paid for, *PC Pro* would have

Tim Danton is *PC Pro*'s editor-in-chief and is looking forward to having his office back

> **"Deciding which PCs won awards in this month's Labs was a fuzzy logic decision that I'd struggle to explain to DeepMind"**

RIGHT The look, feel and sound of a PC are important factors too

winked out of existence many years ago. Although I do confess, my voice dropping to a whisper, that Dell did treat me to a rather nice Christmas lunch once.

It helps that I have a mantra when writing reviews, one that I've shared with everyone who reviews a product for this magazine – and that was shared with me when I started in 1999. That is, "no opinion without fact". Whilst there isn't always room to explain *exactly* why I've come to a conclusion about a particular product, I'll do my best to provide a set of reasons so that someone reading the magazine will understand that I'm not giving a product an award because of that nice lunch.

So, facts are good. When it comes to a Labs like this one, however, you can drown in them. With reluctance, I've had to grossly simplify my hours of games benchmarking to the three graphs you see opposite. There's a spreadsheet that contains all the results across all the games, with yet more results on sheets when I "just wondered" how fast that particular system would be with that setting rather than the default. If you're interested, feel free to email me (**editor@pcpro.co.uk**) and I'll send you my master spreadsheet.

Ultimately, though, deciding which PCs won awards in this Labs and how many stars out of five to give them was a fuzzy logic decision that I'd struggle to explain to DeepMind. Not just how fast a PC was, but the quality of the case, how noisy it got during testing, the level of support I believe each company will provide (not based on gut instinct but by what *PC Pro* readers tell us in surveys) and many factors beside. By the end of the testing, the answer is clear. But, hey, that's just my opinion. ●

Sequential read	(AS SSD, MB/sec)
Chillblast Fusion Commando	Recommended 4,035
Chillblast Fusion Marine	Recommended 2,890
Alienware Aurora Ryzen	2,848
PC Specialist Studio Supreme	2,797
PC Specialist Fusion X	2,782
Cyberpower Ultra 7 RTX Elite	2,232
PC Specialist Aurora Mini	1,609 Recommended
Acer Nitro 50-610	1,451
HP Omen 25L	1,428 Labs Winner
HP Pavilion Pro TP01	831
Chillblast Versato Family PC	482
Acer Aspire XC-895	175

Sequential write	(AS SSD, MB/sec)
Chillblast Fusion Marine	Recommended 2,565
PC Specialist Studio Supreme	1,944
Cyberpower Ultra 7 RTX Elite	1,927
Chillblast Fusion Commando	Recommended 1,914
PC Specialist Fusion X	1,914
Alienware Aurora Ryzen	1,619
HP Omen 25L	Labs Winner 1,170
PC Specialist Aurora Mini	900 Recommended
HP Pavilion Pro TP01	872
Acer Nitro 50-610	837
Chillblast Versato Family PC	381
Acer Aspire XC-895	151

Estimated running costs per year	
	Based on two hours of peak power and six hours of idle per day at £0.13 per kWh.
PC Specialist Aurora Mini	£7 Recommended
Acer Aspire XC-895	£15
Chillblast Versato Family PC	£21
HP Pavilion Pro TP01	£22
Acer Nitro 50-610	£28
HP Omen 25L	Labs Winner £37
PC Specialist Studio Supreme	£39
Chillblast Fusion Marine	Recommended £41
Alienware Aurora Ryzen	£47
Chillblast Fusion Commando	Recommended £55
Cyberpower Ultra 7 RTX Elite	£61
PC Specialist Fusion X	£63

The Network

Practical buying and strategic advice for IT managers and decision makers

BUSINESS FOCUS

BUYER'S GUIDE TO
Cloud file sharing in 2021

Sharing documents via the cloud is a great way to keep your employees in sync. **Dave Mitchell** tries out four top services and explains what to look for

You may have spotted a theme to our buyer's guides over the past nine months or so. The pandemic has required businesses to find new ways to work, collaborate and communicate – and while an end to the crisis may finally be in sight, many companies will opt to continue some of those new practices even after restrictions have been lifted.

Cloud file sharing is a natural fit for this new working normal. It gives remote staff a secure, seamless way to share documents and collaborate with colleagues, no matter where they are. There's no need to set up a complicated VPN to provide homeworkers with full LAN access: the cloud lets them get at the resources they need at any time, from anywhere, on their choice of device.

You're not short of options, either. There are plenty of business-oriented cloud services to choose from, offering a diverse range of file-sharing and collaboration features. This month, we put services from Box, Egnyte, IDrive and Tresorit through their paces in the lab to help you make the right buying decision.

■ The lion's share

File-sharing providers invariably offer a range of storage plans, so you can choose the one that best fits your requirements and budget. Some even offer free tiers – but such offerings are unlikely to work for most businesses. They normally come with very limited storage capacities, and restrictive size limits on files that can be uploaded and shared.

That's not to say that paid-for plans are free of restrictions. Don't get caught out: tariffs are often advertised as offering a certain number of gigabytes or terabytes of storage, but this isn't a per-user allowance – it's a total amount of storage that will be shared amongst them all.

As to how much storage you actually require, this will depend on the file types your staff are working with. Office documents, spreadsheets and presentations don't normally require a lot of space, and it goes without saying that you don't want to waste money on a plan that exceeds your needs. However, if you work with very large files, such as raw video footage or medical images, you might want to consider a plan that offers unlimited storage. The price may be steep, but you won't have to worry about running out of space at a critical moment.

On a similar note, check what the limits are on file sizes. Almost all providers won't let you upload files

"User activity logging lets you pull up reports detailing which files each person has viewed, edited, shared and so on"
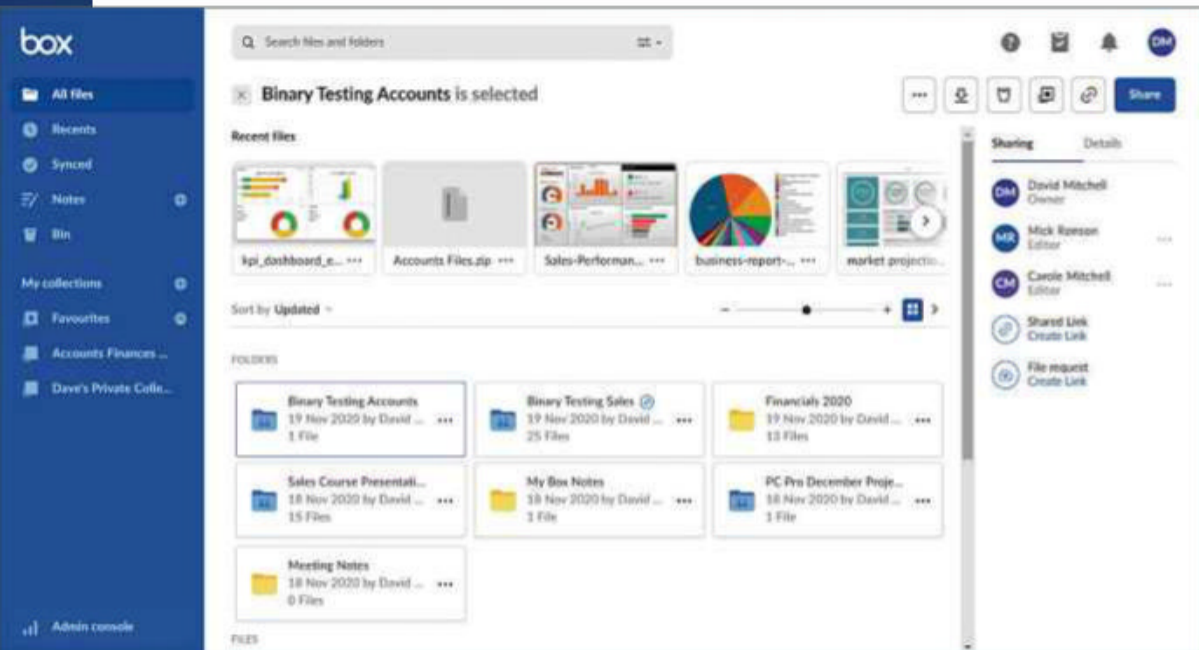
LEFT Office add-ins let users access cloud files directly from their desktop apps

BELOW The iOS apps let you upload files and photos from your mobile to the cloud

Portal perfection

Rolling out a cloud sharing service could hardly be easier. You can normally send email invitations to users containing a link they click on to create their new cloud account and set a personal password. They'll then be invited to download and install a small agent on their desktop, which runs in the background and automatically syncs local files with the cloud repository. Some agents optionally allow you to save on hard disk space by choosing to keep certain data only in the cloud.

It's normally possible for users to access files via their own web portal too. Ideally, we like to see a familiar Explorer-style presentation, with clear navigation buttons and search facilities. After all, workers don't want to waste time picking their way through a complicated interface – they just want to get at their files.

Support for mobile devices is worth looking out for too. Most providers offer free Android and iOS clients, but their capabilities vary considerably. The best ones provide the same levels of access as the web portal, and some even add the ability to use the camera on your phone or tablet to scan documents directly to the cloud and share them.

Integration with apps

Cloud file sharing is supposed to make your workflow more straightforward, not more complicated. To this end, many providers offer some degree of integration with apps such as Google Workspace, Microsoft 365, Salesforce and Slack. One of the services on test this month even has a Zoom add-in, so videoconferences can be started or joined directly from its web portal.

Users of the standard Microsoft Office suite get some love too, thanks to add-ins that let you open cloud documents, edit them and save them directly back to the cloud. An Outlook add-in can be a useful addition too, allowing you to send cloud links to recipients rather than attaching large files directly to your message.

Even if that feature isn't available, it's often possible to generate a web link directly to a specific cloud file, providing an easy way to securely share files with external clients. Look for a service that lets you password-protect links, apply download limits and set expiry dates to make sure your precious data doesn't leak.

The four providers in this month's buyer's guide each provide a wide range of features – and all of them offer time-limited trials, meaning you can evaluate their suitability before committing. Read on to see which one could be your next cloud collaboration partner in a post-pandemic world.

above a certain size and this can range from as small as 2GB right up to a generous 100GB.

Whichever tariff you go for, you may be able to save money through your payment options. Most providers accept monthly payments, but offer substantial discounts if you're willing to commit on a yearly basis.

Part of the plan

There's a good chance that your staff are already using a free, consumer-friendly cloud service such as those offered by Dropbox, Google Drive or Microsoft OneDrive. Don't be tempted to rely on these in a professional setting, though: they're aimed at individuals and lack management or auditing features.

A proper business plan, conversely, should include an administration portal where managers can decide who is allowed to access the cloud storage; the best ones offer fine granular controls over who can view and share cloud documents. If you have a large userbase, look for tiered administration or role-based management.

LEFT The Box Drive app ensures all your folders are accessible from anywhere

BELOW Tresorit's desktop app provides transparent access to encrypted folders

These facilities let you grant certain employees a subset of administrative rights, so they can carry out specific jobs such as granting access, adding new users and changing passwords.

Auditing is essential too, especially if you work with confidential or sensitive documents and need to show compliance with data protection regulations. User activity logging lets you pull up reports detailing which files each person has viewed, edited, shared and so on.

Box Business
A great all-round service, with powerful collaboration tools and unlimited storage for a good price

SCORE ★★★★★

PRICE Business plan, **£12 exc VAT** per user per month (billed yearly) from box.com

B ox has always been one of the top business file-sharing and collaboration solutions, and it's recently added a raft of features aimed at improving the lives of remote workers. One notable arrival is Box Collections, which lets users organise their files, folders and web links into custom groupings, without having to actually move the items around between shared folders.

Then there's the new Box Preview screen, which lets you browse and annotate cloud documents without needing to download them or open the parent application. The Box web portal meanwhile gets a fresh coat of paint, and there's integration with the Zoom videoconferencing platform for extra convenience.

Box offers four plans. The basic Starter tier costs £4 per user per month (assuming you pay yearly), while the Business, Business Plus and Enterprise options cost £12, £20 and £28 respectively. All three business tiers include unlimited cloud storage, with the ability to retain and restore up to 50 file versions. The only real restriction is a maximum 5GB file upload size: that's smaller than many rivals offer, but should still be enough for most businesses.
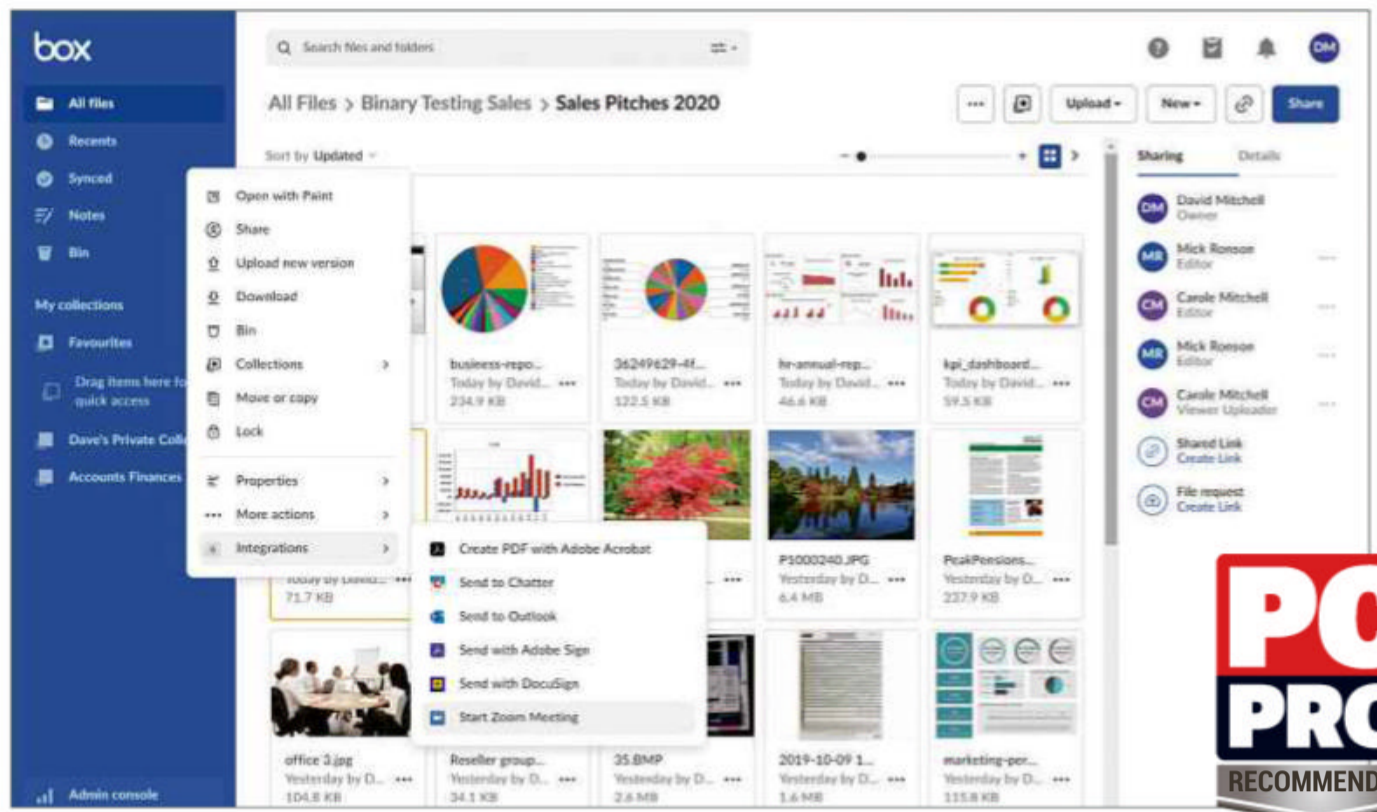
One thing we like about Box is its wealth of management tools, which include advanced user and security reporting, custom portal branding and Active Directory and single sign-on integrations. Getting your team members enrolled is a simple matter of sending them an invitation email; this contains a link enabling them to set a password, after which they can install the local agent and log in to their personal cloud portal.

At this point, those who've used Box before may need to relearn a few things. The old Box Sync software has been replaced by the new Drive app: by default this now keeps all files and folders in the cloud, although items can be marked for offline access if you want to retain a local copy.

As mentioned, the web portal has been redesigned too. Happily, the new layout is easy to get to grips with, opening with a tidy view of your folders and recent documents. Your own collections of cloud content can

"Box can even integrate with a range of external services, including Adobe Document Cloud, Salesforce and Slack"

also be pinned here: to add a file to a collection, you simply browse to its original location, then choose a collection from the dropdown menu. Your collection can then be added to the portal's homepage with a click.

Another neat online feature is the new Preview screen. This isn't just for quickly checking the contents of a file: if you add comments to a cloud document, they'll be visible to all other users with shared access. With the Box Tools component, you can even edit Office documents directly from the preview screen.

On that note, desktop integrations for Google Workspace, Microsoft 365 and Teams are included as standard. The Box for Office add-in lets users access cloud files directly from any Office app, while new options appear in Outlook for sharing cloud files and uploading attachments.

Box can even integrate with a range of external services, including Adobe Document Cloud, Salesforce and Slack. The regular Business plan lets you enable one such integration, while Business Plus users get three.

A final interesting feature is the ability to initiate Zoom conferences from the Box portal. After we'd picked a set of invitees, we were smoothly transferred to the Zoom interface, while colleagues received an email link enabling them to join the call.

The 5GB file size limit may be a deal-breaker for some, but with great app integrations, smart collaboration tools and unlimited storage, Box Business is a terrific package. The price is right too, and the latest feature updates only make an already strong product even better.

REQUIREMENTS Windows 7, macOS 10.13, Android 5 and iOS 12 upwards
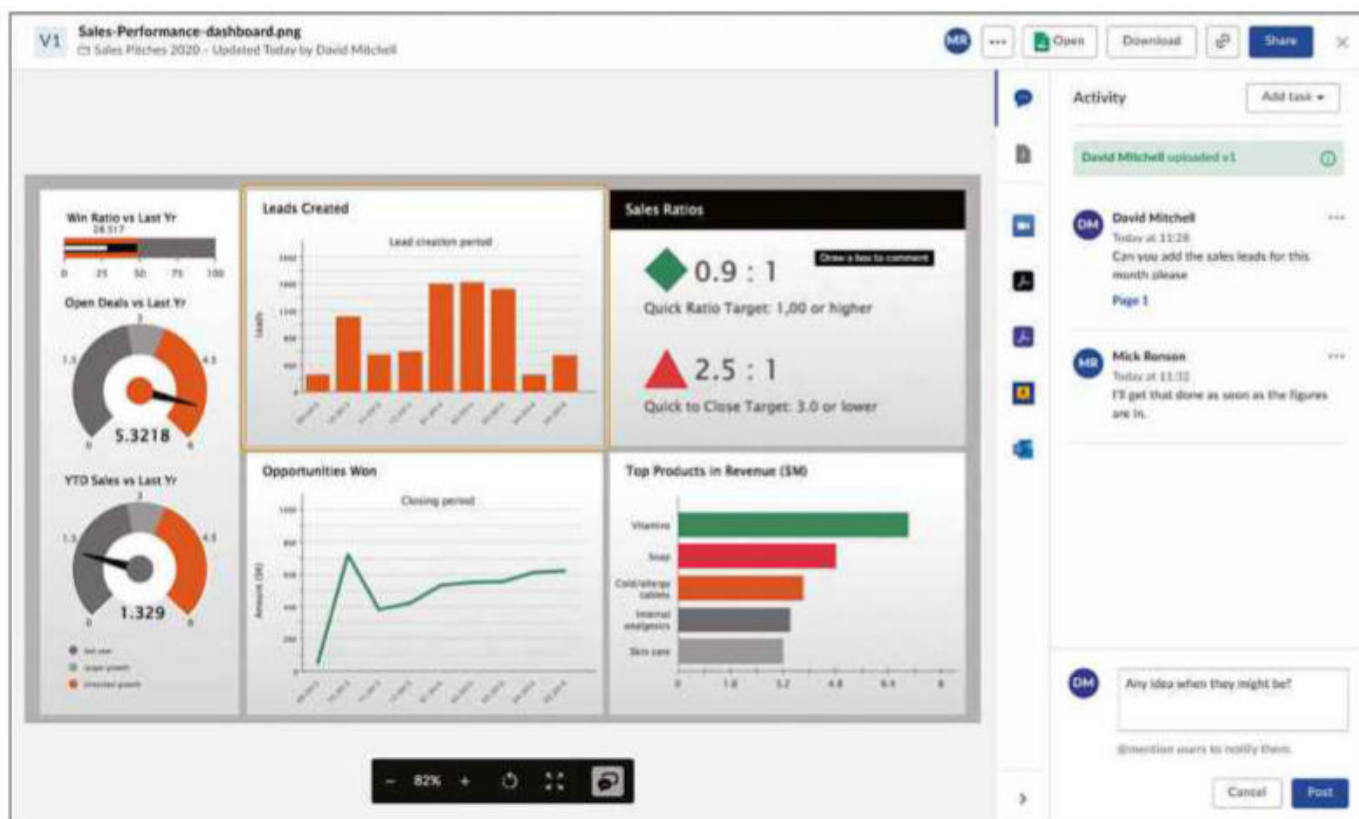
Egnyte Business

This file-sharing platform offers a wealth of useful features, including a smart hybrid storage option

SCORE ★★★★★

PRICE Business plan, £15 exc VAT per user per month (billed yearly) from egnyte.com

Egnyte might not be a familiar name, but it deserves to be. It offers a comprehensive cloud syncing and sharing solution, with its Team subscription tier offering a decent terabyte of cloud storage for a monthly cost of £7.43 per user. The £15 Business plan on test adds 10GB of private storage for each user, plus multi-factor authentication and the company's innovative hybrid storage option – which we'll get into below.

The service creates a good impression from the off, with a free 15-day trial that doesn't demand payment details. And as part of the setup process you're invited to create a custom subdomain name for your account URL, adding an extra touch of professionalism when sharing files with clients and customers.

The administrative web portal lets you create new users and set their privilege levels. "Power users" have the ability to engage in all file-sharing activities, while standard users are limited to uploading and downloading files, editing them and installing the Egnyte mobile apps. This is just the start of Egnyte's access controls, however: individual files can also be locked to prevent editing, and when
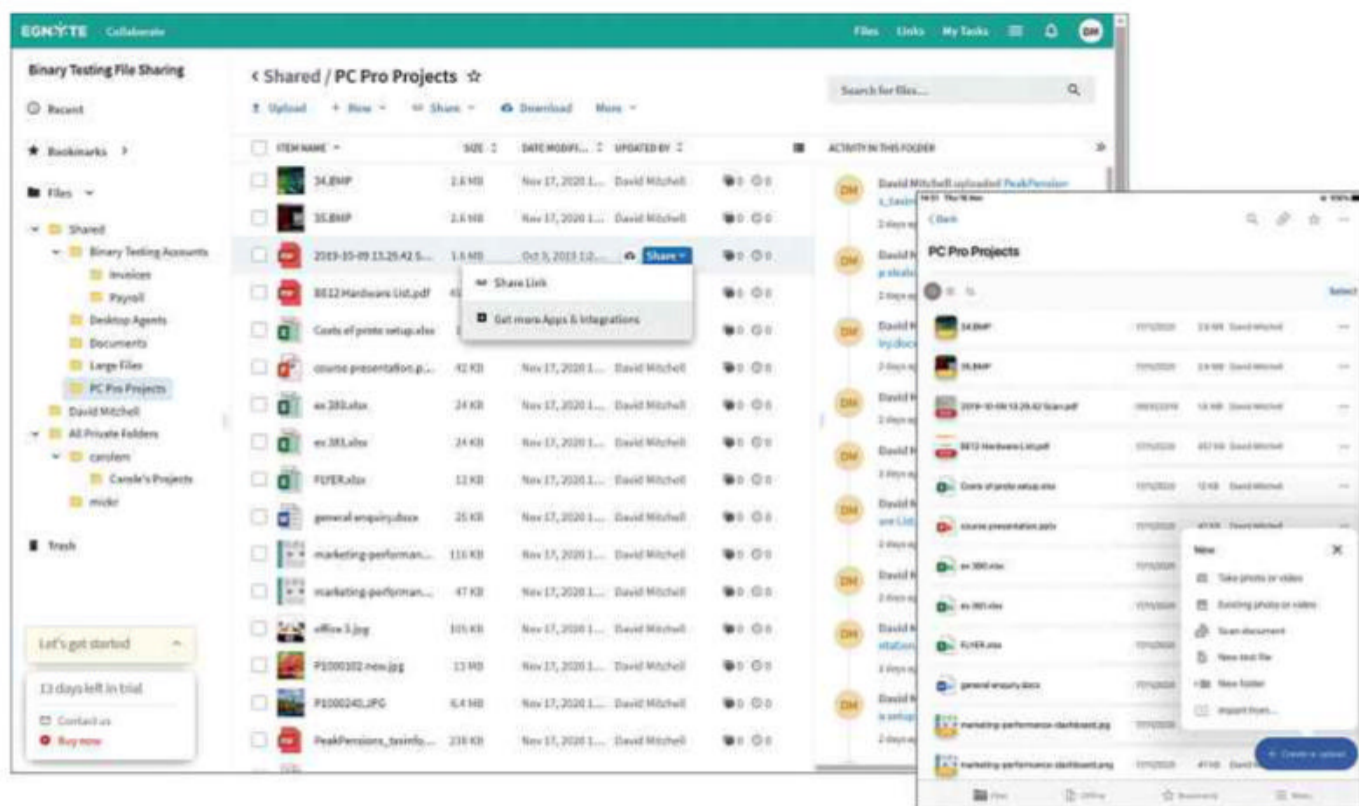
sharing a folder you can decide whether users will be able to edit and annotate the contents, or just download and view them. Permissions can even be set on a per-folder basis, with subfolders either inheriting settings from their parent folder or carrying their own attributes.

Once you've created a user profile, an invitation will be emailed out, prompting the user to set a password and directing them to their personal web portal. From here, they can immediately access their private and shared folders, upload local files and download cloud files to their desktop.

The portal also provides links from which users can download and install the Egnyte desktop apps. We tried these on both Windows 10 and macOS clients and found them perfectly accessible; with the software installed, a new virtual drive appears, enabling easy access to the cloud from all applications.

PC PRO RECOMMENDED

"Permissions can be set on a per-folder basis, with subfolders either inheriting settings or carrying their own attributes"

Egnyte boasts an impressive range of third-party integrations, with add-ons available for DocuSign, Google Workspace, Microsoft 365, Slack and many more. Direct integration with Microsoft Office apps enables you to open, edit and save cloud files without needing to make local copies, and when composing an email in Outlook you'll see new settings for sharing files, uploading them and requesting uploads to a specific cloud folder.

One of our favourite features of Egnyte is its hybrid Storage Sync service. This lets you set up local or external storage systems to sync with your cloud account, for a belt-and-braces solution that can provide continuity if either your on-premises hardware or your internet connection fails. The Business plan entitles you to set up one Storage Sync device, with AWS, Hyper-V, Netgear NAS and VMware systems all supported as destinations. We tested the Hyper-V version by connecting the provided VM to our Egnyte domain, choosing the folders we wanted synchronised and setting up a synchronisation schedule. Users were then able to log into the Hyper-V share with their Egnyte credentials and access the same files and folders as in their cloud account.

The feather in Egnyte's cap is its excellent reporting and auditing features. The administrative console provides a wealth of detail on users, permissions, activity and capacities, making this an ideal cloud platform for any business that wants the very best in access controls and security, as well as robust file storage.

REQUIREMENTS Windows 10, macOS 10.13, Android 7 and iOS 12 upwards
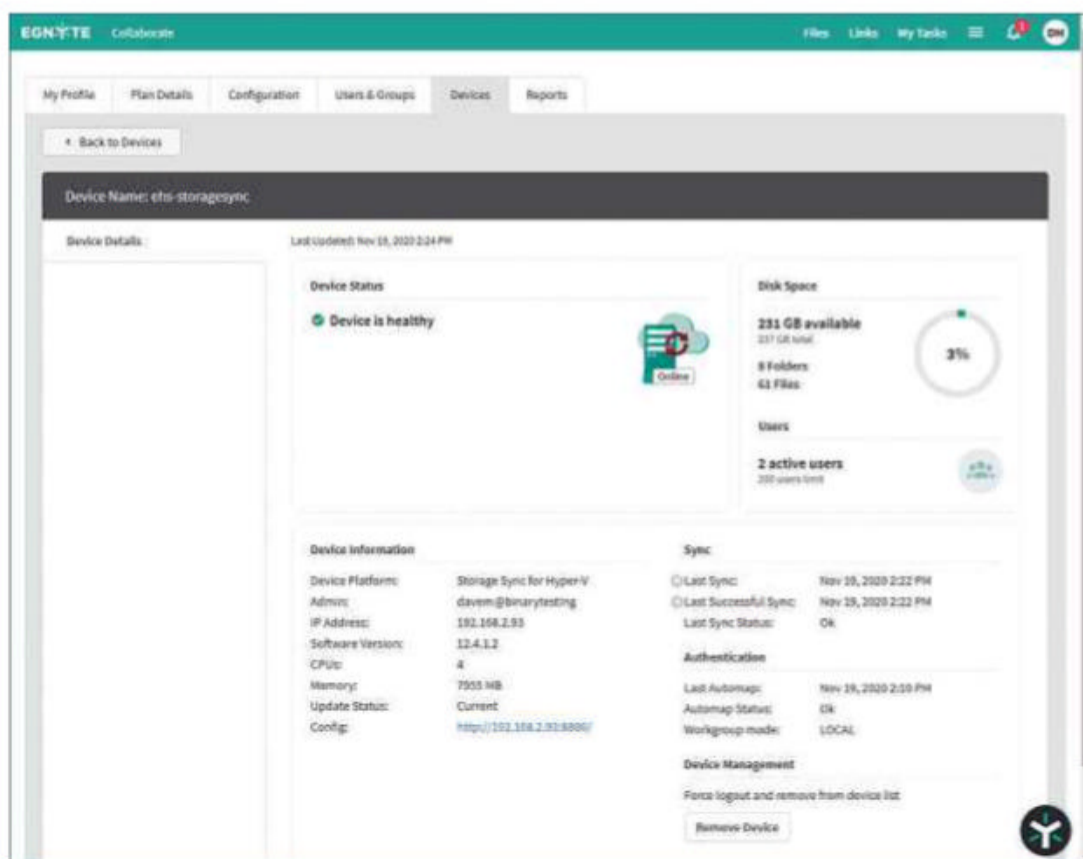
IDrive Business

Cloud syncing meets cloud backup: it's a strong pairing, but collaboration and sharing tools are very basic

SCORE ★★★★☆

PRICE 250GB, £56 exc VAT for first year from idrive.com

The cloud isn't just for sharing data with others – it's also ideal for off-site backup. IDrive has traditionally focused on the latter, but its IDrive for Business service combines regular online backup with file-syncing and sharing, making it an intriguing all-in-one proposition.

There are a few quirks you need to be aware of from the beginning. When setting up IDrive accounts, you'll be given the option of using a private encryption key, but if you want users to be able to share files with one another then you'll need to use the default AES-256 key instead. You'll also need to align your backup and synchronisation schedules, as files can only be shared once they've been backed up to IDrive's cloud servers.

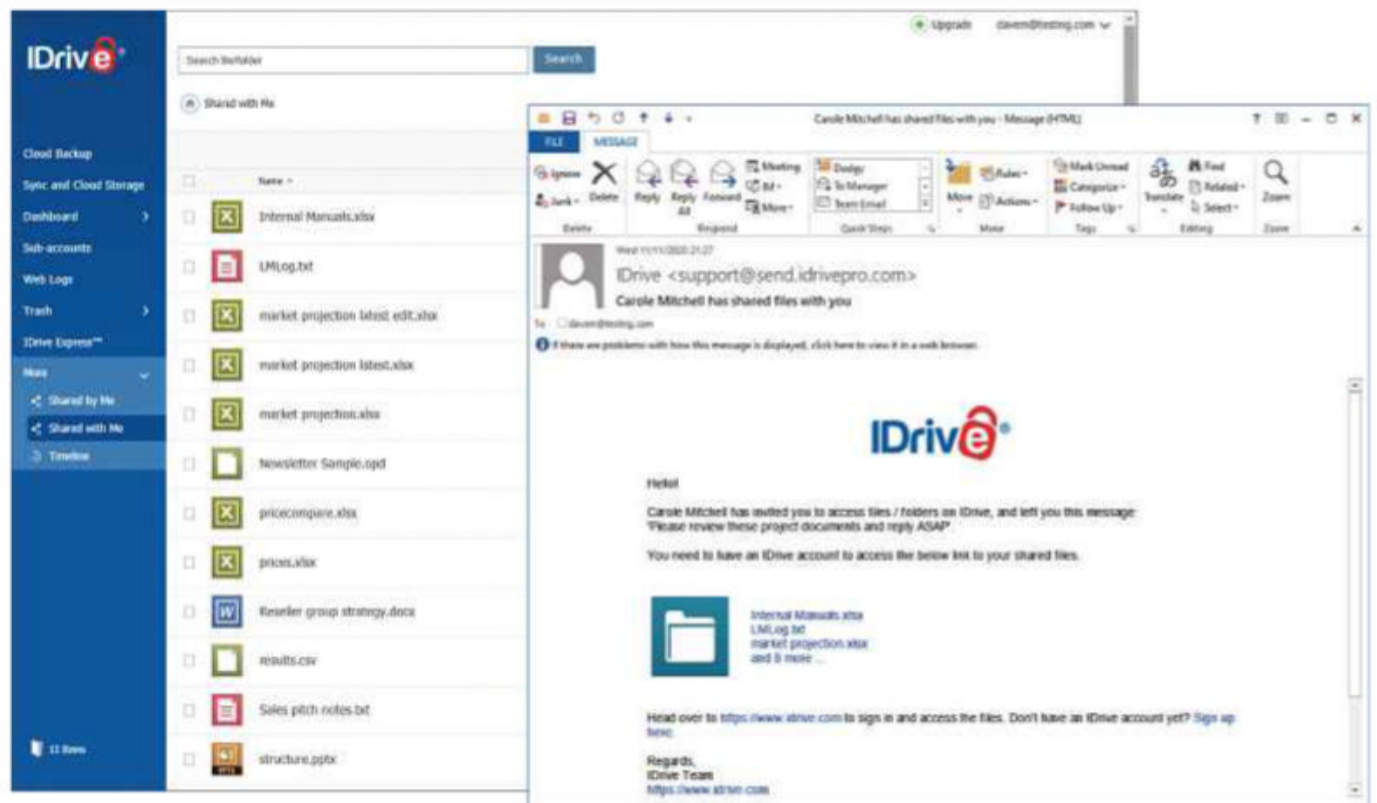Still, for what you get, the price is very competitive. The basic Business plan with 250GB of cloud storage costs only £56 per year, which covers unlimited users and allows you to back up any number of computers and servers. Windows, macOS and Linux systems are all supported, and apps are provided for iOS and Android

mobiles. IDrive can also back up Hyper-V and VMware hosts, along with Exchange, SQL, Oracle and SharePoint servers and even Microsoft 365 accounts.

Users are enrolled via the IDrive web portal, which automatically sends out email invitations containing a link to download the IDrive app. We found this a breeze to install on Windows 10 and macOS desktops; once the user has confirmed their account, they can use either the app or their personal web portal to choose which files and folders they want backed up, and set a schedule to run the job at regular intervals. A great bonus of IDrive is that it lets you create local backup jobs to run alongside your regular cloud backups, although you can't share files from on-premises locations.

ABOVE File sharing is conducted inside the IDrive Business web portal

> **"You'll need to align your backup and sync schedules, as files can only be shared once they've been backed up to IDrive's servers"**

BELOW Received files can be accessed from the web portal or via free mobile apps

Uploaded files and folders can be shared directly from the web portal. Simply select an item, click the share icon at the top, enter the email addresses of invitees and choose to give them view-only or full edit permissions. With the file-syncing service enabled, you can also select files for sharing directly from the desktop – although you're then transported to the web console to complete the invitation process, which feels laboured.

IDrive has some other clunky aspects too. Unlike rival services, it doesn't let you directly edit remote documents: you have to download them, make your changes and upload them back to the shared location. This could lead to versioning issues if multiple users want to make changes to the same file.

Access control isn't particularly robust, either. Even when documents were set to "view only", we were able to download and edit them. And while IDrive claims that shared files can be password-protected, it isn't obvious how to apply this – raising concerns that sensitive data might be sent out into the world unprotected. There's an element of friction involved in receiving files too, as the recipient needs to create their own IDrive account to access shared items.

In a crowded market, IDrive's promise of sync and backup services in a single package is a tempting formula. Its file-sharing features leave a lot to be desired, however, and collaboration tools are almost non-existent, so businesses looking to support remote workers may be better off with a different cloud solution.

REQUIREMENTS Windows 7/Server 2012, macOS 10.10, Android 4.1 and iOS 11 upwards
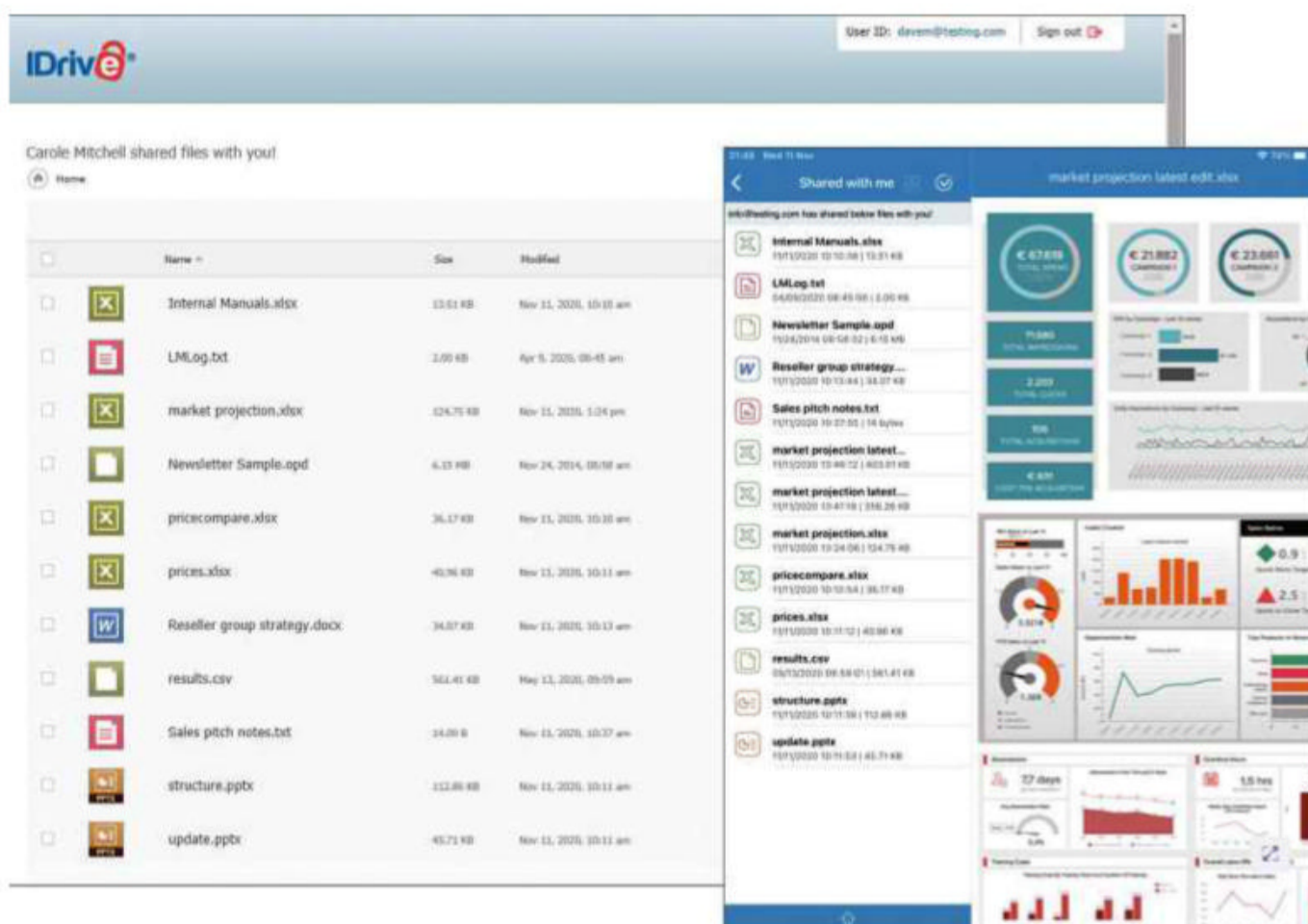
Tresorit Business Plus
Perfect for anyone working with confidential data, Tresorit offers a highly secure file-sharing service

SCORE ★★★★★

PRICE Business Plus, £13 exc VAT per user per month (billed yearly) from tresorit.com

If you're concerned about the security and privacy issues associated with cloud file-sharing, Tresorit should put your mind at rest. It uses full end-to-end encryption, with a zero-knowledge policy that means the company never sees or stores your encryption keys.

It offers a range of plans for individuals and businesses; we tried out the Business Plus subscription, which costs £13 per user per month. This gets you a roomy 2TB of storage per user, along with an unlimited file-version history, which should be ample for almost any purpose. The individual file-size limit is generous too, at 15GB, and business customers can even choose where in the world their data will be stored, from a selection of 11 global data centre locations – a godsend for anyone with specific compliance requirements.

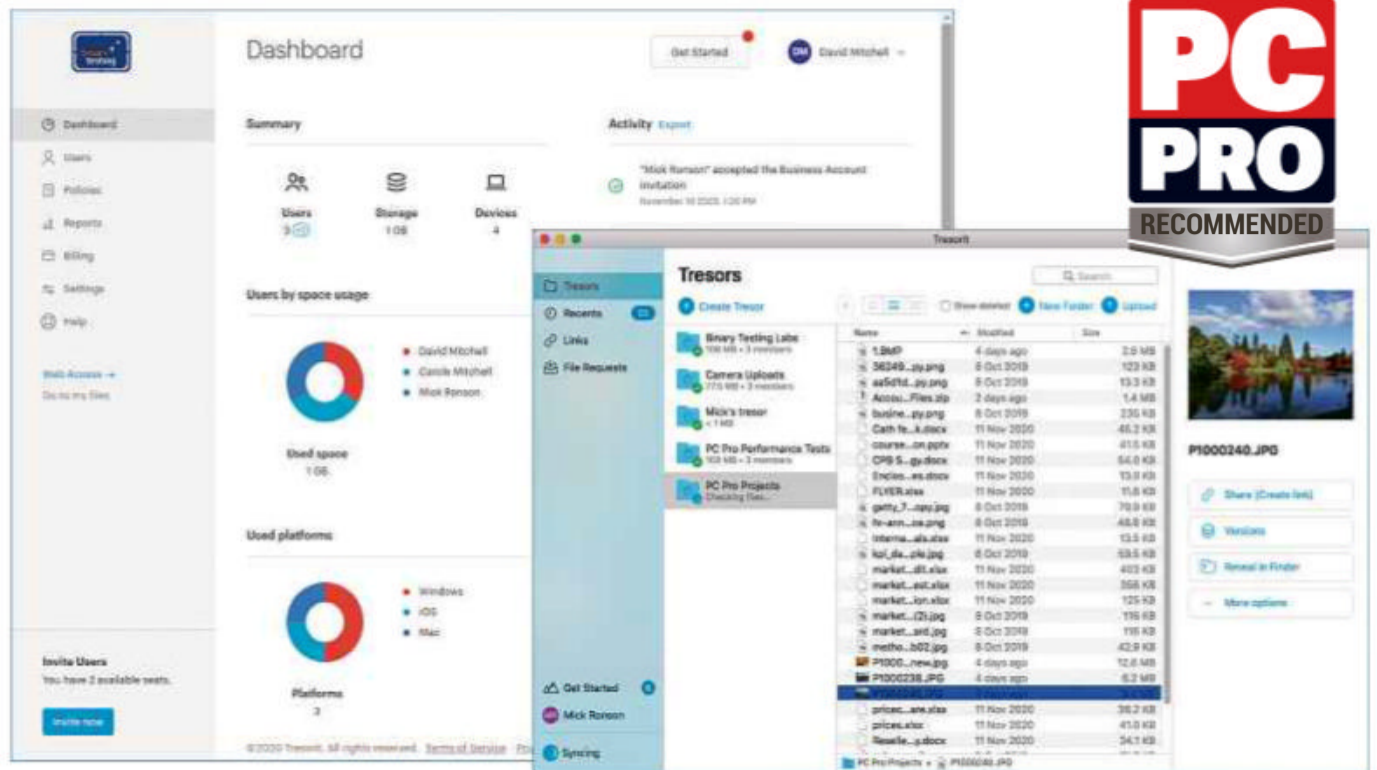As usual, deployment is just a case of emailing out invitations from the administrative portal. When a user clicks on the link, they'll be prompted to create an account and choose a password. Tresorit can't help if these get lost, but administrators can reset passwords as needed, as long as the Advanced Control option is enabled in the portal.

Users are also invited to download the desktop app, after which the system will create their personal "Tresor" – Tresorit's name for a secure cloud folder. Each user can create an unlimited number of Tresors, and the desktop app will set up a virtual drive in Windows Explorer or a Favourites folder in macOS for easy access.

You can share your Tresor with others using either the desktop app or the web portal. In either case, you just need to select team members from the contact list and pick whether they can manage, edit or only view your Tresor.

It's just as easy to share individual items with outside partners and contractors. You can create a web link directly from the desktop app, or send

ABOVE The Tresorit web portal provides administrators with a strong set of tools

> "Business customers can choose where in the world their data will be stored, from a selection of 11 global data centre locations"

BELOW Customisable policies let you tighten up security as strictly as you like

one from any email app; an Outlook plugin provides extra controls such as password protection, link expiry dates, download limits, access logging and a requirement for recipients to verify their email addresses .

Android and iOS apps are provided too, so you can easily access cloud items on the move. These duplicate most of the features in the desktop app, and add handy scanning functions: it only took a few taps on our iPad to photograph a document, convert it into a PDF, encrypt it and upload it straight to a selected cloud folder.

We've noted that Tresorit takes security seriously: that extends to extensive logging of user activity, and the Admin Center portal gives you control over almost everything users can do. Custom policies let you specify which devices they can access their Tresor from, or block access from specific locations. Individuals can be denied access to specific Tresors or banned from downloading, so they can only view files in shared links.

Access security is well covered too. Sessions can be set to expire after a certain period, and you can tell web browsers not to store login details. Two-step verification can be enforced, or you can enable single sign-on using Azure Active Directory or Okta.

The one area where Tresorit is a little light is collaboration tools: you can preview Office documents and PDFs in the cloud, but you can't edit or annotate them there. Still, the service is hard to fault when it comes to security, and it's affordable and easy to deploy too, making it a top choice for SMBs who need to keep their sensitive information locked down. ●

REQUIREMENTS Windows 7, macOS 10.9, Android 4.1, iOS 9 upwards and Linux
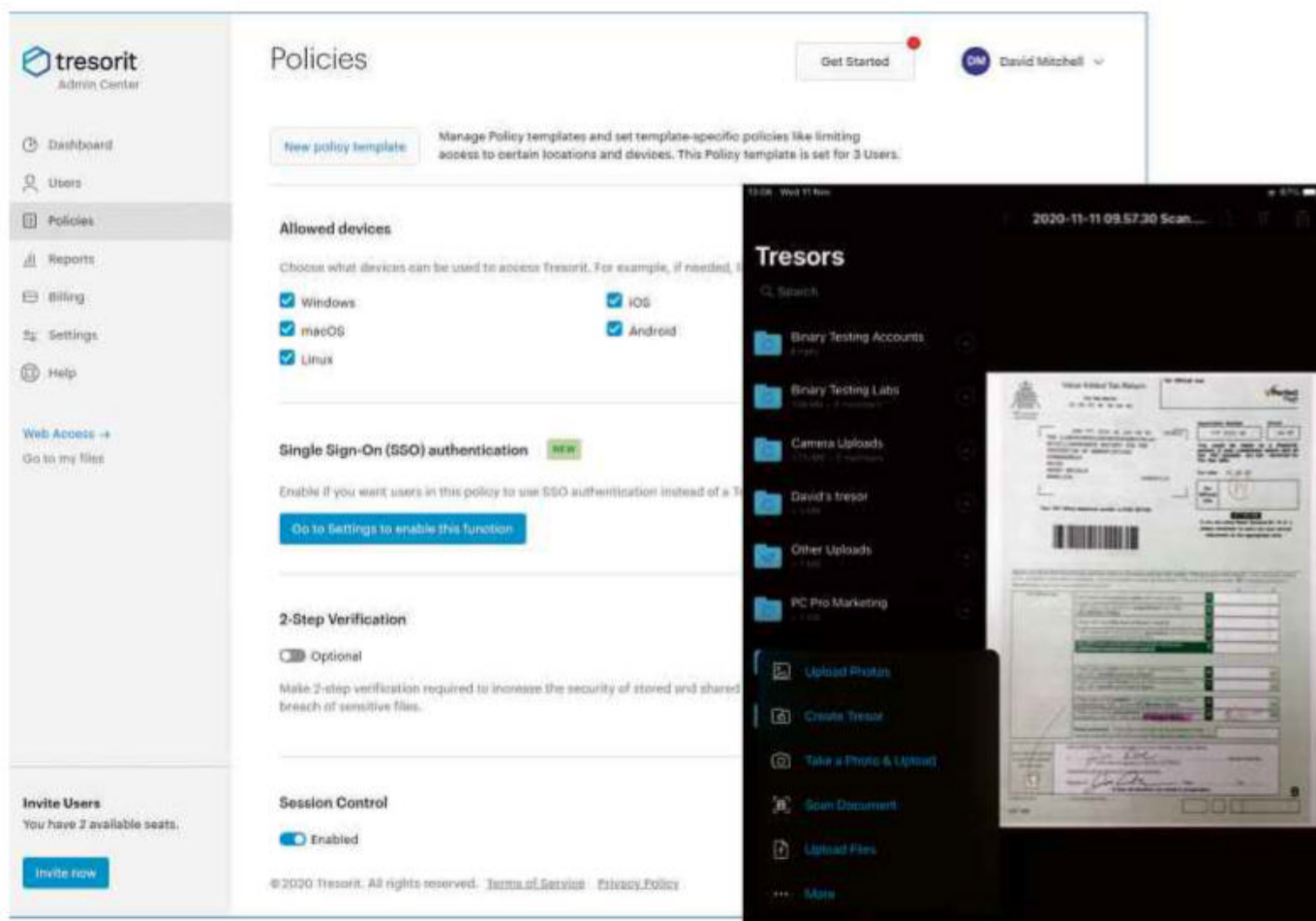
Broadberry CyberServe AM2-B8252

A hugely powerful dual EPYC server with 1TB of RAM, plenty of storage and scope for further expansion

SCORE ★★★★★

PRICE As reviewed, £15,995 exc VAT from broadberry.co.uk

The blue chips have been slow to embrace AMD's EPYC server processors, but for Taiwanese server specialist Tyan it's been full steam ahead: the company now has a portfolio of over 30 motherboard designs supporting the latest core-heavy Gen2 EPYC 7002 CPUs.

From this lineup, Broadberry has chosen the Transport HX TS75-B8252 barebones system as the basis for its CyberServe AM2-B8252 server – and the end product really shows off the potential of the platform. The price above includes not one but a pair of mighty 32-core 2.4GHz AMD EPYC 7532 CPUs, and a whopping terabyte of 3,200MHz DDR4 memory. There's 80TB of storage too, in the form of eight 10TB SATA hard disks – and to hammer the point home, Broadberry includes a dual-port 100GbE card.

Perhaps the most remarkable part is that this isn't even a maxed-out configuration. The AM2-B8252's 32 DIMM slots can support up to 8TB of memory, and all expansion slots are of the ultra-fast PCIe 4 variety, opening up no end of possibilities.

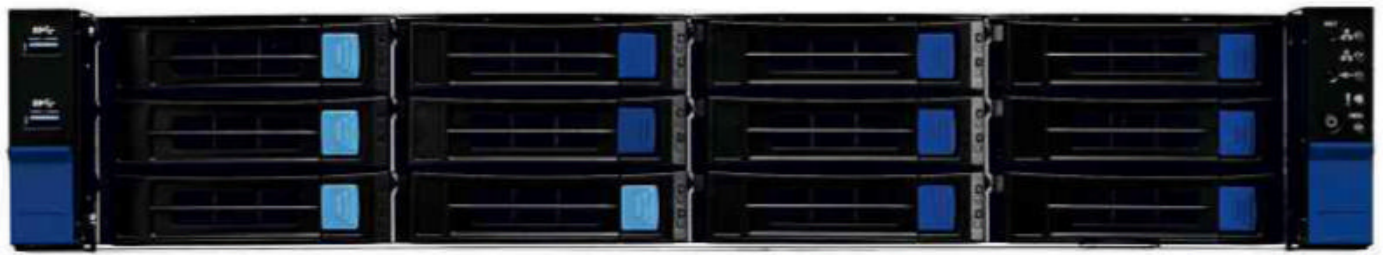Cracking open the lid reveals that Tyan has taken a leaf out of Dell EMC's book when it comes to design, with a similar layout to the PowerEdge R7525. Splitting the PSUs across the rear of the chassis means the CyberServe is compatible with power

distribution units and allows for a balanced airflow, so there isn't a hotspot on one side of the server.

The twin CPU sockets are flanked on each side by those plentiful DIMM slots, with cooling handled by a bank of six hotplug fans arranged along the front of the chassis. Considering the 200W TDP of the CPUs, these are impressively quiet: we measured a modest overall noise level of 61.5dB from a metre in front.

Storage-wise, alongside the eight hard disk bays, you'll find empty hotplug bays for four NVMe SSDs. All bays use a simple hinged locking lever, with colour-coding to help you identify the SSD bays at a glance, and there's also a pair of M.2 NVMe SSD slots that support all card sizes up to 110mm. With all these storage options to hand, it's slightly surprising to note that the server doesn't feature an embedded RAID controller – but it's no problem to install your own and BroadBerry offers an eight-port LSI SAS3 option for £495.

Once that's in place, you're still left with plenty of expansion options. The CyberServe employs four riser cages to present a total of four x16 PCIe 4 slots and one x8 PCIe 4 connector. If you require even more expansion options, there's also a variant of the motherboard available that provides nine x8 slots.

ABOVE Eight 10TB disks are included in the price, and you can add up to six SSDs too

> **"The price includes a pair of mighty 32-core 2.4GHz AMD EPYC 7532 CPUs and a whopping terabyte of 3,200MHz DDR4 memory"**

We've no complaints about the networking provision: the Broadcom 100GbE card comes in addition to dual embedded 10GBASE-T ports, and you can easily increase the port count as the server offers an Open Compute Project (OCP) 3.0 Gen4 slot, with a smart tool-free design allowing you to slot cards in from the rear without having to open the server up.

If there's one area where Tyan's board doesn't quite measure up to the competition, it's remote management: the AST2500 controller simply can't match HPE's iLO 5 or Dell's iDRAC9 for features. Nevertheless, the web console provides all the important details about critical components, with a long list of sensor graphs that can be drilled down into for more detail. There's also a platform event filter (PEF) service that can be used to create multiple policies linking events and errors with email alerts, and great access security courtesy of a system firewall and support for LDAP, Active Directory and RADIUS authentication. Full OS remote control and virtual media services are included as standard too, rather than being held back as optional upgrades.

The CyberServe AM2-B8525 is clearly overkill for a small business role, but SMEs and enterprises seeking an uncompromising rack server at a great price will find it hard to ignore. Not only is it an astonishingly capable server as supplied, but it also has plenty of room for growth as your requirements evolve. **DAVE MITCHELL**

SPECIFICATIONS

2U rack chassis ● 2 x 32-core 2.4GHz AMD EPYC 7532 CPUs ● 1TB 3,200MHz DDR4 (max 8TB) ● 8 x 10TB WD SATA hard disks ● 4 x NVMe SSD bays (unpopulated) ● 2 x M.2 NVMe SSD slots ● 5 x PCIe 4 ● OCP 3.0 slot ● 2 x embedded 10GbE ● Broadcom dual-port 100GbE adapter ● Tyan AS2500 with Gigabit Ethernet ● 2 x 1,600W Platinum hotplug PSUs ● 3yr on-site warranty

LEFT Tyan's remote management services include all of the key features as standard
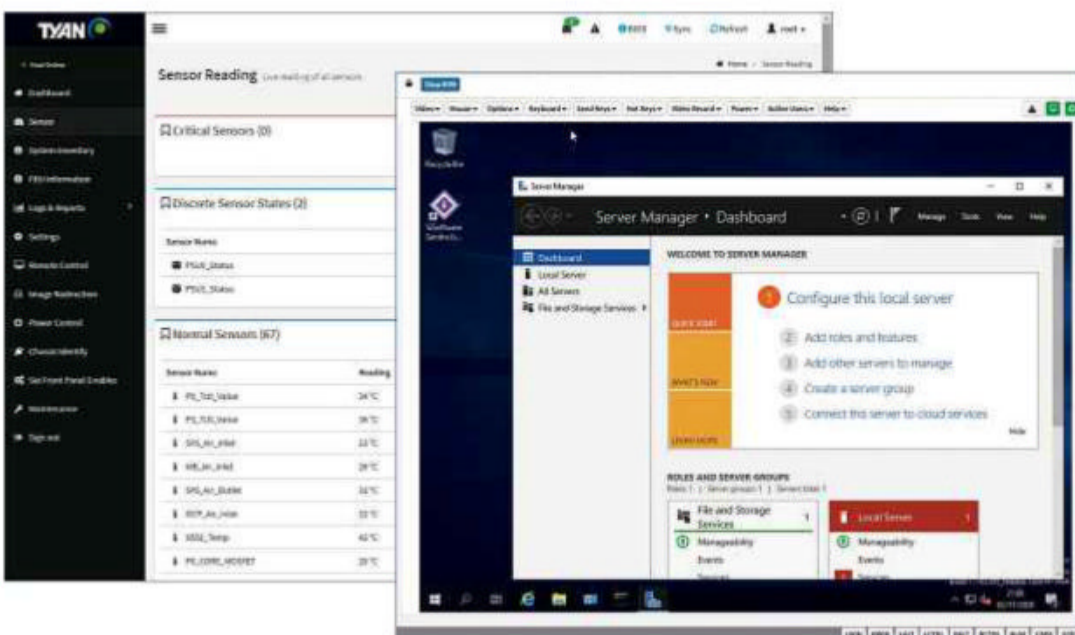
Aruba Instant On AP22

This affordable Wi-Fi 6 AP is perfect for SMBs, combining good performance and slick cloud management

SCORE ★★★★☆

PRICE £144 exc VAT
from uk.insight.com

Next-generation Wi-Fi 6 devices have been on the market for more than 18 months, but we've only recently started to see access points (APs) at prices that make sense for small businesses. Aruba's entry into the low-cost fray is the AP22, which delivers a complete suite of 802.11ax services for just £144.

Despite the price, you get the full complement of management and connections options. The AP22 is part of Aruba's Instant On family, which means it supports Aruba's Smart Mesh technology, and can be cloud-managed from either a web portal or the free mobile app. We tried the app, which quickly discovered the AP and provided a wizard to help us add it to our account and create our first secure wireless network.

Technically speaking, the AP22 is a 2x2 MU-MIMO AP claiming speeds of up to 1,200Mbits/sec on its 5GHz radio and 574Mbits/sec over 2.4GHz. On paper, it's a step down from the AP12, which boasts 3x3 MU-MIMO and a 5GHz data rate of 1,300Mbits/sec – but that model is Wi-Fi 5 only, so you can expect the AP22 to be faster when connected to Wi-Fi 6 clients.

Our tests suggest that it has the edge on Wi-Fi 5 clients too. We copied a set of large files between a Windows 10 Pro desktop equipped with a Netgear Nighthawk AC1900 USB adapter and a server on the LAN. The older AP12 managed 71MB/sec at short range and 64MB/sec at 10m, while the AP22 averaged 74MB/sec up close, dropping to 67MB/sec at 10m.

The AP22 is physically lightweight, weighing in at only 500g, so it's easy to mount on a wall or ceiling; the base kit comes with a universal mounting bracket that will also fit over the T-rails in suspended ceilings. A single Gigabit Ethernet port supports either a PoE or PoE+ power source – if you're in need of one, Aruba's 1930 eight-port PoE+ switch is a worthy contender, as it can be managed alongside the AP in the Instant On portal. Alternatively, you can purchase the AP22 in a bundle with a dedicated power supply.

When it comes to management, there's no real difference between using the app and the web portal. Both present the same simple dashboard, with four panes showing your available and active networks, the number of connected clients, total data transferred over the past 24 hours and an equipment inventory.

Tap or click on the networks pane and you can get more details on current networks, and configure additional SSIDs up to a maximum of eight. Each one can support either WPA2 or the newer WPA3 encryption standard, and you can specify client bandwidth limits and active radios. For guest networks, an L2 isolation option lets clients get internet access without being able to connect to local resources, and the web console provides a superb range of tools for quickly creating mobile-friendly custom portals with your own logo and end user agreement. If you're using the Aruba switch, you can

ABOVE The AP22's light and compact design will fit happily on a wall or ceiling

PC PRO RECOMMENDED

"The web console provides a superb range of tools for quickly creating mobile-friendly custom portals with your own logo"

from here too, each with their own VLAN identifiers.

To keep track of everything that's going on, the portal also provides an overview of client activity. A detailed rundown of app usage on each network is provided, broken down into 20 different categories such as productivity, email, gaming and malicious content – and you can instantly block traffic in any category by clearing the tickbox next to it.

The one thing you won't find is a large range of Wi-Fi configuration options. Aruba handles all of this behind the scenes and the only Wi-Fi 6 setting in the dashboard is a toggle to turn it off if legacy clients are having trouble connecting to the network – which in our experience is a rare issue that you're unlikely to encounter. You should also be aware that ultrawide 160MHz channels aren't available, but this isn't a deal-breaker for SMBs as few clients support it anyway.

In all, Aruba's Instant On AP22 makes a perfect springboard into the world of Wi-Fi 6. It's very easy to deploy and manage, and delivers good wireless performance for a price that would have seemed unthinkable only a few months ago. **DAVE MITCHELL**

LEFT Aruba's web portal and mobile app both provide great management tools

SPECIFICATIONS

Dual-band Wave 2 AC1775 2.4GHz/5GHz Wi-Fi 6 ● 2x2 MU-MIMO ● internal aerials ● Gigabit PoE+ ● wall/ceiling mounting plate ● 160 x 160 x 37mm (WDH) ● 500g ● 1yr hardware warranty
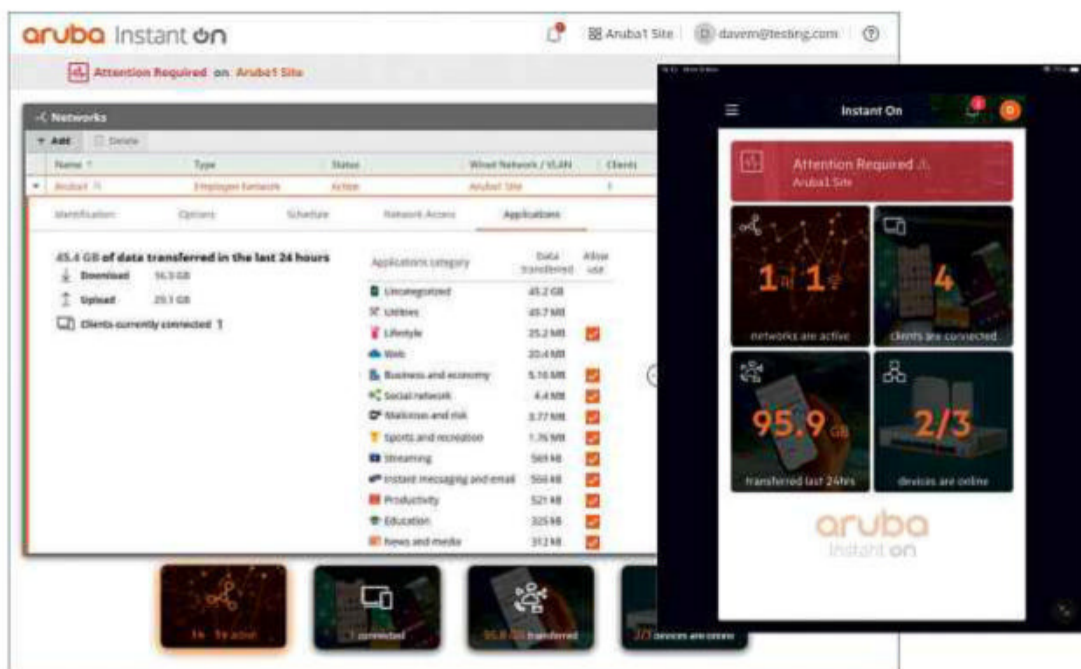
How do I keep my team's distributed IT patched and secure?

Nik Rawlinson provides advice that will help protect your data on Windows, iOS and Android devices – and protect you against fines

An increase in homeworking, and an expectation among many staff that this will continue to some degree in the coming months, leaves businesses with a quandary: how do they ensure devices are fully patched and properly licensed when working remotely?

Relying on staff to manage their own devices isn't prudent when those same devices will be used to access business data. Even the least sensitive inbox, database or shared documents may contain personally identifiable information that, if compromised, could leave the organisation liable to prosecution for non-compliance with GDPR and the UK Data Protection Act 2018. While being able to prove that all devices were fully patched and secured is unlikely to be sufficient to avoid any fine at all, it might help when arguing that the business took security seriously and doesn't deserve the maximum penalty.

Here, we'll look at options for managing Windows, Android and iOS remotely via the cloud.

■ Locked Windows

Windows 10 is the most insistent release to date where updates and patches are concerned. Small business owners, who don't have the benefit of dedicated or outsourced IT, can be fairly confident that their teams' machines will be fit for business – as long as they don't install unauthorised software. Restricting downloads to just software from the Microsoft Store can help. So can Microsoft Intune (**pcpro.link/317intune**).

This cloud-based management tool is built to facilitate remote management of enrolled devices without investment in significant on-site or owned infrastructure. Thus, it works equally well with corporate or BYOD hardware, allowing staff to work not only where they choose, but on whichever device they prefer. Although the feature range is, to some extent, dependent on the hardware choice, it's by no means restricted to managing Windows 10. Recognising that staff are increasingly accessing corporate resources using non-Microsoft platforms, Intune can also be used to manage staff with Android, iOS and macOS devices.

Intune gives organisations the choice of managing PCs as either "mobile devices" using Mobile Device Management (MDM), or "computers" running the Intune software client (**pcpro.link/317mdm**). The distinction has practical implications for the way businesses keep remote machines patched, as well as how they monitor licencing compliance. Microsoft recommends MDM.

MDM doesn't support versions of Windows prior to Windows 10, but it facilitates the use of device profiles, bulk enrolment and conditional access, none of which are available when using the software client. The last of these – conditional access – is perhaps the most important where ongoing management is concerned as it allows for fine-grained control over which apps and devices can connect to company resources such as email and Microsoft 365.

> **"Conditional access allows for fine-grained control over which apps and devices can connect to company resources such as email"**

With Intune, you can configure devices' update settings, optionally withholding feature updates while ensuring security patches still make it through to end users. The earliest build you can stick with is currently 1803, which is now over two years old, giving admins time to patch business-critical applications for later builds. Update policies are defined within the admin centre as rings, which can be run, paused or deleted. It's also possible to extend a paused Windows Update for up to 35 days, as is the case through Windows Update when run locally on standalone machines (**pcpro.link/317update**).

■ Paranoid Android

How strict do you want to be? Google offers three levels of control, from full device management for corporate-owned, business-only devices to work profiles for BYOD devices enabled by their owners (**pcpro.link/317and1**). The latter, which offers the greatest flexibility, lets staff use a single device for both business and personal needs.

Work profiles are a neat solution for staff who don't want to carry multiple devices, allowing organisations to distinguish their own space within the OS. Business-focused notifications are marked with a briefcase icon to distinguish them from personal pop-ups, and business apps and data are kept separate from those for personal use, with a tabbed application drawer providing virtual containers for each app type. Work profiles are supported on Android 5 and later, and data that's included in either a work or a personal profile on a device supporting both will never stray into the other territory, so email, calendars and contacts remain distinct (**pcpro.link/317and2**).

Setting up a work profile allows system admins to specify certain device security requirements that apply globally rather than just to the business-focused aspects, such as passwords of a specific length, which won't be a serious imposition on the device owner. Removing the work profile when the staff member leaves the organisation or upgrades the device deletes both the apps and data associated with it. Staff can initiate this action themselves.

The organisation can access data within the work profile, but not the rest of the device, giving staff a high degree of privacy. If the organisation requires greater oversight than this, it can instead opt for a fully managed device, although this would be most practical on business-owned hardware, rather than BYOD. Work profiles on fully managed devices can only be deleted with admin approval.

Full device management is more prescriptive than just opting for work profiles and extends the degree of control organisations have over the device, its data and security. Device owners can remotely wipe the tablet or handset, as well as remotely installing and removing apps, which can be done silently, without user approval. Users themselves can install optional apps using a managed Google Play store on the device. Full device management is supported on Android 6 Marshmallow and later.

With "zero-touch" enrolment (**pcpro.link/317and3**), staff don't need to configure their phones themselves, but get up and running by scanning a QR code, logging in to an enabled G Suite account or using NFC. The zero-touch service is set up by the device reseller or network, which assigns the enabled devices to your corporate G Suite account. Once they've done so, admins can manage devices via a dashboard by setting up defined configurations to roll out to individual devices, or batches, as soon as users first turn them on.

■ SOS iOS

Apple's mobile hardware supports a similar model to Android, allowing both corporate and personal devices to be managed remotely to ensure only authorised apps are used and sensitive data remains protected.

Maintaining control over app installation and restrictions, automated deployment and remote account setup requires two resources, an MDM tool – such as Jamf Cloud (**jamf.com**) – and Apple Business Manager (**pcpro.link/317apple**). Business Manager centralises the

ABOVE Work profiles let firms access data, while keeping the rest of the device private

> "Business-focused notifications are marked with a briefcase icon to distinguish them from personal pop-ups"

purchasing and deployment of apps through a web dashboard, as well as enrolling devices in the MDM. It can enrol devices running iPadOS, iOS, tvOS and macOS that were ordered from Apple or an Apple Authorised Reseller after 1 March 2011, and handle multiple distinct enrolment tokens, which can be assigned to different sets of devices.

Once up and running, admins can manage remote installation of custom in-house apps, as well as downloads from the App Store and even books so staff always have the most recent corporate documents to hand. Apple Business Manager also allows for distribution of apps developed in-house that aren't available through the public-facing App Store.

It's up to admins whether staff are alerted that an update is ready to be installed, or it simply happens in the background. Likewise, apps can be remotely configured, removing responsibility for setup from staff and allowing the business to move back-end services, if required, and update team members' devices to ensure business as usual. Apps can be bought and deployed in bulk and, because management of this aspect of the business is centralised, on-device access to the App Store can be restricted.

Updates aren't linked to Apple IDs: Apple Business Manager can link to an organisation's Azure Active Directory, allowing staff to use their Active Directory usernames and passwords as a Managed Apple ID.

Both books and controlled apps, can be removed remotely, which makes tidying up when staff depart simple and secure. ●

The expert view Steve Cassidy

The single biggest difficulty I've seen with central control of distributed hardware isn't about the security breaches. It's not about which platform, nor is it about having enough bandwidth at home to download those patches built for corporate networks. It's the blurred lines, described so well here by Nik, between BYOD and "oh, just give them a new laptop".

I am firmly in the "new laptop" camp: pure BYOD has always seemed like an utter disaster to me. Even if you pass over the whole device diversity thing, with a tool that will fit on the MD's iPhone 12 Pro Max as well as the despatch rider's Nokia 7, you are still left with the very strong risk that a sufficient number of your colleagues' phones will only install the BYOD tool after going through a complete factory reset.

Push-downloading isn't the problem. It's when the downloaded installer says "reset?" to the device owner, and they misunderstand the question, and when it has restarted all their stuff is gone. Their history, their contacts and their dreaded photos.

Backing that stuff up to the cloud from a consumer device is a retail-style market these days, with competing offers and Black Friday specials and all that nonsense. You just can't assume that enough of your userbase has been smart enough to pick the right offer, or to check that the promised backup has even taken place. In a heartbeat, what ought to have been a simple remote support job turns into a full-scale reenactment of the Salem witch trials.

This is both a numbers game and an indictment of the whole concept of bringing your own device. What will matter is not the make or model of the device that gets messed up: it will matter that the small slab of plastic and glass they hold in their hands is the lynchpin of teleworking, and your tool lost them their holiday pictures.

Just buy them a laptop with the remote update stuff installed by you before it gains any data from them. Life's simpler like that.

HOW TO
MINIMISE
YOUR
PRINTING
COSTS

Looking to cut your business' running costs? **Nik Rawlinson** provides some ingenious ways to reduce your outgoings

L ook after the pennies and the pounds will look after themselves is both a cliché and a truism. Capping costs at every level within a business – however small – allows resources to be reinvested elsewhere. When businesses worldwide are struggling to survive, never mind thrive, in a tough economic climate, looking again at costs such as ink, toner and paper consumption can pay dividends.

Whatever the size of your business, you're almost certainly spending more than you need to on printing. Using third-party compatible consumables is one way to address that, but these come with their own risks that could ultimately cost you more. What are your other options?

■ Buy consumables on subscription

Buying consumables on subscription is a more predictable way to manage your organisation-wide printing costs, and it's often possible to roll the cost of the printer and consumables into one, much as you can when buying a new mobile phone and data bundle.

When shopping around for a managed print service contract,

consider both the facilities your business needs and – crucially – your anticipated monthly duty cycle. Often, the contract price will include a set number of pages per month, much as the contract on a leased vehicle includes a specified mileage after which charges will apply.

Brother's Managed Print Services (**pcpro.link/317brother**) options include the *PC Pro*-recommended HL-L9310CDW (*see issue 283, p94*), alongside laser and inkjet printers, mono and colour options, and multifunction devices with scan and fax functions. Meanwhile, Canon's

Managed Print Services (**pcpro. link/317canon**) reduced Colchester Institute's total cost of ownership by 37%.

If you already have a fleet of printers and you want to sign up for just consumables, you may find it's not possible to sign up with your original equipment manufacturer, which will want to include the hardware as part of the package. In this instance, turn to third-party suppliers. Printerland's PrintSave plan (**pcpro.link/317printsave**) "includes everything you need… just add paper". It starts at £20.43 a month, excluding VAT, for an HP LaserJet Pro M404 Series printer on a duty cycle of 1,000 pages a month.

Both HP, with Instant Ink, and Epson, with ReadyPrint Go, run consumables subscription services that automatically send replacement cartridges when required. We've been using Instant Ink ourselves for some time, and the accuracy is impressive, with the printer sending remaining ink level information to HP so that new cartridges can be delivered just before the old ones run out.

One of the benefits of this model is its predictability. Whether you print at best quality or draft, in mono or full colour, you're paying per page, rather than per millilitre. Yet, even if you choose high quality colour output for every page, HP claims that Instant Ink delivers considerable cost savings, even for home users.
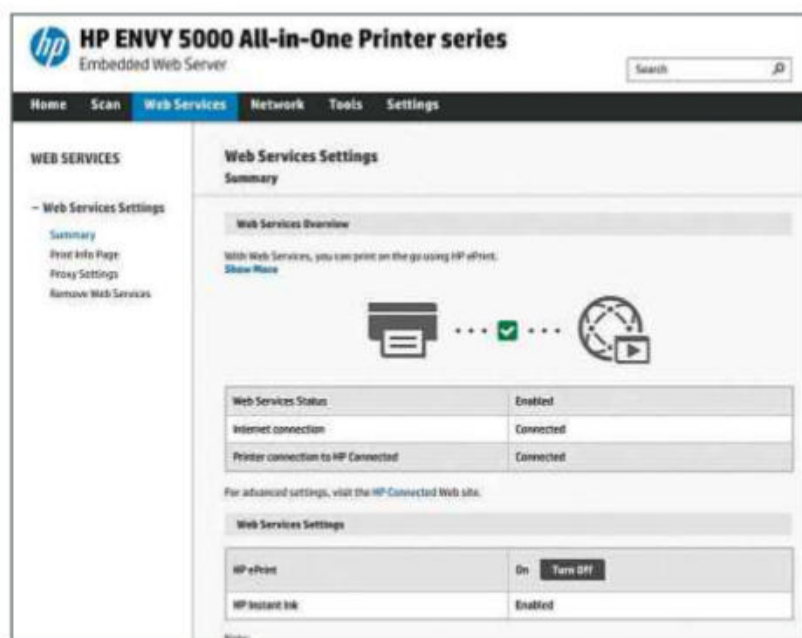
■ Change your template font

Bolder typefaces use more ink; more open, lighter typefaces use less. That's why typeface designers with an eye for a niche have been developing character styles with ink and toner saving in mind.

Stationery shop Ryman has developed Ryman Eco, which is available for free at **rymaneco.co.uk**. Each character in the typeface is made up of parallel lines, rather than a single unified slab. Why? Because the gaps between each line aren't printed, thus reducing ink and toner use. The font is elegant, and the lines, which are visible when it's used at large sizes, make for an interesting design element. These can be eye-catching in titles and headlines.

The trouble with adopting unusual typefaces is that you need to make sure they're installed on every PC in your organisation. Moreover, when you share your documents externally, if those typefaces aren't also in use at the destination, your document may render in unpredictable ways.

That's not to say choosing a typeface with ink saving in mind is a dead end. There's significant variation in the amount of ink used by different "standard" fonts such as Garamond, which is economical at large point sizes, and Impact, which is a heavy consumder of ink and toner at all sizes. When developing a template for use across your organisation, bear this in mind and, if using Microsoft's standard fonts in Office documents, consider switching from Calibri, which is Word's default body copy font, to Calibri Light.

It's not really worth home users switching fonts, but, for businesses with many seats and enough printers to service them, the cumulative saving could be significant. In 2014, for example, it was calculated that the US government could trim $400 million off its overall running costs by switching to a typeface that used less ink (**pcpro.link**/**317typeface**). Although some authorities have questioned the calculations behind the claim, it's still an interesting idea.

■ Use the Ecofont driver

Ecofont (**ecofont.com**) works like a regular printer driver but converts any compatible fonts you've used in your document to less ink and toner-hungry equivalents before sending them to the page. These substitute fonts incorporate minute dots that reduce the amount of the consumable laid down.

ABOVE Ryman Eco is composed of several separate lines rather than slabs of colour
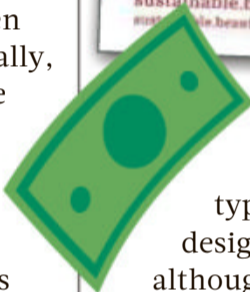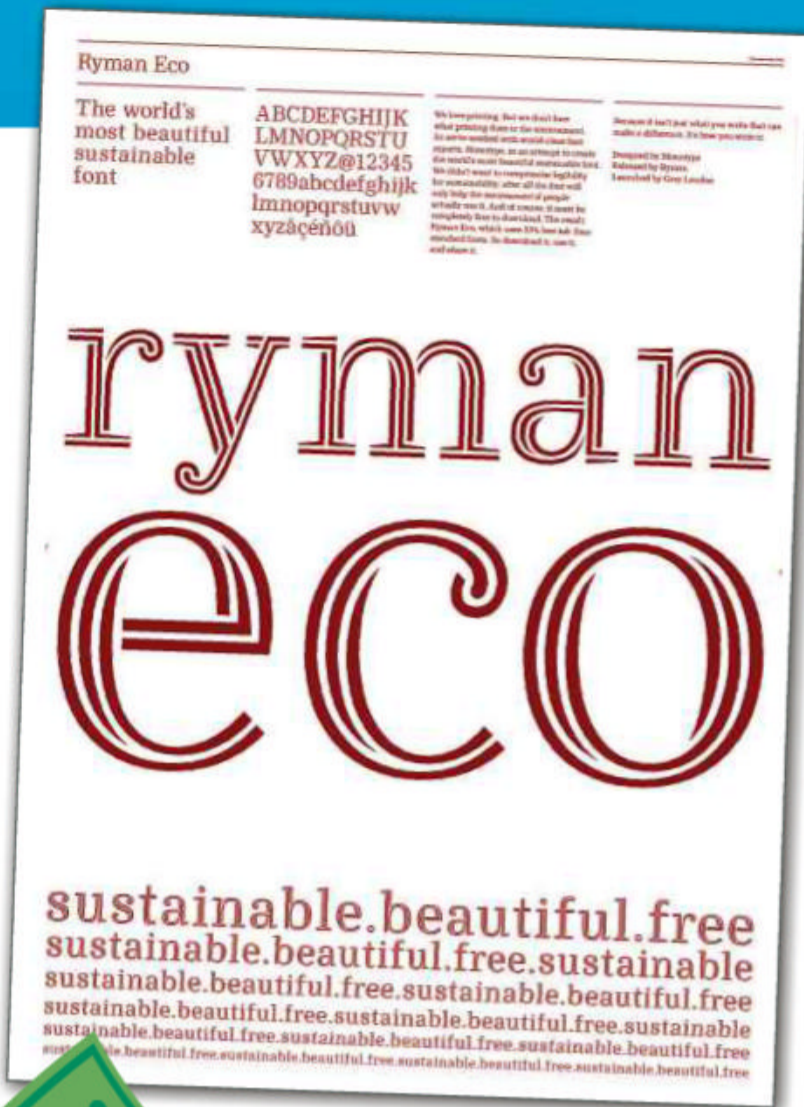
The only limitation is that you need to use typefaces that Ecofont is designed to work with, although that shouldn't be a problem if you're sticking to those enjoying broad industry adoption. At present, Ecofont works with Arial, Calibri, Tahoma, Times New Roman and Verdana, and the developers say that future updates will include additional fonts.

Pricing is tiered, with options for home, business and enterprise use. The €7 per year Home plan limits you to one user. The Business plan, at €10 per user per year, for a maximum of 100 users, adds network installation options but removes the option to also use the software at home. Pricing for Enterprise use, for 100 or more seats, is available on request, and includes support for a custom typeface, which will be essential for organisations

"There's significant variation in the amount of ink used by different 'standard' fonts such as Garamond"

BELOW Printing multiple pages on a single sheet saves paper and ink

that mandate all corporate communications must be set in one of the typefaces not included as standard.

■ Teach staff to use printer controls

The difference between draft and high-quality mode used to be stark but, for a long time, draft has been acceptable on most printers for all but professional correspondence, letting staff save both money and time.

The amount of money you'll save is difficult to quantify as it will vary between manufacturers, but there's a side benefit in that by draining ink or toner more slowly you'll contribute less to the global growth of technology waste. If you have a considerable number of printers installed across your organisation, the marginal savings can have a significant impact over time.

If staff are printing draft documents to proofread before sharing, encourage them to use printers' reduction controls to print multiple pages side by side on the same sheet (*see screenshot below*). This not only reduces paper use but, because the surface area of each character is smaller, it also reduces coverage and ink or toner use.

Likewise, switching to mono printing will reduce colour cartridge use. If you're using a tri-ink cartridge rather than individual tanks for each colour, this can be a significant money saver as it means you don't have to discard a cartridge when one of the three colours has run dry and the other two are only half used. Check your printer's documentation, though, and be mindful of the difference between greyscale and true black and white. Some printers use the colour cartridge to produce a realistic, nuanced greyscale result rather than just mono, which means opting for that might not deliver the savings you expect.

Enterprise-grade printers allow for granular control over who can and can't access specific features, which in many cases includes colour printing. This would allow admins to lock off more expensive printing options from most staff members and restrict more ambitious output options to only those who really need them.
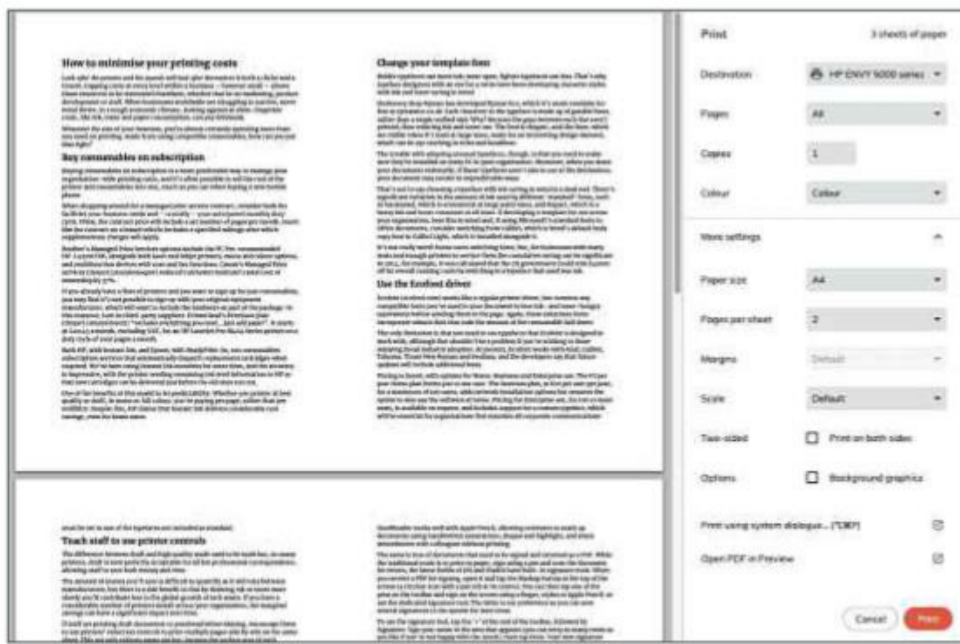
Where possible, set printers to duplex (to print on both sides of the page). While this won't save ink, it will reduce paper consumption. However, you'll need to balance this with the fact that a duplex-ready printer will be a more expensive investment than a device that only prints on one side. Just as you need to work out how long it will take to recoup the additional cost of an electric car in saved petrol or diesel costs, you need to balance the cost savings of duplex printing against the initial outlay. Naturally, there are "green" considerations in each of these scenarios too, which might play a part in your final decision. Again, both the economic and ecological result of a decision will be multiplied by the size of your fleet.

■ Fill out forms digitally

The less your team prints, the less you'll spend on paper and ink. But what's the alternative? If staff need to share documents for sign off, you should encourage them to use PDFs and apps like GoodReader for iPad or Foxit PDF Reader Mobile for Android.

GoodReader works smoothly with the Apple Pencil, allowing reviewers to mark up their documents using handwritten annotations, shapes and highlights. These amendments can then be shared with colleagues without printing.

The same is true of documents that need to be signed and returned as a PDF. While the traditional route is to print to paper, sign using a pen and scan the document for return, the latest build of iPadOS has built-in signature tools. When you receive a PDF for signing, open it and tap the Markup button at the top of the screen (a circular icon with a pen nib at its centre). You can then tap one of the pens on the toolbar and sign on the screen using a finger, stylus or Apple Pencil, or use the dedicated signature tool. The latter is our preference as you can save several signatures to the system for later reuse.

To use the signature tool, tap the "+" at the end of the toolbar, followed by Signature. Sign your name in the area that appears (naturally, you can retry as many times as you like if you're not happy with the result) and then tap Done. Your new signature will be added to the form and you can drag the corners of its
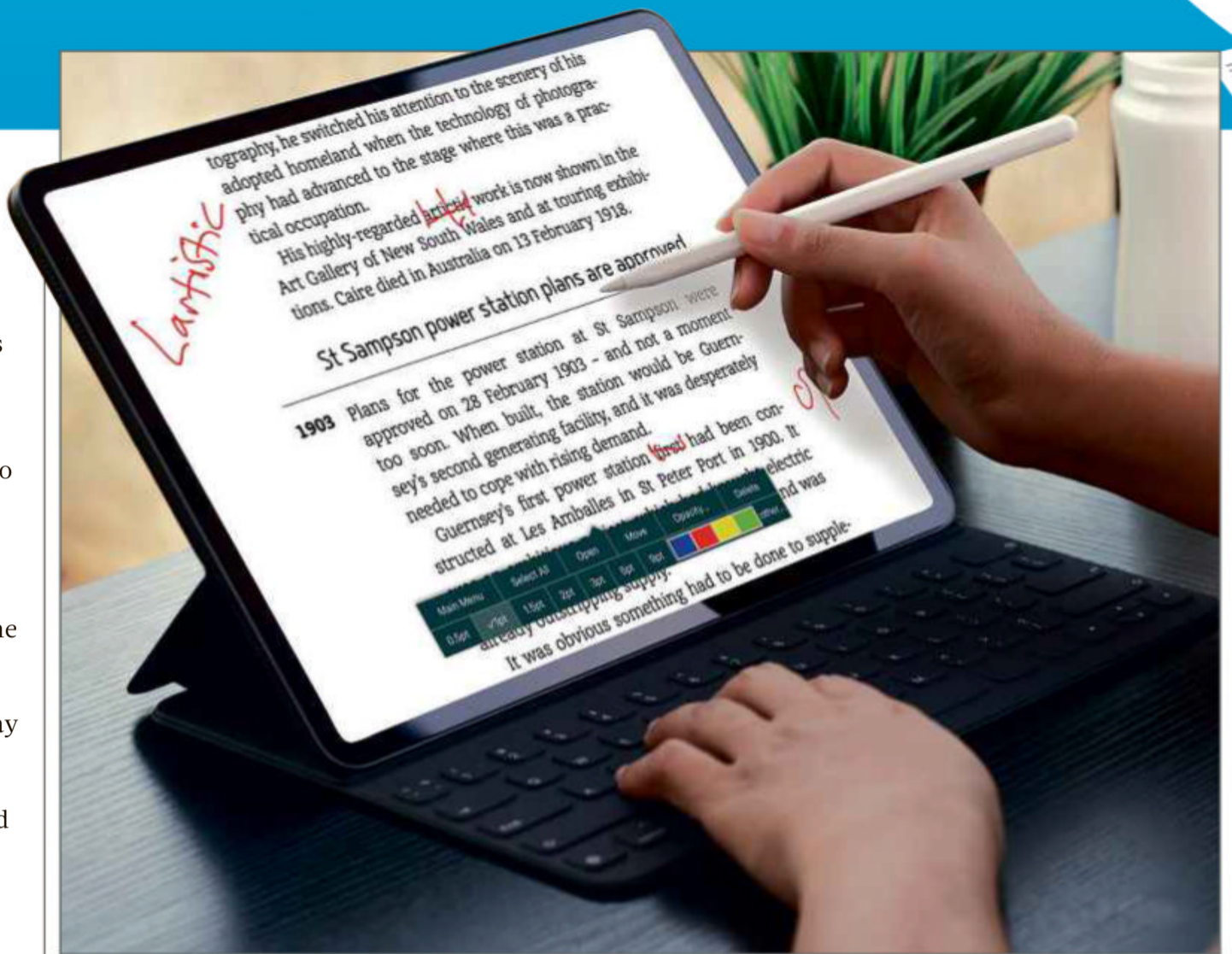
bounding box to change its size and position (*see screenshot below*).

The next time you want to add a signature, tap "+" followed by Signature again, and this time tap your existing signature to drop it onto the page.

■ Proofing without printing

Above, we suggested that sharing documents by PDF is an effective way to get sign off, but if you're proofing work solo, we find text to voice more effective. Why? Because when you read your own text in your head, you have a greater propensity to read what you think it says rather than what it does.

Word, PowerPoint, Outlook and OneNote have text to speech built in. To launch it, click Read Aloud on Word's Review tab, or the speech bubble on the Quick Access Toolbar. (If this isn't shown on the toolbar, click the down-pointing icon at the end of the toolbar and add it.) Be aware, however, that when it's

running your navigation shortcuts will be different. Ctrl with the left and right arrows skips to the start of the previous and next paragraphs, while Alt with the left and right arrows slows down and speeds up the reading speed. Press Ctrl and space to play or pause reading when you need to make amendments.

■ Get someone else to print for you

The paperless office is something we've been talking about for years, and it's time to admit it will never become a reality. But organisations should increasingly think about how and where their documents are being produced and, where possible, adopt a hybrid model.

Outsourcing lengthy print runs to professional organisations can significantly reduce expenditure when the alternative, printing on-site, can cost close to a penny a page. Naturally, this doesn't work for short-run content required immediately, but with planning and negotiation it can seriously impact the overall cost of document production.

Moreover, many professional print shops are finding the current economic climate challenging for the obvious reason that less work is being booked in. You may find that several are willing to negotiate a favourable price, and that spare capacity within the market means your work is turned around more quickly than you'd expect. ●

> "Organisations should think about how and where their documents are produced and, where possible, adopt a hybrid model"
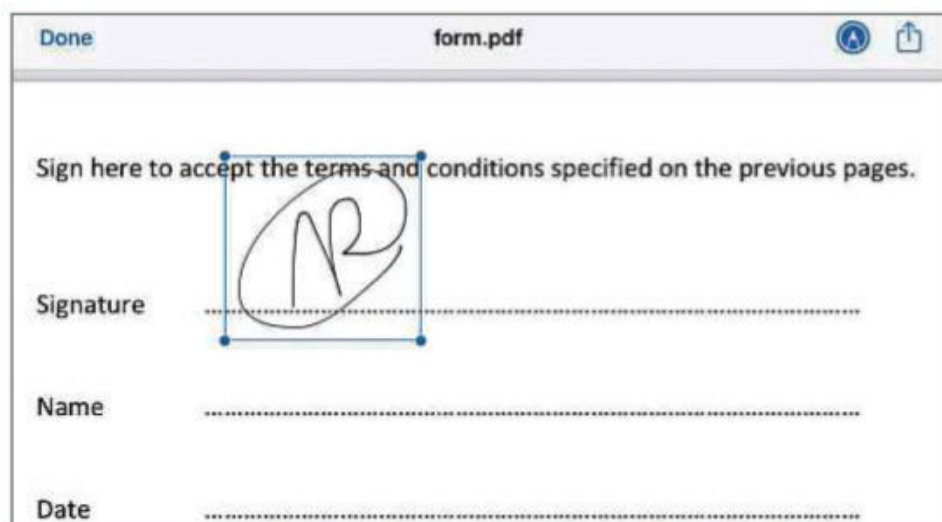
Vulnerability assessments

It's important to know about risks on your network – but, as Davey Winder finds out, knowing is only half the battle

■ Vulnerability assessment? Is that just what it sounds like?
The short answer is "yes". A vulnerability assessment starts with the scanning of your systems, applications and networks for, well, vulnerabilities. Then comes the analysis of the results, which finally leads to an appraisal of your security stance.

■ Are we really talking about penetration testing here?
That's the problem with short answers. Vulnerability assessment and penetration testing are both parts of the larger business of cyber risk analysis, but they're not the same. Penetration testing is a specific, highly skilled process that employs experienced operators to locate exploitable flaws within a specific scope, and explore their potential impact. Since the testers aren't cheap, the scope is usually limited to areas of high value or risk to the business. Vulnerability scanning, by contrast, is generally an automated, all-encompassing process, aimed at identifying known vulnerabilities across devices, networks and applications. There's no exploration of the potential impact of exploiting these: that's not the point. The purpose of the exercise is simply to find problems that can be fixed forthwith.

■ So a vulnerability assessment largely means making a list of outdated software and firmware?
That's a part of it – but we mentioned above that there's also an analysis phase, and this is an absolutely crucial part of the process. Merely enumerating potential security issues is a bit like having a house survey done and ending up with an undifferentiated list of faults, with no indication of which might cause the building to collapse, nor any suggestion of suitable remediation. Indeed, if your assessment just generates a list of issues, that could inspire a false sense of preparedness that, ironically, leaves you less safe.

> "If your assessment just generates a list of issues, that could inspire a false sense of preparedness that leaves you less safe"

■ So what, ideally, should a vulnerability assessment provide?
Context. It really is as simple as that – but that certainly doesn't mean that the job is a simple one. Anyone can run an automated vulnerability scanner, but it takes expertise and site-specific knowledge to translate its output into an appraisal of real business risk. This is where the value of a vulnerability assessment is to be found: connecting the dots between hundreds, if not thousands, of vulnerabilities and identifying which of your business processes could be compromised.

■ Surely we'll be fine if we just focus on critical exploits?
Both software publishers and hardware manufacturers will flag certain updates as "critical"; it's vital to understand that technical severity isn't the same as criticality *for your specific business*. Working out how vulnerabilities relate to your operations is the difference between spending security budgets on compliance checking and gaining real visibility into your risk exposure.

■ At the end of the day, isn't it best to fix every vulnerability?
That sounds like an obvious answer – but remember, "fixing" can mean more than just updating a piece of software. It may affect dependencies, require revisions to security procedures and lead to all sorts of other knock-on changes. A properly prepared assessment will include analysis of which vulnerabilities are worth the cost, in terms of downtime and resources, to fix. Where the risk to the business is negligible, it may be justifiable to leave some issues unaddressed – the important thing is that any such decision is made with open eyes, and in possession of all the relevant facts. ●

How frequent should assessments be?

There's nothing stopping you from running a vulnerability scanner 24 hours a day to catch any potential issues as quickly as possible. This isn't the same as a true vulnerability assessment, however: that needs the extra steps of analysing and contextualising your findings .

So how often should you carry out a full assessment? As we've noted, vulnerability assessment is only one cog in the risk-reducing machine – penetration testing being another. So, for starters, you should run a vulnerability assessment before starting a penetration test, as otherwise you're likely wasting money getting industry experts to discover and document flaws you could have dealt with yourself.

Beyond that, the only limiting factor is what's feasible for you. Remember that an assessment represents a snapshot in time: even if your hardware and software don't change at all, new attack vectors are constantly coming to light, and new patches are rolled out to close them off. If you can take snapshots at least quarterly – or perhaps monthly or even weekly – that will help you stay ahead of the game.

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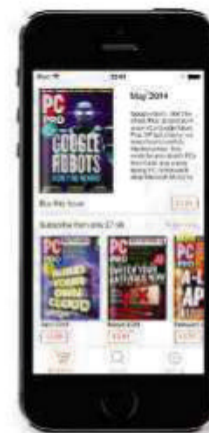
...Windows 8

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STEP 3 Click the 'Subscribe' button and pick your term

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JON HONEYBALL

"It's so easy just to fire up what you need, decide that time is short and you'll deal with it next time"

A shame-faced Jon migrates his final Windows 7 system to Windows 10, before putting his latest dodgy Amazon purchase through its paces

Okay, I confess: just this morning, I moved my final Windows 7 installation to Windows 10. Yes, I know, this section should be called *Jon is a Bad Boy*, and I should have done this years ago. My only excuse, if there is one, is that this is Windows 7 in a virtual machine, it's only fired up once a month for about five minutes and it runs a specific piece of software.

I guess you need some back story. In the lab, we have a full door control access system. This means that there's a door tag reader on both sides of every door. You need to use an RFID token to open the door and the doors close automatically. While this is somewhat overkill in our small company, it's what corporate and government visitors expect to see. On the outside of the front door is a PIN pad and each member of staff has their own PIN number to gain access, along with the appropriate security keys and alarm fobs.

The door controllers are embedded deep in the bowels of the lab. In simple terms, each door controller maintains a list of door tag RFID codes, along with the times and dates when they're valid for that door. These controllers trundle along by themselves and don't need oversight. The only time you need to talk to the door controllers is if you want to reprogramme them – add a member of staff, issue a new token, change someone's working hours or access times.

This is done with a piece of software called Net2 from Paxton, a company well known in this space. Net2 consists of an old-fashioned-looking Windows application and a database engine for the back-end. This polls the door controllers and picks up all the movements, door entries and so forth. It's all very clever: if you have a

reception desk in your organisation then this can create a door tag for the day for a visitor, and assign them access to the doors they need.

In that example, you'd need the software running all the time, but in our case we only need to fire Net2 up when we make changes. I originally installed it many years ago into a Windows 7 VM, and every year or so I call up our alarm system company to get a download of the latest version of the software, to which I upgrade. Like much of the professional services software market, we can only access the mothership by going through our reseller.

To be honest, I just left sleeping dogs lie. It worked, I used it for a few minutes every month to download the logs and to check the system was still happy. At least it would be obvious if the doors didn't work, so there wasn't much scope for things going wrong. The door controllers themselves hold data for many weeks, so I wasn't losing information by doing this.

This morning, I decided that I really had to do something about it. I fired up the Windows 10 media creation tool from the Microsoft site,

Jon is the MD of an IT consultancy that specialises in testing and deploying kit

@jonhoneyball

> **"But having a virtual machine that you can copy is just so much more convenient"**

BELOW Moving my final Windows 7 VM to Windows 10 wasn't without complications

told it to upgrade, keeping the existing software and accounts in place, and then sat back. I'd like to say it was a seamless process, but the Windows installer got a little upset about the apparent desktop size in the Parallels virtual machine. Still, after about 15 minutes of installation, updating and other fiddling, I was up and running.

The beauty of using a VM for this was that I could take an entire snapshot and copy before starting, in the unlikely event that the Net2 installation exploded on finding itself on Windows 10. It's listed on its site as being supported, so I wasn't expecting issues. But having a VM that you can copy is just so much more convenient than having a Windows installation running on a real computer, where recovery would be a major pain.

The downside of a virtual machine hosting an old OS and app that you rarely use is that it isn't there looking at you with a withering glance every time you walk past the computer. Out of sight, out of mind, out of upgrade, for month after month. It's so easy just to fire up what you need, decide that time is short and you'll deal with it next time.
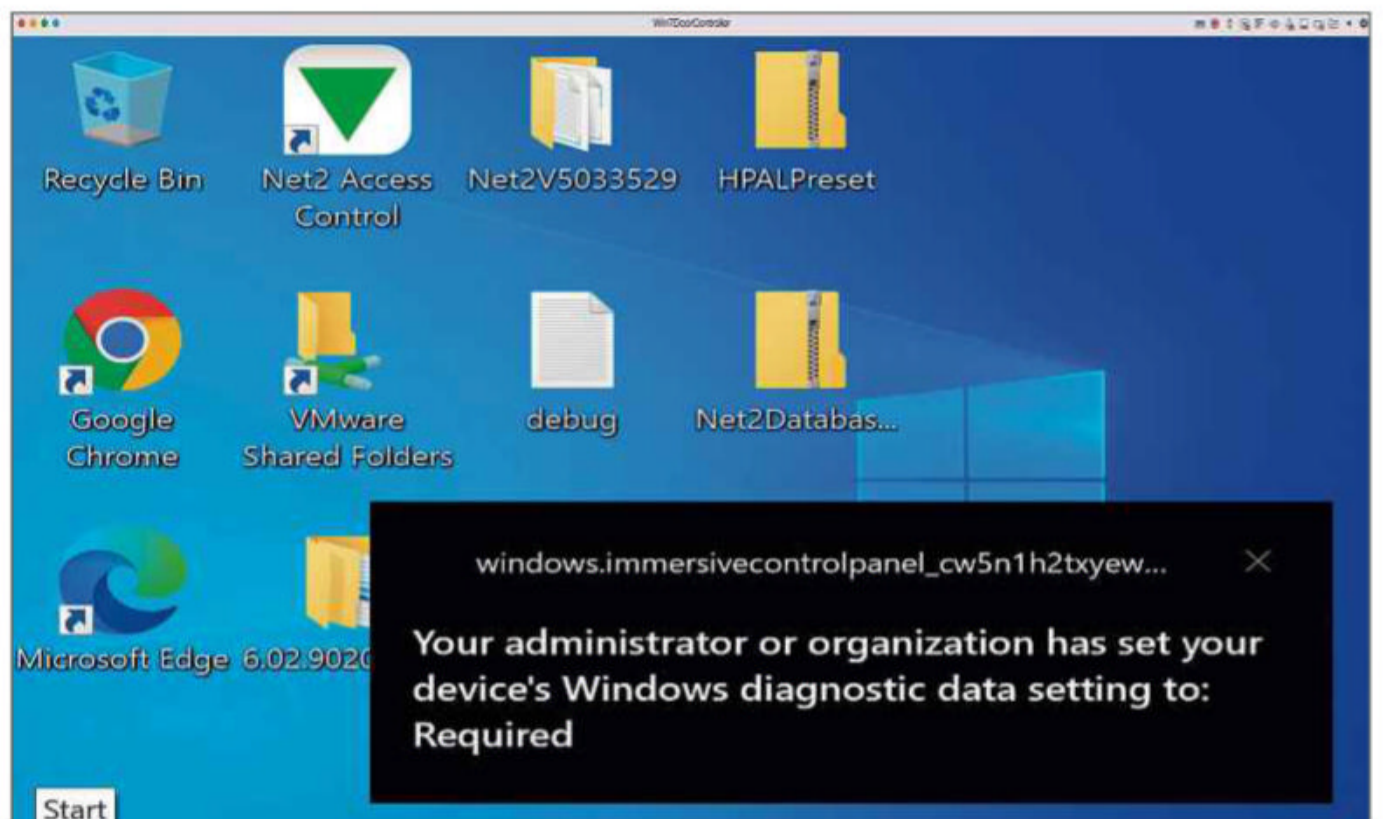
Jon Honeyball
Opinion on Windows, Apple and everything in between – p110

Paul Ockenden
Unique insight into mobile and wireless tech – p113

Lee Grant
Tales from the front line of computer repair – p116

Davey Winder
Keeping small businesses safe since 1997 – p118

Steve Cassidy
The wider vision on cloud and infrastructure – p120

However, I'm happy to report that all Windows 7 has been expunged, except for a few VMs that I keep for test purposes. All I can do is ask for your forgiveness.

QuickBooks, American Express and open banking

Back in 2018, UK regulators (based on an EU directive dating all the way to 2015) rolled out a series of changes under the broad heading of "open banking", which forced the nine biggest British banks to essentially open up their data. Up until then, it seems that accounts packages essentially did a screen scrape of banking websites in an attempt to pull out the data and load it into their account information.

This became impossible after the arrival of open banking, which ensured that there was a defined set of APIs that existed between trusted parties in the conversation. And that the user was fully involved and is required to reauthorise the connection every few months.

This is all very grown up and the sort of interfacing between accounts packages and banking services that you'd want to see in 2021.

The problem is the way in which it has been implemented. I moved to QuickBooks Online for the company accounts some two years ago, and it has mostly worked… albeit accompanied by the worrying feeling that it's all hanging together using chewing gum and some masking tape. This view hasn't been helped by the handling of open banking. For some years, I've used a British Airways American Express card, which has served me well. The benefits have been of little use since the Great Unpleasantness began and I haven't flown since visiting CES with Mr Editor Danton back in January 2020. Nevertheless, I need to feed it into my QuickBooks Online accounts package.

Back in March, this connection stopped. QuickBooks said it was working on it. Every month or so, when pressed, it continued to say it was working on it. It's still working on it now, with the company saying that it might have open banking working in 2021 at some point. This means that every week or so since March

I've had to go to the American Express site, log in, download a CSV of transactions, then swap the sign of the transaction value for each entry in the CSV file (because QuickBooks and American Express can't agree on what's the correct sign for a credit and a debit), then import them into QuickBooks. At which point I can start handling the transactions. Frankly it's a pain. What's worse is that competing accounts packages such as Xero have working open banking feeds between their platforms and American Express.

It's hard to know whether the problem lies with American Express or with QuickBooks, so I'm going to take the generous view and blame them both. It appears that open banking has exposed all sorts of unpleasantness, both at the banking and accounts package ends of the conversation. Moving my credit card away from American Express would be annoying, but it's doable. Moving accounts packages is more painful. All I can do is wish them an Unhappy New Year and a plague on both their houses.

5G… but not with dual SIM

I've still managed to resist upgrading to the iPhone 12 Pro Max (*see issue 316, p73*) to replace my long-suffering iPhone 11 Pro Max. The camera and speed improvements are tempting, but not enough to justify the cost. Nor the loss of the useful battery case that

ABOVE No multi-SIM with 5G means no upgrade to the new Apple shiny yet

BELOW Who's at fault for my woes: AmEx or QuickBooks? Let's just say it's both of them

keeps my 11 Pro Max going for most of the day and makes battery life worries a thing of the past.

The 5G support? Well, I continue to be cynical about the whole 5G sales pitch, and it only takes a few minutes looking at the current 5G coverage maps for the big players to realise that, just like Pooh Bear, the more you look the more it isn't there.

However, on those occasions when I travel to the centre of London, it could be nerdy fun to have 5G pop up on my phone and try some network speed checks. That might not the strongest of justifications for spending £1,500 or so, I accept. But even that idea fell apart when I found out that you can't have 5G operating if you have two SIMs in your phone. That can be a physical SIM and an eSIM, or two eSIMs.

The iPhone has two radio sections and can log in to two separate networks at once. This is useful, and I have both a Vodafone business physical SIM and an EE eSIM in my iPhone. But dive into the Apple support page at **pcpro.link/317dual** and you find the following statement: "While using two lines in Dual SIM mode, 5G data isn't supported on either line and will fall back to 4G LTE." So as soon as you have two SIMs running, you lose 5G capabilities on both. There's no mention of this limitation on the main iPhone 12 pages on the Apple website.
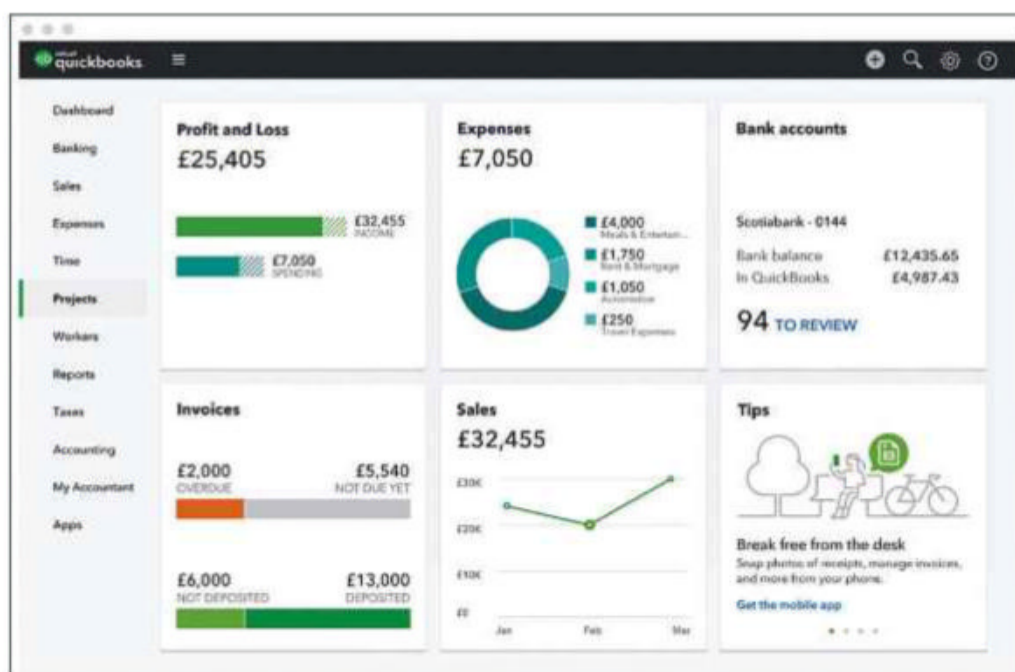
Delivered
Parcel was left in letterbox

Micro SD 1024 GB

400GB/512GB/1024GB Micro SD SDXC Flash Memory Card Class 10 for Cell Phone Camera Laptop + Free Adapter (1024GB)
Sold by: binchengquzhongyiculiangfandian
Eligible for return until 31 Jan 2021
£25.99

[Buy it again]

[Track package]
[Print packing slip]
[Return items]
[Share gift receipt]
[Leave seller feedback]
[Write a product review]

I'm told, but I haven't confirmed this, that the issue afflicts other 5G phones too, including my Samsung S20 Ultra. I believe that the limitation is within the Qualcomm chipset, and a page on its site talks about 5G and multi-SIM, but it fails to clearly define that both should work at the same time (**pcpro.link/317multi**).

Wherever the problem lies, the reality is that the iPhone 12 Pro Max can't do multi-SIM and 5G. Which, for me, is the final nail in the coffin for any upgrade.

1TB microSD card

If it's too good to be true, then it probably is going to disappoint. I was trundling around Amazon UK, looking at 1TB microSD cards. I didn't really need one, and I confess I have concerns about that much storage in something so small. The prices have certainly come down, with Amazon selling the SanDisk Extreme Pro 1TB device for a shade under £220 inc VAT, but then I spotted a 1TB microSD card for just £25.99. Clearly this was going to be a fake, but I was interested to see what came.

The first clue came from the vendor name of "binchengquz hongyiculiangfandian", which is a bit of a mouthful. And then the description said "400GB/512GB/1,024GB Micro SD SDXC Flash Memory Card Class 10 for Cell Phone Camera Laptop + Free Adapter (1024GB)". That wasn't necessarily a bad thing, though, because many Amazon listings are for devices available at multiple sizes, and you choose on the page which of them you want. I hit "Buy now".

The no-name product came in a no-name

package. I popped it into my Dell XPS 15 and it reported itself as being 1TB in size. So I fired up some SD card data-scrubbing and testing software, and let it run for several days.

The bottom line: there was 22GB or thereabouts of storage, and then a sea of red warnings. Was I surprised? Not at all. I could return it for a refund, but I'll think I'll hang onto it as a curiosity, sitting alongside the fake iPhone I bought from a man in the pub a few years ago. Yes, it really was a man in the pub. "Only for cash, mate – it's a quality product."

You have to be careful about what you buy and Amazon appears to attract a certain sort of scam artist. The original advert for the product I bought has long since vanished from Amazon. However, it only took a handful of moments to find another today: a "1,024GB High Speed Class 10 SD SDXC Card" from a brand called "Genericca". The price? £10. And you can have it in black, blue, yellow, purple or green. This time, however, I think I'll pass.

Memory matters on the M1

I was attempting to find out how much of the Unified Memory on the M1 chipset is actually used by the

"I'll hang onto it as a curiosity, alongside the fake iPhone I bought from a man in the pub"

video/GPU function because Apple is being rather coy about the matter. It simply claims that it's a movable feast, and that main system RAM and video/GPU RAM is all from the same on-package store. I looked at Activity Monitor, but that gave no clues. I also tried the ever-trusty iStat Menus, but its analysis maintained that there was 0GB of video RAM at all times, which wasn't helpful.

Thanks, then, to a *PC Pro* reader on Twitter (**@peter_woodworth**) who pointed me in the direction of another reporting tool called iStatistica Pro. I went online and bought this utility for a few pounds and fired it up. It's currently reporting that I'm using 155MB of 301MB of RAM in the graphics subsystem. Fire up a graphically intensive task and this can rise to around 1.5GB. So it's reporting numbers that mostly look correct. More investigation is required, but I shall keep digging.

Windows on ARM

Parallels, which makes the excellent hypervisor product for Intel Macs that I use on an almost daily basis, has announced that its M1-based beta programme will be starting soon. It has been somewhat reticent to say
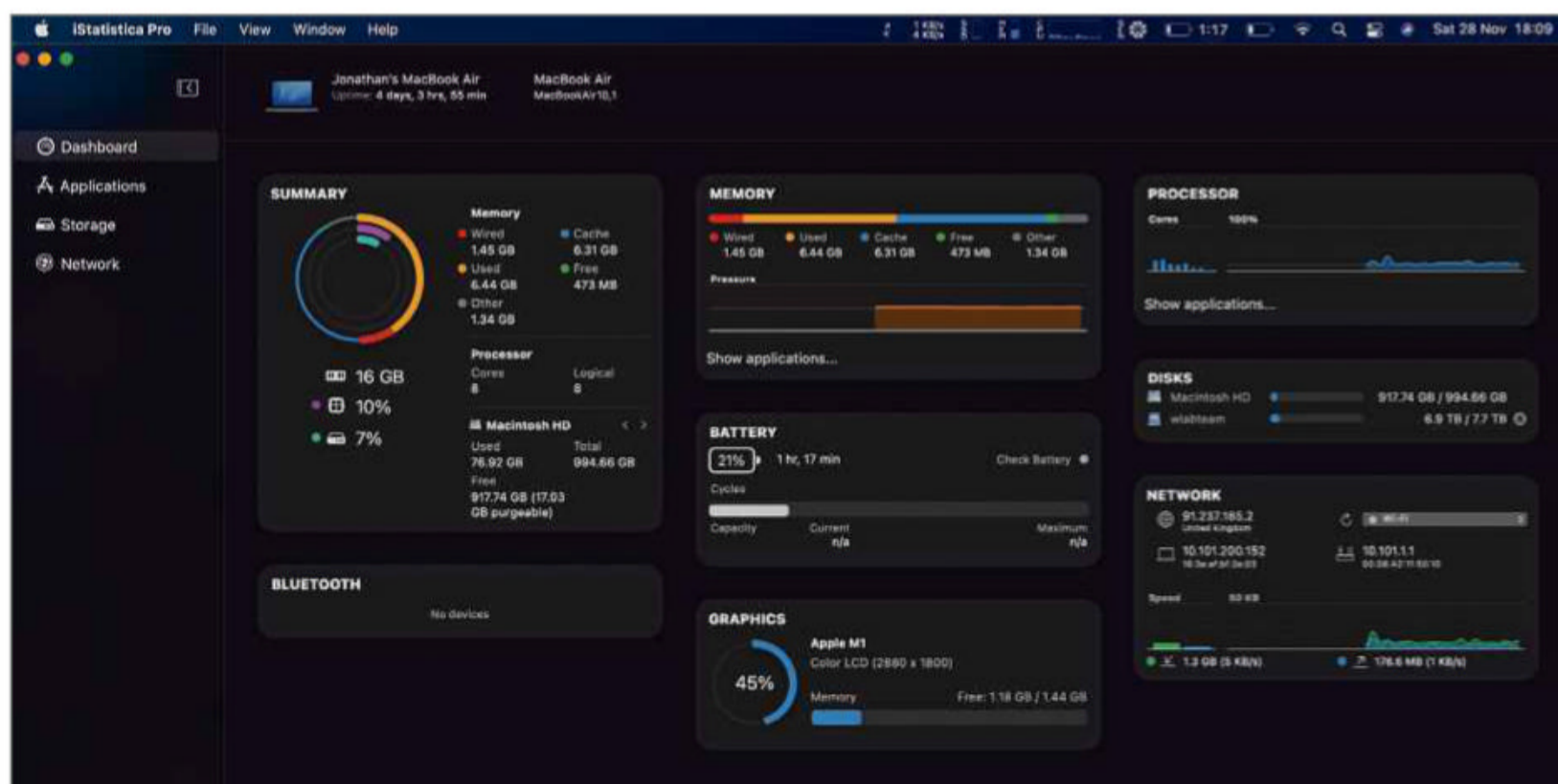
what this will support. Obviously, it will be able to run ARM-based operating systems and code in the Apple hypervisor engine, and indeed Apple has already demonstrated a hypervisor doing exactly that.

The elephant in the room, however, is support for Win64 Intel code in Windows. I might be wrong, but this is what I think is going to happen. Parallels has apparently already ported its management tool to the M1 platform. Craig Federighi, Apple's senior vice president of software engineering, has reportedly said that the ARM version of Windows could run on M1, but it would be "really up to Microsoft". Remember that Windows 10 on ARM isn't a retail or corporate-licensed product. It is only available with an ARM-based computer such as the Microsoft Surface Pro X.

Windows 10 on ARM currently supports Win32 Intel executables using a software emulation layer. Microsoft has said that Win64 support is coming sometime this year.

So here's the likely path. Parallels persuades Microsoft to allow the Parallels M1 customer to in-app purchase a licence and download to a pre-built Windows 10 on ARM virtual machine, complete with Win64 Intel emulator. This neatly sidesteps the need to use Rosetta 2, the Apple tech that allows 64-bit Intel macOS apps to run on M1, and which Apple has explicitly said isn't for use outside of its own ecosystem.

Is this a good idea? Well, it's a solution for Parallels and gives it a market moving forward. I love Parallels on Intel Mac, but that's a hardware virtualisation for the Windows Intel platform, and a Win64 app doesn't know any different to a real computer. Running Win64 Intel code through the code translator within Windows 10 on ARM will immediately open up comparisons with how well devices such as the Microsoft Surface Pro X manage to do the same thing. It might be a comparison that Microsoft would rather not happen. Only time will tell, but my M1 MacBook Air is ready and waiting, and I have signed up to the beta programme. Let's see what comes, and how well it works in real-world testing.

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PAUL OCKENDEN

"I can't imagine anything more boring than watching someone else play a video game!"

Paul provides a deep-dive into a piece of hardware that's aimed at the streaming generation – but that is capable of doing so much more

Gerry, a *PC Pro* subscriber, contacted me recently and asked whether I had any experience of a range of products from Elgato called Stream Deck. As it happens, yes – I've been using them for years!

What's a Stream Deck? Well the best way to explain it is visually, so start by looking at the picture at the bottom of this page. It's a bank of software-aware buttons that are fully programmable, including the graphics behind each button. It's a simple concept, well executed.

My original Stream Deck was the original model with 15 keys. It was okay, although there were a few annoyances, which I'll get on to in a while. However, I recently upgraded to the 32-key Stream Deck XL. Do you really need those extra keys? If I'm honest, not really, because you can cascade the functions – effectively press one button to get a whole new bank of different buttons, a bit like a subfolder. But I'm jumping way ahead of myself here…

Why the name Stream Deck? It's because the primary target audience for these devices is online "streamers". For the people reading this who don't have the foggiest idea what a streamer is, the clue is in the name – a streamer is a person who live-streams video,

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@PaulOckenden

BELOW The Elgato Stream Deck provides 15 programmable, customisable buttons

and that's a really big thing these days. There's a massive community of people live-streaming themselves playing games, for example. This must appeal to a certain audience, but personally I can't imagine anything more boring than watching someone else play a video game!

However, it's a huge community, which in some instances is quite profitable – people monetise these streams via adverts, sponsorship and paid product placement. Other types of online streaming include low-end broadcasts, and live broadcasting of events and gigs on platforms such as Twitter and YouTube. The Stream Deck is designed to allow you to switch feeds, cue in graphics and effects, and generally create a professional presentation.

If you were pre-recording video for later uploading to YouTube or a similar platform, you'd no doubt edit it using one of a number of packages out there – think Adobe Premiere Pro, Blackmagic DaVinci Resolve or Apple's Final Cut Pro X. You'd make all of your drops, cuts and fades, add captions and graphics, switch shots and so on. It's what makes a video watchable, as I'm sure you'll agree if you've ever accidentally clicked on an unedited YouTube link.

Yet when the video is being streamed live, you can't review the footage to do those things – they all need to happen in real-time. There's software that can help: Open Broadcaster Software (now known as OBS Studio) is well regarded, but reputable alternatives include XSplit and Telestream Wirecast. The thing is, they're controlled via keyboard and mouse, and that's not best suited to seat-of-the-pants broadcasting. Elgato's Stream Deck is a perfect accompaniment to all these systems: just press a button to add a caption, switch cameras, play a jingle or whatever. I often see it described as a "live content controller", and I'm told that the

device is even well used in the adult entertainment industry.

Income stream

As you may have guessed, I don't do any of that video-streaming stuff – and especially not the latter example! For me, the Stream Deck is just a brilliant workplace productivity tool; I don't use it for its original intended purpose at all.

When I fire up Adobe Photoshop, for example, the buttons on my Stream Deck XL all become shortcuts to the features that I most regularly use. Switch to Microsoft Word and the buttons change once more. And back in the main operating system they change again to application shortcuts, web bookmarks, media control and the like. I try to keep shortcuts in the same place between the various programs, so saving a document is the top-right key no matter which set of keys is being displayed. I even have a selection of signatures available for when I'm working in an email client. If you were really lax about security, you might even trigger some of your more complex passwords from a single key press, although there's no way I'd recommend doing something like that!

The keys are clear physical buttons with a programmable screen behind each one. They have a positive feel, and I find the buttons on my newer Stream Deck XL to be better than those on my old original model, which would occasionally stick down. If you read many of the online reviews or look at some of the YouTube videos describing these devices, you'll see people suggesting that each key has its own tiny screen at the back, but it's actually just one big screen behind all of the keys, with a mask between the buttons.

I know there are many programmable keyboards on the market, and that it's even possible to download software to reprogramme keys on an existing keyboard, but Stream Deck is on a different level. It's all controlled from an application running on your PC or Mac. There are third-party hacks available for Linux, but they aren't as feature-rich as the official Windows and Mac software from Elgato.

The configuration utility allows you to set the visuals behind the keys

and the action that happens when the key is pressed. It normally needs to be something that can be accessed via a keystroke, but there are exceptions such as media controls, starting an application or going to a URL. And it allows you to set up several banks of these triggered on a software-defined basis. The software monitors which application currently has focus on the computer and switches to the relative bank of buttons. It all happens quickly too, which is great.

One initial disappointment is that there's nothing built in to control software such as Photoshop, Word or other common productivity tools. The built-in actions are pretty much limited to streaming, and include software such as OBS Studio, Streamlabs and Twitch Studio. You can download further actions from Elgato, including Visual Studio Code and PowerPoint.

That initial disappointment soon fades, though, when you realise two things. First, it's easy to set up your own buttons and application-specific profiles. Second, to take Photoshop as an example, the functions I use are probably completely different to the functions you might use, so any

ABOVE It's not just game streamers who can take advantage of the Elgato kit

"It's really easy to integrate the Stream Deck with services such as IFTTT and Domoticz"

BELOW You set up your Stream Deck using a powerful configuration utility

predefined setup would be useless. It's much better to customise it to work the way that you want to.

When it comes to the icons for your buttons, you can either upload files from your computer (you'll find lots of suitable icon sets available online) or use the handy online button creator software that Elgato provides at **elgato.com/en/gaming/keycreator**. If you upload your own buttons, you don't have to get too hung up on the file format or image size as this will be converted as needed. You can even use or create animated buttons by uploading animated GIFs, but although fun at first I find these distracting.

As well as using the Stream Deck with productivity software, there are a few people in my circle of extended acquaintances who I've convinced to give the hardware a try and who now use it for all kinds of other things. One friend helps to stage plays and gigs at a local community theatre and uses a Steam Deck XL to trigger scene lighting changes, preprogrammed sound effects and auditorium announcements. Another friend of a friend has physical disabilities that mean that she's able to use a keyboard for simple typing and control tasks, but struggles when it comes to Control+Shift key combinations – think "Save As" in a typical office application. She has her frequently used key combinations set up on a 15-key Stream Deck. In fact, it's my old 15-key Stream Deck that I donated to her good cause!

I also know of someone who uses a Stream Deck as a home automation controller: one button to dim the lights, another to switch on the TV – that kind of thing. It's a nice idea but the need for the Steam Deck to be plugged into a USB port limits how and where it can be used; great for controlling the lights in your office, not so great in a living room.

What's useful, though, is that it's really easy to integrate the Stream Deck with services such as IFTTT and Domoticz, because one of the functions that you can assign to a button is to open a URL, and you can set that to either happen in the foreground – via your normal web browser- or else a background task. And as you'll know from previous columns, both IFTTT and Domoticz,
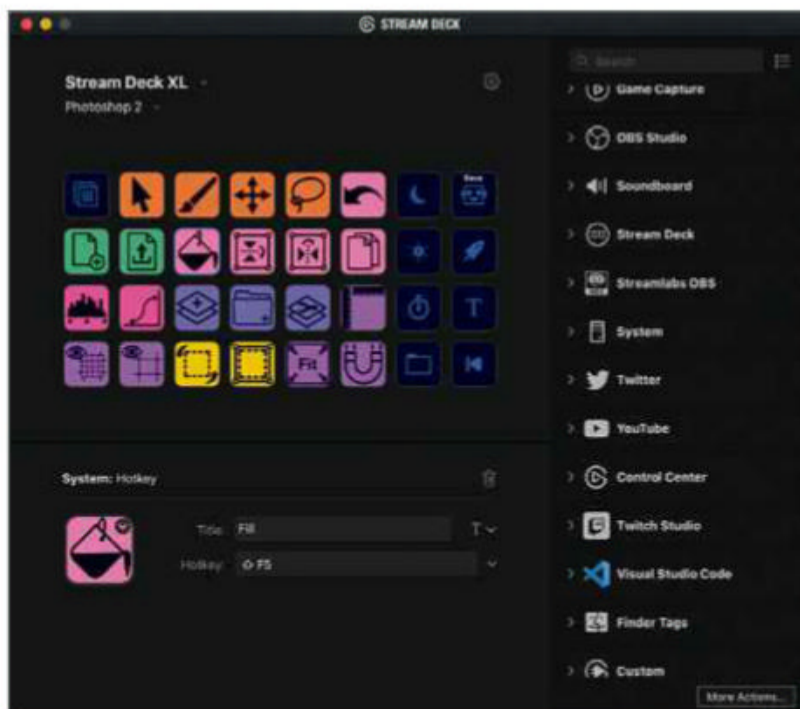
and indeed many other things, can be controlled using webhooks.

Data stream

Let's walk through an example using IFTTT. I'm going to simply use IFTTT to send me an email when I press a button on the Stream Deck. I'm sure you'll be able to think of a more imaginative use! Anyway, sign in to the IFTTT website and click the Create link at the top of the screen. Then click the Add button on the following screen, which will bring up a list of services. Near the bottom (or you can search for it), you'll find Webhooks. Click that and then hit the Connect button. You might see a window briefly appear and you'll get a chance to name the webhook – let's call it "Streamdeck_button" as it's best not to use spaces here, so use underscores instead.

Now you'll be back on the applet page and will need to click Add to create the action. You'll see another list of services. These will be slightly different from the previous list – they were all things that provide triggers, whereas this list is all about actions. Having said that, many services will be in both lists because they provide both triggers and actions. Anyway, look for Email in this list (there's also Email Digest there, but ignore that), and click it.

This brings up the email editor. You can type the subject and email body, and there's also a number of variables that you can include, but we're not interested in those at the moment. So just set the email subject to be "Stream Deck" and the message body something like "Button pressed". Then press the Create Action button. Hit the Continue button and press Finish.

Now look towards the top of the screen and you'll see two icons next to each other: the funny triangular shape for webhooks and the usual envelope icon for email. Click the webhooks icon and then, near the top on the right, click settings. This will show the URL that details the webhook. It will be something like

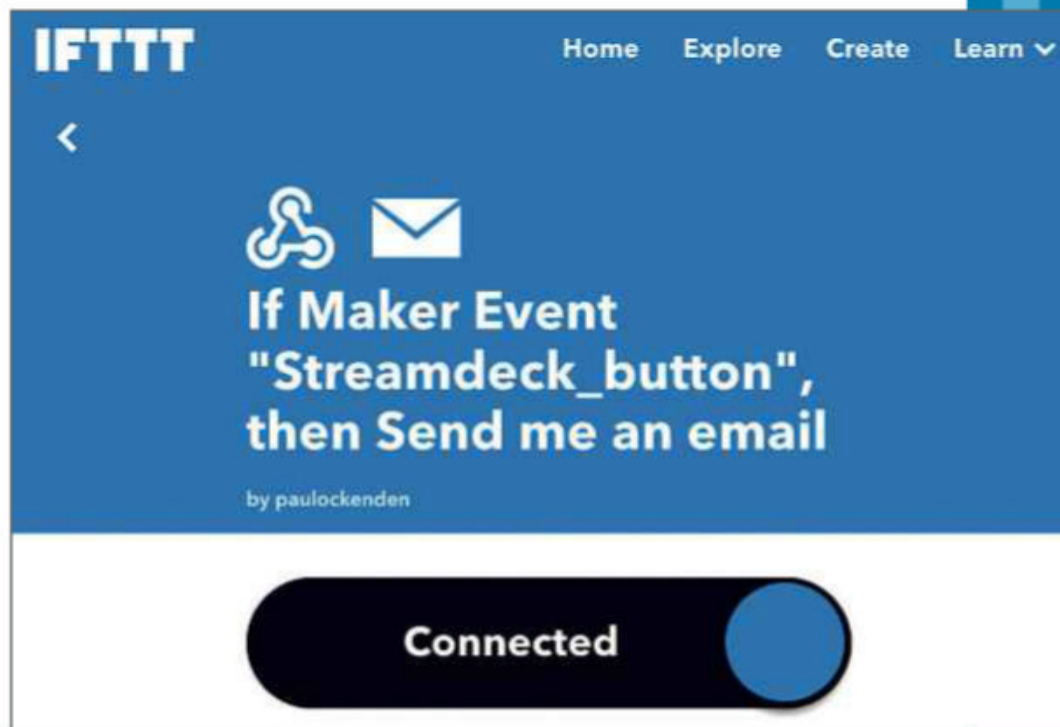https://**maker.ifttt.com**/**use**/ and then a shedload of random characters. Copy this URL (be careful because they sometimes split over two lines).

While you have that URL in your clipboard, go to a web browser and visit that URL. It will show you a whole load of guff, but the thing that we are interested in is the trigger URL. You'll see it will have the string {event} in the middle of it. Copy that URL and paste it into another browser window. You'll need to change {event} to Streamdeck_button, or whatever you called the webhook earlier (and because we're using it in a URL, this is why it makes life simpler to not use spaces).

In your web browser you'll see a message saying something such as "Congratulations! You've fired the Streamdeck_button event" and, shortly afterwards, you'll receive an email that says "Button pressed".

To hook that up to Stream Deck, you need to open the configuration utility, look in the System group and find an item called Website. Drag that to the left onto one of the keys, and you'll see that it uses a default icon of a globe. The physical button on the plugged-in Stream Deck will change instantly when you do that. An editor sits underneath the keyboard layout, so type IFTTT into the title and paste in the trigger URL, which you've hopefully still got open in your web browser. Finally, tick the "Access in background button". You don't need to press Save or anything: all changes that you make in the Stream Deck configuration utility take immediate effect. And that's it. Press the button and, as if by magic, an email should arrive shortly afterwards.

I know that was an artificial example, but it shows just how powerful a Stream Deck can be, and why having one sat on your desk is about so much more than online live-streaming.

IFTTT

If Maker Event "Streamdeck_button", then Send me an email

by paulockenden

Connected

ABOVE One way to interact with the Stream Deck is using IFTTT webhooks

"Press the button and, as if by magic, an email should arrive shortly afterwards"

BELOW I've found the keyboard on the Raspberry Pi 400 to be pretty good

However, a major quibble with the Stream Deck is the cost. I really like the XL model because it feels more substantial than its smaller siblings, but it's just shy of £230 on Amazon as I type this, which is a lot to pay for 32 programmable keys.

Having said that, I still think it's worth it, and the price does vary – I bought mine in June 2020 when it dropped to below £200 for a few weeks. The 15-key version is £140, but its stand isn't as robust as the XL model, although it is adjustable for angle. The 15-key version also has a captive cable sticking out of the back – a potential weakness – whereas the XL version has a USB-C port tucked neatly in the back. There's also a six-key version available for £80, but I wonder what the point of that is. I'm hoping that at some point Elgato (which is owned by Corsair) revamps the 15-key version to match the better aspects of the Stream Deck XL.

For now, despite the price, my advice to Gerry is to buy a Stream Deck XL. I think you'll love it!

Desktop Pi

A couple of people have asked me what the new Raspberry Pi 400 (*see Steve's column on p120*) is like, and in particular whether the keyboard is much cop. Well, I really like to give new bits of kit a proper workout for at least a month or two before writing about them in this column, and as I write this I've only had the thing for just over a week.

I thought I'd put the keyboard through its paces, though, so I wrote this column entirely on the Pi 400. And I'm pleased to report that it's fine. Not as good as my MacBook Pro, but perfectly adequate, and I didn't struggle at all writing this column on it.

@PaulOckenden

LEE GRANT

"Bereavement is traumatic enough without having to find someone to expose personal information"

Lee asks us to face up to an inevitable fact: we will all die at some point, so how do we make it easy for our loved ones to deal with our digital legacy?

This section of the magnificent magazine you hold concerns matters of the real world, but I'm going to talk about the implications that relate to people who have departed from it. If you're not in the mood to think about end-of-life matters, mark this page and move on, but remember to come back as I've got things that you will need to consider.

Geoffrey, George, Sue and Chris are amongst the long-term customers we've lost this year. Their passing generated vast amounts of IT-based anguish for loved ones, which we helped to resolve.

The most frequent request we get is to remove Windows passwords so grieving families can access financial details stuffed into an email folder. Occasionally, this becomes more involved when I'm asked to provide passwords for email accounts so loved ones can hurdle a legal barrier or retrieve confidential documents. I'd go as far as to say secret documents. One data-recovery job for precious photos also turned up files that were, let's say, a surprise for the grieving family. Somehow, I'd become *Who Do You Think You Are?* and Jerry Springer in one afternoon.

Those of you who are more security-minded may feel that this type of work could be construed as hacking, and I wouldn't disagree. The pandemic-led shift to homeworking and home-schooling, combined with high laptop prices, has sent people scrabbling to the back of wardrobes, garages and eBay to dig out machines that should have been condemned to the crusher years ago. Most of these antiques will be good enough for a spreadsheet and a round of *Times Tables Rock Stars* (**ttrockstars.com**), but they end up in our shop because of a forgotten password.

Lee Grant and his wife Alison run Inspiration Computers, a repair shop in Kirkheaton
🐦 **@userfriendlypc**

"I'd become Who Do You Think You Are? and Jerry Springer in one afternoon"

Whose data is it anyway?

Let me give you a scenario. Imagine that you own a small computer repair business and your first customer brings in a battered old laptop, with a hard drive packed with countless photos, documents and music that need transferring to USB. The laptop will then be reset and passed on to a grandson. The laptop is "protected" with an unknown Windows password and the client has asked for it to be removed. What do you do?

Maybe you're visualising a customer in need and your skills will get them, and their grandson, out of a mess. Perhaps you're seeing someone less honest and instinct is screaming that the boot of a nearby car is now missing this laptop. I'm deliberately pushing you down a slippery slope towards bigotry here to emphasise a crudely constructed dichotomy. What should you do to protect yourself, the laptop's owner (who may or may not be standing in front of you) and the data it contains? Unsure? Let's add something else into the mix.

Since GDPR began on 25 May 2018, the scrutiny on our data's handling and processing has been in the spotlight. The legislation covers the creation and governance of passwords, but not the above password-hacking scenario. There's an argument that claims you're a data processor (**pcpro.link/317ico1**) and can thus be prosecuted in court for "any damage caused by processing, including non-material damage such as distress" (**pcpro.link/317ico2**). What could cause the distress if you unlock the laptop? Perhaps all the personal photos now available on 4chan or the mischief being caused by someone with access to the passwords stored in the browsers. As it's an open house, how about a spot of identity theft with the downloaded utility bills and email? Is this helping your decision-making process? Let's ask the experts for guidance on best practice.

Last week, I spoke to a police officer who until recently worked for the Yorkshire and Humber Regional Cyber Crime Unit (RCCU). This team spread the word about the dangers of cybercrime and the devastating impact it can have on people's lives. I described the scenarios and the response was surprising: "I've never been asked this." The officer explained that there's a belief that legitimate traders will ask for proof of identity and ownership, but there are no formal best practice guidelines.

I've also spoken with *Which?* Trusted Traders (**trustedtraders. which.co.uk**), which admitted it had nothing to offer in this scenario. Like the RCCU, they advocated obtaining proofs of legitimacy but also went on to say that if a GDPR prosecution did occur, the computer shop may have
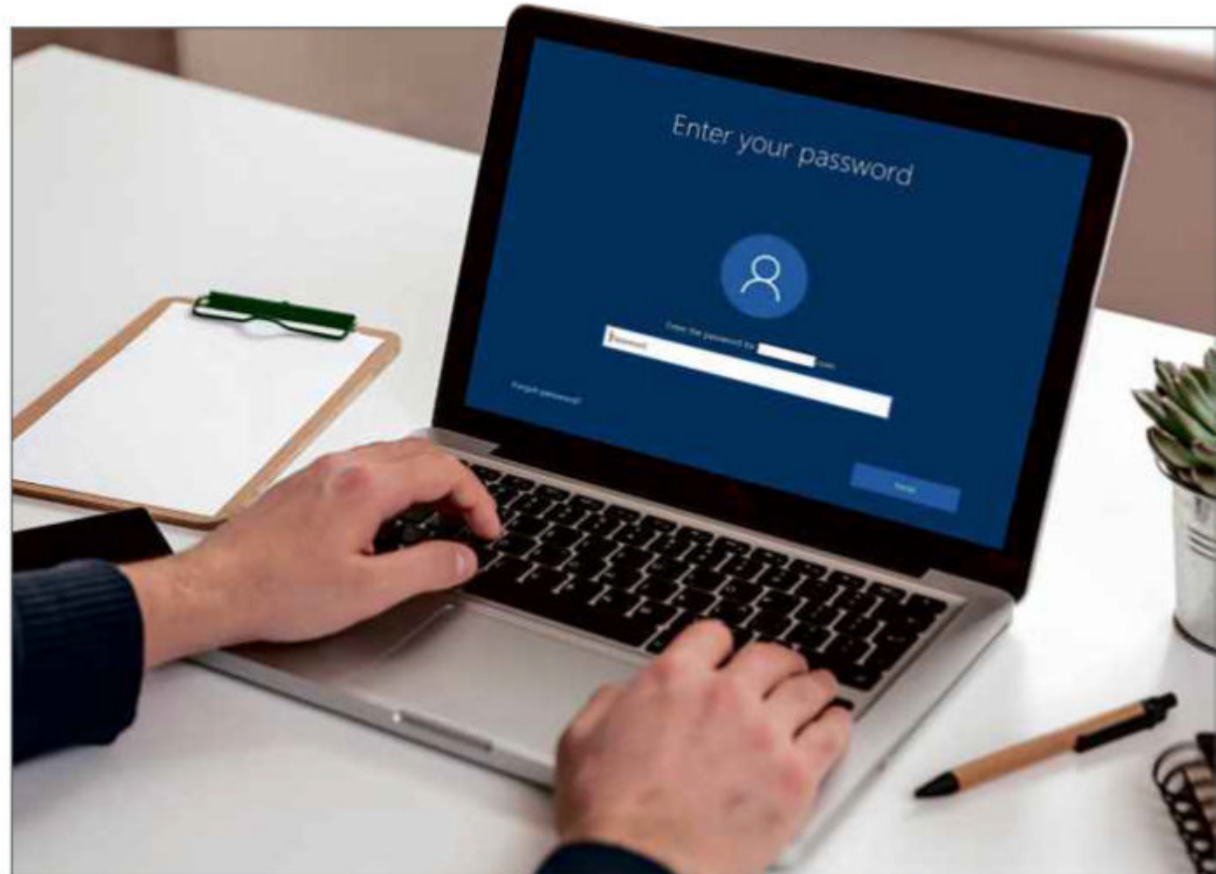
RIGHT "Hacking" a loved one's laptop can be avoided with a bit of forward planning

to prove that they've seen valid documentation. This implies that PC repair businesses need to store death certificates, driving licences and so on. One has to admire the irony of avoiding prosecution for accessing confidential data by storing lots of confidential data. Who said Sir Humphrey Appleby was fictional?

Whilst you're still behind the counter, let me wheel in another customer who also brings in a battered old laptop along with a brand-new one they've just purchased. The old laptop doesn't turn on, so they've asked you to copy the files to the new machine. From your perspective, does this require the same caution as password removal?

For the record, the RCCU and *Which?* Trusted Traders don't know, either. Last week, I performed these scenarios enough times to see me locked away until the end of days, and although I know each of the customers in question, that counts for nothing in court. I'm onto the ICO to see if I can obtain any clarity, and as soon as I have a response, I'll let you know.

Your digital legacy

Passwords, 2FA and biometrics are ingrained into our daily lives and, as discussing end of life is rarely fun, it takes a real shock to make us think about the people left behind to untangle the mess.

In the summer of 2020, I received a call from Phillipa. She owns a local business that has modest IT needs and, over the years, we've supplied her with various laptops and printers. Amongst Phillipa's pool of staff was Malik who, apart from his day-to-day tasks, was the person who sorted out all the IT. Three days before Phillipa's call, Malik had taken his own life. Overnight Phillipa had lost a friend, colleague and confidant.
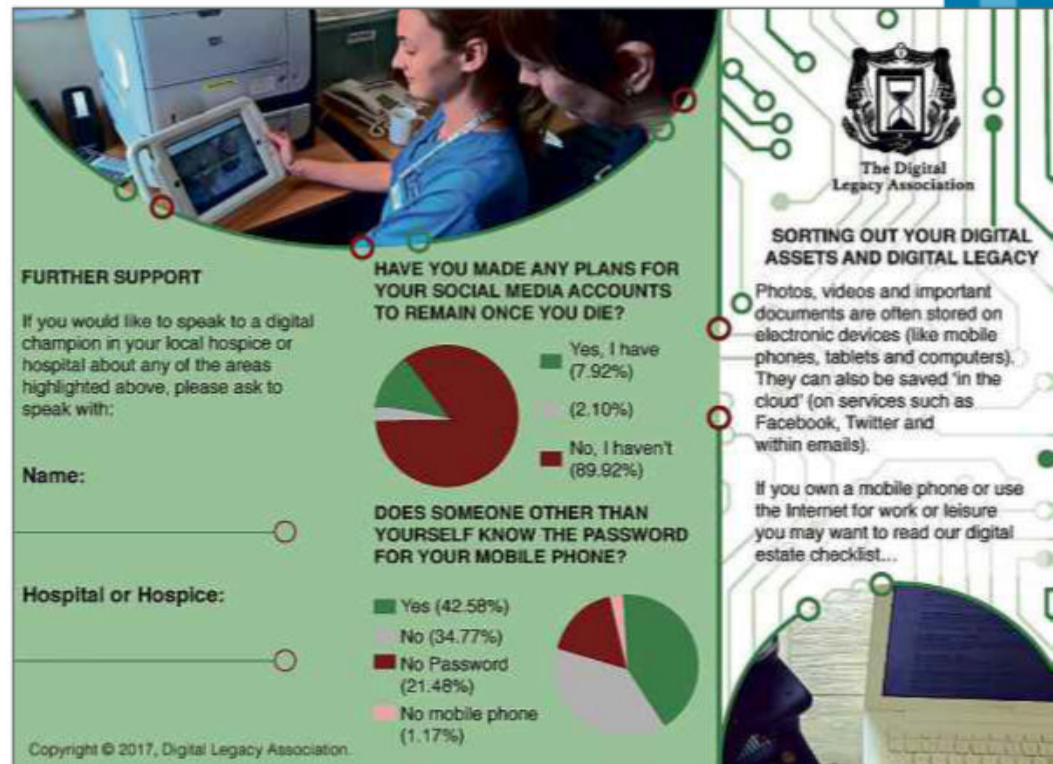
At such a miserable time, the last thing anyone in that business wanted to think about was IT, but an issue with a supplier brought the realisation that, from a purely technical perspective, they were in trouble. Malik was the only person who knew passwords, usernames, cloud backup providers, payment processors for the website – the list goes on. Phillipa knows that such sensitive information should never have been under the control of one person, but so many small businesses, like hers, focus solely on customers, profit and growth

and never get around to IT security.

It's not just businesses. Currently, we're working with a family where, sadly, the father's long-term neurological disorder has advanced to a point that makes many mundane tasks an impossibility. This includes using his PC, which is a problem compounded by the fact that he's the only one with any technical ability. At the request of the family, we now have a permanent remote link to the machine along with unrestricted access to all email accounts – they pick up the phone, sit in front of the computer and tell us what they want to happen. The GDPR issues that we've highlighted are still hovering around but we're ignoring them. Although this family has been a client since we opened, they're still putting an immeasurable amount of trust in Alison and myself to look after them at a very traumatic stage of their private lives.

There are steps you can implement to help yourself and others. Digital legacy is recognised as an important part of end-of-life planning so speak to your solicitor, funeral care agent or insurer about it. We need to consider what happens to our data when we're gone. Recently a customer brought in two machines that belonged to his deceased grandfather who had left explicit instructions to erase and scrap both units. Job done!

Not all wishes will be that simple. Many customers have been helped by advice from the Digital Legacy Association (**digitallegacyassociation. org**), whose website is packed with practical information including a template for a digital will (where you can leave explicit instructions as to your intentions for digital assets) and step-by-step guides of how to deal

HAVE YOU MADE ANY PLANS FOR YOUR SOCIAL MEDIA ACCOUNTS TO REMAIN ONCE YOU DIE?
- Yes, I have (7.92%)
- (2.10%)
- No, I haven't (89.92%)

DOES SOMEONE OTHER THAN YOURSELF KNOW THE PASSWORD FOR YOUR MOBILE PHONE?
- Yes (42.58%)
- No (34.77%)
- No Password (21.48%)
- No mobile phone (1.17%)

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FURTHER SUPPORT

If you would like to speak to a digital champion in your local hospice or hospital about any of the areas highlighted above, please ask to speak with:

Name:

Hospital or Hospice:

SORTING OUT YOUR DIGITAL ASSETS AND DIGITAL LEGACY

Photos, videos and important documents are often stored on electronic devices (like mobile phones, tablets and computers). They can also be saved 'in the cloud' (on services such as Facebook, Twitter and within emails).

If you own a mobile phone or use the Internet for work or leisure you may want to read our digital estate checklist...

ABOVE The Digital Legacy Association includes a template for a digital will

"Consider how they would deal with it and what you could do now to ease their stress"

BELOW Keep a note of important passwords just in case the worst should happen
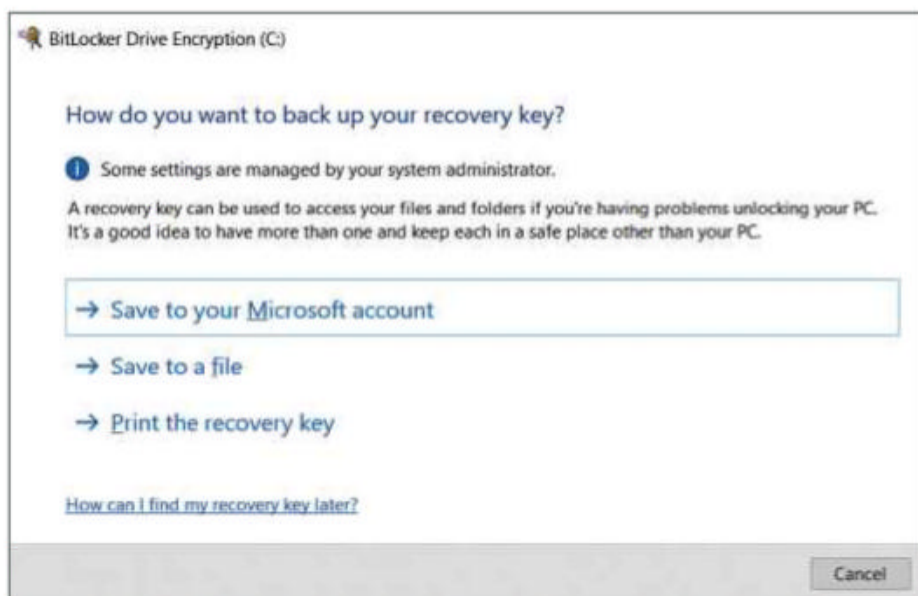
with social media accounts. It also provides guidance for companies, hospices, solicitors and care homes.

If you're planning on staying around for a little longer, there are things you can do now should you unexpectedly end up under the bus of destiny on your way to the post office. Think about your digital life and its components, then consider how the people left behind would deal with it and what you could do now to ease their stress.

It may be as straightforward as putting the master password for your password manager into a safe place or making a list of your gadgets and the PIN codes to access them. Remember that BitLocker recovery code or the 2FA one-time-access codes? Where are they? Leave full instructions of backup processes and providers so if your device also fails to make it back from the post office, your loved ones still have something to work with.

One client of ours has a password-protected Word file containing every login, password, bank account, PIN and so on – it's the kind of document that gives Davey Winder nightmares. He updates it with modified details, and devices purchased or retired. Only his wife, son and solicitor know the password to this document.

This is something we all need to think about. Bereavement is traumatic enough without having to find someone to expose personal and sensitive information. As I'm often that person, it can be a harrowing process to reverse-engineer a loved one's virtual life, so others are able to move forward with their real one.

Legacy is now much more than a matter of who gets the bungalow and the priceless collection of *PC Pro* magazines. With a bit of planning, the grieving process can be much easier for those left behind.

📧 **lee@inspirationcomputers.com**

BitLocker Drive Encryption (C:)

How do you want to back up your recovery key?

ℹ Some settings are managed by your system administrator.

A recovery key can be used to access your files and folders if you're having problems unlocking your PC. It's a good idea to have more than one and keep each in a safe place other than your PC.

→ Save to your Microsoft account

→ Save to a file

→ Print the recovery key

How can I find my recovery key later?

Cancel

DAVEY WINDER

"I'm as far from a 'fanboi' as you're likely to get, so the decision was more pragmatic than emotional"

After ten years, Davey says goodbye to Android and hello to iOS. Here, he explains the security problems he found and how you can sidestep them

Loyal *PC Pro* readers may recall that I switched from being an iPhone user to an Android one a decade ago. At the time, I felt that Apple had stagnated in terms of hardware innovation and, as I never invested in the wider Apple computing ecosystem, the move wasn't a hard one to make. Roll on ten years and I'm doing the reverse: I'm switching back to an iPhone and iOS.

The move has been harder than it should have been, especially from the security side of the fence where I get most of my perspective. But before I head into the nuts and bolts of switching securely from one OS to another, I need to explain why I felt the move was necessary at all given how much I, mostly, love Samsung flagship devices.

The key word to focus on there is "mostly". The hardware is great, with the Note the flagship of flagships as far as I'm concerned. It's the device that Samsung throws everything at in terms of specs, innovation and features for power users. The obvious choice would have been to upgrade my Galaxy Note10+ 5G to the Galaxy Note20 Ultra 5G, which is a real powerhouse beast. The 120Hz display is as smooth to scroll through as you'd imagine and, in contrast, the 60Hz of the iPhone 12 Pro Max I bought a week ago is starting to sound old-fashioned. In everyday use, though, my old eyes can't tell that much difference.

The iPhone's A14 Bionic processor blows away the Galaxy in benchmarks but falls into much the same category: in real-world usage, there's little difference to see. I don't intend this to be a review of either device, but safe to say that both these flagships are more than deserving of their status. So, why did I feel I had to switch ecosystem now? It should

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@happygeek

BELOW The Note20 Ultra 5G is the HMS *Victory* of flagships – so why didn't I buy it?

come as no great surprise that this boils down to security and privacy.

Let's get this straight from the get-go: Android isn't an insecure OS per se. It does get the lion's share of attacks aimed at phones, but that's as much to do with the volume of devices out there as it is the threat surface itself. The whole "Windows or macOS security" argument can largely be drawn along similar lines. However, there's another "but" coming. While the OS isn't necessarily any more insecure than iOS, the Android ecosystem is fractured to hell and back. It's that fracturing of the ecosystem – the devices that Android is installed upon and the myriad of differing update options created – that makes Android less secure.

My Note10+ is a good example. I bought this SIM-free at launch, and it remains the flagship of the previous generation of Galaxy devices. Yet it's still not running the latest version of Android, and it took more than a year

to be updated to Android 10. Now you could argue that this isn't as bad as it sounds because both Google and Samsung roll out monthly security updates to Android. But quite when in the month, or indeed which month, or whether you get them at all is another thing altogether.

I research threats – and publish analysis and news pieces based around them – as part of my job, so I know when something needs an urgent patch. Maybe it's a zero-day being exploited in the wild with critical consequences if your phone gets compromised. In just such a recent scenario, I didn't get the security patch that would have protected me from this at the start of the month. Nor, indeed, at the end of it. I had to wait until the start of the following month before that security update was pushed out to my device. Routinely these updates will arrive in week three or four, leaving the threat window open for a couple of weeks. This is just not good enough, and it's this that finally drove my switch to an iPhone.

The Apple ecosystem is far from perfect, and I'm as far from a "fanboi" as you're likely to get, so the decision was more pragmatic than emotional. 100% pragmatic when it comes to matters of security and privacy. Users of iPhones know that not only will they continue to get major iOS upgrades for years, but they will get them at the same time, as soon as they're released. It matters not one

jot who your network supplier is, where you bought the phone or the direction the wind is blowing in.

The same is true for point releases to patch vulnerabilities: they're there for everyone to install on the day of release. For me, and it really should be for you, this is a big deal. A huge deal. This is what drove me over the edge of the Android cliff.

The good ship Apple that picked me up did not, however, provide plain sailing from one OS to another. There is no "back up and restore everything as it was" option. There is a "Move to iOS" Android app that promises to ease the pain, but it's a hot mess. Read the Google Play store reviews – they're not wrong.

In the end, I was left with little choice but to install apps anew. My partner laughs at me when I have to enter passwords on any new devices as my passwords are ridiculously long and random (we're talking in excess of 25 characters, as I explained in last month's column) and then there's two-factor authentication (2FA) to throw in the mix.

The smooth with the rough

I'll start with 2FA because it's something that many people worry about. The solution to making this an unexceptional event is to choose your 2FA app wisely. Which means using Authy (**authy.com**). Authy is Google Authenticator-compatible, meaning it works with any service that supports Google 2FA. Where it differs is the ease of use when working with different devices, as you can set up multiple devices using it. No more disabling 2FA for everything, one account at a time, and then tediously re-enabling on the other side. It's just as secure as any other 2FA app, but you can back up and restore encrypted 2FA account tokens to other devices, with decryption happening on the local device only and no passwords stored in the cloud. It could be argued this dilutes your security posture as two app instances provide a larger threat surface than one, but the benefits outweigh this. Backup is purely optional, so disable it if you don't want that risk.

Authy's multi-device option is disabled by default, so an attacker with a SIM-swapped device wouldn't be able to install

another instance and sync your 2FA data. However, when moving to my new device, I simply enabled the feature, installed Authy on the iPhone and got a verification code from the old device. This could just as easily have been the desktop version, which I recommend installing so you have that backup if you ever lose your phone, for example. That was it: done and dusted in a matter of minutes, including the disabling of the multi-device option again.

If only moving my primary authentication factor solution of choice, 1Password, had been as straightforward. It should have been, but in the end it wasted more hours than I care to mention. This was easy enough to begin with, despite needing my "secret key" as well as master password and so on, because I could scan a setup QR code. However, although I ended up with everything entered correctly, I faced one last test before being able to sign in: a tiny padlock and Wi-Fi bars-type icon with a number keypad beneath it.

For the life of me I couldn't figure out what it was asking for. I even raised a support ticket, but after about 40 minutes of staring blankly at the icon, and long before the support response arrived, I realised it was for a 2FA code. A quick trip to Authy and all was sweet (well, sort of; more of that to come momentarily). Here's the thing: I'm a veteran security professional and it flummoxed me. No wonder "ordinary" folk just give up and say this security stuff is too difficult to bother with. The UI stinks – instead of, or in addition to, the meaningless icon, would it have been too much trouble to just add text asking you to enter a 2FA code? Obviously, yes.

That syncing feeling

I'd have let it slide if that was the only problem. After a few hours of use, I noticed that my vaults were no longer syncing between the app and **1password.com** account, via

Fill usernames & passwords. Securely.

fan@lastpass.com

Enter password

websiteurl.com — LastPass
fan@lastpass.com

q w e r t y u i o p
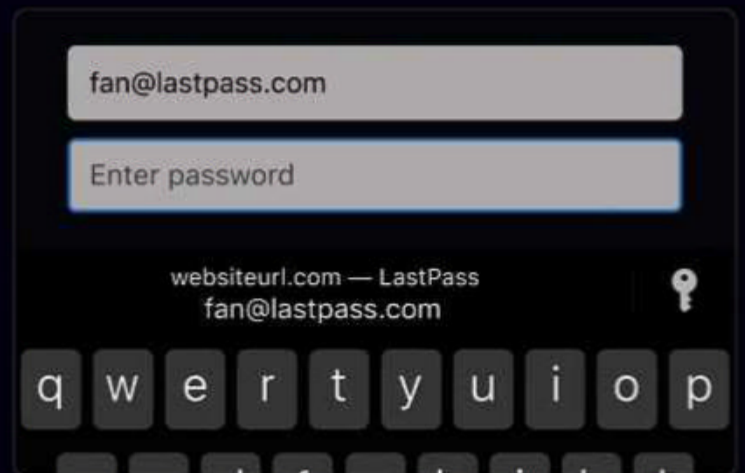
Safely, conveniently, and automatically **fill usernames and passwords** right from your keyboard.

Enable **AutoFill** for LastPass and breeze through your next login.

ABOVE A password manager should "just work" and LastPass on iOS did for me

"No wonder 'ordinary' folk just give up and say this security stuff is too difficult"

BELOW Authy makes device switching easy, but disable Multi-device after use!

Dropbox, as they were before. I searched for a solution, but the sync menu option mentioned was nowhere to be found.

After wasting another hour or so on this, I raised another support ticket. The response wasn't what I'd been hoping for: "If you're signed in the app with your 1Password subscription, you wouldn't have a sync button," it told me, adding: "Third-party sync methods such as iCloud or Dropbox do not get stored which also means if you run into issues with third-party syncing, we are unable to provide extensive support if syncing goes sideways." I had deleted the Dropbox file and it wouldn't restore, so I gave up at that point and installed LastPass, which just worked. I have since managed to get sync working by deleting storage data in the app and reinstalling on Android then iOS, but the lack of supportive support was disappointing to say the least.

Online banking also proved a challenge. I have personal and business accounts across a few different banks, and two of the three were seamless: install the app, log in, get a verification code from existing app or via SMS, and I was done. One was not. I'm not going to name the bank for, hopefully, obvious reasons, but it plain refused to accept my login with the "Continue" button greyed out. This also required a support call, and the solution was to completely reset my online banking account, password and all.

Exit   **Devices**

Allow Multi-device

THIS DEVICE

Davey's iPhone

ABOVE Face ID is great, but Face ID and Touch ID would be better

This is when I discovered it was the password that was the problem. I had changed this to something long and random, and it worked fine, although I never needed to use it because of biometrics. Until I did need to use it and discovered that the bank's security didn't like the special characters that were included. It was a problem I also had when setting up a burner SIM for an old phone, with iD Mobile only allowing specific special characters. Sigh. It's yet another reason why people get fed up with complex passwords, and use crappy and insecure ones instead.

Speaking of biometrics and 2FA, here are two final thoughts. The lack of fingerprint scanning (Touch ID) on the iPhone 12 Pro Max is unfortunate, especially given the mask-wearing culture we're now part of. Face ID is great and it even works when I'm wearing one of the three different surgical neck collars I have to use at the moment, one of which squashes my face somewhat. But a fingerprint scanner on the power button would have been a good addition.

As for 2FA, Apple, you stink. The only 2FA method I can use for my Apple account, as I don't have another Apple "trusted" device, is SMS. Which is pants. I have a hardware token key, but I can't use that; I have Authy for codes, but I can't use that.

Otherwise, dear reader, I'm pretty stoked with my iPhone purchase and will be writing more about the privacy implications in months to come.

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STEVE CASSIDY

"The Pi 400 includes possibly one of the most complex pieces of code produced by humanity"

Is the £99 Raspberry Pi 400 really suitable for business? Steve provides his unique take and, despite some niggles, gives it the thumbs up

In hindsight, it seems perverse: I have an interest in IoT from a network perspective, and yet I've not fiddled with either of the two great platforms most likely to be included in any smart device deployment – and then two come along at once in the same month.

The first one through the door was the Raspberry Pi 400. If you didn't read the review in last month's *PC Pro* (*see issue 316, p58*), let me alert you that this new packaging for the Pi platform ought not to be left out in the frigid wastes of fizzy drink-proof education-sector projects or stuffed down the back of a smart fridge, LEDs blinking naked and alone to hungry rats and mice. The 400 is completely different (even though it's entirely the same on the inside): a little keyboard, white on top and red underneath, containing the entire Raspberry Pi architecture. In a neat row of ports at the back you have Ethernet, USB 2, two USB 3 connectors, two 4K outputs, USB-C for power in and a microSD slot.

I know, a picture's worth a thousand words and all that, but I thought the text list much more in

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BELOW Just like the TARDIS, the 400 pulls off the trick of being bigger on the inside

the spirit of the Pi 400. It's got a certain immediacy about it, the idea that you can encapsulate everything in a sentence about a machine that definitely meets the *Doctor Who* requirement of being bigger on the inside. People of my age will also get an immediate nostalgia hit for that whole generation of machines such as the BBC Micro and Commodore 64, which shared the design concept of being a computer in a keyboard.

Although the Raspberry Pi product family is now diverse, multifaceted and supported by a range of vendors and peripheral makers, I don't count that as reason to be excited. I'm most interested in two basic facts about the device: the price and the software bundle. I know, we've been telling readers to strip off the bloatware for decades, but consider that the Pi 400 comes with Wolfram's Mathematica. It's not quite the same calibre as an ugly cloud backup trial or an incompetent antivirus app, as we've been seeing on laptops since the turn of the century: the Pi 400 bundle includes possibly one of the most complex pieces of code produced by humanity. There's also LibreOffice,

and two submenus of development tools and environments, which I'm too excited to enumerate because they're not relevant to my point.

My point gets slammed home by the pricing. You can buy a Raspberry Pi 400 for £67 if you already have the appropriate cables and charger. Most of my intended recipients wouldn't have those, in which case the right bundle of bits - including the OS on a microSD, cables, a mouse, a user guide and the Pi 400 keyboard itself – will set you back £99.

I've spent a lot of time championing the use of regular Microsoft Windows running PCs for office work, on the basis that they're far cheaper than the other reasonable options. The Pi 400 completely blows this position away. For most simple small business uses – handling emails, writing papers, wrangling the web – the humble £99 machine works well. Video is responsive, the keyboard itself is usable if a tad small, the mouse is excellent and the basic interface is just about familiar enough.

I've written enough Cheat Sheet (*see p107*) pieces that I can imagine the furrowed brows from fast-moving and beleaguered entrepreneurs as they read this. "What has a computer with cases available from, literally, Lego, got to do with my serious bread-and-butter-earning business?"

A piece of the Raspberry Pi

Think about this from a ransomware or business continuity perspective. Let's say that you have a classic ransomware process being run on your network. Not only do you have to talk to the bad guys, you have to work out if they present a credible threat; you have to confirm that their suggestion of your total vulnerability is actually correct – but most important of all is to keep the flow of work in progress rolling. It's not losing documents from three or five years ago that's going to do you immediate damage; it's failing to pick up the phone or read that email from a new customer that will sink you.

The best way to ensure that such basic business activities keep happening during a ransomware crisis is to have various resources in parallel. Things that could do the job of maintaining work in progress, without breaking the bank or being as vulnerable as your frontline systems. That means low-performance cloud-based file-access services, local and

non-Windows machinery, and backup services that don't lock your files away inside huge, monolithic archives you must fully restore before you can touch even the smallest or most recently updated files.

This used to be a tall order as the credible platforms were trendy and, consequently, expensive. Spending £12,000 on three Apple laptops as your "DR/BC stock" achieves the same effect as I'm proposing here, but at 40 times the expense. Not that Apple laptops are incapable in this role – there's a good reason why a certain demographic of nerd-heavy management prize the ability to demand a new MacBook in every business they join.

So I believe that a basic device with good web-browsing capability, a reasonable spread of office apps and access to storage devices down a common interface standard ought to add up to prime disaster recovery stock. In fact, it's a sensible place to start out if you're trying to run your own new business, just so you can be on something that's not being beaten to death daily by the demands of gaming or social media. The Pi 400 is

> **"For most simple small business uses, the humble £99 machine works well"**

for now, a very close match to that brief – even though it's not without its niggles.

Both home and office life now tick along on videoconferencing, yet the world of Zoom and the world of Pi don't quite line up in oddly trivial ways. For starters, there's no audio jack on the Pi 400 – the sound goes up the HDMI connections, which left me staring at my ragtag collection of screens, wondering if any of them put the HDMI audio through an outbound audio jack. The short answer, after a long search, is no. That's frustrating. Even more frustrating is the fact that I successfully paired my favourite Blaupunkt Bluetooth speaker, but still no audio could be heard.

This is a classic study in the way that the more niggly bits of integrating a fully fledged computer into your network can turn into far too much of a drama. While it's a three or four-click job to get a Pi to show the contents of a Windows share, it's set up with the assumption that you have a classical workgroup. Changing that to a named DNS zone is a matter of hitting the support sites. Getting to the point where you can have an icon the Pi users' desktops pointing to a shared folder on a NAS or server is a long and bumpy road, with a mixture of GUI options, files to edit, code repositories to explore – and conflicting advice from tech support resources unearthed by search engines. Probably the most important tool for businesses is an RDP client to connect to Windows servers. While the Pi flavour of Linux has a variety of apps

How to build a cyber-resilient business
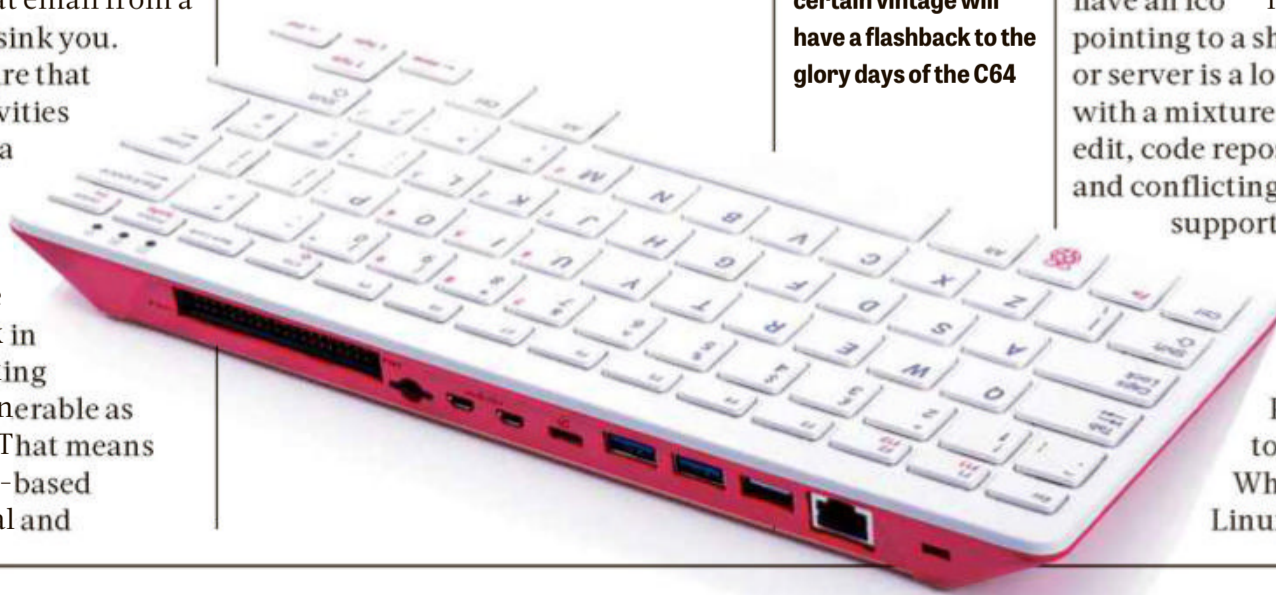
capable of doing this, they're not part of the standard Pi distribution included with your Pi 400. Rather like working on the Common Internet File System (CIFS) workgroup settings, getting a couple of icons onto users' desktops for rapid access to remote hosts is a messy process, compared to either Windows, macOS or other flavours of Linux.

There is also no way to use the Pi 400 as a slave keyboard to an existing machine. That's a dumb option, you may think, but it's one I would certainly consider using in a crowded server room during a hack attack, company crisis, natural disaster or connection meltdown.

I wasn't impressed with the local storage for my purposes, either. A microSD card just like the one that goes in your phone, limited to a somewhat stingy 16GB, arrives with the "kit" (I assume this term is somehow historical, given that the earlier Raspberry Pi models were case-less circuit boards). That gave me an excuse to explore using the USB 3 connections, into which I put a 256GB Integral-branded USB 3-connected SSD.

I didn't have time to think about whether the OS would be movable to this drive, however, because some quirk of the USB port, or of the cable, meant that the Pi kept telling me the volume had been unmounted and remounted every time I even slightly moved the assembled collection of cables, SSD and Pi. Very annoyingly, this aped the macOS behaviour of not removing the alert from the screen until you acknowledge it with a click: if there's some hack I can do to take

A recent press release claims that 12 million British people have decided to start their own business during lockdown. Like a lot of PR statistics, it's a big number, and would need a lot of obscure research to fully validate, but the point about a big number like this is that it's made up of individuals. People who are stuck indoors during pandemic isolation, alone with their thoughts, and so it doesn't matter how many there are, because the advice will be in the singular.

If you happen to be one of those "12 million", allow me to point out that the earlier that you build in some thinking on cyber-resilience, the better. Fight the impulse to just extend your personal finances and banking relationships to your shiny new business: the resilient thing to do is to keep them separate. That's not simply because your home network and tablet are built and coded for domestic use, and certainly not because the bank may tell you that you're not allowed to receive money into a home bank account directly, but

because you will want room to manoeuvre when things get frantic.

When buying hardware, consider that if prices are low – and they are – functional separation is simple. Again, resilience. Bear in mind that many home connections and services have remarkably low data caps, designed to catch out the unwary teleworker or home business. Have a backup plan for outages, too: research how common they are in your area and think about options such as having a business line in the garden shed. It's not as silly as it sounds.

Think about the cloud resources you plan on using. Remember that what you see as a single web page is a series of software layers over a hardware stack that doesn't belong to you. Any of the parties involved can decide not to be in that business anymore, at any time. Work out how hard it would be to change cloud provider while trying to deliver the product or service that ought to be taking up your time in your new business.
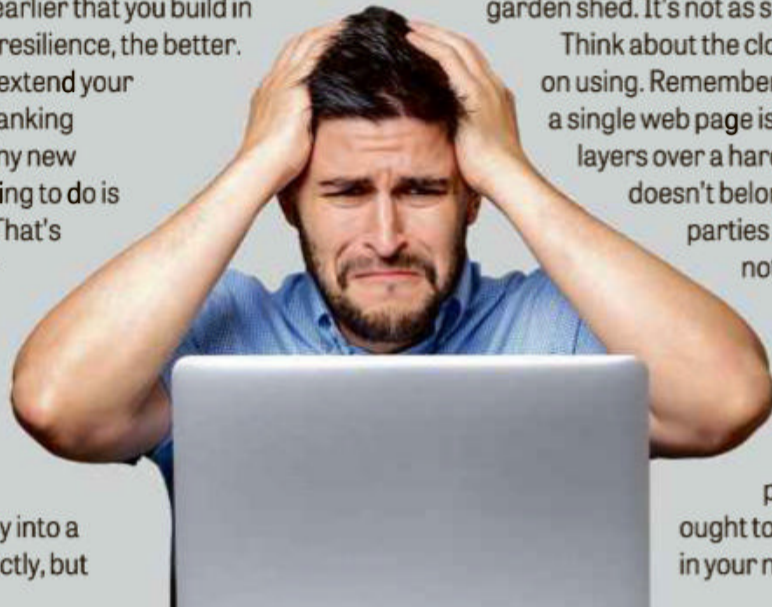
that out of the OS, I'll walk through fire to find and apply it.

Clearly, there's design lag here. One of these machines with a modern NVMe SSD mounted internally would be a giant killer.

But the list of niggles doesn't contain a showstopper. Most of the funny behaviours aren't such an interruption to the job of a business that they come out worse than the everyday bugs, delays and crashes that bedevil Windows PCs. Yes, I'm grinding my teeth as I write this, because de-cluttering and update work will clean up even the most

BELOW I can separate the eBay wheat from the chaff again, thanks to the Pi 400

scabrous Windows PC: we simply shouldn't have to jump to a new architecture in 2021 just to get away from poorly coded extras. However, at £99, the decision becomes a no-brainer.

eBay coding woes fixed by Raspberry Pi

I spent a few frustrating days this month attempting to delete watched items from my eBay profile. I ticked the relevant box in the Watch List then pressed Delete and watched the page refresh to show… exactly what it had shown before I started. Great. There was no error message and no explanation from eBay.
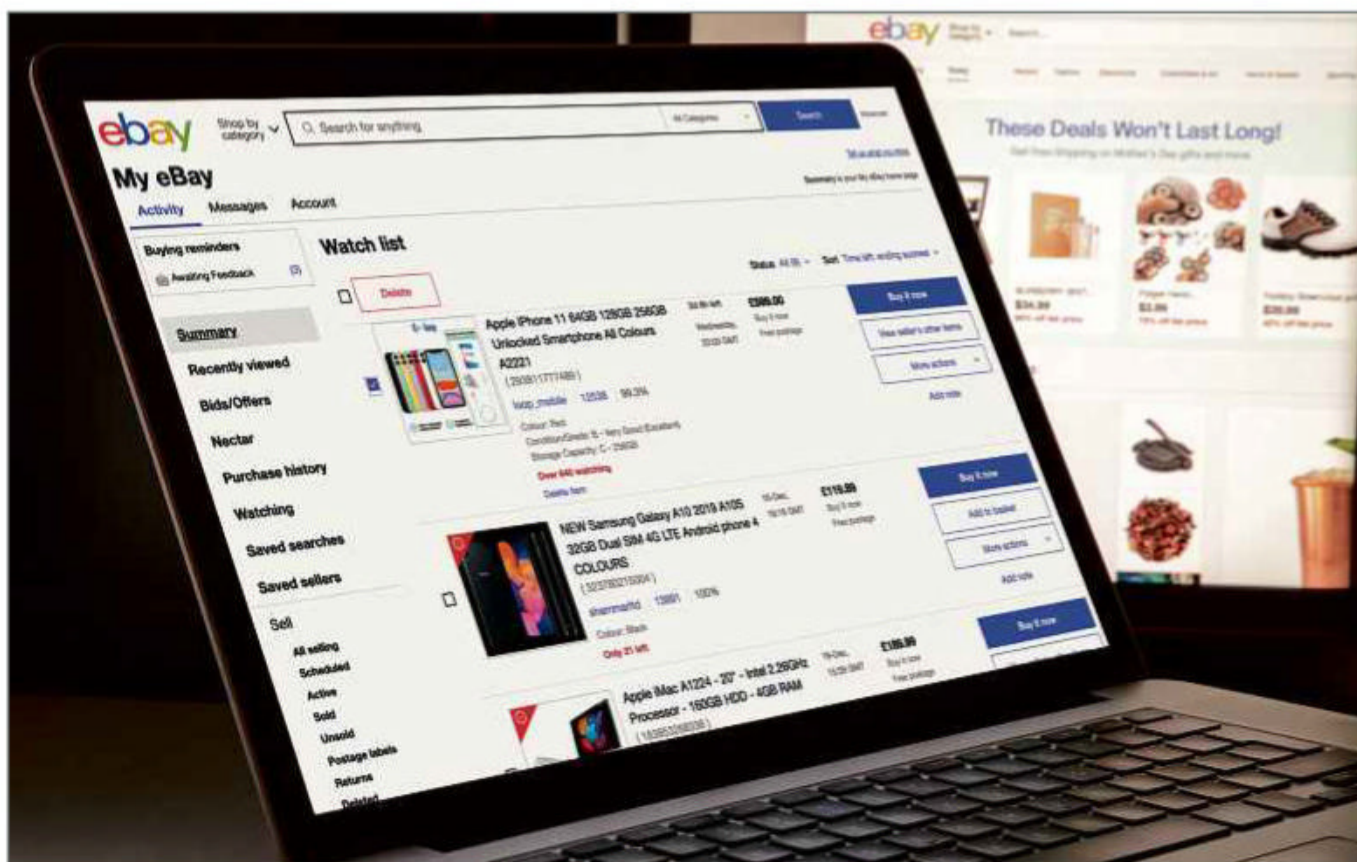
Quite accidentally, I checked eBay on the Pi 400 and a completely different interface presented itself, in which the Delete button worked!

This is big news in the Cassidy dungeon lab because, when I'm buying large lumps of enterprise kit, I use the eBay Watch List as a handy shortlisting tool, deleting out the listings that don't make the grade for whatever reason.

As ever, there's a technical point here about poor web coding and the whole continuous-delivery model of development. eBay's coders, either by moving fast or by neglecting to clean up, broke an important feature. Being able to sidestep their laziness and get on with my business is certainly worth £99 as an investment in a separate code platform.

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The indie shops that **kickstarted** computing

David Crookes examines how Britain's independent computer shops created a foundation for the UK's tech industry and helped turn some customers into stars

Apple knows a thing or two about running successful stores. By letting people play around with the goods, congregate for a natter and ask experts for advice and support, its shops attract large crowds and even encourage some to whip out their credit cards to make a purchase.

When Apple opened its first branch in Tysons, Virginia almost 20 years ago, this approach felt invigorating. Where rivals would keep a beady eye on customers and discourage attempts to touch the products, Apple's growing number of stores began to feel like welcoming social hubs.

In many ways, they invoked memories of the earlier days of computing. If you rewind to the late 1970s and early 1980s, computer shops were similarly more than just places to buy software and hardware.

They were destinations that allowed enthusiasts to share their passion and form friendships – and they arguably underpinned a fledgling industry by nurturing the talent that would go on to drive it.

Just as Neil Tennant met Chris Lowe in a hi-fi store on King's Road, Chelsea in 1981 and formed the synth-pop duo Pet Shop Boys, and just as Curly Music in Liverpool attracted the likes of Frankie Goes to Hollywood, independent computer shops encouraged creativity by acting as a focal point on high streets up and down the country.

Early days

It didn't take long for computing's own pop-star equivalents to emerge. At the forefront of this revolution was Bruce Everiss, a trained accountant who had already set up a computer bookkeeping company.

"I would read the trade magazines *Computer Weekly* and *Computing*," he told *PC Pro*, discussing publications founded in 1966 and 1973.

"These covered the beginnings of home computing in the US and the opening of computer stores there and I realised what was going to inevitably happen in the UK."

It was 1978 and those US stores were doing a roaring trade, particularly by selling the 8-bit Apple II. When Everiss opened Microdigital in Brunswick Street, Liverpool – Britain's first dedicated computer shop – he also sold Apple's first mass-produced microcomputer. His shop also had the £200 Z80-based Nascom 1 and £40 MK14 computer kits on the shelves, the latter created in 1977 by Science of Cambridge, the company that went on to become Sinclair.

"In the early days there was no commercial software, only hardware," said Everiss, whose shop ended up repairing hundreds of Nascom 1s when customers struggled to get them to work. "Meaningful commercial software only eventually
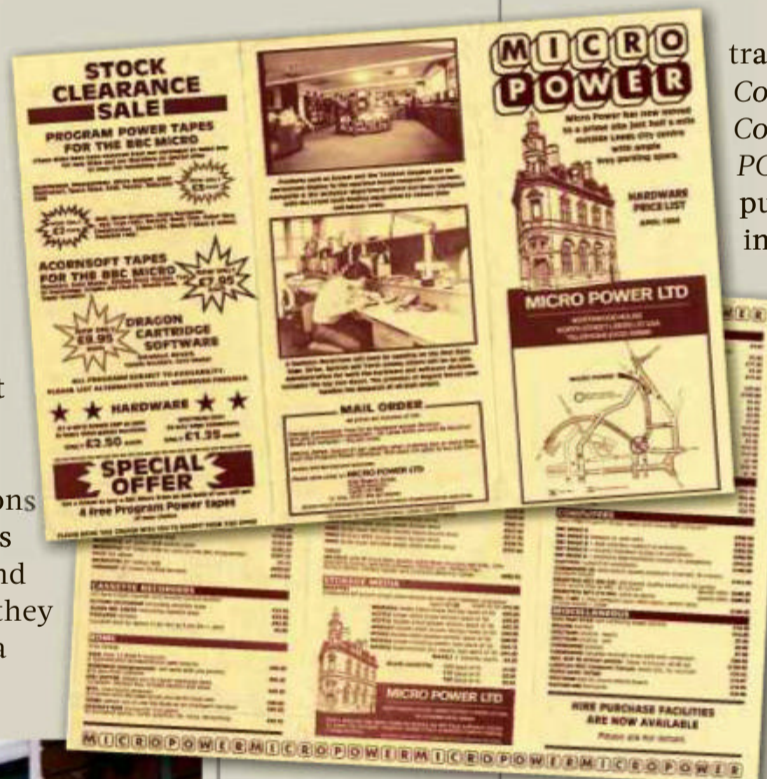
ABOVE Leeds-based Micro Power also supplied products by mail order

LEFT Micro Fun in Rotherham was at the heart of a flourishing demo scene

Photo by Luke Wildsmith, son of Paul Wildsmith who owned Micro Fun, Rotherham

The clipping (Home Computing Weekly)

It started with a kissometer

Electronics can be put to some strange uses, as Dave Carlos found when he talked to Jim Gregory — the man behind Mr Micro

Mr Micro is not only the name of a company but also an apt name for its founder Jim Gregory. The foundation of the firm was laid while he was still at school.

Jim became interested in electronics, he says, "at a time when transistors were just becoming available". "We used to make such things as kissometers with all the attendant extra activities that entailed!"

This led Jim into an apprenticeship in electronic engineering and a qualification to work on radar and defence systems. At about this time he discovered games, of the board variety, and soon became hooked.

Jim invented one called "Island Election" which, he says, "had thousands of rules and needed a million pieces to play it". Due to this complexity he never managed to sell the idea, and it was only later he realised that computers would be best for playing such games.

"At that time, computers were still a priesthood into which only the chosen were called. The ordinary man didn't realise how easy it was to use and program them," he recalls.

Jim's first program was written on a programmable calculator with only two stores, "just like having a two byte memory!" It was a rate relief program and the machine had no branch instructions and method of program storage at all.

"The operators had to key the program every time they used it. With early equipment like that, you learned to be very conservative in your programming. Now programmers who work for us have to try very hard to convince me that something cannot be done," Jim said.

"In July 1980, we decided to start a business aimed at the new home computing market. My wife Val would work fulltime until it could support us both properly. All we needed then was a name.

"We tried all sorts, before one day, while reading a Mr Men book to my son, the name Mr Micro came to mind. It seemed to fit well so we used it and, as we have already had a couple of offers to buy the name, others must like it too."

The first product that Jim produced for a computer was a screen address programming aid for the Pet which sold thousands of copies and encouraged him to think more about the new computers and their use.

"The only games for the Pet at the time were of the bang-bang, shoot-shoot variety but I wanted to go into deeper mind-involving games," he said. "That's how we came to be programming for the VIC, we decided to try to have the

Mr Micro himself — Jim Gregory

first all-British game for that machine and had to borrow a pre-release VIC from a friend inorder to do so."

The game, Gold Rush, was to be a graphic adventure, one game leading to others and all providing clues to the final solution. It was released in June 1980 and by Christmas had sold over a thousand copies. In February '82 someone cracked version 1 but Gold Dust 2 is still selling well and the prize is still to be won.

This encouraged Jim and Val to go into the business full time, and so they started to look

around for the money to do so. Jim recalled: "In our walks around the high street banks we heard some amazing things. One told us that their predictions forecast the boom in home computing would die in Autumn 1982, another that their predictions to put their high-risk capital in non-risky enterprises, and yet another that they were not loaning in the north west of England as it 'is a depressed area'. Eventually we got what we needed, partially by mortgaging the house and kids but also from a helpful bank."

Mr Micro now has several facets. There is the retail shop below his office at 69 Partington Lane, Swinton, Manchester, where I couldn't count the number of different micros, much less the quantity of programs they stock!

There is the program publishing side and a collaborative venture with another group to develop a superior software protection device. So far all the 'experts' have failed to beat the unique system. All Jim would say about it was, "No-one copies a car because it is simply too expensive to do and that is what will prevent people from cracking this device too."

He also has plans to enter the educational market with a completely different approach. "One of the things that makes Britain great is the individuality the schools allow and that is also what makes the education market so difficult.

"Unlike other countries there is no common curriculum and therefore providing software becomes impossible. We intend to aim our software at the home, where a product must be attractive to be used, so our programs will aim first to be great fun so that learning is a by-product."

On the games side, Jim likes to get new ideas and concepts. "Mysterious Island" for example, is really 20 games in one, linked together by an adventure concept. Mr Micro provides a personalised certificate to any one who completes it and lets them know. "We are sad to some extent that arcade game copies are so much in demand as we would prefer to try to take games to a different level," said Jim.

But believing that the public is not yet ready for new games concepts, Mr Micro has just launched three new titles for all types of machines. Called Hunchy, Bengo and Humphrey, they are all fast action games.

Coming soon are dual program tapes, with a program for say a

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arrived with spreadsheets and games, but we did sell enormous quantities of books, which I imported from the US and sold in the shop. This brought knowledge to the UK."

■ Sense of community

Information about computing in the UK was relatively scarce at the time. Hobbyists would scour *Electronics Today International*, published in the UK from 1972, and they would go on to devour Britain's first computing magazine, *Personal Computer World*, six years later. But they generally learned by talking and sharing.

"The store quickly became a social centre and a vital fountainhead of knowledge," Everiss said. "The microcomputer post docs from the University of Liverpool visited frequently and there was a computer club with everyone learning from each other. We even published our own magazine, *Liverpool Software Gazette*, which was another great source of knowledge."

One employee, a teenage Eugene Evans, worked at Microdigital every Saturday, soon joining the games company Bug-Byte where he earned £35,000 per year. Evans, coder David Lawson and another former Microdigital employee Mark Butler went on to co-found Imagine Software. Everiss joined to run the PR department after selling Microdigital to Laskys in 1981.

Everiss, Evans and Butler were by no means the only ones to progress from retail to software development and publishing. Brian Howarth ran a computer shop called Digital Fantasia around the corner from the colossal Norbreck Castle Hotel in Blackpool and used it as a base to create and sell the *Mysteries Adventures* series of text adventures.

Buffer Micro in Streatham, London, published games, utilities and gambling tools for the ZX Spectrum in 1984, including *Athlete,*

Super Bridge, Pools Predictions, Make Music and *Buffer Adventure.* Mr Micro in Swinton, Manchester, ran a developer/publishing house above the shop and released *Mysterious Island* in 1983, as well as *Crazy Golf*, *Harlequin*, *Punchy*, *Willow Pattern* and more.

But who could forget Just Micro, a popular weekend hangout on Carver Street in Sheffield? It opened its doors in 1983 and soon began developing its own titles, becoming one of the UK's most successful games companies: Gremlin Interactive.

"I opened the shop because large retailers such as Boots and WHSmith were selling software but they weren't offering support," said Ian Stewart, a former tool maker who began his retail career with Laskys. "I also noticed Laskys was selling loads of computers but hardly any software and I saw it as an opportunity to get in early.

"This was the time when the BBC Micro was driving enthusiasm from a school's point of view so we focused on software with Just Micro, always envisioning that we'd also get into some form of publishing."
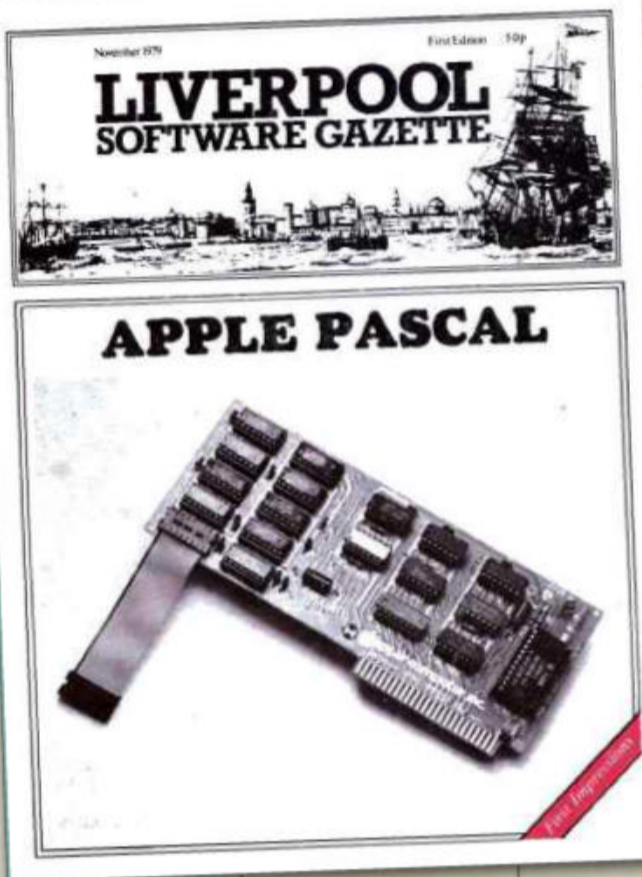
Just Micro was a busy shop. "We had a solid foundation of regulars who we'd have to chuck out at the end of the day, but they all got to know each other," Stewart recalled. "I think we just created the right vibe, making the kids welcome and having all of the machines set up so they could play any game they wanted before buying it."

Sometimes as many as 60 children would pack into the shop – "when they were coming out of the rain, it did start to smell a bit" – but before long those young people were also bringing in demos of games they had made. "They would ask if they could put it on a machine to show us and we'd gladly take a look," Stewart said. One of those customers was Peter Harrap who created *Wanted: Monty Mole* in 1984, a game that became a smash hit and spawned five sequels.

"That's how the first steps were taken," said Stewart. "We hired a couple of programmers, had an artist and brought in more. We then began to distribute the games across the UK and eventually into Europe. Looking back, it felt natural to progress from retail to publishing but you have to

> **"We had a solid foundation of regulars who we'd have to chuck out at the end of the day, but they all got to know each other"**

remember there were no rules to follow. We were making it up as we went along."

Even so, it was a winning formula that introduced scores of people to computing. "You'd have groups of kids piling in and maybe one of them would have a Spectrum and they'd go round to that person's house to play or code," Stewart said. "We also sold a lot of Z80 and 6502 programming books. People wanted to see what they could do with computers."

■ Demo scene

Micro Fun in neighbouring Rotherham attracted a strong demo scene – a computer art subculture that saw creative minds vie to produce boundary-pushing audio-visual presentations. Computer clubs were also formed by some shops, including Micro Power in Leeds, founded by former accountant Bob Simpson.

Such gatherings were common across the country (and indeed, the world – it was how Apple founders Steve Jobs and Steve Wozniak met). In the case of Micro Power, the club was a way of seeing what people could do.

"Micro Power offered a way for introspective people to talk with others and bounce ideas around," said Chris Payne, who ended up working for Simpson after interviewing him as part of his business studies degree. "It also provided a focus for creativity: remember, in those days, people could live on unemployment benefit and it allowed people time to tinker and code. People are creative given the resources."

Micro Power had its own software arm, Program Power, and one of the most prominent developers for the label was University of Leeds graduate Richard Hanson, who developed a *Centipede* clone for the publisher as well as *Martians*, *Invader Force* and *Alien Dropout*.

He went on to form Superior Software, which released titles
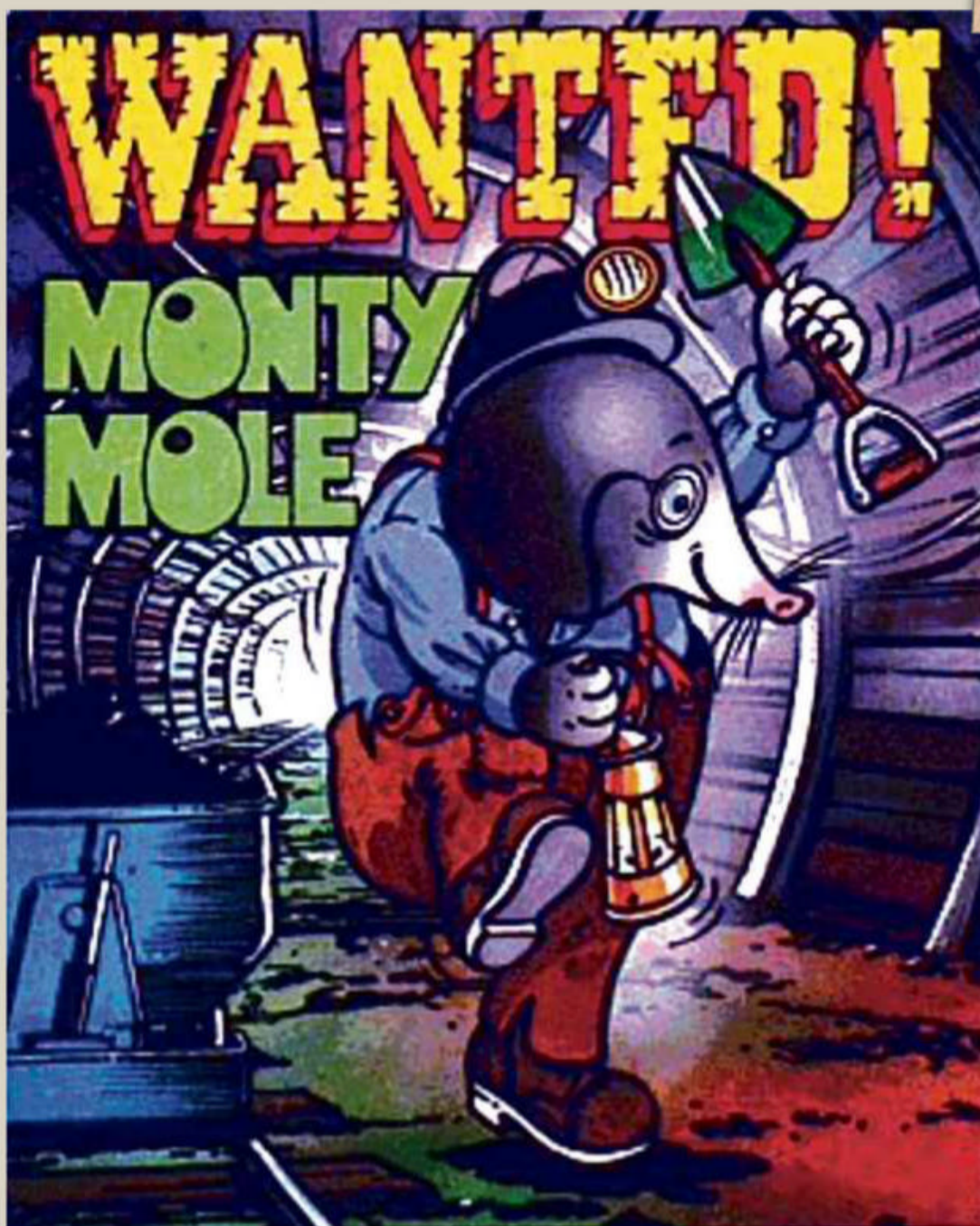
ABOVE High street retailers like Argos put the squeeze on independent shops

such as *Repton*, *Stryker's Run* and *Zarch*. Meanwhile, Micro Power would continue to expand. "It opened another outlet in a beautiful former bank in Leeds and we laid out BBC Micros upstairs so that headmasters and computing teachers could come and look around," Payne said.

"We'd also demonstrate these huge, super-wide daisy wheel printers which needed lots of space. Each time, we'd be forming relationships."

By the end of the 1980s, the independent shops were under threat and closing. Up until then, the shops had done a wonderful job of keeping up with the conveyor belt of home computer launches from the TRS-80, Acorn Atom, BBC Micro and Dragon 32 to Sinclair's Spectrum range, the Commodore 64 and the Amstrad CPC. They had continued into the 16-bit era and carried on supplying software for machines that had been and gone: "The likes of WHSmith would clear the shelves and start selling something else when a computer was discontinued," explained Payne.

However, increasingly, mainstream buyers were as likely to head for Dixons as their local, independent supplier and computer magazines were selling in their hundreds of thousands, meaning that knowledge was a mere turn of the page away. "Time had moved on," said Stewart, who sold Just Micro in 1989. And yet the foundations had been laid and stars were made. ●

> **"Remember, in those days, people could live on unemployment benefit and it allowed people time to tinker and code"**

LEFT *Wanted: Monty Mole* was created in reaction to the 1984/85 miners' strike

Perfectly private, completely confusing

The QUANTUM INTERNET is on its way

A pair of key experiments show how quantum tech could add unbreakable security to the internet. Nicole Kobie reveals what you need to know about the quantum internet

You may not have realised it as you were doom-scrolling through news about pandemics and politics, but 2020 was the year of the quantum internet – all thanks to a pair of experiments that suggests this futuristic networking technology could indeed be possible.

It's not a new idea, with the US military's Defense Advanced Research Projects Agency (DARPA) setting up the first quantum key distribution network in 2003 and experiments in quantum teleportation going back to 1997 at the University of Vienna.

So what was so special about 2020? In February, scientists from the University of Science and Technology of China published a paper detailing a 1,200km quantum link with the Micius satellite, the longest yet. A few months later, in September, researchers at the University of Bristol revealed a way to scale this nascent tech beyond a single connection.

"When I started, getting quantum computing to work between two people was a big deal," said Siddarth Joshi, a research fellow at the University of Bristol's Faculty of Engineering. "Now we are getting it to work between larger and larger networks. And satellites, when I started, were a dream. Now there's a satellite in orbit and we're building other satellites."

Plenty of other researchers are investigating this area, with notable work at the University of Innsbruck
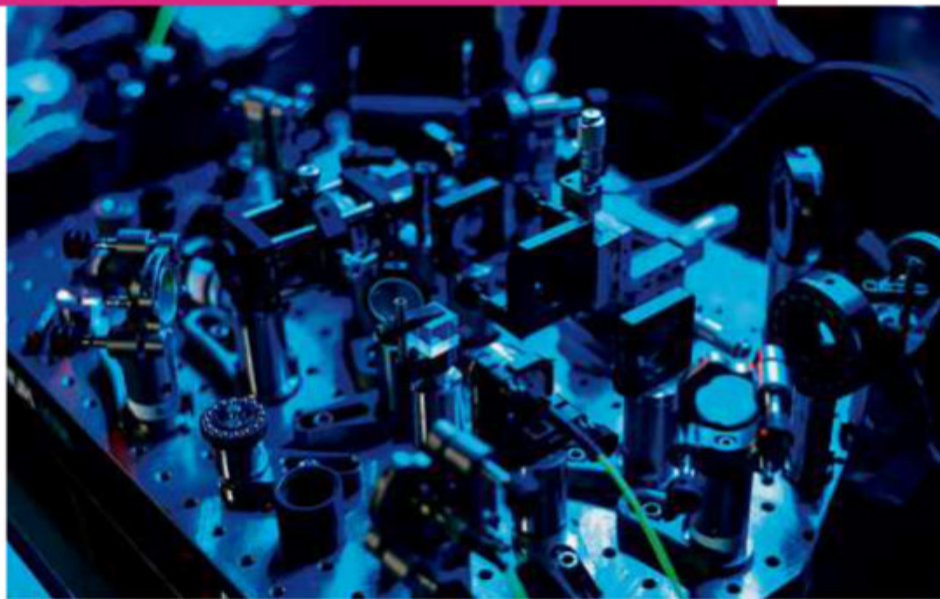
ABOVE The Bristol experiment is a key step towards quantum cryptography

and the University of Chicago, and a Delft University of Technology project to build a network between four cities. But, in 2020, these two sets of results marked a step forward for the tech.

"We can do a lot of interesting things on a one-to-one basis at a near distance," said Dr Harun Šiljak, assistant professor at the School of Engineering at Trinity College Dublin. "But when we try to stretch it over hundreds of kilometres, or if there's dozens of participants, things get ugly. And 2020 brought us both an advancement in trust-free communications over distance with the Chinese, and in terms of scaling with what's being done in Bristol."

■ How it works

What is the quantum internet? With the standard internet, packets of data are sent via networks and reassembled at the other end. For added protection, those packets are now largely encrypted.

Quantum internet takes advantage of inherent connections between quantum bits, or qubits. That link between particles is known as entanglement, and whatever change you make to one entangled particle happens to the other. Rather than sending packets of data, the quantum internet sends an entangled light particle down a fibre-optic line, holding back the particle that's linked to it. They now have a connection for sending data. Meddle with that and it's immediately obvious, as any attempt to measure a quantum state automatically changes it – it's a rule of physics – making it impossible to intercept the transmission.

Qubits can act like binary but better: rather than a one or a zero, a qubit can be either, both or neither, making it possible to encode even more data. Shove one of those qubits into the particle you held back, and the data will show up in the one you sent down the fibre-optic cable.

That's the simplified version, and it's so much more complicated than that in reality – not least because physics is hard and particles of light are finicky at best.

We've already seen the first wave of this technology, which uses

the property of entanglement to share something similar to encryption keys, called quantum key distribution (QKD).

The first quantum key distribution was in 2004 for a bank in Austria, and commercial QKD services are already on offer from companies such as ID Quantique and MagiQ technologies. QKD is one aspect of the quantum internet, but now there's work sharing even more information over longer distances to more people.

"The big advantage of quantum communication is that it's far more secure than anything else," Joshi said. The encryption we use to protect our communications now is difficult to decrypt, but not impossible – and will become simple when quantum computers arrive. "If somebody has a sufficiently powerful computer, they can solve the problem and be able to decrypt it very easily," he said.

After all, anyone with a fast PC today could decrypt communications from 30 years ago, if they had access to them. "If you want to keep data secure in the long term, you want something like quantum communication, where it's not based on a problem that is difficult to solve, but a problem that is impossible to solve – it relies on the laws of physics to ensure that a process is one way, like burning a message on a piece of paper."

That said, Joshi notes that transmission is only one aspect of security or privacy: if the person you're sending it to takes a screenshot of the message and posts it to Twitter, it doesn't matter if it was sent using 30-year-old encryption or quantum networking.

■ The Chinese satellite
With both experiments, the issue to overcome wasn't with the idea of the quantum internet but scaling: first in the distance covered and, second, with the number of participants.
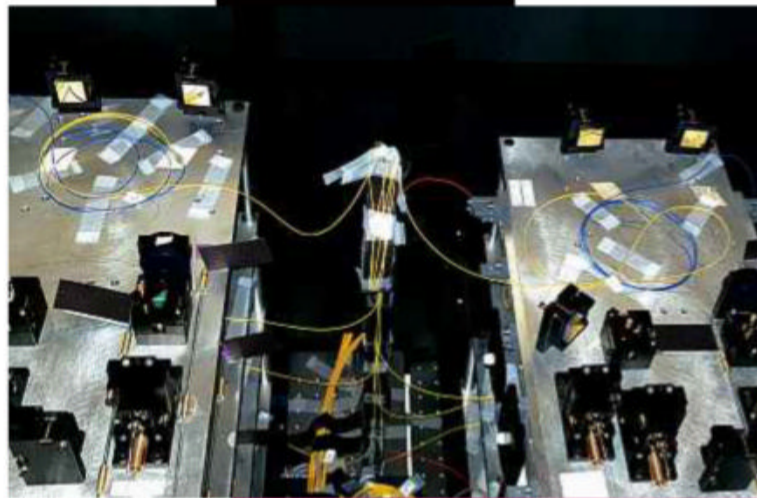
Let's start with distance. This is a problem because of attenuation; the signal decays and that can cause the quantum properties to fade. "You're trying to distribute something that's very fragile over a large distance, and you're doing it through fibre-optic cable," Šiljak said. That's true for traditional communications as well, with repeaters in place to boost the light signal and send it forward, but the physics aren't the same for quantum signals, he added.

One way of avoiding that issue is line-of-sight transmissions, which works with satellites. In 2016, China launched the world's first quantum satellite, named Micius, as part of the Quantum Experiments at Space Scale (QUESS) project – at the time, it was dubbed by *Popular Science* as a "satellite for the post-Snowden age". It's widely assumed that China's focus on satellite quantum communications is due to potential military benefits.

Indeed, this style of quantum communications only works if you trust who runs the satellite. "That's a major thing," Šiljak said. "Back when Micius was just launched… every participant in the conversation had to trust the satellite – you established a connection with the satellite, and agreed on the keys… we pretty much trusted that the satellite on our side is not managed by some entity that we don't trust."

That's no longer the case, with the key exchange happening between the sender and receiver via the satellite, but without the satellite having the means to intercept the data. "That was a big advancement, since that's what we've been imagining with the quantum internet," Šiljak said. "And it's finally happening."

While this means quantum satellites could work, it doesn't solve

ABOVE In the Bristol test, light is distributed into optical fibres and each fibre is adjusted

ABOVE The network in operation, with the receiving hardware for all eight users

RIGHT Every user has a single glass fibre connected to a source of entanglement

> **"It relies on the laws of physics to ensure that a process is one way, like burning a message on a piece of paper"**

the attenuation issues for fibre optics, with researchers in Chicago building a 50km fibre-optic quantum loop to investigate the problem. "If we want anything resembling the internet, we need quantum repeaters," Šiljak said. "That's the holy grail we're pursuing."

■ More people
The University of Bristol project, part of the Quantum Communications Hub and UK National Quantum Technologies Programme, scaled up the number of people in the network, connecting eight via quantum communications. It's not many, but it's a start.

Previously, one of the challenges with quantum networks was the need for both a transmitter and a receiver, rather like the walkie-talkies you may have had as a child. One set let you speak to a friend, but to include a third friend, you'd need another set. "Now imagine that scaled up to 100 people," Joshi said. "You'd have to have 99 walkie-talkies."

The other way to manage such communications is to have a trusted node. Everyone on the network shares their message with the node, which in turn doles it out to the recipient. That's what Joshi's project managed using an idea called multiplexing, which means that everyone on the network has a quantum-entangled state with everyone else. He compares it to the internet, where you have one device and one internet cable or Wi-Fi connection, but that setup means you ➡

can receive signals from anyone. "We were able to do this across the city of Bristol, so it's not just a lab demonstration," he said.

However, there's a limit to this technology: go beyond 50 to 100 people on the network and it won't work. This time Joshi compares it to a home Wi-Fi network, which can normally only connect 32 devices. "The way around that is you have to figure out how to connect one router to another router, and start building larger and larger networks," he said. "That is exactly what our next step is."

It won't be easy. Not only will adding users increase the network complexity, but it's unclear exactly how the quantum internet will be used in the future, so Joshi and his team don't know exactly what to optimise for. "Because quantum networks are such an emerging field, you're trying to create networks that are as flexible as possible," he said.

■ Other challenges

Another major challenge for the quantum internet is memory. "The fundamental principle of memory, of something that could store quantum information, is as yet unsolved," Šiljak said. "It's another major issue and it touches both on computation and communication."

Another hurdle relates directly to Šiljak's own work: connecting the existing internet to a quantum version. At the core is the idea of reversible computing, in which computers don't lose information when performing an operation. "Imagine that you have a computer that is summing two numbers. You put in two numbers and you get an output third number – but you aren't able to reconstruct the inputs from the outputs," he said. "If the answer is seven, you have no idea which two numbers were used."

It gets a bit weird here: by losing that information about the inputs, power is dissipated. It's like entropy, but for computers, Šiljak says of the theory. "If your computer forgets things, it has to spend more energy than a computer that does not," he explained. When Šiljak started working on that idea, the one example that kept being raised was quantum computers, which have to be reversible by their nature.

What does that have to do with interconnects? While traditional computers aren't reversible, quantum ones would be – and for them to interact there needs to be a structure in between them. Building that won't be easy, though.

■ When will the quantum internet arrive?

Quantum internet won't replace the existing internet but be an added function. Joshi believes it will start being adopted for specific use cases by government and financial institutions to keep backbone connections secure. That work has already started, with Joshi working with commercial partners, but could take a decade.

It will take much longer for a quantum network to connect all the way down to your house, and will require optical fibre to do so. "We might see limited applications that to an extent resemble our electrical computer network, but not necessarily the internet," Šiljak said.

That may make the idea of a quantum internet sound unlikely; after all, so far, it can connect two people sitting nearby. But that's exactly how the internet itself began, argues Joshi, "connecting just two universities in CERN". In particular, the first communication was sending simple messages. "That's exactly how the quantum internet is starting right now," he said. "We have good analogies from the past, we've done this all before."

Indeed, Joshi looks to optical fibre rollouts as another analogy from the past to explain how quantum internet will arrive. First, it will link data centres and other important back-end sites. Then it will filter down in stages, eventually reaching individual homes. "That's the kind of adoption curve we're looking at here as well," he said.

TOP A quantum network provides perfect encryption keys (by Holly Caskie)

ABOVE An artistic depiction of the quantum network (by Anta Bucevic)

"Rather than a one or a zero, a qubit can be either, both or neither, making it possible to encode even more data"

■ Security for all

Perfectly secure communication has a clear use case for the military, financial institutions and governments, who not only need to know a message hasn't been read but also have the money to run cutting-edge systems.

However, the researchers behind these projects believe the quantum internet will be for everyone – and should be. "I would say that privacy and security are fundamental rights," Joshi said. "One day this is going to be universal, everybody wants this."

In fact, he argues that in the long-term, it's personal data that matters the most. A financial transaction, such as with your bank, is only of interest to hackers to hijack in the moment, not decades down the line. "You send money, it's received on the other end of the globe within seconds," Joshi said. "If you have a sufficiently complex problem that a current computer cannot hack in a few seconds, that's fine.

"But what do you want to really keep private? Your personal details, your medical information. You don't want that information to leak out 30 years later and embarrass you," he added. "That is where quantum communication really shines."

Of course, governments have long fought against end-to-end encryption for private individuals, arguing that it gets in the way of prevention and investigation of serious crimes such as terrorism. We can expect them to do the same here. "There'll be two competing interests," Joshi predicted. "The government will want the technology to exist in its unmodified and perfectly secure form, and also want the technology to exist such that they can snoop on everybody else."

This won't just have a niche application, Šiljak says. If quantum internet can be built in an affordable, scalable way to be used by the military or fintechs then it shouldn't be too expensive or complex for everyone to use.

"I don't see a scenario in which it remains a closed technology," Šiljak said. "Once we have it, it's going to be distributed globally." ●

Next month's issue

PC PRO

Thursday
7 February 2021

👁 LABS

Wi-Fi 6 routers

Whether your budget is £50 or £799, and whether you're looking for the home or the office, next month will reveal a router that's right for you.

🔄 FEATURES

Why you can't always bank on online banks

Tempted by the new breed of challenger banks? While they're slick and convenient, they come with unadvertised risks.

Create your own Alexa skill

Amazon's handy blueprints make creating Alexa skills far easier. We explain why rolling your own skill can be useful – and how to do it.

The rise, fall and rise of the keyboard phone

Remember when the Psion Series 5 was king? A new breed of keyboard phones is emerging, but who's buying them and why?

Please note: Labs and features are subject to change

If employees are to work from home then the office network must move with them, argues Jon Honeyball

We need a proper, open discussion about the future of working from home. This has significant impacts for office provision and transportation, let alone the existential changes it will bring to the myriad services that support a working conurbation.

But that's not where I'm looking today. Like many, my business has been in "work from home" mode as much as possible these past months. Some clients have essentially moved to the shires. Others are balancing in-office with out-of-office working. The shift from face-to-face meetings to Zoom or Teams has bedded in and we are unlikely to return to normal by late 2021, if ever.

Yet this has brought with it significant issues for a company's IT provision and infrastructure: historical ideas about network boundaries are being blown away. Of course, we've had VPN tunnelling for years, albeit nothing like the adoption levels we saw in 2020. Some companies have already moved to entirely cloud-based services for their infrastructure, and this makes working outside the perimeter of the traditional business network significantly easier than a more traditional on-premises model.

Or does it? I'm far from convinced, and my doubt has nothing to do with the capabilities of cloud services. Instead, it's the shockingly poor state of IT services into the home. As people have been spending hours on video calls, it's become clear who has an adequate infrastructure at home and who doesn't. Not just wobbly, slow ADSL with constrained inbound network speed, but upstream contention and difficult Wi-Fi installations, often in blocks of flats.

What might be adequate for streaming and web browsing in a domestic environment, where much of the traffic is inbound, often doesn't meet the requirements of high-quality connected services for long periods of time. I've lost count of the times a user's video feed has frozen, or the sound has turned into a modern answer to Max Headroom, which will only make sense to those of a certain age.

As part of the strategic replanning for IT services for 2021 and beyond, consideration must be given to how staff can be appropriately supported when working from home. We have proper legislation and best practices in place for workplace requirements – whether that be correct seating, lighting, screen quality or positioning. If businesses are going to cope, let alone succeed and flourish, in this new homeworking reality, IT needs to be refactored to take the particular challenges of this new world into account, just as if you were supplying chairs and desks to meet the individual needs of staff.

Here's my suggestion. It's time to consider rolling out a company-managed ADSL or FTTC service to the homes of your staff. This would be installed separately from the home network. It would be there for work purposes only and would be to a speed, reliability and capability that matches the requirements for Teams, Zoom and other services.

Critically, this has to include the appropriate service-level agreements from the telco for a business service. If a member of staff goes offline then the situation should be considered with the same degree of urgency as the doors jamming at an office. All of this is possible, but it needs to be appropriately specified, ordered, implemented and managed.

Another requirement is dark tunnelling straight back to the main company network, to ensure access to internal services and security policies. This could be a VPN tunnel from the router to the network, but it could be a hardware-level device too. Such a security box would lock down access to the approved MAC addresses of company-provisioned devices, whether they be laptops or phones or printers.

> ❝ I've lost count of the times where a user's sound has turned into a modern answer to Max Headroom ❞

Since it would be a wholly business-only service, HMRC couldn't claim it was a perk for the home user away from work.

Wouldn't this be expensive? That depends. I'm sure there are deals to be done on what might be called "business-grade ADSL" from suppliers. It requires something more than a toy-town router being delivered to the house – a proper professional solution with centralised management is essential, even for SMEs. This is a big potential marketplace, and it doesn't need the largest suppliers to own this space. The smaller and mid-sized regional ISPs have a huge opportunity staring them in the face, if they're ready with an appropriate package of connectivity, management and security.

I'm sure some businesses will baulk at the cost, but what is the price to the business if your employees can't do their work in an adequate and professional manner?

■ Jon is a contributing editor to *PC Pro*. If he were prime minister, he would insist we install gigabit fibre to every house in the UK. Email jon@jonhoneyball.com

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3440x1440 (21:9)

144HZ

WQHD
3440x1440

34"

FreeSync

1 MS