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PC PRO

UPGRADE YOUR SCREEN

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ON
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Spotify vs the world

SWITCH AND YOU COULD...

- Slash your monthly bill
- Enjoy better audio quality
- Discover new music & podcasts p26



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HIGHLIGHTS THIS MONTH

Full contents overleaf

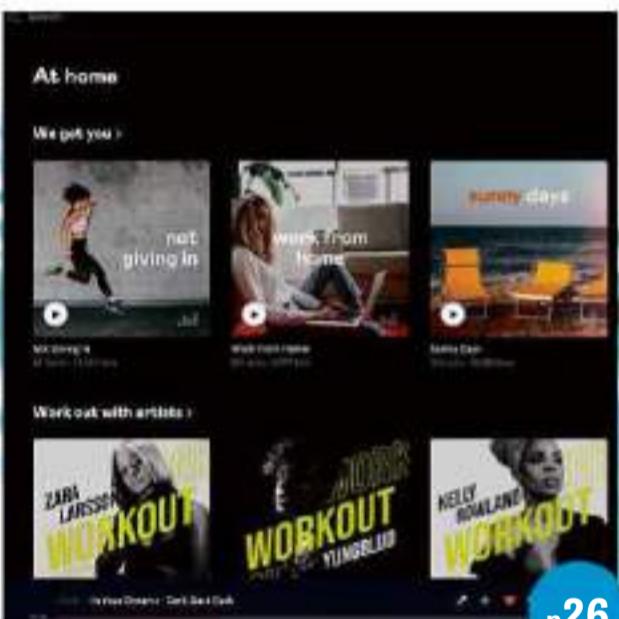


REVIEW OF THE MONTH

Microsoft Flight Simulator

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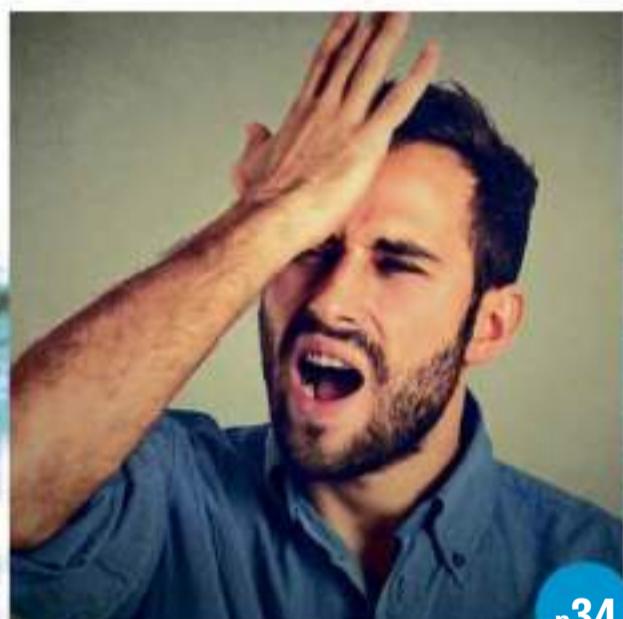
What is it about Microsoft's Flight Simulator that catches the imagination? The realism? The history? The sheer joy of flying to wherever you want in the world? Whatever the reason, we know that it's far more than a game to many and, to find out whether this 2020 update is a worthy addition to the legendary series, we asked commercial pilot Gavin Hall to deliver his verdict. You'll find this from p42. Plus, on p45, we review a special edition PC from Chillblast that's specifically designed to run *Flight Simulator*. Hide your wallet.



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MUSIC SERVICE OF THE MONTH

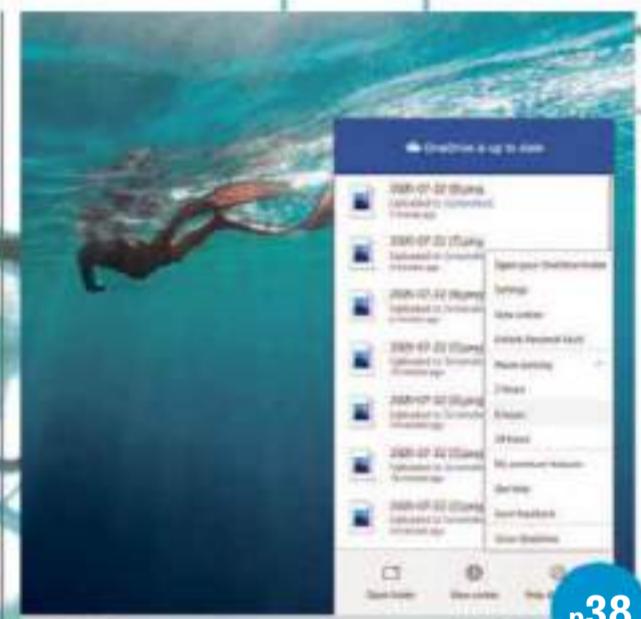
Spotify deserves huge recognition for shaking up the music market, but that doesn't mean it also deserves your monthly cash. We see how it compares to its key rivals from p26.



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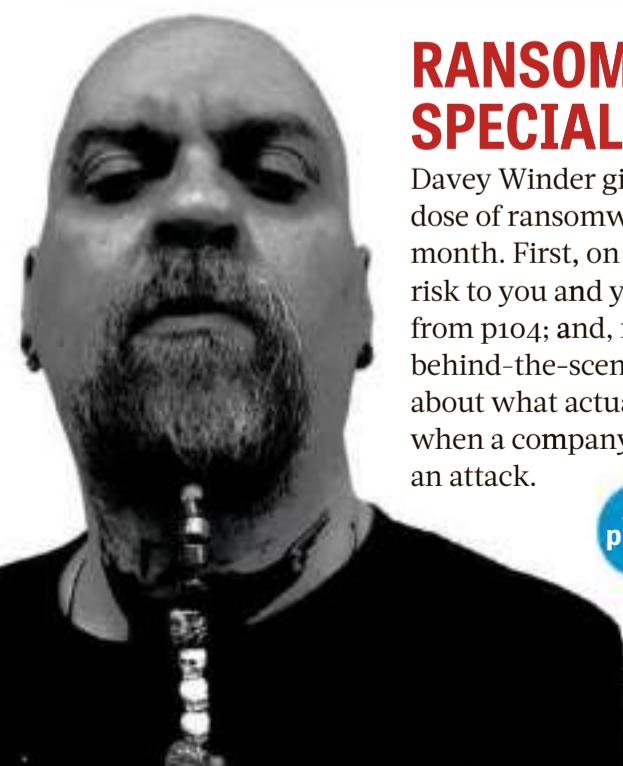
WINDOWS TIPS OF THE MONTH

Want to make Windows go faster? Nik Rawlinson runs through ten handy – and free – ways to give your stuttering operating system a boost from p38.

RANSOMWARE SPECIAL

Davey Winder gives us a double dose of ransomware advice this month. First, on managing the risk to you and your business from p104; and, from p120, behind-the-scenes information about what actually happens when a company gets hit by an attack.

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THE LABS IN ONE NUMBER

This is how many individual tests we performed on the 35 monitors in this issue's Labs – if you're looking for a new screen, this is your lucky month.



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Windows 10 10 FREE WAYS TO MAKE WINDOWS FASTER p38

PC PRO

UPGRADE YOUR SCREEN

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Are you sick of software lagging and your PC taking an age to start up? Nik Rawlinson provides a selection of simple – and not so simple – methods to streamline Windows and make it run like new. The good news? None of them cost a penny.



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Vodafone's Curve keeps an eye on your bag, dog or even children...



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Editor's letter British retailers need to fight back with... scones

IT'S HARD TO find a positive headline at the moment – unless, that is, you're a shareholder of an US technology company. “Combined, Alphabet, Amazon, Apple and Facebook earned \$28 billion,” reported *The New York Times* on 31 July. “Amazon had warned investors to expect profits to be wiped out by \$4 billion in coronavirus-related costs. Although the firm spent as much as promised, sales grew so fast that it turned a \$5 billion profit for the second quarter, double the result of the year before.”

Three weeks earlier, by contrast, John Lewis announced that it was closing eight of its 50 department stores, including the Watford branch where I worked for three years during the late 1990s. This was yet another hammer blow to shopping centres that rely on John Lewis, and other big retailers, to lure in shoppers from miles around.

As it has for years, the Amazon juggernaut continues to plough through the UK's high streets. Combined with the impact of Covid-19, it doesn't take an epidemiologist to predict the result. Until last Saturday, I hadn't visited our local town for several weeks, and while I was expecting shuttered windows I was taken aback by the sheer number of closed shops. Closed forever, that is.

Perhaps this shouldn't have shocked me as much as it did. Since March, our household has relied on online deliveries more than ever, with Amazon earning the lion's share of non-grocery sales. Aside from one local shop, which pivoted to deliveries when doors were closed, my money has been diverted out of town, out of county and, to a larger extent than I'd like to admit, out of country.

So why are we collectively turning to Amazon and other US firms when we know that the profits head overseas and we're inflicting harm on much-loved British retailers?

If I had to distil it to one word, it would be convenience. Pushed for a second, I'd go for laziness. And I include myself in this. Amazon makes my life easy because it does what John Lewis used to do: provide a one-stop shop for everything. Its seemingly infinite marketplace stretches from aardvark soft toys to ZZ Top CDs.

While we've seen plenty of British companies innovate online, I struggle to think of a success story that comes close to Amazon. Yet don't imagine for a second that Amazon is so brilliant that it's impervious to attack. If you turn to this month's Labs (see p68), where I pit 35 monitors against one another, you'll see that I end up castigating Amazon's awful decision to lump a family of similar-sounding monitors together. Let's not even begin to talk about whether you can trust the star ratings or the reviews.

It's not too late for British companies to adapt to this new and most challenging of decades. It doesn't have to be purely online, either. I know from my time at John Lewis that The Place to Eat was always the least profitable of all the departments, often operating at a loss, but it's also the honey that attracts the shopper bee; even as I type these words, I'm visualising one of its warm cheese scones cut in half with a dollop of butter slowly melting.

Short of popping a microwave, cheese scone and butter in every box, Amazon can't match this experience. This advantage, a genuine pleasure attached to shopping, is what will keep me coming back to John Lewis for years to come. If British retail is to survive then it needs to come up with more “people magnets” – and fast.

Tim Danton
Editor-in-chief

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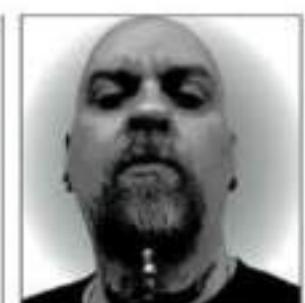
Sarah Kidner
Have we become too used to receiving instant gratification from tech in a world full of uncertainty? Sarah provides a nuanced response on p34



Gavin Hall
Who better to review the brand-new Microsoft *Flight Simulator* than a commercial pilot who grew up on sims? Read Gavin's verdict from p42



Barry Collins
A long-time Spotify user, Barry couldn't help but wonder whether its rivals offered something better. His discovery? That Spotify is no longer king. See p26



Davey Winder
Davey provides a double dose of ransomware advice this month: how to avoid it on p104 and then what happens when it hits from p120



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To tie in with our "Spotify vs the world" feature on p26, we wanted to know how our contributors listened to music while they're working...

"I have a 400-strong CD collection sitting in my office and nothing to play them on – so, on those occasions when I feel like some music to keep me going, Spotify is my go-to source."

"Indoors, I listen to Spotify via hi-fi, and Spotify on my phone and wireless buds when walking outdoors."

"I used to put on a CD and tell myself I'd take a break when it finished. Then it would be four hours later and I'd have no recollection of having heard any music..."

"*To Cut a Long Story Short*, I don't normally listen to music when I'm working – or I end up with Spandau Ballet interspersed in my copy."

"YouTube for oddities; home MP3 library from back in the day for nostalgia. Working on warehouse parties made me blasé about fidelity."

"Pocket Casts on my phone via AfterShokz Trekz headphones for the walk to work. This syncs with the workshop's Echo, which also pipes in Amazon Music."

"Lots of CDs and vinyl, along with Qobuz streaming and rips on my NAS. I use Roon to control all the streaming."

"When I'm working with numbers, I listen to music, mostly ripped CDs streamed from my NAS."

"Music is verboten in the office at all times, unless I don't want to be productive. At home, it's usually Spotify."

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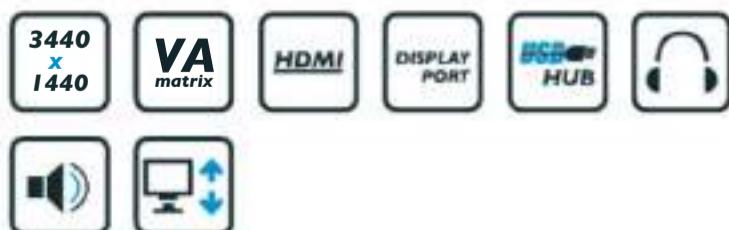
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Briefing



Background and analysis on all the important news stories

Calls for regulator to calm algorithm angst

Plans to govern by algorithm raise red flags in wake of A-level chaos

Critics have warned that algorithmic injustices highlighted by the A-level results furore will only increase without an official regulator to monitor their usage.

Officials in the UK are increasingly using computer models to automate decisions based on the government's datasets, but as the recent A-level fiasco has shown, such practices have huge implications for individuals.

"We've talked about algorithm regulation in academia and now there's going to pressure for a regulatory body in charge of this," said Paul Bernal, professor in law at the University of East Anglia. "The thing that made a difference with the A-levels is we saw a direct impact – people were going to lose university places because of this algorithm."

While the A-level scandal, which initially saw thousands of students' grades downgraded, was the first major event to bring the issue to the fore, Bernal claims it's been a simmering issue that was always

going to boil over. "Algorithms are being made to make decisions that they shouldn't be used for and the natural consequence of that is that individuals are punished through no fault of their own," he said. "The same things will have happened to people already – where algorithms have been used in credit ratings, job applications and personalised pricing – but it's less visible."

There's immediate potential for similar scandals too, with the government already planning to use algorithms to allocate and adjudicate on benefit decisions, as well as in the medical arena. "They will look at AI to decide who's going to get the Covid-19 vaccine first and decisions about access to medicine will be made through algorithms and health data," said Bernal. "And they're building up systems to assess people's benefit entitlement algorithmically, which is a recipe for disaster."

With the government continuously ramping up its "digital by default" ambitions, global watchdogs are also

cautioning over damage. "We are witnessing the gradual disappearance of the post-war British welfare state behind a webpage and an algorithm," said special rapporteur Philip Alston in a report for the United Nations on poverty and human rights in late 2018. "The impact on the human rights of the most vulnerable in the UK will be immense."

“The methods should be made public to all concerned and made available to people with stakes in this”

It's not only government-led initiatives that concern critics, either, with union bosses concerned that algorithmic bias will impact job seekers. "Employers already use all sorts of shortcuts to sift through applications. If an algorithm was used I wouldn't expect applicants to be told," said Karam Bales of the National Education Union.

"It can reinforce the postcode lottery. If you are from a deprived neighbourhood you are less likely to succeed due to having access to

fewer opportunities, because algorithms would pick this up and downgrade candidates based on the area they grew up."

■ Damage limitation

Experts believe the only way to prevent further damage is to create a regulator to ensure public service algorithms are opened up before they are implemented, so that civil society can inspect them. "This is all happening after the event, but the methods should be made public to all concerned and made available to people with stakes in this," said Bernal. "They should have a chance for input before they have an impact on individual people."

"Like with the NHS tracking app, data-risk assessments need to be done in advance to see what's going to go on. Effectively, you could have an 'algorithmic fairness assessment' that is made public and people can criticise it and the methods. There is no reason to keep this method secret, unless you're afraid that if you make it public somebody is going to criticise you," Bernal added.

"Statutory oversight would involve at least a framework, setting out when algorithms can and can't be used, what data they can and can't consider, what standards of transparency are needed, and would empower an independent body to investigate the procurement, deployment, and use of algorithms."

■ Closed shop

The situation is exacerbated, critics argue, by the fact that much of the planning and development of systems happens behind closed doors, either in government departments or outsourced to private companies, and there's little that anyone that's given a raw deal can do to contest decisions. On top of that, there's a lack of transparency because neither companies nor departments want to share the details of the systems they've put in place.

"Sometimes they're proprietary – it really depends on how they've been procured," said Jennifer Cobbe, coordinator of the Trust & Technology Initiative at the University of Cambridge. "In some cases they'll be outsourced to a private company, who will claim that they're confidential."

"That's obviously incompatible with basic principles of public sector transparency and accountability. Sometimes they're developed in-house and public bodies will try to keep them secret – which again is incompatible with basic principles of public sector transparency and accountability," Cobbe added.

News in brief

Microsoft tries risky new form factor with the Surface Duo

Microsoft is attempting to kickstart the market for dual-screen devices, with the launch of the Surface Duo.

The Android device, announced in October 2019 alongside the still-absent Surface Neo, will go on sale in the US at the stark price of \$1,399 – significantly more expensive than most smartphones, tablets and many laptops. However, analysts say the device might find a niche between those three product categories.

"Surface Duo's uncomfortable position in this no man's land between smartphone, tablet and notebook is exactly why Microsoft is addressing the category," explained Geoff Blaber, an analyst with research firm CCS Insight. "The company sees significant, long-term potential, and in time it might get there."

The Duo has two 5.6in OLED displays that fold out from a hinged design. "Designing a slim product that unfolds to a large display is difficult, especially when you consider thermal and battery performance," said Blaber. "But ARM-based processors now offer the horsepower within a workable thermal envelope."

Unlike Microsoft's disastrous last foray into the mobile market, the Surface Duo runs on Android, not Windows, which is another important breakthrough, according to Blaber. "A proper set of apps is the essential bread and butter on a mobile device," he said. "It's not going to be a blockbuster, but it's only the beginning and more apps will be optimised for dual displays. As with other Surface devices, Microsoft will fine-tune the Duo."



Absent information commissioner under fire

The information commissioner has come under attack after seemingly slashing fines for high-profile data breaches and leaving the country for months during a time of crisis.

British Airways had been facing a fine of £183 million for a 2018 loss of credit card and personal details of 500,000 customers. Yet, more than a year after the announcement of the fine, the Information Commissioner's Office (ICO) has again postponed action and it is increasingly likely BA will pay only 10% of the original penalty. In its Q2 results filed with the London Stock Exchange, BA's parent company IAG said it was setting aside only €22 million (£20 million) to cover the fine.

"The exceptional charge of €22 million represents management's best estimate of the amount of any penalty issued by the ICO in the UK relating to the theft of customer data at British Airways in

2018," the group said. "The process is ongoing and no final penalty notice has been issued."

Marriott, meanwhile, had been fined £99 million for its breach, but has also received another postponement for further negotiations. The company's financial records explain that "based on the ongoing proceeding involving the ICO, the company also reduced to \$65 million (£49.3 million) the fine proposed in relation to the security incident".

Neither the companies nor the ICO are commenting further on the proceedings.

All this comes as the information commissioner is facing personal criticism for spending months working from her home in Canada. In the midst of concerns over the fines and "track and trace" privacy, Elizabeth Denham (left) was in Canada from mid-June to early September, the ICO confirmed.

Although the ICO insisted that Denham had been continuing with her duties, she came under fire, with Heather Burns of the Coalition for a Digital Economy stating that: "We are in a national crisis, and she has abandoned her post. She must resign."





PCProbe

Should we stop selling the crown jewels of tech?

After a string of high-profile sales, **Stewart Mitchell** asks if it's time to protect the UK's technology assets

The UK has a rich history in tech, but many of Britain's biggest tech firms are sold to overseas investors, with assets and know-how heading overseas.

Britain runs a free-market model, but many believe that there's value in greater intervention. "In the modern world, all the national returns are in the profit and the share of income and assets," said Dan Ciuriak, a trade consultant and senior fellow at Canada's Centre of International Governance Innovation.

"This is where new national wealth is being generated – it's no longer labour income [through taxes] that's generating the money. If your economic strategy remains in the industrial era, you will see a shrinking as a percentage of global wealth."

No matter how much money a company such as Facebook makes in the UK, or how much formerly UK-owned chip design giant ARM makes globally, the UK's benefit is negligible. "The question for a government is do we intervene or not? What matters is who owns these assets and do they reside on your territory," said Ciuriak.

The UK has waved goodbye to several leading tech companies in recent years as venture capital companies and multinational giants shop for bargains. Logica, CRM, Autonomy, ARM and Sophos have all vanished from the UK stock market in the past eight years, along with a host of others that had potential to be big players.

Senior figures in UK tech believe authorities have been too relaxed about the sale of such assets, allowing valuable

or strategic companies to be lost overseas. Not only does this damage tax revenue, it reduces the country's influence and sees talent, knowledge and intellectual property leave.

Take Sir Hossein Yassaie, former CEO of Imagination Technologies, which still resides in the UK but is largely owned by Chinese capital and has been under scrutiny over who is really running the firm. In May this year, addressing a House of Commons committee exploring how to stop foreign asset stripping of UK companies, Yassaie said that some UK assets were too important to lose, and that current policy left too much to chance.

“Not only does this damage tax revenue, it reduces the country's influence and sees talent and knowledge leave”

to make sure the right thing happens."

Asked by the committee whether control mechanisms in the UK were sufficient, Yassaie said: "What we have is lax. I think it is very important that there is sufficient control around ownership and definitely governance."

■ Protect and serve

In contrast, the US is more robust due to the Committee on Foreign Investment in the United States (CFIUS), which was set up to review national security implications of acquisitions by foreign investors of US companies.

Could sold-off tech be weaponised?

With tensions increasing between the West and China, there's concern that technologies might provide an inadvertent security threat if lost overseas.

In evidence to the Foreign Office committee investigating UK asset stripping, former CEO Hossein Yassaie said Britain must ensure it understood what technologies were involved in tech buyouts or risk problems in the future.

"We comfortably talk about autonomous driving cars, but the technologies that would make a car

driverless or autonomous can be deployed in other applications, such as military or other targeting applications," Yassaie explained. "The chips that go in the car to detect pedestrians and drive the car are sophisticated pieces of equipment and completely programmable.

"If the development continues in the member state and it is quite clear what is going on, I would be much more relaxed about that than a situation where the technology is transferred to some other country."





In recent years, for example, CFIUS has ordered Chinese gaming company Beijing Kunlun to sell Grindr due to worries over security, while foreign acquisitions of semiconductor makers Lattice and Qualcomm have also been blocked. At the time of writing, TikTok's US operations are up in the air, with demands for a sale to an American company.

Whether that sale of TikTok is actually a security question or merely US protectionism is debatable. "If you look at TikTok, it had gathered a lot of data and was only starting on how to monetise it – but the market valuation was soaring, not because of what it had, but because of the future and it was on a track to be the next Facebook with a trillion-dollar market cap," said Ciuriak.

"Governments are looking at this and thinking: do we want a Chinese company capturing this future prospect of a one-trillion dollar market cap and the US said 'no' – they want to capture that in the US."

ARM is the best example of a British asset being sold off. The Cambridge-based company has been designing chips since the 1980s. With ARM-designed processors powering 95% of the world's smartphones, it was the jewel in the crown of UK technology until it was bought by Japanese company SoftBank in 2016 for \$32 billion.

It's now up for sale again, and there are fears that it could face a bleak future depending on who buys it. "The one saving grace about SoftBank was that it wasn't a chip company, and retained ARM's neutrality," ARM co-founder, Hermann Hauser told the BBC recently. "If it becomes part of Nvidia, most of the licensees are competitors of Nvidia, and will of course then look for an alternative to ARM. It will become one of the Nvidia divisions, and all the decisions will be made in America, no longer in Cambridge."

According to Hauser, the fact that SoftBank is hungry for a deal means a UK buyback would make perfect sense. He argues that if the UK could afford £500 billion to bail out banks, why not invest a few billion in a profitable, strategically important technology player? "The great opportunity that the cash needs of SoftBank presents is to bring ARM back home and take it public, with the support of the British government," he said. "It's not about the

ABOVE Experts warn that too much intervention could drive startups away

money, it's the industrial strategy statements that the government can make."

Leave it be

Despite the calls for greater government intervention, there are concerns it could deter investors and startups from locating in the UK. Given the goal of many startups is to reach, say, a million users and sell, experts say too much intervention might force them to look elsewhere when founding a business. "With DeepMind [bought by Google] it was a genuine acquisition – it's not like they didn't have a choice about selling it," said Palitha Konara, senior lecturer in international business at the University of Sussex.

"If the government was going to intervene to that extent it might well be counterproductive, because a lot of the good acquisitions would not take place and that could stop people setting up in the UK."

The great opportunity that the cash needs of SoftBank presents is to bring ARM back home and take it public

There are also fears that the UK doesn't have the economic clout to keep tech companies on our shores. We spoke with one former industry-government liaison professional who didn't want to be named.

"The UK keeps making interesting innovative tech companies of a decent size, good talent and growth and they get the attention of other

people and become strategically valuable businesses to acquire – that's a good thing," he said.

"We can grow to a certain scale, but there are limitations," he added. "There are large players in the platform markets who have the money and capacity to buy people out. That's a global competition question that hasn't been solved. The reality is that this is always going to happen to an economy the size of the UK that keeps making innovative things."

There are also questions over whether the government is really capable of working out when and where to invest. "Would you trust them to be the ones saying we can predict what ARM's business plan should be in ten years' time?" said one of our commentators, who asked for the comment to be unattributed. ●



The A-List

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



PREMIUM LAPTOPS

Apple MacBook Pro 16in

Powerhouse laptop with a price to match, from £2,399
from apple.com/uk



If you know you'll take advantage of what the 16in MacBook Pro offers, you won't regret buying it. The only question is where you draw the line, with options right up to 8TB SSDs and 64GB of RAM. Whichever version you choose, you'll benefit from an improved keyboard, spectacular screen and the very best audio setup on a laptop.

REVIEW Issue 305, p52

ALTERNATIVES

HP Spectre x360 (2020)

HP keeps producing exceptional laptops and the new 13in Spectre x360 is one of its best. A striking convertible with all the mod cons. **£1,399**
from store.hp.com
REVIEW Issue 307, p60

LG Gram 17

A 1.3kg 17in laptop with battery life of over 11 hours might seem unbelievable, but here it is. It's not the most powerful system, but it's more than fast enough for most workers. **£1,550** from argos.co.uk
REVIEW Issue 311, p57

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. **£1,700**
from johnlewis.com
REVIEW Issue 312, p86

SMARTPHONES

OnePlus 8 Pro

Android 10 phone, 256GB, £899
from oneplus.com



The OnePlus 8 Pro is the company's most polished smartphone so far. Gone are the rough edges of the previous generation, with flagship features such as IP68 protection, a top-quality quad-camera setup and a stunning 120Hz AMOLED screen. But the key to its top billing on the A-List is that it delivers all of this at a price that undercuts the equivalent Samsung and Apple phones by at least £150.

REVIEW Issue 309, p58

ALTERNATIVES

Apple iPhone 11 Pro

Apple's latest flagship phone is fast, chock-full of new features and has an unbelievably good set of cameras. **64GB, £1,049** from apple.com
REVIEW Issue 302, p52

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. **£300**
from johnlewis.com
REVIEW Issue 312, p68

NEW ENTRY

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. **£1,179**
from johnlewis.com
REVIEW Issue 313, p58

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 310, p52

ALTERNATIVES

Apple iPad (2019)

The iPad Pro makes the plain iPad look both cheap and rather dull, but it's still a great portable choice – especially with the £159 Smart Keyboard. **From £349** from apple.com/uk
REVIEW Issue 303, p50

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 311, p68

Samsung Galaxy Tab S6

A super-light tablet that does it all, and the price includes a stylus. Only Android's tablet app selection lets it down. **£559** from johnlewis.com
REVIEW Issue 305, p70

EVERYDAY LAPTOPS & CHROMEBOOKS

Honor MagicBook 14

Metal-bodied 14in laptop, £500
from hihonor.com



It's astonishing how much Honor crams into this 1.38kg 14in laptop. It starts with the all-metal chassis and extends to the AMD Ryzen 3500U processor: together with 8GB of RAM and a speedy 256GB SSD, this propelled it to 109 in our benchmarks. It's even pleasant to use thanks to a positive keyboard and decent screen, with an 8hrs 15mins battery life the cherry on top.

REVIEW Issue 311, p65

ALTERNATIVES

Acer TravelMate X3

A fast, solid laptop with excellent battery life that would be a fine choice for SMBs, thanks to Windows 10 Pro and quality in all the right places. **£878**
from laptopsdirect.co.uk
REVIEW Issue 303, p59

Huawei MateBook D 15 (2020)

Huawei has performed a minor miracle by producing a high-quality 15.6in laptop – with an all-metal chassis – that's both fast and stylish for a wallet-friendly price. **£500** from argos.co.uk
REVIEW Issue 307, p64

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

PC Specialist Inferno L2

Ryzen 9 3900X PC, £1,499

from pcspecialist.co.uk/reviews

What do you get if you mix an AMD Ryzen 9 3900X with Nvidia GeForce RTX 2070 Super graphics? The answer is truly phenomenal power: for the price, this is the fastest system we've tested by a distance.

REVIEW Issue 305, p65



Scan 3XS Vengeance RTX Ti

And what do you get when you go all-out for a powerful PC? This: a Ryzen 3950X system with 32GB of 3,200MHz RAM, a 2TB PCIe 4 SSD and a GeForce RTX 2080 Ti graphics card. Suffice to say, this machine ground all our benchmarks into dust. **£2,481 from scan.co.uk**

REVIEW Issue 306, p56

NEW ENTRY

Chillblast Captain Flight Sim PC

Built to tackle the demands of *Microsoft Flight Simulator*, this quiet system plays that "game" at 4K in High settings – with a Core i7-10700K, GeForce 2080 Super, 32GB of RAM and 5TB of storage. **£2,200 from chillblast.com**

REVIEW Issue 313, p45

WORKSTATIONS

Scan 3XS GWP-ME Q132R

Ryzen 9 3950X workstation, £4,200

from scan.co.uk

Any Ryzen 9 3950X system will give you earth-shaking performance, but Scan won our Labs thanks to its attention to detail – and the fact it provides 64GB of RAM, Quadro RTX 4000 graphics and a 2TB SSD in Fractal Design's impressive Define R6 USB-C chassis.

REVIEW Issue 307, p87



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. **£6,758 from armari.com**

REVIEW Issue 307, p84

Chillblast Fusion Ryzen Render RTX 4000

A saving is always welcome, and you can trim £800 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. **£3,340 from chillblast.com**

REVIEW Issue 307, p85

MONITORS

NEW ENTRY

LG UltraWide 38WN95C

38in widescreen, £1,329

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



NEW ENTRY

Philips Brilliance 328P6

If you can't stretch to the top-ranked LG, this 4K 32in screen (or Philips' curved 34in 346P1) comes very close to matching it for quality, while also including both a 60W USB-C connection and DisplayHDR 600 certification. **£549 from box.co.uk**

REVIEW Issue 313, p85

NEW ENTRY

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. **£258 from scan.co.uk**

REVIEW Issue 313, p79

NAS SERVERS

Synology DS218+

Two-bay NAS, £310

from pcpro.link/305syn1

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 UI – but techies and gamers should investigate the Asustor for its sheer speed and flexibility.

£460 from overclockers.co.uk

REVIEW Issue 305, p82

Synology DS1019+

This five-bay NAS includes many of the features that make 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 Hybrid RAID. **£637 from pcpro.link/305synology**

REVIEW Issue 305, p88

WIRELESS NETWORKING

Netgear Orbi RBK50

Mesh extender, £300

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. **£299 from pcpro.link/300ax**

REVIEW Issue 300, p62

BT Whole Home Wi-Fi

For anyone who just wants to extend the reach of their network, BT's Whole Home Wi-Fi is an easy recommendation, providing both strong and consistent performance at a great price with minimal fuss. **Three-node kit, £170 from pcpro.link/309bt**

REVIEW Issue 309, p79

WORKGROUP PRINTERS

Brother MFC-L9570CDW

Colour laser, £699 exc VAT

from printerland.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.

£883 exc VAT from printerland.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.

£444 exc VAT from printbase.co.uk

REVIEW Issue 309, p99

HOME OFFICE PRINTERS

Canon Pixma TS8350

Multifunction inkjet, £186

from printbase.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.

£223 from printbase.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 amazon.co.uk

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



NEW ENTRY

NEW ENTRY

NEW ENTRY

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 best4systems.co.uk

REVIEW Issue 313, p100

BUSINESS WI-FI

Ubiquiti Networks UniFi Dream Machine

Managed wireless appliance, £235 exc VAT

from reichelt.com

Yet another brilliant release from Ubiquiti Networks, this remarkable appliance serves up true business-class network services at a great price. It delivers a complete, secure and fully managed networking solution in one compact cylinder.

REVIEW Issue 306, p101



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.

£540 exc VAT from broadbandbuyer.com

REVIEW Issue 311, p103

Ubiquiti Networks UniFi UAP FlexHD

SMBs that want an unobtrusive wireless access point will love this device. It's fast, offers plenty of deployment options, and its free wireless management services are simply second to none.

£137 exc VAT from broadbandbuyer.com

REVIEW Issue 304, p103

SCANNERS

Brother ADS-3600W

Network scanner, £491 exc VAT

from printbase.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.

£425 exc VAT from uk.insight.com

REVIEW Issue 310, p99

Kodak Alaris S2040

A USB-only scanner, but with a powerful onboard CPU that handles image processing and enhancement internally, you don't need to hook it up to a high-end PC. We found the Alaris S2040 to be a speedy operator, hitting 40ppm in our tests.

£371 exc VAT from bmisolutions.co.uk

REVIEW Issue 310, p101



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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

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

CREATIVITY SOFTWARE

Adobe Creative Cloud



Adobe entrenches its position as an indispensable resource for creatives, with upgrades to core print-orientated apps such as Photoshop, and exciting new additions for digital designers.

Complete plan, £50 per month from adobe.com/uk

REVIEW Issue 268, p72

Affinity Publisher

Showing that Affinity Photo, its Photoshop rival, was no fluke, Affinity Publisher is another brilliant Adobe alternative (this time to InDesign) that works superbly on low-power hardware. **£49 from affinity.serif.com**

REVIEW Issue 299, p75

CyberLink PowerDirector 16 Ultra

An excellent tool for 360° video production, and also a fine choice for normal video, with powerful plugins that boost it yet further. It's not cheap, but it's worth it. **£87 from pcpro.link/278cyb**

REVIEW Issue 278, p73

RACK SERVERS

Dell EMC PowerEdge R340

A versatile Xeon E rack server with good upgrade potential, plenty of storage choices and the best management features. It's good value too: the price here includes the iDRAC9 Enterprise upgrade, which enables full OS remote control and virtual media services. **£1,414 exc VAT from dell.co.uk**

REVIEW Issue 298, p97



Lenovo ThinkSystem SR250

Despite its modest proportions, this Xeon E server can handle a wide range of business applications, with big storage potential, great features and remote management. **£1,495 exc VAT from uk.insight.com**

REVIEW Issue 298, p99

NAS APPLIANCES



Synology RackStation RS1619xs+

One of the best-performing 1U rack NAS appliances, offering a truly superb range of storage and data-protection features – and a five-year warranty. **Diskless, £1,711 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, £832 exc VAT from span.com**

REVIEW Issue 309, p94

SECURITY

NEW ENTRY

WatchGuard Firebox T20-W



Crams a great set of security services into a neat and affordable little box. With a superb set of deployment and management 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, £720 exc VAT from guardsite.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

BACKUP

BackupVault Cloud Backup

This online backup offering is a fine choice for SMBs, providing easily managed data protection services and almost instant access to your backed-up data – and its simple pricing structure keeps storage costs under control. **50GB, £24 exc VAT per month from backupvault.co.uk**

REVIEW Issue 309, p98



Retrospect Backup 17

This backup solution offers a wealth of data-protection features at an SMB-friendly price, and the automatic onboarding feature makes rolling out a backup strategy very easy. **£2,015 exc VAT from retrospect.com**

REVIEW Issue 311, p102

VoIP SERVICES

3CX Phone System Pro 16 Update 4

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

PHILIPS

Momentum

Take console gaming
to the **next level**



Available at:

amazon

BOX

ebuyer.com

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4K
Ultra HD



Low input lag



AMDR FreeSync Premium

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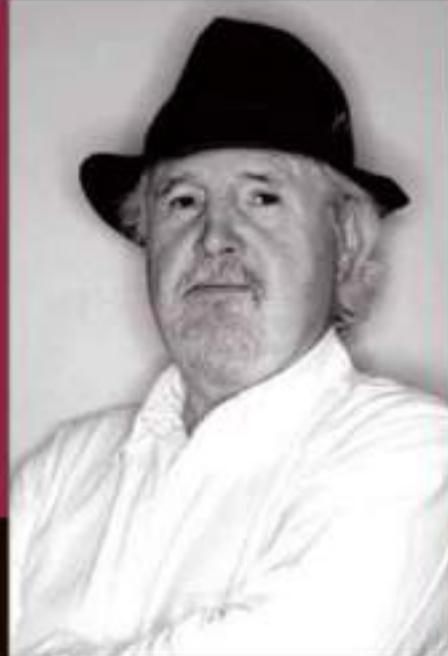
Sound by

Bowers & Wilkins



The show must go on, but who's paying for it?

With theatres still closed, the only way to enjoy “live” performances from musicians is via your screen – and that brings its own problems



Dick Pountain is editorial fellow of *PC Pro*. He tries to alternate music videos with ones about Chinese cooking, military armaments and rusty tractor restoration.

Last night I “attended” a superb jazz session by world-class musicians Wayne Shorter, Herbie Hancock, Dave Holland and Brian Blade. Admittedly, it happened 16 years ago in Salzau in Germany, but I heard it almost as well as – and saw it far better than – if I’d been there.

It was a free YouTube video, in HD, which I Chromecast to my LG smart TV, pushing the sound through my vintage hi-fi system (an excellent but hardly audiophile combo of Denon amp and Castle speakers).

The advantages over a live concert are easy to list. For a start, the camerawork was exceptional: I saw the players’ fingers on their instruments and facial expressions in a closeup that I’ve never experienced at a live gig. I also avoided queuing for the cloakroom and being surrounded by people eating steak and chips and chattering instead of listening. It turns out my sofa is far more comfortable on the bum than concert hall seats too. So was this virtual concert a satisfactory replacement for the real thing?

I won’t go all gushy about the excitement of travelling to a venue, about sharing an enthusiasm with other warm, breathing human beings (which was once true), but will focus on more pragmatic considerations. First off, those musicians got as good as they are through a lifetime of playing to live audiences in clubs all over the US and UK, being paid a pittance by tight-fisted promoters. Are kids coming up today via Logic-Pro-on-bedroom-laptop and social media going to develop similar or equivalent skills? Only time will

tell, but many YouTube channels suggest not.

Secondly, can a viable music scene be maintained through payment for online performance? I didn’t pay for that Salzau video, and had YouTube been charging I probably wouldn’t have watched it, not knowing how good it was going to be. On the other hand, I frequently pay £40 to see acts at the Jazz Cafe and Ronnie Scott’s. I don’t know what percentage of that gets to the musicians; nor do I know what slice (if any) of YouTube’s ad revenue went to them for that video. I can, though, safely guess which earns the performers more.

This applies even more in the world of classical music. During lockdown, I watched a week of lunchtime concerts streamed from the Wigmore Hall, including a staggering *Winterreise* by Mark Padmore and Mitsuko Uchida. The visibly empty seats brought home frighteningly just what the virus is doing to us. As a regular attendee at the Wigmore, I like to sit stage-side, which costs £12 to £20 a head. I didn’t pay that for all those streamed concerts, although I did make a one-off donation.

The brutal truth is that the psychology of paying for streamed entertainment is very different from paying for live entertainment. Rightly or wrongly, you’re unlikely to pay as much to watch from your own sofa, providing your own refreshment, as you would to travel to a concert hall. Even the alternative ways to pay for online entertainment can be fraught due to the distinction between pay-per-view and subscription.

Yet streaming has two huge advantages: instant access without travelling, and a vast

“If Covid-19 changes the way we consume entertainment forever, market forces alone are unlikely to save ‘the talent’”

repository of past performances. Instant access can make it possible to sample artists you wouldn’t normally consider, and hence be educated and change your tastes – but only if it’s cheap enough that quitting ones you dislike after a minute or two doesn’t hurt too much. That was the difference between Spotify and Apple’s now-deprecated iTunes. I’m happy to pay £10 per month for Spotify Premium: I use it every day, not just listening to favourites while walking, but for finding new music or researching all versions of some tune. I wouldn’t do any of that were I paying per track.

Movies and TV are more complicated. I don’t subscribe to Netflix, Amazon Prime, Hulu or the like because they don’t have enough of what I enjoy to justify another monthly bill. But I do buy or rent films – for example, hard-to-find oldies such as *Tampopo* or *Babette’s Feast* – and I use BBC iPlayer and All4 to binge-watch series.

If Covid-19 changes the way we consume entertainment forever, market forces alone are unlikely to save “the talent”. The print industry faced this problem for years over library lending, and it came up with Public Lending Rights and the Authors’ Licensing and Collecting Society, which collects royalties on behalf of authors. I suspect similar institutions will need to be cobbled together to collect revenues from online service providers on behalf of musicians, to say nothing of all those poor, starving Hollywood moguls.

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“The brutal truth is that the psychology of paying for streamed entertainment is very different from paying for live entertainment”

Algorithms can't predict reality's twists and turns

The A-level results debacle should end our fascination with algorithms, but it probably won't

David from Gateshead was expecting A*AA in his A-levels, but he was downgraded to A*AB because his school had never had such a good maths student before. "The college thought it would be the best year we've ever had, but the algorithm says it's not allowed," he told the BBC. He's not the only one to be left disappointed this year – all because of one algorithm.

Thanks to the pandemic, students didn't sit their exams, raising the question of how to decide final grades with which to apply for university. There were myriad possible solutions: use their grades from the mocks, ask their teachers for predictions, find a way to sit exams online or with social distancing, or (and this is my preferred option) admit that exams are a terrible way to assess knowledge and set homework to round out their grades.

Instead, the government chose to use an algorithm to estimate students' exam grades, despite warnings. How often have we discussed the problems of bias, bad data and unintended consequences? These challenges are known but not trivial to solve.

The result was five days of heartbreak before the government swerved into a hard U-turn in favour of teacher assessments, which come with their own problems but are at least founded in reality.

Here's what the algorithm did: it looked at grades at the school in previous years and fit its prediction into that range. That punished edge cases: high-achieving students in low-performing schools who outdid their classmates were pulled back

down to earth. The system didn't think it was possible for them to have done so well – yet these are the very students academic systems should be celebrating and encouraging.

Think of it another way: what if algorithms were deployed to decide sport? Instead of playing the game, we could just take all the data about scoring, player performance and so on, and let the machine spit out a winner. The team that was best on paper would always win, and there would never be an exciting upset, come-from-behind win or any of the other clichés.

Look at football. I don't watch the Premier League, but I've lived in this country long enough to know its importance to British culture and how shocking it was for matches to be halted in lockdown. Our local stadium was turned into a food bank and it looked like there might not be any more matches this year.

Yet there was no algorithm offered to pick the winner. Indeed, that had already been decided: Liverpool had a 25-point lead as we started lockdown, and no one was going to catch up. There were other qualifications and whatnot that needed deciding, but you didn't need an algorithm to work out who would be champions.

But still the games were eventually played. The difference between the rankings at lockdown and at the end of the season were small, but surely a big deal for the teams, players and fans affected. We know the importance of this sport for the UK, and it would clearly have been unfair if the games weren't played and the numbers allowed to decide the rankings, so teams were lined up in empty stadiums to play quiet matches.

"The system punished edge cases: high-achieving students in low-performing schools were pulled back down to earth"



Nicole Koblitz is PC Pro's Futures editor. Born in Canada, she's confused by the British education system, as well as football. Algorithms are easier to understand.
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However, those football teams had enormous resources. The education system does not. Perhaps that's why no such solution was found for students. We could have run online exams for some and set up socially distant exam centres for others, with desks surrounded by disinfectant-streaked plexiglass. It would have been difficult, but possible.

"Algorithms aren't good at complexity. They're good at volume, at sifting through a lot of data, but that's not the same thing"

Instead, a government that doesn't understand tech once again leaned on it as a solution for complicated problems. Algorithms aren't good at complexity. They're good at volume, at sifting through a lot of data, but that's not the same thing. Consider search: it's difficult to read all the pages of the web looking for specific terms to match what you've plugged into Google. Without machines, we couldn't do it. But type in a search that's even marginally complex, and the results are still more miss than hit.

Algorithms take time to design, and trial-and-error testing to evolve into something useful. Edge cases and complexity tangle the results, as do bad data and bias. Machines shouldn't ever make decisions for us, as they have no subtlety of thought and can't understand anything new or remarkable – be that a thrilling underdog comeback in a football match or a child who has for years diligently studied to perform at a level far beyond their peers. Try capturing that magic in data, expressing it in code. It can't be done, and shouldn't be attempted.

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It's the laptop era, but don't write off the desktop yet

Despite a sharp drop in shipments, companies shouldn't dismiss the idea of kitting out homeworkers with desktops

Last November, noting that my old laptop was starting to creak, I had a decision to make. Should I go for a powerful desktop with top-notch graphics and more storage than I could ever fill? Or should I sacrifice some of that graphical oomph and storage capacity for a laptop that I can take on my increasingly occasional business jaunts and foreign trips? I plumped for the latter's flexibility.

Nine months on, circumstances have made me regret that decision somewhat. I'm still a big fan of the MacBook Pro, but given that the coronavirus has left us all decidedly jauntless, I now wonder if I'd have been better off with that desktop.

These ponderings were reinforced recently when I had a chat with the global MD of IT analysts Context, who was trumpeting how well the IT channel had done during the Covid-19 crisis. While the British economy was heading south faster than Dominic Cummings after an eye test, the IT distribution industry grew 2.3% during the second quarter. It normally tracks around 1 or 2% better than GDP, Adam Simon told me, but while GDP had plunged 20%, IT distribution went on a growth spurt.

This was largely due to businesses and education providers rushing to get laptops to employees and students. Given that China (where most laptops are made) was locked down at that start of the year, and in light of the challenges of our own lockdown, the figures were a minor miracle, Simon told me, and a success story for British distributors.

“There’s little doubt in my mind that, if you’re working from home even semi-permanently, a desktop setup is better than a laptop”

However, there were losers too. While laptops were selling out faster than loo roll, there were “loads of desktops sitting in inventory,” Simon noted. Laptops had shown almost 100% year-on-year growth, while desktop shipments fell by 14%. Sales were down so much that “we’re wondering if it’s the end of the desktop” he said, given that few companies are bringing employees back into offices for the time being.

I began to feel for the poor old desktop. There’s little doubt in my mind that, if you’re working from home even semi-permanently, a desktop setup is better than a laptop. Even with my MacBook Pro, I have an external screen, mouse and keyboard plugged in almost permanently. As lovely as the MacBook Pro’s keyboard is, I barely ever use it.

How much worse things are for the millions who are suddenly working from a back bedroom or on kitchen table, hunched over a laptop in a semi-foetal position, banking musculoskeletal problems for years to come.

I have sympathy for business IT buyers too. When a pandemic arrives with almost zero notice, you don’t have long to chew over what’s best for your staff’s long-term wellbeing. You get on the phone and order a hundred laptops from your supplier before the other six million British businesses do. And there’s no doubt that when it comes to reclaiming said device from a departing employee, it’s a darn sight easier to package up a laptop than it is a computer, screen and peripherals.

Still, if working from home does become a long-term trend – and it’s starting to look that way – then I wonder if it could trigger a comeback for the



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beleaguered desktop. The hardware is comparatively cheaper, especially now there are warehouses piled high with stock. And although it’s possible to tie yourself into RSI-inducing knots when sat at a desktop with monitor, it’s much less likely to cause posture and strain-related issues than bashing away on a tiny laptop for ten

“I wonder how many lawsuits we’re going to get in five years’ time, when laptop-equipped staff find they can’t twist their necks”

hours every day. I wonder how many lawsuits we’re going to get in five years’ time, when laptop-equipped staff find they can’t twist their necks.

Laptops are still a strong option for homeworkers, of course. Given the increasingly cramped living spaces that many of us dwell in, not every worker has space for a full desktop setup. And, if they have the budget, there’s nothing to stop laptop users from doing what I do with the MacBook, creating a pseudo-desktop with the advantage of that secondary display to work with too.

Still, if I could turn back the clock and make my November buying decision again, I’d go for a desktop. I hope companies give employees the option to do likewise when it comes to supplying the next round of equipment for homeworkers.

That said, do you want to hear the most hypocritical, column-defeating point of them all? I’ve written this column on my iPad, whilst sitting in the back garden, trying to escape the heatwave-induced sweat bucket that is my home office. Maybe we don’t need laptops or desktops, after all...

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Readers' comments

Your views and feedback from email and the web

Loss of latency

Mesh extenders have become the new must-have toy for those who want coverage throughout their house. However, each extender must rebroadcast each packet on a separate frequency, which involves some delay. This mainly impacts gamers, who need to be sure that their highly honed reactions are matched by an equally honed network.

However, none of your recent reviews of mesh extenders has seen the need to mention typical latency figures for each device and whether these are a significant issue in the real world. Is this an oversight or has the technology improved to a level that the delay simply isn't noticeable?

Associate editor Darien Graham-Smith replies: An excellent point! As you mention, latency is mostly a concern for gamers, but it can also impact applications such as live videoconferencing and remote desktop access. In future mesh tests, we'll include latency measurements to identify the most responsive systems, as well as the ones with the fastest total throughput.

Adobe alternatives

Your shootout comparing PDF-editing alternatives to Adobe's Acrobat Pro (see issue 310, p72) was a great help to me. I've uninstalled Acrobat Pro from my Mac and replaced it with the *PC Pro* Recommended award-winning Wondershare PDFelement.

I'm hoping you'll continue to run "shootouts" between alternative apps to Adobe's subscriber-only products in future. Over recent years, Mac users

Star letter

Paul Williamson's article (see issue 312, p118) reminded me of my introduction to computing.

He and I are contemporaries, but followed different paths. As a nascent experimental scientist, I began at the Atomic Energy Research Establishment (AERE) in Harwell in 1965 as a scientific assistant, where my introduction to computing and computers was with IBM's first transistorised "supercomputer", the IBM 7030 Stretch at the Atomic Weapons Research Establishment (AWRE) in Aldermaston.

Communication with the Stretch was by way of a van, which each day picked up trays of Hollerith cards from Harwell, transported them to Aldermaston and returned the following day with the trays and, hopefully, the printed results. Very quickly, I learned to triple-check the order of the Hollerith control cards to prevent "job failed" printouts returning.

In 1970, I transferred to the newly created Institute of Hydrology at Wallingford, where I first encountered mini-computers (which were still the size of a modern fridge!) in the form of the HP 2116B housed in a caravan (*see image*). This contained 8KB of 16-bit-wide memory on individually wired ferrite cores. Built to US military specification, it could be, and very nearly was on several occasions, dropped onto concrete from several feet without damage. It cost \$26,000 at that time.

The HP 2116B was used to control, analyse and print data from a set of meteorological sensors on towers above Thetford Forest. Beginning as a mere

operator of such a system, I rapidly involved myself in the production of Fortran coding. Later in the 1970s, the first low-power CMOS microprocessors became available from RCA: the CDP1802 COSMAC, which with a CDP18S601 Microboard computer and a CDP18S643 ADC board allowed our team to develop a battery-powered system for measuring the atmospheric turbulent eddies using novel miniature sonic anemometers and infrared gas analysers.



Without any formal training, I was asked to write the controlling software in assembler, which required a steep learning curve before even being capable of writing code. The requirement was to record, initially at 16Hz, measurements from the sensors, convert, apply calibrations and algorithms, create moving averages and output to book-sized 16KB CMOS memory stores. At 16Hz, this proved impossible – and even at 10Hz, a whole 100ms cycle at the end of each 30-minute measurement period had to be allocated for creating and storing the period averages and variances.

My computing journey continued right through to my retirement in 2007 as an adjunct to my scientific studies, and I increasingly used robust battery-powered data loggers to devise, construct and code increasingly complex measurement systems for use around the world in harsh environments from the Amazon to Sub-Saharan Africa. **Dr Colin Lloyd**

Our star letter writer wins a copy of Serif Affinity Designer. Built from the ground up over a five-year period, every feature, tool, panel and function has been developed with the needs of creative professionals at its core.



BELOW There are plenty of far cheaper alternatives to an Adobe subscription

have found their expensive Adobe Creative Suite and Acrobat Pro perpetual licences rendered useless by the pincer movement of Adobe's 2013 move to a subscription-only model and Apple's ongoing upgrades to the macOS.

My original purchase of Creative Suite included publishing stalwarts such as Acrobat Pro, Photoshop, Illustrator, InDesign and Dreamweaver. As a retired media industry worker, I still wanted to dabble with the tools, but I couldn't justify the expense of a Creative Suite subscription. By refusing to switch to the subscription model I therefore lost the option to progressively update my significant investment in Adobe's Creative Suite.

For some years, I continued using my old perpetual-liscence Creative Suite apps, but their functionality diminished progressively as Apple has updated its OS. Now that functionality has gone completely. That's because the Catalina OS only supports 64-bit apps and the pre-subscription versions of Creative Suite are defunct because of 32-bit dependencies.

I'm aware that I could set up a secondhand Mac with an old macOS and continue to use my obsolete apps. But I think the time has come to abandon Adobe and move on. That is why I value any advice *PC Pro* is able to give on alternative creative media products that offer good functionality without the financial drain of an Adobe subscription. **Rob Carter**

PDF editor shootout



personal computer as we currently know it.

Sure, the idea could offer cost benefits and there will be plenty of takers happy that, for a small monthly fee, you have access to an all-singing, all-dancing computer that far exceeds what could be bought for the monthly outlay, but these ideas only work in an ideal world where the internet is fast and very reliable – and not forgetting slow Wi-Fi internally.

This is starting to feel Orwellian, where we don't own anything and our thoughts and memories are no longer stored locally but in the cloud, and our ability to access them depends on that monthly fee, the internet and the storage provider.

I do use a cloud storage service, but it's only used to remotely back up my own physical media from my PC, along with a copy on my own backup storage NAS server. Doing this prevents problems of "cloud provider says no" or "Openreach can't repair your phone line for a month".

Michael Ashworth

Ousted from Office

Your Microsoft Office offer last month (see issue 312, p45) raises once again in my mind the decisions made by the

“But this is just another nail in the coffin of the personal computer as we currently know it”

likes of Microsoft. Publisher, a basic desktop publishing program that's ideal for making, say, a cute card for granny, a menu for a cafe or a little poster for the church hall isn't in there. PowerPoint, which is much less needed for those users, is.

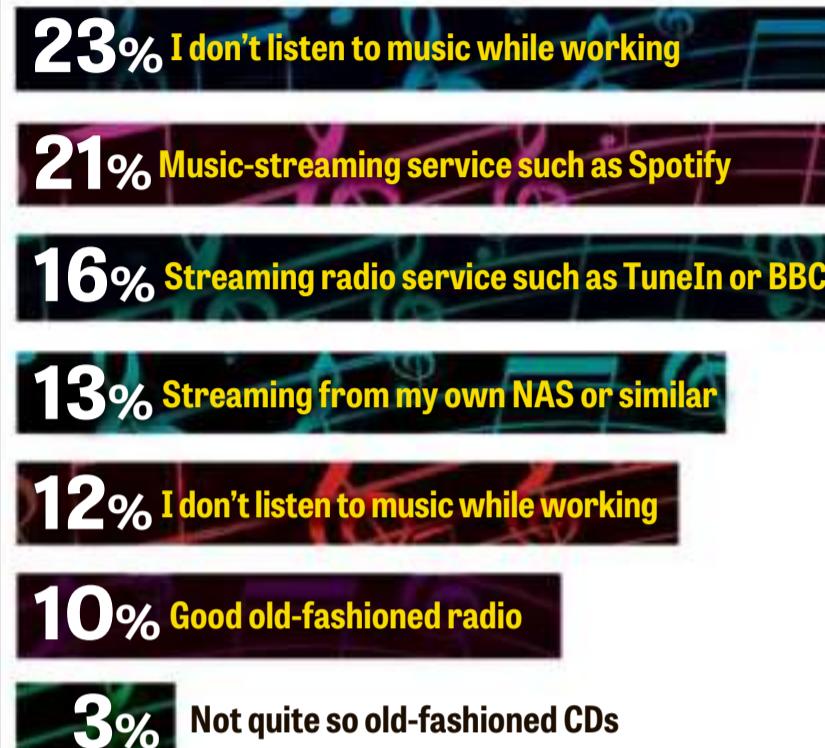
As with those Windows 8 Charms that, like a malevolent genie, only appeared when you didn't want them to, or how the Start menu was redesigned to maximise its muddle while restricting the ability to organise it, I find myself asking "what were they thinking?". Terry Bernstein

We have a Winver

I just turned the page to your article on "20 new features in Windows 10" (see issue 311, p26) and was shocked to see your extremely long-winded method to find the Windows version number. My method? Type "Winver" into the search box, hit Enter and read the version number from the pop-up. Job done. If you've never used Winver before it may not be the first search result, but you can always hit Win+R and then type "Winver". Ron Manser

Readers' poll

This month, Barry Collins explores the alternatives to the streaming titan Spotify (see p26), but how do PC Pro's readers primarily listen to music while they're working?



RIP CDs. It seems that our forward-thinking readers much prefer streaming, whether locally or online, to older technologies. Yet there are some who are still waving the high-fidelity flag: "I use an Apple iPod Classic (fitted with an SD card) playing lossless audio ripped from not quite so old-fashioned CDs," wrote Roy Tait.

Meanwhile, Mobailey has splashed out: "As it looks like I'm going to be working from home for a while longer, I've treated myself to a new smart micro hi-fi system." And there's no doubting Mark Walsham's commitment to the cause: "I listen to locally stored high bit-rate files via a dedicated music playback device with a decent pair of DACs – everything else sounds mushy."

Join the debate



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“I use a combination: Sonos Move to stream radio, plus some Spotify and NAS” LadyBird

“I sometimes have the music channels on in the background when working from home” Dale Connolly

“If you don't listen to music, people will try and talk to you. There's no choice!” Anonymous

“I listen to Spotify all day, every day via headphones and have been known to loudly sing along – much to the annoyance of my home office co-worker!” Max Figgott, PC Pro's production editor





SPOTIFY vs THE WORLD

Still top of the charts?

Barry Collins tests all of the major music streaming services to discover if Spotify still deserves its place as the world's most-used streaming service



Spotify's bold move to make streaming free and legal almost 15 years ago won it hundreds of millions of users, almost half of whom have since been converted to paying customers. But does Spotify still deserve such loyalty? Is it really that much better than the other streaming services or is it trading on the inertia advantage that stems from being the first company to crack the streaming market?

I've been testing six streaming services for the past few months, letting them learn my music habits while I get to learn theirs. If you thought all services were the same, broadcasting the same catalogue at the same quality, I urge you to read on as that's far from the case.

Spoiler: Spotify is no longer the benchmark for the rest of the industry.

AMAZON MUSIC

SCORE



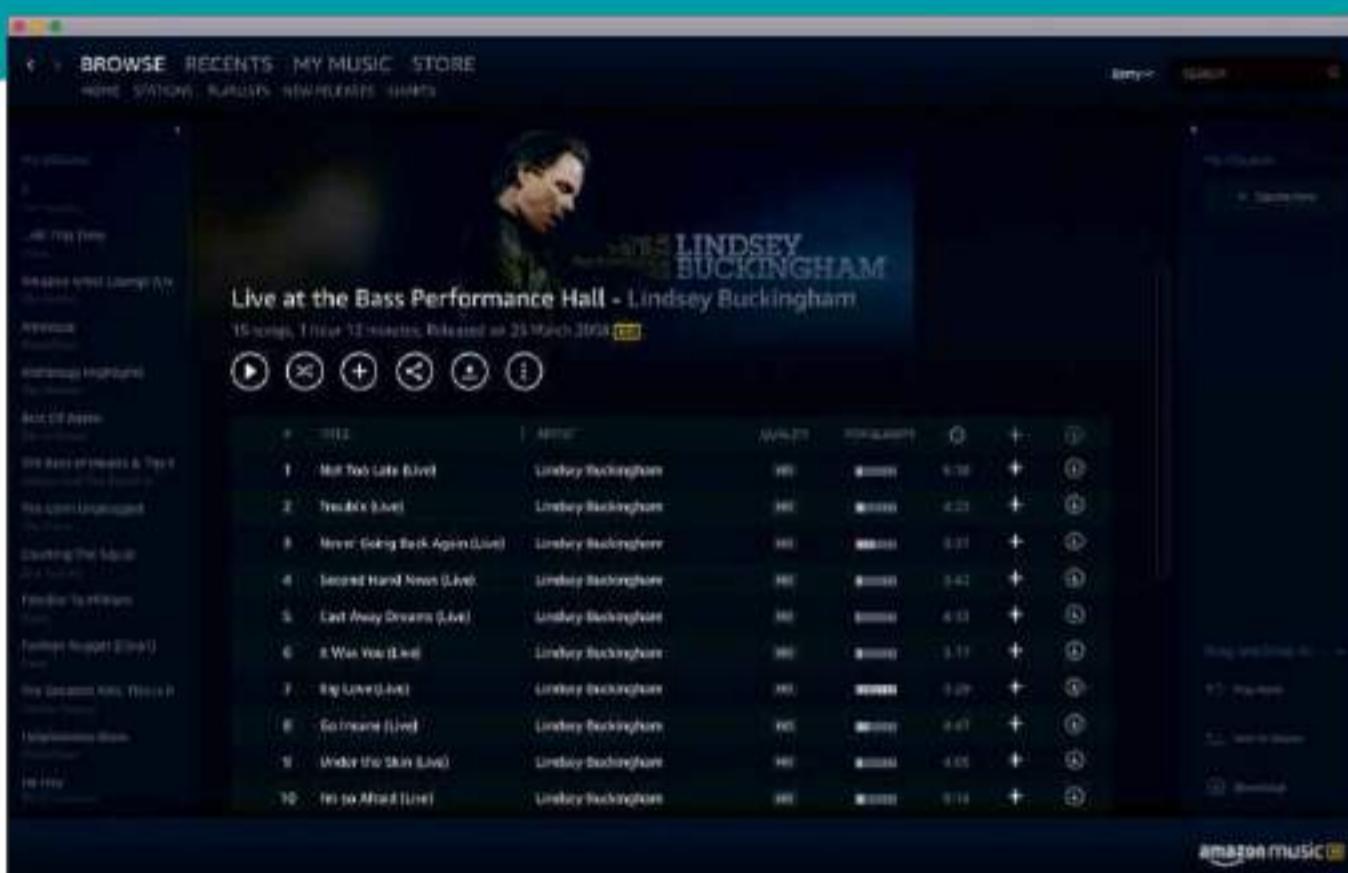
The fact that Amazon is the cheapest service on test here is about as shocking as discovering the sun came up this morning. Although Amazon does reserve its best deals for those already paying the company a stipend for Prime.

Amazon delivers a reasonable chunk of its streaming library for free to Prime subscribers, but to unlock the full library you'll have to pay for Amazon Music Unlimited. Amazon has the lowest entry point of any service here, with the option to create a subscription for a single device – such as the company's own Echo – for a reasonable £3.99 per month.

A full subscription costs £7.99 per month for Prime subscribers, which

is cheaper than the £9.99 baseline you get with most other services; otherwise, it's the regular £9.99. Amazon also offers a discount if you pay for a year upfront, so a full year of Music Unlimited for Prime subscribers costs £79 or £6.59 per month.

To add a further layer of confusion, Amazon wants another fiver per month for Amazon Music HD. This unlocks the library of HD (16-bit, 44.1kHz, average bit rate of 850Kbits/sec) and Ultra HD tracks (24-bit, up to 192kHz, 3,730Kbits/sec). My finger-in-the-air estimate is that more than half of Amazon's library is available in Ultra HD, with newer recordings more likely to feel the benefit. You won't notice much difference if your primary playback device is a regular Echo speaker, but if you own high-end gear then you'll find the Ultra HD sound quality is saturated with detail,



right up there with Tidal's "master" quality offering.

With such a rich library of music on offer, it's a shame that Amazon's apps are blander than the brown cardboard boxes it delivers parcels in. There's little in the way of curation – no handpicked selections for individual artists, for example, and nothing to rival Spotify's Daily Mixes. There is a naked attempt to ape Spotify's Discover Weekly, in the form of the weekly My Discovery Mix, but you'd have to have been living in a cave in Borneo not to have "discovered" Lou Reed's *Perfect Day* or *Here Comes The Sun* by The Beatles, which were both on my list at the time of writing.

That's indicative of a lack of ambition and inventiveness in Amazon's offering. The suggested playlists largely veer back to the mainstream, everything feels as

tired and familiar as a new Coldplay album (sorry, Coldplay fans). If you're comfortable navigating your own musical path and don't much care for curation then Amazon Music will deliver at a decent price. If you're looking to broaden your music tastes, search elsewhere.

APPLE MUSIC

SCORE ★★★★☆



On the basis that if you have nothing nice to say you should say nothing at all, the rest of this review should be left blank because Apple Music is the weakest offering here.

Okay, it has roughly the same library of music that most of the others have and a fair few exclusives recorded for iTunes Festivals and such over the years. There's a strong library of video and, unlike any of

TOP Amazon's range of premixed playlists don't set the world on fire

ABOVE You can "go your own way" by dropping songs into a new playlist

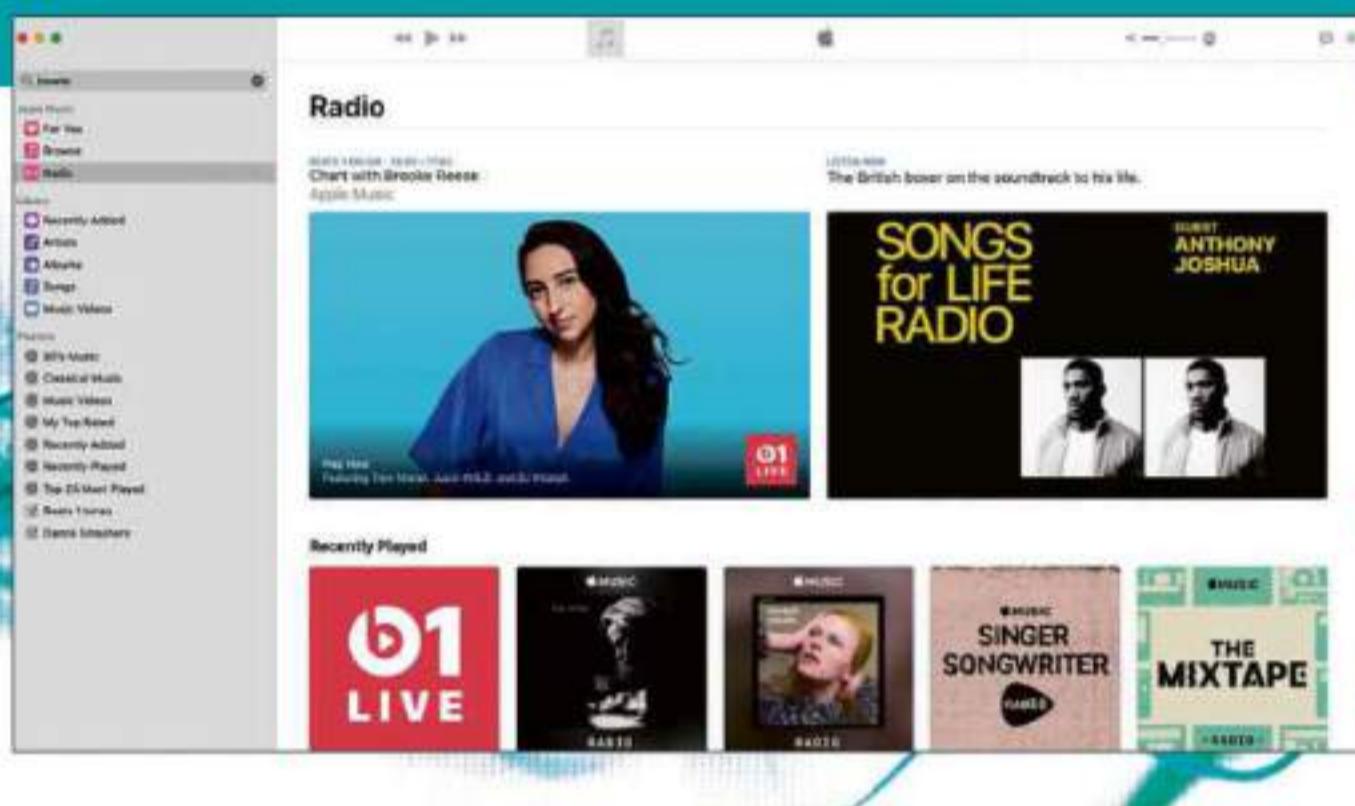
the other services, Apple still persists with its own live radio station, Beats 1, keeping Zane Lowe off the streets. That is about the only thing that sets it apart.

The Apple Music interface is a hot mess – the worst current example of Apple interface design that I can think of. It feels like the old iTunes team and the new Apple Music crew had a dust-up in the car park about what the software should look like on a Mac, and the customer lost. Search is tucked away in a small bar on the left, vast expanses of white space fill the main pane, and you're caught in a constant tussle with the main interface and the mini-player fighting for attention. To compound matters, it's desperately sluggish on the Mac.

The iOS/iPadOS and Android app design is better, more like what you'll find from Spotify and the others, but



Deezer has features that leave even chart-topping Spotify in the shade



your cardiologist need not worry about your heart skipping a beat as there's little here to raise excitement levels. Apple's algorithms do a so-so job of generating automated playlists, but there's nothing like Spotify's Daily Mixes or Release Radar – you have to manually start “radio” playlists by selecting albums, artists or tracks to spin an automated set from. Confusingly, Apple Music contains actual radio stations supplied by TuneIn, which is also labelled as “radio” from within Apple Music.

Apple does put effort into curating playlists. Search for any well-known artist and you'll likely find “Essentials” and “Next Steps” playlists for them, allowing you to get a taste for their wares. But even doing something as simple as “loving” a song to help train Apple's algorithms to your tastes requires a right-click on the Mac. Songs can also be added to your “library”, but they seemingly disappear into a void never to be seen again. It's hard to imagine how Apple got something so simple so wrong.

Sound quality is pegged at a maximum of 256Kbits/sec AAC, which is lacklustre compared to Amazon and Tidal's lossless streams, and surprising given Apple's usual desire to deliver maximum quality.

So there's nothing that sets Apple Music apart from its rivals and plenty of reasons to give it a wide berth.

DEEZER

SCORE



Deezer is a bit like The Stereophonics – it's been around for ages without ever becoming anyone's favourite. That comparison is, on reflection, a tad harsh on Deezer, because the French service has a number of excellent features that leave even Spotify in the shade.

Let's start with the music quality. The top-grade Hi-Fi plan (£14.99 per month for six users) gives you access to CD-quality, lossless 16-bit FLAC streams delivered at 1,411Kbits/sec, which means you're making no compromises if you're streaming

TOP The Thin White Duke in Apple Music's fat white macOS interface

ABOVE The Beats 1 radio station is Apple Music's only stand-out feature

through high-end audio gear. If you have a compatible pair of cans, Deezer also offers a selection of albums in what's called 360 Reality Audio, which claims to deliver immersive surround sound. It's gimmicky, but gives tracks such as Bowie's Space Oddity a new tilt.

Unlike the majority of rival services tested here, Deezer also builds radio stations into its service – by which I mean stations such as Radio 6 Music and Absolute Radio, not Spotify-style “radio”, which is merely algorithm-chosen song selections. One very thoughtful touch is that Deezer displays the song currently playing on radio stations, allowing you to add them to playlists or favourites with a donk of the finger. Podcasts are included too, making Deezer a one-stop-audio shop.

Even if you're not listening to music on Deezer itself, the service has you covered if you hear a great tune on the TV or blasting through shop speakers. The mobile app has a Shazam-like SongCatcher built



in, letting the phone listen to what's playing and name that tune.

Deezer's algorithms are finely tuned. Whereas Spotify tends to play it safe, driving you back towards the mainstream hits with its automated playlists, Deezer finds more eclectic selections. Asked to build a playlist off a track by the niche, Mercury Prize-nominated singer Tom McRae, for instance, Spotify opted for artists such as Mercury Rev, Paul Weller and David Gray. Deezer, on the other hand, reached for more esoteric artists such as Jeremy Messersmith, The Staves and Théodore, Paul & Gabriel, broadening my musical horizons and introducing me to great artists that I've only previously brushed past.

It too offers Spotify-like Daily playlists and Monday Discovery, and there's a strong selection of editorially curated playlists and content. Take, for example, the At Home section,

which includes workout playlists, playlists designed to keep the kids occupied, "binge-worthy" podcast series such as *The Harrowing* and podcasts to help you learn a new foreign language. Like everything else on the service, it's impressively well thought out.

Deezer isn't going to be the first service audio equipment manufacturers think of when it comes to integrations, but it's not a poor relation in this department either. Deezer can be accessed through Amazon Echo speakers, Google Home devices and a range of other mainstream equipment. And note Spotify users: if you start a stream on, say, your Amazon Echo speaker, it doesn't immediately cut off the stream on your phone or computer – a major irritation. That said, the Echo skill is particularly poorly reviewed by users and you can see why. Automated



Below Deezer has plenty of "bangers" to help you work up a sweat...

Bottom ...and its playlist algorithms broadened my musical horizons

The screenshot shows the Deezer mobile application interface. On the left is a vertical navigation bar with options like Music, Shows, Explore, and Favorites. The main screen is titled 'At home' and features two sections: 'We got you' and 'Work out with artists'. The 'We got you' section displays four playlists: 'not giving in' (Not Giving In - Various Artists), 'work from home' (Work From Home - Various Artists), 'sunny days' (Sunny Days - Various Artists), and 'nothin' but bangers' (Nothin' But Bangers - Various Artists). The 'Work out with artists' section shows four album covers: 'In Your Dreams' by Zara Larsson, 'WORKOUT' by Yungblud, 'KELLY ROWLAND WORKOUT' featuring 'YUNGBLUD', and 'WORKOUT' by Ally Brooke.

The screenshot shows the Spotify mobile application interface. It displays a list of recently played tracks under the heading 'Recently played on the mix'. The list includes: 'Fitzhen Miles Downriver' by Tom McRae, 'Ghast' by Jeremy Messersmith, 'One More Mile' by The Staves, 'Steady' by Theodore, Paul & Gab., 'The Sheets' by Greg Laswell, 'Piazza, New York Catcher' by Various Artists, 'Kite Decoration Lines' by Various Artists, 'Kaleidoscope' by Various Artists, 'Came And Went (In Waves)' by Greg Laswell, 'Tom McRae' by Tom McRae, 'Jeremy Messersmith' by Jeremy Messersmith, 'The Staves' by The Staves, 'Theodore, Paul & Gab.' by Theodore, Paul & Gab., 'Wife and Bachelor' by Various Artists, 'Clare Fischer' by Clare Fischer, 'Venus' by Various Artists, and 'Greg Laswell' by Greg Laswell. The bottom of the screen shows the standard Spotify playback controls.

playlists stop after one track and it couldn't find specific playlists saved in my Deezer library.

That is one of the few flies in the Deezer wine glass, though. It's a comprehensive, intelligently designed service that has several features that many of its better-resourced rivals omit.

SPOTIFY

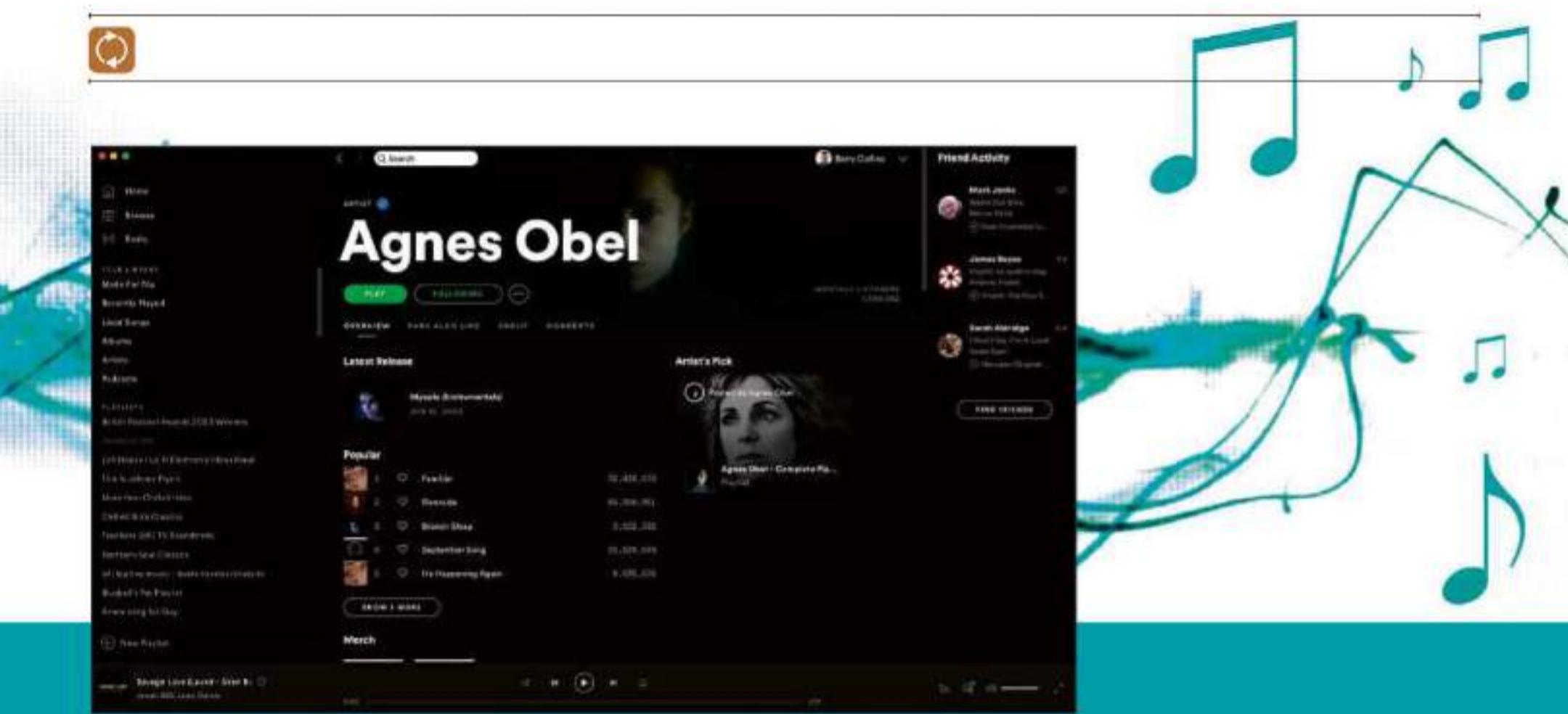
SCORE



Spotify might not have reached Hoover levels of ubiquity, but it's getting there. Think streaming music and most people think Spotify.

Omnipresence has big advantages. For instance, no mainstream smart speaker or home audio system would dare to launch without Spotify support; smartwatches have Spotify apps; in-car audio systems proudly announce they too support Spotify. The same can't be said for any of the other services on test here.

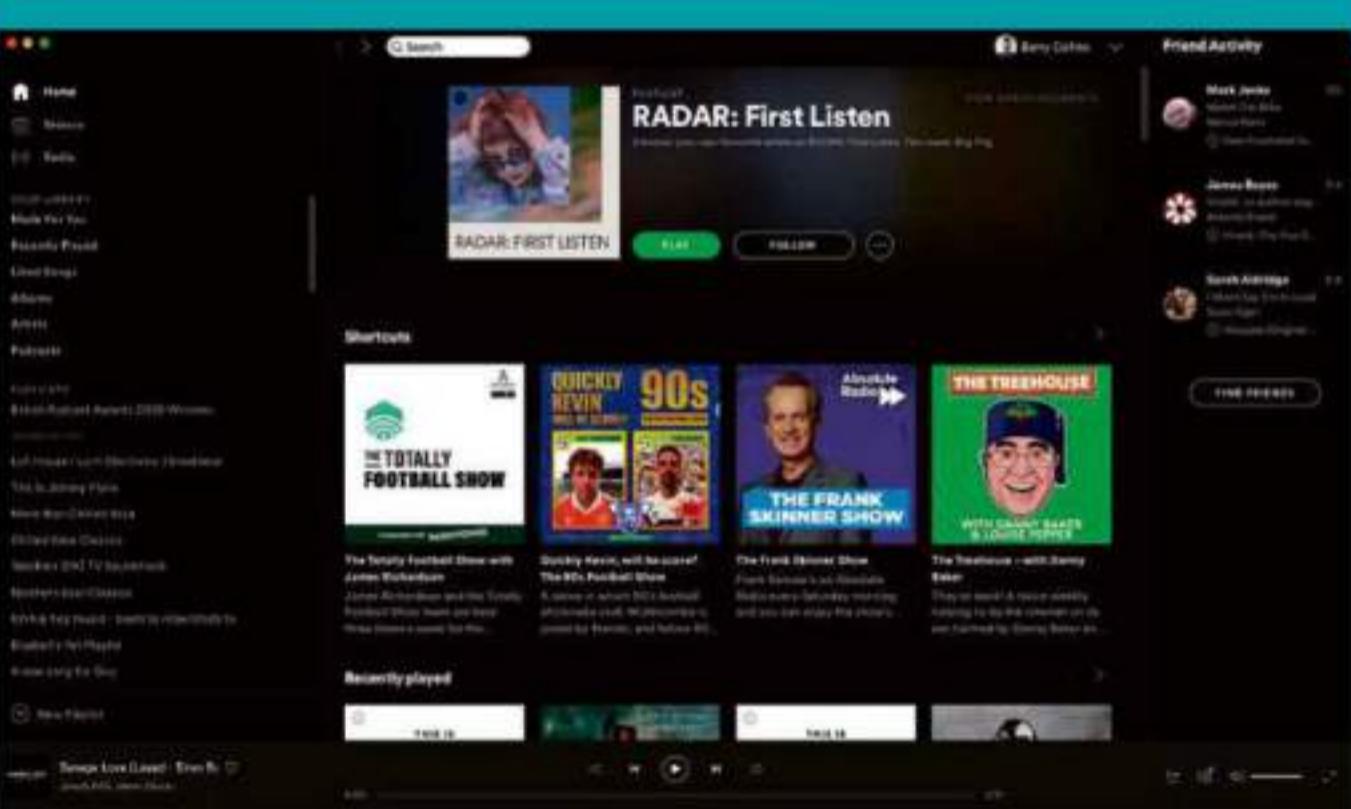
Aside from ubiquity, Spotify's biggest strength is its algorithms. It does a tremendous job of finding music that matches your tastes and delivering that in a variety of forms. Take the automatically generated Daily Mixes – up to six different never-ending playlists that are based on your recent history. They guarantee you can head out on a long drive and never have to worry about running out of music. The equally excellent Discover Weekly is a broader, more eclectic "mixtape" of tunes in your orbit, while the weekly Release Radar ensures you don't miss any new releases from favourite artists. You could spend your entire Spotify existence listening to these auto-generated lists alone and be perfectly sated.



While it might be missing a few features, Spotify still offers a heck of a lot to free users

Spotify also does a great job of leading you down different audio wormholes. Curate your own playlists and Spotify allows you to start a “playlist radio”, finding tunes that are related to the selection you have just assembled. Artists, albums or even individual songs can also be given the “radio” treatment, meaning you’re never left to do the discovery legwork yourself. Don’t neglect the search engine, either. It’s deceptively powerful, letting you search by sub-genres, within certain dates and by record label if you know the right terms to use.

A word too for Spotify’s editorial team, who do a better job of curating that most of the competition. If you come across a new artist in Discover Weekly, for example, you will almost certainly find a “This is [Artist Name Here]” playlist that pulls together the artist’s best tunes and saves you the effort of working through their albums yourself.



Over the past year or so, Spotify has also made a big play for the podcast market. Whilst initially very US-centric, it’s broadened its catalogue to include almost every British podcast of note (including *PC Pro*’s own) and its feature set too, such as the ability to download episodes in advance. That said, Spotify still leaves a lot to be desired as a podcast player. It frequently loses its position in podcasts if I stop playing halfway through a show and resume later in my Android app; there’s no ability to quicken the playback speed if you want to nip through a show nor automatically download the next episode of a show as it arrives.

Having spent a few months playing with its streaming rivals, it’s also fair to point out what Spotify lacks. There’s almost no video content, unlike the vast libraries you will find on Tidal or YouTube Music. There are few overtures to the audiophiles, either, with nothing to

TOP Spotify does a fine job of keeping you up to date with artists’ releases

ABOVE Spotify now contains most British podcasts – including *PC Pro*’s

match the master-quality audio albums on Tidal or the more gimmicky 360 Reality Audio on Deezer. The “very high” quality available only to Premium subscribers is streamed at 320Kbits/sec, although Spotify is reported to be experimenting with lossless streams. There’s no ability to upload your own collection, as you can with YouTube.

While it might be missing a few features, it’s worth pointing out that Spotify still offers a heck of a lot to even those who don’t pay for a monthly subscription. That free tier is one of the reasons why Spotify remains popular, even if it’s not the last word in streaming anymore.

TIDAL

SCORE

Ever get the feeling a service isn’t pitched at you? When you first sign up for Tidal, which is owned by Jay-Z, it asks you to pick three or more

of your favourite artists, with the first screen devoted to hip-hop stars such as Kanye West, Lil Baby and, of course, Jay-Z himself. I had to do a fair bit of scrolling until I found someone in my musical orbit...

There's no doubt Tidal is pitched at a younger, trendier audience than a 43-year-old IT journalist, but that's not to write it off, particularly if music quality is high up your priority list. Tidal's Hi-Fi tier offers most albums in 16-bit 44.1kHz FLAC, but there are also "thousands" of albums in what Tidal labels "Master" quality. This is, according to Tidal, "an authenticated and unbroken version (typically 96kHz / 24-bit) with the highest possible resolution – as flawless as it sounded in the mastering suite".

Debate rages in audiophile circles over the Master Quality Authenticated (MQA) used for these recordings, but there is an appreciable difference between these streams and regular Spotify-quality music when you listen on a decent set of headphones. You'll notice little details – background vocals, delicate strings, even a singer exhaling – that are masked out in compressed files. Whether that's

worth the stiff £19.99 per month fee for the Hi-Fi tier is questionable, but take the low-cost trials and listen for yourself.

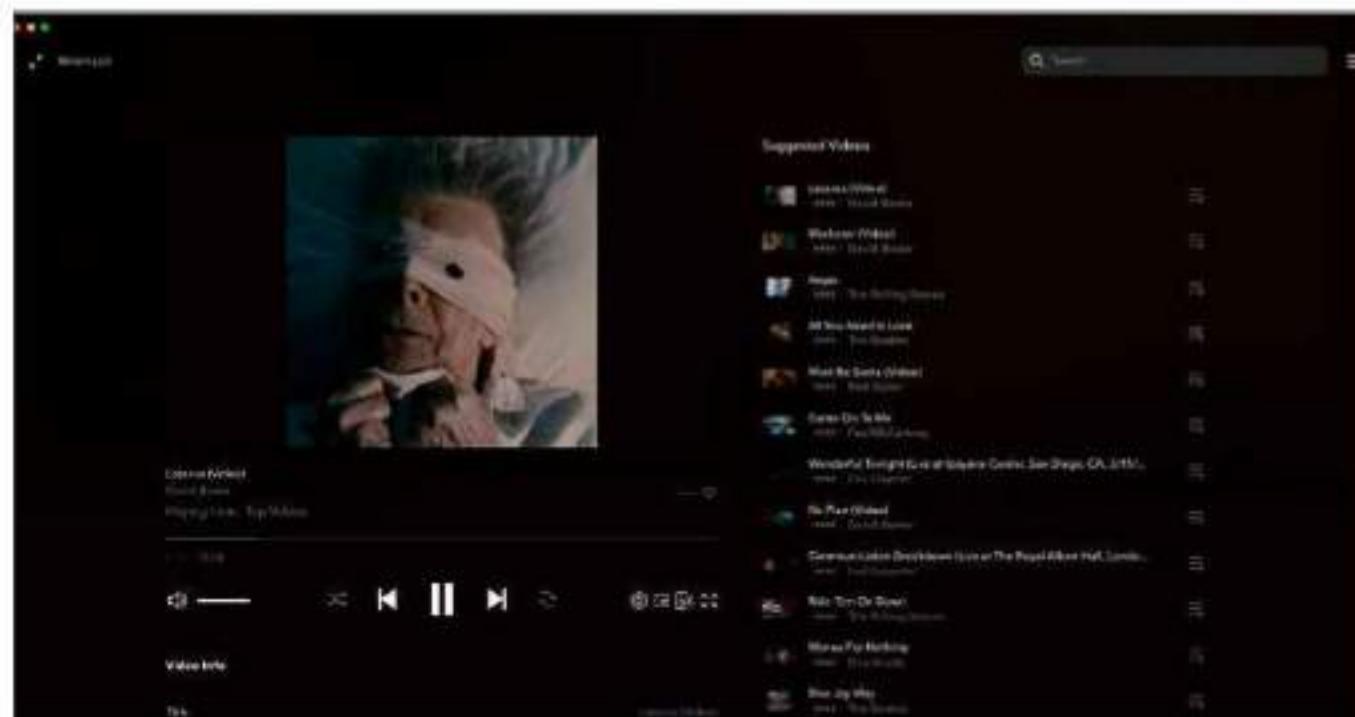
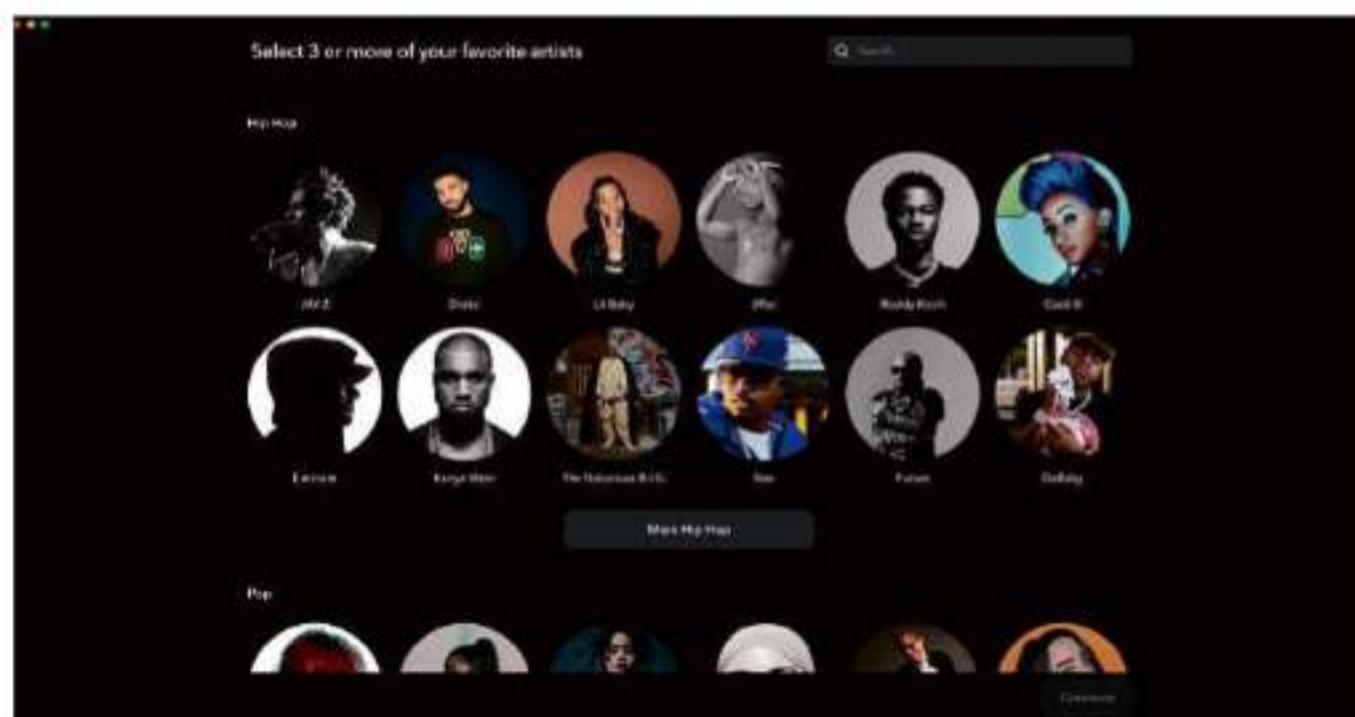
Tidal's streaming audio library is swelled by a vast video collection that's undersold in the service's brilliant apps. These videos include sensational live performances from artists such as Eric Clapton, Noel Gallagher and David Bowie, and the audio quality is generally fine – unlike YouTube's quality lottery, where half the videos have seemingly been nabbed on someone's smartphone.

The Tidal app is well designed, with everything easy to navigate. Once Tidal gets a handle on your music taste, it will start to generate a selection of "mixes" that are similar to Spotify's Daily Mixes. Then there are the usual options to start "radio" mixes from individual tracks or artists, although there's no option to spin off a new automated playlist from your own playlists, like there is on Spotify. Tidal also creates Video Mixes, which are excellent for viewing on a smart TV – almost like a personalised MTV (a reference for the teenagers there).



BELOW Strangely, Tidal's owner Jay-Z tops the favourite artist list

BOTTOM Tidal's vast video library includes Bowie's haunting *Lazarus*



How easy is it to swap music services?

Rather like switching banks, you might worry that switching streaming services would be a headache. What about all those playlists you have spent years carefully curating? Can you really face manually adding thousands of songs from scratch? Good news: you don't have to.

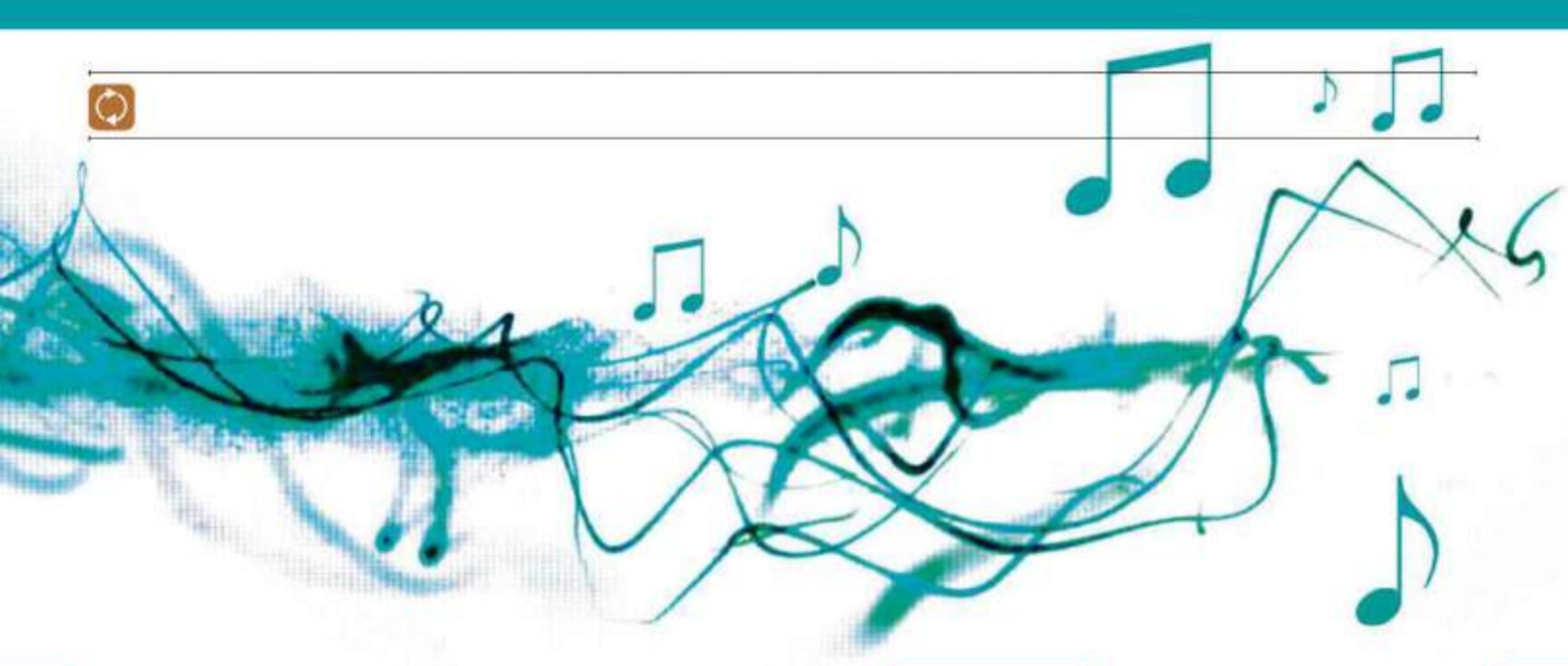
In the same way banks now handle the transfer of Direct Debits and standing orders, so too are there web apps that will shift your playlists, saved songs and albums to another streaming service. You don't even have to pay for the privilege.

TuneMyMusic (head to tunemymusic.com) will transfer your music collection between Spotify, Apple Music, Tidal, YouTube and others. I asked it to heave my 10,199 songs, albums and playlists from Spotify to Deezer and it completed the transfer in just over an hour. TuneMyMusic allows you to pick which parts of your library you want to transfer, so if there are playlists you haven't touched in your old service for years, you can clear out the cruft.

If you're (rightly) worried about handing your username and passwords to a third party, don't be – you sign into the services themselves and use OAuth to give TuneMyMusic permission to edit your music libraries. TuneMyMusic doesn't store your credentials and if you're worried that it will tinker with your music at a later date, you can revoke its permissions after the transfer is complete. In Spotify, for example, go to spotify.com, click on your profile, select Apps from the left-hand menu and revoke TuneMyMusic from there.

Not all of my tracks survived the journey from Spotify to Deezer – 760 went AWOL. You can click on each playlist to see what's gone missing. In a good number of cases, the missing tracks were recorded exclusively for Spotify, although there were some whole albums that weren't available in Deezer.

TuneMyMusic is a free service – you don't even need to register to perform a transfer. With no obvious onsite advertising, that does make one wonder what its angle is. A company spokesperson told me that it has a paid-for-service which allows you to keep playlists in sync across two different streaming services.



Tidal's algorithms are something of a mixed bag, though. For example, an automated "radio" playlist off the Elbow song *The Birds* included three Kate Bush songs in the first 15 tracks. There's nothing wrong with Kate Bush *per se*, but unless I missed her brief spell in the band, that seems like an overload.

However, there generally is very little to criticise about Jay-Z's Tidal. Granted, it might not be pitched at the average PC Pro reader, but that really shouldn't prevent you from embracing a well-designed streaming service that is rich in both content and music quality.

YOUTUBE MUSIC

SCORE



YouTube Music is a strange beast. It offers unique features, not least ad-free access to YouTube's vast library of uploaded music – but not all of it, unless you take out a YouTube subscription too.

YouTube Music Premium by itself costs £9.99, but £2 extra a month buys you the full YouTube Premium, which includes Music Premium and eliminates the ads from YouTube's video service. It might be worth sucking up that extra couple of quid

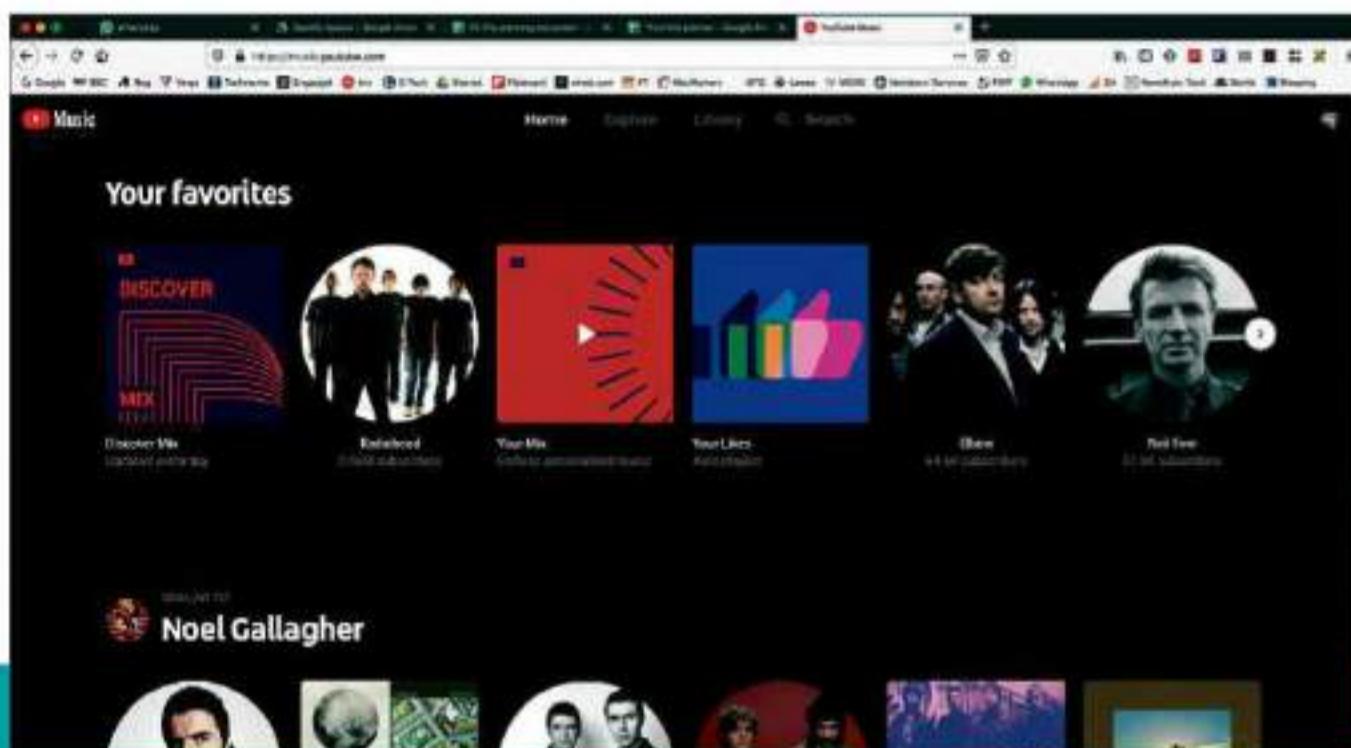
per month, as it ensures there's no content you're going to miss out on.

To give you an example: I have a YouTube playlist of live performances from Jools Holland's *Later Live...* programme, and a handful of these performances are available from within YouTube Music. With the full YouTube Premium subscription, you can watch all the videos, ad-free, and without your phone or tablet's screen powered on.

That video library is one of YouTube's biggest strengths, giving you access to a vast catalogue of performances – albeit a catalogue that varies enormously in audio

| | Amazon Music | Apple Music | Deezer | Spotify | Tidal | YouTube Music |
|------------------------------------|---|-------------------------------|--------------------------------|--|-------------------------------|-------------------------------|
| Star rating | | | | | | |
| Free tier? | ✓ (for Prime subscribers) | ✓ | ✓ | ✓ | ✓ | ✓ |
| Standard account price | £3.99 for one device, £7.99 for Prime subscribers, else £9.99 | Student £4.99, else £9.99 | Student £4.99, else £9.99 | Student £4.99, else £9.99 | £9.99 per month | Student £4.99, else £9.99 |
| Family account price | £14.99 for up to six members | £14.99 for up to five members | £14.99 for up to six members | £12.99 for two members, £14.99 for up to six members | £14.99 for up to five members | £14.99 for up to five members |
| Hi-Fi Premium account price | £5 extra on subscription plan | * | £14.99 | * | £19.99 | * |
| Maximum audio quality | Lossless 24-bit, 192kHz, 3,730 Kbits/sec | 256Kbits/sec AAC | 16-bit FLAC at 1,411 Kbits/sec | 320Kbits/sec AAC | 96kHz, 24-bit MQA | 256Kbits/sec AAC |
| Video | * | ✓ | * | * | ✓ | ✓ |
| Podcasts | * | * | ✓ | ✓ | Limited | * |
| Radio streaming (eg Radio 6 Music) | * | ✓ | ✓ | * | * | * |

All prices inc VAT and correct at time of going to press

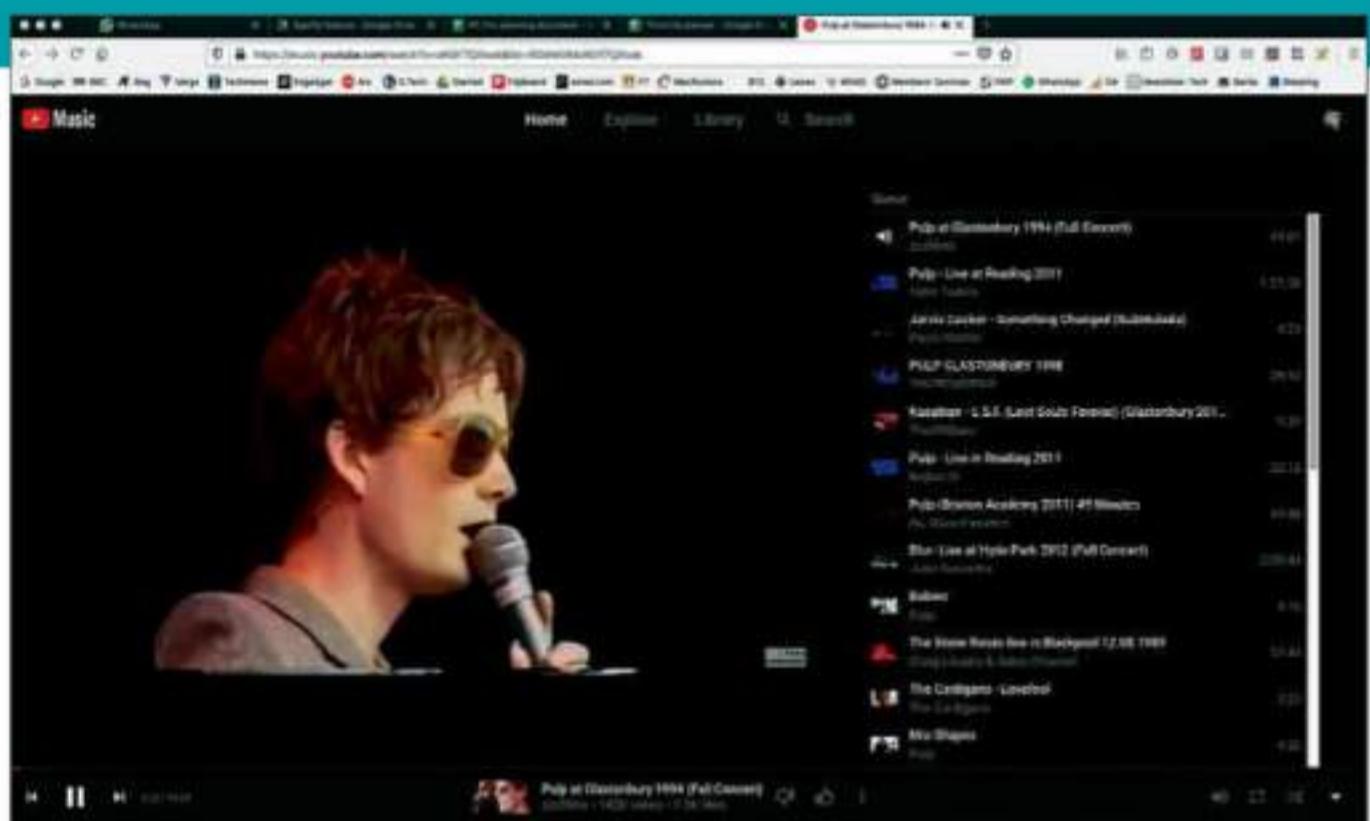


quality. Some recordings are officially sourced from broadcasters and come through crystal clear, others are appalling VHS-quality recordings off the television with sound quality that makes AM radio sound like lossless FLAC. It's a lottery, albeit one containing plenty of gems.

Aside from the videos, YouTube has access to much the same audio streaming library as the other services here. The highest streaming quality is 256Kbits/sec AAC, which is poorer than the lossless offerings from Deezer and Tidal, and even worse than Spotify's Premium offering. That said, you'd need decent headphones or hi-fi speakers to notice – music sounds fine for day-to-day listening.

YouTube has another unique feature that it inherited from the recently shuttered Google Play Music, namely the ability to upload your own MP3s to the service. That's handy if you own a collection of the more obscure albums not found on the major labels licensed by the streaming services and want access to it wherever. Note, however, that the handy syncing tool Google Play Music provided has now been retired and you'll need to upload each track/album individually from your PC. You get the sense YouTube is maintaining this feature somewhat reluctantly to avoid alienating Google Play Music subscribers and may find an excuse to drop it somewhere down the line.

When it comes to discovering new music, YouTube's algorithms play it safer than Geoffrey Boycott (another metaphor for the teenagers). Despite years of varied YouTube video history and my large MP3 collection to divine my tastes from, YouTube insists on feeding me a staple diet where almost every automated playlist must include the same dozen tracks. If I



asked YouTube for a playlist of Hardcore Flamenco it would still find an excuse to slip Oasis's *Don't Look Back In Anger* in there.

YouTube Music has apps for Android/iOS but there are no officially supported apps for either Windows or macOS, which is a curious omission. Instead, you access the service via the browser, which is largely fine, but I've occasionally found myself accidentally chopping off the music when closing a batch of browser tabs. You may wish to pin your YouTube Music tab if you listen as you work.

YouTube Music is an incredibly hard service to summarise. That huge video library arguably gives it greater breadth than any of its rivals, but then it does a shoddy job of delivering that huge variety to you. If you're prepared to scour for the treasures yourself and can live with the more than occasional iffy recording, then it's worth consideration. If you're seeking a more low-maintenance lifestyle, give it a swerve.

TOP YouTube's playlist algorithms are anything but adventurous

If you're prepared to scour for the treasures yourself then it's worth consideration



ABOVE Remember the first time you saw Pulp? Relive the gig on YouTube



DO SMART DEVICES MAKE US LESS INTELLIGENT?

Nowadays, we can ask Google or Alexa anything and get an instant response, but is this creating a false sense of certainty? And what happens when the machines don't know the answer? **Sarah Kidner** investigates

Benjamin Franklin wrote “nothing can be said to be certain, except death and taxes”. Fast forward to today, and the answers to life’s endless questions are a few keystrokes away or a shouted request to Alexa. Lost? Your smartphone can tell you where you are and get you from A to B. Need to check the weather? Ask Google and you’ll get an instant, local forecast. Want to know what’s happening in the world? Log in to Facebook or Twitter for a personalised stream of news.

Yet, few of us stop to question the truth behind what our devices tell us, or as German psychologist Gerd Gigerenzer put it: “When the soothsayers work with computer algorithms rather than tarot cards, we take their predictions seriously.”

Some say this illusion of certainty makes us less resilient to life’s uncertainties, while others are embracing uncertainty to make the algorithms behind the answers smarter still.

THE ILLUSION OF CERTAINTY

For Generation Z, who were born into the information age, technology is the first port of call for information. It’s creating a sense of dependence, according to Dominique Thompson, a GP, author and TEDx speaker who specialises in working with young people and mental health. “Their first response to any question, be it their homework or something from a TV show is to Google it.”

Yet many are lacking the skills to question where the information comes from. “You can go online and search for anything; the illusion is the first thing that pops up is somehow definitive, but people aren’t looking to see who created it; they’re not going under

the covers,” said Frank Gillett, vice president and principal analyst for Forrester Research. “It concerns me when my kids say they’ve learned something from the internet or Instagram. My daughter commented most of her news in the last day or two came from Instagram. That’s not a good source of news. Social media feeds, especially Facebook, are filtering what they show you based on how you act, so it’s a biased response,” he added.

Social media networks create a filter bubble that reinforces our values and beliefs, which creates a false sense of security. “Technology allows us to reduce uncertainty and control our world,” said Ellen Henriksen, clinical psychologist and founding host of the podcast *Savvy Psychologist*. “We can stay immersed in worlds of our own choosing.”

But when the bubble bursts, it causes anxiety and distress, according to Thompson. “You have to be quite confident to venture outside [of that bubble], and I think a lot of young people, in particular, lack that confidence. It might shake them,” she said. “But it’s important to make yourself uncomfortable, to venture out on Twitter a little and see what’s out there. We have to go through the looking glass and realise that there are opposing views.”

That means learning to tolerate uncertainty, even embrace it as a life skill. “Having information at our fingertips leads to a lack of practice tolerating uncertainty,” said Hendriksen. “And when we are faced with big uncertainties in life such as ‘what career path should I take?’ we are less able to deal with that because that muscle is underdeveloped.”

“Let’s take Covid-19, we’re learning... there’s no right answer,” she added. “Do I send my kid to summer camp because he’s been isolated for four months and



I'm worried about his social development? Or do I not send him because it would increase the risk of exposure? Being able to tolerate uncertainty and make the best decision we can with the information we have at the time is an important skill to build."

Intolerance of uncertainty can have a negative impact, said Thompson. She cites differences in the way that junior doctors and consultants handle medical uncertainty. "Take, for example, the case of an elderly lady coming into the hospital with some abdominal pain," she said. "We perform a load of tests but can't find what's wrong, and she feels fine. The patient can go home, but the young doctors won't discharge her because they don't know what caused it. They perform endless tests because they can't live with not knowing."

DOES NOT COMPUTE

Others argue that powerful computer models have raised our expectations – perhaps unreasonably. Conrad Wolfram, CEO of Wolfram Research Europe and author of *The Math(s) Fix* explains: "If you asked 50 or 100 years



ABOVE Wolfram's Alpha is more like a research assistant than a librarian

ago, do you think you can predict exactly what's going to happen in this pandemic...[or] how hot it's going to be in 50 years, most people would just think it was crazy that one could even attempt to do that. But computers, computation, maths are apparently able to predict anything precisely, or model anything, so people now flip this on its head and are sort of expecting the certainty," said Wolfram.

Our ability to quantify means often we're looking in the wrong place. "Numbers or quantifying things has assumed importance beyond the ability to judge. If you're driving a car, the main thing you've got to measure is your speed, but you could still be driving very badly. People assume that the quantification is sacrosanct," said Wolfram.

Brett Frischmann, co-author of *Re-Engineering Humanity*, agrees. He cites the example of fitness trackers, which have been designed to track steps as a measure of how active we are. "The device tracks certain things because they're easy or they're more efficient, or it has the relevant sensor or the proxies are good. And that leads you to think that that's the

thing to track, step taking is the relevant measure of fitness," he said. "In fact, it's relying on bad proxies. I may have just moved my arm a bunch of times, and the motion fooled it. And so, I actually didn't really take 10,000 steps."

Instead, Wolfram says people and algorithms should work together. "People say we shouldn't allow people to use a computer to calculate equations before they know how to do it by hand, because maybe the computer will fool you, [but] computers and other automated devices help us progress. The question is how you avoid being misled."

There's a need for what Wolfram calls "computational thinking". "It is a new way of thinking. In a new world where we're sharing with artificially intelligent machines, we as humans need to find a new way to ask the questions," he said

Some of this thinking is evident in Wolfram Alpha, which he describes as a knowledge engine; distinct from a search engine. "If you think about a search engine, what it does is go out and ask if anyone else has a similar question and they try and answer it. You go to a library and ask for books on a subject and the librarian points you in the right direction."

DOES YOUR SMART ASSISTANT REALLY KNOW IT ALL?

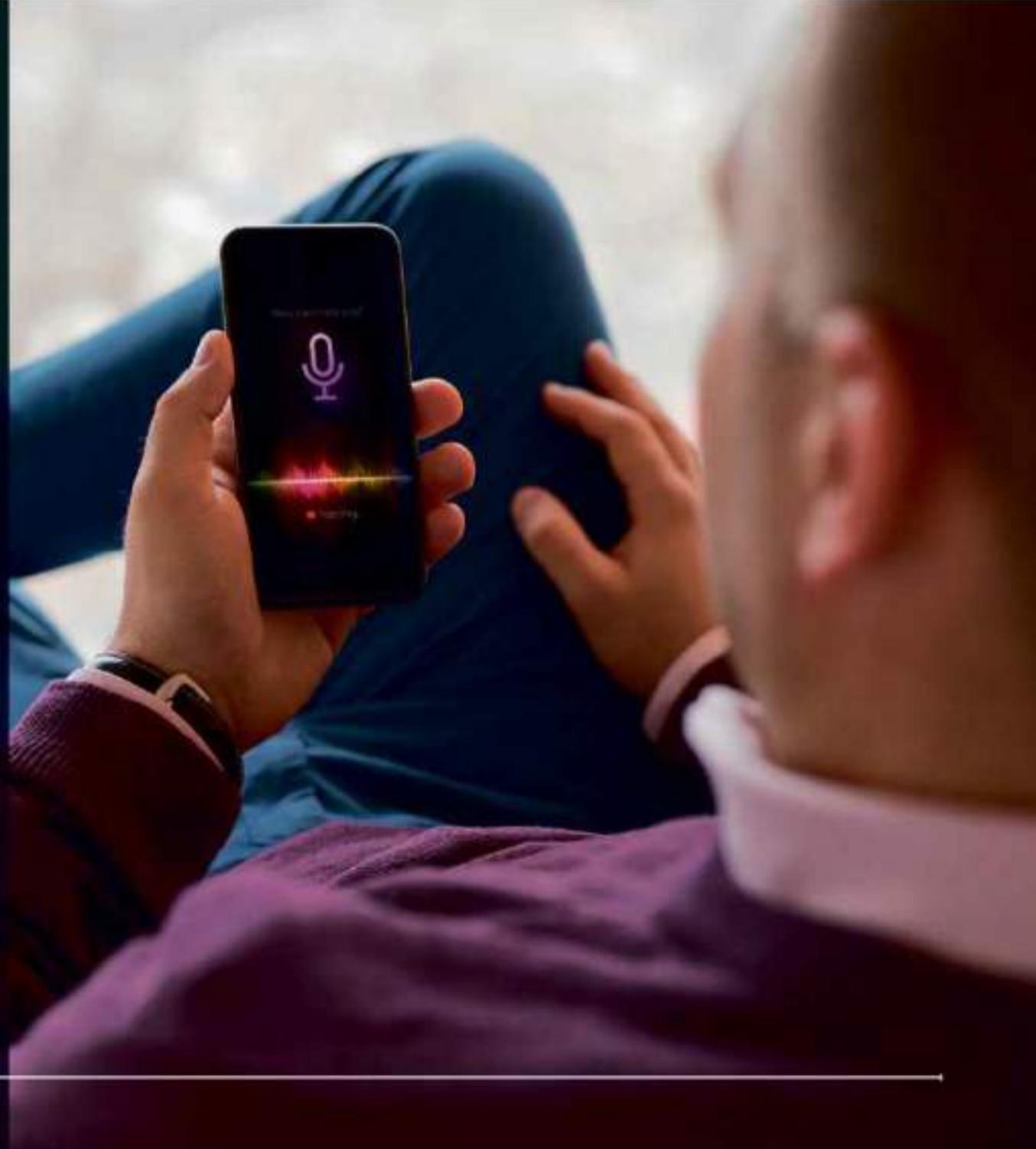
There's now so much data on the internet that it would take 181 million years to download – and yes, I did Google that. Meanwhile, the three billion of us who own a smartphone can use our voices to quiz Siri and Google Assistant. At home, we don't even have to leave the comfort of the sofa to ask Alexa et al. But where are these devices getting their data from and can it be trusted?

Research by Forrester shows that people prefer phone assistants to smart speakers, but both are only as smart as the sources they use to get the information.

"Amazon Alexa and Google Home use complicated machine learning techniques to understand what you're saying, but once they do, they can revert to some of the dumb old techniques," said Carroll Wainwright, a research scientist at the Partnership on AI. "If you ask, 'Alexa, what's the weather look like today?' it could just give you the same result that you'd get from Google."

Similarly, smartphone voice assistants use search engines. In 2017, Apple switched the default search engine to Google from Microsoft's Bing for its Siri digital assistant.

In 2019, Forrester put smart voice assistants to the test with 180 commercial questions, and concluded that only 35% of their questions yielded satisfactory answers. It's worth noting that, as with search engines, you only get out of smart devices what you put in. Another Forrester study found, in the case of smart speakers, that people are only using them for limited functions: for 65% of those asked, the most common request was a weather forecast.



IT CONCERNS ME WHEN MY KIDS SAY THEY'VE LEARNED SOMETHING FROM THE INTERNET OR INSTAGRAM



In contrast, Wolfram Alpha's aim was to take "systematic knowledge" and make it computable, as Wolfram explains: "It's more like a research assistant. You give it a precise question and ask it to come up with a precise answer."

To produce these precise answers, Wolfram Research has bought information resources that sit behind Wolfram Alpha. "We've curated a lot from various sources that we've often had to clean," said Wolfram. "It's not a replacement for search, it just works differently, and it works well when you have something that is somewhat computational but also fuzzy."

The company's proprietary Wolfram Language is responsible for computing the answers from these sources. The programming language began life as Mathematica and is built from various "commands, thousands of functions and the largest set of built-in algorithms".

"You're presented with precisely what you're asked for, or it may say, I don't know the answer so that there's a certainty in that lack of certainty," said Wolfram.

AN UNCERTAIN FUTURE

Uncertainty may actually be the key to delivering smarter programs, including AI. US startup Gamalon, for example, is developing a technique for teaching machines to handle language, which embraces ambiguity.

The firm developed a way of teaching machines to process language that can sit behind a chatbot.

MIT Technology Review argues that it "lets a computer hold a more meaningful and coherent conversation by providing a way to deal with... multiple meanings. If a person says or types something ambiguous, the system makes a judgement about what was most likely meant."

Applying ambiguity in other areas could make for smarter, safer AI. Carroll Wainwright is a research scientist at the Partnership on AI and specialises in the technical aspects of AI safety. Intelligent cars, he said, are an example where too much certainty can be dangerous. "There was a high-profile death in one of the Tesla autopilot cases. A truck moved in front of the vehicle, and it was a

BELOW One Tesla crash highlighted the danger of too much certainty



cloudy day. The sky was white, and the truck had a big white side. The algorithm didn't distinguish between the sky and the truck, so it ran into the truck. So, you could couch this as a problem with the certainty of the algorithm," he said.

Wainwright is building an environment that will train AI "agents" to question when there's a lack of certainty. The example he gives is that of an intelligent robot designed to fetch coffee from another room when the door is shut. The agent would stop and ask how to get through it, allowing you to open the door. "In this instance, uncertainty can be incredibly helpful. Essentially, the agent, rather than taking brash actions, will stop and ask you, 'Should I open the door or should I just smash through it to get you your coffee faster?'"

It's a strange example, but one that teaches us neither tech nor humans know it all. "We're entering an era where the value add isn't so much knowledge-based, knowing a fact, it's knowing how to interact with AI or computational machinery to get the best decisions," said Wolfram. "The only way to do that, I think, is for our education to step up to another level so that we can then know what the questions are, know how to manage the AI."



Ten **FREE** ways to make Windows as **fast as** **possible**

Nik Rawlinson provides a selection of simple – and not so simple – methods to streamline Windows and make it run like new

Your PC gets slower as it ages. Windows isn't always to blame, but as the interface between your hardware and your apps, and the largest piece of software running on your machine, you can be excused for making it the focus of your frustration.

So it seems only fair that we give Windows the best chance we can of performing well. We've compiled the ten most effective changes you can make to help Windows keep running as fast as your PC will take it.

We're not going to recommend installing more memory and swapping in an SSD: as a *PC Pro* reader, you'll have considered these already. Instead, we'll focus on settings and options, all of which you can implement for free.

1 Slim things down

We'll start with everyone's favourite piece of advice: don't start up any applications or processes you don't need. Windows 10 generally launches quickly but, over time, the more applications you install, the more processes will be added to its startup payload. So, while the OS itself

might still be running quickly, it will have to perform a lot of additional background tasks before it can hand over control of your PC's resources to you. Your first couple of minutes might feel sluggish and, if any of those processes are the start of an ongoing cycle, checking and updating things in the background, they could carry on using processor cycles and memory the whole time your PC is active.

Open Task Manager by pressing Ctrl+Alt+Delete and clicking it on the list of options. Switch to the Startup tab then remove any applications you don't need to use every time your PC starts. You'll often find browser engines, sync tools, maintenance utilities and VoIP clients dropping bundles here, many of which can be safely disabled. In some cases, their only job is to make the app launch faster when you need to use it. Unless it's something you use every day, you can probably afford to wait a few seconds for that software to launch – and reap the benefits elsewhere.

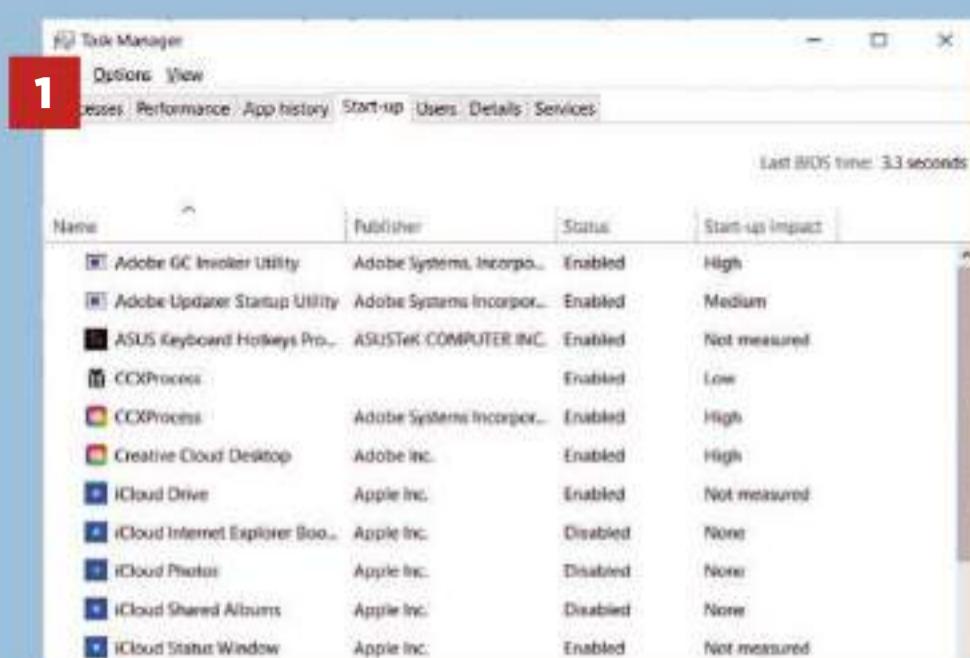
2 Conserve bandwidth

Windows updates are chunky bundles, so Microsoft would like to

use your PC to help it distribute them. By including your machine in a mesh of computers, each of which stores parts of the latest update, it can offload the job of serving patches to other machines and its own servers will run more efficiently. The benefit of being part of this network is that you should receive each download more quickly but, in return, your PC will do some background work for other Windows users who find themselves in the same position.

Open Settings by pressing Windows+I, then click Update & Security followed by Delivery Optimisation. Check the switch below "Allow downloads from other PCs". If this is enabled, select "PCs on my local network" if you only want to share update bundles with other computers on your LAN, rather than those on the wider internet. Alternatively, click the switch so it slides to the left if you want to turn off the sharing option.

At the same time, make sure your active hours are correctly configured. Active hours are the times of day during which Windows assumes you're working, and during which it won't apply patches. Later versions



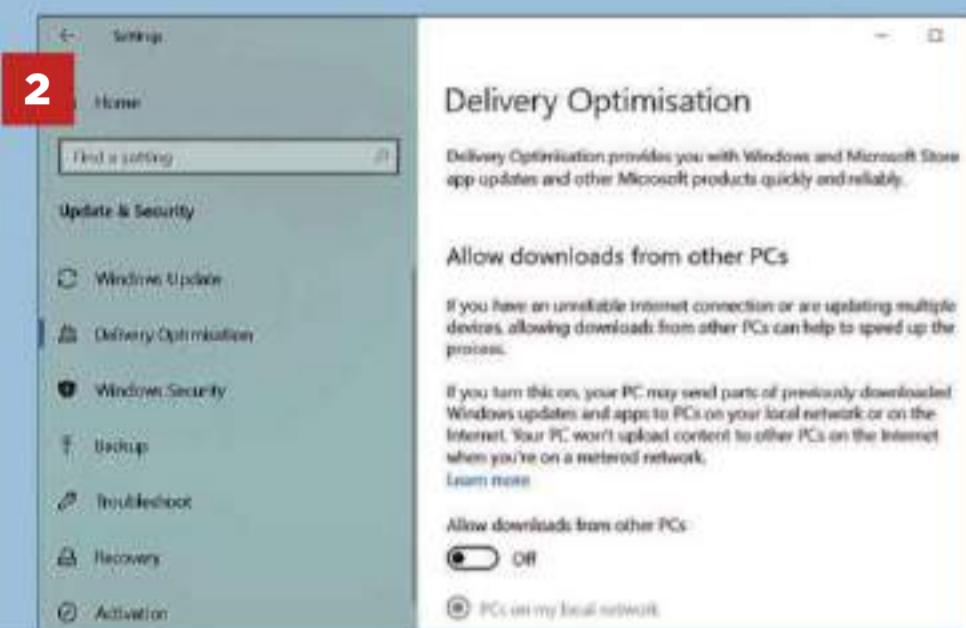
ABOVE Don't burden your PC with programs and processes it doesn't require: slim down its startup items

BETWEEN Windows' delivery optimisation tools let you share patches with other users – or not

RIGHT Reducing the number of visual effects Windows uses can help it run faster



BETWEEN Tweak your laptop's performance by using this slider in the battery control panel



of Windows 10 are adept at working out for themselves when these hours are but, if you want to define them manually, open Settings and click Update & Security, then Windows Update, followed by "Change active hours". To let Windows work these out for itself, select "Automatically adjust active hours for this device based on activity"; otherwise, click the switch below that option to turn it off, then click Change and specify them yourself.

3 Turn off visual effects

Windows might not be as glassy as it once was, but rendering that interface still takes some effort. Tone it down and your processor can spend the saved time on more important tasks. Open the control panel and type "performance" into the search box. Click "Adjust the appearance and performance of Windows" then uncheck the boxes beside any of the effects that you don't want it to use.

4 Check your energy settings

Windows' default energy saver settings allow your PC to run as fast

as it can when on mains power, but trims performance when it detects that you're using a laptop battery to help extend its running time. There's also a balanced setting, which should give you acceptable performance for an acceptable span of time.

To ensure Windows has access to your PC's full potential, regardless of power source, click the taskbar battery icon and then drag the Power mode slider to the right ("Best performance"). If you don't see the slider, make sure your PC is set up to use balanced performance by pressing Windows + I to open Settings, clicking System followed by "Power & sleep" and then "Additional power settings".

5 Switch off enhanced search

The old concept of drives, folders and files is a hangover from the analogue world of office work, in which their equivalents were filing cabinets, buff folders and documents, and we didn't think twice about being expected to dig through them manually. It made a lot of sense for a long time, but not any longer. Now that we work across multiple platforms and are just as

likely to store our data in the cloud as we are on our own machines, it's an outdated construct that needs to be consigned to computing history. Search is the only tool that will help us do that.

The Search tool built into Windows 10 is getting more accomplished all the time and, as well as indexing files based on their names, it can ingest their contents so that you can search on subject matter, keywords, phrases and more. But running the indexing system's background processes full time uses up processor cycles and, although Microsoft has made improvements in build 2004, you may still want to consider minimising Search features on an older machine.

Open Settings by pressing Windows + I and click Search. Click Searching Windows in the sidebar and make sure "Classic search" is selected to confine the index to your desktop and libraries (such as the Documents and Pictures folders). Scroll down and click Advanced Search Indexer Settings, then click Advanced. Switch to the File Types tab and deselect any of the extensions that you don't want to include in the search results to



minimise the amount of data the crawler needs to process.

6 Free up disk space

Windows doesn't only use disk space for storing apps and the files and folders you can access directly. It's also used as a temporary stash for data that won't fit into system memory. The RAM on your motherboard is faster than your hard drive so Windows will reserve it for only the data it's working with immediately. Anything it won't need for the next few seconds can be offloaded to a disk-based cache that, even if it's stored on an SSD, will be slower than RAM as it has to traverse an interface.

When you have insufficient disk space, it can naturally only accommodate smaller amounts of data, so Windows will have to read and write it in reduced chunks. This will negatively impact your PC's performance. As a rule of thumb, make sure at least 10% of your hard drive is available, but more is better.

As well as deleting programs you no longer use, uninstall Windows features you don't need, like language packs. To get rid of these, open Settings and click "Time & Language"

followed by Language. Click on the languages you don't require, then click the Remove button that appears. If you only have one language installed, you can't remove it.

Use Windows' Disk Cleanup tool to shrink bloated caches and remove temporary files it no longer needs. Click Start, type "cleanup" and click Disk Cleanup. Select the files you want to remove in the "Files to delete" section, followed by OK. You can delete old installation and admin files by clicking "Clean up system files".

You can also free up disk space by using Storage Sense, which automatically deletes files you no longer need, empties the recycle bin and, if you're using OneDrive, removes local copies of files you haven't used for a while. To turn it on, open Settings and click System followed by Storage. Click the switch below "Storage Sense" so it slides to the right. To tweak what Storage Sense can do on your machine, click the link "Configure Storage Sense or run it now".

7 Defrag your drive

This tip is becoming less relevant as computers increasingly use SSD

storage, for which the traditional concept of fragmentation doesn't apply. However, if you're using a hard drive – particularly one that's been in use for several years – defragmenting can make an appreciable difference. Why? Over time, Windows has to break up files and applications and slot them between existing blocks of data where gaps open up when other data is deleted. Often these gaps will be too small to accommodate what needs to be written to them contiguously, so bookmarks need to be set in the file allocation table recording where each part of every file has been deposited. The read/write head uses this to scavenge for the blocks it needs. The more the head has to move to piece a file together, the longer it takes to open, execute or update. SSDs, which don't have any moving parts, don't have the same problem.

There's a broad selection of third-party defragmentation tools to choose from, but we recommend sticking with Windows' own tool unless you have a reason for looking elsewhere. Click Start and type "defrag", then click "Defragment and Optimise drives". Find the drive you want to work with in the list of



5

Searching Windows

Indexing Status
Indexing speed is reduced due to user activity.
Indexed items: 15,291
Pending: 0

Find My Files
 Classic: Search only your libraries and desktop.
 Enhanced: Search your entire PC including your libraries and desktop.
Commission accelerated search from time to time. Initial crawl of your data will only take place when connected to power. This option may reduce your battery life and increase CPU consumption.

LEFT Minimising the range of files will save Windows from doing a lot of indexing work



6

Disk Clean-up for OS (C)

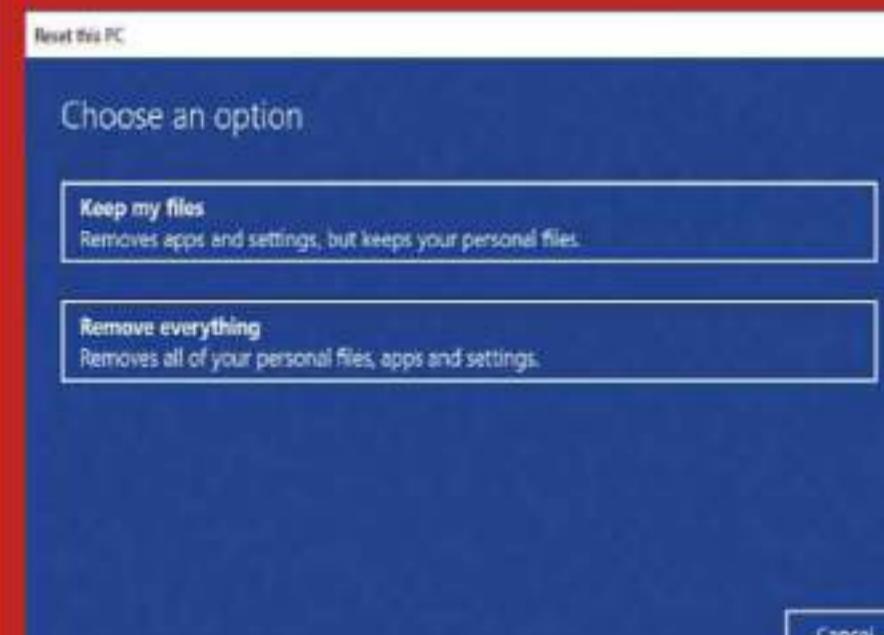
Disk Clean-up

| |
|--|
| You can use Disk Clean-up to free up to 75.4 GB of disk space on OS (C). |
| Files to delete: |
| <input checked="" type="checkbox"/> Downloaded Program Files 0 bytes |
| <input checked="" type="checkbox"/> Temporary Internet Files 45.2 KB |
| <input type="checkbox"/> Windows error reports and feedback diag... 9.91 MB |
| <input type="checkbox"/> DirectX Shader Cache 688 KB |
| <input type="checkbox"/> Delivery Optimisation Files 15.5 MB |
| Total amount of disk space you gain: 92.5 MB |
| Description |
| Downloaded Program Files are ActiveX controls and Java applets downloaded automatically from the Internet when you view certain pages. They are temporarily stored in the Downloaded Program Files folder on your hard disk. |
| Clean up system files |
| View Files |

LEFT Windows' clean-up tools know what should be safe to remove

Refreshing option

If none of these methods work, and you don't want to take the nuclear option of a full rebuild, then try Windows' "Reset this PC" option. This is a great way to scrape away the accumulated crud that builds up in the operating system over time, especially if you've been busy installing lots of software. You will be given two options: one to remove everything, including apps and files; the other to keep your files. Always bear in mind that you will need to reinstall all the apps you own, and in some cases that may not be possible.



ABOVE If none of the tweaks in this feature work, there's always the option to start afresh

installed devices and check the “Current status” column. If the entry beside it says anything other than “Needs optimisation”, you can leave it as it is. However, if it needs attention, select the drive and click Optimise.

8 Quiet things down

It's easy not to notice how chatty Windows can be. Aside from new mail notifications, you've got application pop-ups, good news from Windows Defender that it's not found any problems... even hints and tips. Every time it remembers something it needs to tell you, it interrupts the job in hand. Minimising these interruptions won't only be good for your concentration – it can also help your PC run more efficiently.

Press Windows + I to open Settings and click System followed by “Notifications & actions”. Scroll down to the notifications section below Quick actions, and choose whether you want banners and/or sounds for some, all or none of your applications, whether you want to see notifications on the lockscreen (turning this off may be sensible in a shared office), and if you still want to see Windows tips, tricks and suggestions.

9 Stop syncing

OneDrive is built into Windows 10, where it's taken up residence on the taskbar. Leaving it running the whole time is convenient but, if you only use one PC, do you really need to be syncing its contents to the cloud the whole time and wasting processor cycles on checking for updates that are never going to appear? You could use OneDrive through the browser instead. The same is true of Dropbox and other cloud sync services.

To uninstall OneDrive, click Start and type “remove”, then click “Add or remove programs”. Scroll to Microsoft OneDrive in the list under “Apps & features” and click it, followed by Uninstall. You may be asked for your admin password, which, if you're using a corporate machine, might be controlled by IT.

If that's too dramatic, you can either unlink your account, or just pause syncing. To unlink, right-click the OneDrive icon on the taskbar, then click Settings. Switch to the Account tab, then click “Unlink this PC” followed by “Unlink account”.

To pause syncing while your PC is doing something else demanding, right-click the OneDrive icon,

followed by “Pause syncing...” Choose how long you'd like to pause for: two, eight or 24 hours. Notice that the OneDrive icon is overlaid with a pause button as a warning that your edits won't be reflected on the server. To resume syncing before the pause period expires, click the icon again, then click the pause button at the top of the OneDrive tab.

10 Reboot

Some problems can't be fixed when Windows is still running, but a reboot sees to that. Restarting your machine closes and unlocks any files that are in use, clears virtual memory from the hard drive and unloads background processes that started since your last boot and haven't properly disengaged. In short, it frees up a lot of resources.

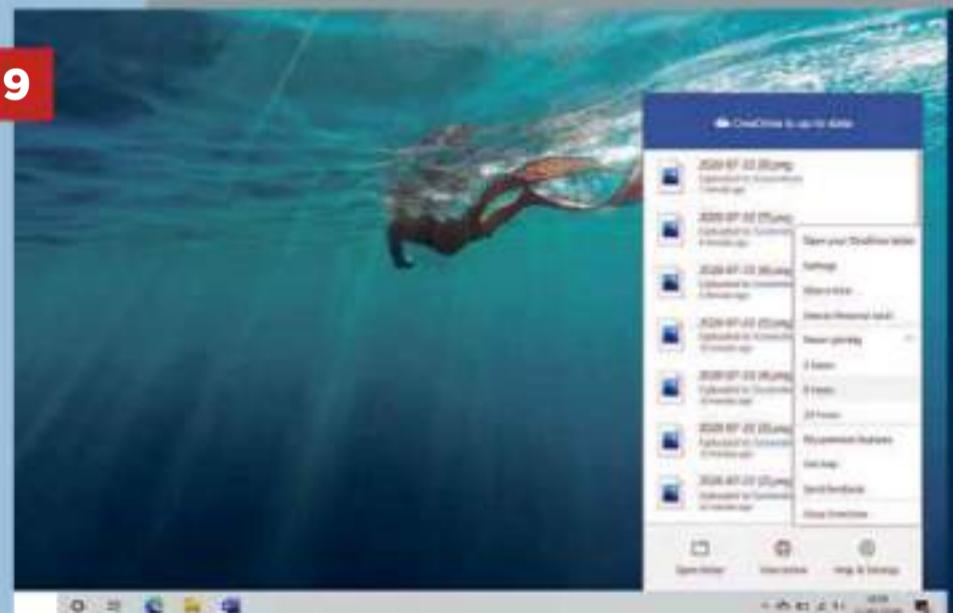
Make sure that you've followed tip one before rebooting and removed any startup applications that you no longer require before power cycling.

As with all of these tips, the improvement is likely to be marginal but, deployed in concert, they should make an appreciable difference to your computer's performance – and may be enough to put off the time you need to splash out on a replacement.



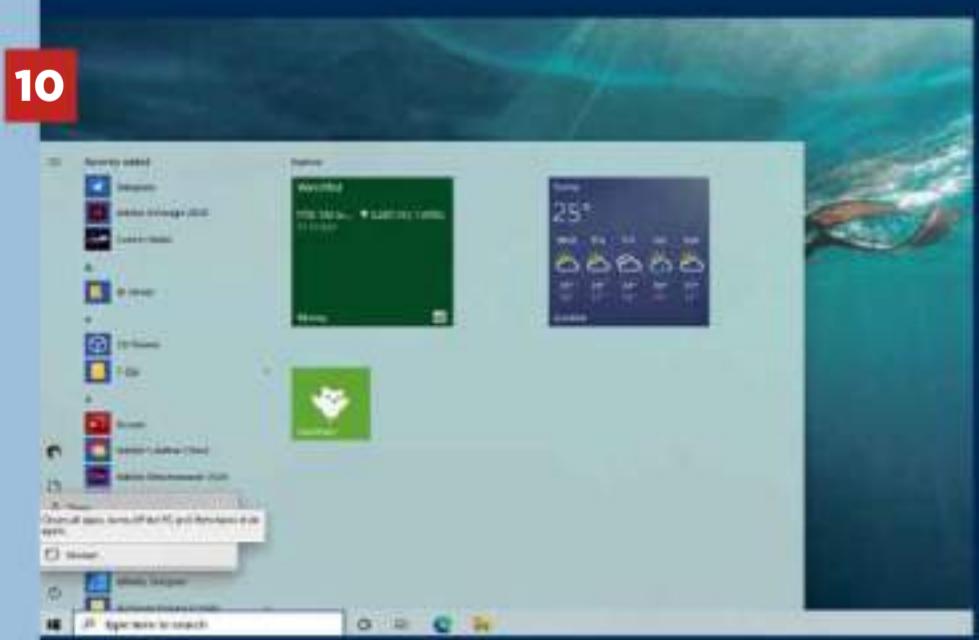
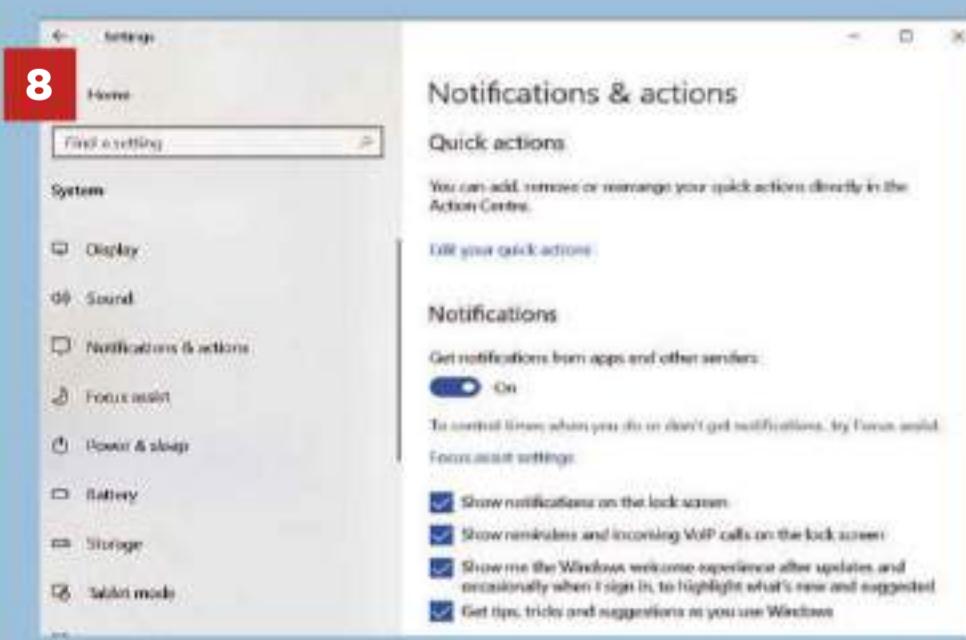
ABOVE Fragmented drives can negatively impact a PC's performance. Fortunately, ours is in good condition

BELOW Switching off Windows notifications can help with your concentration



ABOVE If uninstalling OneDrive is one step too far, you can pause it when your PC is working on something demanding

BELOW If all else fails, try restarting – just remember to remove any startup applications you don't need first



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Microsoft Flight Simulator

A stunning rebirth for the long-dormant *Flight Simulator*, with realistic mechanics wrapped in a beautiful package

SCORE

PRICE Standard, £50 (£60 inc VAT)
from the Microsoft Store or Steam

Humankind had been obsessed with taking to the skies for millennia – just think of Icarus – so it was no surprise that early programmers were quick to simulate flight. Preeminent among these was Bruce Artwick, whose work dates back to the mid-1970s. When Microsoft was looking for a product to show off the power of IBM-compatible computers, it commissioned Artwick to bring his simulator to the PC.

So, in 1982, *Microsoft Flight Simulator* was born. Its launch met with critical acclaim as reviewers and consumers alike sensed a purpose for PCs beyond running VisiCalc, storing recipes or playing trivial games. However, after 27 years and 12 releases, internal issues at Microsoft led it to close down its developer, Aces Game Studio, and with it seemingly end the *Flight Simulator* program.

Not that it ever truly died. The 11 intervening years have seen continued

support from third-party add-on developers and a 2014 rerelease of *Flight Simulator X* on Steam. The underlying codebase also went on to become the core of Lockheed Martin's *Prepar3D*. Despite this, the flight simulation scene has been weaker for Microsoft's absence. Other simulators have their strengths, but Microsoft's baby could be all things to all people, whether you desired a simple game or a sophisticated simulator.

■ Pro enough?

With games being outside PC Pro's usual remit, why should we care? Firstly, there is significant debate about the degree to which this is a "game" at all, given the many serious use cases for it. Secondly, if we ignore the 11-year hiatus, *Flight Simulator* is Microsoft's longest-running piece of software. It predated Windows and outlived MS-DOS, making it a key part of computing history.

However, a historical artefact it is not. With this release, developer Asobo has produced a generational leap in what's possible on a home computer and the first genuine wow moment for cloud computing.



"Asobo has produced a leap in what's possible on a home computer and the first genuine wow moment for cloud computing"

ABOUT THE AUTHOR

Gavin Hall is a commercial pilot who caught the flying bug due to *Flight Simulation* for the Spectrum (see p118)

I'm not merely referring to the graphics, but of all this product's living parts: the terrain, airports, cities, air traffic, weather and lighting.

The global terrain database, which courtesy of Bing Maps accurately represents the whole world, is two petabytes. Rumour has it that Jon Honeyball has a two-petabyte USB stick for updating his coffee machine firmware, but the rest of us will have to stream the data as needed from Microsoft's Azure platform.

To transform 2D satellite data into a living 3D world, replete with buildings and trees, Microsoft recruited Blackshark.ai. Its machine-learning system reads the Bing data and automatically generates 3D buildings to populate the simulated world. Fly low and you can nitpick the results, but when viewed from up high, and bearing in mind the planetary scale, it's a stunning achievement.

"What if I have poor bandwidth or no internet connection at all?" you might ask. Well, there's an adaptive streaming system, where your results

will depend on the available bandwidth – more bandwidth equals more eye candy. You can pre-cache areas of high detail, while a zero-data mode uses procedural generation to give reasonably accurate results if you don't want to use any data. You can also set how much bandwidth the system can use, so that other people on the same connection get a look in.

Airports and weather

Flight Simulator X held about 24,000 airports, and this has now swelled to 37,000. If it has an ICAO four-letter identifier, it's probably here. Each one has its runways, taxiways and parking positions accurately modelled.

This next part I didn't believe until it came from the mouth of a senior developer: even tiny farm strips that are used only a few times per year are present if visible in the satellite data.

Most of these airports have their buildings generated by Blackshark.ai, meaning that while the essentials are correct, the aesthetics are a bit off. Certain airports, however, are "handcrafted", meaning that a team documented the airport in minute detail so that the artists could work their magic. The exact quantity of handcrafted airports, and the aircraft selection, will depend on which of the three versions you buy (*see boxout overleaf*). The airports feel alive too, with ground vehicles, airport staff and jet bridges all doing their thing.



All of this hard work brings practical benefits. It means scenery is accurate enough to navigate between airports using just the view out the window and real-world charts, thus raising the possibility of practising actual navigation skills from home.

Flight Simulator's weather system is extraordinary and could fill an article all by itself. Over the past two years, the Swiss forecasting company Meteoblue created a setup that's unparalleled in the consumer realm. This divides the planet's entire atmosphere into 250 million boxes, 60 layers deep, with full temperature, pressure and humidity data. The weather isn't just for looks, either, having a genuine impact on the operation of the aircraft.

It's alive!

The lighting and weather engines are interconnected, with clouds casting shadows – including on each other. You'll see rain shafts, lightning, rainbows and many other atmospheric effects, including wind-induced sea swell.

The idea has been to create a living, breathing world for you to explore, and part of that is other air traffic. Asobo created what it describes as a "one shared world", where all of the players inhabit the same space, along with real-world air traffic. The promise is that Azure will provide instant server scalability for as many players as necessary.

Filters allow you to configure whether you want to play with those who prefer actual aviation rules, or with folk who wish to hoon around in a more carefree manner. Either way, there are no sessions to join and nothing to set up, with the only choice being whether to join either the European or North American servers.

Then there's the audio system, which has been reworked from the ground up: the developers sampled a broad array of aircraft noises, from engines to landing gear and flaps. Environmental sounds have received much attention too. Different areas

of the world are divided into distinct "biomes" so that the African savanna will sound different from the wilds of Alaska and daytime sounds will be different from night. Of course, to hear any of this you will

need to shut down your engine.

Learning curve

You don't need to be a pilot to enjoy *Flight Simulator*. In fact, the level of complexity is up to you. If you simply want to start at the end of the runway, add some power and go flying, you can absolutely do that. This doesn't mean you're using a dumbed-down arcade version, but that there's more hand-holding from a virtual



ABOVE If an airport has a four-letter ICAO identifier, it's most likely on the map



"Scenery is accurate enough to navigate between airports using just the view out the window and real-world charts"

LEFT Microsoft has put a lot of effort into getting the layout of airports just right

instructure – much like going for actual flying lessons. There's a great selection of tutorials for those who are new to all this, covering the content you would expect in the first 30 hours or so of real-world flying lessons.

At the beginning, you may find yourself noodling around the sky, which is within everyone's grasp. Who cares if you can't land at first?

When you're ready, add layers of realism. If, for instance, you want to start an Airbus A320 from cold on a foggy morning in Zurich, surrounded by mountains you can't see, and then simulate a standard instrument

departure (SID), that's here too.

Microsoft and Asobo had to make a judgement call about whether to go deep or broad in terms of aircraft selection and detail levels. All of the aircraft here are fully licenced, so they had access to the pilot's operating



reached out to these developers and around 700 are now onboard. Their wares will be available via an in-game store and directly via the individual developer websites.

Despite all this testing, there are still bugs and the game does occasionally crash. At this stage there are notable omissions from the aircraft roster, including gliders and helicopters. These are on the way from Microsoft/Asobo and

LEFT The inside of this Cessna cockpit will become very familiar at the start

opposite) for a couple of days only hammered this point home.

On the graphics side, I have a much more recent Nvidia GeForce RTX 2060 and this sits somewhere between the “Recommended” and “Ideal” specs. Running at the native resolution of my monitor, 1,920 x 1,200, I had great success on Medium settings. Even with everything set to Low, this is still a pretty game and you can have a lot of fun. Loading times can be long and

handbooks, many test pilots and even some CAD files. Additionally, they got input from people who fly these machines, because sometimes there are characteristics that simply aren't documented anywhere.

Small general aviation (GA) aircraft are complete and accurate, but an airliner is an order of magnitude more complex and, unsurprisingly, the accuracy tails off as you move up to these larger machines. For example, the A320 and B787 autopilots don't always do what an experienced operator would expect; these aircraft have very different systems, with all sorts of nuances that a generic autopilot system can't replicate. There is more than enough detail to go flying but these aren't study-level airliners.

This is where the community comes in. Microsoft has been keen to point out that it sees two groups here. There is the community of “simmers”, or gamers if you prefer, and the community of developers. These are the people who kept unsupported software alive and kicking in Microsoft's absence.

From scenery packs to aircraft models detailed enough for real-world exam study, there's almost no end to what's available. As soon as the project was made public, Microsoft



others, but may involve further cost. Then there's support for VR; this is promised, but Asobo isn't saying anything more than autumn 2020.

Finally, note that when you first download the game there's a moment where you think, “Wow, that was quick!” At that point you only have the base game, which is relatively small. Then the 90GB data download begins...

■ Power play

Which brings us to the specs. Starting outside of the PC, you don't need anything more than a mouse and keyboard to control planes, but I found an Xbox controller useful – it makes looking around the cockpit easy. Ideally you want a nice joystick, rudder and throttle setup, and a lot of the modern ones are supported out of the box. Mine is an older model, which does work but needed a laborious setup process.

This is a power-hungry game that has been designed to scale up in the future; however, the minimum processor dates back to the 2013/14 Haswell era. That's what I did most of the testing on, and it was a perfectly serviceable experience. Performance is significantly impacted by the complexity of the terrain, airports, weather and quantity of air traffic. For the first time since 2013, I wanted more power. Stepping up to the Chillblast Captain Flight Sim PC (see

ABOVE This is how our test pilot likes to spend his time: playing in a Pitts Special

increase with the detail level, so use an SSD if you can. I'll be switching to an NVMe drive at the first opportunity.

As an airline pilot, you might assume that I'd want the maximum level of realism, but you'd be wrong. Following standard operating procedures (SOPs) and crew resource management (CRM) principles is one of the reasons air travel is so safe today. We take these things seriously and put a great deal of professional pride into getting them right.

“That's Flight Simulator all over: freedom. The expansive, free-roaming joy of going wherever you like in whatever manner you want”

However, simulating this at home isn't how I prefer to spend my spare time. Indeed, the sheer number of buttons and switches, which are easy to reach in the real aircraft, but which require fiddly actions to operate in the game, mar my enjoyment of the more complex machines. The simple pleasure of flying a small plane around the bush or performing aerobatics in a Pitts Special is more my thing.

And that's Microsoft Flight Simulator all over: freedom. The expansive free-roaming joy of going wherever you like in whatever manner you want. In a Covid-19 world, this release could not be more timely. It's not only a simulation – it's balm for the soul. Hop in a Cessna 172 and meet me at the blue horizon. I'll be waiting for you. **GAVIN HALL**

Which version should you buy?

There are three versions: Standard, Deluxe and Premium Deluxe. Standard is good value for money at £60, and includes the same base game as the other two. These versions add more aircraft and handcrafted airports, as described in the review. It's up to you what value you put on these, but if you go on to buy this content as an add-on, it will cost more in total than the £80 or £110 of getting it bundled.

There is no difference between buying *Flight Simulator* on the Microsoft Store or Steam; you'll still connect to the same shared world. Note, though, that you can buy a 10-DVD set from Aerosoft to save you the 90GB download.

Chillblast Captain Flight Sim PC

Beware the quiet ones: this PC packs all the punch you need to get the most out of *Microsoft Flight Simulator*

SCORE

PRICE £1,833 (£2,200 inc VAT)
from chillblast.com

It's fair to say that Chillblast is on *Flight Simulator*'s case. Head to chillblast.com and you'll find 14 PCs tailor-made for flight sims, ranging from £760 to £4,900, and it's had early access to *Flight Simulator*'s alpha and beta code to help fine-tune its offerings.

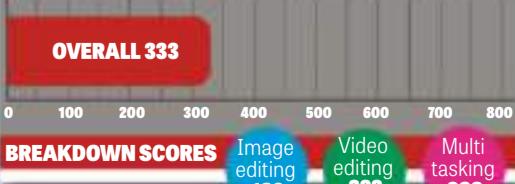
That said, the ingredients behind a flight sim PC are well understood. First, you need as powerful a processor as you can afford, and that honour goes to the eight-core Core i7-10700K here. Next up, the graphics chip: the GeForce RTX 2080 Super shoulders



this burden. And to complete the crew, two 16GB sticks of 3,200MHz memory, a fast 1TB PCIe SSD and a 4TB mechanical hard disk – the latter useful when trying to meet *Flight Simulator*'s heavy storage demands.

This potent combination still isn't quite enough to earn the PC an "Ultra" quality rating in *Flight Simulator*, but High is only one step down and looks spectacular on the Chillblast. Most importantly, the game ran smoothly

BENCHMARKS



at 4K in a range of environments, so if flight simulation is your primary application for this PC then you should be happy for years to come.

Naturally, it's a powerful machine outside of virtual flying worlds. It motored to 333 in our benchmarks, which is what we'd expect from an air-cooled Core i7-10700K. There's room to overclock it should you wish – and note that the Asus TUF Gaming Z490-Plus motherboard is primed for such activities – but Chillblast has struck a nice balance between speed and noise that we'd be loathe to disturb. In general use, this is one of the quietest systems we've heard, with the fans only kicking in once *Flight Simulator* has been on for a few minutes.

If value for money is key, consider a system based on an AMD Ryzen 3700X, as it's equally fast but cheaper. You won't make enough savings there to upgrade the RTX 2080 Super to the 2080 Ti, which might have been just enough to push this PC into the Ultra category, but this is still a fast gaming system. At 1080p, it averaged 69.8fps in the *Hitman 2* test with our tough settings, and while it struggled to 18.9fps in 4K that increased to 68.4fps once we dropped super sampling from 2x to 1x.

Note that this Asus motherboard doesn't support SLI, and that you would need a higher-spec power supply to support two graphics cards anyway. Not that we have any complaints about the high-quality Corsair RM650x, nor the Fractal Design Define 7 chassis: it's a hunk

A pilot's view

The Intel Core i7-10700K is a worthy choice, given that *Microsoft Flight Simulator* is one of the most processor-intensive releases in years. The RTX 2080 Super is an excellent partner, but you must carefully consider your requirements – do you have a 4K monitor? If not, an RTX 2060 Super would still provide great results, and the £400 saving could be spent on upgrading the SSD to 2TB, leaving £100 towards a joystick. Also, be wary of using the Seagate 4TB hard disk for storage of data; it's a 5,400rpm unit, so load times will be far longer with the scenery stored here than on the SSD. **GAVIN HALL**

ABOVE It may not be aerodynamic, but the chassis is packed with pilot-friendly features



LEFT The 4TB storage should be enough for the game's cargo hold-filling demands

chunk of black metal, with the added bonus of a door that opens to reveal a DVD writer. Useful if you decide to buy *Flight Simulator* on ten DVDs rather than as a download. Another nice touch: if you need to quickly hook up a joystick, rudder and throttle, you might appreciate the four USB ports on the top of the case.

Working inside is a breeze, with two easy-to-reach DIMM slots and one spare M.2 slot. We're happy with the storage setup as supplied, though, with the Seagate PCIe SSD returning a speedy 2,847MB/sec for sequential reads and 2,989MB/sec for writes. The hard disk is more pedestrian, with scores of 175MB/sec and 185MB/sec, but that's hardly surprising.

Is all this power necessary to run *Flight Simulator*? No, just take a look at the Cyberpower overleaf, which will run it at Medium settings for half the price – and still looks great and runs smoothly. Will you appreciate

the Captain's smooth air, extra reserves of power and staggering amount of storage? Absolutely. We'd go so far as to say that it's First Class.

TIM DANTON

"This is one of the quietest systems we've heard, with the fans only kicking in once *Flight Simulator* has been on for a few minutes"

SPECIFICATIONS

8-core 3.8GHz/5.1GHz Intel Core i7-10700K processor • Asus TUF Gaming Z490-Plus (Wi-Fi) motherboard • 32GB 3,200MHz DDR4 RAM • 8GB Nvidia GeForce RTX 2080 Super graphics • Noctua NH-U12S CPU cooler • 1TB Seagate Barracuda 510 M.2 PCIe SSD • 4TB Seagate Barracuda hard disk • 24x DVD writer • Fractal Design Define 7 chassis • Corsair RM650x 80 Plus Gold 650W PSU • Windows 10 Home • 240 x 547 x 475mm (WDH) • 5yr warranty (2yr C&R, 3yr labour-only RTB)



Cyberpower Infinity 79 RTX

A fast gaming PC with room for expansion and upgrades, but we wish it didn't make quite so much noise

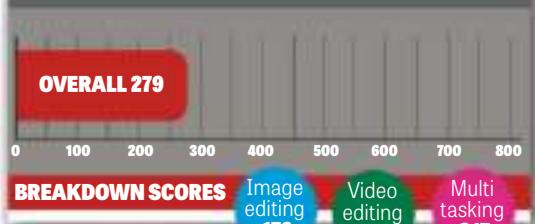
SCORE

PRICE £1,083 (£1,299 inc VAT)
from cyberpowersystem.co.uk

While I enjoyed using the Chillblast Captain Flight Sim PC (see p45), there isn't a compelling reason to spend more than £2,000 if you want to enjoy *Microsoft Flight Simulator*. This Cyberpower system is a case in point: while it hasn't been designed to run that highly demanding flight sim, it copes with it comfortably even at 4K. You'll need to drop the settings from High to Medium, but the rolling hills still look amazing beneath you.

That's because Cyberpower invests in the core components, with an eight-core Coffee Lake-S Intel Core i7-9700KF chip arguably the most important. This has been usurped by the tenth-generation Core i7-10700KF in Intel's lineup, but there isn't a huge generational leap between the two: the older chip's Turbo Boost speed of 4.9GHz ensures that there's plenty of power on tap, and it's unlocked if you want to try your luck at overclocking. Cyberpower includes a Cooler Master Liquid Lite 120 CPU cooler to help on this front, and in combination with the Asus Prime Z390-P motherboard it's a good choice for "hobbyist" overclockers. Those who are serious about squeezing every last ounce of power from their chosen processor will need a more heavyweight cooler and board, however.

BENCHMARKS

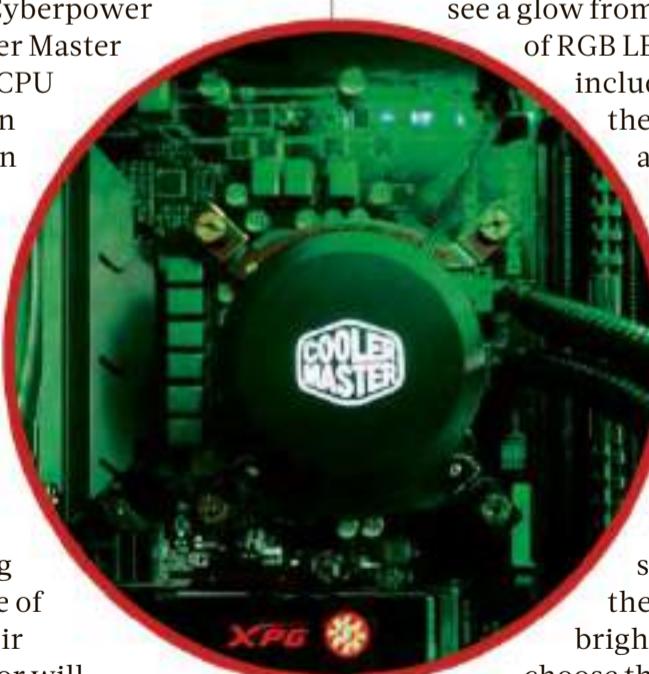


There's actually an argument for downgrading to a standard air cooler, because if you sit beside the Infinity 79 RTX you'll hear a near-constant stream of pops and gurgles as the watercooler does its work. Air coolers are more predictable. Nor is this a good choice for people who like ultra-quiet PCs due to a constant whirr of fans; if you prefer a system that runs quiet when idle, upgrade the fans using Cyberpower's excellent online configurator at the time of order.

You might also want to invest in extra RGB fans for the front of the Onyxia chassis, because as supplied there's nothing to light up the sheet of tempered glass that sits here. You can see a glow from the single strip of RGB LEDs Cyberpower includes, but these are best appreciated from the side – naturally, this is made of tempered glass too. One nice touch: Cyberpower includes a remote control so you can set the LEDs' brightness and choose their colours, or simply switch them off.

Neat cabling both adds to the Infinity's aesthetics and makes life easier when it's time to upgrade. At some point, you might want to add to the 16GB of RAM, for instance, with two sockets sitting free. Or you can fill the spare M.2 slot on the motherboard. Or use the numerous spare SATA sockets to add more storage, with two

ABOVE Cyberpower's neat interior cabling makes upgrades easy when the time comes



LEFT A press of the remote control turns the LED strip to your choice of colour

2.5in mounting plates above the bay that holds the 650W power supply and space for a second 3.5in hard disk if you remove the right-hand panel. Nothing requires immediate upgrading, however, with a pacy 512GB Adata NVMe SSD – we recorded 2,665MB/sec sequential reads and 2,173MB/sec writes – accompanied by a 1TB Seagate hard disk.

This PC raced through the rest of our benchmarks, too, with a fine overall score of 279, while Geekbench 5 returned 1,317 and 7,668 in the single-core and multicore tests respectively. Inevitably, the Chillblast's superior

processor and 32GB of RAM mean it was faster still, but there's enough power here to keep most people happy for years to come. You can save money by opting for AMD Ryzen systems instead; five months ago, I reviewed Cyberpower's Ultra 5 RTX Gaming PC (see issue 308, p59) with a six-core Ryzen 5 3600 inside and it scored 254 in our benchmarks – while costing £300 less.

The Infinity 79 RTX benefits from Nvidia's RTX 2060 Super card, as

opposed to the plain RTX 2060 in the Ultra 5. You could pigeon-hole this as a card suited to 1440p gaming, and it scored 90.6fps in *Hitman 2* with our usual challenging settings – bar for super-

sampling set to 1x rather than 2x. It can cope at 4K in many games, though. *Hitman 2* dropped to 45.8fps, but *Metro: Last Light* ran at 84.3fps while *Dirt: Showdown* averaged 165fps.

With an 802.11n Wi-Fi card to round things off – leaving one PCIe x1 slot and one PCIe x8 slot free – this is a fast all-rounder that should appeal to anyone who wants to stick with the Intel/Nvidia combination. And there are plenty of options for upgrades. Before you buy, though, consider opting for quieter fans. **TIM DANTON**

SPECIFICATIONS

8-core 3.6GHz/4.9GHz Intel Core i7-9700KF processor • Asus Prime Z390-P motherboard • 16GB 3,000MHz DDR4 RAM • 8GB Nvidia GeForce RTX 2060 Super graphics • Cooler Master Liquid Lite 120 CPU cooler • 512GB Adata XPG SX8200 Pro M.2 PCIe SSD • 1TB Seagate Barracuda hard disk • 802.11n Wi-Fi PCIe card • Cyberpower Onyxia chassis • Inwin A65 650W PSU • Windows 10 Home • 203 x 475 x 473mm (WDH) • 3yr warranty (6 months C&R, 2yr parts, 3yr labour)

Acer Nitro N50-610

A lightweight gaming PC in almost every way; Acer needs to go heavy if it's going to mix with its UK opposition

SCORE

PRICE £749 (£899 inc VAT)
from currys.co.uk

What if. That is the question that haunts the Acer Nitro N50-610. This gaming PC comes tantalisingly close to being a bargain, but it's handicapped by two crucial cost-cutting measures that it can't quite overcome. If you have sufficient technical nous, it's easy to rectify them both – but it will cost a little money.

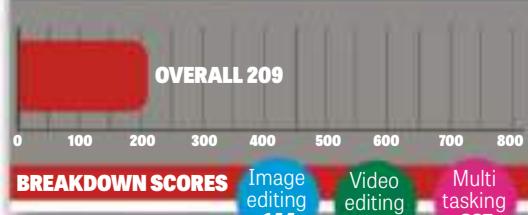
The first and most obvious handbrake is 8GB of RAM. Supplied as two DIMMs, this leaves two empty sockets so you can add two more sticks yourself at around £20 each. Is doing so necessary? No, because Windows 10 runs happily with 8GB of RAM in general use, but it seems a shame to hold back a six-core Intel Core i5 processor that's so capable at multitasking. Note that the tenth-generation Core i5-10400F supports Hyper-Threading too.

Next, we'd address the SSD. While it's positive to see a NVMe SSD fill the motherboard's single M.2 slot, Acer saves pennies by choosing a low-cost and mediocre drive: sequential read scores of 1,460MB/sec are tolerable, but we expect far quicker writes than 830MB/sec from a NVMe SSD. Nor does it help to only have 256GB of storage; this is meant to be a gaming PC, in which case you want your main games to be installed on the solid-state drive. We all know how greedy modern games can be.

Again, an upgrade is relatively easy, although it will involve reinstalling Windows (and there's no DVD writer here; if you want that, consider the Nitro N50-110 instead) and you'll need to dispense with the supplied SSD. There's also the small matter of spending around £70 on a fast 500GB SSD, or £150 on a 1TB unit.

While we're considering upgrades, you may find that after you've

BENCHMARKS



installed a few heavyweight games that the 1TB hard disk is bursting under the strain. Fortunately, a 3.5in bay lies in wait for a second drive, and due credit to Acer for lining up the SATA connector to make this easy.

The bad news? That's your lot when it comes to upgrades, with the compact case containing an equally compact motherboard that provides zero available PCIe slots. If you want a more powerful graphics card in the future then you'll probably need to upgrade the 500W power supply too. There's good news, though, in that Acer uses a separate expansion slot in the motherboard to fit a Wi-Fi 6 Intel card (which also adds Bluetooth); wires trail across the top of the case to a single external antenna. Unlike most Wi-Fi cards, you can't fiddle with two antennae to fine-tune your connection, but this proved solid in our tests.

Curiously, Acer includes a line of red LEDs inside the case too, but unless you open up the side – secured by a pair of Philips crosshead screws – you won't see them. There's no tempered glass here, just boring old metal. Note that while the photos make the Nitro's front look metallic, with splashes of red for extra vigour, plastic is its medium of choice.

The plus side of Acer's chassis is that it's so compact and light: 6kg is nothing for a gaming PC. I half-expected to find a handle built into the top to make it easier to carry to LAN parties, but no such luck. It also offers plenty of 3D acceleration thanks

ABOVE There isn't a lot of upgrade wiggle room here, but the machine is compact

"Move away from games and flight simulators and you're buying a fast PC, even with the supplied 8GB of RAM and 256GB SSD"

BELOW The chassis has a Robot Wars feel, but the front "helmet" is plastic, not metal



to Nvidia's GTX 1660 Super graphics chip. This is at its strongest at 1080p, where the Nitro proved capable of playing *Hitman 2* at 108fps once we dropped super sampling from 2x to 1x. The far less demanding *Dirt: Showdown* reached 134fps at 4K, while *Metro: Last Light* returned 51fps at 4K and 182fps at 1080p.

I wouldn't recommend this PC for *Microsoft Flight Simulator* as you're reliant on the hard disk; it took an age to start, but it ran smoothly at Medium settings at 1440p once we had lift off.

Move away from games and heavyweight flight simulators and you're buying a fast PC, even with the supplied 8GB of RAM and 256GB SSD. A score of 209 in our benchmarks underlines the fact that this machine can crunch numbers when necessary, and in day-to-day usage the only hurdle you'll hit is when that 8GB of RAM becomes saturated. The Nitro scored a creditable 1,080 in Geekbench 5's single-core test and 5,889 when all six cores were called into action.

One thing you'll notice if you start to push the Nitro is fan noise. There's no space for a big rear-mounted fan, so Acer uses a 9cm unit that – together with the fan keeping the CPU cool –

results in a mid-range hum when it gets going. On a more positive note, this drops down to a barely noticeable whirr during less intensive times. You can also take more control of the fan

using Acer's NitroSense software, and I was pleased to see a general lack of "bloatware" here. Less experienced users will appreciate Acer's Care Centre software, which offers a handy central location for customer support and basics such as backups and driver updates (even if the latter simply points to Windows 10's built-in tool).

There are plenty of reasons to like the Acer Nitro N50-610. If you're looking for a decent amount of power now with the option of upgrading, and appreciate that your upgrade options are limited to RAM and storage, it's fine. I would, though, recommend speaking to British PC manufacturers first to see what they can provide for this price. They'll probably offer a better warranty than one year of return-to-base cover too. **TIM DANTON**

SPECIFICATIONS

6-core 2.9GHz/4.3GHz Intel Core i5-10400F processor • custom Acer motherboard • 8GB 2,666MHz DDR4 RAM • 6GB Nvidia GeForce GTX1660 Super graphics • CPU air cooler • 256GB Kingston M.2 PCIe SSD • 1TB Western Digital hard disk • Wi-Fi 6 • Bluetooth 5 • custom Acer chassis • 500W PSU • Windows 10 Home • 175 x 386 x 392mm (WDH) • 1yr RTB warranty • part code DG.E1ZEK.002





Dell XPS 15 (2020)

A gorgeous laptop with a modicum of gaming ability and a (mostly) fabulous display

SCORE

PRICE As reviewed, £2,083 (£2,499 inc VAT)
from dell.co.uk

While the Dell XPS 15 has been one of our favourite laptops for years, it was starting to look dated. With a lightweight design to match the XPS 13, the all-new Dell XPS 15 aims to establish itself as the laptop of choice for those who value performance as much as portability.

2020's Dell XPS 15 comes stuffed with high-powered components. You have the choice of either a six-core Intel Core i7-10750H or an eight-core Core i9-10885H, accompanied by a discrete Nvidia GTX 1650 Ti GPU and a range of RAM and storage options. And it's all squeezed into a chassis that's easy to sling in a rucksack.

The biggest update from a physical point of view this year, however, is the screen, which is nigh-on bezel-free on all four sides. Previously, the XPS 15's

"Infinity Edge" display had a large bezel at the bottom; that's now almost disappeared. Tellingly, the OLED display option of last year's Dell XPS 15 has gone too, but since the 4K touchscreen on this year's machine is a wide-gamut unit rated at 100% Adobe RGB coverage, that isn't a great loss.

Slim by design

Whichever spec you choose, the Dell XPS comes in the same, slim, tough-feeling body. The laptop measures 345 x 230 x 18mm (WDH) when closed and weighs 1.83kg for the non-touch variant or 2.05kg for this 4K model. That's good for a 15.6in workstation laptop, and the USB-C power supply is remarkably small and light, tipping the scales at 443g.

The finish is smart, with smooth, matte aluminium covering the lid and underside and a natty carbon fibre inside surrounding the keyboard and wristrest. There's barely a creak when it's manhandled, and the lid is stiff and flex-free.

There isn't much in the way of legacy connectivity here – aside from a full-size SD card slot and a 3.5mm headset jack – but you get three USB-C ports. Two of these are Thunderbolt 3 and one is USB 3.2 Gen 2 (10Gbit/sec). Wireless connectivity is handled by a 2x2 MIMO Killer Wi-Fi 6 AX1650s card with Bluetooth 5.1 support.

ABOVE The XPS 15 is slim and stylish, with nary a creak when you open the lid



As expected, the Dell XPS 15's keyboard is excellent: it has plenty of travel and positive feedback. The layout is great too, with large left and right Shift keys, a double-height Enter key and a power button in the top-right corner that doubles as a fingerprint reader.

The diving board touchpad is a joy to use. It's a massive 151 x 90mm in size, worked reliably during testing, and the left and right clickers have just the right responsiveness. They're not too heavy or too light and the sound that accompanies each press is a quiet thunk, rather than the brittle plastic clack of certain touchpads.

The XPS 15's resolution of 3,840 x 2,400 gives an aspect ratio of 16:10 and that extra height is a boon for productivity apps

Super screen?
The 4K screen on our review sample is top quality. A resolution of 3,840 x 2,400 gives an aspect ratio of 16:10 and that extra height compared to 16:9 displays is a boon for productivity apps such as Adobe Photoshop.

Unlike so many displays on Windows laptops, Dell chooses a wide-gamut unit. Where most laptop screens are only capable of reproducing the sRGB colour space, or marginally more than it, the 4K screen on the Dell XPS 15 can go well beyond.

BATTERY: video rundown, 7hrs 24mins

BENCHMARKS
OVERALL 191

BREAKDOWN SCORES
Image editing 170
Video editing 187
Multi-tasking 200

Indeed, keen photographers will be pleased to discover that the panel covers more than the Adobe RGB (107.7%) gamut. That equates to around 156.4% of the standard sRGB gamut and 110.8% of DCI-P3.

Nor can we complain about peak brightness or contrast: figures of 464cd/m² and 1,518:1 ensure images have plenty of pop. Colour accuracy also hits the heights. You'll need to make sure the HDR Windows settings are disabled (or adaptive contrast ruins everything), but you'll be rewarded with an average Delta E in Adobe RGB of 1.23.

The Dell's display is HDR400-certified and Dolby Vision capable. But this is where things start to fall apart, due in no small part to the display's heavy-handed use of adaptive contrast.

Enable HDR in the Windows settings, fire up the Netflix app and you'll see that many shows such as *Altered Carbon* are listed with Dolby Vision logos, showing that something is working. The problem is that, where an advanced TV might deploy local dimming to achieve the high contrast ratio required by Dolby Vision, only dimming and brightening specific parts of the screen, the XPS 15 appears to dim and brighten the entire display. This is disconcerting when scenes transition from dark to bright, with the adaptive contrast lagging a second or two behind cuts.

That's not the only flaw. Enable HDR and the laptop appears to cap frame rates at 30fps with the result



that all onscreen animations, and games, drag horribly. I'd advise against using Windows' HDR mode as a result, but this does mean missing out on one of the key benefits of the new 4K display. Let's hope that gets resolved in a future update.

Games and frames

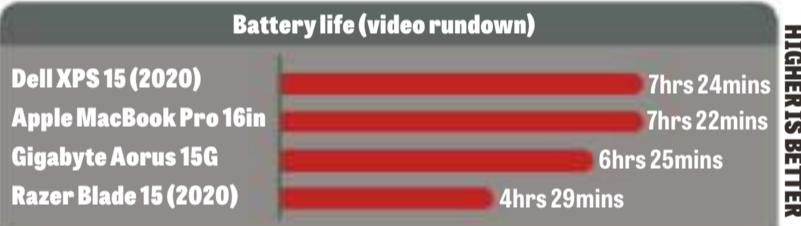
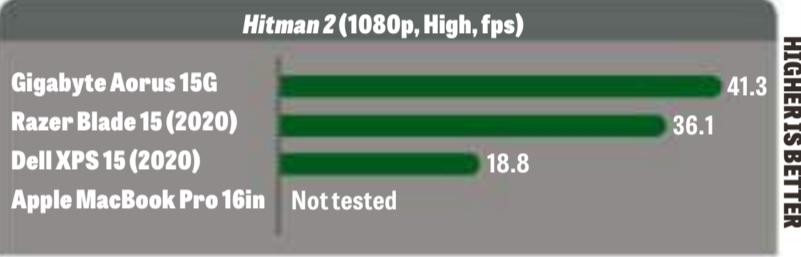
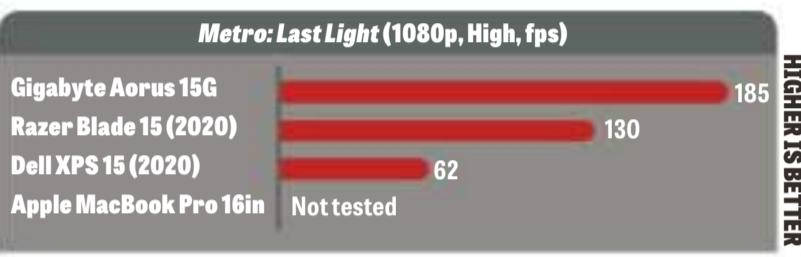
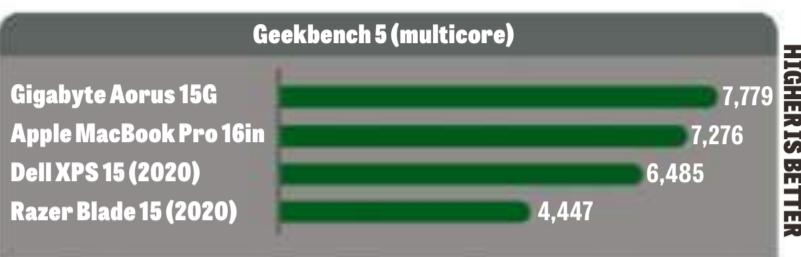
These issues also put paid to the idea that you might use the XPS 15 to game in HDR, which is a shame because the hardware is capable. That said, you can get more for your money

elsewhere if you're after a gaming system: our review unit's Core i7-10750H CPU and GTX 1650 Ti graphics card compare poorly to the £1,949 Gigabyte's Aorus 15G (pcpro. link/313gig) with its Core i7-10875H and RTX 2070

Super, while the Base version of the Razer Blade 15 (see p54) includes a Core i7-10750H and RTX 2070 Max-Q for £2,100. You can see the effect of their superior graphics chips in the gaming graphs.

The speed of the 1TB Micron SSD is a mite disappointing: 2,088MB/sec sequential read speeds are fine, but 985MB/sec sequential writes are half of what we'd hope for. Still, the XPS 15 is more than fast enough to take on demanding applications such as raw photo editing and video editing, and isn't that far behind the 16in Apple MacBook Pro in our benchmarks – while costing £600 less.

Battery life is also good for such a large machine: in our video-rundown



ABOVE LEFT The excellent keyboard will have you typing at your fastest pace

test, the XPS 15 lasted 7hrs 24mins. That's a match for the 16in MacBook Pro and superior to both the Gigabyte Aorus 15G and the Razer Blade 15.

Mixed blessings

Let's start with XPS 15's positives: the build quality is excellent and the display astounding. The keyboard and touchpad are beyond reproach and there's enough power for the most demanding creative applications. Plus, it's a huge amount cheaper than the equivalent 16in MacBook Pro.

However, that wide-gamut display doesn't deliver on its Dolby Vision-enabled promises. And, if gaming is a must, there are rival Windows laptops that offer more bang for your buck.

Yet, despite its foibles, the 2020 XPS 15 is a fine laptop for creatives. If you want a 16in MacBook Pro rival for less, it makes an excellent choice.

JONATHAN BRAY

SPECIFICATIONS

Six-core 2.6GHz Core i7-10750H processor • 32GB DDR4-2933 RAM • 4GB Nvidia GeForce GTX 1650 Ti graphics • 3,840 x 2,400 15.6in IPS touchscreen • 1TB M.2 PCIe SSD • 2x2 802.11ax Wi-Fi • Bluetooth 5 • 2x Thunderbolt 3 • USB-C 3.1 • SD card reader • 3.5mm jack • 86Wh battery • Windows 10 Home • 345 x 230 x 18mm (WDH) • 2.1kg • 1yr C&R warranty

Configurations and competition

The table below shows the seven currently available configurations for the new Dell XPS 15, ranging from £1,949 to £3,209. Its main competitor has to be the 16in Apple MacBook Pro. It has a fractionally larger, non-touch display (that's wide gamut, just like the Dell's) and is also targeted at creative professionals who need power on the move.

The MacBook costs more, with prices starting at £2,399 for a six-core Core i7-9750H, AMD Radeon

Pro 5500M GPU, 16GB of RAM and a 512GB SSD. However, you can push the MacBook configuration much further than the Dell's, right up to an eight-core 2.4GHz Core i9-9880HK, AMD Radeon Pro 5600M, 64GB of RAM and a massive 8TB of SSD storage. The downside? That will cost you £6,699.

If your budget is between £2,000 and £2,500, we suggest you also consider the Base version of the Razer Blade 15 (2020), which we review on p52.

| Screen | CPU | RAM | SSD | Graphics | Price |
|-------------------------|----------------|------|-------|-------------|--------|
| 1,920 x 1,200 non-touch | Core i7-10750H | 16GB | 512GB | GTX 1650 Ti | £1,949 |
| 1,920 x 1,200 non-touch | Core i7-10750H | 16GB | 1TB | GTX 1650 Ti | £1,999 |
| 3,840 x 2,400 touch | Core i7-10750H | 16GB | 1TB | GTX 1650 Ti | £2,349 |
| 1,920 x 1,200 non-touch | Core i9-10885H | 16GB | 1TB | GTX 1650 Ti | £2,459 |
| 3,840 x 2,400 touch | Core i7-10750H | 32GB | 1TB | GTX 1650 Ti | £2,499 |
| 3,840 x 2,400 touch | Core i9-10885H | 64GB | 1TB | GTX 1650 Ti | £3,209 |

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- 3 Year Premium Warranty

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- 2U 19in rack server
- 3 Year Premium Warranty

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3XS SER 4U44E1

- AMD EPYC 7002 CPU with up to 64-cores
- Up to 2TB 8-channel DDR4 3200 ECC Registered
- 2x M.2 SSDs, 4x NVMe SSDs, 2x 2.5in SSDs, 36x 3.5in HDDs/SSDs
- Redundant 1200W PSUs
- 3 Year Premium Warranty

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SCAN[®] Business



Razer Blade 15 (Base model, 2020)

A powerful specification for the price and the design is superb, but poor battery life severely dampens its appeal

SCORE ★★★★½

PRICE £1,750 (£2,100 inc VAT)
from razer.com

We tested the fully loaded Quadro Studio Edition of the Razer Blade 15 earlier this year (see issue 308, p56), but the Base model goes back to relative basics. The key word there being “relative”: this is still a powerful laptop, based on Intel’s six-core Core i7-10750H processor, 16GB of dual-channel 2,933MHz DDR4 memory and Nvidia GeForce RTX 2070 Max-Q graphics.

I ran the machine through a variety of our benchmarks and it performed brilliantly across the board; you can see precisely how it compares to the new Dell XPS 15 using the graphs on p49. It falls behind the Gigabyte

Auros 15G ([pcpro.link/313gig](#)) in the gaming tests, but that’s because the Auros uses RTX 2070 Super Max-Q graphics. If you want the 2070 Super, you’ll need the Advanced version of the Razer Blade 15 – and have to pay another £550.

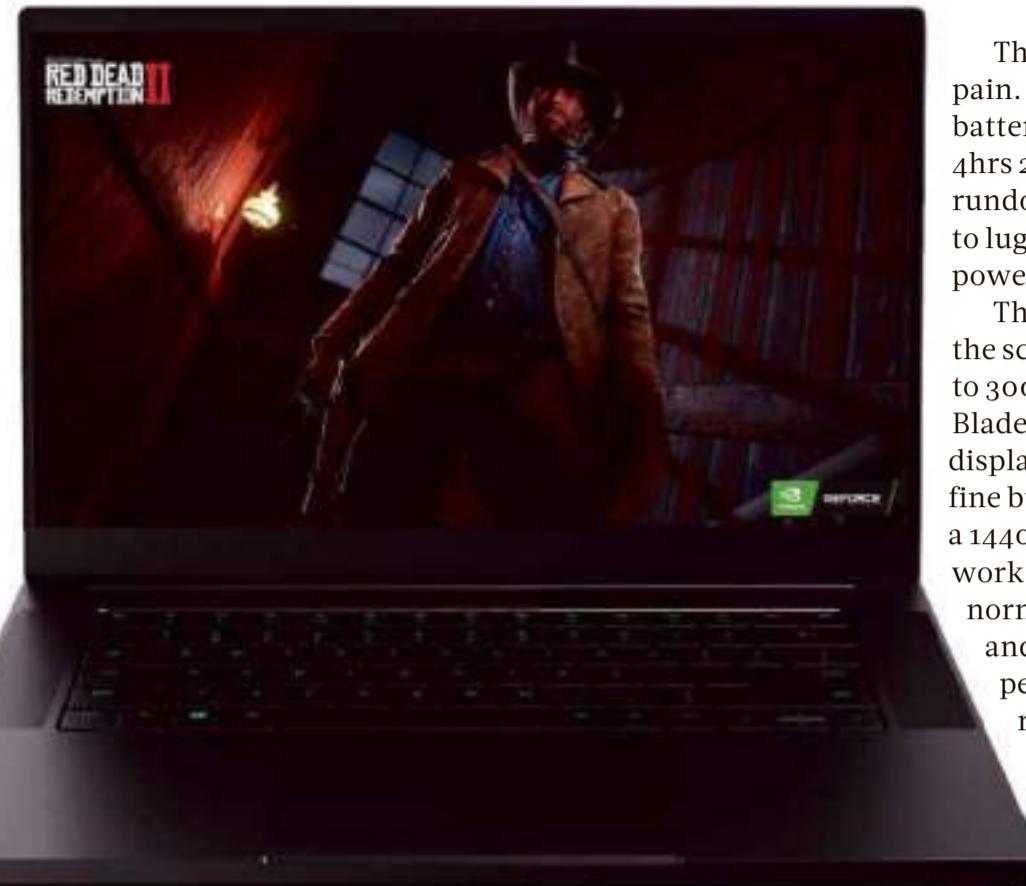
When you can get playable frame rates in AAA games by dropping settings – for instance, reducing Super Sampling from 2x to 1x in *Hitman 2*’s Mumbai benchmark doubled its average from 36fps to 72fps – you have to wonder if it’s worth the money. Without ray tracing, it hit 120fps in *Wolfenstein: Youngblood*, and even with this

BATTERY: video rundown, 4hrs 29mins

BENCHMARKS

OVERALL 183

| | | | | | | | | | | | |
|---------------|-----|---------------|-----|---------------|-----|-----|-----|-----|-----|-----|-----|
| 0 | 30 | 60 | 90 | 120 | 150 | 180 | 210 | 240 | 270 | 300 | 330 |
| Image editing | 158 | Video editing | 174 | Multi-tasking | 198 | | | | | | |



enabled it managed 98fps with DLSS switched on.

The fans stay quiet most of the time, although you’ll be in no doubt when the CPU and GPU are working hard because they ramp up to maximum. That’s one consequence of such a slim machine, and this is the most attractive gaming laptop you can buy. It weighs a mere 2.1kg and measures 19.9mm thick, which isn’t much more than the equally gorgeous 16in MacBook Pro (see issue 305, p52).

You should take note of other differences between the Base version of the Razer Blade 15 and its Advanced brother. First up,

connectivity.

There are two USB-C

ports on each machine, with Thunderbolt 3 on the right, USB 3.2 Gen 2 on the left. On the Base model, though, neither can be used to charge the machine, which is disappointing if you keep it connected to your monitor via USB-C all day.

These USB ports are supplemented by three further USB-A ports, all USB 3.2 Gen 1 (maximum 5Gbits/sec) – two on the right, one on the left – and a Gigabit Ethernet socket, which you don’t get on the Advanced model. There’s also a full-sized HDMI output on the right edge.

However, the Advanced variant has a better vapour-chamber cooling system than the Base model and a slightly larger battery.

ABOVE The keyboard is nothing special, but you could play cricket on the huge touchpad



“What hurts is that this is, in most other respects, a great laptop. It’s achingly gorgeous, quick, light and even reasonably good value”

LEFT There’s no sign of the customary chunkiness of gaming laptops here

That, it turns out, is a pain. The Base model’s 65Wh battery meant it only lasted 4hrs 29mins in our video-rundown test, so you’ll need to lug around the meaty power adapter.

The other key difference is the screen, which jumps up to 300Hz on the Advanced Blade. The 144Hz 1080p display in the Base model is fine but not great; we’d prefer a 1440p resolution for office work, but it’s sharp at normal viewing distances and has a decent 377cd/m² peak brightness. It has a relatively limited gamut of 87.1% sRGB coverage (90.3% volume), but an average Delta E of 1.94 shows colour accuracy.

The keyboard is similarly middle of the road: it has a shallow action but is comfortable and has no annoyingly placed keys. There’s RGB backlighting too, but the Base model doesn’t have the Advanced model’s per-key customisation. You can turn the whole keyboard one colour, or have it pulse or cycle through the colours, but you can’t highlight the WASD keys in one colour and have the rest show another. The touchpad is much better: it’s enormous, measuring 130mm wide and filling the wristrest almost

from top to bottom at 80mm in height.

So where does this leave the Base Razer Blade 15? It can’t be a go-anywhere laptop because of its limited battery life, in which case what’s the

point in having a laptop that combines power and portability so beautifully? What hurts is that this is, in most other respects, a great laptop. It’s achingly gorgeous, quick, slim, light and even reasonably good value. If its battery life had been a couple of hours longer, it might have won an award. As it is, this version of the Razer Blade 15 loses out to rivals such as the Dell XPS 15. **JONATHAN BRAY**

SPECIFICATIONS

Six-core 2.6GHz Core i7-10750H processor • 16GB DDR4-2933 RAM • 8GB Nvidia GeForce RTX 2070 Max-Q graphics • 15.6in non-touch IPS display, 1,920 x 1,080 resolution • 512GB M.2 PCIe SSD • 720p webcam • 2x 802.11ax Wi-Fi • Bluetooth 5 • Thunderbolt 3 • USB-C 3.2 Gen 2 • 2x USB-A 3.1 Gen 1 • 3.5mm jack • 65Wh battery • Windows 10 Home • 355 x 235 x 19.9mm (WDH) • 2.1kg • 1yr limited warranty

BELOW There’s a USB-C, USB-A and Gigabit Ethernet port on the left



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.

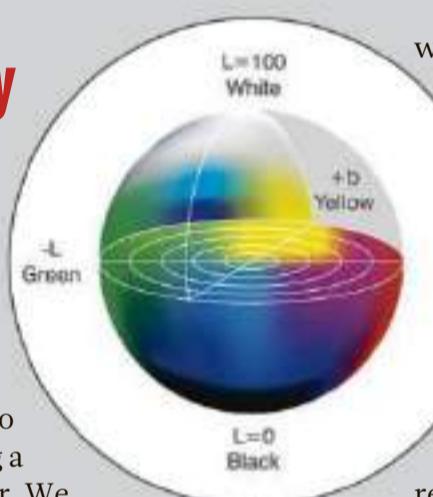
We test laptop battery life by playing back a full-screen video until the battery runs out. We set the screen brightness to 170cd/m², or as close as we can get using its settings, and switch to Flight mode.



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 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 (gfbench.com) to see how well the phones and tablets are likely to perform in games.

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



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.

Phones and tablets

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



What our awards mean



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



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

Samsung Galaxy Watch 3

An attractive and feature-laden watch, but it doesn't improve on the original as much as we'd like

SCORE

PRICE 45mm, £349 (£419 inc VAT)
from johnlewis.com

In spite of its name, the Galaxy Watch 3 is only the second "true" Galaxy Watch Samsung has made. While the sporty Galaxy Watch Active 2 (pcpro.link/313active) surfaced in early 2020, this is the first proper upgrade to the company's flagship, which launched in 2018.

The Watch 3 comes in two sizes – 41mm and 45mm – and both run Samsung's Tizen operating system, meaning you can use them with Android and iOS smartphones. The smaller model starts at £399 for the Bluetooth-only variant and comes in bronze and silver, while the larger model costs £419 and is available in black and silver. Another £40 buys you 4G, irrespective of which size you pick, so a 45mm 4G Galaxy Watch 3 costs £460.

The Galaxy Watch 3 is smaller and thinner than the Galaxy Watch despite having a larger display. Take the 45mm model I tested: it has a 1.4in AMOLED panel while being 1.8mm thinner and weighing 9g less than the 46mm original. The 41mm variant includes a 1.2in display and both have a 360 x 360 resolution. This makes for a noticeably less bulky watch than before, but the 45mm Galaxy Watch 3 still isn't exactly svelte.

Samsung sacrifices battery size for the smaller chassis, with a 340mAh capacity compared to the 470mAh unit in the 46mm Watch. Samsung promises a typical life of over 56 hours between charges, but I squeezed in three to four days of use despite logging the occasional GPS activity. Both models support wireless charging, so you can charge them from any Qi wireless charger, as well as the one supplied in the box.

Although the Galaxy app store is notoriously limited compared to both Apple's watchOS and Google's Wear OS equivalents, one of the main perks is that the operating system's native Spotify app lets you store playlists for offline playback. Both sizes come with 8GB of onboard storage, of which you can use around 4GB to store music. Note, though, that you can't



transfer locally stored songs from an iPhone.

In terms of other features, the Watch 3 does everything you'd expect from a flagship smartwatch. It has GPS for tracking speed and distance, an optical heart-rate sensor, an accelerometer and it's waterproof to 50m. New to this release: it can measure your blood oxygen levels using a built-in SpO₂ sensor, and it will now give you a sleep score.

Runners will be pleased to learn that the Watch 3 can estimate your VO₂ max and even offer advanced running analysis. Amazingly, the watch records asymmetry, contact time, flight time, regularity, vertical oscillation and stiffness directly from the wrist. Those are insights you'd normally associate with specialist running watches from Garmin, while the Samsung Health app offers plenty of info on how to interpret the data to improve your running form.

The Watch 3 works brilliantly as an everyday fitness tracker too, letting you see how active you've been and prompting you to move around if you've not done enough. It will also automatically start workouts after you've been moving for ten minutes, which is handy if you forget to hit the record button.



ABOVE A rotating bezel makes perusing widgets a smooth and fun process

Sadly, the Watch 3 still falls short of being a truly great sports watch. For instance, there's no option to manually set your heart-rate zones in the Samsung Health app, and you can't use a Bluetooth heart rate monitor along with the watch's native fitness apps. The good news is that the optical sensor is accurate.

There are plenty of non-sporty features. There's NFC for making contactless payments via Samsung Pay, while a speaker and microphone enable you to make calls from your wrist. I found it useful to answer calls without having to reach for my phone and call quality was clear via the tiny built-in speaker – those I spoke to reported they could hear me well. Replying to messages from my Google Pixel using the watch's canned responses was a cinch. Note this feature isn't available for iOS users.

The last significant new feature is fall detection. After adding up to four SOS contacts to the Galaxy Wearable app, you can choose which one the watch calls should it detect a fall.

It's disappointing that the Watch 3 uses the same 1.15GHz Exynos 9110 processor as its predecessor, but this doesn't mean it feels slow. Navigating its widgets via the brilliantly tactile rotating bezel is both nippy and enjoyable, and all the info you might want relating to your health and fitness is easy to find. Samsung also lets you pick from a wide range of watch faces.

"I found it genuinely useful to answer calls without having to reach for my phone and call quality was clear via the tiny speaker"

The Galaxy Watch 3 is a brilliant-looking smartwatch that does the basics well – you can even make the case that it's the best smartwatch

Android users can buy – but thanks to its elderly innards and limited app store, it isn't the world-beating smartwatch it should be for the price. You can enjoy a similar experience with both the Galaxy Watch (the 46mm version costs £279 from John Lewis) and Galaxy Watch Active 2 (44mm for £269) and save a considerable amount of money in the process. **EDWARD MUNN**

SPECIFICATIONS

- 1.4in AMOLED display, 360 x 360 resolution
- 1.15GHz Exynos 9110 processor
- 1GB RAM
- 8GB storage
- 802.11n Wi-Fi
- Bluetooth 5
- NFC
- accelerometer
- barometer
- gyro sensor
- light sensor
- optical heart-rate sensor
- SpO₂ sensor
- 340mAh battery
- Tizen OS
- 46.2 x 45 x 11.1mm (WDH)
- 54g
- 1yr RTB warranty

AMD IMPULSE (RYZ7)

AMD Ryzen 5 2600 - 6 Cores (O.C 4Ghz)

ASUS PRIME B450M-A

CORSAIR 8GB DDR4 3000Mhz

INTEL 512GB M.2 nVME 660P

AMD RX 560 2GB

GAMEMAX Expedition

MICROSOFT Windows 10 or 10 Pro

£499.99**Impulse****INTEL i5 MERCURY (COF9)**

INTEL Core i5 9600K (O.C 5Ghz)

ASUS PRIME Z390-P

CORSAIR 16GB DDR4 3000Mhz

INTEL 1TB M.2 nVME 660P

INTEL UHD 630 Integrated Graphics

KOLINK Stronghold

MICROSOFT Windows 10 or 10 Pro

£599.99**mercury****AMD NAVIGATOR (RYZ8)**

AMD Ryzen 5 3600X (O.C 4.3Ghz)

ASUS TUF X570-Plus Gaming

CORSAIR 16GB DDR4 3600Mhz - RGB

INTEL 512GB M.2 nVME 660P

SEAGATE 2TB Sata3 HDD

AMD 5700XT 8GB

CORSAIR iCUE 220T RGB White

MICROSOFT Windows 10 or 10 Pro

£1249.99**NAVIGATOR**

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Samsung Galaxy Tab S7+

The fast, light and good-looking Tab S7+ is gunning for the iPad Pro – and in many ways it succeeds

SCORE

PRICE 12.4in, £666 (£799 inc VAT)
from johnlewis.com

The Galaxy Tab S7+ is clearly intended as a direct competitor to the recently refreshed iPad Pro (see issue 310, p52). Just like its rival, it comes in two different screen sizes, with the regular S7 costing £619 and including an 11in screen. Here, we focus our attention on the 12.4in S7+.

This is the only model with the potential for 5G, but you pay another £200 for the privilege. Unlike the iPad Pro, it comes with a bundled stylus – now even more responsive thanks to the 120Hz screen – and you can expand the Tab's 128GB storage via the SD card slot by up to 1TB. But its real advantage is price. The entry-level 12.9in iPad Pro costs £969, with the Apple Pencil adding £119.

Both Apple and Samsung hope to squeeze more money out of you for a keyboard, but Samsung takes a more unconventional approach with its two-part keyboard option (£220). The first part comprises a cover that magnetically snaps to the back of the tablet. This has a kickstand and a smooth hinge that lets you angle the tablet up to almost 180°, plus a handy slot to store the S Pen stylus.

The keyboard part attaches to the magnetic three-pin connector on the tablet's bottom edge, includes a touchpad and doubles up as a protective cover for the screen. Each key has a decent amount of travel and feedback. The spacing between each letter is just right too. You won't hit your full touch-typing speed on it straight away, but nor will you make loads of mistakes.

What truly turns this machine into a makeshift laptop, though, is DeX

mode: a desktop-like user interface that can even be displayed on an external monitor. You can open multiple windows at once, drag and drop, and right-click for context-sensitive options. I was particularly impressed with how DeX managed incoming notifications – they appear in the bottom-right corner of the screen, as they would in Windows 10.

The Tab S7+ is also one of the first mobile devices to support Microsoft's Project xCloud game-streaming service. From mid-September, if you have an Xbox Game Pass Ultimate subscription (£11 a month) then you can stream and play over 100 Xbox games straight to the tablet. This counters one of the perennial objections to Android tablets – the lack of apps compared to Apple – but that spectre still looms large. Sadly for Samsung, it's also out of its hands.

What Samsung can control is the hardware and there's much to like here, starting with the 120Hz, HDR10+ "Dynamic AMOLED" panel. The Tab S7+ uses a 2,800 x 1,752 display with a pixel density of 266ppi, matching the 12.9in iPad Pro's 265ppi, and gives you the choice of "Natural" or "Vivid" colour profiles. These are aptly named.

Natural mode is the most colour accurate of the two, with an average Delta E of 2, and it covered 93.5% of the sRGB colour space with a total volume of 94.5%. If you want rich, bold colours, switch to Vivid. The only slight disappointment is that brightness peaks at 367cd/m², which falls behind the iPad Pro's 520cd/m².

Build quality is excellent, despite skinny bezels and a 5.7mm thickness. It still feels light, and whether you choose Mystic Bronze, Mystic Black or



ABOVE Skinny bezels and a skinny price make this a pretender to the tablet throne



"The Samsung Galaxy Tab S7+ is a great tablet for everything from working on Word documents to watching Netflix"

Mystic Silver finishes, you'll be buying a stylish device. And a speedy one. Qualcomm's Snapdragon 865+ pushed it to a single-core result of 965 in Geekbench 5, with a multicore score of 2,814; that's twice as fast in multicore processing than my work laptop, a 2016 MacBook Pro with a dual-core Intel Core i5-7267U. An Adreno 650 graphics chip ensures games run smoothly, with 131fps in the off-screen Manhattan 3 test and 70fps onscreen.

Samsung supports Qualcomm's latest chipset with 6GB of RAM and a beefy 10,090mAh battery. This lasted 11hrs 5mins in our standardised video-rundown test, which is a 36% decrease on the Tab S6's (15hrs 6mins) but the battery should last a full work day without needing to be charged. You can squeeze out an extra couple of hours if you dial the screen refresh rate down to 60Hz. There's no denying that the iPad Pro is the more versatile tablet, whether that's due to its extra features, range of apps or richer ecosystem of accessories. But the Tab S7+ is a great tablet for everything from working on Word documents to watching Netflix. And the price, which is considerably less than the iPad Pro equivalent, makes it a tempting purchase. **NATHAN SPENDELOW**

ABOVE There are 13 megapixels at your disposal on the rear of the tablet

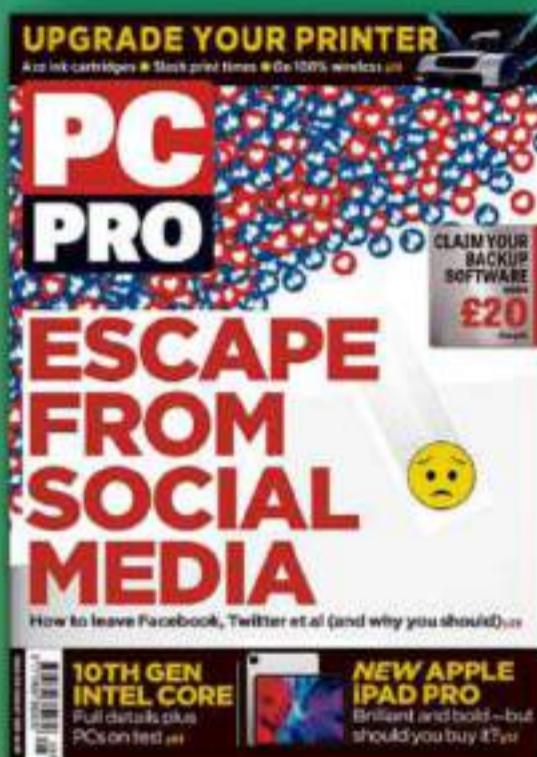
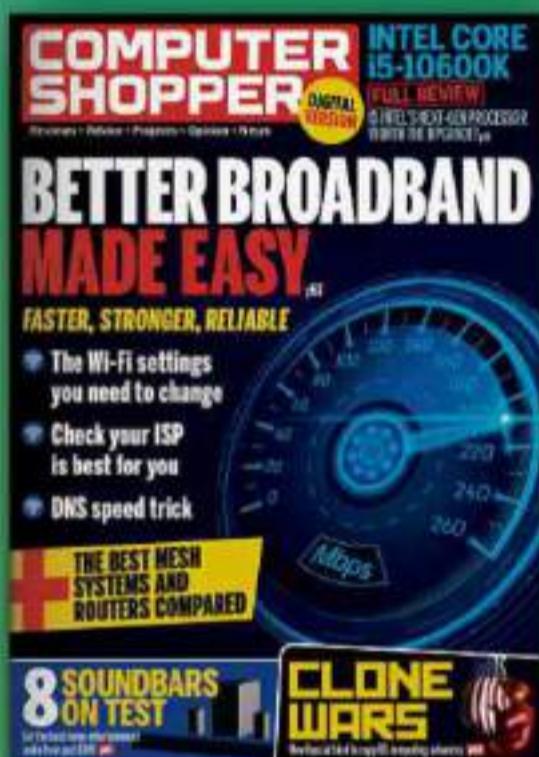
LEFT Luckily, the Mystic Bronze model falls on the right side of bling

SPECIFICATIONS

Qualcomm Snapdragon 865+ chipset
Adreno 650 graphics • 6GB RAM • 12.4in AMOLED screen, 2,800 x 1,752 resolution
128GB storage • microSD slot • dual 13/5-megapixel rear camera • 8-megapixel front camera • 802.11ax Wi-Fi • Bluetooth 5
NFC • USB-C connector • 10,090mAh battery
• Android 10 • 285 x 5.7 x 185mm (WDH) • 420g • 1yr warranty



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Samsung Galaxy Note 20 Ultra

A bigger screen and battery are matched with an inflated price, but in a sea of similar handsets the Note 20 series stands out

SCORE

PRICE 256GB, £983 (£1,179 inc VAT)
from johnlewis.com

The term “phablet” might not be fashionable anymore, but Samsung’s Galaxy Notes are still the first handsets that spring to mind when you think of that term. Despite outlasting the designation once used to define it, the Note is back once again, and this time around Samsung isn’t resting on its laurels when it comes to upgrades.

There are two models of Note 20 to choose between in 2020. The Galaxy Note 20 Ultra is primed to steal the limelight, since it’s where you’ll find all the extras. Just be prepared to fork out the most you’ve ever had to spend on a (non-folding) Samsung phone: while the plain Note 20 is £849, the Ultra starts at £1,179.

In return, you get a monster list of upgrades compared to last year’s Note 10+ (see issue 304, p81). That includes Samsung’s most up-to-date

flagship processor, the Exynos 990, as well as a 6.9in 120Hz screen, a 108-megapixel camera (accompanied by wide-angle and telephoto zoom lenses) and 5G as standard. The S Pen returns with new features, along with DeX mode, Samsung’s desktop-like interface, which now supports wireless screen mirroring.

■ Key features

There’s no hiding from this phone’s size, but Samsung keeps it comfortable in the hand, with curved sides – unlike the regular Note 20 – that literally take the edge off the 77mm width. It’s tall at 165mm, but an 8.1mm thickness means it’s more svelte than you might expect while a weight of 208g is reasonable.

The 6.9in screen dominates first impressions. A neat hole-punch notch sits in the top-centre portion of the display, which houses the ten-megapixel selfie camera, and it also has some of the skinniest bezels I’ve ever seen on a handset.

Flip the phone over, though, and we encounter the first of Samsung’s aesthetic missteps. The rectangular camera housing, which sits in the top-left corner, is unsightly. It takes up a lot of space, increases the weight of the top portion of the handset, and protrudes a noticeable 4mm. Nor am I a fan of the harsh-edged top and bottom sides of the phone, and there isn’t even a 3.5mm headphone jack for compensation.

Still, the remaining rear space is quite lovely. There are three elegant colour choices, with a fingerprint-



ABOVE The front is almost entirely screen while the S Pen has picked up new tricks



“Other work-friendly improvements include a PC-like folder, deeper Windows integration and autosaves to the cloud”

friendly frosty finish to chew over this year: Mystic Black, Mystic White and Mystic Bronze. This looks just as good here as it does on the Samsung Galaxy Tab S7+ (see p56).

■ Pen features

The S Pen’s interior housing has switched sides and is now in the bottom-left corner instead. There are a few minor upgrades this year, most notably when it comes to writing precision: the Note 20’s S Pen has a speedy 9ms latency, which is a 40% improvement upon last year’s model. There are five new waggle-like gestures too, including one that allows you to shake the S Pen to take a screenshot and then directly annotate it.

The phone’s note-taking software can now straighten wonky handwriting and you can attach voice recordings to your notes, allowing you to read and listen at the same time. Other work-friendly improvements include a PC-like folder and sub-folder structure, deeper Windows integration, autosaves to the cloud and wireless DeX functionality with any TV or monitor that supports screen-mirroring.

As for play, both Note 20 phones are among the first to support Microsoft’s Project xCloud streaming

LEFT The main camera is spectacular for all of the right reasons – unlike its ugly housing



service. As long as you have an active Xbox Game Pass Ultimate subscription, and both phones come with a three-month pass, you'll be able to stream and play more than 100 Xbox games when the service launches in mid-September. You'll need to pair a compatible Bluetooth controller to play games, however.

There's one notably absentee: Bixby. Samsung's naff digital assistant wasn't mentioned at Samsung's official launch of the Note 20, and the dedicated Bixby button on the side of the phone has gone. Rumours about the upcoming Google Assistant integration might be true.

So nice it hertz

Not only does the Ultra benefit from the largest-ever screen on a Note handset, it's also the first Note with a 120Hz refresh rate. The caveat is that you can't enable the 120Hz setting at the phone's native screen resolution of 3,088 x 1,440. Instead, you have to dip the resolution down to FHD+ in the display settings. The regular Note 20, which is £330 less, doesn't have this problem as it uses a 60Hz panel.

The Dynamic AMOLED screen also supports HDR 10+ content, with two display modes to choose from. With the Natural profile activated, the Note 20 Ultra reproduced 93.7% of the sRGB colour space with a total volume of 95.2% and an average Delta E of 3.3. Switch to Vivid and you sacrifice accuracy but it covers 88.8% of the Adobe RGB and 96.6% of the DCI-P3 gamuts – far better if you're looking for punch.

It's bright, with a measured peak luminance of 688cd/m² with the auto-brightness setting engaged, which is more than enough to ensure that the screen is readable in sunny conditions. Likewise, HDR 10+ content on Netflix, Prime Video and YouTube looks sublime, with deep, rich colours and boosted highlights in darker scenes.

Notable power

The Ultra is powered by Samsung's latest in-house flagship chipset, the Exynos 990. This eight-core processor has a maximum clock speed of 2.73GHz and it's a capable performer.

It isn't, though, as fast as the Snapdragon 865+ inside US versions of the Galaxy Note Ultra, as shown by the OnePlus 8's superior results in Geekbench 5. How much this matters in

real-world use is questionable but it's still annoying when you're paying this much for a phone. The good news is that the Exynos 990 is a third faster in multicore tests than the Exynos 9825, which powered the Galaxy Note 10+.

Gaming performance follows a similar trend, with the Note 20 Ultra significantly behind its rivals but far faster than last year's Note 10+. Again, though, you can hardly call this phone slow, and it's helped by the 120Hz screen. Provided the game supports it, you should expect to reach above 60fps in a wide variety of titles.

Elsewhere, there's a healthy 12GB of RAM for multitasking, as well as either 256GB or 512GB of internal storage. While the vanilla Note 20 doesn't have expandable storage, the Ultra model has a microSD slot, which takes cards up to 1TB in capacity.

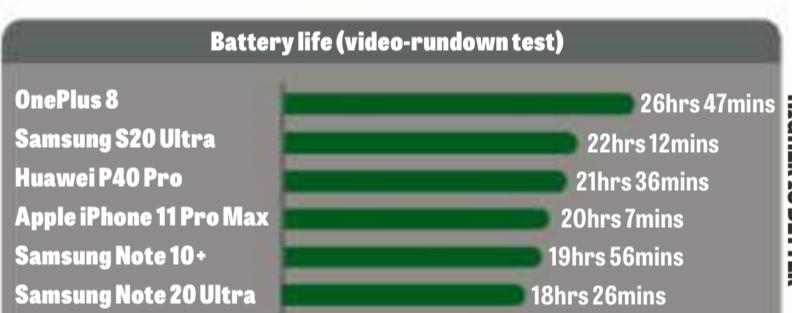
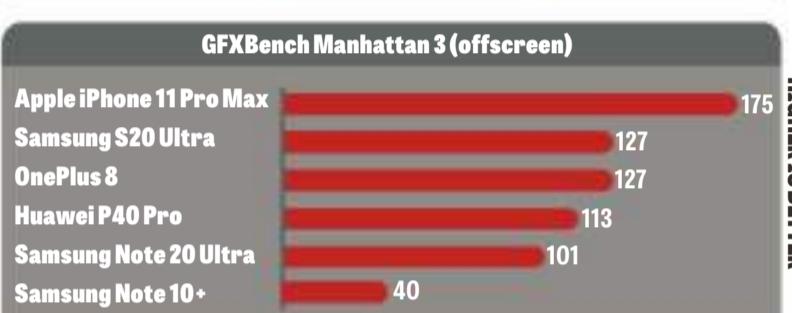
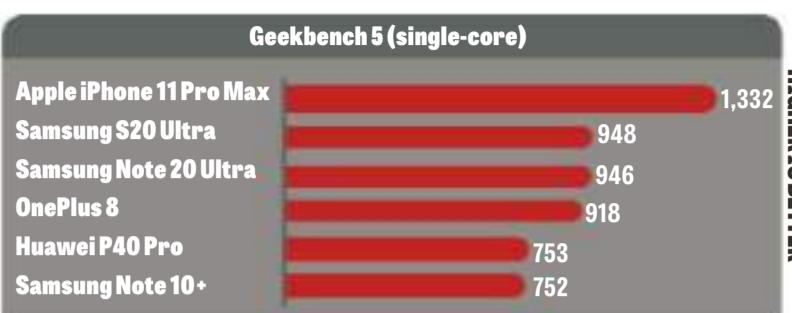
The Ultra also has a larger battery, at 4,500mAh, with support for 25W charging – it can charge up to 50% from empty in only 30 minutes. In our video-rundown test, it lasted 18hrs 26mins at native screen resolution, before needing to recharge. If you dial the resolution down to FHD+ but increase the refresh rate to 120Hz, the stamina decreases by 14%.

Advanced cameras

The camera offering is also slightly different to the regular model, most notably when it comes to "Space Zoom". Both phones have a triple-camera array at the rear, but the regular Note 20's telephoto unit can only use Samsung's hybrid zoom technology up to 30x, while the Ultra is capable of "zooming" up to 50x.

I don't think this is worth buying the more expensive phone for, but where the Ultra does beat its Note 20 stablemate is with its huge 108-megapixel main camera unit – which works with the 12-megapixel zoom sensor and a 12-megapixel ultra-wide camera.

The Ultra can capture video at up to 8K resolution, although you'll have to drop the resolution down to 4K to record at 60fps. Samsung has also updated the camera software and you can now enable an onscreen histogram, as well as audio level indicators. The zoom slider has been improved too, and you can now tinker with multi-source mic controls, if you decide to pair the phone with a Bluetooth mic – including the new Galaxy Buds Live.



Winning notes?

The Ultra is everything you could ask of a modern flagship. It's fast, takes great pictures, has a delightful screen and its software experience is refined.

But there's one major sticking point: the high launch price. At £1,179, I can't imagine Samsung is going to be inundated with orders. Other than the three months of Xbox Game Pass Ultimate, there aren't any freebies to sweeten the deal, either.

Perhaps Samsung is busy looking at the iPhone 11 Pro Max (see issue 304, p80), which costs £1,299 for the 128GB model. Or perhaps it knows it's selling something unique.

If you want the best Android phone you can buy, and will take advantage of its features, nothing can match it. **NATHAN SPENDELOW**

SPECIFICATIONS

8-core 2.73GHz/2.5GHz/2GHz Samsung Exynos 990 processor • Mali-G77 graphics • 12GB RAM • 256GB storage • microSD card slot • 120Hz 6.9in AMOLED screen, 1,440 x 3,088 resolution • triple 108/12/12-megapixel rear cameras • 10-megapixel front camera • 802.11ax Wi-Fi • Bluetooth 5 • NFC • USB-C • 4,500mAh battery • Android 10 • 77 x 8.1x 165mm (WDH) • 208g • 2yr warranty (via John Lewis)

LEFT Don't bother looking for the Bixby button because it's gone – thankfully



HIGHER IS BETTER

HIGHER IS BETTER

HIGHER IS BETTER

HIGHER IS BETTER

59



Google Pixel 4a

The Pixel 4a is a fabulous smartphone: compact, lightweight, streamlined and very reasonably priced

SCORE

PRICE £291 (£349 inc VAT)
from store.google.com

Google's cheapest smartphone is almost here – it goes on sale in October – and it's immediately obvious that Google is aware it must work harder with the 4a than the Pixel 3a (see issue 304, p85). Not only does it cost less than last year's phone did at launch, its slim body houses a larger screen and is crammed with handy upgrades.

Such improvements are essential. Whichever way the company turns, it has competition. Above: OnePlus with the pricier expensive Nord (see p62). Below: Motorola with the £300 Moto G 5G Plus (see issue 312, p68). And to the side: Apple with the revamped iPhone SE (see issue 310, p77).

Winning formula

To fight off such fearsome opposition, Google has simplified its offering. There's only one of its low-priced Pixels in 2020, with the new handset sitting neatly between the 3a and 3a XL in terms of screen size: you'll enjoy a 5.8in AMOLED display with a 1,080 x 2,340 resolution. That results in a sharp pixel density of 443ppi, with an eight-megapixel selfie camera in a small hole in the top-left corner.

It's a peach of a screen too. Brightness peaked at 437cd/m², which is enough to ensure easy readability on all but the sunniest days, and you have a choice of three colour modes in the Settings menu: Adaptive (the default), Natural and Boosted.

In Natural mode, the phone covers 93.7% of the sRGB colour gamut out



of a total volume of 94.5% with an impressive average Delta E score of 1.05. That's an excellent set of figures for a phone that costs as little as this. In Boosted mode, colour coverage most closely matches the DCI-P3 colour space, with coverage of 83.9% out of a volume of 84.2%. Meanwhile, the Adaptive mode appears to fall between Boosted and Natural, with a DCI-P3 coverage of 80.5% (out of 80.6% volume).

Don't get too excited by this phone's support for HDR playback: with Boosted or Adaptive mode enabled, HDR video tends to be too dark for my liking.

Simple design

Google has also simplified its choice of colours, with a Ford-style offering of black or nothing. It's built from a block of matte-finish polycarbonate rather than more exotic materials, and this gives it a simple, functional appearance that I rather like. Despite the lack of gleaming aluminium or glass, it doesn't feel cheap – plus it barely picks up fingerprints.

Then there are the nice user-friendly touches. For instance, I love the way that the circular fingerprint reader at the rear blends seamlessly into the plastic housing, while the white power button on the right edge makes it easy to differentiate from

the volume buttons so you don't accidentally switch off the phone.

It's also great that it's small enough to hold and operate with one hand, without being so small that you'll yearn for something bigger. Indeed, at 69 x 8.2 x 144mm (WDH), the Pixel 4a is only a fraction larger than the iPhone SE, which has a smaller 4.7in display.

The only things I'd complain about are the lack of official water-resistance and memory expansion capabilities, although it's worth noting that the 128GB you get is double the storage of its iPhone rival.

Punchy camera

The "simple is best" approach also applies to the camera too. There's only one lens at the rear, but that doesn't matter: this 12.2-megapixel f/1.7 camera, combined with Google's computational photography genius, is capable of serving up truly astonishing results.

The phone's Super Res Zoom feature provides convincingly sharp digital zoom shots without requiring a separate zoom camera; it uses hand shake to fill in the missing details as you zoom into a scene.

Likewise, portraits shot on the Pixel 4a are brilliant. Whether in good light or bad, backlit or indoors, every portrait I captured came out looking sharp and crisp with lovely neutral colours, flattering skin tones and a creamy, simulated bokeh background with my subject isolated in sharp relief in the foreground (see comparison photos overleaf).

Indeed, for zoom and portrait shots, the Pixel 4a beats the OnePlus Nord hands down; in my view, it's even better than the iPhone 11 Pro Max for portraits – a phone that costs almost three times as much.

For regular photos and video, there's a lot less between the Pixel 4a and OnePlus Nord, but the Pixel still puts in a sterling performance. Low light shots are impressive, especially captured in the upgraded Night Sight mode. Although you can only shoot 4K video at 30fps (you have to drop to 1080p for 60fps), it's stabilised effectively and with fewer glitches than on the Nord.

The only area where the Nord does pull ahead is with its ultrawide

ABOVE Practicality, rather than an eye-popping design, is the order of the day



"It's a peach of a screen too. Brightness peaked at 437cd/m², which is enough to ensure easy readability on all but the sunniest days"

LEFT The rear camera delivers flattering portraits and detailed zoom shots



cameras, both on the rear and its 32-megapixel selfie camera, but I'd rather have Google's cutting-edge software – especially when shooting in astrophotography modes and using its Live HDR+ feature.

Software advantage

Nor is the camera alone in benefiting from Google's software expertise. The Pixel 4a uses the latest Pixel Launcher software, which includes all of the features that impressed us with the Pixel 4 (see issue 303, p62), along with new and enhanced ones for good measure.

So you're getting the Pixel 4's fabulous Recorder app, which turns voice recordings into text almost magically (and without the need for an internet connection), but with extra features. On the Pixel 4a, you can now start, stop and search voice recordings, using Google Assistant, and you can now export directly from Recorder to Google Docs.

It's also now possible to use the same voice-recognition tech to add a "Live Caption" box (which is essentially a high-tech version of subtitles) to audio and video calls on your phone, even in third-party apps. Previously, this was only available for general audio and video playback, not calls.

There's a lot more besides this, including Google's gesture navigation and some new updates to the Personal Safety app. And not to mention being at the front of the queue for OS and security updates.

Areas of compromise

After all these positives, something has to give. One notable omission is 5G, although Google has said that its cleverly titled Google Pixel 4a 5G will land in the "autumn" alongside the Pixel 5. This might be worth holding on for, as the phone's 4G speeds aren't spectacular, with the Qualcomm Snapdragon 730G's embedded X15 4G modem capable of up to 600Mbps/sec downloads and 75Mbps/sec uploads. (Note the lack of support for Wi-Fi 6 too.)

While that processor is one rung down the performance ladder from Qualcomm's top-end 8-series CPUs, Google gives it a lift by including 6GB

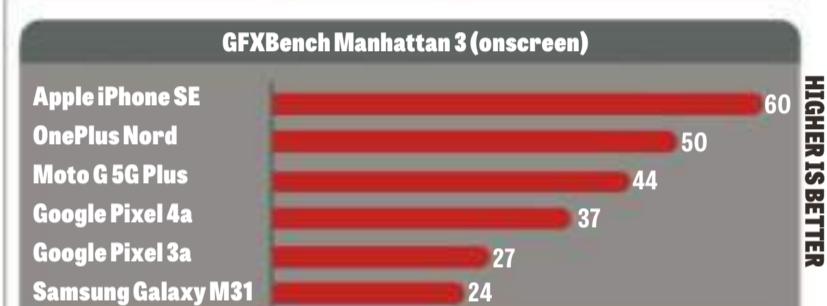
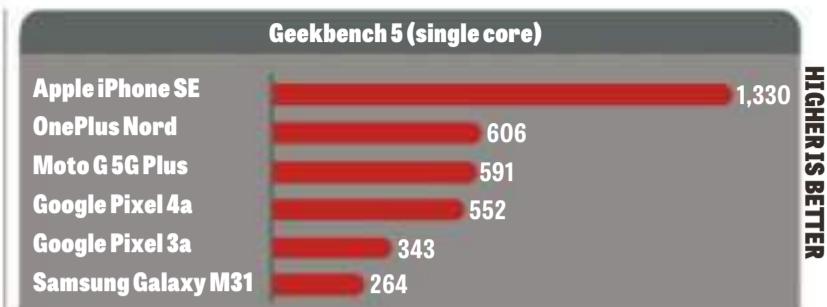


of RAM. This helped the Pixel 4a largely keep up with its close rivals (see the graphs to the right). Only the iPhone SE is significantly faster and, while it's nice to have a little extra performance in reserve, the Pixel 4a is responsive in day-to-day use.

Nor is this the longest-lasting phone, with Google opting for a relatively small 3,140mAh battery. Compare that to the OnePlus Nord's 4,115mAh pack or the 5,000mAh whopper in the Motorola Moto G 5G

Plus. And if battery life is your priority, the cheaper Samsung Galaxy M31 (see issue 312, p70) comes with a huge 6,000mAh unit.

It's hardly surprising, therefore, that the Pixel trailed these rivals in our video-rundown test. However, it still managed to post a respectable time of 18hrs 43mins and it's a whole



ABOVE LEFT Squint and you'll just about see the camouflaged fingerprint reader

lot better than its compact rival, the iPhone SE (2020), which only lasted 11hrs 35mins in this test.

Buying decision

So, where does that put the Pixel 4a? If you're after a phone that won't make much of a bulge in your pocket then it's a great choice. It's a better all-rounder than the iPhone SE, with

a bigger screen, better portrait photography and far superior battery life.

Compared with the OnePlus Nord and the Moto G 5G Plus, it's a more nuanced decision. While both these rivals have 5G, bigger screens, more cameras and better battery life, the Pixel 4a has a charm all of its own; and with the Google Launcher onboard, as well as that amazing camera, there are plenty of reasons to pick one up.

SPECIFICATIONS

Octa-core 2.2GHz/1.8GHz Qualcomm Snapdragon 730G processor • Adreno 618 graphics • 6GB RAM • 128GB storage • 5.8in OLED screen, 1,080x2,340 resolution • 12.2-megapixel rear camera • 8-megapixel front camera • 802.11ac Wi-Fi • Bluetooth 5.1 • NFC • USB-C • 3,140mAh battery • Android 10 • 69x8.2x144mm (WDH) • 143g • 1yr warranty

LEFT The screen isn't quite Pixel-perfect, but it punches well above its price



OnePlus Nord

OnePlus' handset is stylish and packed with tempting specifications – especially if you want 5G

SCORE

PRICE 128GB, £316 (£379 inc VAT)
from oneplus.com

OnePlus made its name by squeezing top-specification components into keenly priced products, but that philosophy went by the wayside as it attempted to elbow its way onto the top table alongside the big names. The Nord is an attempt for OnePlus to rediscover its "true north", as founder Carl Pei put it in a Instagram post.

With more brilliant budget phones on sale than ever before, however, jumping back in and winning cost-conscious customers over is no simple task. Assuming that 5G is on your must-have wishlist, its obvious rival is the Moto G 5G Plus (see issue 312, p68), which comes with the same chipset, 64GB of storage and a similar array of features for £300.

Glossy design

Where the OnePlus Nord immediately wins versus the Moto is style: with both the front and rear of the phone clad in Gorilla Glass 5, it not only looks good but should resist fingerprints, scuffs and scratches. The screen fills most of the front of the phone, with narrow bezels above, below and to either side, and is punctuated only by two cameras, punched into a flat-sided oval in the top-left corner.

The Nord is just as attractive from the rear as it is from the front. It's available in two colours: the striking Blue Marble seen here and Grey Onyx for those who prefer a more businesslike appearance. Both hues have a pleasant, metallic sheen, with the design offset by the phone's four cameras arranged in a vertical stack in the top-left corner.

OnePlus' trademark do-not-disturb slider sits on the right, but don't bother looking for a 3.5mm jack. Nor is there wireless charging or an IP rating, although OnePlus says it has undergone unofficial testing at a depth of 30cm for 30 seconds. There's also an in-screen optical fingerprint reader.



On a charge

Inside is a 4,115mAh battery and Snapdragon 765G chipset, with the latter already proving frugal: it helped the Moto G 5G Plus reach 22hrs 50mins in our video-rundown tests, and the Nord lasted a similarly positive 20hrs 22mins. In real-world use, that should translate to a comfortable day's worth of heavy use, and you may even be able to stretch it to two full days.

The phone also benefits from OnePlus' rapid charging, the committee-named Warp Charge 30T, with a compatible charger included in the box – this can charge the phone to 70% in 30 minutes.

OnePlus also gives the Snapdragon 765G chipset an extra chance to shine by including more RAM than rivals, with the results on p61 for the model we tested with 12GB of RAM. This doubles the storage to 256GB, but with a price hike to £469. If you buy the 128GB version, which includes 8GB of RAM, we'd expect its results to drop a little closer to the Moto G 5G Plus. Note there isn't an SD card slot.

Yet, in terms of speed, dropping to 8GB of RAM isn't a problem. Those graphs show that the Nord and Moto G

LEFT The Nord isn't just a pretty face: the Gorilla Glass 5 screen can repel scuffs



"What really matters is that this phone is fast: it feels so nippy that you start to wonder why anyone spends more on a phone"

have a clear lead over the Google Pixel 4a (see p60), but what really matters is that this phone is fast: the Nord feels so nippy that you start to wonder why anyone spends more on a phone.

Sharp and focused

One reason that it feels fast is the 90Hz screen, which lends Android and supporting apps (such as Instagram) a level of smoothness that 60Hz can't match. It's a great screen in other respects too, which is no surprise as it's the same as that of the OnePlus 8 (see issue 309, p61). A 1,080 x 2,400 resolution and 6.44in diagonal results in a sharp image, while AMOLED tech delivers its usual punchy colours.

Colour accuracy is excellent. In both the phone's Display P3 and sRGB colour modes, the Nord returned average Delta E scores of below 1.5,

and both modes almost perfectly matched their target colour spaces.

While a maximum brightness of 304cd/m² with a full white screen seems disappointing, this reached 771cd/m² in

video playback with a small patch of white against a black background. That hinted at great HDR performance and so it proved, with eye-searing highlights and a rich colour palette.

Such a wide gamut coverage bodes well for photographers wishing to check the colours captured by this phone's cameras, and with six arrayed across the front and rear of the phone the Nord isn't short on options for the photo-obsessed. At the front, there's an eight-megapixel (f/2.4) ultrawide camera with a 105° field of view, and a high-resolution 32-megapixel camera that can capture 4K video at 60fps.

At the rear, the main camera is a 48-megapixel (f/1.75) Sony IMX586 module with a 1.2in sensor that takes 12-megapixel stills by default. That's another piece of hardware borrowed from the OnePlus 8, and wisely so: in good light, images are packed with detail with pleasingly neutral colours. Indoors, in low light, OnePlus' image processing softens images but they remain usable, while its Nightscape lifts extra detail and colour in dim or dark scenes.

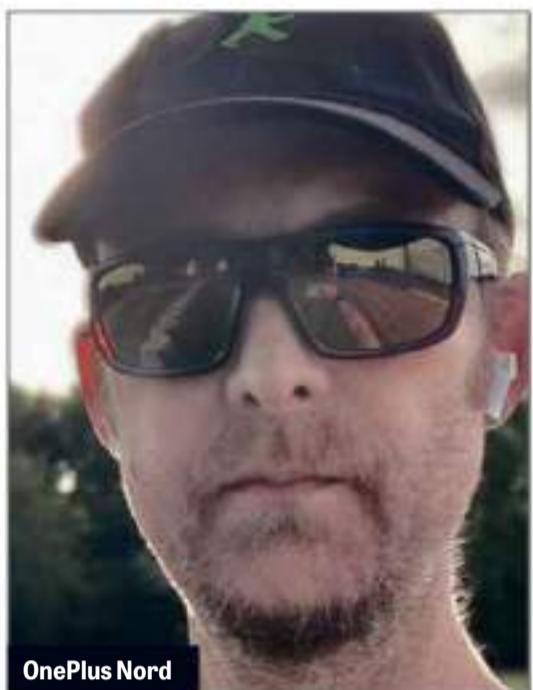
The main camera is on a par with the superb Apple iPhone SE (see issue 310, p76) but, given that you also have the option of ultrawide (eight-megapixel, f/2.2) and macro cameras (two-megapixel, f/2.2), plus an extra ultrawide selfie camera at the front, you can do far more with the Nord. My only caveat is that the extra cameras are best reserved for good light, and in truth I was disappointed by the grainy and sometimes blurred results from the macro camera.



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PHOTO GALLERY

See how the OnePlus Nord's camera compares to the Google Pixel 4a



OnePlus Nord

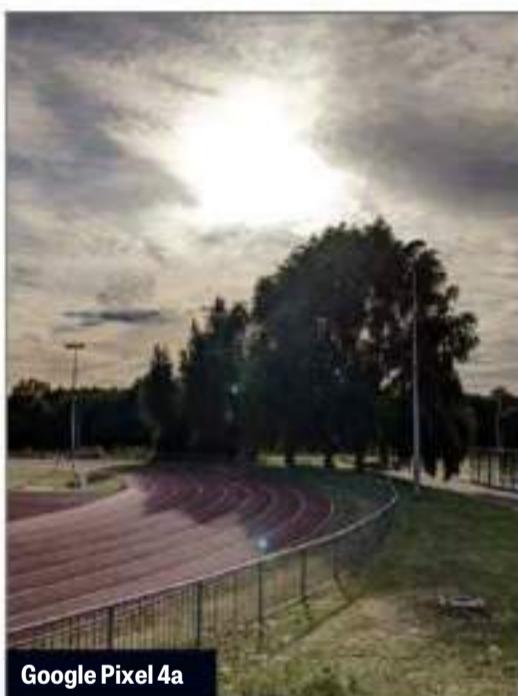


Google Pixel 4a

Every Pixel 4a portrait shot emerged looking sharp with neutral colours against a creamy, simulated bokeh background; the same can't be said for the OnePlus Nord's portraits



OnePlus Nord



Google Pixel 4a

In more general shots, though, there isn't a huge amount to choose between the two phones: both handle challenging conditions well

This wouldn't be my top-choice smartphone for shooting video, either. You can only shoot 4K at 30fps, so if you want 60fps you'll have to drop to 1080p. The stabilisation is as impressive as ever, though, and footage is packed with detail whether you're capturing in 4K at 30fps or 1080p at 60fps.

True Nord?

The big question is whether all these features produce a phone that's worth buying, or should you forget OnePlus altogether and opt for a cheaper rival? It comes down to how much you value build quality and looks over other, more practical concerns. The Nord is certainly one of the best-looking phones we've come across at this price. The specification is great,

battery life excellent and the camera isn't bad at all.

Personally, I'd choose the Moto G 5G Plus because it's cheaper and has a larger battery – and if 5G isn't important to you, consider the Pixel 4a instead. There isn't much in it, though, and you certainly won't be disappointed with the OnePlus Nord.

JONATHAN BRAY

SPECIFICATIONS

8-core 2.4GHz/2.2GHz/1.8GHz Qualcomm Snapdragon 765G • supports 5G • Adreno 620 graphics • 8GB RAM • 128GB storage • 6.44in AMOLED screen, 1,080 x 2,400 resolution • quad 48/8/5/2-megapixel rear cameras • dual 32/8-megapixel front cameras • 802.11ac Wi-Fi • Bluetooth 5.1 • NFC • USB-C • 4,115mAh battery • Android 10 • 73 x 8.2 x 158mm (WDH) • 184g • 1yr warranty



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Vodafone Curve

A neat and affordable GPS tracker from Vodafone that has one obvious downside: it needs to stay charged

SCORE

PRICE £17 (£20 inc VAT) from Vodafone, plus £2 monthly subscription for two years

While Bluetooth trackers are great for finding things that are nearby, there are numerous benefits to a GPS tracker that lives independently. The small, stylish Vodafone Curve promises to be exactly that: you can attach it to your briefcase, your keys (it comes with a strap-on keyring), your dog's collar or your child's backpack and it will regularly ping home and give you a location.

How regularly is up to you. In power-saving mode, it sends updates every two hours with a promised battery life of around seven days. Everyday mode updates every half an hour and should last five days. Switch to performance mode and you're talking five-minute updates and a three-day battery life. You can also set it to real-time updates, but it will only do that for 15 minutes at a time. If you get into trouble, or promised to call home when you arrived at a destination, you can use the Quick Alert button (you need to press it for three seconds, so it's tricky to set off accidentally).

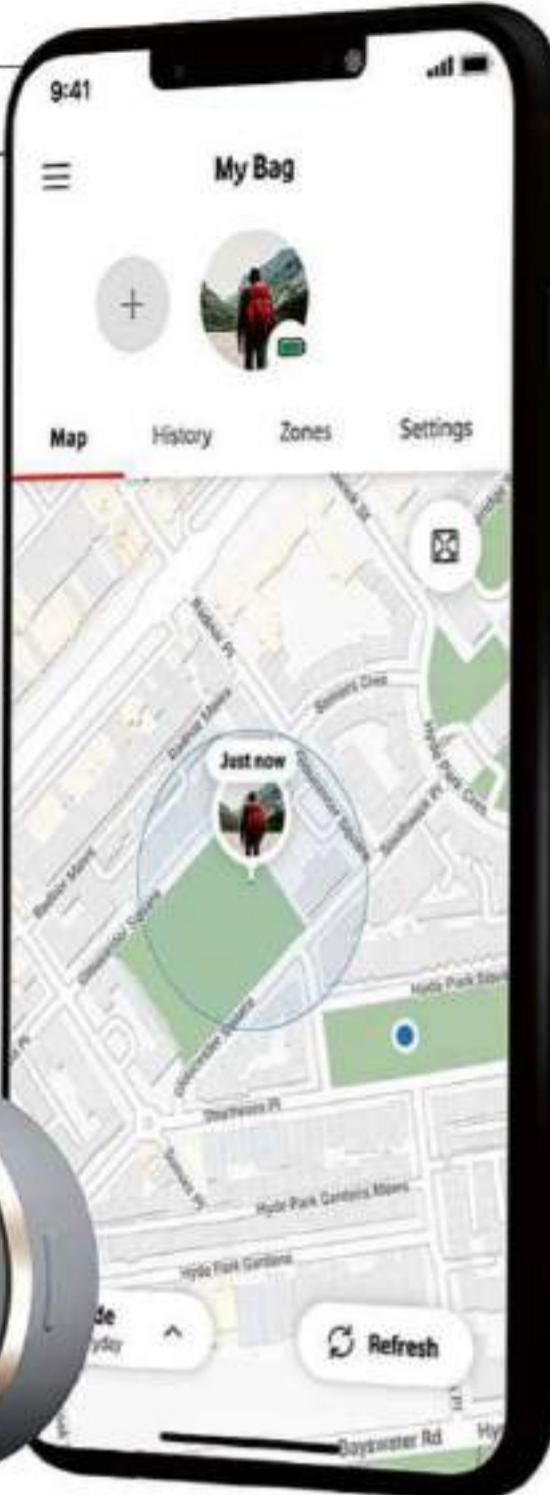
You control all of your preferences from the Vodafone Smart App, which can support up to 20 Curves. Luckily, you can name each Curve, and even associate a photo with it (such as that errant dog), and then play around with zones; so you might have Home and Work, where the tracker will send



a notification each time it enters and leaves that location.

I tested with an Android phone where it smoothly integrates with Google's mapping service to show you where the Curve currently is. For example, I took it for a run and it pinged home as soon as I went outside the "Home" radius, and kept on sending updates for the next 40 minutes. With an IP67 rating, it's safe to use in rain, sandy conditions and extremes of hot and cold.

There are limitations. First, there's no way to track all your devices on one map; you must delve into each unit's setting. Second, battery life is a pain. It uses a proprietary charger and while



ABOVE You can set your own avatar to create a high-tech Marauder's Map

"I took it for a run and it pinged home as soon as I went outside the 'Home' radius, and kept on sending updates for 40 minutes"



LEFT Clip the Curve onto a backpack to keep an eye on your kid's whereabouts

there are LEDs on the front to show basic status (such as charging), these don't provide an accurate indication of how full it is. You'll need to delve into the app for that info.

Perhaps its biggest weakness, though, is that it must be in range of a Vodafone signal for it to ping back its location. That means you can forget about exploring the Siberian tundra. While Vodafone claims that the Curve currently works in 90 countries, that isn't much compensation if your dog, say, has run off in a country field and there's no Vodafone mast in sight.

This is one of the reasons why people who already use similar trackers – such as the Tractive GPS for cats and dogs – prefer a product that isn't tied to one network. Such rivals also highlight one of the Curve's weaknesses, which is that while the app is great at showing you where the Curve is right now, it's much poorer when providing an overview of where it's been. You can see a history in the app, but this is a plain list of locations (such as street name, town) rather than a graphic on a map. Mature products such as the Tractive also work in more countries, with the company currently claiming over 150.

Where Vodafone undoubtedly wins is price. Not merely the £20 upfront cost, but the ongoing subscription fee. Its rivals typically charge £3 to £4 per month, but if you commit to a two-year contract then the Curve will cost £2 per month; that increases to £3 per month if you opt for a 12-month contract. It's a great price for such a useful service.

What's not so great, and the reason this device falls just short of a PC Pro Recommended award, is keeping it charged. Having to do so every week is defensible if it's going to be in constant use, as you'll build this into your routine, but the fact it uses a proprietary charger makes it a pain for occasional use – when you need the Curve, it's bound

to be out of juice, in which case you not only need to charge it before you leave the house but also find the darn charger in the first place. Charging from zero to full takes two hours too.

This counts against it, as does the lack of maturity of the app compared to slicker rivals, but if you have a need for a GPS tracker and aren't affected by the fact it only works on Vodafone networks, this sleek device offers terrific value. **TIM DANTON**

SPECIFICATIONS

GPS • Wi-Fi • Bluetooth • Vodafone SIM (built-in) • quad-band GSM • IP67 rating • 42 x 42 x 16.4mm (WDH) • 30g • lifetime warranty during subscription

Parallels Desktop for Mac 16

This upgrade lacks explosive new features, but it's worth buying to stay in step with Apple's OS developments

SCORE

PRICE New licence, Home & Student, £58 (£70 inc VAT) from parallels.com

Parallels Desktop has been my go-to virtualisation platform for a while, mostly hosting Windows 10 installations. As you'd expect from a fully featured hypervisor, it allows you to do things that you simply can't dream of when Windows is installed onto base hardware. Take a snapshot of how everything is just now? No problem: it takes a few seconds. Roll back five minutes to that moment before you installed an unstable app? Not a problem: with a wave of your magic wand, everything is reset. This is especially powerful when you are working with buggy code, such as a wobbly app or driver.

As before, Parallels lets you set up new virtual machines with a few mouse clicks. It even has pre-cooked download and install images for most everything you could want to do. And if you want to take an existing Windows machine, and "suck its brains out" into a new VM, there are tools to do that too. Pull down a Windows 10 environment complete with the Microsoft development tools stack on a free 60-day licence? It takes a few moments. Want to introduce some network delays and packet corruption into your testing environment? No problem: the virtual switch behind Parallels can do that too.

So what's new in version 16? In truth, nothing too exciting – but that's what you should expect from what was already a very rounded and polished product. There's better 3D support for high-end modelling apps, improved storage optimisation and space reclamation. But let's not get too excited: the problem with virtualisation is that when software really hammers the hardware, you either run out of steam or find that the virtualisation isn't good enough.



Although things are improved here, running Windows 10 in a hypervisor is never going to be as fast as a raw computer running it natively.

I'm more convinced by the other changes, which improve Parallels' core competency: that is, running OSes in a contained, safe environment doing normal, day-to-day things. For instance, you can now freeze-dry virtual machines to a fraction of their size if you don't need them regularly. It also supports all the latest macOS versions, including the forthcoming Big Sur release.

There's a rewritten engine that does away with third-party kernel extensions (KEXTs) in favour of using the Apple hypervisor engine. That's important, because KEXTs are being heavily deprecated by Apple as part of its ongoing security push. As an extension to the kernel, KEXTs have total access to the deepest parts of the OS – and hence everything you do. Apple has been developing new interfaces that shield drivers from the OS and hardware, which means that KEXTs are on the way out. Apps, and hardware, that depend on them, will need to update to keep working in the future. Moving to Apple's hypervisor is one of the biggest changes in this release of Parallels, but it seems to be working well so far.

There are a bunch of other enhancements, including faster load and execution speed. The list goes on and on, as you'd expect from an annual update of a mature product.

ABOVE Don't often use a particular VM? You can boil it down to save space



What hasn't changed much is ease of use, but that's okay: you have to understand what's going on here, and more advanced features, such as the seamless integration of Windows apps directly and individually onto the Mac desktop, requires understanding. This isn't a tool for the beginner, but if you have some technical nous, it can allow an entirely new way of working.

The cost? Still £70 for the Home & Student version, but if you're upgrading then it costs £40. And, to be clear, you really should upgrade: it's best to keep up to date with both the base OS from Apple and your hypervisor tools. It's frankly a modern miracle that these things work at all, so keeping up to date is really important here.

The Pro edition, for developers, testers and power users, is £80 per year, and obviously new editions such as version 16 come as part of the subscription. I have it on

all of my Macs: for me, a Mac isn't complete without a hypervisor, and Parallels is my tool of choice. It gives me the best of every platform, on one computer. It's part of my daily routine, and I can't imagine working without it. **JON HONEYBALL**

REQUIREMENTS

Mac with Intel Core 2 Duo minimum • 4GB RAM (16GB RAM recommended) • 16GB storage space for Windows 10 (SSD recommended) • macOS 10.13 and above

BELOW A Mac that's Dock-full of virtualised Windows apps, as shown by red stripes





Your bonus software

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

Total value this month £130

SoftMaker Office NX Home 2021

■ One-year licence worth £25
softmaker.com

SOFTMAKER OFFICE NX 2021 is a powerful Microsoft Office-compatible productivity suite. It includes a word processor (TextMaker), spreadsheet (PlanMaker) and presentation tool (SoftMaker), and each of these can open both the old-style and Office 365/2010 files used by their equivalent Microsoft applications.

The suite has plenty of useful extras too, including a handy Export to PDF option on every File menu, as well as the ability to run from a USB flash drive.

The commercial version of Office NX Home gives you a whole host of additional features in comparison to the Free version, and we're offering you a whole year's subscription to Office NX Home to take advantage of the additional content.



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

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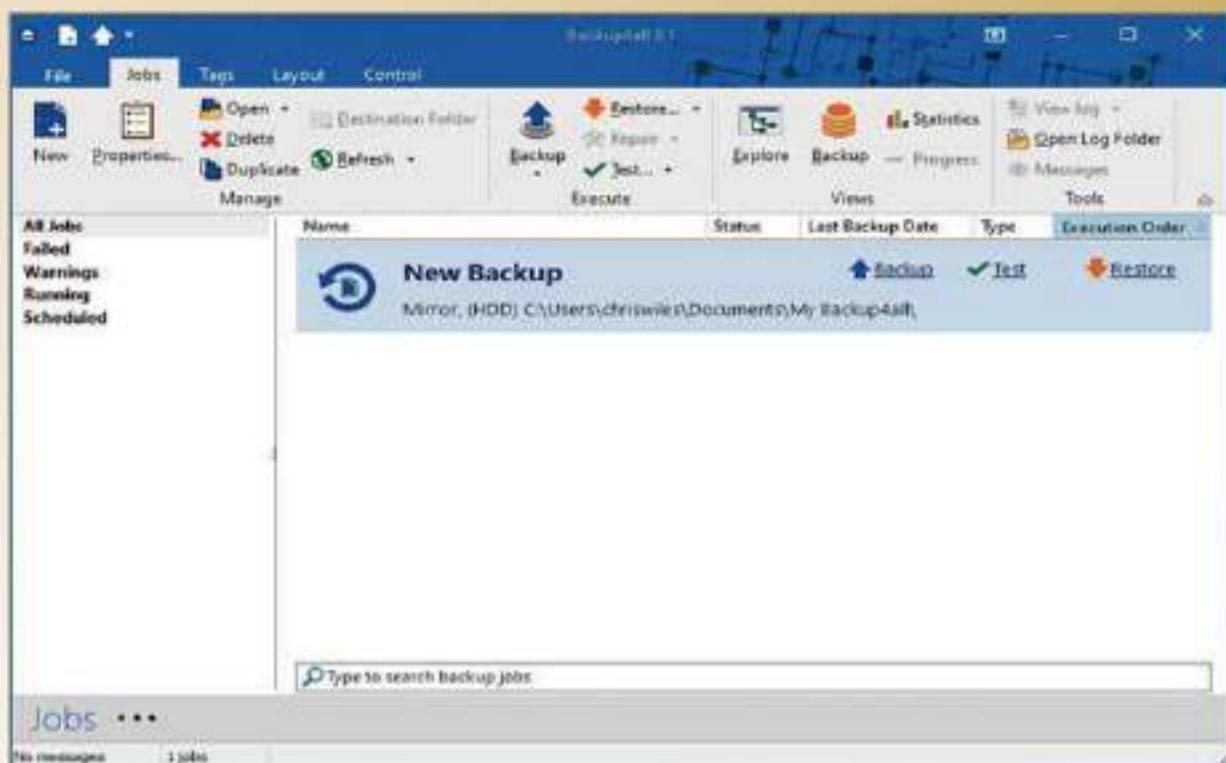
Backup4All 8.7 Lite

■ Full product worth £18
■ backup4all.com

BACKUP4ALL IS AN EASY-TO-USE but very capable backup tool, available in three different versions. The Lite edition here is aimed at home users, but still sports all the core functions most users will need. You can specify the files and folders you'd like to back up, and these can be saved to local, external or network drives; there are options to compress your archives or password-protect them for security; and a simple scheduler can automatically run your backup jobs every day, week or month.

Restoration is just as straightforward, because your backups are mirrors of the original files and folders stored as regular ZIP files. Simply open an Explorer folder and you'll be able to find and recover what you need in seconds.

This latest version benefits from a revamped, more customisable and easier-to-use interface.



REQUIRES Windows 7 or later; 150MB hard drive space; online registration

Ascomp Secure Eraser 5



■ Full product worth £25
■ ascompsoftware.com

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

- Securely delete files and folders using high-level security techniques to overwrite the data numerous times.
- Several levels of security to choose from, ranging from a single overwrite to 35 layers of random data.
- Option to wipe entire drives or partitions also removes the master file table and USN change journal.

Ashampoo Music Studio 2020



■ Full product worth £20
■ ashampoo.com

REQUIRES Windows XP or later; 250MB hard drive space

- A suite of eight tools to help you keep on top of your music collection, covering every aspect of audio management.
- Integrated ripper converts CDs to the format of your choice; separate record component captures tracks from records and tapes.
- Use the editor to normalise tracks, trim unwanted sections and edit file tags.

SoftOrbits Privacy Protector for Windows 10



■ Full product worth £32
■ softorbits.com

REQUIRES Windows 10; 20MB hard drive space; in-application registration

- Block the tracking features built into Windows 10 and Office with just a few clicks.
- Lock down access to your messages, camera and calendar; disable Defender, Cortana and OneDrive.
- Uninstall apps and components that otherwise can't be removed, disable Windows Update and edit the Hosts file.

Kaspersky Total Security 2020



■ Three months of updates worth £10
■ kaspersky.com

REQUIRES Windows 7 or later; 250MB hard drive space

- A powerful suite of malware-hunting, anti-hacker and web-safety tools, including antivirus.
- Includes firewall, exploit protection, vulnerability scanner, parental controls, webcam and audio protection.
- Software Updater checks for updates to common applications, which you can optionally set it to install automatically.



22-24IN



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NON-DOCKING



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DOCKING



31.5-34IN



BIG
SCREEN



HIGH-END
CREATIVE

Monitors

THE TEST

If you're thinking about buying a monitor in 2020, you've come to the right place. We test 35 from £130 to £1,700

Buying a monitor seems like such a simple task. You probably have a rough screen size in mind, an equally rough budget and a solid idea of the tasks you want to use it for. So, head to your website of choice, hit a few selection boxes and your choice is made for you. Job done.

You can do that and the monitor that you buy, in all probability, will be fine. As you'll see from this month's bumper crop of 35 screens, if you stick to a well-known brand then there's minimal chance of buying a dud. The question is: should you settle for "fine"?

We'd argue not. There are some spectacular monitors out there, and not just in terms of image quality. The right monitor can genuinely make you more productive; it can free you from cables; it can make pictures pop and spreadsheets squeal.

So, we urge you, choose carefully. Your next monitor is going to be your companion for many years to come. And in what's surely the UK's most comprehensive test, there's every chance you'll find the perfect model for you.

CONTRIBUTOR: Tim Danton

How we've organised the Labs

With 35 screens, we needed to impose some sort of order on this Labs. That's why we've split the reviews into six rough sections, as shown in the contents box. You'll also find "tags" on each review that show their key technologies at a glance.

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BIG DECISIONS:

How to choose your perfect monitor

Stick a pin in this month's Labs and you'll likely end up with a great screen that delivers high-quality colours. Even if you randomly visit a retailer's website, there's an excellent chance that you'll end up with a screen you're happy with. Despite this, it helps to know exactly what you're looking for – what specs matter, what specs don't – and whether you'll really benefit from spending another £100 on the monitor one up in the range.

■ Pixel density

There's a reason that Apple grabbed the name "Retina" for its high-pixel-density screens. To have enough pixels per inch (ppi) that the eye can't discern them removes one layer of friction between the screen and your brain: you just focus on what you're looking at and aren't distracted by jagged edges. There's no magical number, but if you want a rule of thumb then aim above 100ppi.

However, it really depends on how far away from the screen you'll be sitting. For a handy guide, head to pcpro.link/313retina. Pump in your choice of screen size and resolution and this page will calculate the distance at which the image becomes "Retina". You'll then see a rough distance of how far from the screen you'll need to sit for the screen to appear perfectly sharp.

Consider a 27in monitor. According to the above website, a 2,560 x 1,440 resolution will result in a "retina-sharp" image at a distance of 32in (the same is true for any screen with a pixel density of around 110ppi). That's around 80cm. Depending on your desk arrangement, that probably means such a screen will appear sharp

How do you whittle 35 monitors down to one that's perfect for you? Follow these principles to end up with something that's just right

BELOW The right monitor can double as a docking station, cutting cable clutter in the process



most of the time. Switch up to 4K (3,840 x 2,160, or 140ppi) and the distance drops to 21in (53cm).

This is why we suggest that most people will be happy with a 1440p 27in monitor but will still benefit from a 4K screen if they can afford it. We generally don't recommend a 27in screen with a Full HD resolution (or any screen with a density much under 100ppi), but there are exceptions: for a gamer, a Full HD 27in monitor with a 144Hz refresh rate will be a better choice than a 4K screen that only supports 60Hz.

"We suggest that most people will be happy with a 1440p 27in monitor but will still benefit from a 4K screen if they can afford it"

■ IPS vs the rest

Almost all of the monitors in this group test use in-plane switching (IPS) panels. That's because they offer excellent viewing angles and fast-enough response times that gamers struggle to spot motion blur. While twisted nematic (TN) panels used to be favoured by gamers, TN isn't the most versatile technology (see our review of the BenQ GL2780 on p80) and is best avoided.

Gamers have a relatively new friend in vertical alignment (VA) panels. As a rule of thumb, they provide a similar level of image quality to IPS panels, while offering higher contrast ratios and faster response times. They're also better suited to being curved. They can't match IPS panels

for pure whites or colour accuracy, but they're close enough that most people wouldn't spot the difference.

■ Docking monitors

For the first time in a PC Pro Labs, we've separated out a selection of 27in monitors with USB-C. That's how important we think this connection is. If your laptop can be powered over USB-C (or Thunderbolt in the case of MacBooks – they use the same physical connection), you can hugely reduce the number of cables on your desk. The idea is that the connections you use at your desk – such as a mouse, keyboard and even a network cable – are hooked up to your monitor. When it's time to leave, you simply disconnect the USB-C cable.

Not all USB-C ports are built the same, with different power ratings. Check this before you buy: if your laptop supports power input via USB-C, its manual should state how much wattage it requires. A lower-rated supply from your monitor will still provide some power, but it may not be enough to keep it charged whilst you're using it.

■ Curved or not?

If you want a screen that stretches wider than 30in, you should give serious consideration to a curved screen. That's particularly true for playing games because it makes the experience more immersive. Even for daily use, we think larger screens should be curved. Iiyama's ProLite XUB3493WQSU-B1 on p87 and Dell's

BELOW A larger, arched screen can put you ahead of the gaming curve



UltraSharp U4320Q on p91 suffered from being flat (counter-intuitively, due to the curvature of our eyes, this means the edges appear to bend away when you look at the centre of the screen), and it's no coincidence that so many of our award winners are curved.

Brightness and contrast ratio

Brightness and contrast ratio are two of the most important factors when it comes to perceived image quality. If either figure is too low, the image will look drab. Fortunately, brightness isn't a problem for any of the monitors here. If a screen can reach 200cd/m², it will be fine in an office situation. Higher gives you more flexibility, and support for 400cd/m² and above means you can start to think about HDR-enabled videos and games.

Contrast ratio is more important because it can seriously hamper a screen's performance. We noticed a couple of screens this month where the measured contrast ratio dropped in sRGB mode and turned what had previously been a nice-looking image into something dreary. You'll see certain online guides suggesting that a 1,000:1 contrast ratio is a good guide, but we say be careful: that's a quoted figure and isn't always reflected in day-to-day use. Look out for our comments in the reviews.

HDR support

HDR, or high dynamic range, can give supported videos and games a big,



ABOVE Creative professionals should take careful note of colour reproduction

vibrant boost. If you think you'll be watching a lot of TV or films on your screen then it's a feature worth looking for. In particular, look for certification from VESA: ideally DisplayHDR 600 or 1000. DisplayHDR 400 is better than nothing, but also indicates that the panel can't hit the higher brightness peaks HDR content truly benefits from.

How many colours?

Several monitors promise the ability to display 1.07 billion colours, which sounds far more impressive than the mere 16.7 million of their rivals. And it's an indication of image quality: it means the panel can show smoother gradations between colours. In truth, though, only professionals who also need calibrated screens (to ensure that what they see matches what is output in print, for example) need worry.

You'll also see the term "wide gamut displays" in connection with

How we test

As long-term readers will know, PC Pro is a "real world" magazine so we like to keep our tests as practical as possible. In this case, that means using each monitor as our daily screen and seeing how it performs; for instance, you'll often see notes in the reviews that talk about the quality of the onscreen display (OSD), as that can make a big difference in daily use.

We support this "practical" with a selection of technical tests that check each panel's colour performance across the sRGB, Adobe RGB and DCI-P3 colour spaces. Other checks include gamma tracking, how close each panel gets to the target 6500K colour space, brightness

uniformity across a 5 x 5 grid and measuring each panel's Delta E. To perform these tests, we use an X-Rite i1 Display Pro colorimeter in conjunction with the open-source display calibration and profiling software, DisplayCal.

X-Rite and DisplayCal allow us to test each monitor's colour accuracy from a central point on the screen. This process measures how close the displayed colours are to their intended shade. The difference between the intended and actual colour is measured in the unit of colour difference, Delta E; the higher the figure, the poorer the match. We provide average and maximum figures measured across 51



ABOVE We use an X-Rite i1 Display Pro colorimeter in our technical tests

colours. The smallest colour difference that the human eye can discern is one Delta E, so a display with an average Delta E of less than one is considered perfect.

See the reviews for a summary of each monitor's results and the graphs on p94 for a comparison.

certain monitors, which essentially means the same thing but refers to the ability to cover more colour spaces (sRGB, Adobe RGB and DCI-P3 in particular). We cover this on p89.

Panel uniformity

Although we've included each panel's brightness uniformity under each review, this shouldn't be used as a primary decision-maker: we've tested some great screens this month that don't have uniform brightness. Also note that curved screens arguably benefit from increased brightness at the edges to compensate for the natural drop-off that results from more extreme viewing angles.

Hardware calibration

Most people don't need a monitor with hardware calibration; only those whose professional work relies on colour accuracy need be concerned. Which is fortunate, as only expensive monitors (with 10-bit colour) include it. The Eizo FlexScan EV2785 on p83 is unique in this Labs because it builds in a calibrator that will correct the hardware calibration settings after a period of your choosing.

Flexible stand

It's recommended that you directly face the monitor. If you look down on a monitor, or at a slight upwards angle, colours won't appear as true, and it's not great from an ergonomic point of view. Consequently, any adjustments that you can make to the setup are welcome. That's why we make an effort to mention height adjustment in the reviews if it's on offer (far better than standing the monitor on a pile of old PC Pro magazines). Extra tilt, particularly backwards, is always useful too.

While pivot mode is potentially useful, we find that 27in monitors (and above) give enough desktop space that most people no longer need it. It feels like a tickbox feature.

Marketing bluster?

There are some features that we don't consider important – either because every monitor has them (think blue light reduction and anti-glare coverings) or because they're of niche interest. While video editors may well use a monitor's Picture-by-Picture or Picture-in-Picture mode, where you can view two inputs simultaneously, most of us stick to one input at a time.

All of that said, there may be a feature that's incredibly important to you but irrelevant to 99% of other people. Fortunately, you can easily download detailed user manuals that go through features in minute detail if you want to check for a particular one before you buy.



| | Acer B7 B277U | Acer ConceptD CP7 CP7271KP | AOC Q27P2Q | AOC U2790PQU | Asus Designo Curve MX38VC | RECOMMENDED | Asus ROG Strix XG32VQR | Asus TUF Gaming VG279QM | BenQ EW2780U | BenQ GL2780 | |
|---|-----------------------------|-----------------------------|---|-------------------------|---|-----------------------------------|--------------------------|-------------------------|----------------------|-------------|--|
| Overall rating | ★★★★★ | ★★★★★ | ★★★★★ | ★★★★★ | ★★★★★ | ★★★★★ | ★★★★★ | ★★★★★ | ★★★★★ | ★★★★★ | |
| Price | | | | | | | | | | | |
| Price (inc VAT) | £240 (£288) | £1,424 (£1,708) | £198 (£238) | £234 (£281) | £908 (£1,090) | £429 (£515) | £292 (£350) | £387 (£464) | £125 (£150) | | |
| Supplier | uk.insight.com | alza.co.uk | uk.insight.com | uk.insight.com | currys.co.uk | scan.co.uk | scan.co.uk | shop.benq.eu | box.co.uk | | |
| Part code | UM.HB7EE.014 | UM.HC1EE.PO4 | Q27P2Q | U2790PQU | MX38VC | XG32VQR | VG279QM | 9H.LJ7LA.TBE | 9H.LJ6LB.QBE | | |
| Service and support | | | | | | | | | | | |
| Warranty | 3yr | 3yr | 3yr | 3yr | 3yr | 3yr | 3yr | 3yr | 3yr | 3yr | |
| Manufacturer's reliability ¹ | 92% | 92% | 94% | 94% | 95% | 95% | 95% | 92% | 92% | 92% | |
| Display | | | | | | | | | | | |
| Panel size | 27in | 27in | 27in | 27in | 37.5in | 31.5in | 27in | 27in | 27in | 27in | |
| Resolution | 2,560 x 1,440 | 3,840 x 2,160 | 2,560 x 1,440 | 3,840 x 2,160 | 3,840 x 1,600 | 2,560 x 1,440 | 1,920 x 1,080 | 3,840 x 2,160 | 1,920 x 1,080 | | |
| Aspect ratio | 16:9 | 16:9 | 16:9 | 16:9 | 21:9 | 16:9 | 16:9 | 16:9 | 16:9 | 16:9 | |
| Pixel density | 109ppi | 163ppi | 109ppi | 163ppi | 111ppi | 93ppi | 82ppi | 163ppi | 82ppi | | |
| Panel type | IPS | IPS | IPS | IPS | IPS | VA | IPS | IPS | TN | | |
| Curvature | ✗ | ✗ | ✗ | ✗ | 2300R | 1800R | ✗ | ✗ | ✗ | ✗ | |
| Key specifications | | | | | | | | | | | |
| Peak brightness ³ | 350cd/m ² | 1,000cd/m ² | 300cd/m ² | 350cd/m ² | 300cd/m ² | 450cd/m ² | 400cd/m ² | 350cd/m ² | 300cd/m ² | | |
| Static contrast ratio ³ | 1,000:1 | 1,000:1 | 1,000:1 | 1,000:1 | 1,000:1 | 3,000:1 | 1,000:1 | 1,300:1 | 1,000:1 | | |
| Display colours | 16.7 million | 1.07 billion | 16.7 million | 1.07 billion | 1.07 billion | 16.7 million | 16.7 million | 1.07 billion | 16.7 million | | |
| VESA HDR certification | ✗ | DisplayHDR 1000 | ✗ | ✗ | ✗ | DisplayHDR 400 | ✗ | ✗ | ✗ | ✗ | |
| Max. vertical frequency | 75Hz | 144Hz | 75Hz | 80Hz | 75Hz | 144Hz | 144Hz | 60Hz | 75Hz | | |
| Response time ⁴ | 4ms | 4ms | 4ms | 5ms | 5ms | 4ms | 1ms | 5ms | 1ms | | |
| AMD/Nvidia adaptive sync | AMD FreeSync | Nvidia G-Sync Ultimate | ✗ | ✗ | AMD FreeSync | AMD FreeSync 2 HDR | Nvidia G-Sync Compatible | ✗ | ✗ | | |
| Video inputs | | | | | | | | | | | |
| DisplayPort (version) | 1(v1.2) | 1(not stated) | 1(v1.2) | 1(v1.2) | 1(v1.2) | 1(not stated) | 1(v1.2) | 1(v1.4) | 1(not stated) | | |
| HDMI (version) | 2 (not stated) | 1 (not stated) | 1(v1.4) | 2 (v1.4 and v2.0) | 2 (v2.0) | 2 (v2.0) | 2 (v2.0) | 2 (v2.0) | 1 (v1.4) | | |
| USB-C (power rating) | ✗ | ✗ | ✗ | ✗ | 1 (not stated) | ✗ | ✗ | 1 (60W) | ✗ | | |
| Other | mini-DisplayPort | ✗ | VGA | ✗ | ✗ | ✗ | ✗ | ✗ | DVI, VGA | | |
| Ports and docking | | | | | | | | | | | |
| RJ-45 | ✗ | ✗ | ✗ | ✗ | ✗ | ✗ | ✗ | ✗ | ✗ | ✗ | |
| USB-B | ✓ | ✓ | ✓ | ✓ | ✗ | ✓ | ✗ | ✗ | ✗ | ✗ | |
| USB hub | 4 x USB 3 | 4 x USB 3 | 4 x USB 3 | 2 x USB 3 | 2 x USB 3 | 2 x USB 3 | ✗ | ✗ | ✗ | ✗ | |
| Headphones socket | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | |
| Other | ✗ | ✗ | ✗ | Audio output | ✗ | Audio input | ✗ | ✗ | ✗ | ✗ | |
| Stand features | | | | | | | | | | | |
| Adjustable height | 120mm | 180mm | 150mm | 130mm | ✗ | 100mm | 130mm | ✗ | ✗ | ✗ | |
| Portrait mode | ✓ | ✗ | ✓ | ✓ | ✗ | ✗ | ✓ | ✗ | ✗ | ✗ | |
| Tilt angle | -5°/+25° | -5°/+35° | -5°/+35° | -5°/+20° | -5°/+15° | -5°/+20° | -5°/+33° | -5°/+15° | -5°/+20° | | |
| Swivel angle | 90° | 360° | 180° | 90° | ✗ | 100° | 180° | ✗ | ✗ | ✗ | |
| Other features | | | | | | | | | | | |
| VESA mount | ✓ | ✓ | ✓ | ✓ | ✗ | ✓ | ✓ | ✓ | ✓ | ✓ | |
| Integrated power supply | ✓ | ✗ | ✓ | ✓ | ✗ | ✗ | ✓ | ✓ | ✓ | ✓ | |
| Integrated handle | ✗ | ✗ | ✗ | ✗ | ✗ | ✗ | ✗ | ✗ | ✗ | ✗ | |
| Hardware calibration | ✗ | ✓ | ✗ | ✗ | ✗ | ✗ | ✗ | ✗ | ✗ | ✗ | |
| Supplied cables ⁵ | DisplayPort, USB-B to USB-A | DisplayPort, USB-B to USB-A | Audio, DisplayPort, HDMI, VGA, USB-B to USB-A | DisplayPort, HDMI | Audio, DisplayPort, HDMI, USB-C, USB-C to USB-A | DisplayPort, HDMI, USB-B to USB-A | DisplayPort, HDMI | HDMI, USB-C | HDMI | | |
| Speakers | 2 x 2W | 2 x 4W | 2 x 2W | 2 x 2W | 2 x 10W | ✗ | 2 x 2W | 2 x 5W | 2 x 2W | | |
| Other | ✗ | Monitor hood | ✗ | ✗ | Qi wireless charger (15W) | LED lighting | ✗ | ✗ | ✗ | ✗ | |
| Size and weight | | | | | | | | | | | |
| Dimensions (WDH including stand) | 611 x 208 x 400-520mm | 629 x 269 x 421-601mm | 614 x 200 x 394-544mm | 534 x 199.5 x 485-615mm | 897 x 240 x 490mm | 713 x 299 x 490-590mm | 619 x 211 x 376-506mm | 614 x 196 x 461mm | 639 x 183 x 473mm | | |
| Weight | 7.4kg | 8.3kg | 5.9kg | 6.5kg | 9.6kg | 9.6kg | 5.6kg | 6.7kg | 5.7kg | | |

¹ Monitor reliability rating in reader-voted PC Pro Excellence Awards 2019 (see issue 302, p30). N/A indicates not enough feedback to give a rating. ² Sample size under 50; included for information only. ³ Stated (not measured). ⁴ Grey to grey. ⁵ All monitors include power cables.

| | | | | | | | | |
|-----------------------|--|------------------------------------|------------------------------------|------------------------------------|--|-----------------------------|-----------------------------|-----------------------------------|
| | | | | | | | | |
| BenQ PD2705Q | BenQ PD3220U | Dell UltraSharp U2720Q | Dell UltraSharp U3219Q | Dell UltraSharp U4320Q | Eizo ColorEdge CG279X | Eizo FlexScan EV2460 | Eizo FlexScan EV2785 | HP E27d G4 |
| | | | | | | | | |
| £316 (£379) | £1,000 (£1,200) | £445 (£534) | £740 (£888) | £705 (£845) | £1,410 (£1,692) | £228 (£274) | £773 (£923) | £399 (£479) |
| shop.benq.eu | box.co.uk | dell.co.uk | dell.co.uk | dell.co.uk | wexphotovideo.com | lambda-tek.com | lambda-tek.com | store.hp.com |
| 9H.LJELA.TBE | 9H.LH7LA.TBE | U2720Q | U3219Q | U4320Q | CG279X | EV2460-BK | EV2785-BK | 6PA56AT#ABU |
| 3yr | 3yr | 3yr | 3yr | 3yr | 5yr | 5yr | 5yr | 3yr |
| 92% | 92% | 91% | 91% | 91% | 100% ² | 100% ² | 100% ² | 91% |
| 27in | 31.5in | 27in | 31.5in | 42.5in | 27in | 23.8in | 27in | 27in |
| 2,560 x 1,440 | 3,840 x 2,160 | 3,840 x 2,160 | 3,840 x 2,160 | 3,840 x 2,160 | 2,560 x 1,440 | 1,920 x 1,080 | 3,840 x 2,160 | 2,560 x 1,440 |
| 16:9 | 16:9 | 16:9 | 16:9 | 16:9 | 16:9 | 16:9 | 16:9 | 16:9 |
| 109ppi | 140ppi | 163ppi | 140ppi | 104ppi | 109ppi | 93ppi | 163ppi | 109ppi |
| IPS | IPS | IPS | IPS | IPS | IPS | IPS | IPS | IPS |
| | | | | | | | | |
| 300cd/m ² | 300cd/m ² | 350cd/m ² | 400cd/m ² | 350cd/m ² | 350cd/m ² | 250cd/m ² | 350cd/m ² | 300cd/m ² |
| 1,000:1 | 1,000:1 | 1,300:1 | 1,300:1 | 1,000:1 | 1,300:1 | 1,000:1 | 1,300:1 | 1,000:1 |
| 16.7 million | 1.07 billion | 1.07 billion | 1.07 billion | 1.06 billion | 1.07 billion | 16.8 million | 16.8 million | 16.7 million |
| | | | | | | | | |
| 60Hz | 60Hz | 75Hz | 75Hz | 75Hz | 61Hz | 61Hz | 61Hz | 75Hz |
| 5ms | 5ms | 5ms | 5ms | 5ms | 13ms | 5ms | 5ms | 5ms |
| | | | | | | | | |
| 1(v1.4) | 1(v1.4) | 1(v1.4) | 1(v1.4) | 1(v1.4) | 1(v1.3) | 1(v1.3) | 1(v1.3) | 1(v1.2) |
| 1(v2.0) | 2(v2.0) | 1(v2.0) | 1(v2.0) | 2(not stated) | 1(v1.4) | 1(v1.4) | 2(v1.4) | 1(v1.4) |
| 1(65W) | 2(85W, 15W) | 1(90W) | 1(90W) | 1(90W) | 1(15W) | | 1(60W) | 1(100W) |
| | | | | | DVI | DVI, VGA | | DisplayPort out, USB-C downstream |
| | | | | | | | | 1 |
| | | | | | | | | |
| 4 x USB 3 | 3 x USB 3 | 3 x USB 3 | 4 x USB 3 | 3 x USB 3 | 4 x USB 3 | 4 x USB 3 | 2 x USB 3 | 4 x USB 3 |
| | | | | | | | | |
| | USB-C output (15W) | USB-C output (15W) | | | | | | Audio input |
| 120mm | 150mm | 130mm | 150mm | 60mm | 155mm | 140mm | 178mm | 150mm |
| | | | | | | | | |
| -5°/+20° | -5°/+20° | -5°/+21° | -5°/+21° | -5°/+10° | 0°/35° | -5°/35° | -5°/35° | -5°/20° |
| 90° | 60° | 90° | 60° | 40° | 344° | 344° | 344° | 60° |
| | | | | | | | | |
| DisplayPort, USB-C | DisplayPort, HDMI, Thunderbolt, USB-B to USB-A | DisplayPort, USB-C, USB-C to USB-A | DisplayPort, USB-C, USB-C to USB-A | DisplayPort, USB-C, USB-C to USB-A | DisplayPort, USB-B to USB-A | DisplayPort, USB-B to USB-A | DisplayPort, HDMI, USB-C | DisplayPort, HDMI, USB-C |
| 2 x 2W | 2 x 2W | | | 2 x 8W | | 2 x 1W | 2 x 1W | |
| | Hotkey Puck G2 | | | | Cleaning kit, monitor hood, self calibration | | | Full HD webcam |
| 614 x 231 x 429-549mm | 715 x 186 x 478-628mm | 611 x 185 x 395-525mm | 713 x 220 x 469-619mm | 967 x 249 x 595-655mm | 638 x 265 x 416-571mm | 538 x 233 x 334-474mm | 611 x 230 x 367-545mm | 614 x 220 x 366-516mm |
| 5.7kg | 10.4kg | 6.6kg | 9.6kg | 17.6kg | 10.3kg | 5.9kg | 8.2kg | 8.2kg |



| | Iiyama ProLite XB3288UHSU-B1 | Iiyama ProLite XU2792UHSU-B1 | RECOMMENDED | RECOMMENDED | RECOMMENDED | LABS WINNER | MSI Optix MAG272CQR | MSI Optix MPG341CQR |
|---|-----------------------------------|-----------------------------------|-----------------------|-----------------------------------|--------------------------------|-----------------------------------|-----------------------------------|--|
| Overall rating | ★★★★★ | ★★★★★ | ★★★★★ | ★★★★★ | ★★★★★ | ★★★★★ | ★★★★★ | ★★★★★ |
| Price | | | | | | | | |
| Price (inc VAT) | £292 (£350) | £233 (£280) | £108 (£130) | £215 (£258) | £286 (£343) | £1,108 (£1,329) | £333 (£399) | £724 (£869) |
| Supplier | scan.co.uk | scan.co.uk | scan.co.uk | scan.co.uk | scan.co.uk | laptopsdirect.co.uk | scan.co.uk | scan.co.uk |
| Part code | XB3288UHSU-B1 | XU2792UHSU-B1 | XUB2493HSU-B1 | XUB2792QSU-B1 | XUB3493WQSU-B1 | 38WN95C-W | MAG272CQR | 9S6-3DA05T-002 |
| Service and support | | | | | | | | |
| Warranty | 3yr | 3yr | 3yr | 3yr | 3yr | 2yr | 3yr | 3yr |
| Manufacturer's reliability ¹ | 93% | 93% | 93% | 93% | 93% | 93% | N/A | N/A |
| Display | | | | | | | | |
| Panel size | 32in | 27in | 23.8in | 27in | 34in | 37.5in | 27in | 34in |
| Resolution | 3,840 x 2,160 | 3,840 x 2,160 | 1,920 x 1,080 | 2,560 x 1,440 | 3,440 x 1,440 | 3,840 x 1,600 | 2,560 x 1,440 | 3,440 x 1,440 |
| Aspect ratio | 16:9 | 16:9 | 16:9 | 16:9 | 21:9 | 21:9 | 16:9 | 21:9 |
| Pixel density | 138ppi | 163ppi | 93ppi | 109ppi | 110ppi | 111ppi | 109ppi | 110ppi |
| Panel type | VA | IPS | IPS | IPS | IPS | IPS | VA | VA |
| Curvature | ✗ | ✗ | ✗ | ✗ | ✗ | Not stated | 1500R | 1800R |
| Key specifications | | | | | | | | |
| Peak brightness ³ | 300cd/m ² | 300cd/m ² | 250cd/m ² | 350cd/m ² | 400cd/m ² | 450cd/m ² | 300cd/m ² | 400cd/m ² |
| Static contrast ratio ³ | 3,000:1 | 1,000:1 | 1,000:1 | 1,000:1 | 1,000:1 | 1,000:1 | 3,000:1 | 3,000:1 |
| Display colours | 1.07 billion | 1.07 billion | 16.7 million | 1.07 billion | 16.7 million | 1.07 billion | 1.07 billion | 1.07 billion |
| VESA HDR certification | ✗ | ✗ | ✗ | ✗ | ✗ | DisplayHDR 600 | ✗ | DisplayHDR 400 |
| Maximum frequency (vertical) | 75Hz | 75Hz | 75Hz | 75Hz | 75Hz | 144Hz | 165Hz | 144Hz |
| Response time (grey-to-grey) | 3ms | 4ms | 4ms | 5ms | 4ms | 1ms | 1ms | 1ms |
| AMD/Nvidia adaptive sync | AMD FreeSync | ✗ | ✗ | AMD FreeSync | AMD FreeSync | AMD FreeSync, Nvidia G-Sync | AMD FreeSync | AMD FreeSync 2 |
| Video inputs | | | | | | | | |
| DisplayPort (version) | 1(v1.2) | 1(v1.2) | 1(not stated) | 1(not stated) | 1(not stated) | 1(v1.4) | 1(v1.2a) | 1(v1.4) |
| HDMI (version) | 2(v2.0) | 1(not stated) | 1(not stated) | 1(not stated) | 2(not stated) | 2(v2.0) | 2(v2.0b) | 2(v2.0) |
| USB-C (power rating) | ✗ | ✗ | ✗ | ✗ | ✗ | 1(94W) | 1(15W) | 1(15W) |
| Other | ✗ | DVI | ✗ | DVI | ✗ | ✗ | ✗ | ✗ |
| Ports and docking | | | | | | | | |
| RJ-45 | ✗ | ✗ | ✗ | ✗ | ✗ | ✗ | ✗ | ✗ |
| USB-B | ✓ | ✓ | ✗ | ✓ | ✓ | ✗ | ✓ | ✓ |
| USB hub | 2 x USB 3 | 2 x USB 3 | 2 x USB 2 | 2 x USB 3 | 2 x USB 3 | 2 x USB 3 | 2 x USB 3 | 3 x USB 3 |
| Headphones socket | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Other | ✗ | ✗ | ✗ | Audio input | ✗ | ✗ | ✗ | ✗ |
| Stand features | | | | | | | | |
| Adjustable height | 130mm | ✗ | 130mm | 130mm | 130mm | 110mm | 130mm | 100mm |
| Portrait mode | ✗ | ✗ | ✓ | ✓ | ✗ | ✗ | ✗ | ✗ |
| Tilt angle | -3°/+22° | -5°/+22° | -5°/+22° | -5°/+22° | -3°/+22° | -5°/+15° | -5°/+20° | -5°/+15° |
| Swivel angle | 90° | ✗ | 90° | 90° | 90° | 30° | ✗ | 60° |
| Other features | | | | | | | | |
| VESA mount | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Integrated power supply | ✓ | ✓ | ✓ | ✓ | ✗ | ✓ | ✓ | ✓ |
| Integrated handle | ✓ | ✗ | ✗ | ✗ | ✗ | ✗ | ✗ | ✗ |
| Hardware calibration | ✗ | ✗ | ✗ | ✗ | ✗ | ✗ | ✗ | ✗ |
| Supplied cables ⁴ | DisplayPort, HDMI, USB-B to USB-A | DisplayPort, HDMI, USB-B to USB-A | HDMI, USB-B to USB-A | DisplayPort, HDMI, USB-B to USB-A | DisplayPort, HDMI, Thunderbolt | DisplayPort, HDMI, USB-B to USB-A | DisplayPort, HDMI, USB-B to USB-A | Audio, DisplayPort, HDMI, USB-B to USB-A |
| Speakers | 2 x 3W | 2 x 2W | 2 x 2W | 2 x 2W | 2 x 5W | 2 x 5W | ✗ | ✗ |
| Other | ✗ | ✗ | ✗ | ✗ | ✗ | ✗ | Headset holder | 1,280 x 720 webcam, mouse bungee |
| Size and weight | | | | | | | | |
| Dimensions (WDH including stand) | 730 x 230 x 459-579mm | 614 x 197 x 441mm | 540 x 210 x 373-503mm | 611 x 230 x 413-543mm | 817 x 230 x 415-545mm | 895 x 285 x 474-584 | 612 x 267 x 430-560mm | 811 x 324 x 463-563mm |
| Weight | 8.9kg | 4.6kg | 4.8kg | 7.2kg | 9.5kg | 8.3kg | 5.9kg | 9.6kg |

¹ Monitor reliability rating in reader-voted PC Pro Excellence Awards 2019 (see issue 302, p30). N/A indicates not enough feedback to give a rating. ² Sample size under 50; included for information only. ³ Stated (not measured). ⁴ All monitors include power cables.

| | | | | | | | | |
|-------------------------------|--|---|--------------------------|--|-----------------------------|----------------------------------|-----------------------------|----------------------|
| | | | | | | | | |
| NEC MultiSync EA224WMi | NEC MultiSync EA271U | Philips 242B1 | Philips 328E1 | RECOMMENDED | RECOMMENDED | RECOMMENDED | RECOMMENDED | RECOMMENDED |
| ★★★★★ | ★★★★★ | ★★★★★ | ★★★★★ | ★★★★★ | ★★★★★ | ★★★★★ | ★★★★★ | ★★★★★ |
| £174 (£209) | £632 (£758) | £133 (£160) | £333 (£400) | £458 (£549) | £393 (£471) | £438 (£549) | £493 (£592) | £162 (£195) |
| currys.co.uk | lambda-tek.com | alza.co.uk | laptopsdirect.co.uk | box.co.uk | shop.bt.com | currys.co.uk | uk.insight.com | currys.co.uk |
| 60003336 | 60004302 | 242B1/00 | 328E1CA/00 | 328P6VUBREB/00 | 346P1CRH/00 | LC34J791WTUXXU | VP2785-2K | VX2485-MHU |
| 3yr | 3yr | 3yr | 3yr | 3yr | 3yr | 3yr | 3yr | 2yr |
| N/A | N/A | 93% | 93% | 93% | 93% | 91% | 90% ² | 90% ² |
| 21.5in | 27in | 23.8in | 31.5in | 31.5in | 34in | 34in | 27in | 23.8in |
| 1,920 x 1,080 | 3,840 x 2,160 | 1,920 x 1,080 | 3,840 x 2,160 | 3,840 x 2,160 | 3,440 x 1,440 | 3,440 x 1,440 | 2,560 x 1,440 | 1,920 x 1,080 |
| 16:9 | 16:9 | 16:9 | 16:9 | 16:9 | 21:9 | 21:9 | 16:9 | 16:9 |
| 102ppi | 138ppi | 93ppi | 140ppi | 140ppi | 110ppi | 110ppi | 109ppi | 93ppi |
| IPS | IPS | IPS | VA | VA | VA | VA | IPS | IPS |
| ✖ | ✖ | ✖ | 1500R | ✖ | 1500R | 1500R | ✖ | ✖ |
| 250cd/m ² | 350cd/m ² | 250cd/m ² | 250cd/m ² | 600cd/m ² | 500cd/m ² | 300cd/m ² | 300cd/m ² | 250cd/m ² |
| 1,000:1 | 1,300:1 | 1,000:1 | 2,500:1 | 3,000:1 | 3,000:1 | 3,000:1 | 1,000:1 | 1,000:1 |
| 16.7 million | 1.07 billion | 16.7 million | 1.07 billion | 1.07 billion | 16.7 million | 16.7 million | 1.07 billion | 16.7 million |
| ✖ | ✖ | ✖ | ✖ | DisplayHDR 600 | DisplayHDR 400 | ✖ | ✖ | ✖ |
| 75Hz | 75Hz | 75Hz | 75Hz | 75Hz | 100Hz | 100Hz | 75Hz | 76Hz |
| 6ms | 5ms | 4ms | 4ms | 4ms | 4ms | 4ms | 5ms | 5ms |
| ✖ | ✖ | ✖ | ✖ | ✖ | AMD FreeSync | AMD FreeSync | ✖ | AMD FreeSync |
| 1(not stated) | 1(not stated) | 1(v1.2) | 1(v1.2) | 1(v1.4) | 1(v1.4) | 1(not stated) | 1(v1.2) | ✖ |
| 1(not stated) | 2 (not stated) | 1(v1.4) | 2 (v2.0) | 2 (v2.0) | 1(v2.0) | 2 (not stated) | 1(v1.4) | 1(v1.4) |
| ✖ | 1(60W) | ✖ | ✖ | 1(60W) | 1(90W) | 1(85W) | 1(60W) | 1(60W) |
| DVI, VGA | ✖ | DVI, VGA | ✖ | ✖ | ✖ | ✖ | ✖ | VGA |
| ✖ | ✖ | ✖ | ✖ | ✓ | ✓ | ✖ | ✖ | ✖ |
| ✓ | ✓ | ✓ | ✖ | ✖ | ✓ | ✖ | ✓ | ✖ |
| 4 x USB 2 | 3 x USB 3 | 3 x USB 3 | ✖ | 4 x USB 3 | 4 x USB 3 | 2 x USB 3 | 3 x USB 3 | ✖ |
| ✓ | ✓ | ✓ | ✖ | ✓ | ✓ | ✓ | ✓ | ✓ |
| ✖ | USB-C output (15W) | ✖ | ✖ | ✖ | ✖ | USB-C/Thunderbolt 3 output (15W) | USB-C output (15W) | ✖ |
| 130mm | 150mm | 150mm | ✖ | 180mm | 180mm | 100mm | 130mm | ✖ |
| ✓ | ✓ | ✓ | ✖ | ✓ | ✖ | ✖ | ✓ | ✖ |
| -5°/+35° | -5°/+35° | -5°/+35° | -5°/+20° | -5°/+20° | -5°/+25° | -14°/+34° | -5°/+21° | -5°/+20° |
| 340° | 340° | 360° | ✖ | 340° | 360° | ✖ | 120° | 60° |
| ✓ | ✓ | ✓ | ✖ | ✓ | ✓ | ✓ | ✓ | ✓ |
| ✓ | ✓ | ✓ | ✖ | ✓ | ✓ | ✖ | ✓ | ✖ |
| ✓ | ✓ | ✓ | ✖ | ✖ | ✖ | ✓ | ✓ | ✖ |
| ✖ | ✓ | ✖ | ✖ | ✖ | ✖ | ✖ | ✓ | ✖ |
| DisplayPort, USB-B to USB-A | ControlSync, DisplayPort, USB-B to USB-A | Audio, DisplayPort, HDMI, USB-B to USB-A, VGA | Audio, DisplayPort, HDMI | DisplayPort, HDMI, USB-C, USB-C to USB-A | DisplayPort, HDMI, USB-C | DisplayPort, HDMI | DisplayPort, USB-B to USB-A | HDMI |
| 2 x 1W | 2 x 1W | 2 x 2W | 2 x 3W | 2 x 3W | 2 x 5W | 2 x 7W | 2 x 3W | 2 x 3W |
| ✖ | ✖ | 2-megapixel infrared webcam | ✖ | ✖ | 2-megapixel infrared webcam | ✖ | ✖ | ✖ |
| 507 x 218 x 370-500mm (WDH) | 612 x 250 x 378-528mm (WDH) | 540 x 205 x 351-501mm | 709 x 281 x 523mm | 742 x 270 x 477-657mm | 807 x 250 x 421-601mm | 809 x 309 x 416-516mm | 612 x 215 x 415-545mm | 624 x 250 x 410mm |
| 5.6kg | 9.5kg | 4.6kg | 7.7kg | 9.4kg | 11.7kg | 7.6kg | 6.7kg | 4.2kg |



22-24 IN

Eizo FlexScan EV2460

The king of 24in professional displays, but Eizo is asking a high price in return

SCORE

PRICE £228 (£274 inc VAT)
from lambda-tek.com

With any other manufacturer, £274 inc VAT buys you a 27in monitor. Eizo isn't just any other manufacturer, though. There's a heft to the EV2460 that suggests top-quality electronics, and that's reflected in the best OSD on test: it's blissfully simple to make changes, thanks to front-mounted buttons matched with sensible icons that pop up to show you what to do.

Say you want to switch from the sRGB profile to Movie. There's no digging around in a complex menu, with six presets available within a button press or two. Naturally, image quality is the best around, as reflected by its brightness deviation across the screen; compare its results in the

1,920x
1,080

23.8in

IPS

graphic below to that of the Iiyama. While its cheaper rival actually beats it for coverage of the sRGB gamut, and offers a marginally better Delta E, the difference will be near-impossible to spot in practice. Eizo's excellent 1,304:1 contrast ratio and accurate colour temperature will be far more obvious to the eye.

You have a plethora of inputs to choose from: DVI, VGA, DisplayPort and HDMI. There's no USB-C input, but compensation comes in the form of a USB hub. Two of its four USB 3 ports sit on the left side, along with a headphone jack and line out, and it's

ABOVE The robust build quality reflects the Eizo's equally robust price

easy to access the other two, thanks to a solid yet flexible stand. The FlexScan smoothly rotates into portrait mode, while a 344° swivel makes it easy to share what's on your screen with neighbours. Note its 140mm height adjustment too. This screen's only real weakness is its speakers, which are all treble and no bass.

Eizo provides unmatched support thanks to a five-year on-site warranty, and one of the reasons it can do this is its excellent reliability – as proven through many years of feedback in our annual Service & Reliability survey.

Despite all these positives, the Iiyama wins our recommendation as the 24in monitor of choice simply due to its price. The fact it comes so close to matching the Eizo for quality while costing half as much is incredible. But if you want the very best, the EV2460 is the monitor to buy.

| Panel uniformity (Brightness, % difference from centre) | | | | | |
|---|------|------|------|------|--|
| 3.1 | 0.9 | 0.9 | 2.3 | 2.1 | |
| 9.2 | 6.6 | 0 | 3.5 | 4.2 | |
| 12.4 | 11.5 | 12.7 | 10.1 | 10.1 | |

Iiyama ProLite XUB2493HSU-B1

Not the perfect 24in monitor, but image quality is astounding for the price

SCORE

PRICE £108 (£130 inc VAT) from scan.co.uk

If you're on a tight budget, we can cut to the quick: the Iiyama ProLite XUB2493HSU-B1 offers unmatched value without making any obvious sacrifices. Indeed, you could place this 24in monitor next to the twice-as-expensive Eizo and wonder why they aren't the same price.

Cosmetically, there's little between them. Both employ slim bezels to give an edge-to-edge appearance, with the only blemish on the Iiyama being an ugly sticker that proclaims all of its features. Luckily, it's easy to strip this off. And, in Iiyama's defence, there's quite a feature list: you can flip it into portrait mode, it provides VGA, DisplayPort and HDMI inputs, plus

1,920x
1,080

23.8in

IPS

there are two side-mounted USB 3 ports for easy access.

The Iiyama also uses the same IPS panel technology as the Eizo, and there isn't a huge gulf between the two when it comes to image quality. The ProLite even covers more of the sRGB gamut (93.6% versus 88%) with an outstanding average Delta E of 0.81, while its measured contrast ratio of 1,192:1 is great too. All of those results came in the monitor's preset SRGB mode, which bizarrely locks you into 100% brightness – and it's bright at 278cd/m².

We assume that Iiyama was aiming for a 6500K colour temperature with

ABOVE The wallet-pleasing price makes it easy to overlook slight design hiccups



this setting, but it actually measured at 6367K – which isn't a disaster, but if you're sensitive to such things then you'll need to create your own profile using the OSD. This is where the Eizo proved light years ahead, with context-sensitive controls that show you what each button does before you press it, while the Iiyama relies on the time-honoured and highly annoying system of rear-mounted buttons – but with no onscreen cues explaining what each does, it's far from intuitive. It's also too easy to accidentally switch off the panel by pressing the bottom-most button, which is the power switch.

So there are signs of cost cutting here, but the Iiyama ProLite XUB2493HSU-B1 pulls the win out of the bag with a flexible stand – it even offers 130mm of height adjustment – and a price that none of its equally reputable rivals can match.

| Panel uniformity (Brightness, % difference from centre) | | | | | |
|---|------|-----|------|------|--|
| 16.4 | 9.5 | 8.2 | 6.3 | 10.5 | |
| 15.5 | 5.3 | 0 | 4.2 | 10 | |
| 20.5 | 15.4 | 8.2 | 14.5 | 14.1 | |

22-24 IN



1,920 x
1,080

21.5in

IPS

NEC MultiSync EA224WMi

This one-time great is showing its age, even if it does offer some advantages to corporate buyers

SCORE 

PRICE £174 (£209 inc VAT) from currys.co.uk

It's testament to NEC displays' quality that a product released in 2012 still stands tall next to much more recent models. Although "tall" is stretching things: at 21.5in, it's looking decidedly titchy, despite its 130mm of height adjustment.

Pivot the screen 90° and it's easy to access the DisplayPort, DVI, VGA and HDMI inputs, and there's even a four-port USB hub. Predictably, these are USB 2 rather than USB 3. Another sign of age is its 14ms grey-to-grey response times, but, more tellingly, its viewing angles aren't up to the standards of modern IPS panels, with a notable drop-off as you move away from a head-on view. That's a shame because the panel itself remains technically strong: 94.5% coverage of the sRGB colour space combined with an average Delta E of 1.04 translates into excellent colour accuracy. What you won't get is "punch", with a relatively low contrast ratio of 922:1. Also note that it tracks some way off its sRGB target colour temperature of 6500K, returning 5928K in our tests.

Fortunately, the OSD makes it easy to fine-tune the RGB channels, and there are features here that will appeal to corporates: an Eco mode, ambient light sensor and human sensor will all reduce the electricity bill if switched on. It's a shame, though, that the asking price is so high.

Panel uniformity (Brightness, % difference from centre)

| 14.7 | 12.4 | 12.5 | 13.8 | 9.9 |
|------|------|------|------|------|
| 10 | 6.3 | 0 | 3.3 | 8.7 |
| 8.8 | 8.6 | 10.2 | 12.6 | 10.7 |



1,920 x
1,080

23.8in

IPS

Philips 242B1

An excellent alternative to the Iiyama if you have the budget and will use all its features

SCORE 

PRICE £133 (£160 inc VAT) from alza.co.uk

If you only have limited space on your desk but still yearn for features and versatility, take a long hard look at the Philips 242B1. It even packs a two-megapixel infrared camera – which can be tucked away when not needed – that works with Windows Hello for quick and easy logins. Don't expect iPhone-level image quality, though; it's passable for Skype, but that's it.

Despite the 242B1's competitive price, you'll also benefit from a four-port USB 3 hub, 90° pivot, 150mm of height adjustment and all the inputs most people need: DVI, VGA, DisplayPort and HDMI. It's only a shame that Philips doesn't include USB-C, because that would have lifted it above the Iiyama as our outright winner.

Nevertheless, the Philips 242B1 is still a great choice thanks to a high-quality IPS panel. At its sRGB settings, it defaults to a peak brightness of 268cd/m², but you can switch to other presets (or create your own) using the excellent OSD. In truth, there's little need to do so, with an exemplary set of results across the board; note the 6452K colour temperature in particular.

There's even gaming capability thanks to 4ms grey-to-grey response times and a non-branded adaptive sync setting, making this a great "all-rounder" alternative to the cheaper Iiyama.

Panel uniformity (Brightness, % difference from centre)

| 12.5 | 5.8 | 8.4 | 6.7 | 16.4 |
|------|------|------|------|------|
| 16.8 | 10.4 | 0 | 12 | 21.5 |
| 18.9 | 17.3 | 13.2 | 21.4 | 21.7 |



1,920 x
1,080

23.8in

IPS

USB-C

ViewSonic VX2485-MHU

The USB-C input marks this screen out from its competition, but it loses points for inflexibility

SCORE 

PRICE £162 (£195 inc VAT) from currys.co.uk

Unusually for a "basic" 24in monitor, the ViewSonic includes a USB-C video input. If you use a USB-C-powered laptop that requires 60W or less – and many do – then your desk will look a whole lot neater. Note, though, that ViewSonic relies on an external power supply that's roughly the size of a phone (but double the height) and that it saves money by not including any USB-A ports. As a result, this monitor can't act as a virtual docking station.

Other signs of designing to a budget: no DisplayPort input and a basic stand that only offers tilt and swivel adjustments. The cheaper Iiyama is much more flexible. It also includes a superior panel, but not by much: the ViewSonic covers 88.8% of the sRGB gamut with an average Delta E of 1.03 and a fine contrast ratio of 1,230:1. The only area where it disappoints is peak brightness, hitting 222cd/m² in our tests, but in an office that's enough.

ViewSonic deserves praise for the intuitive OSD; while it uses rear-mounted buttons, it's clear what each does via onscreen icons. There are numerous handy presets, so switching to gaming mode, say, takes only a couple of button presses. Despite the many positives, though, we'd still choose the cheaper Iiyama unless a USB-C input is a key requirement.

Panel uniformity (Brightness, % difference from centre)

| 10 | 11.1 | 9.1 | 11.1 | 14.6 |
|-----|------|-----|------|------|
| 8.8 | 3.5 | 0 | 2.5 | 11.7 |
| 9.5 | 8.7 | 1.4 | 5.6 | 11.4 |



27in NON-DOCKING

Acer B7B277U

A fine alternative to our winners, especially if you need strong gamut coverage

SCORE ★★★★★

PRICE £240 (£288 inc VAT)
from uk.insight.com

Acer produces so many monitors that it seems to have run out of model names. Search for the B277U on its website and the one with part number UM.HB7EE.011 is first to appear – an older model that includes a webcam. We’re reviewing the B277U identified by UM.HB7EE.014, which jettisons the webcam but benefits from a more recent panel.

As always, we’re pleased to see that it’s based on IPS technology. This helped the B277U to a strong showing in our gamut coverage tests, and unusually this wasn’t restricted to the sRGB colour space. While it performed well there – 98.8% coverage, 102.5% volume – we were most taken by its 85.7%/95.7% return in Adobe RGB.



2,560x
1,440

27in

IPS

That rubs shoulders with monitors that target creative professionals. It was a similar story in the DCI-P3 space, with results of 94.1%/98.4%.

This fine form carried on our accuracy tests, with an average Delta E of 0.32 when we switched the monitor to its sRGB mode. Note this locks brightness to 186cd/m². Other modes go much brighter: we measured a peak of 505cd/m², well above the 350cd/m² Acer states, with its only weakness being consistency of brightness across the screen.

All this means that you should be able to find a colour profile that matches your needs, but we

ABOVE Life's a beach with the B7B277U's seriously impressive colour accuracy

recommend you familiarise yourself with the OSD: there are hidden, cryptic depths once you go beyond the basics. Also look out for “gotchas” such as the Super Sharpness setting, which may not be to your eyes’ liking.

Considering all of the quality on offer, and the price, we’re impressed to see so many features crammed in. The stand offers 120mm of height adjustment, 90° of swivel and portrait mode, and round the back you’ll find two USB ports and a mini-DisplayPort to accompany the usual complement of video inputs. Two USB ports sit on the left of the monitor too.

Despite all these strengths, if you’re looking for a workhorse screen we’d recommend the cheaper Iiyama ProLite XUB2792QSU-B1 – it produces cleaner whites right out of the box. But, if you’ll take advantage of the B277U’s wider gamut, it’s an excellent and affordable alternative.

| Panel uniformity (Brightness, % difference from centre) | | | | |
|---|------|------|------|------|
| 19.8 | 15.2 | 11.2 | 12.3 | 13.4 |
| 7.7 | 5.1 | 0 | 1.7 | 3 |
| 13.8 | 13.9 | 8.8 | 10.4 | 10.8 |

AOC U2790PQU

When you’re buying a 27in 4K monitor for under £300, it’s hard to complain about flaws

SCORE ★★★★★

PRICE £234 (£281 inc VAT)
from uk.insight.com

If you’re looking for a 4K 27in IPS screen, and have a budget of under £300, it’s a straight shootout between this AOC and the Iiyama ProLite XU2792UHSU-B1. There are reasons to choose both of them – and reasons not to.

So why buy the AOC? For a start, because it packs a number of valuable features that Iiyama jettisons. Where Iiyama chooses a fixed stand, this AOC includes a surprisingly flexible offering: the three key benefits are 130mm of height adjustment, 90° of swivel and portrait mode.

It also feels more solid than the Iiyama. For example, where that screen wobbles on its stand when you press the OSD buttons, the U2790PQU



3,840x
2,160

27in

IPS

has enough heft to stay (mostly) still when you prod at the joystick on its rear. Although as soon as the OSD interface springs into life, it’s clear that you aren’t dealing with a premium model. For a start, “spring” is too sprightly a word – “heaves” is better. This low-quality impression is further enhanced by the lightweight action of the joystick, which is all too easy to push in the wrong direction.

Nevertheless, you’ll be rewarded with a better image than the default if you head into the Color Setup menu and choose sRGB from the Colour Temperature options. This locks the brightness to 297cd/m² from its peak

ABOVE With 130mm of height adjustment and 90° of swivel, the AOC is a flexible friend

of 465cd/m², but that sacrifice is worth making because it generates accurate colours: it covers 95.6% of the sRGB gamut (with 97.3% volume) while returning an excellent 0.45 average Delta E. What you won’t get is punch, because a 869:1 contrast ratio is this panel’s biggest weakness.

It also has a limited range in terms of colour reproduction. While tweaking colours via the User setting meant it could cover around 77% of the DCI-P3 gamut, this will never be a monitor that will unleash the power of photos or films. For the record, there are speakers, but they fall into the “only for video calls” category.

Still, we don’t want to be too hard on the AOC U2790PQU. It was built to a budget yet both looks and feels more classy than the Iiyama. For day-to-day duties, its panel is fine, and nor should we forget that AOC packs 3,840 x 2,160 pixels into its 27in frame.

| Panel uniformity (Brightness, % difference from centre) | | | | |
|---|-----|------|------|------|
| 6 | 9.5 | 11.5 | 10.2 | 12.6 |
| 9.3 | 2.6 | 0 | 4.7 | 16.1 |
| 4.4 | 4.9 | 3.4 | 4.2 | 12.9 |

27in NON-DOCKING

Iiyama ProLite XU2792UHSU-B1

A back-to-basics affair, but if your priorities are 4K and image quality, it's a steal

SCORE

PRICE £233 (£280 inc VAT) from scan.co.uk

Iiyama clearly had one aim when designing the XU2792UHSU-B1: to build a good-quality 4K monitor for a great price. After all, not everyone wants a feature-laden screen, so why pay for the privilege?

Admittedly, you might be taken aback when you start assembling this monitor. The plastic foot stand is so light that it would be blown away by a gust of wind, so it's little wonder the screen wobbles once you start clicking the OSD buttons mounted on the underside of the bezel.

Note that you may want to find a monitor stand – or a hardback book – to place this monitor on, as it sits low on the desk. We took advantage of the



screen's single piece of flexibility, the fact it tilts, to find a comfortable viewing position.

Once in place, though, such trifles are quickly forgotten. This is a fine-quality panel that benefits from being built in 2020, and Iiyama has tuned it beautifully: out of the box it not only looked good but performed well in our technical tests. Without any tweaks, not even adjusting its 90% brightness, it hit 99.2% of the sRGB colour space with a 108.6% volume, and with a Delta E of 0.36. Note that Iiyama's official claims of 300cd/m² brightness are conservative, with our unit hitting 358cd/m².

ABOVE Don't judge the Iiyama by its wobbly foot: the output and price are superb

What's more, at 1,102:1 its contrast is great for an IPS panel. We think you'll enjoy viewing photos and videos on this screen, and there's even a pair of 2W stereo speakers built in. They're not stunning, but we're pleased to see them at this price, as we were the two USB-A ports.

The OSD is responsive, but you won't find much to significantly adjust the screen's output. There are a measly three colour temperatures to choose from (9300K, 7500K and 6500K), while Iiyama's selection of presets – iStyle Standard, Cinema, Text, Scenery and Game – did little more than brighten or dim the action. This screen is capable of gaming, though, with a 4ms response time.

Compared to many monitors in this Labs, the XU2792UHSU-B1 isn't going to wow anyone... until you show them the quality of its output and explain how little you paid for it.

| Panel uniformity (Brightness, % difference from centre) | | | | |
|---|-----|------|------|------|
| 9.2 | 1.2 | 2.4 | 4.7 | 3.8 |
| 17.6 | 2.4 | 0 | 2.7 | 11.9 |
| 17.7 | 9.6 | 10.2 | 14.1 | 8.4 |

Iiyama ProLite XUB2792QSU-B1

Aside from its lack of USB-C, this is very nearly the perfect 27in monitor

SCORE

PRICE £215 (£258 inc VAT) from scan.co.uk

On the face of it, it might seem odd that we're recommending this 1440p screen when Iiyama is selling a 4K monitor for almost exactly the same price. While the XU2792UHSU-B1 has its undoubted attractions, we think this more rounded monitor is a better choice.

For one, while you do notice a lift in sharpness when you move from a 1440p to a 4K 27in screen, the difference isn't as big as you might expect. At standard viewing distances, 2,560 x 1,440 pixels don't have any obvious fuzz.

If you're willing to accept this argument, this monitor's advantages start multiplying. For a start, it comes



with a far superior stand than its sibling. There's 130mm of height adjustment, support for portrait mode and 90° of swivel. Plus, it simply feels higher quality.

That extends to the all-round design, with slim bezels on three sides and a stylish "brushed metal" effect on the bottom bezel. Once you remove the marketing stickers from the front, you'll like what you see. One of those stickers proclaims support for AMD's FreeSync technology, and while both a 75Hz peak refresh rate and 5ms response time would make pro gamers snicker in amusement, they're fine for casual use.

ABOVE This monitor proves there's life away from the sunlit uplands of 4K



It's as a workday monitor that this Iiyama excels, though, particularly if you head to Iiyama's i-Style Standard colour profile. This locks brightness to 335cd/m² and makes the most of the natural whites of the IPS panel; it covered 99.3% of the sRGB profile with an average Delta E of 0.28. While we would recommend wider gamut panels to anyone doing colour-sensitive work, this is a great panel for the daily grind.

It helps that Iiyama comes close to hitting the sRGB target 6500K colour temperature while offering a fine contrast ratio (for an IPS screen) of 1,227:1. Colours pop.

We mourn the absence of USB-C and wish the speakers had a little more quality, but when you marry the image quality on offer with the low price, it becomes obvious why the XUB2792QSU-B1 steals the award away from its 4K rival.

| Panel uniformity (Brightness, % difference from centre) | | | | |
|---|-----|-----|-----|------|
| 4.6 | 0.7 | 2.1 | 2.6 | 6 |
| 13 | 2.9 | 0 | 5.4 | 15.4 |
| 2.3 | 5.6 | 5.3 | 7.8 | 11 |



27in NON-DOCKING



2,560 x 1,440

27in

IPS

AOC Q27P2Q

A well-priced panel that performed well in our tests, but a couple of flaws hold it back

SCORE

PRICE £198 (£238 inc VAT) from uk.insight.com

The AOC Q27P2Q is the cheapest of the three 27in non-docking monitors on test that include a 1440p panel, but that doesn't mean it's the best value. Not that this screen is short of features: there's 120mm of height adjustment, a pivot mode and a four-port USB hub. The stand doesn't offer any swivel, but because it's so light you can easily twist the whole unit without much effort.

There are signs of cost-cutting elsewhere, with only one HDMI port to accompany the DisplayPort and, unusually, VGA input. And that's it for ports, unless you count the headphone jack and audio output – the latter a sign, perhaps, that AOC knows its pair of 2W speakers won't blow anyone away with their sound quality.

Its image quality is far better. It covers almost the entire sRGB gamut, and even performs well compared to similarly priced rivals in the Adobe RGB and DCI-P3 gamuts. Likewise, we can't complain about an average Delta E of 0.75 or a peak brightness (in our tests) of 349cd/m².

Where it becomes unstuck is for contrast ratio, with a low result of 887:1. Combined with AOC's choice of screen coating – which diffuses reflections well but adds a slight grain – we simply didn't enjoy looking at this screen in the same way we did Iiyama's ProLite XUB2792QSU-B1. While that costs £258, we recommend you spend the extra £20.

| Panel uniformity | | | | | (Brightness, % difference from centre) |
|------------------|-----|-----|-----|-----|--|
| 10.8 | 5.5 | 5.6 | 1.8 | 4.3 | |
| 10.6 | 5.2 | 0 | 2.5 | 4.4 | |
| 7.7 | 5 | 4 | 2.2 | 0.5 | |



1,920 x 1,080

27in

IPS

Asus TUF Gaming VG279QM

A 144Hz IPS screen geared to gamers sounds like a fine combo, but we're left unimpressed

SCORE

PRICE £292 (£350 inc VAT) from scan.co.uk

As the VG279QM's full name gives away, gaming is the clear focus of this Asus monitor, but we can see few reasons to pick it over others on test.

For a start, it has a Full HD resolution. That can work to your advantage in games, especially as lower-resolution panels often include higher refresh rates, but there's nothing special about 144Hz anymore, while the 1ms response times and support for Nvidia's most basic G-Sync standard (Compatible) fail to inspire.

The fact it's based on an IPS panel rather than twisted nematic (TN) should lead to higher image quality, but there's no hiding from the 82ppi pixel density. Text simply looks fuzzy. And, truth be told, for an IPS panel its results are average: in sRGB Mode, its contrast ratio plummeted to 388:1, giving everything a drab look.

There are bright spots (literally, in some places, as brightness uniformity isn't one of this screen's strong suits). The OSD is easy to use and responsive, based on a joystick around the back, and if you're a gamer then there are a huge number of tweaks to choose from – Shadow Boost is definitely worth investigating if you're struggling to see details in darker scenes.

But talking of shadows brings us to the one that hangs over the Asus TUF Gaming VG279QM: at £350, it's fast approaching the cost of larger, better gaming screens with higher resolutions.



1,920 x 1,080

27in

TN

BenQ GL2780

The only TN panel in this Labs fails to shine, despite the best efforts of BenQ

SCORE

PRICE £125 (£150 inc VAT) from box.co.uk

The GL2780 is the sole monitor in this Labs to use a TN panel, and if nothing else it serves as a useful reminder of this technology's limitations. That's despite BenQ's best efforts, because in terms of testing it performed well: in sRGB mode, it covered 90.6% of that gamut with 101.9% volume and an average Delta E of 1.05.

However, numbers never tell the whole story, and as soon as you start using the GL2780 you'll become aware of its limited viewing angles and tendency to wash out colours. This is despite a technically strong contrast ratio of around 1,200:1.

It doesn't help that a 1,920 x 1,080 resolution results in jagged-looking text, which BenQ does its best to iron out with sharpening – but, ultimately, you can't beat the reality of 82ppi. In 2020, that's too low for comfort.

A 1ms response time will appeal to gamers, but 75Hz is not a brilliant refresh rate and there's no support for adaptive sync technology. We still found gaming a smooth affair, but recommend you consider VA panels instead.

And if you're looking for a cheap office monitor, we'd urge you to save £20 and buy the 24in Iiyama ProLite XUB2493HSU-B1 instead. It's superior in almost every way, including a substantially better stand: the only thing we can say in favour of the fixed, basic stand used by the BenQ GL2780 is that it's light.

| Panel uniformity | | | | | (Brightness, % difference from centre) |
|------------------|-----|------|------|------|--|
| 18.5 | 9.7 | 7.5 | 9.5 | 9.3 | |
| 19.6 | 4.9 | 0 | 7.5 | 14.9 | |
| 18.1 | 9.9 | 11.8 | 12.2 | 17.2 | |

| Panel uniformity | | | | | (Brightness, % difference from centre) |
|------------------|-----|-----|-----|-----|--|
| 2 | 3.9 | 11 | 7.1 | 1.9 | |
| 1.3 | 1.3 | 0 | 1.4 | 4.9 | |
| 4.6 | 5.8 | 5.7 | 7.1 | 6.5 | |

27IN DOCKING

Dell UltraSharp U2720Q

Dell wins its award for all-round quality matched with the many benefits of USB-C, even if it doesn't wow

SCORE 

PRICE £445 (£534 inc VAT)

from dell.co.uk

If you're looking for a 27in monitor to set your pulse racing, we can think of many others in this Labs that will do the job far better than the Dell UltraSharp U2720Q. Perhaps most notably the MSI Optix MAG272CQR. If, on the other hand, you're looking for a practical screen that will reduce cable clutter and reproduce accurate colours, this 27in 4K screen fits the bill – and, unlike the technically superior offerings from NEC and Eizo, it does so for a competitive price.

While we say technically superior, in truth there isn't a big gulf between this Dell and its more expensive rivals. Consider its Delta E: while there's no guarantee that the monitor you buy will match the phenomenal 0.33 average we measured, Dell promises that all screens will leave the factory with an average of under two. As such, colour accuracy won't be a problem.

Dell also makes it easy to switch between preset colour spaces. The UltraSharp is shipped in Standard mode, which you can tweak as you wish, but you can choose between sRGB and DCI-P3 by heading into the OSD's Color Space submenu. Or flick between six colour temperatures ranging from 5000K to 10,000K, or select one of its other preset modes of, say, Movie or Game.

We didn't find it necessary to make any adjustments to cover the sRGB and DCI-P3 colour spaces. In sRGB mode, it covered 92.8% of the gamut with 94.7% volume, while slipping into DCI-P3 produced a measurement of 86.7% – not perfect, and falling behind Dell's claims of 95%, but still one of the better returns among this month's monitors.

The OSD is easy to use and responsive, relying on four small buttons mounted at the bottom of



the screen. They change function depending on context – for example, up, down, select and back if changing a value – and the sensible icons make it easy to understand what's going on. The only annoyance when using the OSD is that the screen wobbles on its stand when you press a button (unlike the HP).

In return, you're buying versatility. You can pivot the screen on the stand by 90° in either direction, it tilts backwards and forwards as much as anyone will need, and a 45° swivel either way is enough

to show your neighbour what's on your screen. The *coup de grâce* is a total 130mm of height adjustment, which means it should fit neatly into most workspaces.

The Dell UltraSharp U2720Q is packed with all the ports most people will need, with DisplayPort 1.4 and HDMI 2 inputs keeping the USB-C port company. There's no USB-B connector, so the only way to take advantage of the three USB-A ports is via its USB-C connection (as such, the Dell can't match the keyboard/mouse sharing abilities of rivals such as the NEC). While two of those USB-A ports are unpowered and tucked next to the video inputs, there's a powered USB-A port on the left of the screen as you look at it – it can deliver 2A of

ABOVE The Dell's colour accuracy is, mostly, as crisp as a mountain lake...



LEFT A Vitruvian Man-style diagram showing the Dell's prodigious pivoting power

BETWEEN The stand offers a huge 130mm of height adjustment to prevent neck pains

current – and next to it a downstream USB-C port capable of delivering 3A.

We would have liked to see an Ethernet port, but when the main USB-C connector can deliver 90W of power, you can be confident that all mainstream laptops – other than the more power-hungry MacBook Pros – will only need one wire when docked. This is why we're such fans of the USB-C approach. And note the Dell has a neat hole in its stand for the power cord and signal inputs.

To our surprise, especially after enjoying the audio output of the UltraSharp U4320Q, Dell doesn't provide any speakers here. There's an output jack, but that's it. Dell is more generous when it comes to supplied cables, with a 1.8m DisplayPort and 1m USB-C cable in the box, plus a 1.8m USB-C to USB-A cable.

But where Dell's generosity really shines is its £534 price. You can buy cheaper 4K 27in screens but they lack the all-round quality of the Dell and the versatility provided by USB-C. If you're looking for 4K, want USB-C and can't afford the NEC or Eizo, the Dell UltraSharp U2720Q is the monitor to choose.



| Panel uniformity (Brightness, % difference from centre) | | | | |
|---|-----|------|-----|------|
| 15.6 | 8.6 | 9.3 | 7.4 | 7.2 |
| 7.2 | 0.9 | 0 | 1.1 | 4 |
| 10.7 | 8 | 10.1 | 8.9 | 17.2 |



27IN DOCKING

BenQ EW2780U

A quality display for work duties that's also great for watching videos after hours

SCORE ★★★★★

PRICE £387 (£464 inc VAT)
from shop.benq.eu

With the EW2780U, BenQ is asking one simple question: why spend more than £500 on a 4K USB-C monitor? BenQ covers all the most important basics, choosing a high-quality IPS panel that's well tuned to people's daily needs: in Standard mode, it covers 98.5% of the sRGB gamut with 109% volume, while its average Delta E of 0.29 is exceptional. If you want refresh rates higher than 60Hz or a wider gamut, you'll need to look elsewhere, but a contrast ratio of 1,085:1 and excellent brightness uniformity mean that it makes an excellent first impression.

It has a trick up its sleeve too, which is in part thanks to a strong



peak brightness of 371cd/m². BenQ takes advantage of this to provide three HDR emulation modes, all selectable via the "HDRi" shortcut button on the bottom bezel, and these add instant punch to videos and games. The effect can't quite match an HDR400-certified panel, but it isn't far off.

To access more controls you'll need to reach behind the back for the mini joystick, or tap one of the two user-programmable buttons that sit just above it. These can then become shortcuts to colour modes, audio profiles and inputs. Tapping the

ABOVE The stand feels lightweight, but the speakers' output certainly isn't

joystick itself brings up the full OSD, which is easy to navigate but peppered with obtuse terms such as AMA (for adjusting response times) and Super Resolution (for upscaling).

MacBook owners should try out the M-book setting: this is meant to more closely match their screens. Just note that the USB-C port's power output is limited to 60W, with the EW2780U's claims as a docking station further diminished by a lack of USB-A ports. In fact, there's a stripped-back feel to the whole monitor, with the stand offering -5°/+15° tilt. We were surprised, then, by the quality of the speakers: they're genuinely good enough to listen to music on.

While it has its limitations, this is a monitor that has some surprising strengths for the price. If your list of tickbox features includes 4K, colour accuracy and watching TV, it's a great choice.

| Panel uniformity (Brightness, % difference from centre) | | | | |
|---|-----|-----|-----|-----|
| 3.2 | 0.5 | 0.5 | 2.5 | 3.5 |
| 5.6 | 3 | 0 | 5.1 | 6.8 |
| 3.8 | 4.8 | 4.9 | 5.7 | 5.7 |

BenQ PD2705Q

For creatives who work in sRGB or Rec.709, this is nothing short of a bargain

SCORE ★★★★★

PRICE £316 (£379 inc VAT)
from shop.benq.eu

Not every creative professional can afford to spend over £1,000 on a monitor, but BenQ reckons it has the answer in the PD2705Q: a hardware-calibrated display with the assurance that even screens from different production lines will output consistent colours. Each monitor comes with its own calibration report and the promise of an average Delta E of under three, plus certification from CalMAN and Pantone.

What you don't get is coverage of the Adobe RGB gamut, so print designers need not apply, but if your work is within the sRGB or Rec.709 gamuts then you'll be happy: the PD2705Q achieved stellar scores of 96.2% coverage/98% volume with a



0.47 average Delta E, while you can widen its gamut by switching to Standard mode where it reached figures of 99.2%, 114.4% and 0.28.

If you connect over USB-C or USB-B, you can take advantage of BenQ's Display Pilot software. This gives control over simple things such as brightness, rather than go through the clunky OSD, along with more advanced tools such as automatically associating colour modes with different applications.

An USB-C output means you can daisy-chain two monitors together, and theoretically you could make it three screens; the main USB-C

connection provides 65W of power to the host laptop.

Video editors should note that there's no VESA DisplayHDR 400 certification, but support for HDR10 means you can get a good idea of how content looks before you press "Export". You won't see the full brightness levels because the panel isn't capable of it: our sample peaked at 327cd/m², and even that is well beyond the typical 300cd/m² peak brightness that BenQ promises.

BenQ supplies a flexible stand to match this flexible monitor, with support for pivoting and 120mm of height adjustment, and for the price we can forgive minor annoyances such as the four USB-A ports being placed around the back of the monitor. Nor can we expect 4K. We don't recommend this screen for everyone, but it's terrific value for its target audience.

| Panel uniformity (Brightness, % difference from centre) | | | | |
|---|------|-----|-----|------|
| 4.3 | 5.6 | 4.5 | 1 | 10.2 |
| 16.3 | 10.6 | 0 | 0.6 | 14.1 |
| 17.3 | 12.6 | 5.4 | 2 | 13.7 |

Eizo FlexScan EV2785

Expensive, but that's reflected in the quality of the panel and the package

SCORE 

PRICE £773 (£923 inc VAT)

from lambda-tek.com

While Eizo's FlexScan screens don't have the hardware calibration of its ColorEdge series and can "only" display 16.7 million colours, they still offer phenomenal accuracy. That's shown in the EV2785's results, with 99.1% coverage of the sRGB gamut (116.1% volume) and a Delta E of 0.37. Even its worst result was 1.07, which means that its colours are essentially perfect.

Despite this, we can't recommend the FlexScan EV2785 for print-focused creatives as it only covers 73.5% of the Adobe RGB gamut; ViewSonic's VP2785-2K is the better option here if your budget is limited.

So who is the Eizo right for? Well, anyone looking for versatility, build



quality and reliability. The EV2785's stand offers an unmatched 178mm of height adjustment, while the screen swivels 344°, pivots 90° and tilts back a full 35°.

Eizo also offers the most generous warranty here, with five years of on-site cover and a six-month guarantee that promises replacement if any sub-pixels are fully lit. The company invests in a brilliant OSD, too, with touch-sensitive buttons on the bottom bezel that allow you to flick between its numerous settings with ease. It offers a huge spectrum of colour temperatures, ranging from

ABOVE The whopping 178mm of adjustment will suit even the tallest of users



4000K to 10000K in (largely) 500K increments and, unlike other manufacturers, it's very close at matching those temperatures.

There are two HDMI inputs alongside the DisplayPort and USB-C connectors, which are all easily accessible, while Eizo provides two USB-A ports and a headphone jack on the left of the screen as you face it (the two 1W speakers are as weedy as their specification sounds). Unlike the NEC EA271U, you can't use it as a KVM, as there's no USB-B port. Also note that both monitors' USB-C power output is limited to 60W.

Like the EA271U, this is a brilliant monitor with a price to match. The Eizo edges ahead due to its superior warranty, more flexible stand and outstanding OSD, along with a wider gamut panel. If you're looking for a top-quality 4K monitor for under £1,000, you've found it.

| Panel uniformity (Brightness, % difference from centre) | | | | |
|---|-----|-----|-----|------|
| 8 | 5.3 | 7.4 | 4.9 | 9.8 |
| 11.2 | 5.6 | 0 | 6.9 | 13.1 |
| 6.5 | 5.1 | 5.2 | 5.3 | 4 |

HP E27d G4

A no-nonsense monitor that excels for practicality rather than image quality

SCORE 

PRICE £399 (£479 inc VAT)

from store.hp.com

If the HP E27d was a human, it would wear a sharp grey suit, carry a briefcase and always complete its to-do list. As befits such a creation, HP supplies it in "Neutral" colour mode. This tracks the sRGB colour space and we assume targets the 6500K temperature, although our testing showed it to go a little beyond on both counts: while it covers 99.6% of the sRGB gamut, we measured 110.2% volume and its temperature at almost 6700K. Colour accuracy is spot on, with an average Delta E of 0.44.

You can push brightness up to 352cd/m², well beyond what's necessary in the office or study, where this screen will surely end up, but note that we wouldn't choose it for



watching films. That's largely due to a measured contrast ratio of 865:1 but also because HP doesn't find room for speakers: you must make do with a headphone jack.

That's surprising because HP clearly has web conferencing in its sights with the E27d G4, with a Full HD camera tucked behind the top bezel. You simply slide it up when you need it and down when you want privacy. The camera is only usable when the E27d is connected via the USB-C cable, and that connection is the big selling point of this docking monitor: with four USB-A ports and an Ethernet socket, plus the ability

ABOVE All work and no play makes the HP E27d G4 a good choice for the office

to deliver up to 100W of power, you could reduce the number of cables on your desk to one (aside from the power cable for the monitor itself).

The stand looks minimalist, but you can adjust the screen's height by up to 150mm, swivel through 30° in each direction and pivot it 90°. We also appreciate the stand's solidity: while other screens wobble when you press buttons to control the OSD, the E27d stays steady. It's also one of the most intuitive and pleasant OSFs here.

Assuming you aren't looking for the last word in pumping colours, this monitor only has one "fault" – and that's its resolution. While a 27in 1440p monitor is a big step up from a laptop display or a 24in Full HD screen, a 4K resolution has obvious advantages for information workers who need to view detailed documents side by side. That's why we'd spend £65 more on the 4K Dell U2720Q.

| Panel uniformity (Brightness, % difference from centre) | | | | |
|---|-----|------|------|------|
| 14 | 13 | 10.1 | 12.5 | 10.9 |
| 13.1 | 7 | 0 | 3.1 | 8.5 |
| 16.8 | 9.8 | 5.1 | 6 | 9.8 |



27IN DOCKING

MSI Optix MAG272CQR

An excellent choice for gamers looking for high refresh rates and USB-C

SCORE

PRICE £333 (£399 inc VAT) from scan.co.uk

While gaming monitors aren't the focus of this Labs, when MSI offered us this curved 27in 1440p monitor for review we couldn't refuse. That curve is gentle in practice, with 1500R not obvious in this size of screen, but what really matters is refresh rates and response times. With a VA panel in place, the MSI impresses: a maximum of 165Hz and 1ms, together with a measured contrast ratio of 2,502:1, means you won't miss a detail through smearing or darkness.

Press down on the rear joystick and you also get "Screen Assistance", with a crosshair appearing in the centre of the screen, while pressing up gives a choice of gaming modes: FPS, Racing, RTS, RPG and one user-defined mode.



Press down to enter the full OSD menu, at which point you'll be faced with an array of options – including the ability to activate HDR mode, but a peak brightness of 307cd/m² means the screen doesn't shine here.

You can also use the OSD to fine-tune the User colour gamut, but there's little need to do so: this MSI panel covers 99.6% of the sRGB gamut (134.9% volume) and 88.5% of DCI-P3 in its Standard setting. The MAG272CQR offers colour accuracy too, with an average Delta E of 0.58. It performed excellently in our

ABOVE Enter the dragon: the MSI's speeds mean you won't miss a detail

NEC MultiSync EA271U

An outstanding monitor that offers a cheaper alternative to the Eizo EV2785

SCORE

PRICE £632 (£758 inc VAT)

from lambda-tek.com

The EA271U first graced these pages in early 2019 (see issue 293, p92), earning a place on the A-List for its stunning whites and excellent all-round quality. Those traits haven't changed a jot in the interim, with the monitor still a great choice for any office worker: it offers superb colour accuracy in the sRGB space, covering 98% with an average Delta E of 0.54.

The EV2785 covers a wider range of colours, however. Even after some tweaking and shifting through the different colour presets, we couldn't persuade the NEC to cover more than 70% of the Adobe RGB colour space, with DCI-P3 only slightly better at 76.7%. However, where this monitor



wins is for the range of colour temperatures, with the option to move from anywhere between 4000K and 15000K in 100K increments.

This range of options is typical of what's on offer from the NEC's OSD, which can seem quite overwhelming at first; it doesn't help that NEC eschews graphics for text, with everything in caps to make it that much harder to read. Once you understand its logic, however, it's easy to navigate through the options.

NEC's screen offers many office-friendly features based around its USB-C docking, providing up to 60W

brightness uniformity test, but that doesn't tell the whole story: we prefer IPS panels for office duties as whites appear more uniform across the panel.

Information workers may also appreciate the extra sharpness of a 4K screen over 1440p, but that's reflected in the price. Of the 27in monitors on test with a USB-C connection, only the basic BenQ PD2705Q is cheaper. Note that MSI clearly expects you to power your laptop separately, with a 15W power output enough to keep a laptop topped up but little more. Still, a USB-B port and two USB-A ports mean you can use it as a docking station. Just don't expect speakers.

While this screen only offers a basic stand – its sole but useful talent is 130mm of height adjustment – its higher resolution and USB-C support are both good reasons to spend £50 on it rather than the non-docking Asus TUF Gaming VG279QM.

| Panel uniformity (Brightness, % difference from centre) | | | | |
|---|-----|-----|-----|-----|
| 3.7 | 2.3 | 3 | 1.2 | 2.5 |
| 5.8 | 1.6 | 0 | 0.9 | 2.1 |
| 11.2 | 3.6 | 1.6 | 4.7 | 9.3 |

of power and three USB-A 3 ports – albeit no RJ-45 network connection – and a USB-B connector means it can work as a KVM. Also note the handy downstream USB-C port. We suggest that music lovers take advantage of the headphone output as the two weedy 1W speakers are only suitable for basics such as web conferencing.

This screen is well suited to corporate situations, especially if you'll take advantage of management tools such as ControlSync: this allows you to sync settings to eight "sub-monitors" from one master monitor. Its stand is flexible too, with 150mm of height adjustment and a 340° swivel along with portrait mode.

Almost two years after we first reviewed this monitor, we still love it. The Eizo EV2785 is a better choice if you need a wider gamut, but the NEC is cheaper and has KVM abilities that its rival can't match.

| Panel uniformity (Brightness, % difference from centre) | | | | |
|---|-----|-----|-----|------|
| 10.5 | 7.4 | 7.3 | 8.4 | 13.3 |
| 10.4 | 5.8 | 0 | 5.7 | 11.9 |
| 4.4 | 7.2 | 3.7 | 3.1 | 5.6 |

31.5-34in

Philips Brilliance 328P6

Not only a terrific value monitor but a great all-rounder. If you want 4K with trimmings, choose the 328P6

SCORE 

PRICE £458 (£549 inc VAT)

from box.co.uk

Philips has embraced the idea of docking monitors with gusto, with both its "P Line" monitors here including an RJ-45 Ethernet port along with four USB-A ports: as long as you have a laptop that will charge via the 60W USB-C connection, you can reduce the clutter on your desk to that one wire. If you aren't too fussy about aural output, you should also be happy with the pair of 3W speakers; they're far from audiophile quality, but are fine for background music and videoconferencing.

You can even make the argument for this screen to act as a TV (you can add a TV stick into one of the two HDMI ports and then power it via USB), because the Brilliance does live up to its name: while a peak brightness of 460cd/m² in general use is more than enough, this monitor's VESA DisplayHDR 600 certification means that it can hit 600cd/m² highs when playing suitable material. Sure enough, HDR-enabled videos on Netflix pack high-contrast punch that edge towards OLED territory.

Philips provides a number of "SmartImage" presets that you can select via the OSD, ranging from EasyRead to Office to Movie. The idea is that the monitor analyses what's onscreen and then adjusts properties such as sharpness and contrast to "enhance" the displayed image. So, in the Game preset, it will activate the overdrive circuitry (to give 4ms grey-to-grey response times), while the Office mode sharpens text and reduces brightness.

Alternatively, you may want to dig into the more advanced controls, which is where the touch-sensitive buttons can befuddle as much as they sometimes help; pressing the down button sometimes activates a double-hit, for instance, so you zoom past the setting you want. Also note that Philips doesn't offer a huge amount of control, with your options being sRGB, user-defined and six selectable colour temperatures from 5000K to 11500K.



3,840x
2,160

31.5in



These are approximate figures rather than promises, however, with our colorimeter measuring the 6500K setting at 5995K and 7500K at 6870K. But this doesn't have a material effect on image quality, with this VA panel offering the high contrast ratios we expect – 3,061:1 in sRGB mode – and an excellent range of colours.

You can tie it down to sRGB, where it returned coverage and volume figures of 94.6% and 95.1%, but in its default mode it stretched to 145.8% of the sRGB space and was almost perfectly matched to the DCI-P3 gamut with figures of 97.1% and 103.3%. Add in an average Delta E of 0.6 and this can only be described as an excellent panel; the sole disappointment were its brightness uniformity figures, but we suspect these were deliberately boosted at the edges to counteract some of VA's natural drop-off.

Despite the Game option in SmartImage, we wouldn't recommend the Brilliance to gamers. It can reach 75Hz but only at lower resolutions such as 1,440 x 900, and there's no support for syncing technology such as AMD's FreeSync. You're far better served by dedicated gaming monitors such as the MSI Optix MPG341CQR overleaf.

It's also clear that Philips is going after the business buyer with this monitor's black and silver tones, and while creative professionals should also look elsewhere if they want guarantees of colour spaces, Philips does provide a calibration report

ABOVE Brilliance by name, brilliant by nature: it can hit a searing 600cd/m²



"In its default mode it stretched to 145.8% of the sRGB space and was almost perfectly matched to the DCI-P3 gamut"

BELOW The stand can swivel an owl-like 340° and become 180mm taller



with each monitor and guarantees a Delta E of less than two. It's an office-friendly stand too, with height adjustment of 180mm, pivot support and the ability to swivel 340°.

What you don't get is the feeling of luxury that comes from buying the likes of an Eizo, with the Philips Brilliance 328P6's fit and finish not up to that of the FlexScan EV2785, for example. The stand is a good example of this: while they share similar specs,

the Eizo's is almost like a work of art where the Philips' is far more functional. Nor do you get the long warranty of the Eizo (three years rather than five years), while Philips' policy on pixel defects is much less generous.

But – and this is the crucial point – that's reflected in their relative prices. You can very nearly buy two Philips Brilliance 328P6 monitors for the price of one Eizo FlexScan EV2785. It may not be as beautiful, or as tweakable, but Philips has invested its budget in all the areas that matter to create yet another brilliant monitor for a great price.

| Panel uniformity (Brightness, % difference from centre) | | | | | |
|---|-----|------|------|------|--|
| 8.6 | 9.3 | 8.9 | 9.8 | 8.7 | |
| 4.7 | 2.3 | 0 | 5.6 | 8.8 | |
| 7.9 | 7.2 | 10.1 | 10.6 | 13.1 | |



31.5-34 IN

Asus ROG Strix XG32VQR

A striking monitor that packs in plenty of features to appeal to gamers

SCORE

PRICE £429 (£515 inc VAT) from scan.co.uk

On paper, the Asus has obvious competition this month: the MSI Optix MPG341CQR is also a large VA gaming monitor with an 1800R curvature and 144Hz refresh rate. Placed side by side, though, these are very different screens.

Where the Strix uses a 31.5in panel with a 16:9 aspect ratio, the Optix stretches to a cinematic 21:9. Although the MSI has a wider 34in diagonal, the Asus actually has a larger area of panel and that results in a lower pixel density of 93ppi: it consequently lacks the sharpness of its rival.

Their performance in our technical tests was almost identical, although the Strix benefits from a dedicated sRGB mode. This locked our panel's brightness to 169cd/m² but provided



99.5% coverage with an average Delta E of 0.61. The downside was that it reduced the contrast ratio to 980:1, so you may prefer to switch to a more vibrant mode.

There are plenty to choose from, including Scenery, Cinema, RTS/RPG and FPS. Switching to the latter preset upped the top brightness to 555cd/m², and the contrast ratio to 2,756:1 – more like we'd expect from VA tech.

The OSD allows you to fine-tune colours to create your own profile, with an overly sensitive joystick for controlling the action. Asus provides large shortcut buttons on the rear of

ABOVE An LED shines down UFO-style to create a jazzy pattern on your desk



the screen, with the middle one bringing up game-friendly options such as crosshairs and an FPS counter.

Nor is that the end of Asus' attempt to lure gamers, with the striking tripod stand housing a red LED: this shines downwards to project a pattern onto your desk, with rear-mounted lights for some extra bling.

The stand makes it easy to swivel through 100° while offering 100mm of height adjustment, but we wish the rear ports were equally practical: Asus chooses style over ease of inserting cables, which is a shame when there's a two-port USB hub. Once everything is in place a cover and cable tidy makes this a neat setup, but you'll want to hide the power brick.

Add numerous HDR options, AMD's FreeSync 2 and DisplayHDR 400 certification, and it's hard to argue with the value or flexibility here. Gamers take note.

| Panel uniformity (Brightness, % difference from centre) | | | | |
|---|------|------|------|------|
| 14.4 | 9.3 | 12.1 | 13.4 | 20.6 |
| 10 | 2.5 | 0 | 6.7 | 18.9 |
| 12.8 | 10.7 | 11.5 | 15.6 | 21.1 |

Iiyama ProLite XB3288UHSU-B1

A great choice if you're looking for a 4K monitor but can't go above £400

SCORE

PRICE £292 (£350 inc VAT) from scan.co.uk

The Iiyama XB3288UHSU-B1 has much in common with the Philips 328E1. They both use a VA panel, both have a 4K resolution and are both aggressively priced. Their first and most obvious point of difference is that the Philips is curved while the Iiyama is flat, but the second is that Iiyama still includes many useful "extras" despite its budget.

So, here you enjoy two USB-A 3 ports to the left of the screen. Then there's a flexible stand, with height adjustment up to 130mm and 90° of swivel; there's no support for pivot mode, but you can rotate the screen for easier access to the three inputs: two HDMI, one DisplayPort.



Iiyama takes advantage of VA's fast response times with support for AMD FreeSync. The panel goes up to 75Hz at 1,280 x 1,024, but above that you're stuck at 60Hz. Also note the 3W stereo speakers, which are surprisingly good for the price. Still, if you want depth then connect headphones to the jack on the rear.

One downside to VA compared to IPS is viewing angles, and you will notice some drop-off in contrast as you look across the screen. Nor is this most consistent panel when it comes to brightness. However, it did cover almost 100% of the three gamuts we

ABOVE You get a good number of ports for your pennies, with two USB-As on the left

checked for, from the conservative sRGB (99.1%) to DCI-P3 (95.3%).

With minimal tweaks necessary, you may find that the only control you fiddle with is brightness; this ProLite goes up to 319cd/m², which is more than enough for work and play but not HDR. The OSD is easier to control than other Iiyama screens too, thanks to a rear-mounted joystick rather than hidden buttons. We only wish that Iiyama offered finer control over colour temperature, as the default settings come out at around 5950K, with Warm and Cool being the only other presets.

Still, considering the price Iiyama is charging – and the lack of sacrifices elsewhere – this is yet another terrific value screen from the company. We also don't think the lack of curvature is a big issue for a 32in 4K screen, making this our pick over the Philips if you're on a budget.

| Panel uniformity (Brightness, % difference from centre) | | | | |
|---|------|------|------|------|
| 4.2 | 16.2 | 12.9 | 12.1 | 10.6 |
| 10.4 | 4.9 | 0 | 16.7 | 15.7 |
| 3.9 | 15 | 11.6 | 15.1 | 15.4 |

31.5-34in

Iiyama ProLite XUB3493WQSU-B1

A terrific value panel, but spending more on the Philips 328P6 delivers big benefits

SCORE

PRICE £286 (£343 inc VAT) from scan.co.uk

Take two monitors into the office? Not Iiyama. With this 34in widescrren, it really is like having two monitors pinned together to form one gigantic workspace.

With a resolution of 3,440 x 1,440 you aren't getting the same amount of area as two 27in 1440p screens; in terms of screen diagonal, it's closer to two 21in monitors. Still, no one will want for desktop space, with the panel a gift to any spreadsheet devotee or those who like to have two or three windows in view simultaneously.

However, we found ourselves drawn in closer than with a 27in 1440p monitor, and that means that its 109ppi density becomes a drawback.



3,440x
1,440

34in

IPS

Also note that a 21:9 ratio results in black bars on either side of most videos, which is a shame when the 5W speakers are so good.

Iiyama chooses an IPS panel, so you immediately benefit from excellent viewing angles. It's also strong when it comes to brightness uniformity.

This wasn't the best performer in our other technical tests, however, especially in its default mode. Its sRGB coverage of 88.6% (96.2% volume) is okay, but this panel struggles to go beyond this space. After some tweaks, we pushed those figures up to 92.6% coverage and 100.9% volume, but other panels have far wider gamuts.

ABOVE Like to have a dozen tabs open at once? There's enough screen space here

Iiyama provides a handful of presets via its iStyle options – hidden away in a fiddly OSD – but only Standard gives a notable boost. And, in truth, that was mainly because it pushed our panel to its full and magnificent brightness of 425cd/m² (Iiyama states 400cd/m²).

The stand is more flexible than the panel, including height adjustment of 130mm and 90° of swivel, but don't be fooled by the fact it rotates 90°. This stand doesn't actually support pivot mode, for the simple reason that it's too short even when the height is at its maximum of 545mm.

As ever for Iiyama, its aggressive pricing means that this monitor can't be beaten in terms of bang-per-buck – however, spending more on the Philips Brilliance 328P6 buys you a significantly better all-rounder.

| Panel uniformity (Brightness, % difference from centre) | | | | |
|---|-----|-----|-----|------|
| 11.5 | 8.6 | 7.6 | 6.1 | 12.1 |
| 9.7 | 5.9 | 0 | 3.2 | 13.8 |
| 8.4 | 8.3 | 3.7 | 3.4 | 10 |

MSI Optix MPG341CQR

Gamers with deep pockets will love this 21:9 screen and its plethora of features

SCORE

PRICE £724 (£869 inc VAT) from scan.co.uk

The MSI Optix MPG341CQR is one of the most striking monitors in this Labs. It uses a 34in curved 1440p VA panel with a 110ppi pixel density, and it looks sharp from normal viewing distances. Certainly sharper than the 31.5in Asus ROG Strix XG32VQR, which offers the MSI's closest competition in this Labs.

Well, kind of. The Samsung LC34J791WTUXXU also uses a 34in curved VA panel, but in terms of appearance they couldn't be more different: the Samsung is finished in smooth office-white while the MSI is boys' bedroom grey with a strip of programmable RGB LEDs on the front.

MSI also packs this screen with electronics to enhance the panel's natural gaming abilities. It promises a



3,440x
1,440

34in

VA

USB-C

1ms grey-to-grey response time, support for AMD FreeSync 2 and a bunch of options (zero latency, anti motion blur, crosshairs) to give you that gaming edge. The Optix's big advantage over the ROG Strix is immersiveness: almost all games benefit from a 21:9 aspect ratio, and this screen's curvature places you in the game in a way that flat 16:9 screens can't match.

Go to the OSD's Gaming submenu and you'll find presets for FPS, Racing, RTS and RPG, and what you lose in colour accuracy you gain in impact: for example, FPS mode returned a peak brightness of 433cd/m² with a contrast ratio of 2,828:1 and average Delta E of 2.04. There's also a selection

ABOVE A rainbow of LEDs herald the MSI's gaming chops – as does the high price

of Professional presets, and after adjusting the User setting we reached 99.6% coverage of the sRGB gamut with a Delta E of 0.43.

The OSD is easy to navigate, with a responsive joystick on the rear, but you can also use MSI's feature-packed Gaming OSD software if you connect via USB-B. It's odd that it doesn't work over USB-C as well, but MSI makes surprisingly little of this excellent connection – perhaps because it only supplies 15W of power. USB-B also brings the webcam into play, but that's only really useful to activate MSI's Smart Profile feature. This recognises faces and switches to a profile as appropriate.

You have to wonder if that gimmick is one of the reasons this monitor costs so much, and if so then that's a shame. Only the price stops the MSI from winning an award: this is a great gaming monitor.

| Panel uniformity (Brightness, % difference from centre) | | | | |
|---|------|------|------|------|
| 14.7 | 12.8 | 13.2 | 13.1 | 14.2 |
| 9.7 | 6.3 | 0 | 7.8 | 4.7 |
| 15.2 | 21.3 | 12.5 | 21.9 | 10.4 |



31.5-34 IN

Philips Brilliance 346P1

If you fancy a clutter-free desk monitor, this is a bona fide curved bargain

SCORE

PRICE £393 (£471 inc VAT)
from shop.bt.com

We were so impressed by this monitor three months ago (see issue 310, p69) that we put it on the A-List and, while it loses that top spot to the LG UltraWide 38WN95C, the Brilliance 346P1 remains a phenomenal choice if a large, curved screen appeals.

Philips lifts the 346P1 above rival 34in curved VA monitors by packing it with user-friendly features. It's an excellent choice for anyone wanting a clutter-free desk, with an RJ-45 port, four USB-A ports (all sensibly mounted to the left of the screen) and even a KVM switch if you want to share your mouse and keyboard with a second connected computer. Note that its USB-C connection provides a



wholesome 90W of power too.

While the stand is basic in design, and wobbles more than we'd like when prodding the OSD buttons, there's a superb 180mm of height adjustment and you can swivel it 360°. That OSD offers few controls over colours, but Philips expects you to choose between its eight SmartImage options; think Office, Game, LowBlue Mode. You can also quickly flick between sources, with all other controls via the menu.

We recommend you use this to switch the light sensor on, as this will adjust the brightness of the display – and if you keep it on the maximum 507cd/m² this monitor can achieve then you'll need to wear sunglasses.

ABOVE That price is just the cherry on a luxurious, user-friendly cake



Samsung LC34J791

A high-quality panel backed with handy features for desk life – and it looks great

SCORE

PRICE £438 (£549 inc VAT)
from currys.co.uk

Samsung is best known in the UK for its phones and TVs, but it also sells numerous "professional" monitors. It can't help itself from adding consumer pizzazz, though, and here it's evident in a glossy white finish on the rear of the screen: this 34in curved monitor would be equally at home on a receptionist's welcome desk as it would an executive's office.

Said executives can minimise cable clutter thanks to the Thunderbolt connection, and there are two USB-A ports for attaching peripherals. A second Thunderbolt 3 connector that can supply up to 15W means you have a potent docking station.

Samsung takes a different approach to the stand, opting for what



it calls a "swing-and-tilt" mechanism. As you lift the panel through its 100mm of height adjustment, it moves in a gentle arc. You can then separately adjust the tilt so that it faces you correctly. There's no swivel, but as this is a relatively light 34in screen at 7.6kg that isn't a big issue.

There's nothing particularly special about the panel. It uses VA technology with its inherently excellent response times and contrast, making it well suited to games; you can even push it up to 100Hz at its native 3,440 x 1,440 resolution. It supports AMD FreeSync too.

The panel proved a solid performer in our tests, with its standard setting delivering an average Delta E of 0.69

ABOVE The Samsung offers excellent office performance with a bit of personality



While there is an sRGB mode, you're better off choosing Office as this actually does a better job of covering the sRGB gamut: it reached 99% in our tests versus 91.3% for the sRGB setting, and with an average Delta E of around 0.6, it's accurate too.

While other monitors are directly aimed at gamers, the Brilliance does a fine job thanks to a 100Hz peak refresh (even at the screen's native 3,440 x 1,440 resolution) and support for AMD FreeSync, and the pair of 5W speakers are more than good enough if you don't have your headphones to hand. As an extra bonus, this monitor even supports DisplayHDR 400.

We aren't so convinced by the webcam, which only sporadically worked with Windows Hello, but it hides out of the way when not needed.

The 346P1 isn't perfect, but at this price it adds up to yet another brilliant monitor from Philips.

| Panel uniformity (Brightness, % difference from centre) | | | | |
|---|-----|-----|-----|------|
| 2.8 | 3.4 | 1.6 | 2.9 | 6.7 |
| 5.4 | 2 | 0 | 5.8 | 9.4 |
| 12.1 | 6.7 | 7.5 | 13 | 15.7 |

and 99.9% coverage of the sRGB gamut with 131.8% volume. It covers almost all the DCI-P3 gamut too. Where it proved less exceptional was brightness uniformity, but excellent viewing angles make up for this in practice – it doesn't look obviously less bright.

This isn't a good choice for people who like to hop between colour profiles, with a handful of presets on offer from the simple – simplistic, even – OSD. Dig deeper and you'll find a choice of five colour temperatures (we measured Cool 2 at 8825K, for example, while Normal hit 6360K), but this isn't a monitor created with colour obsessives in mind.

With a fine pair of 7W speakers, this stylish screen offers something different to run-of-the-mill office monitors. At this price, and with Thunderbolt 3 to boot, it's a very tempting screen.

| Panel uniformity (Brightness, % difference from centre) | | | | |
|---|------|------|------|------|
| 18.6 | 7.6 | 9.3 | 7.3 | 18.8 |
| 14.4 | 8 | 0 | 11 | 18.7 |
| 11.4 | 15.2 | 15.6 | 21.4 | 16.7 |

31.5-34in



3,840 x 2,160 31.5in IPS USB-C

Dell UltraSharp U3219Q

A beautiful panel wrapped up in an equally beautiful design, but Dell is charging too much

SCORE

PRICE £740 (£888 inc VAT) from dell.co.uk

This 4K monitor has so much going for it. The IPS panel is top quality, hitting 94.3% of the sRGB gamut out of the box and 99.5% with a little tweaking. It even covers 97.3% of the DCI-P3 gamut. Those are both terrific results, as is its average Delta E of 0.49.

Dell hides this light under the bushel of its feature-poor OSD, which is crying out for preset modes that go beyond the basics of Movie, Game and ComfortView. Unless you have a spectrometer to help you widen its gamut, the best you can do is head to the colour temperature options and find the one that best suits you.

No doubt Dell is aiming for elegant simplicity, and that certainly applies to this monitor's design. It's virtually free of bezels and rotates smoothly into pivot mode, while offering a USB-C power output of 90W to feed all but the hungriest of laptops. Also note the KVM, four USB-A ports (two handily on the left side) and generous 150mm of height adjustment.

It all adds up to a more stylish offering than, say, the Philips Brilliance 328P6, and while Dell does offer a superior warranty – it promises that a replacement will be shipped to you on the next working day if one becomes necessary, while the "Premium Panel Guarantee" means that the screen will be replaced if even one bright pixel appears – there's no way to justify the extra £380 that Dell is charging.

| Panel uniformity | | | | |
|--|------|-----|-----|-----|
| (Brightness, % difference from centre) | | | | |
| 11.8 | 9.2 | 7.8 | 8.3 | 5.6 |
| 11.1 | 6.2 | 0 | 6 | 8.6 |
| 8.2 | 10.2 | 8.8 | 9.1 | 9.4 |



3,840 x 2,160 31.5in VA

Philips 328E1

While it will never top the table for features, this 32in 4K curved screen is unmatched for value

SCORE

PRICE £333 (£400 inc VAT) from uk.insight.com

Read down the listing for the Philips 328E1 on p75 and you'll see a lot of crosses. This monitor is pared down to the minimum, with the clear aim of delivering a curved 32in 4K screen for a price no other manufacturer can match.

The question then becomes whether you care about the compromises Philips has made. For example, many of us can live with three video inputs – two HDMI, one DisplayPort – and do you really need a flexible stand with height adjustment? But the more important limitation is the relatively poor viewing angles of its VA panel. As you look into the corners, there's a visible drop off in contrast. If you mainly work in apps with white backgrounds, where this effect is most visible, we don't recommend the Philips 328E1.

Still, this monitor performed well in our colour accuracy tests, with sRGB coverage of 98.2%, 119.5% volume and an average Delta E of 0.71. Note you can push its brightness up to 335cd/m², far better than the 250cd/m² Philips states.

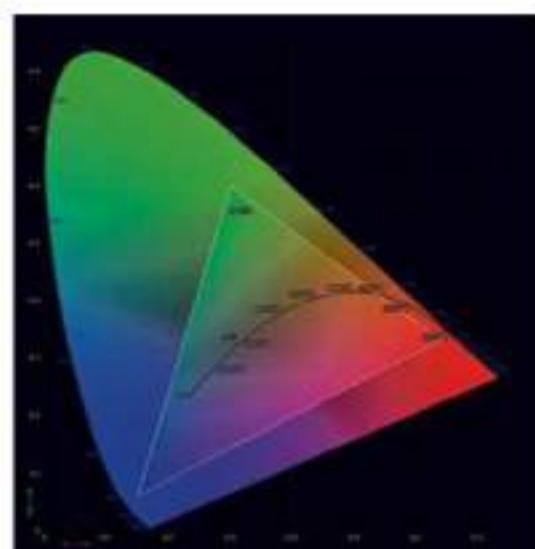
It's also well suited to video and games, with a contrast ratio of 2,228:1 and 4ms response time. While Philips doesn't find space in the budget for FreeSync support, there is a decent set of speakers; good enough to listen to music on. If you're on a tight budget and looking for 4K sharpness over flexibility, the Philips 328E1 will do the job nicely.

| Panel uniformity | | | | |
|--|------|------|------|------|
| (Brightness, % difference from centre) | | | | |
| 17.1 | 12.5 | 14.3 | 16.3 | 18.8 |
| 8.6 | 0.9 | 0 | 6.6 | 12.9 |
| 7.6 | 5.8 | 8.9 | 13.3 | 16.1 |

COLOUR SPACES explained

The colour space below is what your eyes can see. It's far beyond what can be reproduced by a digital device. Colour spaces such as sRGB and Adobe RGB define target gamuts for capture devices (such as cameras) and output devices (such as monitors), so that we have standards rather than the Wild West.

The triangle within the graphic is the sRGB colour space. If we were to show Adobe RGB in the same image, it would extend further into the greens and blues – useful for showing lush landscapes. If you're a professional photographer, this is something to



ABOVE Our eyes can see all the colours in the larger colour space, but sRGB (the triangle inside) has a much more limited palette

bear in mind. Adobe RGB is closely matched to CMYK, as used by most commercial printers, which is why it's so important for print designers.

We mention DCI-P3 in many reviews, as that's the colour space used by digital projectors in cinemas – and thus creators of films. A monitor that supports DCI-P3 will give you the closest match to the director's vision.

While it's obvious what it means for a monitor to cover 99% of a colour space, we also quote a "volume". That's how many colours it shows beyond that colour space, and in marketing you'll often see figures such as "125% sRGB". However, it's more useful for a monitor to have an sRGB profile that shows 99% of the sRGB space, and the same volume, but to then switch to 99% of the Adobe RGB space when you change profiles. That way, you know you're seeing colours as captured.



BIG SCREEN

LG UltraWide 38WN95C

The star screen this month, with a gorgeous IPS panel backed with all the features most people need

SCORE

PRICE £1,108 (£1,329 inc VAT)
from laptopsdirect.co.uk

While most curved panels use VA technology, LG opts for IPS with this 37.5in display. On the surface, this sounds identical to the panel inside the Asus Designo Curve MX38VC, but some digging in diagnostic utilities revealed that the LG's panel was manufactured earlier this year while the Asus uses one created in late 2018. As a result, it benefits from a number of upgrades.

Top of the list is a 144Hz refresh rate, which will naturally make a big difference in games compared to the Asus' peak of 60Hz – if you have a graphics card powerful enough to feed 3,840 x 1,600 pixels. Add a 1ms response time, and adaptive sync support for both AMD and Nvidia graphics cards, and you have a superb gaming display.

Our tests also show this panel can hit 543cd/m² in general use, notably above LG's stated peak of 450cd/m², which explains why it passed VESA's tough certification process to earn a DisplayHDR 600 rating. This is immediately noticeable if you activate the screen's HDR Effect mode, which revealed details that are lost on other monitors.

This panel also offers a much wider colour gamut than the Asus, and LG makes the most of it by including both sRGB and DCI-P3 presets. Testing at 120cd/m², the sRGB mode covered 97.8% of the sRGB volume with 102.7% volume, while at peak brightness in the DCI-P3 preset it covered 94.2% of the DCI-P3 gamut with 97.9% volume. Truly excellent figures, especially when backed with an average Delta E of 0.91. Aside from the very top left, it proved to be a uniformly bright panel too.

One advantage of IPS curved panels over their VA rivals is viewing



angles, with less obvious drop-off as you look across the screen. The disadvantage is the amount of curvature. While LG doesn't state an official figure, we believe this is a 2300R panel (like the Asus) and that means it's a far gentler curve. As a result, you don't get the same level of immersion; indeed, when you're sitting in front of the LG you barely notice any curve at all.

What you do notice is the astonishing amount of desktop space available. You can easily view three windows side by side, and we recommend Microsoft Power Toys' FancyZones to help keep them organised as LG doesn't supply a screen-management utility.

A pixel density of 111ppi ensures that text looks sharp from normal viewing distances too; there's no grain here.

We're pleased to see that LG supplies a more flexible stand than Asus, and coupled with a lighter weight this is a surprisingly easy monitor to move around. It's as compact as it can realistically be, so you can push it back quite far on your desk, and note that it offers height adjustment of 110mm along with 30° of swivel.

LG keeps things neat at the rear, with the standard two HDMI inputs, DisplayPort and a Thunderbolt USB-C port that can supply a reassuring 94W of power to your laptop. There are also two USB ports, again at the rear, but with no USB-B input you

ABOVE The UltraWide was ultra-spectacular in our suite of technical tests



"What you do notice is the astonishing amount of desktop space available: you can easily view three windows side by side"



LEFT The posse of ports, which includes Thunderbolt USB-C and two HDMI inputs

BELOW A compact design makes it easy to find the perfect position on your desk



can't use these with connections other than USB-C (and consequently you can't share a keyboard and mouse between two systems hooked up to the screen). LG doesn't supply a ports cover, instead relying on its supplied white cables to blend in – which is useful if you were thinking of placing this monitor front of house. That all-white theme extends to the external power supply too.

There's no need for separate speakers as the pair of 5W units here do an excellent job with music and films alike, but that's it for "extras". That's fine by us: LG has ploughed its money into the panel and the electronics that power

it – with tangible results. We're even fans of the OSD, which is so quick and easy to understand that you'll be navigating through its options in no time at all (once you find it, as the mini joystick control is tucked beneath the LG logo).

While the LG UltraWide 38WN95C costs substantially more than the Asus, and more still than the 43in Dell, it's worth the added investment. If you buy the LG UltraWide 38WN95C then your eyes will thank you for many years to come – and its width should bring productivity benefits too.

| Panel uniformity (Brightness, % difference from centre) | | | | | |
|---|-----|------|-----|-----|--|
| 20.1 | 8.2 | 10.8 | 8 | 6.2 | |
| 5.5 | 0.5 | 0 | 1 | 3.4 | |
| 2.1 | 1.2 | 5.4 | 7.9 | 8.3 | |

BIG SCREEN

Asus Designo Curve MX38VC

Wireless charging and beefy speakers both appeal, but the LG is in a different class

SCORE 

PRICE £908 (£1,090 inc VAT)
from currys.co.uk

There are three reasons to consider the Asus Designo Curve MX38VC over the spiritually similar LG UltraWide 38WN95C. The £239 price difference is the most obvious because that still buys you a gently curved 37.5in IPS display, but Asus hopes to also tempt you with a 15W wireless charger. Place a suitable phone on the centre of its stand and a gentle blue light starts pulsing to show it's working. There's also a powerful pair of 10W speakers, with plenty of depth to accompany their volume.

The bad news for Asus is that in almost every other way the LG is superior. For a start, it's brighter.



While the Asus's peak of 306cd/m² in our tests is fine for most setups, it lacks the impact and HDR abilities of the LG with its peak of 543cd/m². More crucially, the LG has a wider gamut. While the Asus covers the sRGB space well, with 98.1% coverage and 104.8% volume, it can't hold a flame in DCI-P3: the LG's figures were 94.2%/97.9%, the Asus 74.2%/74.3%.

You can flick between colour presets in the responsive and intuitive OSD, but we recommend you ignore the suggested sRGB mode: it dropped contrast to 571:1, giving the screen a drab look. The Designo Curve MX38VC was at its best in Standard mode,

ABOVE Give your smartphone the spa treatment by placing it on the charging pad

which returned a well balanced 660:6K temperature and 977:1 contrast. Throughout our testing, the Asus demonstrated solid colour accuracy with an average Delta E of 0.92 and maximum of 2.38.

Like the LG, Asus offers a USB-C connection that can power laptops – it doesn't give a rating – and there are two USB-A ports at the rear, but don't expect a flexible stand. The only thing you can adjust is its tilt, and we miss having a swivel or height adjustment when the screen is so cumbersome. While the Asus' unique extras are nice, when you're paying four figures for a monitor it pays to stretch another few pounds for the brighter and more flexible LG.

| Panel uniformity (Brightness, % difference from centre) | | | | |
|---|-----|------|------|-----|
| 7.4 | 4.2 | 10.7 | 7.5 | 8.9 |
| 1 | 3.7 | 0 | 4.4 | 2.9 |
| 1.8 | 9.1 | 7.4 | 17.7 | 3.2 |

Dell UltraSharp U4320Q

A monster monitor that packs a surprising amount of image quality for the size

SCORE 

PRICE £705 (£845 inc VAT) from dell.co.uk

Why buy the 43in U4320Q? Dell has financial firms in one of its sights, with the option of four different computer inputs and the ability to view them side by side. A 103ppi density helps, as it's sharp at the viewing distances this monitor will be looked at.

But you are hitting the usability of a screen on a desk. Shifting your gaze from the left to the right of the panel is reminiscent of spectators transfixed by a rally on Centre Court, and no curvature gives the illusion of the screen bending away at the edges. There's also a discernible drop-off in contrast at this panel's extremes.

It covers 96.5% of the sRGB gamut but only 69.5% of Adobe RGB space and 72.5% of DCI-P3. A Delta E of 0.88



you're using a good monitor, but contrast is a weakness, dropping to 889:1 when we shifted to the 6500K colour space (it produced the most accurate colours here).

Dell's OSD provides a sprinkling of options when it comes to colour presets, including a selection of colour temperatures. You can also create your own setting. It's one of the more intuitive onscreen displays, but odd that Dell wastes one of the four buttons as a shortcut for volume rather than brightness.

Perhaps it wanted to emphasise how powerful the pair of 8W speakers are. They're pleasant for listening to

music on too, with enough bass to usurp a set of Bluetooth speakers. You can also sweep away wires thanks to a USB-C input that delivers up to 90W of power to connected laptops, with three USB-A ports; one sits to the left of the monitor, alongside a downstream USB-C port, but the remaining two USB-A ports snuggle next to the video inputs at the rear.

Getting to these is a real hassle even with the stand's 60mm of height adjustment. Bearing in mind its size and 17.6kg weight, try and get as many of your cables organised (there's a neat cable tidy built into the stand) from the start. Once settled, there isn't much flexibility, with a minimal amount of tilt and a total swivel of 40°.

Still, considering the U4320Q's size, it's impressive that Dell offers any such movement. Perhaps what's most impressive, though, is that Dell keeps the price to under £1,000.

| Panel uniformity (Brightness, % difference from centre) | | | | | |
|---|-----|-----|-----|-----|--|
| 3.5 | 0.9 | 0.8 | 1.2 | 7.5 | |
| 5.2 | 6.2 | 0 | 7.9 | 10 | |
| 4.8 | 8.3 | 6.4 | 7.1 | 7.3 | |



HIGH-END CREATIVE

Acer ConceptD CP7 CP7271KP

An unusually flexible monitor that's great for both gaming and HDR work

SCORE

PRICE £1,424 (£1,708 inc VAT)
from alza.co.uk

Acer has created a wood/metal aesthetic for its ConceptD workstation range, so it's no surprise to see hints of both in this accompanying, stylish monitor. Acer doesn't lose any crucial functionality: you can still adjust the height by 180mm, swivel it round 360° and tilt it back a full 35°.

The only thing you can't do is pivot it into portrait mode, but doing so would make the supplied hood fall off anyway. While its "brushed velvet" texture is odd, the hood is effective at blocking out surrounding light and means you can fully appreciate this panel's finer qualities. Out of the box



it covered 96.6% of the sRGB gamut with 101.2% volume, and minor tweaks took this to 97.6% and 99.9%; mix in average Delta E of 0.35 and you have one colour-accurate panel.

Unusually, Acer's preset modes aren't labelled Adobe RGB or DCI-P3, but the likes of CAD/CAM, Graphics and Movie. Both Graphics and Movie gave us similar returns for Adobe RGB (an excellent 98%/110%) and DCI-P3 (90%/113%), and if you have access to a calibrator then you can fine-tune this and create your own User setting. Note that Acer has obtained Pantone validation too.

ABOVE The wooden foot, metal stand and velvet hood set the Acer apart

The OSD marries plenty of controls with easy-to-understand instructions, although whoever decided to place the on/off switch next to one of the shortcut buttons should be severely disciplined.

Unusually for a professional monitor, it supports G-Sync Ultimate – Nvidia's highest accolade. This panel can even push up to 144Hz and promises 4ms response times, giving it an unusual set of skills. Add DisplayHDR 1000 support and, equally unusually, it's also a great system for checking HDR videos you've created. Just don't rely on the echoey built-in speakers.

Given that HDR certification, it's no surprise that it can peak at 588cd/m² in general use, ensuring this is a screen that has impact in every way. The Acer's unique set of skills (and higher resolution) make it a fine alternative to the Eizo.

| Panel uniformity (Brightness, % difference from centre) | | | | |
|---|-----|-----|-----|------|
| 10.3 | 5.3 | 5.8 | 6.4 | 11.7 |
| 1.4 | 1 | 0 | 0.1 | 5.3 |
| 5.8 | 2.9 | 4.1 | 4.9 | 8.4 |

BenQ PD3220U

Print designers steer clear, but a classy IPS panel makes this a fine choice for others

SCORE

PRICE £1,000 (£1,200 inc VAT)
from box.co.uk

It isn't enough for manufacturers to lure creative pros with the promise of calibrated panels that have a Delta E under two anymore – that's rapidly becoming the standard for mid-range screens. Instead, the likes of BenQ must entice people with features beyond "normal" monitors.

BenQ hopes that its Hotkey Puck G2 will do exactly that. This connects to a port at the rear and provides a handy dial for controlling settings such as brightness. Shortcut buttons allow you to quickly switch between colour profiles and sources too. It's a nice time-saving touch that means you don't need to dive into the more laborious OSD, which is simple to navigate using the joystick on the rear



of the screen but no match for Eizo's when it comes to fine-tuning options.

That reflects the flexibility of the panel too. While you can choose the sRGB and DCI-P3 colour profiles with confidence – the BenQ returned scores of 96% coverage/96.6% volume in sRGB and 94.5%/94.5% in DCI-P3 – when we chose its Adobe RGB mode it only covered 81.2% of that gamut. That's not good enough for print designers. In terms of colour accuracy, however, we can't fault this monitor: an average of 0.44 in sRGB, with a maximum of 1.58, is right up there with the best. And when it comes to brightness uniformity, this panel

ABOVE As the pale diagram below shows, panel uniformity was second to none here

was the best by far, with a stunning average of 1.4% across the panel.

One thing the figures don't show is that a 31.5in diagonal is a stretch for even IPS technology when it comes to viewing angles, so you'll need to look "head on" when checking colours.

That aside, this is a lovely panel to use on a desk. The construction is top quality, as clearly shown by a smooth sliding mechanism that takes the panel through its 150mm of height adjustment. There's also support for pivoting and a respectable 60° of swivel. Finally, note the option to power a laptop through the USB-C port. Three USB-A ports are tucked away at the rear, with one more – along with a second USB-C port and headphones jack – sitting on the right-hand side.

This is a fine and flexible screen, then, but before you buy you should consider the cheaper Dell U3219Q.

| Panel uniformity (Brightness, % difference from centre) | | | | |
|---|-----|-----|-----|-----|
| 0.4 | 0.9 | 1.5 | 2.1 | 1.3 |
| 1.3 | 2 | 0 | 1.7 | 2.6 |
| 1.8 | 0.2 | 0.4 | 0.9 | 0.3 |

Eizo ColorEdge CG279X

Eizo's ColorEdge monitors continue to set the standard for accuracy and control

SCORE 

PRICE £1,410 (£1,692 inc VAT)
from wexphotovideo.com

If you've ever wondered what would happen if you gave engineers the task of building the perfect monitor, and then told them not to worry about silly things such as price, then we present to you the Eizo ColorEdge CG279X. It sets the gold standard for colour-accurate monitors, and is able to perfectly render that gold standard on request.

The OSD brings new meaning to the word "control", with the ability to move up in brightness by 1cd/m² increments. That same level of control extends to colour temperature, gamma, hue and saturation. Plus, the buttons on the bottom bezel are so responsive and well explained that a four-year-old could use them.



2,560 x 1,440

27in

IPS

USB-C

The irony is that you probably won't need to head into such detail, because the nine presets are a button press away and cover the gamut of gamuts: BT.2020, BT.709, DCI, Adobe RGB, sRGB and more. They all proved to be accurate, covering almost the entire range with minimal overspill. For example, Adobe RGB covered 94.2% with 95% volume, DCI 95.4% and 98.5%. Its colour accuracy was also the best here, with a maximum – not average – of 1.07 in sRGB, while it also tracks colour temperatures far better than its rivals. What you see is what you ask for.

The CG279X only has one area of weakness compared to rivals, and

ABOVE You can tweak to your heart's content... and then tweak some more



that's brightness uniformity. Both ViewSonic and BenQ have clearly put in extra work here, and are rewarded with an average variation below 3%; the FlexScan averaged 4.7%.

So it's not all perfection, but Eizo offers a number of "extras" to pull it ahead. Top of the pile is the built-in calibrator, which you can set to autocorrect the panel every, say, 500 hours of use. Then there's the sheer robustness of its stand, with a solidity that would make tanks blush in envy. And you still get pivot support and 155mm of height adjustment.

It goes without saying that the CG279X is expensive for a 27in screen with a 2,560 x 1,440 resolution, and note the USB-C connection only supplies 15W of power, but it's equally obvious that you're paying for the very best panel backed with supreme electronics. With a five-year warranty part of the deal, it's worth the price.

| Panel uniformity (Brightness, % difference from centre) | | | | |
|---|-----|------|-----|-----|
| 5.4 | 8.6 | 12.7 | 8.4 | 6.5 |
| 0.9 | 7.4 | 0 | 8.1 | 2.2 |
| 0.3 | 0.6 | 2.5 | 1.5 | 1.2 |

ViewSonic VP2785-2K

It has its niggles, but this is a superb choice for creative pros on a tight budget

SCORE 

PRICE £493 (£592 inc VAT)
from uk.insight.com

At first sight this 1440p 27in monitor appears to be overpriced: after all, you can buy the 4K Dell UltraSharp U2720Q for almost £60 less. However, unlike the Dell, this ViewSonic isn't designed for life in any old office. Instead, it's aimed at creative professionals who will be jumping from video to print, and with the knowledge that they can trust the colours this panel shows. Naturally, it supports hardware calibration, and you can set a regular reminder in the OSD that it's time for recalibration.

What's most impressive for a monitor this affordable is that it comes with the promise of 100% coverage of the Adobe RGB gamut



2,560 x 1,440

27in

IPS

USB-C

and 96% of DCI-P3. Switching between these presets is easy through the OSD and you can even use the dual colour engine to have two computers' inputs side by side.

While our testing didn't match ViewSonic's figures, we aren't going to argue with 97% coverage of the Adobe RGB gamut, nor 91% of DCI-P3; factor in average Delta E figures of 0.53 and 0.4 respectively and you can be confident of colour accuracy too. We suggest you steer clear of its sRGB mode, however. Here, its measured contrast ratio dropped to 418:1 – everything looks drab as a result.

One area we absolutely can't criticise is the uniformity of its

ABOVE The eyes have it: this is a bargain for print and video professionals alike



brightness across the screen. We show this through the 5x3 grid on the screens below the reviews, and you can see that the ViewSonic's figures are a match for the high-end models that cost over £1,000.

Where it can't match its top-end rivals is styling, with its plain black plastic finish and dull stand unlikely to stir much ardour in the eyes of its target audience. All the features are here, though, whether that's pivoting, 130mm of height adjustment or the inclusion of a three-port USB-A hub. These are all hidden away at the back, which is awkward when you want to quickly add a thumb drive, and note there are no speakers (a 3.5mm jack is again inconveniently at the rear).

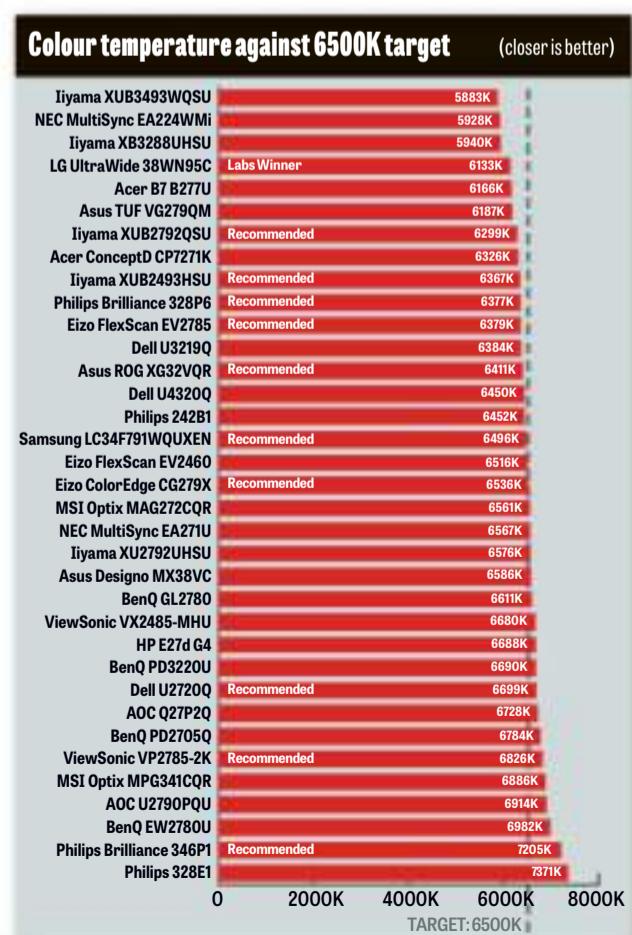
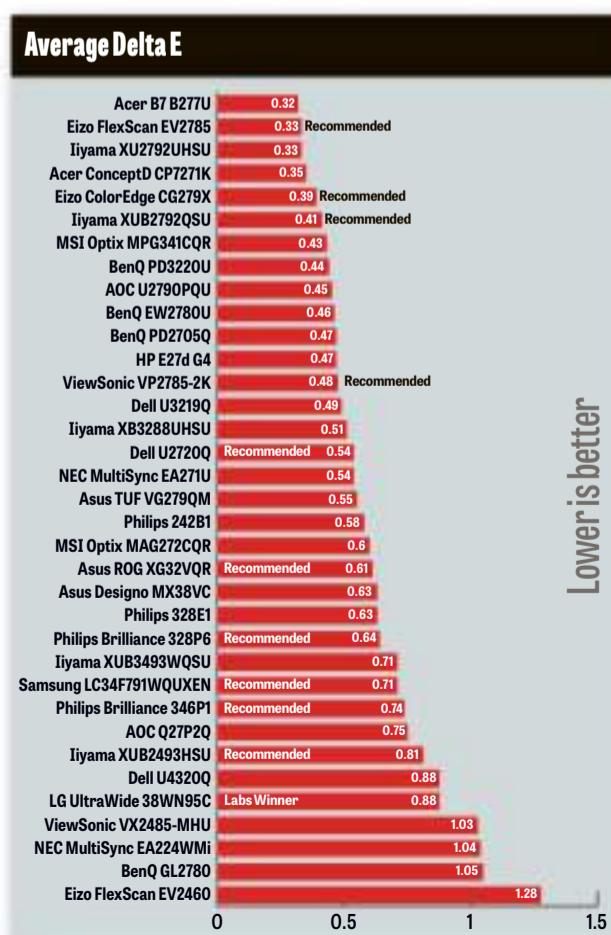
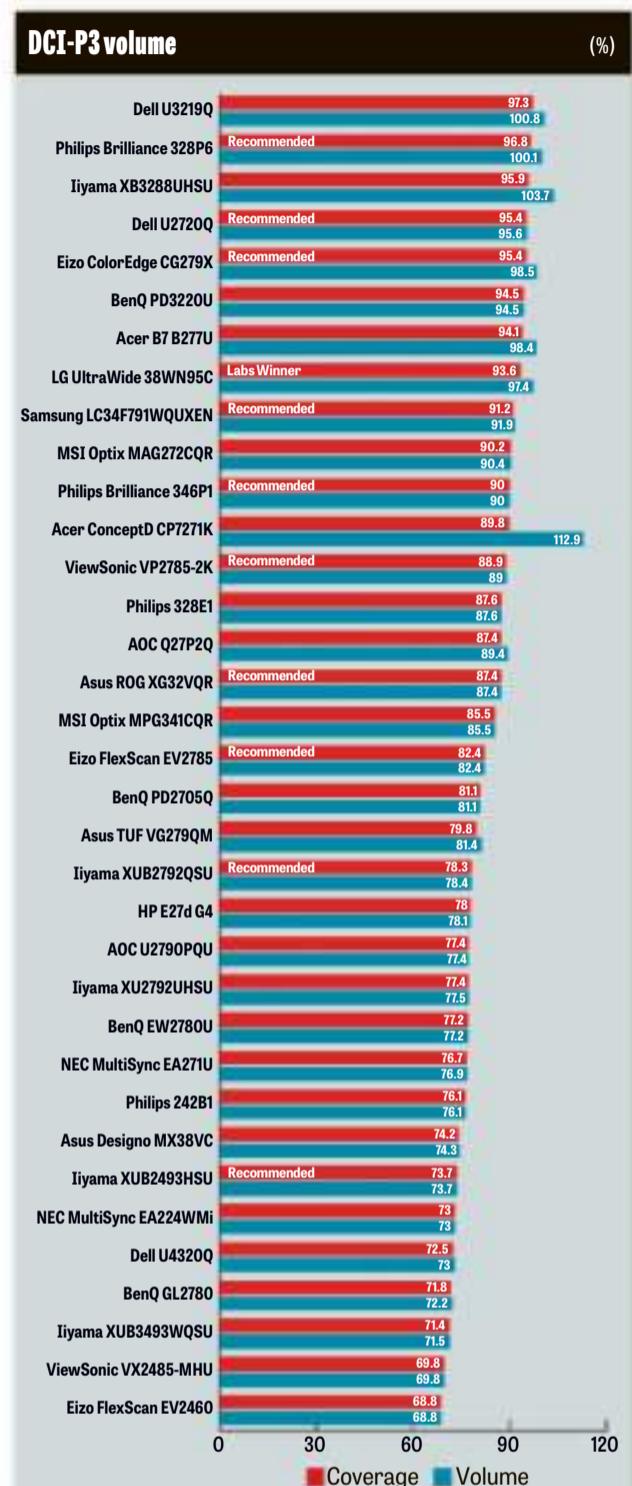
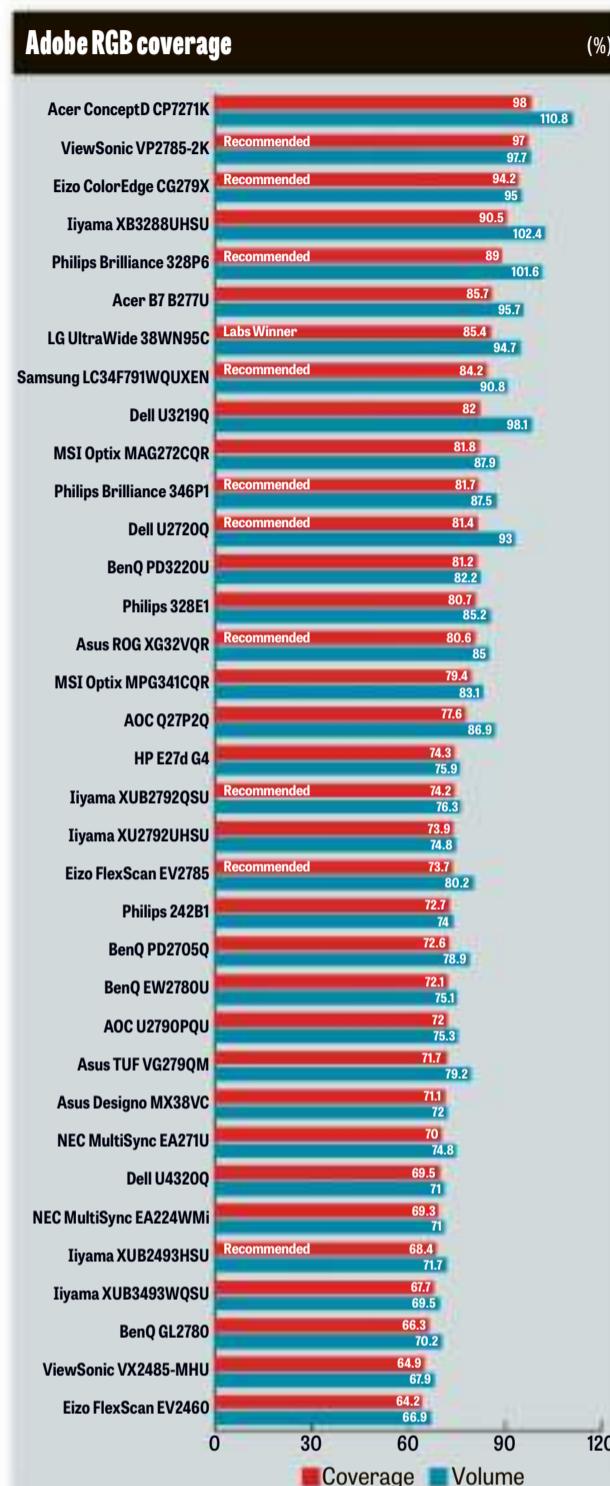
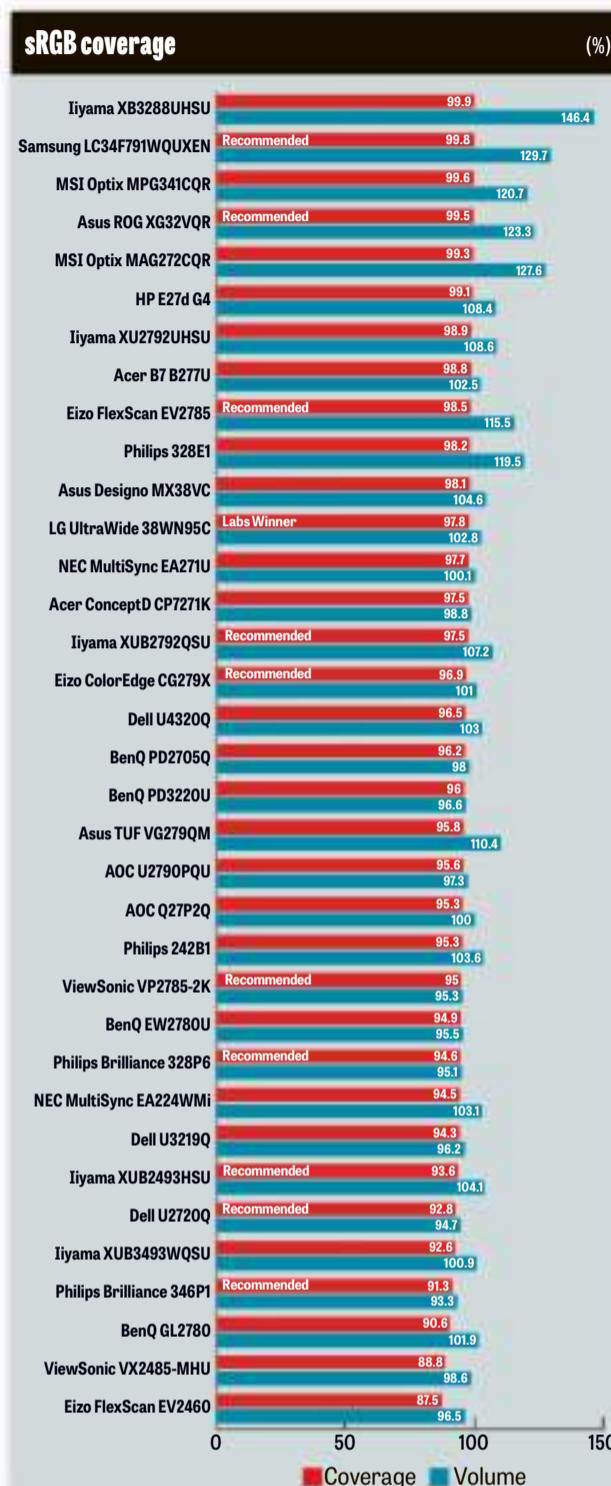
Do any of these criticisms diminish its impact? We think not. If you're a creative professional on a budget, and especially if you work in both print and video, this is a steal.

| Panel uniformity (Brightness, % difference from centre) | | | | |
|---|-----|-----|-----|-----|
| 3.9 | 2.1 | 1.6 | 2.6 | 3.4 |
| 3.9 | 0.7 | 0 | 0.5 | 3.7 |
| 8.1 | 6.1 | 3.7 | 4.6 | 4.9 |



Quality test results

COLOUR TESTING Note that colour space testing was performed in the monitor's relevant mode (such as sRGB) if available. The ideal is for a monitor to achieve 100% coverage and 100% volume; a big difference between the two values is not ideal as it shows the panel is not tuned to that colour space.



VIEW FROM THE LABS

While it's true that there has never been a better time to buy a great screen, booby traps lie in wait for the unwary

You might have noticed there are more products than we normally include in this month's Labs. There are a couple of reasons for this, with one of the most notable being that I'm an optimistic fool: "Let's make this truly comprehensive," I thought to myself in mid-June. "How long can it really take to test 30-odd monitors?" The answer to that, I now know, is six weeks and a lot of early mornings.

But the second reason is that it's so easy to buy the wrong monitor for your needs. By giving you several to choose from, having put them all through the same set of tests and printed those results side by side, you can make a truly informed decision. It could be that you were considering spending over £1,000 on a colour-accurate monitor until you read the review of the £399 BenQ and realised it was perfect for you. Perhaps you could even buy two.

On the other hand, you may have been on the verge of buying that BenQ and have now seen how it performs in the Adobe RGB tests – and realised that, for you, it would be far better to spend over £1,000 on one of the high-end "creative" monitors we review from p92.

All this I could have predicted from before the Labs began. What I hadn't anticipated was just how universally good the monitors would be. Of course, you get what you pay for to a



Tim Danton is PC Pro's editor-in-chief and is extremely glad that this is all over

large extent, and yes there are a couple of displays here that I wouldn't recommend simply due to the quality of rival offerings for a similar price. But my weeks of testing have hammered home that you don't need to spend hundreds of pounds to buy a top-quality, colour-accurate screen. If you read the Iiyama and Philips reviews in isolation, you'll see exactly what I mean.

There is, however, one "BUYER BEWARE!" signpost I would like to share. And it concerns Amazon. If that's your first port of call for online purchases, be incredibly careful. For reasons best known to some frankly insane person at Amazon HQ, it bundles different monitors on the same page – so you can think you're ordering a 32in 4K model but then discover that the item in your shopping basket is actually a 27in Full HD version with a similar, yet not identical, name. It's madness, and we've steered well clear of listing Amazon where at all possible.

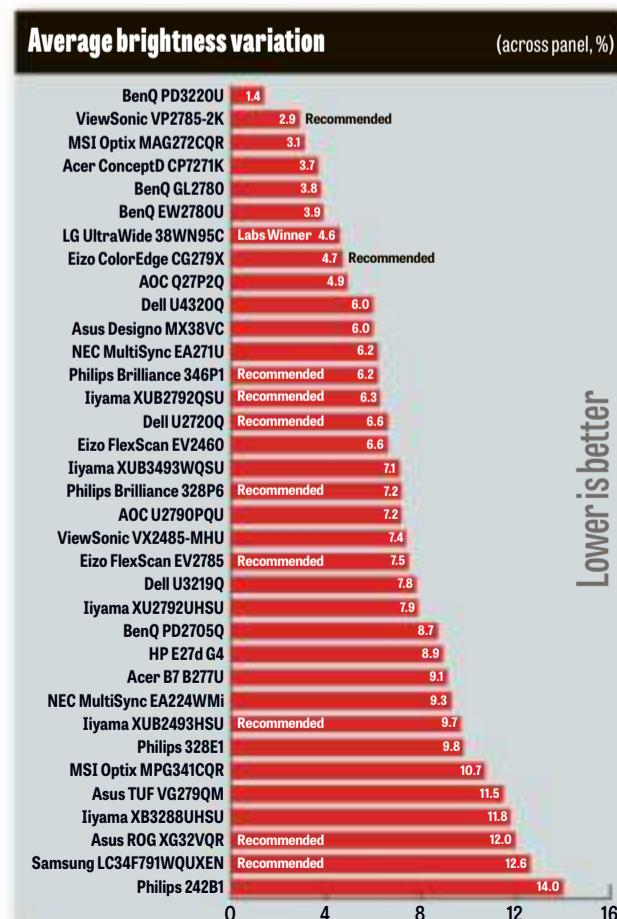
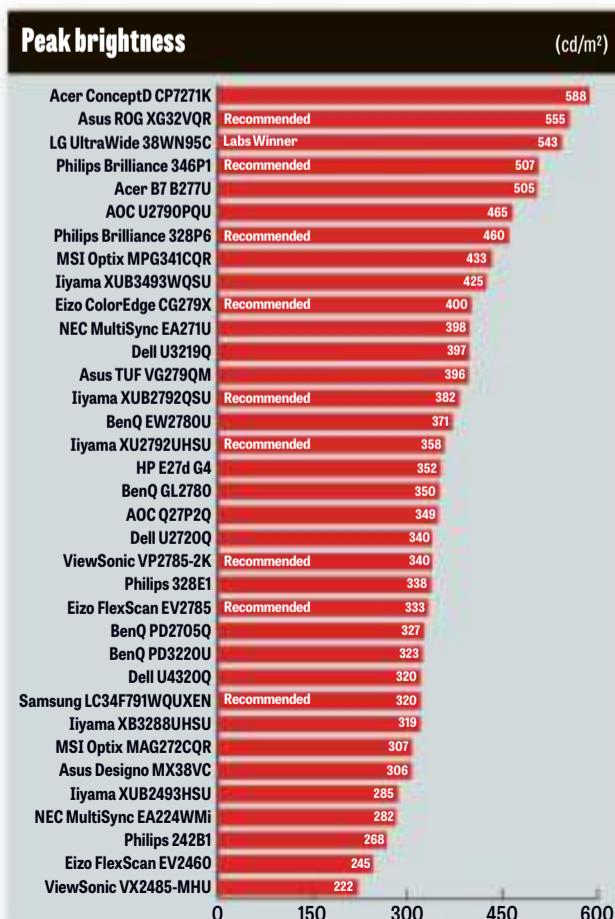
"My weeks of testing have hammered home that you don't need to spend hundreds of pounds to buy a top-quality screen"



ABOVE It's very easy to make an expensive mistake so read our reviews carefully

Fortunately, that doesn't mean we've pointed you somewhere more expensive. In fact, I often found that Amazon was £50 to £100 dearer than two suppliers you will see pop up time and time again: Insight and Scan. You may find that odd. After all, Insight gained its reputation for selling to business customers, not individuals; but anyone can now order from its site. And you might think of Scan as a desktop PC maker, or component reseller, but head to its online store and you'll find a wide variety of electronics to purchase.

So, while it's never been easier to buy a fantastic monitor for very little cash, keep your eyes open: it's also never been easier to be caught out or pay more than you need. ■



Lower is better

The Network



Practical buying and strategic advice for IT managers and decision makers

WatchGuard Firebox T20-W

A five-star security option for small and large businesses **p102**

Ransomware: the truth

Davey Winder explains how to keep your users safe **p104**

Cheat Sheet: Cloud configuration

It's boring, admits Davey, but that's why people get it wrong **p107**

BUSINESS FOCUS

BUYER'S GUIDE TO

Videoconference room solutions



A great videoconferencing setup can make a genuine difference to how teams communicate. **Dave Mitchell** explains what to look for

No doubt about it, 2020 has been the year of the virtual meeting. As companies have found themselves forced to embrace remote working, regular get-togethers have necessarily moved online and videoconferencing providers have seen record growth levels.

This isn't a temporary thing, though. Whenever the restrictions are finally lifted, few businesses will be going back to the way things were. Many organisations have found that remote working brings real benefits, not least in terms of operating costs,

and are looking to make permanent changes to their working practices.

That doesn't necessarily mean the end of the office commute – working from home has its downsides, such as a sense of isolation. However, many companies are looking at allowing staff to split their working week between home and office.

For such a setup, it makes sense for businesses to have a dedicated videoconference room in the office, where on-site staff can have face-to-face meetings with remote workers, suppliers and customers. That might

sound expensive, but surging demand is pushing prices down, making videoconference room systems very affordable. This month, we review four such solutions suitable for SMBs. Those on tight budgets may choose a system that works via a host PC, but

the products in this month's guide are designed for standalone use, giving you the simplest possible setup and operation.

"Even a budget-priced screen will be fine in small rooms – but we do recommend investing in a 4K model"

■ Tap dance

Each of this month's solutions includes a central controller with a colour touchscreen. This connects to the other components in the kit and offers simple controls enabling you to start or join a meeting with a few taps – ideal for users who want to get down to business without wasting time figuring out the user

interface. Certain touchscreens can even change their display to match the application interface of the chosen provider.

You can locate your central unit on a desk or mount it on a wall – but you'll need to think about cabling. Some systems run off a standard Ethernet cable with PoE, while elsewhere you'll find USB connections and proprietary cables.

It's also worth considering if you want meeting participants to be able to connect their laptops or smartphones to the central videoconferencing unit. This can be useful for screen sharing and presentations, but connection methods again vary: some systems use a special USB cable or a standard HDMI port, while others support Miracast and AirPlay for wire-free screen mirroring.

Sound and vision

You can't have a productive meeting without clear sound, so it's important to pick a speaker that suits your meeting space. Video bars with built-in speakers are fine for huddle rooms, but for larger meetings you might need something more powerful. If your monitor has built-in loudspeakers, you can pipe the sound through that; alternatively, you might need to invest in some external speakers.

Similar considerations apply to microphones, as you'll naturally want to be sure that everyone in the room can be heard clearly by remote participants. Video bars and desktop controllers tend to come with integrated mic arrays, and we've found these work well at distances of up to 4m. Other solutions offer separate microphone pods that can be positioned as required, and may even let you add extra pods for large rooms.

4K or not 4K?

There's one component you'll definitely need to source separately and that's the main display, on which you'll view your remote colleagues. It's not necessary to spend a fortune

on this component – even a budget-priced screen will be fine for in small rooms – but we do recommend investing in a 4K model.

It might seem an unnecessary extravagance, especially if you're on a tight budget. After all, very few videoconferencing providers support 4K connections – and depending on

the size of the panel you choose (and the size of the room), the difference between a 4K screen and a 1080p one may not be all that obvious.

There's no doubt, though, that UHD meetings are coming. Most kits already include 4K-capable cameras, while internet connections are getting faster and the highly efficient H.265 video standard is slowly establishing itself in the videoconferencing market. It's only a matter of time until 4K connections become commonplace – so when setting up your new videoconference room, we'd recommend that you future-proof it with a screen that's ready for next-generation video connections.

Cloud connected

Once your hardware is all in place, there's just one more thing you need – a cloud videoconferencing service to handle the actual calls. There's a huge range of providers to choose from, but if you want to keep things as simple as possible then the Lifesize and Starleaf systems on

review this month may appeal, as they come with the vendor's own cloud services built in. This gives you the big advantage of centralised support: any problems you encounter with the hardware, online services or client apps should be easier to resolve, and you won't be passed back and forth between different companies all pointing the finger at each other.

If your company already has a preferred provider, the other two products in this guide might suit you better. The Poly Studio X30 supports five different platforms out of the box, while Logitech's Room Solutions come in a variety of flavours, each one customised for a specific provider.

It's also worth checking out any additional integrations that may allow your videoconferencing system to talk to other business tools. A useful tool is meeting room management, which works with Microsoft Outlook or Exchange to let users check room availability and arrange bookings.

We may not know exactly what a post-pandemic world will look like, but it's clear that videoconferencing will be an essential ingredient for conducting business. With prices now very affordable for SMBs, there are some great solutions to choose from – so turn the page to see which one will fit your future workplace.

The collage includes:

- A screenshot of the StarLeaf app interface showing a video call and a 'Join a Video Meeting' button.
- A screenshot of the Lifesize app interface titled 'Create, schedule and join Lifesize video meetings directly from Microsoft Teams'.
- A screenshot of the 'Home Screen Customization' feature in the Lifesize app, showing options to choose a pre-defined wallpaper or upload a custom one, and a preview of the customized home screen.
- A screenshot of the StarLeaf app showing a video call between two people.
- A screenshot of the Lifesize admin portal showing various performance metrics and graphs.
- A screenshot of the Microsoft Teams interface showing a video call between two people.

TOP Systems from Lifesize and StarLeaf work with Microsoft Teams for scheduling

ABOVE You can customise the display on Lifesize's Phone HD speakerphone

LEFT StarLeaf has its own app, while Poly and Logitech work with Microsoft Teams

LEFT Lifesize and StarLeaf's cloud services both include admin portals





Lifesize Icon 500 and Phone HD

A classy all-in-one 4K videoconferencing solution that's ideal for first-timers – you'll be set up in minutes

SCORE

PRICE £4,750 exc VAT
from voipon.co.uk

Plenty of companies will sell you a standalone videoconferencing system, but Lifesize has been offering an integrated platform from the start. Its Icon cameras and Phone HD base stations combine with the company's own conferencing service to form a complete one-stop system.

Lifesize is also one of few providers that currently supports 4K video calls and content sharing. That's made possible by a proprietary compression scheme, which cuts bandwidth requirements to a modest 3Mbit/sec. Security won't be an issue either as all meetings use end-to-end encryption.

The Icon 500 camera unit we tested is Lifesize's affordable option for small to medium-sized meeting rooms, and includes motorised pan, tilt and 5x optical zoom controls. The Icon 700 option adds around £1,300 to the price but features a longer 20x optical zoom – potentially handy for larger rooms.

The other half of the package is the Phone HD unit, which incorporates a 5in colour touchscreen, an internal speaker and four mics, capable of picking up 360° audio coverage at a range of up to 4.5m.

Remote participants, meanwhile, can connect using native client apps for Windows, Mac, iOS and Android.



The online videoconferencing service lets you host meetings of up to ten people for free, but we recommend you invest in at least the Standard plan (which costs around £10 per user per month) as this adds access to Lifesize's cloud-based management console. Step up to the Plus option, for around £12 per user, and you gain integrations that allow Lifesize to slot seamlessly into Microsoft Teams, Skype for Business, Alexa for Teams and Slack. There's also a Chrome extension for web-based access, and integration with Exchange, Office 365 and G Suite for email and calendar syncing.

We were impressed at how swift it was to set up the Icon 500 kit. All we had to do was connect the camera to the lab network via Ethernet, then attach a monitor and hook up the Phone HD unit using the supplied 9m cable, which carries both data and power. We then booted up the system and were greeted with an IP address, which you can visit in a browser to access the setup portal. Here you can set secure admin passwords and select whether you want audio to come through the monitor or the Phone HD unit.

The final step is to log in to your cloud portal account. This opens with

ABOVE The camera and base unit connect together via a single 9m cable



a dashboard showing a wealth of details on calls, participants and devices; new users are easily added by sending them an invitation email, which includes a web link enabling them to set up their own account.

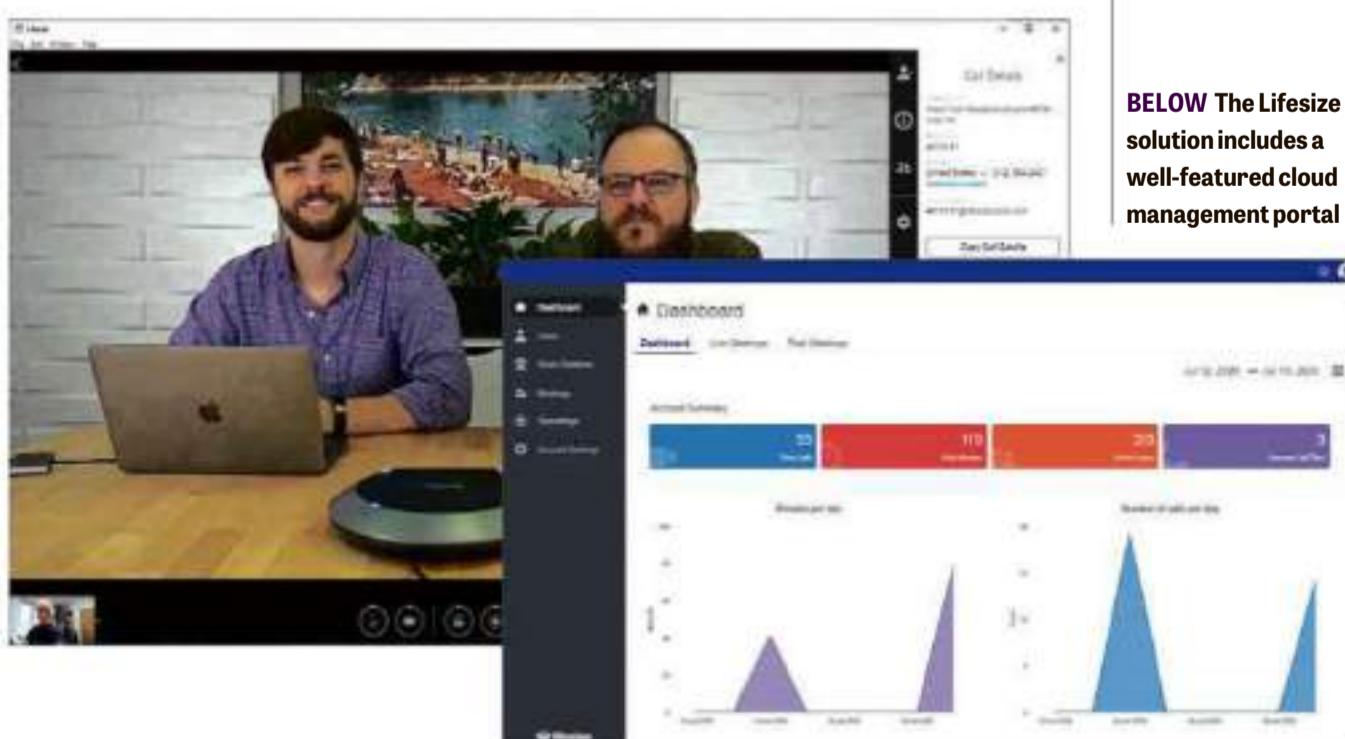
Launching meetings is just as straightforward. We found the Phone HD's touchscreen very easy to use, allowing us to browse our directory of users, choose who we wanted to include and kick off a meeting with a few taps. Likewise, remote clients can browse lists of contacts or room systems, and initiate sessions with a couple of clicks.

In-call video quality is clean and sharp, with very good colour balance. There's no automatic speaker tracking, but far-end controls allow remote participants to take over the PTZ functions from their own app. Sound

quality is great too, and impressively loud: we tested the system in a meeting room measuring around 23m², and found we had no need to push the volume over 50%. The microphone array also worked well, with remote callers confirming that they could clearly hear all of our meeting room members.

Together, the Icon 500 and Phone HD make a videoconference room solution that's easy to deploy and blessed with highly intuitive controls. A fine range of client apps plus great call quality make this a superb choice for any business that's ready to embrace videoconferencing.

BELow The Lifesize solution includes a well-featured cloud management portal



CAMERA 4K resolution, PTZ, 5x optical zoom
• 88° field of view • Gigabit Ethernet • 802.11ac wireless • HDMI in, 2x HDMI out • RJ-45 link port with PoE • 2x USB 2 • external PSU

CONTROL UNIT 5in colour touchscreen
• 4x internal mics • internal speaker • RJ-45 Icon link port • 9m link cable

WARRANTY 1yr RTB

Logitech Room Solution for Microsoft Teams

A bumper package for big meeting rooms that's tailor-made to integrate with your chosen service provider

SCORE ★★★★★

PRICE Large Rooms, £5,000 exc VAT from onelink.co.uk

Logitech released its first webcam in 2002, and it has gone on to develop an impressive range of professional videoconferencing products. Its Room Solutions are a choice of ready-made packages, designed for meeting spaces of various sizes and for specific providers such as Google Meet, Barco ClickShare and Zoom Rooms.

We tried out the Microsoft Teams kit for large rooms, which comes in at 1p under £5,000. That may seem steep, but the money buys you a lot of quality hardware: all bundles include Logitech's intuitive Tap display hub, with its generous 10.1in colour touchscreen, plus an entire Intel NUC mini PC running Windows 10 IoT to serve as the brains of the operation.

Unsurprisingly, the audio-visual provision depends on which package you choose. The Large kit includes the Logitech Rally 4K camera, whose motorised PTZ functions and 15x optical zoom can be controlled with a remote handset. The camera plugs directly into the Tap controller, as do the dual speakers; the twin mic pods attach to a smaller table hub, which is connected to the Tap controller by a standard Ethernet cable. If you need more audio coverage, you can add up to five extra microphone units.



If we're honest, probably the most complicated part of setup is wiring all of this together and finding the best layout for all the components. Happily, the speakers and mic pods all have reasonably long 3m cables, and the table hub can be situated as far as 50m from the Tap, so you have plenty of flexibility.

Finally, your monitor connects to the Tap unit, and the whole thing is hooked up to a USB connector on the mini PC. Logitech helpfully provides a tough 25m USB cable, so you can hide this away wherever you like: there's no need to interact with it, as all the action takes place at the Tap unit.

On first boot, the display hub will prompt you to choose between Skype for Business and Microsoft Teams as your default service, and to log into your account. You'll then be able to browse a list of scheduled meetings, set up new ones and initiate ad-hoc get-togethers by simply tapping to add users, then hitting the icon to place the call. Screen sharing is fuss-free too, thanks to the inclusion of a pair of HDMI inputs on both the Tap unit and the table hub.

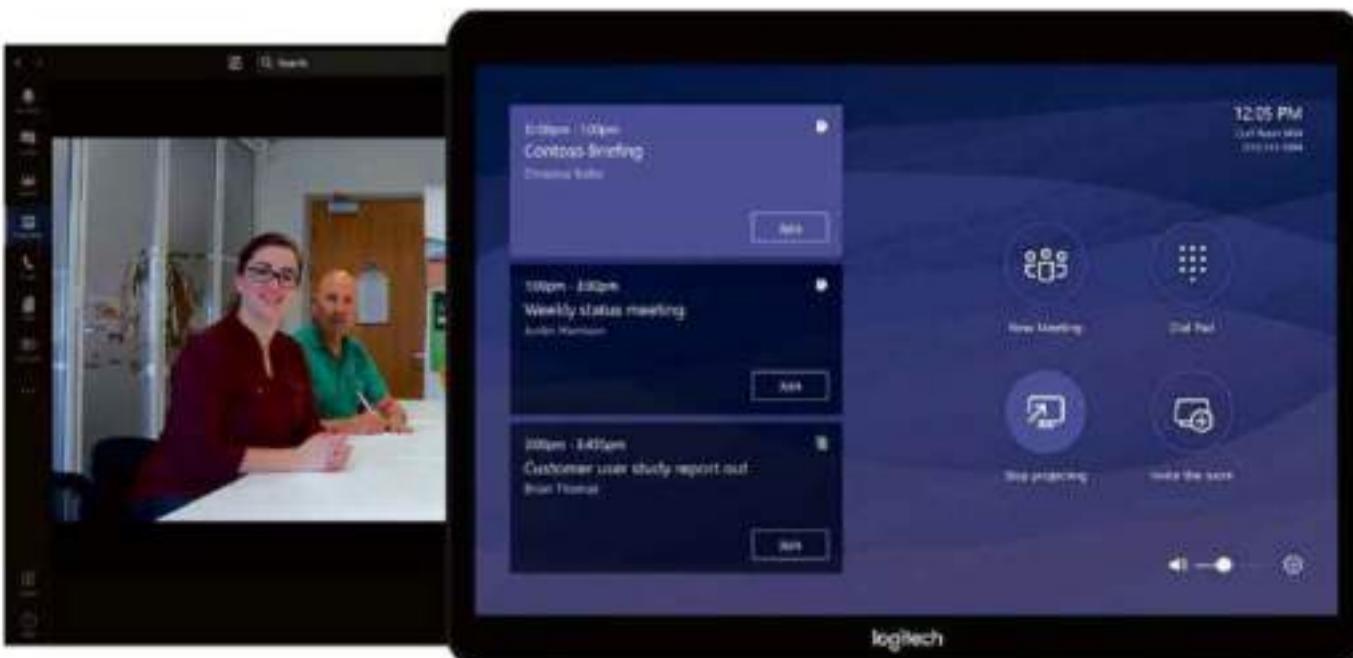
Incoming meeting requests are just as neatly handled. When an invitation is received, a notification pops up on the display, and a single

ABOVE The modular Logitech Room Solution can be set up to suit your location



"Screen sharing is fuss-free, thanks to the inclusion of a pair of HDMI inputs on both the Tap unit and the table hub"

BELOW The Tap unit integrates perfectly with Teams, with easy access to controls



tap adds you to the meeting. At the end of every call, the camera automatically parks itself with the lens body pointing downwards, for immediate privacy confirmation.

It's also possible to find and join meetings using Logitech's Bluetooth proximity sensor. We tried this out on our iPad and found it worked well: we selected the Add Room option, saw the Logitech system pop up as a nearby available location and joined the conversation with one tap.

The best part is that all of this ease of use is combined with truly excellent call quality. The Rally Pro camera does a great job of covering a large meeting room: while its 90° field of view isn't huge, we found it produced a very sharp and detailed video stream, with natural colour balance. The twin speakers delivered perfectly clear sound with punchy bass, while the microphone pods had no problems picking up everyone's contributions.

If you've settled on a supported videoconferencing service, and you need to cover a decent-sized meeting space, Logitech's Large Room Solution offers everything you could ask for. Once cabled up, it's beautifully easy to use, and its audiovisual performance is very hard to fault.

HOST PC Intel NUC • 2.7GHz Core i7-8559U • 8GB RAM • Windows 10 IoT

CAMERA 4K resolution, PTZ, 15x optical zoom • 90° field of view • USB 3

DISPLAY HUB 10.1in colour touchscreen • USB 3 • RF remote control • 2x HDMI out • 2x HDMI in • 2x Mini XLR • Bluetooth

TABLE HUB 2x HDMI in • USB 3 • 2x microphone pods (3m cables)

SPEAKERS 2x Logitech with Mini XLR ports (3m cables)

WARRANTY 2yr limited



Poly Studio X30

An uncomplicated and affordable system with native support for a range of popular cloud platforms

SCORE ★★★★☆

PRICE Studio X30 with TC8, £1,700 exc VAT from best4systems.co.uk

If you're daunted by the prospect of setting up a dedicated videoconferencing system, Poly's Studio X30 is worth a look. Aimed at small meeting rooms with up to six participants, it's a standalone solution that's designed to be up and running in minutes, requiring only three cable connections and no host PC.

The hardware could hardly be simpler. The X30 brings together a 4K camera, a loudspeaker and a beamforming quad-microphone array in a single lightweight bar, which can be controlled via a USB keyboard and an external monitor. For a slicker experience, you can also partner it with Poly's TC8 control unit, which we've included in the price above. This automatically pairs with the X30 over your office network and provides a friendly touch interface for the system – although we elected to keep a USB keyboard connected as well, as we found this the most convenient way of entering login credentials and other details.

Initial setup went smoothly. We connected the power, network and monitor cables to the X30, waited two minutes for the system to boot up, then pointed a web browser at the IP address displayed on the screen. This led us to a quick start wizard, asking us to change the admin password and pick a conferencing provider: unlike



some specialist systems, the Poly X30 lets you choose between multiple platforms, including Poly's own RealPresence service, as well as 8x8 Meeting Rooms, LogMeIn, GoToRoom, Microsoft Teams and Zoom Rooms. You can't be connected to multiple services at once, however, as changing entails a full system reset.

Somewhat unexpectedly, we found that Poly's own service wasn't all that convenient to use, as it obliges you to use the web console to configure which contacts and directories will appear on the TC8.

It was an easier ride once we switched to Microsoft Teams. This time the familiar Microsoft login screen appeared, and once we'd provided our credentials, the main monitor brought up our existing room bookings, along with options to create meetings and invite other members to join us. When the logged-in X30 user receives an invitation from a remote party, you can join with a tap on the keyboard or the TC8, and use the standard Teams app menu to control video and audio, invite other members and leave the meeting.

ABOVE The optional TC8 touch controller provides a slick way to interact with the X30



The Poly's camera is good rather than outstanding. In our tests we found it captured more than enough detail for a productive meeting, but the consensus among our participants was that the focus was a little soft. It also lacks optical zoom and PTZ functions, although these aren't really necessary for smaller rooms.

We were, however, impressed by the X30's group framing and speaker tracking features, which use digital zoom to crop out empty space and focus on whoever is currently talking. The X30 proved accurate at zeroing in

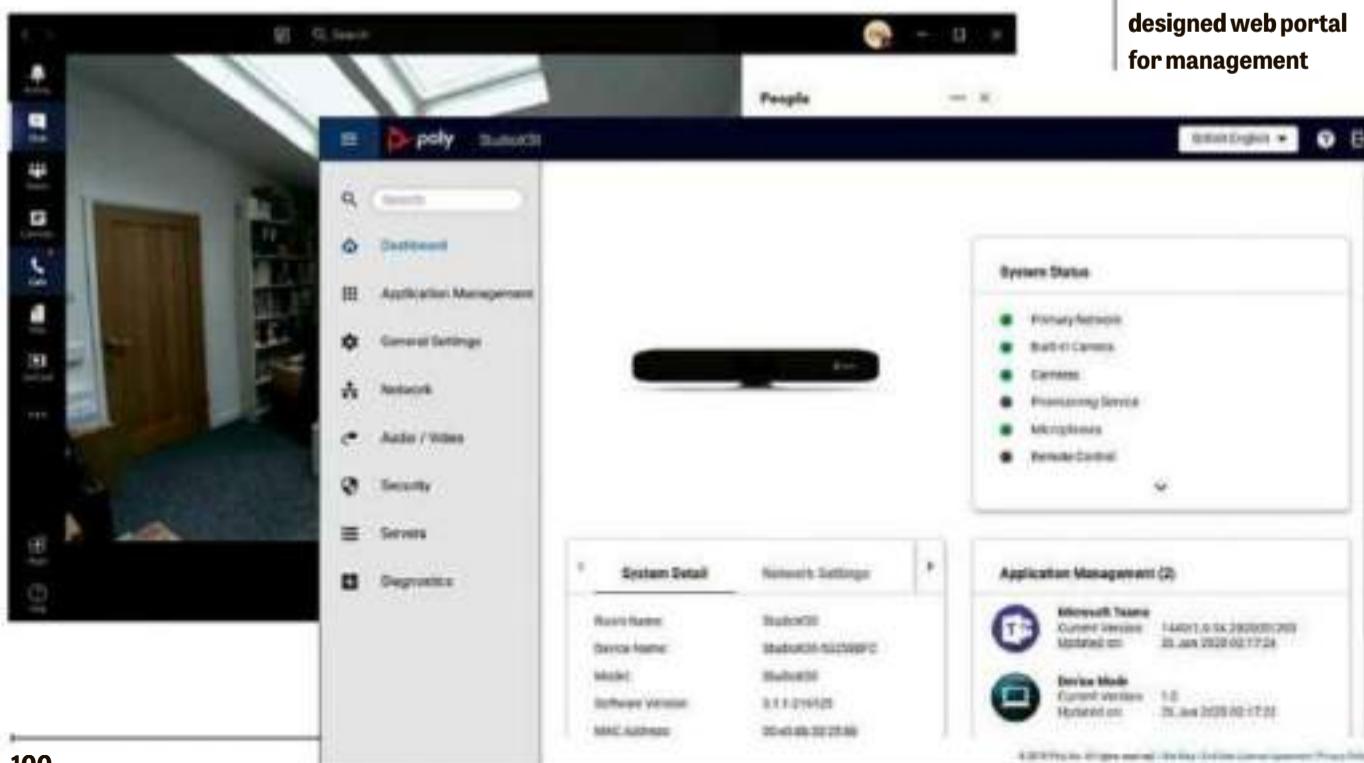
on the active speaker and zooming back out when they stopped. It can even track a speaker as they walk around the room, with the light bar above the camera showing its direction of focus.

Another plus is Poly's Acoustic Fence and NoiseBlock technologies: these aim to suppress unwanted background noises, and again they worked well for us. The X30's single speaker is easily loud enough to fill a modestly sized room, and the participants praised the clarity of the built-in microphones.

The Poly X30 works best when paired with a touch controller and a standalone keyboard, so it's perhaps not such a simple solution as it at first appears. Even so, it's a compact and easily deployed meeting room system, whose support for a range of cloud videoconferencing platforms means it will fit neatly into a lot of offices.

CAMERA 4K resolution, 4x digital zoom
120° field of view • mono speaker • 4x MEMS mics • Gigabit Ethernet • 2x USB 3 • HDMI in • HDMI out • 802.11ac • Bluetooth 5 • external PSU • 730g • 442 x 62 x 63mm (WDH)

CONTROL UNIT 8in colour touchscreen
1,280 x 800 resolution • PoE Ethernet
WARRANTY 1yr RTB



StarLeaf Huddle

A great videoconferencing package for small rooms that's a doddle to use – but you'll need speakers

SCORE ★★★★☆

PRICE From £1,565 ex VAT
from clearvc.co.uk

UK-based StarLeaf has been in the collaboration game since 2008, offering meeting room solutions for companies of all sizes. Its entry-level Huddle system will appeal particularly to smaller organisations, as it includes everything you need to turn a small space or room into an instant videoconferencing suite.

The kit comprises StarLeaf's 3320 10.1in touchscreen control panel, a 1080p camera unit, a USB microphone pod and a small powered cable dock. It also includes StarLeaf's Pronto cable, which lets participants easily connect their laptop to the Huddle system and share screen contents over a USB connection.

One thing you don't get is any loudspeakers. Indeed, the Huddle has no dedicated audio output: sound is relayed solely over the HDMI connection, the expectation being that you'll connect the system to a monitor with its own speakers. For a small room that's likely to be fine; if it's not, however, make sure your monitor has its own audio outputs so you can connect external speakers.

StarLeaf also doesn't give you a choice of providers: the company manages its own cloud services, and provides apps for Windows, Macs, iOS and Android, as well as web access for those without the app. While StarLeaf may not be the biggest conferencing



provider on the block, it's confident in its services, claiming to be the only vendor to offer a "five nines" uptime service level agreement.

It also plays nicely with a variety of other collaboration platforms, including Microsoft Teams. Once you've added the StarLeaf app to your channel and granted it access, you'll be able to start or schedule meetings directly from the Teams app – and use the Pronto USB cable to connect directly to the room system.

The kit doesn't take long to install. You start by positioning the cable dock as required, then connect it to the network and plug in the rest of the components, along with your big-screen monitor. Once the cable dock is connected to the power, the whole system springs to life, and the touchscreen requests a 12-digit code that you should have received in your introductory email from StarLeaf. It also sends an email to the registered account holder, inviting them to download the desktop app and enter an authorisation code.

This grants the user administrative privileges, allowing them to access the StarLeaf cloud portal by clicking on

ABOVE The Huddle kit keeps setup straightforward for small businesses

the account management option in the desktop app. From here they can register users, who will each receive an email inviting them to download the relevant desktop or mobile app.

Starting a call from the Huddle's touchscreen is pleasingly simple. We were able to search our cloud contact directory, browse recent calls or tap in a user's extension number directly. The client apps are easy to use too: we found we could swiftly make both audio and video calls, add recipients to live meetings, share our screen

contents and so forth. Any user can schedule a meeting from their personal web portal, or enable the Spotlight feature for live streaming.

The Huddle camera has a wide 120° field of view, and while it lacks the 4K resolution of rival systems, our participants agreed that its image quality was suitably clear and sharp. The only slight irritation is that the camera's digital PTZ functions are only accessible from the touchscreen, which can be awkward. The mic has a good range and had no trouble picking up everyone in our meeting room: if you need to cover a larger area you can add an optional second microphone unit to the cable dock.

StarLeaf's Huddle kit provides everything you need for a modestly sized meeting room for a very reasonable price. While the camera has its limitations, the quality is more than adequate for small gatherings, while StarLeaf's cloud services offer a great range of features and the touchscreen controller makes it all very accessible.

CAMERA 1080p resolution, 3x optical zoom
120° field of view • USB 3

CONTROL UNIT 10.1in colour touchscreen
USB-C power • 255 x 163 x 113mm (WDH)
WARRANTY 1yr RTB

LEFT StarLeaf's own services and apps cover all the bases for calls and meetings





WatchGuard Firebox T20-W

A versatile appliance that delivers super security for both wired and wireless networks at a great price

SCORE

PRICE Appliance with 1yr Total Security Suite, £720 exc VAT from guardsite.co.uk

WatchGuard's Firebox T20-W is a compact, silent tabletop UTM appliance that will appeal to small businesses – and to larger organisations seeking easily managed protection for remote sites.

The price above includes a year's subscription to WatchGuard's Total Security Suite, which enables a broad selection of security measures: these include antivirus, anti-spam, web filtering, application controls, botnet detection, intrusion prevention, DNSWatch, an advanced persistent threat blocker – plus WatchGuard's RED (Reputation Enabled Defense) service for tighter web security. Alongside its four Gigabit LAN ports, the unit even includes a Wi-Fi gateway that can broadcast its own 802.11ac services or provision other WatchGuard access points.

While this is a great spread of features, it's worth noting that the T20-W doesn't support WatchGuard's IntelligentAV AI-based malware scanner, nor does it perform deep packet inspection of HTTPS traffic, as these functions are too demanding for the appliance's dual-core CPU. The wireless gateway isn't quite state-of-

the-art, either: it's limited to Wave 1 standards, and can work on either the 2.4GHz or 5GHz radio bands, but not both at once.

Still, local deployment is swift and easy. A Gold Support contract entitles you to a remote setup session with a WatchGuard in-house engineer, but we didn't see much need for this, as the web-based quick-start wizard walked us clearly through the process of securing administrative access, configuring the firewall and applying a base set of security policies. For remote sites, a nifty zero-touch deployment option allows newly registered appliances to automatically pick up preconfigured settings from the internet and apply them with no user intervention required.

Once you're up and running, network traffic is handled by a suite of protocol-specific proxies, including HTTP, HTTPS, FTP, SIP, POP3 and SMTP, each of which has its own setup wizard. The APT service checks incoming files with the Lastline cloud service to see if they're known malware, while the gateway antivirus component automatically blocks or drops infected content. Anti-spam

ABOVE The T20-W's Wi-Fi antennae are hidden away inside the bright-red chassis



policies are just as easy to configure: once you enable monitoring of SMTP, IMAP or POP3 traffic, junk messages get a tag inserted in their subject line.

Then there's WatchGuard's Application Controls service, which lets you approve or block a huge range of predefined apps and services, with 12 policies available for Facebook alone. It's partnered by the WebBlocker service, which recognises 130 URL categories and has an optional password feature that lets privileged users bypass the blocks. For even more fine-grained control, the T20-W's wireless services can be

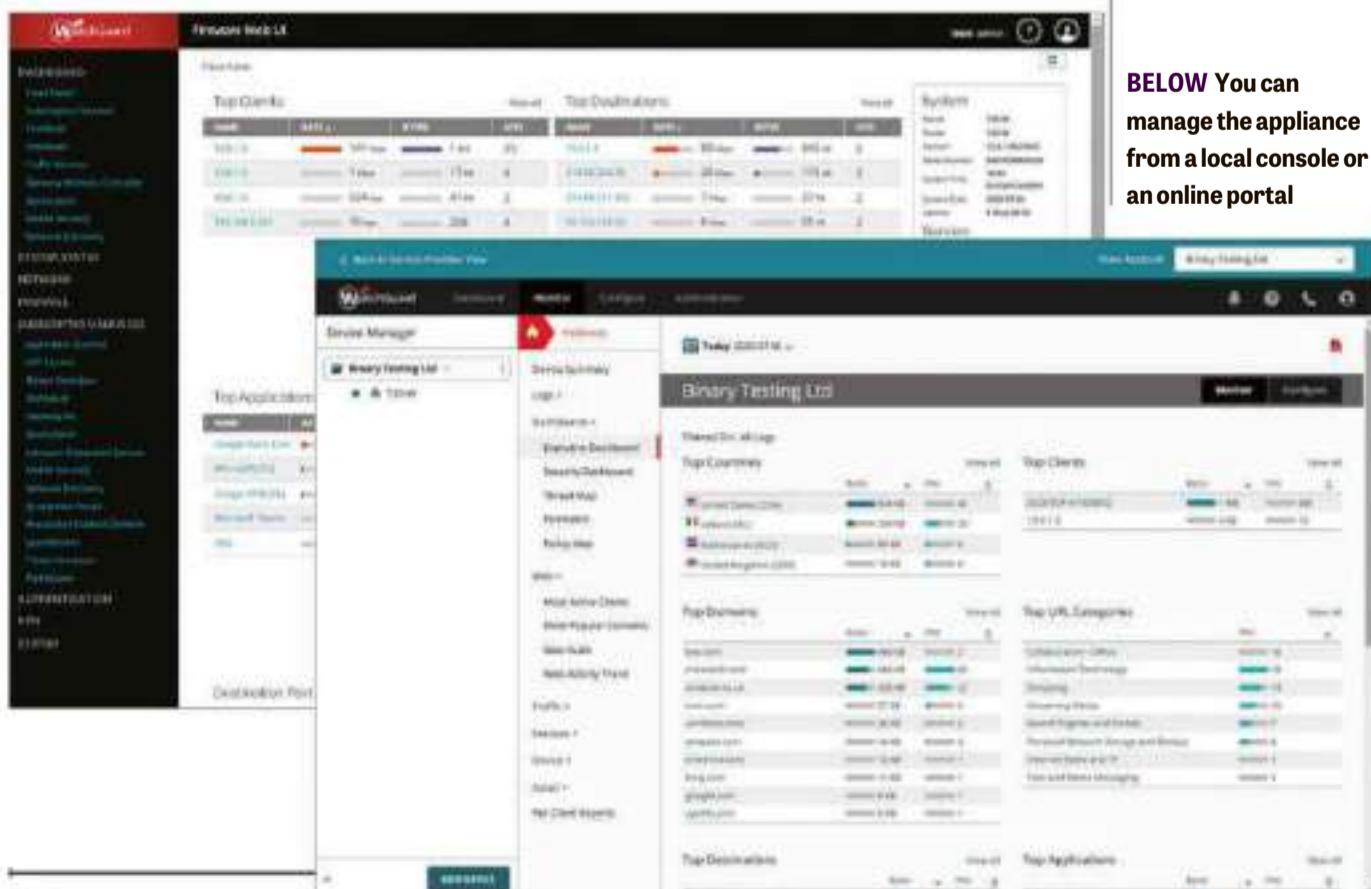
presented as three separate virtual access points, each with its own encryption scheme, optional L2 isolation, DHCP settings and firewall policies.

The T20-W's local web console makes this all a breeze to configure, but the appliance can alternatively be administered using WatchGuard's Dimension software, which is freely available for Hyper-V and VMware hosts. An update later this year will allow you to configure the appliance via your WatchGuard Cloud account too, and this portal can already be used to monitor security services, detected threats and performance.

The WatchGuard Firebox T20-W crams a great set of security services into a neat and affordable little box. With a superb set of deployment and management options, it's perfect for small businesses seeking all-in-one protection, and for larger companies looking to keep their remote workers secure. **DAVE MITCHELL**

"The T20-W's wireless services can be presented as three separate virtual access points, each with its own firewall policies"

BELOW You can manage the appliance from a local console or an online portal



SPECIFICATIONS

- Fanless desktop chassis
- dual-core 1GHz NXP LS1023A CPU
- 2GB DDR4 ECC
- 4GB eMMC
- 5 x Gigabit Ethernet (WAN, 4 x LAN)
- 2.4/5GHz 802.11ac Wave 1 wireless
- 2 x USB 2
- RJ-45 serial port
- external PSU
- 217 x 206 x 44mm (WDH)
- 0.9kg
- 1yr TSS licence
- web browser and cloud management
- warranty included in subscription

Zyxel ZyWall ATP100

This cost-effective security solution brings a good set of protection features to small businesses on a budget

SCORE ★★★★☆

PRICE Appliance with 1yr Gold licence, £434 exc VAT from broadbandbuyer.com

Not every business needs an enterprise-grade UTM. If you're looking for something simpler and cheaper, Zyxel's ZyWall ATP100 could well be the answer. Designed for small offices of up to 25 users, it borrows key features from Zyxel's high-end USG series and adds cloud threat intelligence, sandboxing and analytics, all for a price that's very hard to argue with.

It comes in the form of a fanless desktop unit with one Gigabit WAN port, four copper LAN connectors and an SFP fibre socket for longer cable runs. Across these connections, Zyxel quotes a firewall throughput of 1Gbit/sec, dropping to 380Mbits/sec with all security services enabled.

The £434 asking price includes a year-long Gold licence, after which renewals cost £212 per annum. The licence enables all services, including web-content filtering, application security, IDP, anti-spam, geo-enforcement and the SecuReporter web-based analytics and reporting service. The one box that's notably unticked is cloud management, as Zyxel recently had to withdraw its SecuManager cloud management app due to security issues. This means that, for now, all ATP appliances can only be managed via their local web console, and there's sadly no word on when or whether that will change.



Installation is swift, thanks to a wizard that enables internet access, installs the latest firmware and activates default security services. Since reporting data is stored in the cloud, you're prompted to decide whether personal information such as email addresses and usernames should be uploaded; if not, you can still generate the full range of reports, but they'll be anonymised.

For the best protection against malware, the anti-malware service can be set to operate in hybrid mode, which combines a local signature database with Zyxel's online threat intelligence to check whether downloaded files are safe. Any files that haven't been seen before are automatically dispatched to a cloud-based sandbox service for analysis: friendly files are allowed through, while those that are deemed a threat will be destroyed.

Another service you might want to customise is App Patrol, which lets you control access to over 3,500 apps including webmail services, instant messenger platforms, Facebook and Twitter. To this, Zyxel's web-content filtering adds over 100 categories of website that can be blocked; during testing, we found few sites slipped

ABOVE The Zyxel's five Ethernet ports are joined by an SFP fibre connector

past it. Unusually, it's also possible to enable geo-enforcement, by creating an address object for the region or country you want to block, then subjecting it to a security policy.

Enabling email protection is as easy as toggling on the sender-reputation and content-analysis features, and selecting whether suspect messages should be dumped or tagged for

processing by local mail clients. The IDP, IP reputation and URL threat-filter services are even simpler to activate – a single click will do it, although you can pull up advanced settings and modify their behaviour should you so wish.

For everyday administration, two dashboard views keep you in touch with the action. One presents a hardware status overview along with port traffic statistics; the other one, rather more excitingly, provides seven-day charts and graphs of all security activity, with details of top apps and any detected threats. The SecuReporter service exposes a wealth of information about all web, app and threat activity, with the Analyzer page providing insights into security indicators, sandbox activity, traffic and users at risk. Custom reports can be sent to multiple recipients at regular intervals.

Network gateway protection is a must for any business, and the ZyWall ATP100 is a worthy choice. The lack of cloud management means it's not suitable for companies with workers spread across multiple sites, but the range of security measures on hand is persuasive, especially considering the price. **DAVE MITCHELL**

BELLOW The reporting service and dashboard provide a wealth of revealing information



SPECIFICATIONS

Fanless desktop chassis • dual-core CPU • 1GB RAM • 6 x Gigabit Ethernet (WAN, 5 x LAN) • USB 3 • RJ-45 serial port • external PSU • 216 x 148 x 33mm (WDH) • 1yr Gold licence • web browser management • 5yr limited warranty



RANSOMWARE THE TRUTH

Data-stealing malware can bring the biggest business to its knees – but what is the real ransomware risk, and how do you safeguard against it? Davey Winder reveals all

There's nothing new about ransomware. It dates back at least to 1989, when the AIDS trojan started spreading across the globe. Today, more than three decades later, ransomware is identified as one of the most dangerous cybersecurity threats facing businesses of any size. But is that really the case? With any such threat, forewarned is forearmed, and it's important to understand just how dangerous and prevalent ransomware is, what its impact could be and how you can protect yourself.

The evolution of a cyber-threat

The AIDS trojan seems quaint now. This floppy disk-based virus locked up the contents of your hard drive, then invited you to post a cheque or money order for \$189 to an address in Panama to have it decrypted. The idea was ingenious, but the virus used simple symmetric cryptography, and it wasn't long before helpful souls started sharing free decryption tools.

Things have changed since then. 2006 saw the emergence of the GPcode trojan, which used a very strong 660-bit RSA key – later upgraded to an effectively uncrackable 1,024-bit one. By 2013, CryptoLocker 2.0 was not only using 2,048-bit encryption but asking for payment in Bitcoin.

Then, on 12 May 2017, the stakes were raised again. Using a Windows exploit developed by the US National

Security Agency (NSA), a ransomware worm called WannaCry infected a quarter of a million machines across 150 countries within days. In the UK, it brought swathes of the NHS to a halt: it's estimated that governments and businesses worldwide spent billions coping with the fallout. Meanwhile, the public Bitcoin ledger indicates that the hackers themselves received only around £110,000 in ransoms – a comparatively paltry return on such global mayhem.

Today, the latest attacks can be far more lucrative. It's reported that Travelex paid £1.8 million to the REvil crime group earlier this year, while the University of California, San Francisco confirmed that it paid around £900,000 to the NetWalker ransomware operators in June 2020. I cover the even more recent Garmin attack, reputedly costing \$10 million, in my Real World Computing column this month (see p120). And following an attack against a firm of New York lawyers with celebrity clients, the REvil group demanded an astronomical £33.5 million. If you're wondering why anyone would pay such vast sums, the answer is that it's not just about recovering your data – it's ensuring it remains private.

Data exfiltration: it gets worse

Until a few years ago, ransomware operators relied on blunderbuss strategies. The idea was to attack as many computers as possible, and hope that some victims would pay up. As WannaCry's relatively modest takings show, however, this was never the most efficient approach. Ransom demands were kept fairly low, to encourage victims to pay up, but most individuals chose to give up their files rather than play along. Businesses were far better targets because they were less able to write off their data, and much more likely to have the funds on hand to pay ransoms. The challenge was that well-run businesses also have backup and recovery regimes.

A new approach was needed. Taking down whole networks was one option, since this could also prevent access to backup servers, and proved profitable enough for a while. But the biggest businesses had continuity plans for even this scale of attack. Eventually, a masterstroke of evil ingenuity emerged – introduced, as far as I can tell, by the Maze ransomware group in 2019, but quickly adopted by others. Maze's malware encrypted data as before, but simultaneously sent copies of the original files back to the ransomware operators.

This gave the criminals a whole new sort of leverage, which can be



ABOVE The very first ransomware attack – via the AIDS trojan – was way back in 1989

summed up in one word: blackmail. Even if your business could continue functioning without the encrypted files, non-payment now meant that your most confidential data could be made public, or passed on to unknown parties. And hackers have followed through on such threats: at least one data auction site exists on the dark web where files from those who don't pay the ransoms are offered to the highest bidder. At the time of writing, legal documents purportedly relating to Mariah Carey, Nicki Minaj and Bruce Springsteen are up for sale, with a starting price of \$600,000 each.

How do you get hit?

Knowing how these attacks work is the first step to defending against them. Let's start by looking at a very active ransomware threat known as DoppelPaymer. Its operators are sophisticated, using the kind of tactics more commonly associated with nation states than opportunist criminals. Before trying to drop their malware onto your network, they start with reconnaissance, probing for vulnerabilities and scouring publicly available data sources for information that could be used in phishing and social-engineering attacks.

Perhaps surprisingly, however, they don't make much effort to stay under the radar. When they're ready to launch the attack, they'll often use what you might call "commodity malware" – generic exploit code of the sort that can be easily bought on the dark web. They don't care if their intrusion prompts a flurry of updates and patches, as they only need the exploit window to be open long enough to implant the software that will perform the exfiltration and encryption. And if their first attack is blocked, they can just switch to a different method and carry on until something gets through.

Does this approach actually work? You bet it does because there are plenty of security holes out there waiting to be exploited. One recent report found that 80% of organisations surveyed had at least one unpatched vulnerability, 70% had more than one and 20% had more than ten. What's

more, some of the most commonly exploited vulnerabilities are ones for which patches have long been available – often for many years.

If that sounds shocking, we're not just talking about the sort of Windows vulnerabilities that get fixed on Patch Tuesday. Ransomware actors also look for weaknesses in application servers and collaborative tools. The lesson: make sure you keep all your software and services up to date. Don't focus solely on issues rated as critical either, as the bad guys have been known to target supposedly non-critical vulnerabilities. These are less likely to be patched quickly, yet can still be used as part of a multi-stage attack process.

Finally, even if your systems are water-tight, you can never entirely protect against human fallibility. NetWalker is a ransomware threat that has claimed some big scalps by using phishing emails to get privileged access to internal networks. As with DoppelPaymer, the perpetrators identify specific individuals who could compromise the system. Their fraudulent messages are perfectly tailored to the recipient, making them very hard to recognise. And, of course, it only takes one mistake to open the exploit window.

"Some of the most common vulnerabilities are ones for which patches have long been available – often for many years"

BELOW Maze runs a website to support ransomware "clients" after an attack

Maze support system

Who's just happened?
If you've seen this page it means you have a vulnerability in your system. This vulnerability was used to mostly your valuable data in a way which temporary disable further usage of it. Please upload DECRYPT FILES! using the form below and start recovering your data. If this file is recognized by our platen you will be successfully authorized and provided with further instructions.

Please upload DECRYPT FILES!

Guaranteed?
We can ensure your files are not destroyed or partially damaged to keep the integrity and safety of your files.
Don't be afraid and try! (warning)

Businesses, corporations?
If you are looking for a free license to cover and avoid disruption fees
Our responsibility is to make it smaller. It will ensure decades to come.

Price?
We understand that the customer cannot always pay the fee. We have discounts and price can be negotiated.

you. Earlier this year, DoppelPaymer attacked Visser Precision, a parts maker supplying the automotive, aeronautics and aerospace industries; as part of the ransom leverage, some stolen data was released into the public domain, including documents relating to Visser's work with Lockheed Martin, SpaceX and Tesla.

Clearly, this ramps up the pressure, and that's before you think about issues arising from the EU General Data Protection Regulation (GDPR). Companies can face fines of up to 4% of their annual global turnover if they allow protected information to leak into the public domain, a threat that further inflates the potential cost of not complying with the criminals' demands. If the cybercriminals are smart, they can calculate a steep ransom that's still less than the potential GDPR penalty – and remind the business that a public breach could prompt a regulatory compliance investigation, leading to additional impositions and penalties.

Of course, with a security incident of this magnitude, it's highly likely the facts will come to light anyway. Your business will not only have a regulatory compliance investigation and a fine to deal with, but the additional reputational damage of succumbing to a data breach, and trying to buy your way out of it.

To pay or not to pay?

Ransomware operators will assure you that, if you just pay up, you'll receive the decryption key promptly, and all exfiltrated copies of your data will be deleted. And by all accounts, the decryption does normally work. Often there's even technical support on hand, should you need help restoring your files.

Let's not forget, though, that when you accept the terms, you're putting your trust in the word of a criminal organisation. There's no way to prove that stolen data is not kept, nor to be confident that it won't be sold to the highest bidder at some later date.

What you can be sure of is this: if you pay the ransom, you're effectively supporting the criminal industry, and promoting the development of the next ransomware threat. Of course, it may be very difficult to take a principled stand if you find yourself in a position where the future of your business hinges on paying a ransom. That's why it's crucial to properly plan ahead to ensure that you never find yourself in such a situation.

Managing the threat

Good backups are invaluable in mitigating the immediate impact of a ransomware attack. Unfortunately, ransomware actors know this and

will try to delete or encrypt any backups they can access, both locally and in the cloud. You should ensure, therefore, that your backup plan follows what I call the "Dusty Bin rule" – also known as "3-2-1". This means retaining three separate copies of your data, stored on at least two different media or services, with one copy located off-site and isolated from the network. All of that may sound cumbersome, but it ensures your data won't be lost in the eventuality of a ransomware attack – or a burglary, natural disaster or what have you.

Sadly, sorting out your backups isn't enough to save you from a ransomware attack that includes data theft. Consequently, it's best to focus on preventing exploits from getting through in the first place. As usual, there's no silver bullet, but getting the basics right can go a long way towards stopping your business becoming the latest ransomware statistic.

Start by addressing the human factor, with a focus on security awareness and training. Everyone needs to know the common social engineering signs to look out for, and the consequences of ignoring them – although in a context of ensuring awareness, rather than victim-blaming. Make sure the message goes all the way up to the boardroom, as attackers will be keen to target senior staff with privileged access.

Within the IT department, it goes without saying that you need multiple layers of intrusion prevention: that means everything from spam filtering and anti-malware detection through to DNS protections and the closing or securing of remote desktop ports.

Rigorous patch management is a must too, with a formal process in place encompassing OSes, software and device firmware. As we've noted, vulnerability criticality cannot be the only metric: keep your patching priority in a real-world, attacker-oriented context. Instituting a system like this might seem complicated and costly, but in terms of what it could save you, it's a sound investment.

Another project worth undertaking is the elimination of weak passwords, and the introduction of multi-factor authentication. An additional layer of authentication protection is often all it takes to completely stymie an attempted ransomware attack before it gets off the ground.

Grubman pack - Bruce Springsteen

All Bruce Springsteen legal documents from Grubman office.

| | | | |
|------------------|-----------|--------------|-------------|
| Minimum deposit: | \$50,000 | Top bid: | - |
| Start price: | \$500,000 | Blitz price: | \$1,500,000 |

Opened Time left: 9 days, 18 hours, 55 minutes and 52 seconds



ABOVE No More Ransom is a one-stop shop for ransomware attack advice

Even when users do log in successfully, you should apply the principle of least privilege – for everything. This means that if access to a file, directory or network share isn't critical for a person to do their job, it should be closed off. If someone needs additional permissions, these can be enabled on a granular, time-limited basis. In this environment, any attempted ransomware attack will be severely limited in its ability to move around the network and cause trouble. Similarly, if you have multiple networks and data stores, these should be logically and physically separate.

When the worst happens

Hopefully, all of these measures should ensure that your business is never brought to its knees by ransomware. However, in order to be fully prepared, you need to have a response plan in place for that very

"Let's not forget, though, that when you accept the terms, you're putting your trust in the word of a criminal organisation"

eventuality. We can't tell you exactly what your plan might include, but as an example you should have statements ready for immediate communication to staff, customers, the police,

the media and so forth. You also need to have network and device isolation measures in place to ensure the ransomware can't spread any further. And you need a plan for fully neutralising the malware, while also preserving as much information as possible for the investigation that should follow.

Having such a plan worked out ahead of time ensures that mistakes aren't made in the heat of a major attack – and the process of developing your plan should shine a light on any gaps in your current security measures, helping you to reduce the risk in the first place. Just remember that a procedure is just a piece of paper unless it's actually put into practice: once you've drawn up your plan, test it properly so that everyone knows what they need to do before the very stressful crisis hits. ■



Cloud configuration

It may not be glamorous, but **Davey Winder** explains how cloud settings may be all that stands between you and a data disaster

This sounds like a boring topic. Do we really need to talk about it?

Cloud configuration does indeed sound boring, which is probably why it doesn't get a lot of attention. Yet that's exactly why we need to talk about it: recent research suggests that configuration errors have contributed to more than 200 data breaches in the past few years, exposing 30 billion items of private information. Indeed, a shocking 91% of deployments analysed by cloud specialist Accurics were compromised by at least one major misconfiguration exposure.

Wait, what exactly do you mean by a misconfiguration exposure?

Simply put, we're talking about real or potential data leaks that are made possible by inappropriate security settings or practices. Obvious examples might include allowing open access to a sensitive database, using hard-coded or default passwords, leaving administrative back doors open and failing to use encryption.

Isn't configuration the responsibility of the service provider?

Only to a extent. Your cloud provider may well be responsible for securing and maintaining the infrastructure – but when it comes to setting the right access controls for your internal resources, that's on you. In the event of a data leak, claiming "I thought someone else would deal with that" won't get you off the GDPR hook. And it goes without saying that if you're hit by a destructive attack – such as the recent "Meow" bot exploits, which have trashed thousands of databases around the world by overwriting exposed indexes with the word "meow" – pointing fingers won't undo the damage. You need to take responsibility for devising and correctly implementing suitable security policies before a breach happens.

"In the event of a data leak, claiming 'I thought someone else would deal with that' won't get you off the GDPR hook"

That doesn't sound too difficult, so why is misconfiguration so common?

It's easier than you might think to get caught out. Default settings can trip you up, and one common scenario involves database security being temporarily disabled or downgraded as part of a maintenance task. Even if this state of affairs is short-lived, it can be quickly spotted and exploited by automated hacking tools that are designed to scan for such things. In fact, you might characterise this sort of attack as data mining rather than hacking, as the data is just sitting there waiting to be extracted.

What can I do to avoid becoming a victim of cloud misconfiguration?

It's a good idea to start with the basics and, in this case, that means your base configuration settings. Security policy updates should always be propagated into your base settings to ensure you're learning from past mistakes, rather than repeating them. You should also regularly review the configurations of your cloud servers and applications, and ensure that they remain secure. Configuration compliance must be part of policy compliance before provisioning, before deployment.

Anything else?

As with most security issues, the solution is multilayered. Apply the principle of least privilege to identity and access management, and carry out regular audits to ensure not only that your cloud resources are secure, but that they remain so throughout their lifecycle. Automation can be your friend here too: you can even use the same tools that attackers do to find accessible databases, such as the Shodan discovery engine. Finally, bear in mind that misconfiguration cases most commonly boil down to human error – so training and awareness have a role to play. ■

The cost of cloud misconfiguration

Weighing in at just ten short pages, Accurics' summer 2020 State of DevSecOps report is a quick read – but a potentially eye-opening one for any cloud-based business. In its analysis of hundreds of cloud deployments, the company's researchers note that no fewer than 93% were found to be at risk owing to misconfigured storage services. Even worse, an incredible half of deployments had access credentials hard-coded into configuration files, of which 41% conferred "high privileges" that

could be used to provision compute resources. And in every single case, researchers found a way to enable access over the internet to a supposedly private subnet.

Perhaps the most alarming number, however, relates to remediation: the report estimates that, once issues are detected, only 4% are properly addressed – illustrating just how little attention this crucial issue gets. For more information, you can register to download the full report for free from pcpro.link/313accurics.



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JON HONEYBALL

"In one of those weird twists of fate, this rogue DHCP server decided to play with my mind"

Jon tells Microsoft what to do about Windows 10X, but first has to solve the mystery of an IP device going wrong on his home – or is it office? – network

Andre called up the stairs: "Netflix isn't working on the TV". Keeping one's partner happy is obviously priority number one, so I scampered downstairs to see the issue. The TV is a 40in Samsung UHD/HDR model in our kitchen/lounge, and we use its built-in Netflix app. And he was quite right: it was complaining about there being no data feed. I tried the Amazon app and that was dead too. Clearly something was amiss in IP-land.

Going to the TV network settings showed it had managed to obtain an IP address of 192.168.168.101, with a default gateway of 192.168.168.1. Which is odd, because my network runs on the 10.101.x.x range. The only explanation was that I had a rogue DHCP server on my network.

Now, I need to explain that my network is unusual, but has been designed this way for a good reason. My boundary router/firewall is in the data centre across the yard from the lab. There's a 1Gbit fibre connection between the two buildings. Why did I put the boundary router in the data

centre? It meant I could put backup servers in that building too, and have them within the realm of my internal network. In addition, there's a 1Gbit dark fibre connection from my boundary router/firewall in the data centre to my house, some ten miles away. So there's essentially a unified IP space spanning three physical locations, all interconnected on fibre. Access to this LAN is tightly controlled – no test devices join it, for example. And none of my team know the Wi-Fi password for the Meraki Wi-Fi units on the LAN, either. I keep a close eye on the IP allocations and which ports are in use in the main Meraki switch in the lab.

My first thought was that it must have been something stupid I'd done at home. So I went to the garage where the Cisco router and fibre boxes live, and unplugged the fibre to the lab. This would, of course, disconnect the LAN and take out the DHCP server that sits within the pfSense firewall at the data centre, but it would allow me to see whether this rogue DHCP server disappeared too. And that would



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indicate if it was physically located at the house, the lab or the data centre.

The intention was good, but in one of those weird twists of fate, this rogue DHCP server decided to play with my mind. I had my laptop set to an address of 192.168.168.102 on its Ethernet port and it was cheerfully pinging the 192.168.168.1 address. I disconnected the feed from the fibre and the 192.168.168.1 ping stopped. Ah, clearly this meant the problem was at the other end of the fibre, most likely in the lab. I reconnected the fibre feed and the ping resumed shortly after.

There was no choice: I had to get in the car and drive to the lab. Repeating the exercise, I could still see the rogue DHCP server. The next task was somewhat easier: I knew the MAC address of the device, so I could look up where it was on the ports of the Meraki 48-port switch. Well, that was easy enough, but it left me confused. It wasn't in the lab. This required a quick SMS to Richard, who runs the Merula data centre across the yard. Despite it being a Saturday, he quickly answered. By logging into the Cisco routers, he ascertained that indeed it wasn't in the lab. It wasn't in the data centre, but it was on port six of the Cisco router back at my house. I could have logged into the Ciscos, but I leave that part of the infrastructure to Richard, who understands the dark art of Cisco routers far better than me.

Back into the car to drive home. Port six on the Cisco router was the feed from the fibre that fed into the house, so clearly it was somewhere in the house. I plugged my laptop back in and started pulling Ethernet from the main distribution switch, one at a time. The house is pretty well covered with Gigabit Ethernet – one feed goes to the roof space, to various cameras and then drops down the side of the house to rooms. One heads to the kitchen/lounge space. Another one goes over fibre to the garage, which has various bits in it. Disconnecting these didn't stop the ping.

BELOW A Netflix error revealed a world of IP pain. "Whoops" indeed



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Opinion on Windows, Apple and everything in between – p110

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Of course, the last cable I pulled killed it. It was for an IP security camera mounted on the side of the main garage, near to where the fibre comes in. I plugged it back in and the ping resumed. I then plugged it into a spare port on the Cisco and Richard remote-confirmed that the MAC address had indeed appeared on the port. I did the only thing possible – I pulled the feed from that camera and went to the pub for a beer.

How did this IP camera go rogue and fire up its own DHCP server on my network on the 192.168.168.1 address? Well, it turns out that this camera (a somewhat elderly Y-cam Bullet HD camera) can be run over Wi-Fi. When you set it up on Wi-Fi, it creates a hotspot so you can connect your laptop to it. This, of course, requires a DHCP server on the camera to support the hotspot. I hadn't even plugged in the Wi-Fi aerial, always using it over wired Ethernet. The camera had decided to launch its configuration and had crashed into a setup routine. Except it wasn't really working, as there was no web management page on the 192.168.168.1 address. It had simply gone rogue and, in doing so, had managed to wreak havoc across my network.

There are some lessons to learn from this. Firstly, it's much easier to fault-find this sort of issue if you have access to the monitoring on the ports of your switch. Knowing the MAC address of the offending device, I could have easily worked out where it was. This was easy to do in the lab on the big-boy's-long-trousers Meraki switch. But most switches in the home and SMB environment don't have that sort of management interface capability.

Secondly, it is a good reminder that devices that try to be "helpful" by

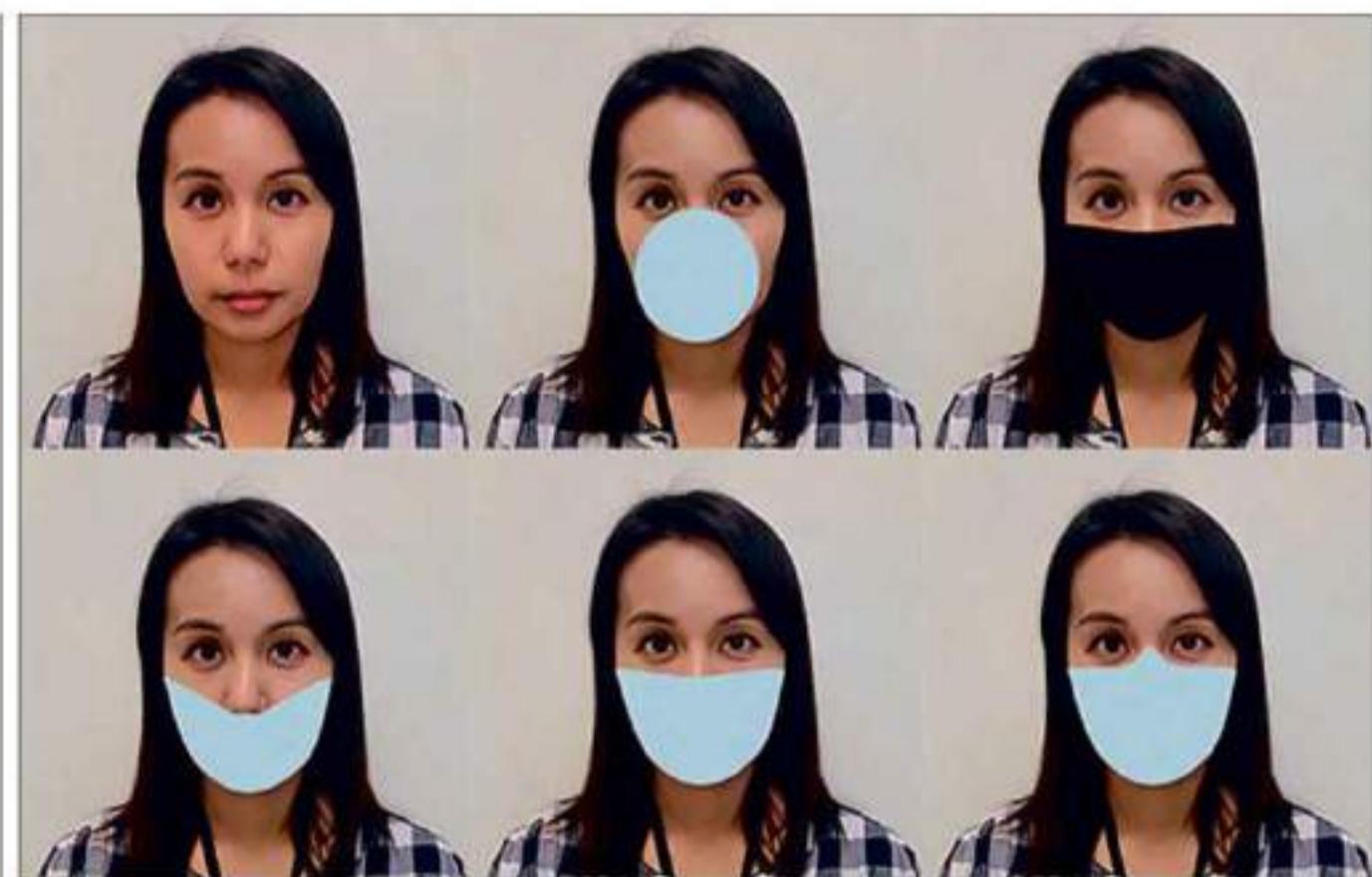


Image: B. Hayes/NIST

setting up their own Wi-Fi hotspots can turn out to be a liability when they go rogue. I'm coming to the conclusion that most IoT devices are really quite horrible in their implementations, and make far too many assumptions that don't stack up in the real world.

Said camera has been forcibly removed from the side of the garage, and a Samsung Wisenet QNO-6020R replaced it. Which reminded me that another Y-cam died last year and was replaced by one of these nice 6020Rs. At least that time it just flatlined, rather than attempting to invade my network. That leaves four more of the Y-cams around the house, all fitted high up under the eaves. I can see some ladder work in my future to pull them off before they die too.

Oh, and to answer the obvious question – why, in my initial fault finding, did the rogue DHCP server disappear when I unplugged the fibre from the house? I can't explain that, other than the camera appeared to be going through an ongoing spasm of booting and rebooting. Maybe it was coincidence. I prefer to believe that it was simply doing its best to ruin my day.

Facial recognition in a face mask era

I recently came across an interesting report from the National Institute for Standards and Technology (NIST) in the US about the effect that wearing a face mask

ABOVE NIST applied stylish digital masks to assess the role of colour, size and shape

has on facial recognition algorithms (pcpro.link/313mask).

According to this work, the most accurate algorithms have a failure rate of about 0.3%, meaning they're correct 99.7% of the time. An image of a masked person causes the failure rate to rise from 0.3% to around 5%. Other "competent algorithms" fail under the same circumstances between 20% to 50% of the time. The size of the mask has a significant impact – the more you cover your nose, the worse the algorithms perform, as you'd expect. And there's a suggestion that the colour of the mask matters too.

Clearly, this is a technology race. With the significant rise in the use of face masks due to the Ongoing Unpleasantness, it will have an effect on the facial-recognition systems used, not only by the authorities but also by businesses. For example, it's long been held that Las Vegas casinos have serious face-recognition systems in place. I wouldn't be surprised if large department stores along, say, Oxford Street use similar technology to aid and inform their in-store security teams. The rise of masking will clearly have the unfortunate (to them) side effect of making systems like this less effective. While rising from 0.3% to 5% might well be considered adequate, that sounds like a best-case scenario. A failure rate of 50% sounds more likely and renders it useless. I'm sure the vendors of such technology will be scrabbling to reassure their customers that their solution is still valid in the new masked era.

"Vendors will be scrabbling to reassure their customers that their solution is still valid"



LEFT I'm now in a race against time to pry off my other Y-cams before they conk out

And then there's some illuminating research from the Computer Science department at the University of Chicago (pcpro.link/313fawkes). Called "Fawkes", this is a technology for making almost imperceptible pixel-level changes to photos that appear to seriously compromise the ability of facial recognition engines to work. They claim that they have a better than 95% protection rate against user-recognition systems, irrespective of how the system is trained.

This is a very big claim. Yet it's certainly interesting if such capabilities could be built into your selfie software, thus helping to prevent those who do mass data scraping of the internet to build up a training library that can accurately recognise you. This won't work for cameras that watch you as you walk down the street, but it's a twist for the mass of photos that get shared from phones onto sites such as Instagram, Pinterest and Facebook.

I've long held the view that smartphones could and should be doing much more to digitally watermark photos, both in terms of embedded watermarks and blatant banners, to help reduce the incidence of images being taken by third parties for their own use. This, along with the Fawkes technology, is something I'd like to see Apple and Samsung bring to market.

Wherefore art thou, Windows 10X?

The somewhat tortuous development path of Windows 10X continues to confuse and surprise. The latest news appears to be that it will now ship in early 2021, on single-screen devices first. A delay is always a possibility, even a probability, when working on a project of this size, so this doesn't come as a shock.

However, the news that it won't ship with the Win32 support is unwelcome indeed. It appears that the clever containerised technology that allows a Win32 app to run within a secure boundary isn't delivering as expected. Microsoft is being tight-lipped on this, but it's going to be

one (or both!) of two issues: either the performance is poor or the compatibility with existing apps is problematic. Poor performance could be simply that apps run slowly. Or it could be that they use a lot of power, impacting battery life, or a lot of RAM. Or the access to services like the screen is disappointing. Whatever the reason, Microsoft has said that the Win32 support will appear in 2022.

Frankly, that means it might as well not bother. Microsoft is at a critical turning point for Windows on the desktop. It desperately needs to move forward if it's to have relevance against ARM-based alternatives. And let's not forget that Microsoft's ARM version of Windows 10 is really "Windows for Qualcomm", and even that's still delivering disappointing performance and battery life.

Windows 10X had the possibility of starting a new era, but the brave design is being reigned back. The reason for this, I suspect, is quite simple. It was never going to work well, or deliver a performance and battery life that



ABOVE Fawkes adds pixel-level changes, or "cloaks", to fool online recognition systems

made sense over the next decade. With the ongoing decline of x86 as a relevant platform for many of the world's population, a solution that tried to be new and shiny and yet still supported the old guard of Intel-based Win32 code was never going to deliver.

Microsoft desperately needs to compete with the Chromebook marketplace, especially in the education market. It needs to compete on ARM, and to do so with a platform that delivers much

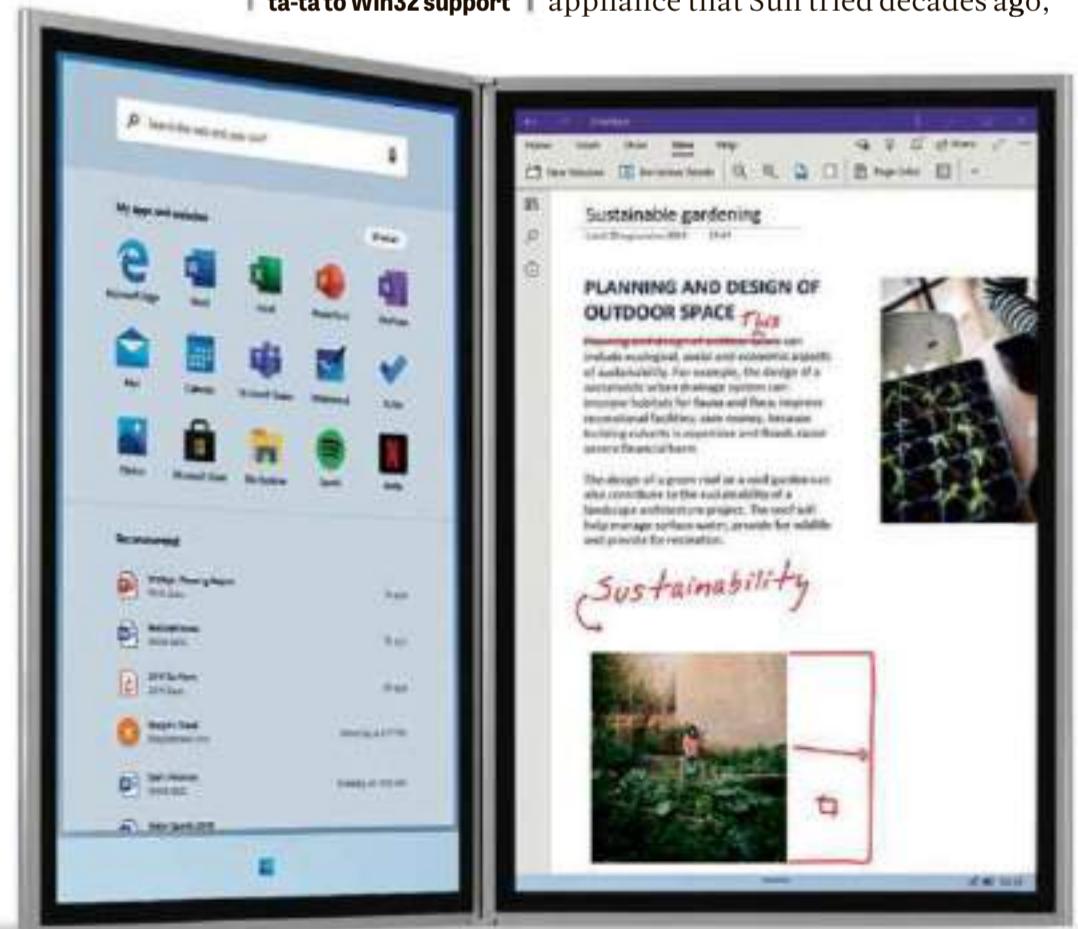
more than its existing Windows-on-Qualcomm effort.

Which leaves it with a quandary. 10X appears to have come short, with major structural components being left out, at least initially. So what's the big plan?

The 10X factor

Well, this is what I'd do if I was in Microsoft's position. Nowadays, everything for the company revolves around monthly subscription income – which doesn't sit well with the traditional upfront licensing model of Windows.

How about taking the good parts of Windows 10X, moving it aggressively onto the wider ARM platform and giving it an exceptionally easy set of administrative tools? This could be a modern answer to the network appliance that Sun tried decades ago,



but this time supported by a strong networking, wireless and 4G/5G infrastructure. Apps would only be from the app store, and be properly curated. With no Win32 in sight, it would be a vastly more secure platform than Windows 10 is today.

What's that in the back? What about those pesky x86 applications that users still want to use? Here, the answer is both simple and very complicated: you run them in virtual machines in the Azure cloud.

Microsoft already has a full platform for this, but it's generally only available to corporate users. What if it was to do a virtual machine in the cloud that could be spun up and down as required? It would then "project" its UI onto the desktop/laptop, cleanly working alongside the native local applications.

The model is simple and elegant – and allows Microsoft to charge a per-minute or per-month subscription for such cloud-based technologies. The problem is how the user gets their app into the cloud session, not only for the home/SMB user but also the corporate user. And how will they square the licensing circle, where some old-fashioned apps can have quite stringent licensing requirements about where and on what they are executed? Well, the answer here is to fall back to the full-fat old favourite of Windows 10 on Intel.

This would be a brave move, but it would give Microsoft a platform to move forward. It would be interesting to know how the major OEMs would react to it, because the Windows licence component becomes a much smaller item, given the thin nature of the platform and the competition from Chrome OS. However, it would be a move that clearly established a new direction, whilst also cementing the role of Windows 10 for the "classic" market.

From that perspective, I wonder if the changes to Windows 10X are just part of that plan. Why waste effort on making Win32 apps work on 10X when that really locks you into either the Intel platform or the Qualcomm ARM with the necessary extensions? I hope Microsoft can have a moment of clarity, and launch something radical and innovative.

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PAULOCKENDEN

"This complete and utter cobblers appears to get regurgitated over and over again across the internet"

Paul fixes his Wi-Fi, looks at some hidden sound options in macOS and adds a watchdog to his Raspberry Pi

It seems unlikely, but if I am ever suddenly put in charge of everything, the second law I pass will make it illegal for people who aren't really sure what they're doing to mess around in the settings of their broadband routers. I've lost count of the number of friends who have asked me to look at their broken setups, only for me to find all kinds of random things that have been "tweaked" by people who didn't realise what those settings actually do.

What's worse is that they probably haven't just clicked these settings randomly – there's a whole raft of websites out there that will, when you search for Wi-Fi problems or look to increase your connection speed, give you no end of spurious advice. And this same complete and utter cobblers appears to get regurgitated over and over again across the internet. You can see how this happens: someone posts a question, someone else does a web search and finds some claptrap on the subject, and they then post that in response to the original question, so as to appear clever or, more likely, to win points on one of those "gamified" technical support websites. And then, a few days later, someone else finds their advice and the cycle continues.

I recently saw a Wi-Fi network where the MTU had been set to 1,532.



Paul owns an agency that helps businesses exploit the web, from sales to marketing
@PaulOckenden

If you've not heard of MTU before it stands for maximum transmission unit, and it's the biggest packet of data that your network thinks it can send; bigger packets need to be "fragmented", or split into multiple sections with sequence numbers that allow the receiving end to glue the original packet back together again.

If you set the MTU too small, your network runs slowly because it starts to fragment packets that it doesn't need to, resulting in twice the normal traffic rate. Set it too big and stuff quickly starts to fail. Especially external traffic, which won't reach your ISP, or other times won't be received. The annoying thing is that it won't affect all of your traffic. You might be looking at a web page and find that certain images don't load while others work fine. That's because their file size sits in that gap between your actual MTU and the duff value set in the router. Similarly, you might find that some online games don't work while others do, or particular web pages refuse to load. It's this intermittent nature of MTU problems that make them hard to track down; on the other hand, for experienced network bods this acts as a big clue as to where the problem might lie.

Many websites tell you how to determine the correct MTU size to use

for your broadband connection, but many are utter tosh. I just Googled it as I'm writing this, and found a support page from probably the most well-known broadband router manufacturer, which says to adjust the value in increments of ten. That's terrible advice – it needs to be multiples of eight! So ignore all these websites and simply ask your ISP. If you're using the ISP-supplied router, it might even be locked to support the MTU that your provider expects to see, but if you're

"Many sites tell you how to determine the correct MTU size, but many are utter tosh"

BELOW This is what happens when you take dodgy forum advice as gospel...



using your own router then your provider is the best source to tell you the correct MTU. You may even find the correct value printed on your welcome letter or email.

Anyway, back to the MTU that was set to 1,532 – how did it get there? You should almost never see an MTU of 1,532. “I saw it on a website somewhere,” I was told. I love the internet, but it’s getting to the point where the technical help you’ll find there is about as reliable as the political opinions on Twitter.

And now comes the bit where it gets quite embarrassing... A couple of weeks ago, I noticed that my own Wi-Fi network was running slowly. Regular readers might remember that I use a mesh-based setup with a dedicated 1,733Mbits/sec backhaul channel running between the various nodes. However, from my MacBook Pro I could only reach a speed of 54Mbits/sec when talking to other local devices on the network, or when using my broadband connection.

My broadband connection was fine: I plugged in a laptop via an Ethernet port on my main router and got pretty much the full 80Mbits/sec in, 20Mbits/sec out that my FTTC connection allows. So next I thought it might be the speed between the mesh nodes that was being clobbered, but again, using wired connections showed that this was working well.

Oh, and it wasn’t the MTU either! I never fiddle with that, but I did check, just in case a router firmware update had messed with it; the value was 1,492, which is correct for my ISP.

It was at that point that I looked at the wireless connection between my Mac and its nearest mesh node. That’s really easy on a Mac: you just hold down the Alt key then click the Wi-Fi symbol in the menu bar. Doing so shows all kinds of useful information, and I could instantly see that my Mac was only connecting at 54Mbits/sec.

Lots of head scratching ensued. At first, I assumed it was a problem with the Mac, so I messed around with various settings (yes, I know... do as I say, not as I do!), but I couldn’t get it to connect at a better speed. Next, I started to dig around in the router settings and I noticed that the WMM option box was unticked.

Now that shouldn’t be a problem, right? WMM stands for Wireless

Multimedia. I wasn’t doing any multimedia stuff on my Mac – no streaming videos or VoIP calls. WMM is designed to give priority to these kinds of multimedia traffic and is part of the quality of service (QoS) stuff you’ll find in various wireless chipsets.

Yet, with certain brands of router (particularly Netgear) if you disable WMM, you don’t just lose the priority for things such as audio and video, you also severely limit the wireless connection speed. And that has to be a bug, right?

No, it’s just that Netgear is a bit stricter in how it handles the 802.11n (and higher) Wi-Fi specs than some other manufacturers. The issue is that WMM is a subset of 802.11e (the QoS functionality mentioned above) and the 802.11n spec says that 802.11e is required. The higher speeds that were introduced with 802.11n and later piggyback on some of the 802.11e features, especially WMM, to function.

That’s why you’ll find that WMM is enabled by default in all fast, modern wireless routers. Some manufacturers have tweaked their firmware so that if you turn WMM off it only removes the multimedia optimisation but still allows fast connections. Others, such as Netgear, are strict about this: untick that box and your network will still work, but not as quickly. But there’s often no warning when you disable WMM, and I guess many people probably won’t even notice that speed drop.

The thing is that you’ll find loads of forums that suggest disabling WMM to improve throughput or fix other issues. Once again, it’s bogus advice. But it was unticked on my router too, and when I ticked it again everything went back to normal. I’ve no idea why it was unticked. Perhaps



ABOVE I could see that my Mac was only connecting at 54Mbits/sec

You'll find loads of forums that suggest disabling WMM to improve throughput

I’d been looking for answers on the internet.

Sounding out a Mac

Sticking with Macs, usually you’ll find it’s pretty easy to use external speakers. You just plug ‘em in or connect via Bluetooth and they’ll just work. If you have several speakers connected, you can flip between which one you want by clicking the speaker icon in your menu bar and selecting the appropriate speaker from the list.

There’s a bit more control available if you open up the Sound panel in System Preferences. Here you can set things up so that media plays through

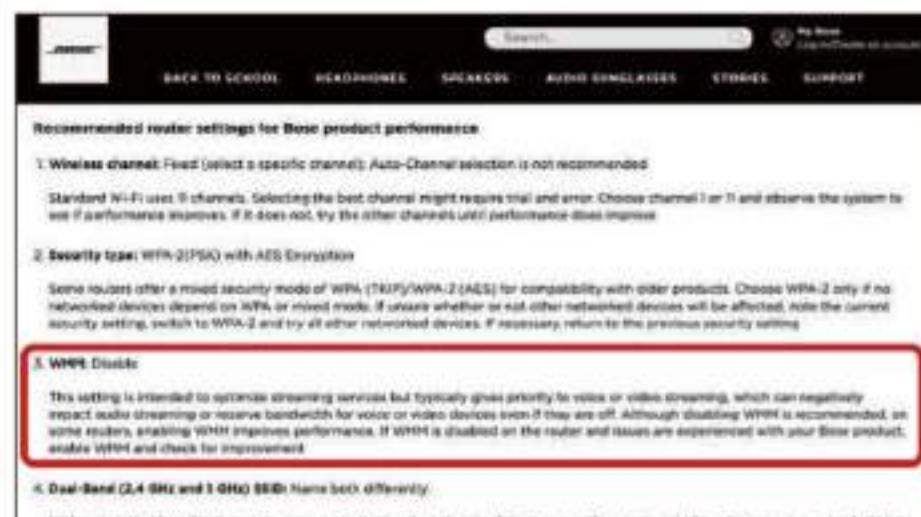
your external speakers, but you can still have system alerts bleeping out via your internal speakers, if you want. It’s all quite sensible and easy to use.

What many Mac users don’t realise, though, is that there’s yet another layer of control available. The reason they don’t realise is a) because it’s an application that you need to use, rather than the more usual System Preferences where you’d expect to find control things, and b) because the application is called “Audio MIDI Setup” and it even has a picture of a musical keyboard as its icon. If you don’t use your Mac for MIDI-based music, you’ll almost certainly have ignored this tool.

Take a look, though, because there’s all kinds of goodness hidden inside. In particular, it will allow you to select the bit rate and bit depth for all of your sound output devices. You might find that by default they aren’t being driven optimally.

The real magic comes if you click the little “+” in the bottom-left corner. Here you can create a “Multi-Output Device”. This is effectively a virtual speaker, where you can combine several output devices into one; just tick the speakers you want to include. You then need to right-click your Multi-Output Device and select the options to use it for sound output and/or system noises.

There’s also an option to add an Aggregate Device. This is more complicated than the Multi-Output Device as it also combines various inputs. Plus, it ties



the devices together in a slightly different way – as we'll see later.

If you make a combined device using both wired/internal speakers and Bluetooth devices, you'll get a noticeable delay between the two. This is caused by the Bluetooth codec introducing a processing delay. It's the same reason that you end up with lip-sync problems if you try to use Bluetooth headphones (or indeed speakers) with your TV. There are ways around this for audio-visual use by using devices that support the aptX Low Latency codec. That way you'll find that lip-sync issues are pretty much eliminated. Sadly, although Apple provides the bog-standard aptX codec, there's no aptX Low Latency (aptX LL) support. It's the same for Windows 10 – there's standard aptX built in, but not the LL version.

Anyway, back to the Mac. While you have the Audio MIDI Setup allocation open, you should also check out the Configure Speakers button, which you'll see down in the bottom-right corner. If you have a simple stereo speaker setup, it doesn't offer much, other than allowing you to swap the left and right channels if you've somehow got them connected the wrong way around. Where the configuration really comes into its own is if you have a multi-speaker setup: you'll see a range of options for different speaker positions.

I mentioned that Multi-Output and Aggregate devices are combined differently, and you'll see that in the Configure Speakers screen. If you combine, say, a MacBook's internal stereo speakers and a Bluetooth stereo soundbar into a Multi-Output Device, you'll only see the options for the position of stereo speakers. But if you use an Aggregate Device, you'll also get options for quadraphonic sound, treating all four speakers separately.



It's quite un-Apple-like to offer this much control over things. Usually it's a case of "our way or not at all". Perhaps that's why it hid it all in such an unlikely place!

Watching the dog

As regular readers will know, I'm a big fan of using a Raspberry Pi to run Domoticz for home automation. If you do this, a problem you're likely to find is that sometimes Domoticz will fall over. It's usually not the fault of the software itself; I've found that most often it's a third-party interface or driver that causes problems.

You don't want your home automation system offline, but you can use a watchdog timer to reboot the Pi if Domoticz crashes. First, see if you have the watchdog device available by running:

`ls -al /dev/watchdog*`

If you see devices called **watchdog** and **watchdog0**, you're okay, but if not you'll need to edit `/boot/config.txt` and add a line saying the following to the end of the file:

`dtparam=watchdog=on`

Then reboot and those watchdog devices should appear. To install

ABOVE You'll have to dig around for the extra levels of Mac speaker control

"Then, whenever your Raspberry Pi hangs, it will automatically restart itself"

the watchdog package, use the following:

```
sudo apt-get install watchdog
sudo update-rc.d watchdog
defaults
```

The next step is to configure the watchdog. Do this using:

```
sudo nano /etc/watchdog.conf
```

You'll want to change the watchdog timeout value to be 15 seconds. At this point, you can do:

```
sudo service watchdog start
```

Then, whenever your Raspberry Pi hangs, it will automatically restart itself. This is useful for all kinds of tasks, not just Domoticz.

A step further is to actually check that Domoticz is working. What you need to do is:

```
sudo nano /etc/init.d/domoticz.sh
```

Look for the OPTIONS line and change it to be something like:

```
OPTIONS="-www 8080 -loglevel=normal -log /tmp/
domoticz.log"
```

Then re-edit the `watchdog.conf` file like you did above, and add the following lines:

```
File = /tmp/domoticz.log
change = 600
```

We've just told Domoticz to write out a basic log file while it's running, and then we've instructed the watchdog process to check whether that file has been updated in the past ten minutes. If it hasn't, the Pi will reboot.

If you make an error, ten minutes should be enough to fix it before the Pi reboots. If you need longer, use:

```
sudo service watchdog stop
```

That other law

Right at the start of this column, I skipped over the first law I would enact if I was in power. Well, it would be to stop an HGV on a speed limiter from trying to overtake another HGV, also on a speed limiter. The punishment for carrying out this manoeuvre would be harsh, but doubly so if the stunt was pulled on a two-lane motorway. If you want to tweet and accuse me of being a typical BMW driver, the address is below.

@PaulOckenden



LEFT You can combine your Mac's output devices by simply ticking the boxes

LEE GRANT

“Mandy’s tally clocked in at 87,086 FreeCell games, demonstrating Roy Castle levels of dedication”

Lee fixes a Tesla with a USB drive, helps a FreeCell addict keep her high scores and has a stroke of luck with a dodgy Wi-Fi card

During lockdown, I rummaged through various boxes and cupboards looking for items that have been gathering dust for too long. I've done the same with my hard drive, so this month's column is a selection of tales that never made it into the magazine. Think of it as an unreleased Monty Python script with none of the funny bits and absolutely no cultural significance.

Let's start with Tesla. Mr H owns several Teslas, but the one he'd selected to drive to our shop was a Model X P100D, which has a forecourt price of around £85,000. Mr H pushed two USB sticks towards me and asked me to "fix his Tesla".

Teslas have a feature called Sentry Mode, which uses the external cameras on the car to detect potential threats. The footage writes to a USB stick and the one supplied by Mr H's dealer had met an unfortunate end inside a washing machine. Mr H had sourced a replacement, which his fleet of Teslas refused to utilise.

One USB was a dealer stick from another Tesla and the other was the larger capacity stick that refused to play. I used MiniTool Partition Wizard Pro (give the free version a try at partitionwizard.com) to compare and saw straight away that the dealer stick had FAT32 formatting but the new stick was NTFS. Two mouse clicks later I stepped into the Tesla, which refused the reformatted stick.

I'm not a Tesla owner so had no direct experience to formulate a solution, but there's some truth in the aphorism that computer technicians are just normal people who can use Google better than everyone else. I discovered the answer on several Tesla owners' forums. The USB stick should be FAT32 but there's an extra requirement that a "TeslaCam"



Lee Grant and his wife Alison run Inspiration Computers, a repair shop in Kirkheaton

[@userfriendlypc](https://twitter.com/userfriendlypc)

BELOW That's right, I'm an HP bigwig and I get to download Canon flyers. For free!

folder must be present on the root. I created this in Windows and scuttled back to the car to watch Sentry Mode activate. Mr H claims his £85,000 computer on wheels doesn't include an option to format and prepare empty USB sticks so perhaps Tesla needs to license Clippit from Microsoft. "I've detected an empty USB drive. Shall I use it to record the sod who keeps keying your car?"

Mr H was kind enough to give me a whirlwind tech-trip of the car and, as shiny as it was, only one part of the demonstration wowed me in a technological sense. With a few deft twiddles, he reconfigured the sensors in the seats so that when passengers sit down, the luxurious audio system emits a very sour whoopee cushion sound. £85,000 well spent!

Teacher learns a lesson

I often mention a look of dread and panic clinging to a customer's face. It's happened to us all and results from realising that data of tremendous importance is missing. Teachers seem to suffer the most from this as they juggle portable storage between their home PCs and work laptops, unconsciously accumulating years of files. I asked this particular teacher if they had any backup, but

they shrugged, looked at their shoes and promised not to do it again.

The damage to this USB-A plug was considerable. If you're in the market for a new USB drive, try to purchase solid one-piece unibody drives as they're more robust (Kingston does a nice range called DataTraveler). Providing the circuitry isn't too badly damaged, it's a few moments work to solder wires into place as a temporary fix whilst the recovery is attempted. This customer would not be that lucky. I opened the plastic case to examine the circuit board, only to find that it was missing. The customer had unwittingly brought an empty USB casing for data recovery and the location of the chip, containing years of work, is still unknown.

Most valued non-partner

When we opened our shop in 2003, we were besieged by vendors wanting to support us. Don't imagine delightful trips overseas: more in the line of pens, T-shirts and, on one memorable occasion, a branded doormat from BullGuard. Over the years these promotional items have dried up, but last year I received a gift from the Canon Partner team to promote its i-Sensys range. The email proclaimed "Take productivity to the next level", so naturally I was breathless with anticipation. To guarantee our rise, the email offered the opportunity to download an A5 i-Sensys flyer for FREE. It seems the only productivity being elevated was that of Canon's marketers, who believed that their patronising benevolence for not charging partners for a poorly produced flyer should engender ripples of gratefulness.

I'm not fooled by Canon's generosity, which is designed to entice me away from Hewlett-

Packard. It seems that I'm something of a big player in the Hewlett-Packard Enterprise Community. Its most recent communication trumpeted:

"Congratulations Lee Grant, you just earned a new badge! Member for 15 Years... you're one of our most valued members! Thank you for all the

contributions you've made in the last 15 years." It's official - I'm an HP MVP. In

reality, after I registered the account on 29 June 2004, I've never returned to it, let alone contributed. HP needs some serious GDPR attention.

The image shows a composite of two screenshots. On the left is a LinkedIn profile page for 'Lee Grant' with a green profile picture. The profile details show 'Rank: New Member', 'Member Since: Jun 29, 2004', and activity metrics: 0 Posts, 0 Kudos Given, 0 Solutions. Below this is a section titled 'Member Information' with fields: 'Date Registered: 06/29/2004 (09:41 PM)', 'Date Last Visited: ', and 'Total Messages Posted: 0'. At the bottom of this section is a 'Badges' section showing six circular icons. On the right is a promotional flyer for the Canon i-Sensys printer. The headline reads 'TAKE PRODUCTIVITY TO THE NEXT LEVEL'. The text below describes the printer's features, including its speed of up to 30 ppm and its ability to handle various paper sizes. There are also sections for 'Download Now!' and 'Learn More'.

Solving the *FreeCell* puzzle

Our business has always struggled to fit into partner schemes as we're too small. We've been part of the Microsoft Partner Network for years, which understandably targets the business and enterprise sectors. The organisation has made half-hearted attempts at embracing home users, but with all the empathy of an escaped lion approaching the penguin enclosure whilst claiming to be a vegan. The reason they fail is because Microsoft personnel don't meet customers like Mandy.

We built Mandy's Windows XP PC over 15 years ago and hadn't seen her since installation, but in January, she strolled through our door to order its replacement. The XP machine had been problematic for a while, but Mandy had fought the upgrade for one reason. In the movie version of this story, this is the part where we show you a cutscene of me asking Satya Nadella why Mandy didn't upgrade to the latest and greatest Windows. He'll splutter lots of interesting yet incorrect reasons why Windows 10 is great before we cut back.

The answer was *FreeCell*: Mandy didn't want to lose her high score. However, she had finally accepted that Windows 10 comes with a funky updated version of the game and that it was time to move on. Part of our role is holding people's hands as they cross to a newer platform whilst introducing improved methods of working, but this all went out of the window the moment I clapped eyes on Mandy's *FreeCell* statistics. Her tally clocked in at an unbelievable 87,086 games, demonstrating Roy Castle levels of dedication. At three minutes a game, that's around 180 days of solid clicking. I'm a sucker for protracted acts of pointlessness (see my own at bowiesmysteryguest.com) and triviality of this magnitude requires preservation.

The old versions of *FreeCell* were offline entities so the high-score and stats reside within the Registry at HKEY_CURRENT_USER\Software\Microsoft\Windows\CurrentVersion\Applets\FreeCell. The game didn't rely on installers but ran directly from the Windows folder, so a quick

search for any file that contained the word *FreeCell* gathered them.

I created a *FreeCell* folder on Mandy's new machine and dropped in the files. The Registry key imported nicely and, since the new versions of *FreeCell* don't utilise that Registry location, it doesn't cause a conflict. The only problem was that it didn't work. Research revealed that I'd missed CARDS.DLL. All those old XP games use this file to draw and animate the deck, so once it was in the right place, *FreeCell* launched, complete with the incredible high score.

Baffling messages

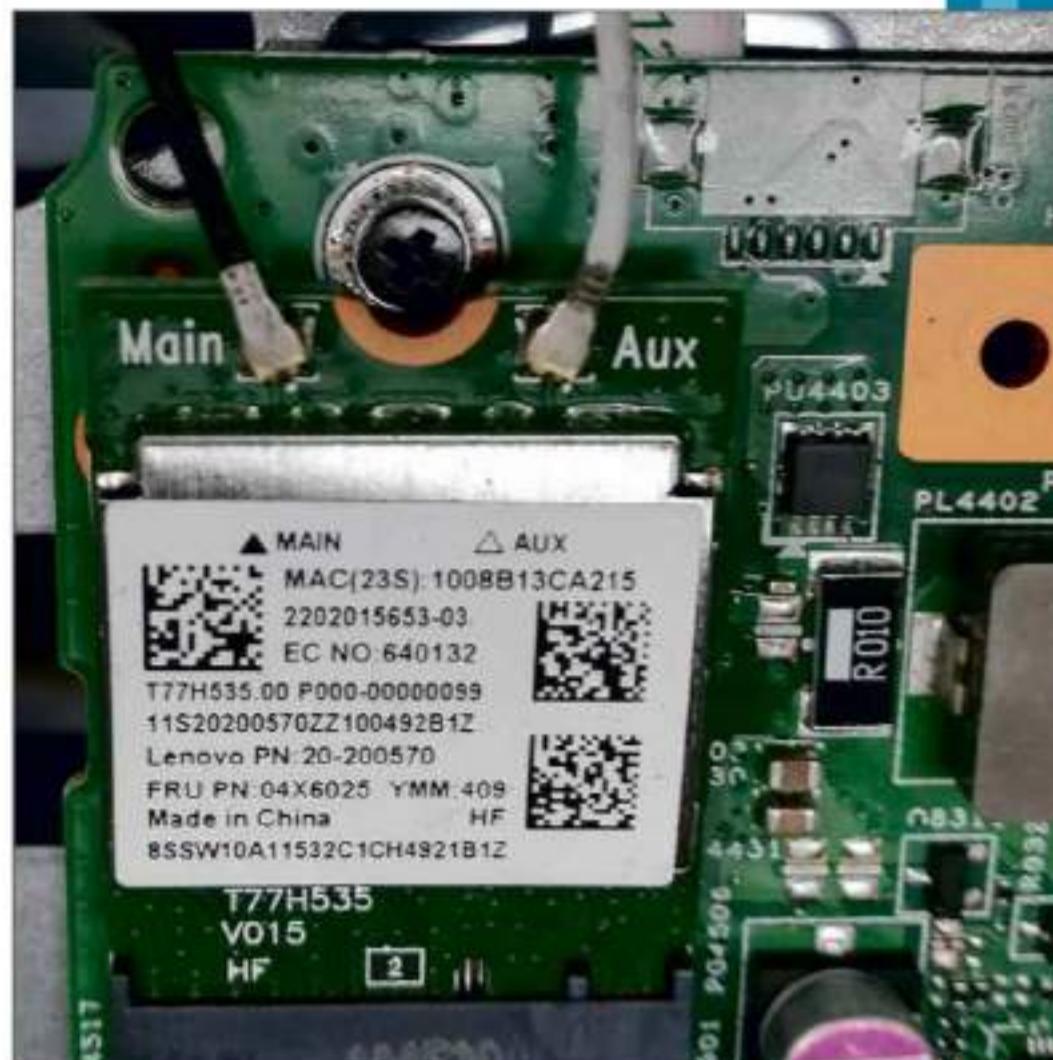
I wonder if Mandy's joyful resumption of her *FreeCell* obsession will offset the misery of the Windows 10 update system. If you're running a perfectly healthy Windows 10 machine, you'll be unaware that threats are made if your PC gets too out of date. The messages are similar in tone to those telling Windows 7 users to move on but with extra confusion. Telling Windows 10 users that they're about to be unsupported triggers phone calls asking me to install Windows 11.

Like the Canon flyer, it's hard to believe that anyone at Microsoft HQ has reviewed the error messages before excreting them on the public. My favourite Windows 10 error bafflingly declares that "This PC can't run Windows 10" with a petulant aside of "See below if you're interested in finding out why".

The crucial error is "We couldn't upgrade the system reserved partition," which would be news to users who don't realise that they have one. The fix is simple, but has a complicated implementation and differs if the machine has an MBR or

GPT partition. The method requires using the Windows command prompt to temporarily assign a drive letter to the System Reserved partition before navigating to the Fonts folder and deleting everything in it.

The madness that font files in a



ABOVE Like a clumsy Fonz, a bump from me was all it took for the Wi-Fi card to pop out

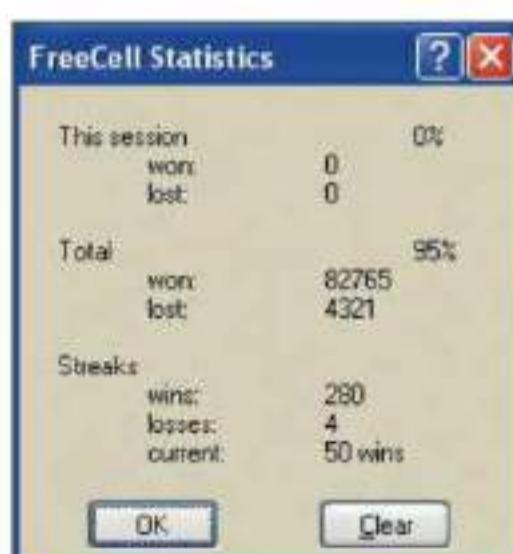
hidden partition inaccessible to 99% of users can cause this error is compounded by Microsoft's own TechNet website being crammed with solutions (pcpro.link/313technet). Where is the Microsoft fix-it tool? Why can't the update resolve this? Forget what I said earlier – Tesla should avoid Microsoft.

A screw loose

Sometimes all that's required to solve a problem is a fresh pair of eyes and some luck. Just before lockdown, a laptop with a problematic wireless connection arrived that had been back to the manufacturer and then pushed under the noses of several other local technicians. The wireless card kept vanishing from Device Manager, which is normally a sign of a part failure. I examined the card, scratched my chin and made a cup of tea. I bumped into the workbench on my way to the kitchen and the wireless card popped from its socket. The fault was a perfect storm of a slack socket, a card with connectivity tolerances and an ill-fitting screw thread. The retaining screw wouldn't fully tighten, so wasn't holding the Wi-Fi card in place. The card would agitate during transport, disconnecting and, unusually, reconnecting at random.

Eric Idle's outmoded punchline to the story could be "the customer was satisfied with a bigger screw" but it's hardly the calibre of "nudge nudge, wink wink" is it? And now for something completely different...

lee@inspirationcomputers.com



LEFT Mandy's truly astonishing *FreeCell* stats had to be saved for posterity

GAVIN HALL

"I'm convinced that mucking about with aircraft from our living room was pivotal in selecting my career"

Guest columnist Gavin Hall explains how Psion's *Flight Simulation* for the ZX Spectrum kickstarted his career as a pilot

Popular Computing Weekly said of Psion's *Flight Simulation* on the ZX81: 'No words can do justice to this most elegant of programs. You will not see a better computer game until Psion produce one for the Spectrum.' Here it is. Learn to fly, bank, dive and climb, see the world outside through the cockpit windows, land and take off with the aid of many cockpit instruments."

So reads the inlay of the cassette tape for the 48K ZX Spectrum version of *Flight Simulation* by Psion. Deep in that area of the brain where earliest memories and nostalgia swirl into a dream-like haze, I long held an image in my mind of the cover art for that game. A cockpit... nighttime... runway lights. An image search and there it was, along with the sensation of neurons firing as an ancient memory rises to the surface.

I was about five years old when my dad came home with that little computer, along with a collection of a dozen games such as *Jetpac*, *Cookie* and *Pssst*. Despite it not being as "fun" as the others, *Flight Simulation* held a strange allure.

Later on, having seen fast jets at the local airshow, we acquired a copy of *Fighter Pilot*. Objectively, it wasn't much better, but it had guns and now we were in an F-15 Eagle! Any Top Trumps player worth their salt knew that if you had the F-15 you'd won before you started.

For years, I played with the keyboard until I managed to get hold of a Kempston interface and joystick. The key with computer games is always the suspension of disbelief – ten-year-olds are strong in this department – but having that joystick took it to a new level.

Later on, long after those who could afford it had moved to the



Gavin Hall is a commercial pilot and long-term flight simulation aficionado

@GavinHallPhoto

"My brain nearly melted when I first saw the Eurofighter in flypast view"

BELOW The cover of *Flight Simulation* transports me back to being five years old



Amiga, it was the turn of *F-16 Combat Pilot* to punish the little Sinclair. In hindsight, how this was done with 48KB of RAM I'll never know. Air-to-air missiles, radar, a mission planner...

By now we're up to 1995 and our 1988 vintage PC (Intel 8088 processor, Hercules graphics adapter and black/amber monochrome monitor) was also being press-ganged into running an early version of *Microsoft Flight Simulator*.

My parents were now enduring nagging for a new PC. A year earlier, a family friend had bought *Tactical Fighter Experiment* (*TFX*) by Digital Image Design (DID) for a 486 PC. The packaging for *TFX* was a masterclass in 1990s excess, the huge box constructed of sturdy cardboard. Prising it open revealed the most beautiful manual ever seen for a piece of software. This wasn't just software to run, it was a thing to own. My brain nearly melted when I first saw the Eurofighter in flypast view. And don't even mention the night-vision bombing missions. I had to have it.

Eventually, my mum relented at a point when my dad was away with work. It was a bad moment for her to

do so. Escom, the high-street computer chain, supplied a Pentium P60 with 8MB of RAM and a double-speed CD-ROM drive, running DOS 6.22 and Windows for Workgroups 3.11 – very similar to the machine reviewed in the first issue of *PC Pro*!

Computing historians may recall that the Pentium P60 was a dud – the 486 DX4-100 was faster – and, by the end of 1995, the same money would have bought a P75 or even a P90, a quad-speed CD-ROM drive, 16MB of RAM and, crucially, Windows 95.

However, none of that mattered as my brother and I set off down the runway of Chicago Meigs Field airport in a Cessna 172, scenery smoothly scrolling by in full colour. Nor did it matter as we shot down countless enemy aircraft and obliterated enemy airfields with cluster bombs launched from an F-117 Nighthawk.

The deficiencies of that PC manifested in the run-up to Christmas 1995. DID was about to release *EF2000* – we'd been staring at screenshots in *PC Zone* for the past six months. It seemed impossible that graphics like that were possible on a home PC and so it proved for ours – it fell a long way short of the minimum specs. Gutted doesn't even begin to cover it.

Taking to the skies

When I was growing up, the received wisdom was that it was tough to become a pilot, which I took to mean that I couldn't do it. Yet, somewhere along the line, self-belief emerged, and I decided to give it a go. I chose the A-levels I guessed would be helpful: maths, physics and computing.

A part-time job working in McDonald's began paying for all sorts



of PC upgrades, allowing us to continue making the most of the flight sim golden era that was the mid-to-late 90s. My brother bought Jane's F-15, which came with a manual that detailed pretty much every non-classified thing about that aircraft. If you wanted to play, you had to read and digest – I could never bring myself to put in the effort. Being honest, we were now more interested in Quake and Half-Life than simulation.

At 17, I flirted with the idea of joining the RAF. It was an exciting time for prospective pilots as the long-delayed Typhoon (formerly Eurofighter) was due to enter service at any moment. To cut a long story short, life took a different route, and in the January after A-level results, I ended up moving to the US for 14 months to train for my airline pilot's licence. It was a fantastic time – a real case of work hard, play hard.

Flying in the US has a sense of space and freedom that doesn't exist in the UK. Cruising around the Michigan skies on a summer evening, sometimes in convoy with friends, is something I'll always treasure.

Those 14 months passed in a blur of study, exams, flying, tests and road trips. Before long, we were back in the UK for the final hurdle of getting a professional licence: the Instrument Rating (IR).

What you soon realise is that each test is nothing more than a ticket to move on to the next stage. Even once you're "fully qualified" and working as a first officer (or co-pilot) with an airline, every day is a school day. There's only so much that books can teach, and I am hugely indebted to the many older and wiser colleagues whose patience, grace and good humour guided my development.

Magnificent flying sims

So two decades on, does PC simulation have a place in my life? As you might guess, it doesn't occupy the same spot in my affections that it once did. That's not to say it has no place at all – I do have several options to play with, and still enjoy a few minutes of hooning around in a fast jet at low level, imagining the road not taken.

Can PC simulation aid in actual flight training? To a certain degree, yes, and certain groups have been taking this option more seriously in recent times. Anything that you learn in a flying lesson can be practised on a PC simulator, which is good from a consolidation perspective.

Using a PC-based simulator to instruct students on new skills has its



challenges, but it has definite value. With book learning at one end of the scale and actual flying at the other, "simming" can provide a middle ground where concepts, such as the importance of altimeter settings, can be brought to life. Flight training is an expensive business, so if basic concepts have been squared away by the time you climb into the aircraft, you'll get more value for money.

Where I've found it handy is before a conversion course from one jet type to another. Conversion courses are intense and don't have much room for delays, so the more prepared you are, the better. Some of the aircraft expansion packs on the market offer enough detail to learn panel layouts, scan flows, and even give you a feel for how various failure modes work. These things are not "certified" from a regulatory standpoint – for that you'd have to add a zero to the price tag – but as pre-course homework, they certainly don't hurt.

It is possible to add another layer of realism using the Virtual Air Traffic Simulation (VATSIM) network. This

ABOVE Sims such as *Prepar3D* can help pilots get to grips with new aircraft

"Even once you're working as a first officer with an airline, every day is a school day"

BELOW From the moment I set eyes on TFX – and its manual – I had to have it



allows simulator pilots to speak to real people acting as air traffic control. They operate as close as possible to real-world procedures, and there's a good deal of professionalism in the whole setup. In fact, some of the VATSIM controllers are real-world air traffic controllers.

Looking back, I'm convinced that the mucking about with aircraft from our living room was pivotal in selecting my career path, even if you couldn't map that at the time. I suspect that this is not a unique story, either. It's been exciting to watch my godson have a similar experience. His father is a private pilot, which has had a tremendous influence, but he has been playing with various flight simulators from a young age. In the last 18 months, gliding has become a passion for him, with powered flight on the horizon as soon as age allows.

I would say to anyone who fancies getting a private pilot's licence but can't afford it that PC simulation gets you so much closer than you'd imagine. Sure, it's not exactly the same – of course it isn't – but the spirit is there. For my money, the joy of taking a light aircraft somewhere picturesque, setting the time to sunset and noodling around the sky, even if it's only for 15 minutes, is still immense.

As for the new version of Microsoft Flight Simulator... gobsmacking (see Gavin's review on p42). Suspending disbelief scarcely seems like a requirement. Popular Computing Weekly would be impressed. And will I be playing it? You bet.

gavinhallphoto@outlook.com

DAVEY WINDER

“Ransomware actors have become some of the most technically adept in the cybercrime industry”

What happens after a business gets hit by ransomware? Davey provides a glimpse into the machinations that go on behind the scenes

Cast your mind back to the end of July when the world stopped for people who not only like to run but have an almost obsessive need to record details of every last step. Garmin, the technology titan when it comes to smartwatch GPS for runners, suffered a multi-day service outage. The outage, as many of us within the infosec community suspected, was actually a ransomware attack. It took Garmin four days to almost admit as much. I say “almost” because the nearest it came to uttering the “R” word at the time was to say that it had been the victim of a “cyberattack that encrypted some of our systems”.

This didn’t surprise me. It’s an approach I’ve seen over and over from businesses big and small, unwilling to admit to having been caught napping by ransomware actors. It’s not the most embarrassing confession to make these days: ransomware actors have become some of the most technically adept and successful in the cybercrime industry. But rather than holding Garmin’s feet over the fire, I thought it might be helpful to devote this column to how the response to a ransomware attack plays out in the real world. This comes about partly because of what Garmin was and wasn’t saying at the time, and partly due to mainly disappointing reporting that left a lot to the imagination of the reader.

According to a Sky News report at the time, an anonymous source with knowledge of the incident said that Garmin obtained the decryption key to the WastedLocker ransomware attack that took services offline. Garmin “did not directly make a payment to the hackers,” the source told Sky News. The Garmin press release also said the company had “immediately began to assess the nature of the attack and started remediation”.



Davey is a journalist and consultant specialising in privacy and security issues

@happygeek

BELOW Some gangs are now so big they have made the FBI most wanted list

When I pressed Garmin on whether it had paid the ransom or not, I was told that there was “no further comment on any additional details” beyond what was in the press releases. So what does that all mean? As I’ve said, this column isn’t about Garmin *per se*, but these statements confuse rather than clarify incident response. Transparency is key when it comes to any cybersecurity incident because it helps everyone understand how to do better when the sticky stuff hits the fan.

A new and profitable ransomware threat

For a moment, though, let’s look at Garmin. It was reported by Bleeping Computer that WastedLocker was the ransomware concerned long before Garmin admitted the “encrypting cyberattack” detail. Bleeping Computer had inside information from anonymous sources, but sources who supplied what appeared to be quite clear images of encrypted Garmin files with the WastedLocker path on view.

WastedLocker is a new addition to the ransomware map, although the threat actors behind it are known to

have been active since 2007. Evil Corp, a Russia-based cybercriminal group, was perhaps most infamous for its use of the highly successful Dridex malware. So successful were Evil Corp, with Dridex reported to have stolen at least \$100 million, that the US Department of the Treasury’s Office of Foreign Assets Control imposed sanctions against it in December 2019.

Those sanctions mean that it’s generally prohibited for US citizens to engage in financial transactions with Evil Corp. They also state that “foreign persons may be subject to secondary sanctions for knowingly facilitating a significant transaction or transactions with these designated persons”. Garmin had been reported as being held to ransom for the sum of \$10 million, which I’d describe as a significant transaction, if it turns out a ransom was paid. So it’s understandable that any company in such a situation wouldn’t shout from the rooftops that it had paid up for a decryption key. Which is where I’ll stop the Garmin references and start talking about the generalisations of ransomware incident response.

Forget about an ideal world

Anyone who understands anything at all about how ransomware negotiations work, especially at the large enterprise level, knows better than to say a \$10 million ransom is the beginning and end of the story. Sadly, way too many commentators don’t have a clue and assume that a ransom is set in stone: the clock starts ticking, the victim pays up or loses everything.

That really isn’t how it works, and hasn’t been ever since criminal gangs got serious about the kind of money they could make from the ransomware threat by targeting bigger businesses instead of randomly spraying malware and praying enough people would cough up one-tenth of a Bitcoin.

In an ideal world, business disaster recovery strategies would swing into action. Incident response plans would be well rehearsed, networks shut down, the source and spread of the threat located and nullified, data restored to clean machines and the whole system restarted after testing. Yes, that could well put any organisation out of action for a day or two, and



WANTED BY THE FBI

MAKSIM VIKTOROVICH YAKUBETS

Conspiracy; Conspiracy to Commit Fraud; Wire Fraud; Bank Fraud; Intentional Damage to a Computer

DESCRIPTION

Aliases: Maksim Yakubets, "AQUA"
Date(s) of Birth: Used: May 20, 1987
Hair: Brown
Height: Approximately 5'10"
Sex: Male
Citizenship: Russian

Place of Birth: Ukraine
Eyes: Brown
Weight: Approximately 170 pounds
Race: White

RWARD

The United States Department of State's Transnational Organized Crime Rewards Program is offering a reward of up to \$5 million for information leading to the arrest and/or conviction of Maksim Viktorovich Yakubets.

hit the bottom line hard. Some firms might either discover that they can't do this, or the cost of doing so far exceeds what the perpetrators are demanding by way of ransom.

If a call is made to pay the ransom, the negotiations begin. Not directly between the organisation itself and the likes of Evil Corp, but rather through the services of a specialist incident response team that will handle the remediation from the point of contacting the ransomware gang through to the restoration of data.

This involves many steps, including the initial one of how much money it will take for a decryption key to be released. Traditionally, the ransom demanded has been a starting point and, with most enterprises having data backups anyway, will drop down to a figure that fits that "less than doing it ourselves" option.

Evil Corp's evil twin

That all changed when the likes of Evil Corp's BitPaymer ransomware evolved into DoppelPaymer and exfiltrated data as part of the attack. This exfiltrated data could then be used as leverage in the payment negotiation. The ransom then included return of the stolen data, with non-payment meaning it would be sold off on the dark web or exposed in public in a piecemeal fashion. It's obviously not a good day for any business to see its data published or sold, but the cybercriminals are smart and know that if they have data involving third parties, those in the supply chain, the stakes go up exponentially.

A good example here concerns the DoppelPaymer ransomware, when it hit a company called Visser Precision based in Colorado at the start of the year. A precision parts manufacturer that supplies the automotive, aeronautics and aerospace industries, its customers included Lockheed Martin, SpaceX and Tesla. To press for payment, the DoppelPaymer gang published non-disclosure agreement documents related to SpaceX and Tesla with a warning that there would be other data to come.

The REvil ransomware group has taken this kind of holding stolen data hostage to a new level, at least as far as monetisation is concerned. When a New York law firm was hit by the Sodinokibi ransomware threat from REvil, the exfiltrated data appeared to contain documents pertaining to all sorts of celebrities and politicians. Naturally, REvil started twisting the

leverage knife pretty quickly and deeply. Unless a ransom of \$42 million was paid, it said it would start leaking "dirty laundry" data on President Trump.

REvil has quite the reputation in the ransomware world, what with the devastating attack against Travelex at the end of 2019. That reputation wasn't helped when the law firm called its bluff and the first batch of Trump data turned out to be more of a damp squid (for all you *The IT Crowd* fans) than dirty laundry. Having seen the data myself, it looks like all they did was **grep** for **trump*** in any context, and so people talking about

being trumped, or mentioning a Trump hotel, were included.

Nothing relating to Trump himself, though. REvil then started an auction site, hosted on the dark web, to sell off data from the likes of Madonna, Lady Gaga, Bruce Springsteen and more. So, as you can see, the ransomware threat is always evolving.

No data exfiltration doesn't mean no problem

However, WastedLocker isn't known to have developed a data exfiltration capacity, and is thought to remain a reasonably simple "encrypt and extort" threat. Which makes ransom negotiations more straightforward, and hence is the reason why it's unlikely Garmin, if it did indeed pay, or anyone else for that matter, would hand over the full amount demanded.

The incident response team negotiators would contact the

For more ransomware advice from Davey, turn to p104

TRUMP



ABOVE REvil's dirty laundry was merely a search for the word "trump" in all contexts

"When it comes to ransomware the dance played out is more capoeira than tango"

BELOW Auctions have become the norm for ransomware operators like REvil

| Grubman pack - Lebron James | | | |
|--|-----------|--------------|-------------|
| 0.6Gb of Lebron James legal documents. | | | |
| Minimum deposit: | \$60,000 | Top bid: | - |
| Start price: | \$600,000 | Blitz price: | \$1,500,000 |
| Opened Time left: 5 days, 20 hours, 31 minutes and 39 seconds | | | |
| Grubman pack - Mariah Carey | | | |
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| Opened Time left: 5 days, 20 hours, 31 minutes and 45 seconds | | | |

cybercriminals behind the attack, using the channels opened up by the gang for ransom payment to start negotiating the price down.

WastedLocker negotiations are a grey area, what with those US Treasury sanctions against Evil Corp, and many incident response teams refuse to take on any such contracts for that very reason. Any negotiation is a two-way street, and when it comes to ransomware the dance played out is more capoeira than tango.

The ransomware gang has the advantage of time. With the clock ticking, and the potential destruction of data timer counting down, they rely upon those pressures to work in their favour. The fact that a ransomware negotiator is even involved, however, is the ace up the sleeve of the victim. The cybercriminals know that they aren't being strung along, and provided they can agree a "fair" price then monies, or cryptocurrencies to be precise, will be exchanged at the end of the day.

You might think, then, that once a price is agreed, the ransom paid and a decrypter key provided, that would be the end of the affair. But no, far from it. Firstly, surprising as it sounds, reputation is an important thing for ransomware gangs operating at the larger end of the criminal spectrum. They know that if someone pays a ransom and then the decryption key isn't provided, exfiltrated data is sold on anyway or the key doesn't work, word will soon spread and further extortion becomes more difficult. This is precisely the reason why so many have, I kid you not, customer service operations that provide technical support for their clients. And that's

Continued from previous page

actually what they refer to their victims as. Relying upon such help is one thing if you're an individual or small business, but quite another for a large enterprise with complex networks and highly sensitive data.

Which is where the incident response teams tend to bring in another third party on contract. This time it's a company, and there are only a very small handful that can efficiently and effectively extract the decryption key from the relatively unreliable decryption tool provided. By extracting the key and then incorporating it into a custom-built decrypter tool, the process of restoring networks and data can be undertaken forensically and safely. Evidence can be preserved, data protected and logs kept.

Many organisations may not be 100% transparent about their dealings with such negotiations, but they want total visibility when it comes to this stage of the remediation process. Following the successful decrypting of data and, after thorough testing (including being sure there are no further malware nasties left behind by the attackers), the network can be made available again.

To pay or not to pay, that is the question

So that leaves me to answer the, erm, \$10 million question: would I recommend paying the ransom? My simple answer: nope.

Would I make that same recommendation under any circumstances? Nope again.

While paying ransoms of any sort, across any illegal sphere of life, only serves to further encourage that criminal activity, it's not a clear-cut decision one way or the other. If there are not working backups, if sensitive data has been stolen, if the option is between going out of business and doing business with a scumbag then the latter is likely to win out.

In which case, you'd better be prepared for the old adage of no honour among thieves: make sure you factor in the expense of a specialist incident response team with expertise in the ransomware negotiation field.

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STEVE CASSIDY

"Having developers assume that everything ought to be open is an altogether new cause for distrust"

Steve reveals one big takeaway from a global security briefing, explains why you need to be wary of Discord and solves two VM problems

I don't think I'm cut out for the cybersecurity industry. If you put me in a security presentation, I'll be squirming in my seat, biting my lip, desperate to ask some questions and jump the rail tracks of death by PowerPoint. The security business loves to list things: this turns what could be punchy, short, relevant bursts of information into agonisingly detailed lists of malware names and the "krew" behind each one.

Is it of practical interest to know all those names when they're all made up in the ephemeral world of online chatrooms and forums? Not when the headline that drew me to this particular talk was "nation-state cyberattacks". FireEye makes security hardware and software, so of course it wants you to feel under threat – but it's of no use to the small business operator to know the names of several hundred bits of malware.

What we really need to know is: which risks should we pay attention to first?

Based on the FireEye presentations, I don't think Mr Putin is after our VAT returns. This part of the speechifying was useful to me from my intolerant perspective because I instinctively



Steve is a consultant who specialises in networks, cloud and human resources

 @stardotpro

"What we really need to know is: which risks should we pay attention to first?"

BELOW The biggest factor in nation-state intrusions? A worker letting the baddies in

trust those who tell me not to worry about a threat that's grabbing headlines over those who tell me the sky is falling and action is required. Ransomware news is especially hard to turn to practical use, because the main defence is human, not technical

It was interesting to see the "market" of malware loosely divided by national stereotypes – it seems the Iranians, for example, want to deface websites, whereas the Chinese like trade and industrial secrets. Once again, however, I found myself wondering just what was useful to me or you in this kind of observation, when the very first slide on the matter of nation-state intrusion says that human-factor penetrations are the main method of entry. Translated from security speak: someone in the company (or government department) lets the bad guys in. No need to try and make head or tail of each security product's endless feature-comparison tables: it turns out that having a good cathartic rant at the sales pool is probably more effective.

Discord and online chat

It's no good just grumping away about the online communications

The screenshot shows the FireEye Managed Defense landing page. At the top, there's a navigation bar with links for Products, Mandiant Solutions, Customers, Partners, Resources, Company, and a search icon. Below the navigation, a large section is titled "Managed Defense" with the subtext "Managed detection and response (MDR) service that leverages the full power of FireEye". There are two buttons: "VIEW DATASHEET" and "TAKE A TOUR". A circular icon with a hand holding a group of people is shown next to the text "Analyst Driven Detection". Below this, there's a bulleted list of features: "Amplify your team with expertise gained on the frontlines", "Leverage proven hunting methodologies that identify covert attacker behavior", and "Hunt frequently and systematically across your environment to reduce the risk of detection gaps". To the right, a laptop screen displays a complex, multi-panel monitoring interface with various data feeds and charts.

revolution the pandemic has brought upon us. Like most people, I was doing fine with a spread of Skype, Lifesize, WhatsApp, SMS messaging and even email. However, the social mood was very much against older products as the lockdown wore on and it's bad form not to have a solid product to recommend when people ask. And that's tricky if you're like me and inclined to find fault all around.

I was quite interested by Discord (discord.com), mostly due to earlier exposure to Slack at PC Pro HQ. Discord

looked to me to have a lot of the look and feel of Slack, with added audio and video and a handy way to either use public servers or set up your own Discord host. The interface is for gamers, which has its pros and cons, but the way that new users would grab the app and run with it was all the recommendation I needed. When people asked me for my solution to the flakiness of Zoom or the strange bait-and-switch duo of Skype versus Teams, I'd propose Discord.

That came to an abrupt halt in mid-July, when I had the creepy feeling that our household's stream of adverts on social media was starting to follow topics that we had only discussed verbally, not by typing. That's an eclectic selection this year: my partner has been down at Churchill's statue, which has provided her with many urban legends, new campaigns and even musical genres (from Somalia, in that case).

I know what you're thinking. There are probably more conspiracy theories about audio snooping in the home than there are about the Moon landing, and most rigorous tests of the common home speakers show that there's no correlation between advert output and conversation input. That doesn't cut much ice with a partner fresh back from defending a statue, so rather than have another lockdown disagreement, I went round the machines trying to figure out who or what might have been listening. And found that when you install Discord, it turns everything on. Absolutely everything. Put your headset down by the laptop and the microphone stays open.

This is, at the very least, bad form. Having developers assume that everything ought to be open is an altogether new cause for distrust. And, if you assume that the normal audio-process architecture involves



throwing the raw waveforms up to a cloud-based (and potentially very large) speech-recognition system, it's hardly surprising that turning all the voice stages off makes your home PC run better.

Are they really listening, though? Is it even possible that there are subjects with words so rarely spoken, and so incredibly dangerous, revealing or subversive, that a mass upload system like this might actually give the world's spies something of value? I strongly doubt it. If anyone really wants to listen, it's more likely to be a supermarket chain trying to sell washing-up liquid than some vast intelligence network.

Second-generation virtualisations

If there's one job well suited to lockdown, it's figuring out what to do with all your VMs. I don't mean those run in fleets of millions in cyberspace by corporations and hackers alike: I mean that mess of experimental XP images cluttering up your USB drives, or all the different Linux distros you once managed to pack into a RAID

ABOVE Discord has many plus points, but it's also listening at all times by default

"Windows really does do the best job of maintaining your portfolio of VMs"

BELLOW An attempt to upgrade my Linux laptops led to an Ubuntu snafu

array in an oversized workstation. The orphans, in other words.

It's not my job to stoke up platform wars arguments, but I have to be brutally honest here: Windows really does do the best job of maintaining your overall portfolio of VMs. You don't need to be using Hyper-V for the Desktop, either. Both VMware Workstation and VirtualBox have a better relationship with your VMs under Windows.

Two lockdown frustrations backed up my findings. One was a tad childish: I wanted to bump my Linux laptop fleet up to Ubuntu 20.04, which was released in the quietest period of the pandemic. I had paid a lot of attention to building my machines, and had taken the various advices on tweaking and tuning as found on the well laid-out web help resources such as Ask Ubuntu. In particular, the advice to set the temp folder to prevent the running of any executables deposited there by fair means, or foul, seemed wise to me, so I gingerly extended my command-line interface skills by setting that attribute. Which, it turns out, stops the Ubuntu 20.04 live updater from operating at all.

That's wholly understandable, because the only way to have a clickable downloadable updater is to let it loose on an area of disk that has open file create and run rights. The problem for Linux here is that TMP is a whole separate partition. In Windows, there are a few places where full access rights are given to downloaded resources; places such as Internet Explorer's



Temporary Internet Files folder, which can in some circumstances grow to completely fill your C drive, if you're not careful.

The Linux solution sizes the TMP partition for use as a TMP partition, not an alternative boot volume for OS updates. A more rationally driven design, of course, but driven into a frenzy by competing advice sources. Would you like the TMP file system to be proof against Linux infectors? Of course. Would you like the efficient, streamlined update install? Well, yes...

One client listened to my tale of woe and finally decided to take some advice I'd given him a couple of years ago. Once he had enough desktop VMs (over eight!), it would rapidly become annoying to run them on a fleet of ever larger, ever faster desktops. What he ought to do was buy a server-grade machine, fill it up with RAM and some decent SAS disks, and then consolidate the hodgepodge of VMs on to this new, fast server.

Initially sceptical, he saw the sense of the idea once a couple of update processes had proved a trifle difficult on one or two of his PCs. So I was both pleased and relieved when he announced he had a licence key for VMware ESXi 7 – and much less pleased to find that the robust and powerful server we'd selected, a Dell PowerEdge R610, was perfect in every way... except that VMware's installer stops at boot, informing the operator that the CPU found is incompatible and can't be used.

Except, it's not. Despite some prolonged embarrassment while trying to figure out what to Google for, the solution is as simple as adding one new parameter to the BOOT.CFG file on the ESXi installer USB key:

allowLegacyCPU=TRUE

This is fully described in appropriately cautious terms at pcpro.link/313vph.

There are plenty of reasons to honour the implied requirement in the setup procedure, as the sysops people point out. Whatever VMware has done inside the code of its hypervisor, you're quite likely to run into a situation where you'd like it to work as designed – but then the hack parameter was designed too, and could trigger all manner of other bits of code to behave

Where's Tony?

So come on Steve, last month you promised Tony Blair! Yes, I know I did – and I should have held my tongue until the whole show was over. I confess: not a single sound bite or memorable concept emerged from our former leader's lips in over an hour of speaking.

Even worse, a news agency had obviously put the online conference together, using some custom videoconferencing software to present their star commentator. This was fine, until it came time for questions. Then the format of the software started working against the journalists: we typed questions into a little text box about as big as the display on my last soap-bar Nokia phone from the 90s, to be raked over by the production team and then presented to the great man if they were found worthy. Most of them actually were because the audience was pretty much an assembly of A-list names in journalism: I liked Rory Cellan-Jones' question because it was all about 5G as a regulatory space and, therefore, at least close to a subject Mr Blair could address.

My question wasn't like that, and wasn't crafted to appeal to the kind of PR guys and news agency techies who supervise a delivery platform such as this. Normally, I actually do okay in Q&A sessions with the higher-end person because things such as tone of voice and a sense of timing

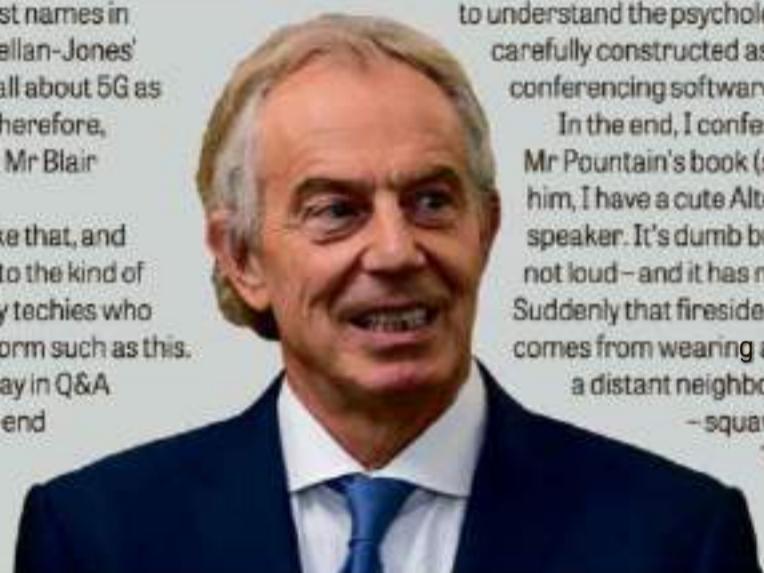
give you a big advantage over typing 200 characters into a crappy text box on a web page. The long and short of it was that my question wasn't answered.

So what did Tony have to say? The main takeaway is that, if working from home and videoconferencing are going to be the rule for the foreseeable future, make sure you exercise your right to disagree and complain. Videoconferencing has always been a rather curious medium, heavy on formality and opportunities for embarrassment: people get extra stiff and extra wary in front of a lens or a microphone. A lot of the mutual respect and interest that's plain in a crowded meeting room ceases to be apparent once the room is entirely virtual. Even when it's Tony Blair.

In making use of this technology as a substitute for a meeting room, a pub or a railway carriage, we need to understand the psychological impact that carefully constructed asymmetries in conferencing software imposes on you.

In the end, I confess, I took a leaf out of Mr Pountain's book (see issue 312, p8): like him, I have a cute Altec Lansing USB speaker. It's dumb but well made, clear but not loud – and it has no inbuilt microphone. Suddenly that fireside chat acoustic that comes from wearing a headset retreats into a distant neighbour listening to Radio 4 – squawks from a little box.

The psychology of conference calls cuts both ways.



differently, thereby avoiding crashes at the penalty of some performance.

Information on this kind of decision in the guts of the machine is hard to pin down. I can remember one of the Hyper-V architects, when presenting on best practice for desktop virtualisation, quietly suggesting that we should all try to get laptops or desktops with Intel Core CPUs in them because the concordance between Hyper-V code and the Core series was unusually beneficial. Personally, I never noticed that improvement on the dual-core and quad-core Core 2 CPUs of the preceding era, primarily because the arrival of solid-state drives made such comparisons both difficult and academic.

BELOW The VMware installer refused to budge until we added the new parameter

So, we instituted the legacy CPU bodge, being quite unable to see what specific small business-friendly feature of virtualisation it prohibits or crashes with, or what the threat might be. This left us figuring out how to convert the various VMs so that they're acceptable to the file systems and inventory management of the ESXi 7 server. On the bright side, even though it might seem to be a legacy CPU server, the dedicated hardware SAS RAID card and matched set of SAS drives from the refurb experts at **etb-tech.com** bring the performance of the first couple of moved VMs well up above the standard "enjoyed" on the desktop PCs formerly giving them room and board.

Which ought to have been enough for a month of apparent lockdown – were it not for the other customer whose accounting server ran out of a VM file system expansion room. A whole separate problem, apparently caused by keeping backups of backups while developers were working on the overall ecommerce system. A problem that, as is so often the case with smaller businesses, benefits not one whit from the fancy CPU changes implemented between ESXi 6.7 and 7: it's a basic, simple storage problem. If only all of them were like that!

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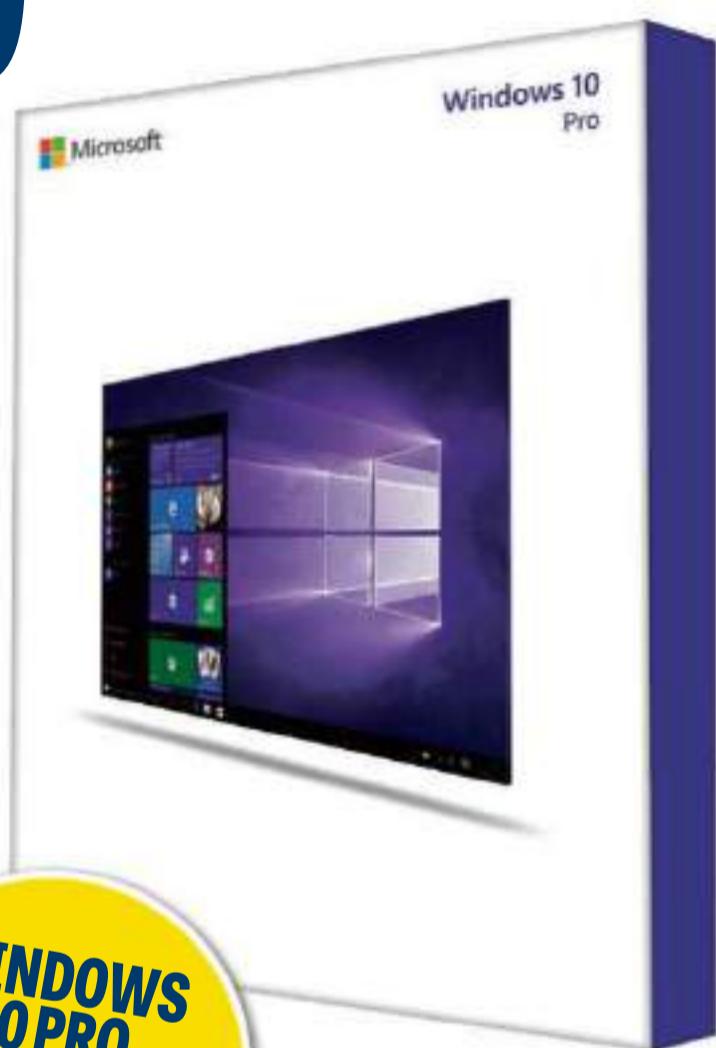
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Futures



We explore the trends and technologies that are set to shape the future

Why the future needs optical data centres

Researchers are leaping the hurdles holding back optical networks. Nicole Kobjie reveals the technical challenges they've overcome – and what that could mean for the future of data centres

Driverless cars, AI, automated everything – these future technologies all have one thing in common: they'll make and use huge amounts of data. And our current data centres may not be enough. "The industry is constantly innovating, but the challenge for some data centre providers is keeping up with the rate at which new technologies are emerging," said Rob Spamer, director of data centres at Pulsant.

That's particularly true with technologies such as neural networks, which are distributed across thousands of specialised processors that can churn through data 20 times that of a standard CPU. "Because they consumed so much more, they can communicate much more as well," explained Georgios Zervas, associate professor at University College London's department of electrical engineering. "You need networks that can sustain this growth."

Data centres have kept up with the growth in data because Moore's law has continued to hold: every couple of years, transmission speeds would double. That "law" is set to come to an end, which means we can no longer rely on faster chips to hold up network

speeds. There are different ways to address the data centre quandary: build more of them, tweak setups for efficiencies or manage data better using AI. But it's unlikely any of those ideas will be enough.

Researchers at UCL and Microsoft may have another solution: optical networks. That may not sound very futuristic, but while you may get your internet down a superfast optical line, most data centres still rely on electronic networking. That could be the significant change that brings data centres into the fast lane.

■ Unseen innovation

Before exploring optical networking, it's worth considering why data centres seem behind the curve of emerging tech. "The idea that data centre providers are slow to innovate probably comes down to the fact it can take time to implement new technologies to avoid disruption to services," said Spamer. "Ultimately, data centre providers strive to be at the forefront of innovation but must also plan carefully to maintain service-level agreements."

The last few years have seen serious innovation in data centres, notably

the use of telemetry to fine-tune systems. "Controlling conditions such as cooling, chilling and humidity inside data centres can be a significant challenge," Spamer said. "However, developments in telemetry are presenting data centres with the opportunity to automatically tune and control these elements, enabling optimal conditions for equipment consistently across all sites."

Another solution is building more capacity, and while this may not solve all of our data hoarding woes, it means new technologies can be introduced for specific requirements. "With demand for rack space constantly growing, capacity can be another common challenge, which is why some providers are building surplus server halls," Spamer said.

"As demand grows and technology evolves, those halls can be fitted out to serve customers' higher density requirements with the latest innovations instead of subjecting customers to the time and cost that goes into optimising existing data halls that have older technology. Building data centres in phases allows providers to follow this strategy," Spamer added.



BELOW Rob Spamer is the director of data centres at colocation provider Pulsant

EXTREME DATA CENTRES

Sunken treasure

Off the coast of Orkney, Microsoft sunk a moonshot into the sea as part of Project Natick, an effort to build sustainable, modular data centres. The shipping container-sized prototype was filled with 12 racks holding 864 servers, assembled in France before being shipped via lorry to Scotland, where it was towed out to sea with a barge. Before it was sunk, the cable holding the fibre optic and power wiring was hauled up from the seabed to be connected to the data centre and turned on – thankfully, it worked, and the data centre was sunk 117ft.

Why sink a data centre? For one, it's so cold down there cooling isn't needed, removing one of the biggest power drains and costs. Plus, it's the ultimate test for a black-box data centre system. "We know if we can put something in here and it survives, we are good for just about any place we want to go," said Ben Cutler, a project manager in the Special Projects Group, at the time.



Indeed, Spamer predicts that data centres will evolve into different types – some will remain massive where multiple partners hold data, others will become smaller, local operations. "These will essentially create a virtual bridge between centralised platforms and micro-edge locations such as base stations and masts.

"This is a trend that's likely to continue, so the whole data centre model will become less centralised, making way for a grid-like architecture, with more providers establishing sites across various locations," said Spamer.

In short, data centres are ripe for disruption – we just need the right tech to reboot how they operate.

Optical solution

Fully optical networks could be the solution, although there are real challenges to making it work – after all, if using faster networks was easy, they'd already be in place. At the moment, whenever a data centre needs more capacity, cloud providers and operators simply throw more electronic switches at their systems.

But with Moore's law fading and technologies such as neural networks

becoming ever more demanding, electronics can't keep up. "If we want to create machines that have the same number of neurons as our brains, we need hundreds of thousands of processors to interconnect between them so they appear as a single machine," UCL's Zervas explained. "Electronics can't do that, because they're power hungry, take a lot of space, and impose a lot of penalties. Every time you use a network based on electronic switching, you increase the latency."

Zervas and his colleagues believe optics can change all of this, but there are three main challenges. First, we'll need a fast enough optical switch, as taking too long to process small data packets will negate any of the gains from going optical. Second, clocks need to be synchronised. And third, the network needs to be better managed, rather than just sending packets out and telling them to find their way as the internet works.

To begin, an optical switch needs to be superfast. Zervas says that a 125-byte data packet on a 100Gbits/sec comms link – which is what data centres tend to operate at – would take ten nanoseconds. "A switch needs to react in less than a nanosecond so the overhead is just 10%," he said.

That's already on the way. Researchers Chris Parsonson, Zak Shabka and Thomas Gerard at UCL have demonstrated one technique of switching as fast as half a nanosecond, an order of magnitude faster than had been done before, suggesting optical switches are on the way, though more work is needed. "The other key optical switching challenge is to design and prototype large-port-count (128 to 256 ports) switches that allow for a single server to communicate with as many others as possible yet at the speed I described above," said Zervas.

The second challenge is clocks. "Current electronic switched networks are formed of switches with optical links and transceivers (transmitters and receivers) between them," Zervas said. "Two transceivers on either side of the optical fibre link are in continuous communication and so their clocks can be easily synchronised so the data can be correctly recovered."

Taking advantage of a fully optical network means having multiple transmitters talking to a single receiver. "What happens when you have two transmitters communicating to one receiver, but in the middle you have an optical switch... each has slightly different clocks in terms of frequency and in terms of phase," Zervas explained.

There are a few ways to solve this problem. "One of the approaches we

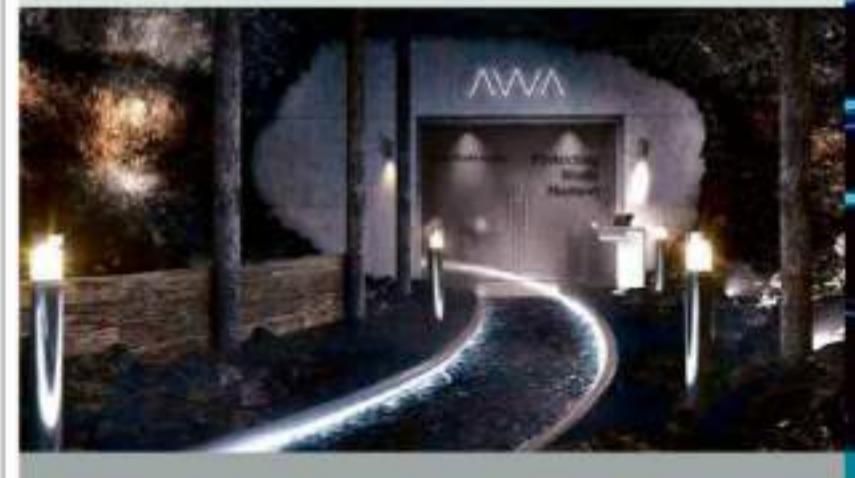
EXTREME DATA CENTRES

Svalbard's "doomsday vault"

Tucked away in a disused mine on Svalbard, a Norwegian island famous for polar bears, the Arctic World Archive began in 1984 to hold seeds as a backup against extinction in case of disaster – it now contains 1.5 million samples. In 2017, it started archiving data, thanks to a Norwegian company called Piql. Key documents, books and more are held on film in specialised boxes designed to last for a millennium, and stored below freezing at a deep enough level to not be impacted by a nuclear weapon.

The data is held offline on film, so no electricity or human intervention is needed, the company says. Have something important you'd like saved? The archive accepts contributions that are globally significant, as well as files that are important to your company or even just yourself – just fill out the form at the website and they'll get in touch with a storage option for five years through to forever.

"We like to think of the Arctic World Archive as a way to ensure we never lose items of historical and cultural value – we help the world remember," Piql's MD Rune Bjerkestrand said at the last deposit event, which included contributions from the Brazilian Museum of the Person and the European Space Agency.



used with Microsoft Research was to have one centralised clock that you broadcast to all servers... so they all have the same frequency," he said. To address the phase differences, the receiver can tell transmitters which phase to operate at. "So when you arrive at my receiver, the data is going to be in phase."

"The whole data centre model will make way for a grid-like architecture, with more providers establishing sites"

BELOW Dr Zhixin Liu is lecturer in optical communications and networks at UCL



That does take time, but UCL researchers Zhixin Liu and Kari Clark managed it at fewer than 600 picoseconds, which is a 6% overhead. "It doesn't slow you down," he added.

The third challenge is controlling the network. Zervas compares sending packets over the internet to driving without a GPS; you follow the road signs. "You start, but you don't know exactly which route until you see the sign," he said. That's fine for the internet, where a buffering video or missing pixel can be tolerated, but data centres require a guaranteed service – so such a network needs GPS. "It calculates your path but it also guarantees a space on the road, irrespective of traffic," he said. So far, that's been done with software, but that takes microseconds or



EXTREME DATA CENTRES

To the OrbitsEdge

Where we're going, we'll need data: as humans continue their push into space, it's clear we'll need communications and data storage to come with us. To help, Florida company OrbitEdge is creating mini data centres in orbit. The company uses standard servers – Hewlett Packard Enterprise EL-8000s – but bolts them onto satellite frames, powering them via solar panels. The system can gather up data from other satellites and then process it without sending it back to Earth, which is helpful for those up in space but also for those on the ground who want faster satellite photos.

"Unlike the satellites in orbit today, they will feature processing speeds that are competitive with what is available on Earth," the company explained in a blog post. "The EL-8000s will provide 1,000 times more computing power than current space-grade systems. Most satellites have 'radiation-hardened processors' but their processing capabilities are similar to a 2000-era flip phone." The company expects to launch in late 2021, with stress tests within the next few months.



ABOVE It will be one small step for an HP server, one giant leap for serverkind

milliseconds to compute one request. This needs to be done faster.

To solve this challenge, Zervas and his colleagues developed a custom processor that acts as a network scheduler. "We're able to make decisions in nanoseconds," he said. "This is fundamental because the demands are unpredictable in data – you don't know when a Google search is going to take place – so the dynamics change all the time... and the network can reconfigure itself extremely fast."

Distributed data centres

With some solutions in place, the race is on, said Zervas. He predicts such technologies will begin to show up in data centres in five to seven years, as cloud operators realise they can't just throw more electronic switches at their problems, but also as it becomes clear that new technologies such as AI and neural networks require different sorts of data centres.

Optical networking means that storage need not be located in close proximity to processing, letting data centres become more modular, flexible and distributed, an idea called "disaggregated data centres". "When you operate on the speed of light... you can create new applications and computing systems that you couldn't imagine before," Zervas said.

That means data centres can be more efficiently used but also combined into massive distributed

systems for demanding neural networks. "Currently many of distributed parallel computing tasks are contained in a small number of machines or could have substantial performance degradation due to electronic switched networks," Zervas said. "Optical networks could be used to form large scale distributed learning. For example, machine learning models can be trained across 100,000 or one million nodes." That's simply not possible now.

Green benefits

Capacity and capability aren't the only challenges facing data centres. They're also energy hogs. "Data centre storage is extremely power hungry," said Zervas. "They consume an equal amount of power as the whole of the UK, and the projection is that by 2030 they will consume 15% of global electricity."

As the demand for data goes up, so too does the demand for power – and that puts data centre operators on the front line of the battle for energy efficiency. "Data centres are power intensive and the industry does recognise this," said Spamer.

Apple and Google have focused on encouraging renewable energy sources, helping to push the industry to greener techniques such as locating data centres in colder climates to reduce cooling demands. "Continual investment is going into reducing carbon emissions, from buying

energy from green suppliers, adapting existing data centres with the latest cooling technologies, to ensuring new data centres are fitted with the most energy-efficient solutions," said Spamer.

But switching to optical could reduce energy demands. If data centres become more modular, unused sections can be powered down to save energy. Plus, optics are completely passive, meaning they don't need electricity to power them and don't require expensive and wasteful cooling. "Optics can make these problems more manageable than just taking data centres to Nordic countries," said Zervas.

Exactly how data centre and cloud operators decide to address these challenges remains to be seen, and Zervas said it will

likely be more of a business decision than a technology question. "The overarching mission for optical networks is to deliver simple systems that can reduce complexity, cost, power yet offer substantially better performance in latency, throughput and flexibility and all these at scale," he said.

"We might first see optics deployed in a subset of a data centres, between clusters or between racks of a cluster rather than a fully transparent optical network across all servers," said Zervas. "This will depend on the pressure from new types of workloads [such as machine learning and artificial intelligence] and the cloud providers' strategy on innovation." While questions remain, solving some of these hurdles could well signal an optical future for data centres.

BELOW Kari Clark is a PhD student at the Optical Networks Group at UCL



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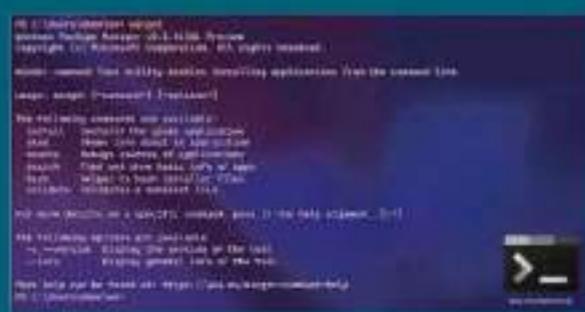


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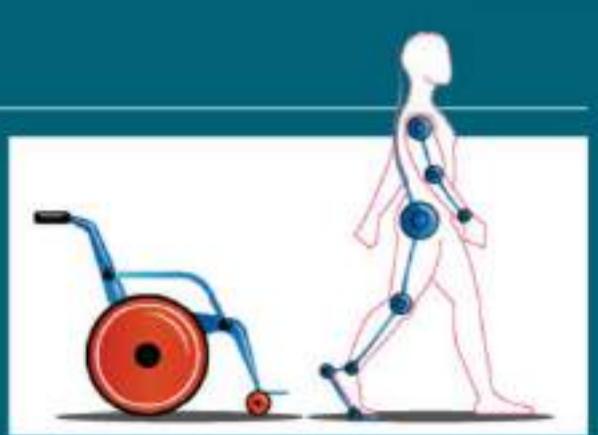
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It was the sort of plaintive phone call that makes your heart sink, although perhaps my own fault; after all, I did inadvertently advertise my tech-fixing services in last month's column (see issue 312, p130). I'll rename this distraught caller, a good friend from my village, Mary. Her laptop, an aged ThinkPad, was "going very slowly and I can't get any work done".

Mary's employer, a utilities company, had decided that working from home was the best thing to do during The Great Unpleasantness. So Mary had rearranged the lounge in her house to ensure that she had a good table, a view out onto the road, good lighting and a proper chair. After all, she would be sitting there for most of the working day, so there was little point in crippling herself with bad ergonomics and an unhelpful working space. But it was all for nothing if her computer didn't work.

A few minutes later, she arrived at our front door clutching said ThinkPad. The first thing you need to do, when attempting to diagnose any significant computer problem, is to make a pot of strong tea. And dig out some chocolate biscuits, along with some slightly more diabetic-friendly plain ones for me.

Starting up the laptop turned into a long, dark searching of the soul as the hard disk audibly ground away. It took five minutes to get to the Windows login screen and then another three to fight its way to the desktop. That's if it even got that far: almost every time, there was a kernel panic, the process ground to a halt and the machine rebooted.

Clearly, something was amiss. I did manage to get to a workable desktop, using Windows 10 Safe Mode, to see that nothing seemed completely horrible, and Mary reassured me that Windows Defender was up to date, that Windows 10 was fully patched and that all the data on the hard disk was properly backed up. I could have hugged her, because it's usually around that point when the lower lip starts to tremble and a pleading look appears in the eye that says "oh, and there are irreplaceable photos of my granny/PhD thesis/last year's accounts on there and I haven't got a backup".

We'll gloss over the multiple antivirus installations, which were probably installed in a fit of overprotective worrying. Clearing out the

Bring your own device has snuck in through the back door, and **Jon Honeyball** thinks it's time to get tough

spare packages helped a little with the boot time but was no panacea. I was intrigued to find a whole Citrix client installation – it seemed that her employers had an installable package that allowed staff to connect to the office servers and run the line of business apps.

We got to the end of the teapot, and it was clear, after about 90 minutes of fiddling, that no quick fixes were going to work. It was time for the machine to be blown away and reinstalled from scratch. Once this was done, it sprung back into life and all was well.

It got me thinking, though. While I can accept that we live in exceptional times, there needs to be a long hard conversation about the whole BYOD philosophy – too often, bring your own device turns into bring your own disaster. At least Mary's employers had managed to get VPN tunnelling set up, complete with two-factor authentication, and a method of remoting apps onto the laptop. Full marks for this. I wonder just how many other firms have had such foresight, and how many were left scrabbling around, wailing that "all our apps are in a web browser" whilst attempting to get VPN tunnels available for staff.

I don't mind BYOD, providing it's properly managed and implemented, but we shouldn't allow the pandemic to reset expectations. Although I understand the desire for a business to not supply laptops when they've already invested in desktops, there needs to be a discussion at board level about the sort of IT

infrastructure needed moving forward. Laptops should be *de rigueur* now (see Barry Collins' column on p22 for a different view – Ed), along with appropriate larger desktop monitors, keyboards and mice. And companies need to think about the requirements for asking staff to use their home broadband for business on a daily basis.

This shouldn't be hard or radical, but a company with entrenched and backward-thinking IT processes needs to wake up to the new world order. This is an ideal time for directors to carefully assess what they need from staff who are working from home, and what impositions it's appropriate to apply. The new world order is not an excuse to save money by pushing burdens onto staff, even if they aren't paying thousands a year for train tickets. This is a hard discussion to have within the management of a company and with its IT teams, but it's long overdue.

"A company with backward-thinking IT processes needs to wake up to the new world order"

■ **Jon Honeyball** is a contributing editor of PC Pro and a firm believer in bringing your own doughnuts. Email jon@jonhoneyball.com



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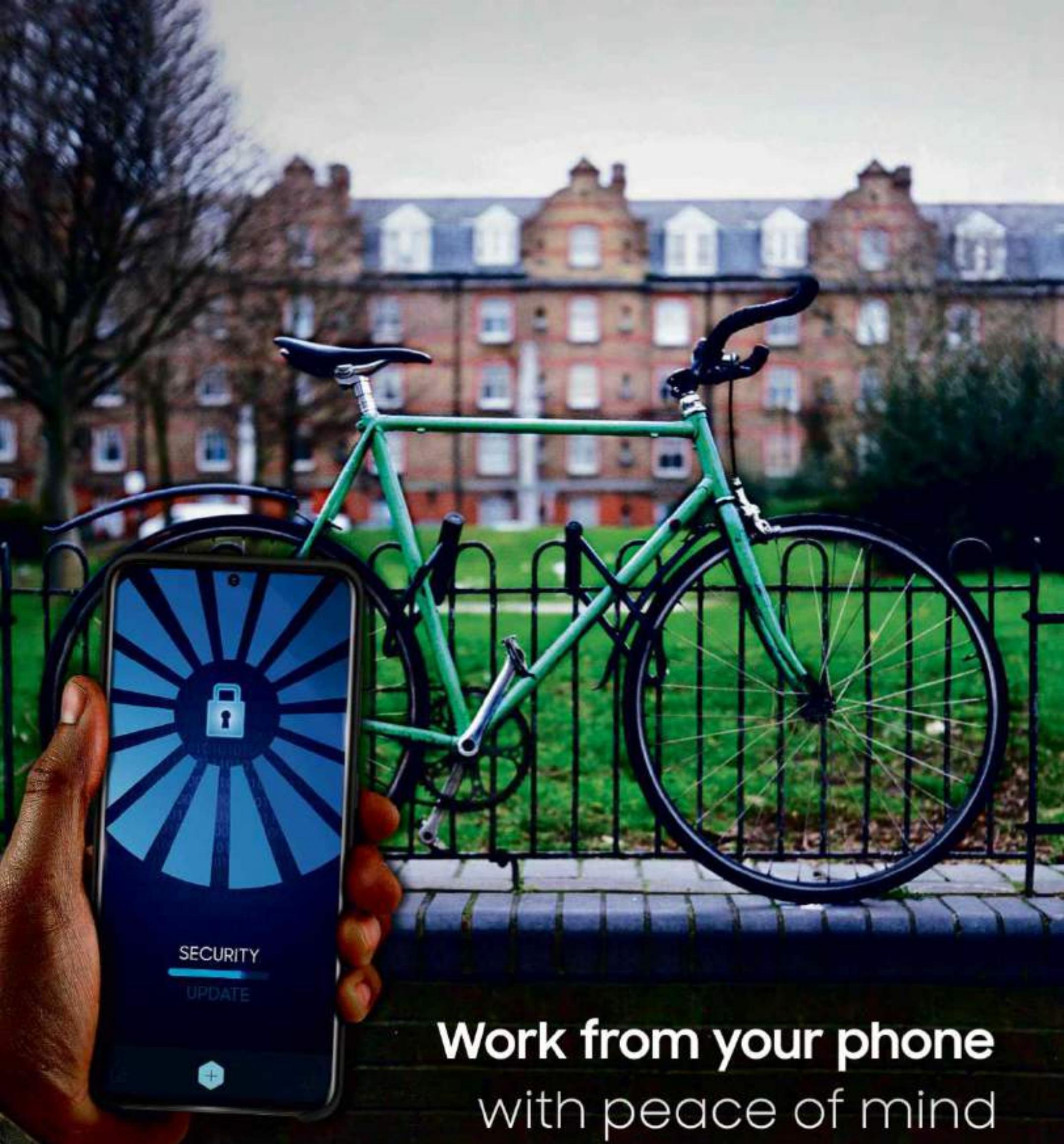
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