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99 things you need to know p44

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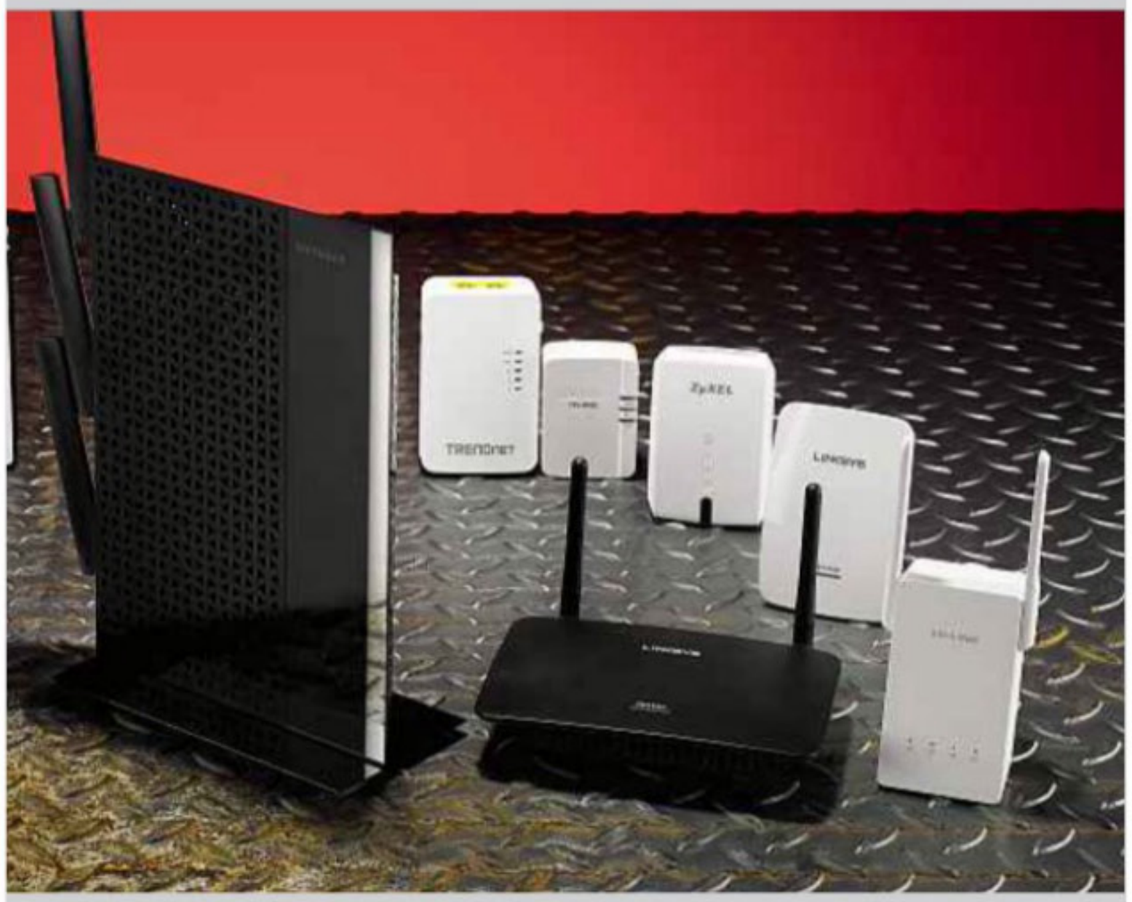
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Vote in the UK's biggest technology awards and win a drone. See p67

Editor's letter

SLEEPLESS NIGHTS. Constant worry. The feeling that you're jumping into the unknown. But also, the knowledge it will all be worth it, because your creation will be something unique – and so full of vibrant new life that you'll want to show it off on your mobile phone all the time.

Fear not, Facebook friends: a new baby isn't on the way. At least, not something pink and gurgling with an ironic approach to sleeping patterns. This baby is our new website, and its chief similarity to a real baby is that, like every proud father, I love it to bits.

The site is called Alphr, and you can check it out right now at **alphr.com**. It's a new name to reflect a new remit: Alphr celebrates the cutting-edge technologies, people and businesses changing our lives. Across an upbeat mix of features, reviews and blogs, you'll recognise many familiar faces from *PC Pro* on the site, along with new voices and guest contributors.

The magazine you hold in your hands isn't going anywhere, of course. For more than 20 years, *PC Pro* has proudly brought you the best in expert advice and insight from our Real World Computing team, and we'll continue to do so. Almost 700 of you took part in our recent reader survey, so we know how much you care about what we do – and what you want from us for the future.

All the same, flick through this month's issue and it's clear that we live in changing times. Alongside familiar-looking laptops and home-networking hardware you'll find exciting new wearable devices, and explosive emerging technologies from virtual reality (*see p58*) to 3D-printed houses (*see p126*). It's only Windows 10 (*see p44*) that maintains a connection back to 1994, when this magazine was itself a spanking new baby.

And honestly, I wonder how much we'll be talking about Windows in the future. There's no doubt that Microsoft is deeply proud of its newest offspring, and it has much to be proud about. It seems to have finally worked out a way to usher people between tablet and PC mode without making them want to scream. There's great thinking on show from Microsoft's engineers, too: they've recognised that we're entering a new era of computing, in which systems and services are built around people rather than devices.

But no amount of great thinking can disguise the truth about Windows 10, which is that it isn't really new at all. Over the years, Windows has grown into a Frankenstein's monster of a system, with bolt-ons to please all those different factions who have become used to certain ways of doing things. Is it the right platform for the connected technologies we'll be using next year, and in five years? The future is wide open.

In other words, it's a time that favours the brave – a time to experiment. That's Alphr's mission, and I couldn't be more excited about it.

Meanwhile, *PC Pro* will be taking on a higher profile too. You'll see us at more live events later this year, starting on Wednesday 8 July at Collaboration & Communication 2015 – a professional event showcasing how today's amazing communication technologies can improve your business, with futurologist Peter Cochrane OBE as the star of the show. Sign up at **collaborate2015.co.uk** – I look forward to seeing you there!

Tim Danton
Editor-in-chief

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Jack Schofield As former computer editor of *The Guardian*, Jack has seen it all before. So why does he think that virtual reality could be a success this time around? See **p58.**



Ian Betteridge Head to **p68** to discover why the editorial director of Alphr has become so attached to his Apple Watch in such a short space of time. But it's not for everyone...



Eileen Brown Imagine this: you're in the middle of a presentation about social media, and direct people to your own site only to find that it's been hacked. See **p116**.



Bruce Bell Fancy living in a 3D-printed house? It's no futuristic fantasy: it's already happening in the UK. Read our fascinating interview with the Facit Homes MD on **p126**.

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What have you backed on Kickstarter?

"I pre-ordered the Swimmo smartwatch. Whether I'll still be regularly swimming in October, when it's supposed to arrive, remains to be seen."

"The Egloo tea-light heater, as mentioned in my column (*see p25*). It nearly went up in flames, which certainly helped warm the room."

"I backed the Pebble Time Steel smartwatch. Then I spotted the massive bezel and promptly cancelled my pledge."

"I was horribly tempted by the Ouya Android console. I'm glad I didn't waste my money."

"I backed the ARKYD space telescope. It will not only search out asteroids to mine, but also let you display a selfie in outer space!"

"The child in me wanted to back the 3Doodler 3D-printing pen – it looked VERY cool!"

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Briefing

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An end to geoblocking?
Access your services across Europe with the single digital market p12

The web we want
Internet experts call for net neutrality and openness p14

PC Probe
Are Google's algorithm tweaks hurting innocent sites? p16

The future according to Google: Android M, Brillo and more

Google I/O played host to announcements on the next version of Android, Project Brillo for smart devices, and other plans for the future. Nicole Kobie reveals what it means for you



GOOGLE HAS LAID bare its plans for Android, smart homes and wearables at its annual developer conference, Google I/O, announcing extensions to its Now smart assistant, an OS for the Internet of Things, and updates to Android Wear.

Head of Android, Chrome and Apps Sundar Pichai revealed that a billion people now actively use Android. While that usage is predominantly on phones, Google has plans to extend Android into our homes, onto our wrists and beyond.

"Google I/O underlined the company's ecosystem advantage by virtue of the Android installed base, user knowledge, machine learning and integrated services," said Geoff Blaber, an analyst at CCS Insight.

One area that lacked excitement was Android Wear: with the launch of the Apple Watch, many analysts had predicted this would be the year of the smartwatch, but Google had little news for its own platform.

Blaber suggested that the smartwatch OS has yet to reach mainstream status, remaining "firmly in the early development phase", although Google did impart that its wearable platform now has 4,000 applications for smartwatches. That includes an update to taxi app Uber, letting you say "OK Google, call me a car" to book a cab, plus an emoji tool that lets you send an icon by drawing it on the watch face, which drew audience applause.

ABOVE Google's Sundar Pichai (*inset*) revealed the company's plans to extend Android into our homes and beyond

M is for meringue?

We also learnt more about Google's mobile OS, Android M. Google hasn't yet unveiled a dessert-themed nickname – we're hoping for "meringue" – but the search giant did divulge that it will arrive in the third quarter of this year, and will feature built-in support for fingerprint sensors and USB-C, simpler permissions (so it's clearer when an app wants access to your camera or data), and Android Pay, its own mobile-payments system.

Five stories not to miss

1 Ofcom warns of Wi-Fi pain

The telecoms regulator will auction off more spectrum to beef up mobile networks, but the change could wreak havoc with Wi-Fi routers. Ofcom is considering selling off 2.3GHz spectrum, which sits next to the 2.4GHz band used by most routers – one reason you may want to opt for a dual-band device with 5GHz support.

2 Lenovo smartphone uses projector for keyboard

Lenovo has revealed a concept smartphone that can project a display you can interact with, giving users a bigger touchscreen surface or keyboard. The Smart Cast system uses a built-in pico projector combined with laser sensors, but the technology isn't expected to arrive in retail devices for another year or two.



3 Snoopers' Charter returns with new bill

The new Conservative government introduced the Investigatory Powers Bill, reviving plans to increase security services' access to online communications data. The law looks set to extend the last set of proposals – known as the Communications Data Bill – which was previously blocked by the Liberal Democrats.

Google is also making it easier to use Chrome in apps: when you click a link you'll be taken to a full browser page rather than a cut-down version. Google also said that Android M will as much as double battery life on standby using a power-management feature called Doze, which uses motion detection to determine if your device is unattended and turns off background activity.

Those changes may seem small, Blaber said they could be significant for many users. "Android M is an iterative update that delivers important security and user improvements, but most notably seeks to address a core business model challenge by better integrating apps and the web," he said.

"Consumers are sleepwalking into a world where huge swathes of data resides with Apple or Google"

One intriguing new feature is Google Now on Tap, which brings the Google Now smart assistant into apps. If a friend suggests a restaurant in a messaging client, for example, you can pull up Now while still inside the app to find out where it is and retrieve reviews. Google Now on Tap will use context, so you can ask "Where is this?", rather than actually name the restaurant.

Internet of Brillos

Project Brillo is Google's step into the Internet of Things, extending Android to smart-home devices. It's not the search giant's first attempt at pushing its mobile OS into smart homes; four years ago, it used its developer conference to unveil Android@Home, but the initiative failed to take off.

With its second try, Google is using a cut-down version of Android. "Brillo is taken from Android, but we've taken the lower layers, the kernels, the core essentials so it can run on devices with minimum footprint; we've whittled it down," said Pichai.

Google's senior vice president also unveiled Weave, a communication layer for IoT devices. "It's a common language," he said, noting it will work across different platforms, not only Brillo. That means you can send a single command to your home hub and have it understood by all your devices, rather than having to open a fresh app for each connected item to tell it you're on holiday for two weeks, for example.

Brillo and Weave are only the latest entrants to IoT standards, with each tech firm seemingly adopting its own. "Google's Brillo and Weave IoT announcements represent further evidence of growing standards fragmentation," warned Blaber. "Nonetheless, the moves stand to better integrate Google's own offerings and underlines the company's strength by virtue of its raft of services and Android installed base."

A developer preview of Brillo will be released in the third quarter of the year, while Weave is expected by year end.

More data than ever before

As ever, Google's push into new areas raises fresh concerns over data privacy. Alongside its IoT plans – which will see Google collecting and using data from devices in the home – the company also updated Google Photos (*see What else from Google?, above*) to offer unlimited storage, hoping to encourage users to keep all their snapshots in its cloud.

Both moves mean Google is going to be hosting even more data from its customers, Blaber warned. "It's increasingly clear that consumers are sleepwalking into a world where huge swathes of their personal data resides with Apple, Google or both," he said. ●

What else from Google?



Google Photos

Photography fans will be keen to look at Google Photos, an extension to the firm's existing photo-storage system. It aims to converge all of your pictures into one place, rather than leave them scattered across multiple devices and cloud storage.

Google Photos will organise images automatically, by dates, places and even people (without the need for tagging). The flipside is that this involves reading metadata and using facial recognition, so those concerned about privacy may prefer to avoid the free service.

While the search giant is offering unlimited storage, it's setting a resolution limit of 16 megapixels for photos and 1080p for videos – sure to disappoint anyone with a decent DSLR. Google Photos is available immediately for desktop, Android and iOS.

From smart jeans to encryption

The Advanced Technology and Projects (ATAP) group at Google – perhaps best known for Project Ara, Google's modular smartphone – had a host of new ideas on show. First up was Project Jacquard, a smart fabric that incorporates conductive wiring, which is being used by Levi's to make smart jeans.

Also on show was Project Vault, an encryption tool in the form of an SD card with an ARM processor and NFC chip, letting you encrypt communications and securely store data. Google also demonstrated Project Soli, a tiny radar sensor that can read the movement of your hands; fitting it into a smartwatch would enable the use of gesture recognition rather than tapping the screen.

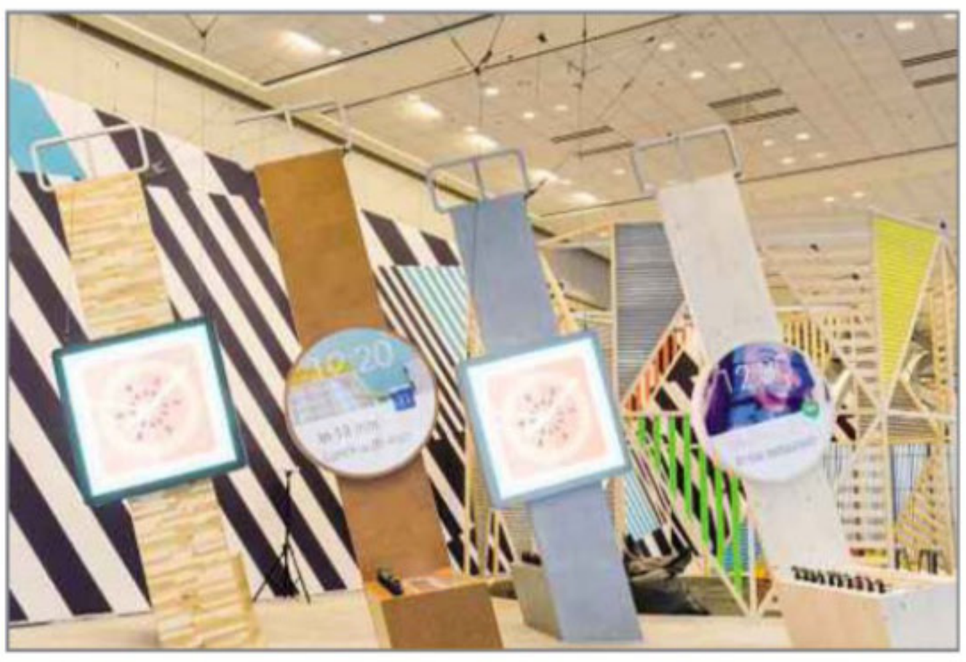


Cardboard VR

Google showed off a new version of its Cardboard VR system, powered by your phone, which is slipped inside the low-rent headset. The new version has been redesigned to work with any phone – including the iPhone – and to support it Google has released an SDK for iOS and a Cardboard app on the Apple App Store.

Google also demonstrated Jump, a simple method to shoot VR video. Working with GoPro to make a 16-camera rig to record video for 360-degree applications, Google said it would release the design this summer so anyone can make a Jump rig. All you need to do is feed your footage into Google's Jump Assembler tool to compile your stereoscopic video, then upload it to YouTube. (*See p58 for our comprehensive guide to the other virtual-reality systems vying for success.)*

The team didn't announce any major updates to the Ara smartphone, but they did demo its modular nature by installing a camera to the phone after it was already running, and then taking a snapshot within seconds.



ABOVE Despite the imagery, news on Android Wear was thin

4 iPhones crashed by malicious messages

Apple has rushed to fix a flaw that allowed carefully crafted malicious text messages to crash iPhones. It's unclear where the text originated, and it appeared to do little beyond frustrating users. Apple quickly issued instructions on how to regain control of locked iPhones, and was working on a patch at the time of publishing.

5 Windows 10 release date confirmed

Microsoft has confirmed that Windows 10 will be released on 29 July as a free upgrade to those on Windows 7 and 8.1 (*see p44 for our feature on Windows 10*). Windows Insiders – those who have been testing the new OS in beta – will also receive free upgrades.

What is... the EU single digital market?

Hey, don't run off! The single digital market is more interesting than it sounds. Here's what will happen when the internet can truly cross borders

You can cross EU borders without presenting a passport, but your Netflix subscription can't come with you. That could be set to change under a European Union plan to create a single digital market, with a 16-point proposal covering everything from rationalising VAT to ending geoblocking of online services. Here's what the plan means for you.

A 16-point proposal from the EU? Isn't this just more Brussels bureaucracy? With a referendum looming, it's clear many Brits have complaints with the EU, particularly concerning red tape. But for the most part, this proposal aims to make it easier for businesses to sell across the common market and for customers to access services and buy goods, according to EC president Jean-Claude Juncker and vice president Andrus Ansip. The plans include a single online tax, modernising copyright laws, and speeding up cross-border parcel delivery. Currently only 7% of SMEs sell across borders.

And what does that have to do with using Netflix in Spain? One of the proposals aims to make sure consumers can access their digital content anywhere in Europe by ending "unjustified" geoblocking. That means that a Brit with a Netflix subscription should be able to use it when travelling through Europe, and that all Europeans should be able to sign up for the video-streaming service, rather than it being available only to some countries as it is now.

The aim is also to ensure all Europeans pay the same price for services, so if you're trying to book a car in Germany, you'll pay the same as a Greek, rather than seeing a different price as is often the case now.

The EU is also keen that European firms do a better job offering security and privacy solutions for businesses and consumers, citing concerns over the "vulnerability" of products made elsewhere.



ABOVE **Take your Netflix subscription with you on your travels around Europe**

Sounds like another dig at US tech firms. The EU has come out swinging against the US dominance of the IT industry, particularly since Margrethe Vestager took over as commissioner for competition. Indeed, the single digital market plans were announced alongside an investigation into online commerce, looking at "potential barriers erected by firms to cross-border online trade". She's promised to take action against firms hurting online competition.

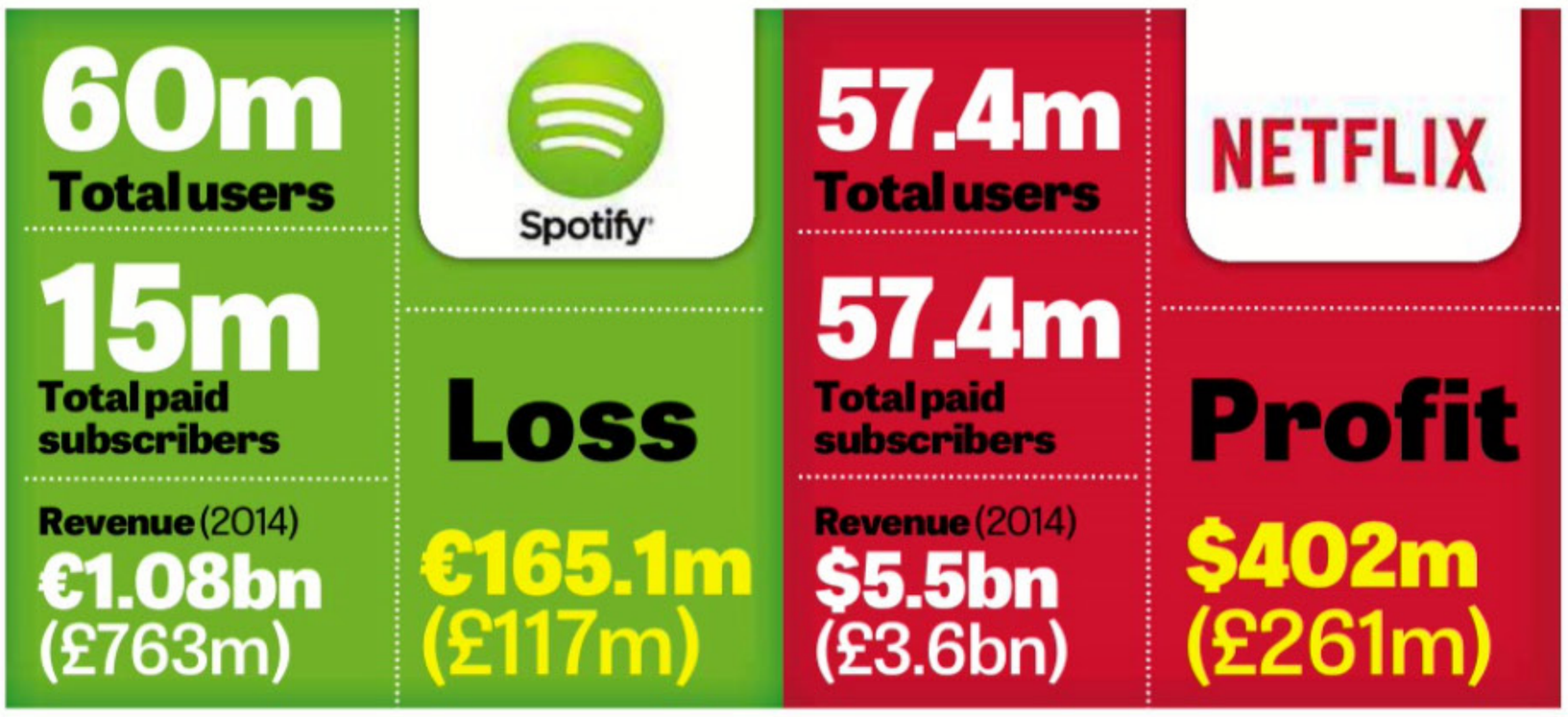
When will this brave borderless world arrive? The EU plans to have the relevant legislation in place by 2016, but it will take years for it to be implemented by member countries. Online services might decide to speed progress along and offer access before they're forced to, and the BBC has already said it's examining how its iPlayer catch-up service will work under a single digital market. Of course, the whole project is moot if the UK pulls out of the EU. In the meantime, keep your VPN handy if you're travelling on the continent and want to keep up with your Netflix shows.

Spotify turns to video as profits slide

SPOTIFY IS CHANGING its tune and widening its streaming service from music to podcasts and video – opening up the possibility that it could offer TV shows and movies to challenge the likes of Netflix and Amazon Prime Instant Video.

Currently, video is limited to short clips from channels such as BBC, ESPN, Vice News and Comedy Central, but CEO Daniel Ek has said Spotify is now considering longer formats. The move acknowledges that most streaming-music listeners also look to the web for videos: research from GlobalWebIndex suggested 87% of Spotify users had watched a video clip online in the past month, and a third already pay for a video-streaming service.

Taking advantage of its customers' willingness to pay for online content could help Spotify finally turn a profit: the company's latest round of results, revealed in May, showed that its annual revenue topped €1 billion, but it still posted a loss of €165.1 million (£117 million) for 2014. Research from Mintel earlier this year indicated that 41% of music subscribers and a third of video customers would be interested in a package that combined both services.



ABOVE **Offering video could turn Spotify into a profitable venture**

The move may have as much to do with fending off competition from music rivals as it does taking on incumbents in the video market. In March, Jay Z and a host of other big-name musicians launched their own music service called Tidal, while Apple is widely expected to unveil a music-streaming service based on Beats Music, which the company bought in May last year. Giving Spotify users more for their money – be it podcasts or videos – may help keep them loyal when tempted by such challengers.

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It's time to get involved: we need to create a Magna Carta for the web

Sir Tim Berners-Lee leads discussions at the Web We Want Festival about the future of the web he created. Nicole Kobie reports

IF WE WERE to write a Magna Carta for the web, what would it look like? That was the question considered by speakers at London's Web We Want Festival, with Sir Tim Berners-Lee at the forefront.

"There's never been a time when there's been so much up for grabs, so much to change and so much pressure in each direction," he told attendees. "There's never been a time when there's been more incentive for a government to quietly take control of the internet, and take a stranglehold and use it to spy on its citizens... Similarly, there's never been as much incentive for companies commercially to do the same thing, to analyse and take control of consumer life experiences – to control where they buy their shoes. Because it's so valuable to control what you think."

> **"The web is an essential service of our time, on which all other services are provided to us"**

To help keep the internet free, the Web We Want campaign is pushing five ideas for its Magna Carta: net neutrality, affordable web access, data protection, freedom of expression, and an open infrastructure.



ABOVE Sir Tim wants access to his own data to do with as he pleases

Protecting our rights

Amanda Long, head of consumer-rights group Consumers International, described the web as an "essential service of our time, and it is the service on which all other services are provided to us," making it vital to get right now.

However, she warned, existing regulations are "unable to cope" – they're out of date. She pointed to UN guidelines that are the blueprints for consumer rights and laws worldwide; they didn't mention the web until two years ago, because they were written in 1985.

Even now, she said, the situation isn't ideal: "On some of the key digital points – in particular data protection – some of the big countries, including the US, have argued them out. There are loopholes in this global blueprint that still haven't been dealt with," she said. "So if anybody asks the question, 'do we need a Magna Carta [for the web]?' – the answer is, resoundingly, yes we do, and we need it now."

Anonymity vs security

Another challenge for the open internet is data protection, and security services' demands for access to our data – in other words, keeping us safe from corporate and government snooping.

Nick Pickles is the head of public policy for Twitter UK, and he stressed

The web the government wants

The Web We Want Festival took place in the same week as the Queen's Speech, in which the new Conservative government laid out its plans for legislation. This included a revival of the so-called Snoopers' Charter.

The last government saw the Liberal Democrats block the Tories from passing the Communications Data Bill, which among other proposals demanded that web firms and ISPs collect messaging metadata and hold it for a year in order to give security services easier access. Those plans have been revived and extended under the new Investigatory Powers Bill.

Speaking to *The Guardian* ahead of the Web We Want Festival, Tim Berners-Lee said: "The discussion of increased monitoring powers is a red flag." He called for proper debate before any legislation is brought in, rather than allowing changes to be rushed through. "It's important that legislation is left out for a seriously long comment period," he concluded.



that these issues deserve public discourse, saying discussions shouldn't involve only companies and government departments. "This needs the public's involvement," he said, explaining that it's the only way people will trust services such as Twitter. This is the reason why the site is currently suing the US government over data-access transparency: "People do deserve more information about how their data is being used."

The panel recognised that the web can't offer perfect anonymity, particularly on issues such as online bullying – Twitter has experienced issues with trolls terrorising users, and faces mounting pressure to offer better ways of dealing with such harassment.

In the face of bullying and harassment, "we should be able to remove the veil", said Sir Tim – but he also pointed out that if you're a reporter in Syria then "anonymity could save your life".

"The anonymity that's used in some cases for ill purposes is the same anonymity that helps a human-rights

> **"These issues deserve public discourse – discussions shouldn't involve only companies and government"**

activist report," agreed Twitter's Pickles. "Sometimes we forget that the impact of a conversation in London will affect a human-rights activist in Syria. We need to remember that what we do here echoes around the world." That's why Twitter doesn't request real names when signing up to the service – a policy that has had negative repercussions, with feminists being harassed online – and also strips metadata from posted photos.

Addressing such a topic in the web Magna Carta would be difficult, Sir Tim admitted. He noted that anonymity can't be guaranteed but is often necessary, and there are perhaps too many instances to make it feasible to decide on a case-by-case basis. "It's a complicated answer that involves constructing process," he said.

Data ownership

Ownership of data is a key issue raised in consumer-rights discussions, according to Long. Companies are using data to "manipulate that consumer



ABOVE Panellists, including Sir Tim Berners-Lee (*right*), discuss the implications of the web

experience," she said. "Who owns your data needs to be a key part of the Magna Carta going forward because, certainly from a consumer perspective, it drives behaviours."

For Sir Tim, web openness boils down to data ownership rather than data protection. In fact, he believes that the activity of gathering data and then aggregating it, before selling it on to advertisers, is a "red herring". Instead, he wants to be able to access and control his data for his own purposes.

"What I want to see in the future is ordinary consumers being able to buy programs that use huge amounts of their own data," he said. "I put it to you that all that data about you, if you could download it all – all the MRI scans from the hospital, all the blood-test results, all the information that the retail industry has gathered on items you've bought – you'd actually find that really valuable."

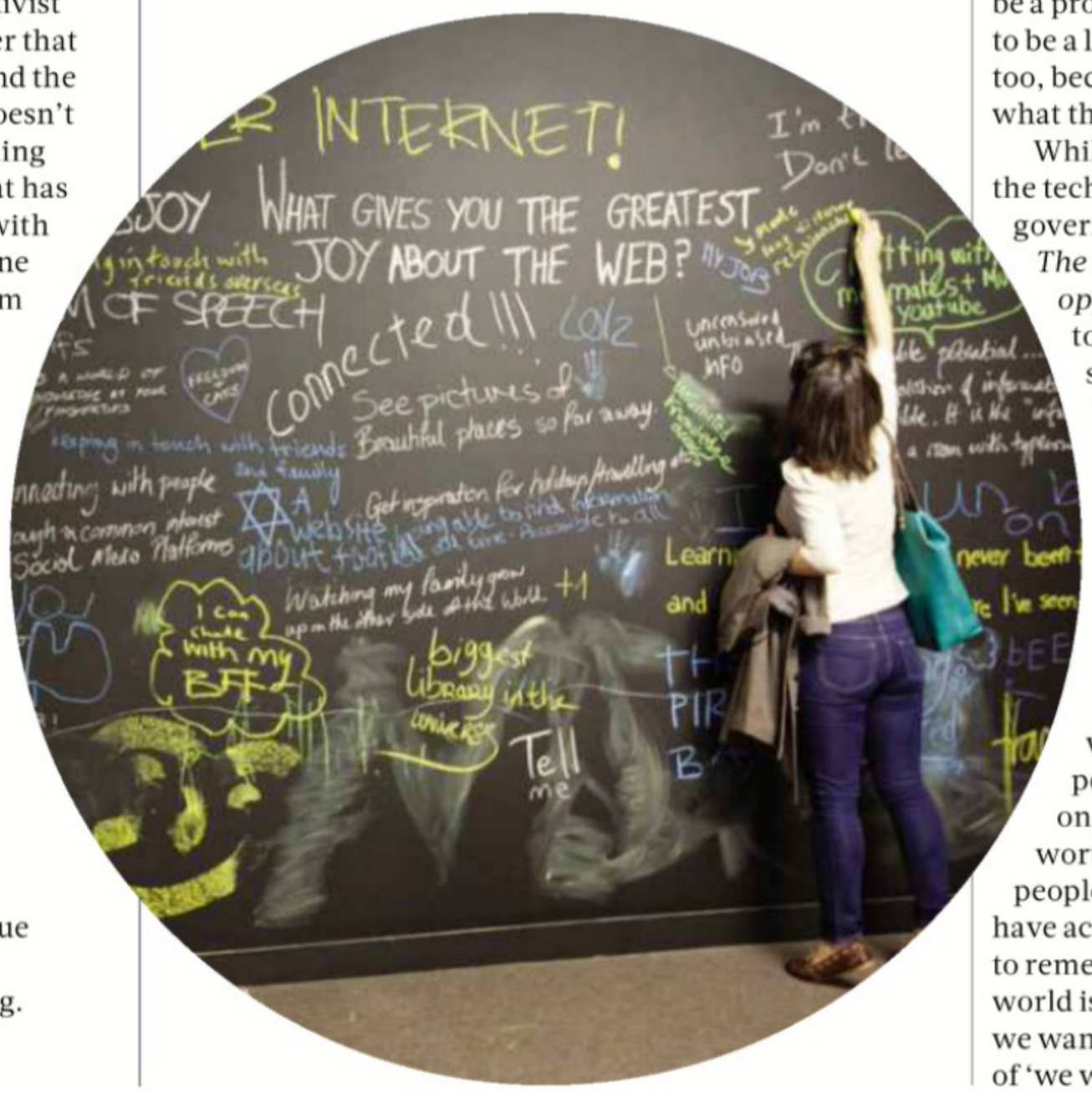
Online education and access

The speakers at Web We Want were united on one point: the key to the web's success is education. We need to teach digital literacy, not only to encourage women to take up technical and engineering jobs, but also to ensure everyone has the ability to understand the issues raised by the web and other new technologies.

That includes MPs, noted Sir Tim. "We need to teach people to code when they're young so they learn what's possible," he said. "This doesn't only apply if you're going to be a programmer, but if you're going to be a lawyer or a parliamentarian too, because you need to understand what the code can do."

While we may not celebrate the tech-related laws our own governments come up with (*see The web the government wants, opposite*), at least we're allowed to discuss it. The artwork serving as a backdrop to the main discussion at the festival was by Pakistani group PeaceNiche, whose leader Sabeen Mahmud was murdered in April for trying to set up discussions on similar topics of openness and rights.

Long pointed out that while it's great to be in a position where we can decide on the sort of web we want, it's worth remembering that many people around the world still don't have access to the internet. "We have to remember that two-thirds of the world isn't on the page of 'the web we want', but instead on the page of 'we want the web'." ●



Event images: Belinda Lawley

How Google's Penguin can trample a business

Google regularly tweaks and rebalances its search algorithms, in a bid to keep improving its results. But could its changes end up running small firms out of business? Michael Passingham investigates



You may have heard of Wholesale Clearance UK – it enjoys excellent press coverage. The bulk-buying business and reseller hit the headlines last summer for picking up England football mugs that had mistakenly had US President Barack Obama's face superimposed in place of defender Chris Smalling.

Stories such as these are good for business, but most of the outlet's sales have historically come via search traffic – most of it via Google. Then one day, in April 2012, that traffic plummeted by 90%. "One moment we were riding high on Google's trust, and doing really well," Wholesale Clearance managing director Karl Baxter told *PC Pro*. "We took on staff, warehouses, and were expanding at a fantastic rate. As if overnight, it all came crashing down."

This wasn't a one-off, 24-hour tech fault: traffic continued to stay down, slashing 70% from the firm's income. The reason? Google had changed its algorithm. The search giant makes hundreds of tiny tweaks to its system every year to improve search results, but on occasion it's a seismic shift. In 2011, it was "Panda"; in 2012, "Penguin"; this year it was the so-called "Mobilegeddon", designed to push mobile-friendly sites up the rankings for people searching on phones. Such updates are often designed to punish sites trying to game the system, but they can also leave legitimate webmasters such as Wholesale Clearance scrambling to pick up the pieces.

Eats, searches and leaves

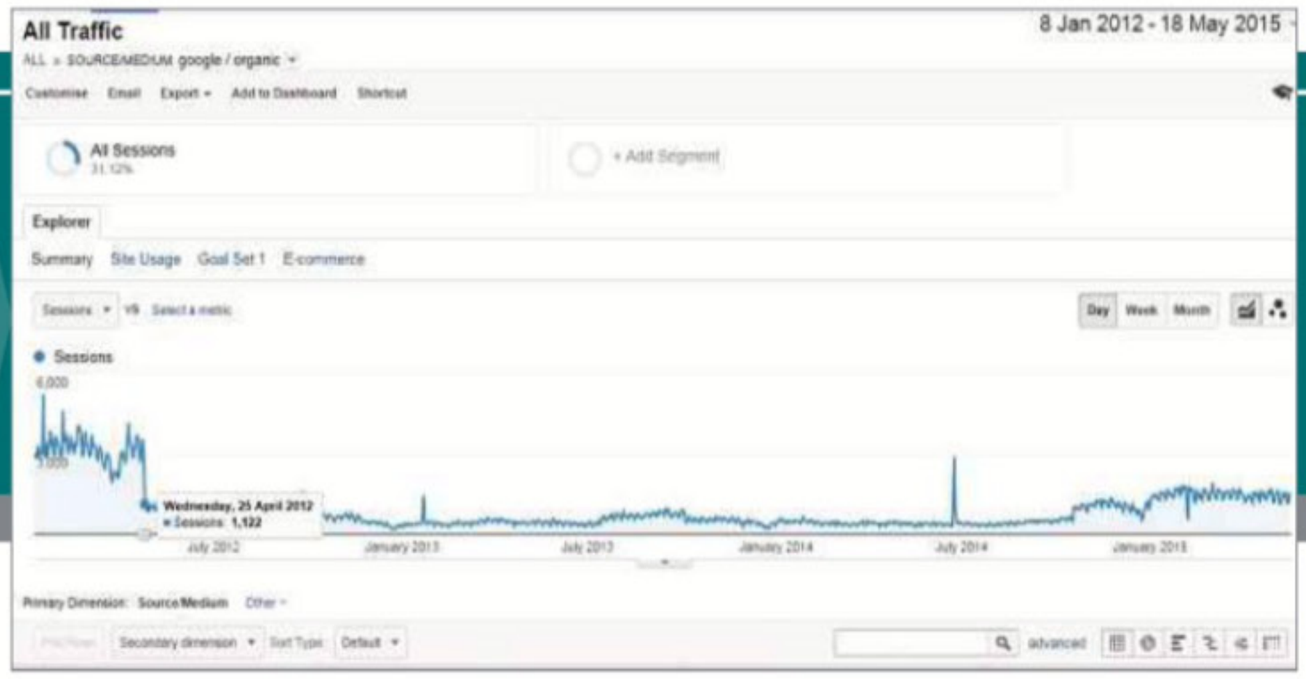
Panda was Google's first attempt to tackle the problem of "low-quality" sites outranking their supposed superiors sites that used repetitive wording, misleading links, hidden keywords and nonsensical content to try to push their way up the rankings. Google has worked hard to eradicate such sites from its results in recent years, which is why you no longer see pages of jumbled keywords pointing to suspicious-looking websites.

The second algorithm tweak was Penguin, the one that hit Wholesale Clearance, which targeted websites with inbound links from untrustworthy sites. For example, if the spammy dodgywebsite.com contained a link to yoursite.com, Google would have punished your site for having a bad site linking to it. The perfectly sound idea behind this move was to end the practice of link trading, with dodgy sites being set up entirely to push others up the ranking. Great in theory, but if such a site links to you, there's little you can do about it.

And these links were indeed the source of Wholesale Clearance's woes. The SEO contractor it had employed in 2010 to help boost its search-engine prominence had been buying up links on thousands of such sites every year, trying to trick Google into thinking **wholesaleclearance.co.uk** was being shared across the web on many websites, thereby making it worthy of a higher search rank. By April 2012, there were more than 6,000 domains with pages linking to the Wholesale Clearance website. And then the Penguin update hit.

> **"Google punished your site for having a bad site linking to it – but if such a site links to you, there's little you can do about it"**

It took two years for Wholesale Clearance to see any kind of recovery – and to Google's credit, an update in October 2014 registered Baxter's efforts to remove and disavow links to his site from rogue domains – but thus far the recovery has been only very slight. Four previous updates had no effect on the search rankings whatsoever, leaving Baxter in the dark as to





whether he was heading in the right direction. In that time, the family-operated company was forced to lay off staff, including Baxter's own brother, who was made redundant in 2013.

"I felt really victimised," Baxter said. "Google is using Penguin as a prison sentence. It took more than a year for the company to reverse the Penguin penalty, and it's impossible to recover until they refresh the data."

This story is one repeated by countless small businesses that hired well-meaning but incompetent SEO firms to help keep them in Google's favour, and are now feeling its wrath with no idea how to make things right.



ABOVE Karl Baxter's business Wholesale Clearance (*above right*) suffered from Google's Penguin update, with traffic to the site plummeting by 90%

ABOVE LEFT Google traffic can make or break a business

Clueless collateral damage

Dan Sharp, director of UK SEO firm Screaming Frog, said that few businesses understand Google's algorithm. "For the average business or webmaster, it can be confusing," he said. Since Google only makes major Penguin- and Panda-type updates every few months, businesses have no idea whether their efforts to fix their low ranking have been successful, leaving their business' survival hanging in the balance.

"Google can certainly do a better job of making its algorithm data refreshes more regular, so businesses that have worked hard to fix any problems can recover faster than having to wait a year or more to have the opportunity to recover," Sharp said. "A 12-month-plus recovery period is too long for genuine businesses that want to try to do the right thing."

Google didn't respond to a request for comment on this story, but a recent Google Hangout suggests the search giant is trying to do better. Fielding questions from webmasters waiting for the next algorithm update, Google Switzerland's John Mueller said that speedier algorithm updates were in the pipeline: "I know it's frustrating... and you're just waiting for things to kind of open up again," he said. "That is something we're definitely working on, to update that data again to make it a little bit faster."

Thanks to websites trying to game the system, Google has no choice but to keep updating its algorithm to stay a step ahead. "Google would argue that it has improved its search results, though, and that these websites had 'low-quality content' based upon user-engagement signals," said Sharp. "I would agree with that; Panda has been very successful in improving search results over the past four years. However, there are plenty of businesses and entire industries that would argue they have been impacted unfairly, and we've seen some genuine cases of 'collateral damage' along the way."

Change of Google heart

There are signs Google is listening. Rather than unleash "Mobilegeddon" without warning – typical of its previous algorithm updates – it gave sites two months' prior notice via a blog, even providing advice on how to check a site's mobile friendliness and what to do about weaknesses.

However, Sharp believes that the warning doesn't reflect an increase in dialogue between Google and webmasters. "I think this was more of a PR move by Google to speed up the improvements for mobile user experiences, with such a high proportion of searches now taking place on mobile," he said. "In reality, the impact of 'Mobilegeddon' was tiny from our analysis."

It's a welcome move nonetheless: without such warnings from Google, it's difficult for small businesses to tweak their SEO strategy and keep up. What's more, if an SEO contractor gets it wrong, those mistakes could destroy a business – Screaming Frog's figures suggest that fewer than one in ten Panda-afflicted websites made a full recovery, even after several years. As Google tries to crush dodgy SEO practices, it may well be delivering a crushing blow to legitimate small businesses too.

Search victims

It isn't only small firms that are caught out by Google's rules – some global brands have fallen foul too.

BMW (2006)
The Bavarian carmaker found its website completely removed from Google's search results for a few days in 2006. Why? It had been "cloaking" content on its web pages, hiding invisible words in areas that were designed to be seen by search engines, not users.

The Washington Post (2007)
In 2007, Google decided to crack down on the growing practice of selling spammy links, which allowed smaller sites to effectively buy a share in the host site's popularity. *The Washington Post* was one culprit, and it paid the price: the newspaper wasn't removed entirely from rankings, but was bumped down a few spots in search results.

Google (2012)
Hilariously, Google punished itself in 2012, following an ill-conceived marketing campaign in which hundreds of sponsored blog articles were posted across the web to promote the Chrome browser. When the promotion was exposed, Google apologised, and the official Chrome download page was knocked off the first page of Google search results for two months.

BBC (2013)
The BBC received a notice in 2013 that Google had detected "unnatural links" on its website. The assumption was that a staffer had been posting links to irrelevant sites in a bid to lend them credibility. Google didn't go into specifics, however, revealing only that it had taken "granular action" against the page in question – so the details remain as murky as most internal BBC investigations.

The A-List

The ultimate guide to the very best products on the market today

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Apple MacBook Pro 13in with Retina display

2015 model, from £999

apple.com/uk

With its innovative Force Touch trackpad, new Broadwell processors and the same excellent Retina screen, the MacBook Pro is better than ever. It's fast, with superior battery life to the previous generation, and that trackpad adds to all-round usability.
REVIEW: pcpro.link/almb13rd



ALTERNATIVES

Lenovo IdeaPad Yoga 2
A versatile hybrid laptop with the best IPS screen in its class – now available at an irresistible price. **£350; johnlewis.com REVIEW: pcpro.link/alyoga2**

Asus Zenbook UX303LA
The latest Broadwell Core i7 and a quality screen make this Ultrabook both desirable and great value. **£680; laptopsdirect.co.uk REVIEW: pcpro.link/alzb303**

HP Stream 11
Good-looking, well built and equipped with a decent display, the petite Stream 11 is as good as it gets for the money. **£179; hp.co.uk REVIEW: pcpro.link/alhp11**

SMARTPHONES

Samsung Galaxy S6

Android, 32GB, free phone, £35/mth, 24mths

omio.com

With the Galaxy S6, Samsung has finally created a phone as beautiful as it is capable. Superb performance, a nigh on perfect display and an astonishingly good camera provide the perfect foil to the most attractive Samsung handset yet.
REVIEW: pcpro.link/algals6



ALTERNATIVES

Motorola Moto G (2nd Gen)
A bargain: 5in screen, good battery life and 4G too. **From free, £17/mth, 24mths; omio.com REVIEW: pcpro.link/almotog2**

Sony Xperia Z3 Compact
Speedy performance, decent battery life and a fine camera – all for a great price. **From free, £25/mth, 24mths; omio.com REVIEW: pcpro.link/alsonyZ3**

Apple iPhone 6
Apple steps up to a larger screen size with the classy, long-lasting 4.7in iPhone – but it's pricey. **64GB, from free, £35/mth, 24mths; omio.com REVIEW: pcpro.link/alip6**

TABLETS

Apple iPad Air 2

9.7in tablet, 64GB, £479

apple.com/uk

Even faster, even lighter and just as pretty as ever – the iPad Air 2 takes everything that made the original great and improves upon it. Updated cameras and the arrival of Touch ID are welcome upgrades, too. Its only real rival is the original 32GB iPad Air, now discounted to a tempting £359.
REVIEW: pcpro.link/alipair



ALTERNATIVES

Tesco Hudl 2
Tesco's budget Android tablet sports a high-quality 8.4in IPS display and great design. You can't top it for value. **£99; tesco.com REVIEW: pcpro.link/alhudl2**

Linx 8
Part of a new wave of ultra-affordable compact Windows tablets, the Linx 8 squeezes in plenty for the price. **£80; pcworld.co.uk REVIEW: pcpro.link/allinx8**

Sony Xperia Z2 Tablet
The most desirable full-sized Android tablet yet, thanks to great design and battery life. **16GB, £330; johnlewis.co.uk REVIEW: pcpro.link/alxz2tab**

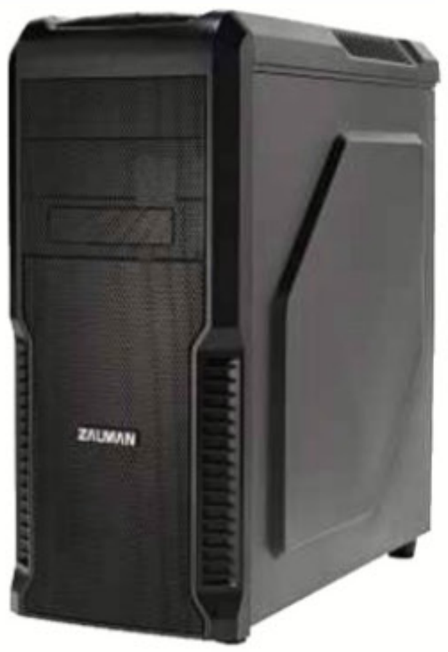
PCs

Chillblast Fusion Quasar

Base unit, £600

chillblast.com

Chillblast's Fusion Quasar is the very definition of a classy all-round base unit. A Core i5 CPU overclocked to 4.3GHz delivers plenty of raw power, combined with good gaming capability and serious upgrade potential. A five-year warranty seals the deal.
REVIEW: pcpro.link/alchill



ALTERNATIVES

Apple iMac 21.5in
A classy all-in-one with a compact frame, ample power and a colour-accurate screen. **From £899; apple.com/uk REVIEW: pcpro.link/alimac215**

Apple iMac 27in with Retina 5K display
Astonishing image quality and stunning resolution: a great PC. **From £1,599; apple.com/uk REVIEW: pcpro.link/alimac275k**

Acer Revo One RL85
An elegant but versatile compact PC with great expansion options and a competitive price. **From £230; currys.co.uk REVIEW: pcpro.link/alacerrevo**

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MONITORS

Asus PB287Q

Premium monitor, £430

overclockers.co.uk

Not so long ago, a 4K display for less than £500 was unimaginable. Asus delivers exactly that: a razor-sharp image on a 28in panel at a very reasonable price.
REVIEW: pcpro.link/alpb287q



Eizo ColorEdge CS240

Eizo ticks almost every box with the 24.1in, 1,920 x 1,200 ColorEdge CS240. With a highly colour-accurate IPS screen, it's the first truly professional-class monitor we've seen at anywhere near this price.
£462; wexphotographic.com
REVIEW: pcpro.link/alcs240

AOC q2770Pqu

A feature-packed, 27in 2,560 x 1,440 display offering a huge workspace, an adjustable stand, a four-port USB hub – and a three-year warranty. Super PLS technology gives great viewing atngles too. At this price, it's a steal. **£330; overclockers.com**
REVIEW: pcpro.link/alq2770

PRINTERS

Canon Pixma MG6450

All-in-one inkjet printer, £67

pcworld.co.uk

The MG6450 inherits its predecessor's status as *PC Pro*'s favourite inkjet all-in-one, offering high-quality output at a very reasonable price.
REVIEW: pcpro.link/almg6450



Canon Pixma iP8750

Canon's mid-range inkjet is ideal for anyone with a fancy for prints larger than the usual A4. It can print photos at up to A3+ in size, and its six-ink cartridges produce immaculate photographs, yet the price is very reasonable. **£230; pcworld.co.uk**
REVIEW: pcpro.link/alip8750

Epson Expression Photo XP-950

Epson's high-end inkjet all-in-one is a fantastic all-rounder for the enthusiast photographer. It combines high-quality prints with a decent scanner, a great touch interface and the ability to output photos at up to A3 in size. **£200; pcworld.co.uk**
REVIEW: pcpro.link/alxp950

ROUTERS

Netgear R7500 Nighthawk X4

AC2350 router, £170

broadbandbuyer.co.uk

Top Wi-Fi performance close up and at long range, swift USB NAS performance and all the latest Wi-Fi goodies make the new Nighthawk router our Wi-Fi router of choice.
REVIEW: pcpro.link/alr7500



D-Link DIR-868L

This 802.11ac wireless router may not have the most impressive set of features, and it lacks an internal modem. However, in our tests it outpaced models costing twice as much, making it an affordable way to get speedy wireless performance.
£89; broadbandbuyer.co.uk
REVIEW: pcpro.link/aldir868l

Netgear Nighthawk AC1900 Extender

NEW ENTRY The most powerful wireless extender on the market, Netgear's Nighthawk marries five Gigabit networking ports with fast, dual-band 802.11ac support and a host of features.
£130; broadbandbuyer.co.uk
REVIEW: p89

HOME NETWORKING

Synology DiskStation DS214play

Network-attached storage, £216

dabs.com

A hugely versatile NAS with built-in Wi-Fi and some of the best media-streaming and cloud features we've seen, as well as eSATA and USB extensibility. It packs a lot of power into a solid, compact unit.
REVIEW: pcpro.link/alds214play



Netgear ReadyNAS 314

This NAS drive isn't cheap, but it's fast, reliable and easy to use – while offering advanced features such as unlimited block-level snapshots and iSCSI thin provisioning. The best buy is the diskless model.
£432; ebuyer.com
REVIEW: pcpro.link/alrnas314

Google Chromecast

This is the future of TV streaming – cheap to buy and simple to use. Plug the Chromecast into a spare HDMI port at the back of your TV, then browse on your smartphone or tablet and beam Full HD content directly onto the big screen.
£30; play.google.com
REVIEW: pcpro.link/alccast

WEARABLES

Pebble Steel

Smartwatch, £150

argos.co.uk

The Pebble Steel isn't the flashiest smartwatch out there, but it offers great battery life, brilliant apps and a simple interface with solid physical controls. Plus, it supports both iOS and Android.
REVIEW: pcpro.link/alpebsteel



LG G Watch R

Android Wear smartwatches don't tend to have great battery life, but the G Watch R is the best we've seen. With an attractive, round-faced design, a punchy and colourful display and a heart-rate monitor, it's the best Android Wear watch so far. **£170; expansys.com**
REVIEW: pcpro.link/algwatchr

Apple Watch

NEW ENTRY The long-awaited wearable from Apple is here, and despite a high price, it's excellent. The scrollwheel crown takes navigation up a notch, while the advanced haptics have to be felt to be believed. For iPhone owners, it's the watch to buy. **From £299; apple.com/uk REVIEW: p68**

SECURITY SOFTWARE

Kaspersky Internet Security 2015

Another year, another excellent performance for this super-secure, lightweight and unintrusive security suite.
3 PCs/1yr, £25; store.pcpro.co.uk
REVIEW: pcpro.link/alkasis15

Avast Free Antivirus

Still the best free antivirus, although others are catching up. It offers dependable protection – and it doesn't nag you about upgrading. **Free; avast.com**
REVIEW: pcpro.link/alavast15

Norton Security 2015

It isn't the cheapest, but the protection provided is good and it covers up to five devices, from laptops to tablets and smartphones.
5 devices/1yr, £29; amazon.co.uk
REVIEW: pcpro.link/alnort15

PRODUCTIVITY SOFTWARE

Microsoft Office 2013

Microsoft retains the top spot for the ultimate office suite, although tablet users may be disappointed by lacklustre touch support.
From £110; office.microsoft.com
REVIEW: pcpro.link/aloffice13

LibreOffice 4

The UI looks a little dated, and Microsoft Office has the edge on features. All the same, LibreOffice is an impressively powerful office suite – and it won't cost you a penny.
Free; libreoffice.org
REVIEW: pcpro.link/allibreoffice

Scrivener

A brilliant package for serious writers: not just a word processor, but a tool that helps you organise your ideas and manage the process of composition from start to finish. **£29; literatureandlatte.com**
REVIEW: pcpro.link/alscrivener

CREATIVITY SOFTWARE

Adobe Creative Cloud

The licensing model won't suit everyone, but Adobe's suite of creative tools is second to none, covering everything from photo and video editing to web development.
Complete plan, £46/mth; adobe.com
REVIEW: pcpro.link/alccloud14

Adobe Photoshop Elements 13

Adobe's home image-editing tool is a terrific and powerful buy, although users of older versions won't find much reason to upgrade.
£60; amazon.co.uk
REVIEW: pcpro.link/alelements13

Steinberg Cubase Pro 8

A big bump in performance and a handful of UI improvements keep Cubase at the top of the audio-production tree. A worthwhile upgrade.
£369; dv247.com
REVIEW: pcpro.link/alcubasepro8

SERVERS

HP ProLiant DL80 Gen9

Massive storage capacity combines with a high-speed Xeon E5-2600 v3 CPU and a scalable design to push this HP rack server to the top of the tree. The price is very reasonable as well. **£989 exc VAT; hp.co.uk** **REVIEW: pcpro.link/alhpdl80**



HP ProLiant ML150 Gen9

NEW ENTRY

HP's latest compact tower server packs in a huge range of features, and couples that with impressive expansion capabilities so it can grow as your business does. **£853 exc VAT; hp.co.uk** **REVIEW: p101**

STORAGE APPLIANCES

Qnap TS-EC880 Pro

Qnap's eight-bay desktop NAS sets new standards in the desktop NAS appliance space, combining ultra-powerful hardware with every storage feature you could wish for. It has huge expansion potential, and 10GbE networking seals the deal. **Diskless, £1,381 exc VAT; ballicom.co.uk**
REVIEW: pcpro.link/alec880pro



Synology RackStation RS2414RP+

Built with speed and expansion in mind, this 2U rack NAS offers a veritable feast of storage features and plenty of expansion potential. It's good value, too.
Diskless, £1,362 exc VAT; ballicom.co.uk
REVIEW: pcpro.link/alrs2414rp

SECURITY

Sophos SG 115w

A security appliance that gets it right on almost every level. Easy deployment, a huge range of features and a tempting price make this the perfect choice for SMBs. **With 1yr FullGuard, £809 exc VAT; sophos.com**
REVIEW: pcpro.link/alsophossg



Sophos Cloud

User-based policies and slick mobile support make this a top-class cloud solution. Performance is impressive, too. It isn't the cheapest option, but it's a pleasure to use.
10 users, £510/yr exc VAT; sophos.com
REVIEW: pcpro.link/alscloud

BUSINESS PRINTERS

Epson WorkForce Pro WF-5620DWF

Shatters the myth that inkjets are only for low-demand use, delivering fast output speeds, low running costs and tons of features. It prints at 20 pages per minute, and quality is perfectly acceptable – it can even print glossy photos. **£187 exc VAT; printerland.co.uk**
REVIEW: pcpro.link/alwf5620



HP Color LaserJet Enterprise M553dn

HP's latest colour laser is an astonishingly good printer, offering an unbeatable combination of value, low running costs, performance and excellent output quality. **£400 exc VAT; printerland.co.uk**
REVIEW: p102

BACKUP

Barracuda Backup Server 290

A beautifully simple appliance that brings together on-site and cloud backup. There's block-level deduplication, extensive support for Windows systems and applications, integral Exchange MLB, and simple deployment and management.
£4,446 exc VAT; barracuda.com
REVIEW: pcpro.link/alserver290



IDrive Online Backup for Business

Brilliant cloud backup at an unbeatable price. There are all the features you'd expect, including AES-256 encryption, Dropbox-like sync and more besides, and it's refreshingly easy to use. **250GB, £49/year exc VAT; idrive.com** **REVIEW: pcpro.link/alidrivebiz**

NETWORK MANAGEMENT

Paessler PRTG Network Monitor 15

A network-management solution that's ideal for businesses on a tight budget. Supports a wide range of devices, which are included in the price, and licensing is based purely on sensor count, so there are no hidden costs. An excellent way to keep tabs on what's going on in your network.
500 sensors, 1yr, £786 exc VAT; paessler.com
REVIEW: pcpro.link/alprtg15

SolarWinds Orion NPM 11.5

Offers excellent value for money, packing in a huge number of monitoring features as standard, including support for 802.11 wireless access points and virtual machines. **250 elements, £4,110 exc VAT; solarwinds.com** **REVIEW: pcpro.link/alnpm115**

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Profile

BACKGROUND INFO ON INNOVATIVE BRITISH COMPANIES



Linguamatics

Clinical research and drug trials produce millions of pages of data every year. This British company has developed software to extract the relevant information and bring vital medicines to market more quickly

KEY FACTS

IN A NUTSHELL
Linguamatics provides natural-language processing tools to pharmaceutical, biotechnology and healthcare sectors, enabling researchers and healthcare workers to make connections between thousands of text-based sources.

LOCATION
Cambridge

FOUNDED 2001

EMPLOYEES 70

WEBSITE
linguamatics.com

Data is a hugely important resource: information can guide you towards making the right decisions. The difficulty lies in finding and correlating the relevant data within a mass of diverse information – hence the rise of "Big Data" tools and techniques.

Cambridge-based Linguamatics has come up with a software solution focused on medical research that allows researchers to rapidly search the text of dozens of publications, both proprietary and in the public domain, in order to make better-informed decisions.

We caught up with co-founder and CTO David Milward, and senior vice president Phil Hastings, to find out how their text-mining software is helping the pharma-biotech and healthcare industries speed up the drug-discovery cycle and improve patient outcomes.

Making sense of Big Data

Linguamatics was founded in 2001 by four computer science PhDs, who had observed that medical research was generating a growing quantity of unstructured data, and realised the potential benefits of making it more structured and searchable.

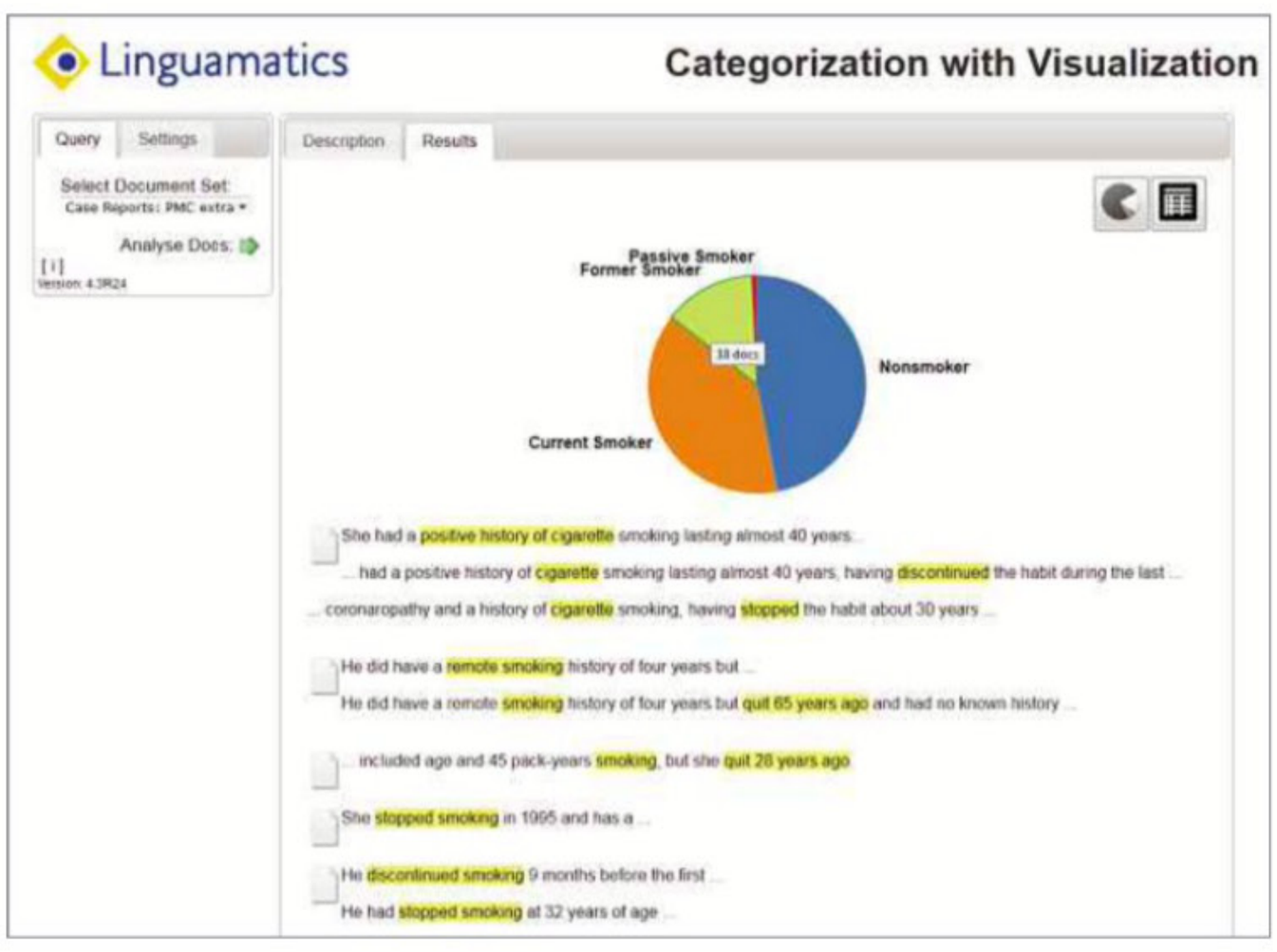
"With the amount of extra data coming in, we could see people not only wanting to find documents via keyword search, but really to have the facility to get straight to the answers to questions," Milward told us.

"For example, a researcher might want to know which genes are associated with prostate cancer, but they wouldn't be looking for a single document – they'd want to pull back the information from lots of different documents, collect it together, get rid of the duplicates and then get a straight answer to that question," he explained.

Natural-language processing (NLP) tools were already available at the time of Linguamatics' founding, but they weren't tailored to answering specific questions. Search engines, meanwhile, allowed for keyword-based search, but left the user to sift through a mass of results to unearth the relevant information. Linguamatics' idea was to bring these two technologies together, and to build in a "terminology" function focused on medical language.

"Terminologies, rather than words, make it easier for people to look for concepts, " explained Milward. "So if you're looking for cancer, you might sometimes use synonyms, such as carcinoma or, particularly in the case of children, lymphoma and leukaemia. You can end up using one concept search, which actually pulls back all the equivalent tens of thousands of search terms," he said.

Grammatical analysis can also be carried out among the results to infer relationships that a simple search would have missed. "For example, in one document we can pull out a relationship between a compound, a drug and a gene, and in another document, we can find a relationship between a gene and disease. We can put those together to get new associations between the original compound and the disease," said Milward.



RIGHT **The software helps classify patients based on their smoking history**

Building a reputation

Of course, having a unique product isn't enough to make a successful business – you have to build a name



Current Smoker		Doc		Hit
Current Smoker	▸ 61	PMC1325239/1	▸ 8	Case study 1: The tobacco industry and the Fair Trading Act 1986
Former Smoker	▾ 21	PMC3337737/1	▸ 4	She had a positive history of cigarette smoking lasting almost 40 years...
		PMC3337737/3	▸ 2	... coronaropathy and a history of cigarette smoking, having stopped the habit about 30 years ...
		PMC2740271/2	▸ 2	He did have a remote smoking history of four years but ...
		PMC2843670/1	▸ 2	... male, who was an ex-smoker with a smoking history of ...
		PMC2672240/3	1	... included age and 45 pack-years smoking, but she quit 28 years ago.
		PMC3109347/1	1	She stopped smoking in 1995 and has a ...
		PMC2008204/1	1	He discontinued smoking 9 months before the first ...
		PMC2008204/2	1	He had stopped smoking at 32 years of age ...
		PMC2922630/1	1	He had a past history of smoking (bidi 10/day...
		PMC3385373/2	1	He quit smoking on advice.
		PMC3016827/2	1	... had a history of heavy smoking for 35 years but had quit 5 years earlier.
		PMC3015566/2	1	He was a reformed smoker with a 30-pack/year ...
		PMC3337793/3	1	... he consumes alcohol daily and smoked 3 packs per day for 35 years, having quit at the time of his ...
		PMC3279508/1	1	He had a history of smoking for decades and quit for many years without drinking...
		PMC1693551/1	1	... patient was strongly advised to stop smoking, and was released from ...
		PMC2429898/4	1	... previously; she was an ex-smoker and had hypertension and hypercholesterolemia...
		PMC3251244/1	1	The patient stopped smoking one year ago with a ...
		PMC2804722/1	1	A 51 year-old male, ex-smoker, presented to the ED ...

ABOVE The Linguamatics team receives the Queen's Award for Enterprise in International Trade

TOP RIGHT Linguistic analysis makes the software smarter than the average search engine

for yourself as well. According to Phil Hastings, this was, in part, the thinking behind keeping the company HQ in Cambridge.

"I think the Cambridge name and being associated with Cambridge University helped us a great deal in the early days. It gave us the credibility we needed to talk to Fortune 500 companies and be taken seriously," Hastings said.

A similar calculation was behind the decision to focus on a specific industry: "We decided to go after the big fish, targeting the top 20 global pharmaceutical companies," Hastings explained. "We recognised that there'd be an audience there that wouldn't only have high-value problems to solve, and have an unmet need, but that would also be willing to embrace something that was new."

It was a strategy that paid off. Today, Linguamatics counts 17 of those 20 companies among its clients, with the technology being used in two different ways. In some environments, the software is used as an ad hoc search tool to help researchers retrieve information quickly and share it with others within the organisation. In other cases, Linguamatics' text-mining software is integrated into workflow applications, running natural-language processing in the background, with the end user not necessarily even knowing it's there.

> "With the amount of extra data coming in, people wanted the facility to get straight to the answers to questions"

"In this second example, it's used for actions such as alerting people to clinical drug trials that mention two different drugs, or if there's anything in the literature coming out that talks about a particular disease or particular genes," said Milward.

And the benefit isn't only convenience. "It's estimated that each day you delay getting a drug to market as a pharmaceutical company, it costs you somewhere between $1 million and $3 million," Milward continued. "That's a lot of money. Our software has had a massive impact, removing the need to sort through hundreds or thousands of documents manually, which is time-consuming," said Hastings.

Protecting patients

While the pharmaceutical and biotech industries were the first areas targeted by Linguamatics, the company has now extended its sights to include the broader healthcare industry. "Healthcare is the next step from pharmaceuticals and biotechnology, and it's an area that's become pretty big for us over the past three to four years," said Hastings.

Within this industry, Linguamatics' software is being used to make better use of patient data in general, and to help doctors better monitor the risk profile of individual patients, he said.

"It may be surprising, but a lot of the key data on any individual patient is still recorded by a physician, radiologist or nurse in the form of textual notes. These can be a real goldmine of valuable information, but it takes a technology such as the Linguamatics solution to identify the key facts within the text and provide a risk assessment for them, offering potential suggestions for follow-up," Hastings said.

Two areas in particular where this can be useful are preventing hospital readmission and matching patients to upcoming clinical trials. "The software can be used as an early alert system for doctors, flagging certain patients so that the physician can see the particular risks associated with them across a range of diseases," explained Milward.

"Re-hospitalisation, where patients come out of hospital only to be readmitted quite soon afterwards, is also a big concern. You want to be able to assess the likely risk of that happening," he added.

Mining the future

Given its broad adoption in pharma-biotech, and now healthcare, will Linguamatics be extending its software to other sectors?

"There are other areas, such as legal, finance and chemicals more generally, that we've thought about targeting for some time now. We'll continue to monitor these and make decisions based on where we can get the best bang for our buck," said Hastings. At the moment, though, the focus remains on pharma-biotech and healthcare.

"These are two markets of significant size, and there's still a huge amount of untapped potential here. So, as we think about different applications and supporting different types of user, there's an awful lot of business growth that will still come from these areas," he said.

"I think what we'll see more and more of is the routine embedding of NLP agents into workflows that are processing and surfacing business-critical or patient-critical information, to provide the necessary report for people to get where they need to go faster," he concluded. "And that, for us, is really exciting." **JANE McCALLION**

What about you?

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

Viewpoints

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

Multitasking: the worst gift computing ever gave us

Juggling multiple tasks isn't for us, it's for the machines – and they're better at it anyway



Darien Graham-Smith is *PC Pro*'s deputy editor, and no stranger to interruptions and an overloaded task list.

Search Google Images for the word "multitasking" and you'll find that, of the top ten hits, no fewer than eight are illustrations of individuals with six or more arms. These exceptional beings can be seen holding phones, pens, laptops and documents all at once, and the message is clear: multitasking is a superhuman capability. Even more telling is the image of a regular two-armed individual surrounded by a similar spread of devices and documents, who sits with his hands thrown aloft in an expression of total despair. On p54 this month, Barry Collins asks whether multitasking could actually be harmful to your health, and you can see his point.

I find it interesting that the word "multitasking" is originally a computing term. Its first recorded usage can be traced to an IBM white paper published in 1965, referring to the capabilities of the System/360. Before this date, so far as I can make out, the English language lacked a word to describe the process of managing multiple disparate tasks at once. Make of that what you will.

Nowadays, multitasking is a core business skill. Job adverts at almost every level proclaim that the successful candidate will be a "talented multitasker", and it isn't hard to imagine why: if one employee can handle two portfolios at once then you don't need to hire a second person, and you can put the money instead towards important things like directors' bonuses and share dividends.

If we want to get technical about it, multitasking doesn't describe a single way of working. Today the pre-emptive approach, based on time-slicing and interrupts, is more or less universal, both in computing and in the way we manage our own time at work. An example from my own life might be when I plan to go into a meeting with Tim Danton between 3pm and 4pm, then spend an hour writing a feature, before spending the last hour of the day proofing magazine pages. If the phone rings while I'm working, I stop writing, and resume once I've dealt with the interruption.

This isn't the only multitasking model out there, however. In co-operative multitasking, tasks in progress voluntarily pass focus back and forth among themselves. There's something very agreeable about the idea of the processes in a system all getting along in peace and harmony, and the lower management burden doesn't hurt either. Unfortunately, if you remember Windows 3.1 or Mac OS 9 (both of which used co-operative multitasking), then you'll know that individual tasks don't always know what's best for the system as a whole. If Tim is in a particularly garrulous mood, he might talk all afternoon, and if I wait around to be dismissed, my schedule is liable to fall to pieces.

> **"Psychologists point out that a change as minor as walking into a different room can cause a person to lose his or her mental thread"**

Left to my own devices, the model of multitasking that I instinctively follow is neither of these; in fact, it's the one used by the original System/360, which is called multiprogramming. Simply put, a multiprogramming system focuses on a single task until it either finishes or reaches a point where it needs to stop and wait on an external resource. Then, and only then, does its attention switch to the next item on the list. You'll struggle to find a better description of what happens at home when I put my dinner in the oven and then sit down to finish off a piece of work.

Admittedly, if you were to bring this particular model of multitasking to a modern office job, you probably wouldn't find yourself on the fast track to promotion. After more than one carbonised pizza, I'm coming to see its shortcomings myself.

But as our feature points out, there's much to be said for staying focused. A computer can hop from one complex task to another in a matter of nanoseconds, and then switch back and resume without missing a beat. For a meatbag like me, jumping between contexts isn't so easy. Psychologists point out that a change as minor as walking into a different room can cause a person to lose his or her mental thread. When I come back to an interrupted piece of work, it takes time and effort to regain my focus, and I can never escape the haunting feeling that I've forgotten something along the way. It isn't much of an exaggeration to say that pre-emptive multitasking leans heavily on one of the things we humans are worst at.

Perhaps the cruellest catch is that it also requires you to be your own supervisor. In another time, your employer might have hired you a PA to manage your schedule; today, you have to stay on top of your own priorities and deadlines, while also doing all the actual work. In practical terms, that means you have to be a skilled multitasker before you even get to the main task of multitasking. If you see what I mean.

It's ironic really. Technology's grand promise is supposedly to save human labour, but in this case it seems to have brought us a way of working that only increases the burden on our tiny minds. As our feature makes clear, whether multitasking is actually bad for your health is a complex question – and if you can't escape the demands of the modern-day workplace, you'll find some techniques and perspectives that can at least help you manage the load.

Fundamentally, though, I see multitasking as a question of dignity. Like putting the caps on tubes of toothpaste, it's a dehumanising job that a 21st-century adult shouldn't be expected to do. I say let's leave it to the machines; they can do it better than we can, and frankly they're the ones who started the whole sorry business in the first place.

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A lesson in making crab bisque – for $72,000

Our man in China – albeit only for the four days of CES Asia – ponders immortality through a robotic chef



Sasha Muller is now Life & Culture editor on Alphr. His culinary talents extend to a repertoire of two dishes: beans and toast.

A pair of huge disembodied arms reach out above the kitchen top. Initially, they look menacing, more *RoboCop* than *MasterChef*. Then they begin to move. Graceful, with the gentle, considered motions of a professional chef. Soon one robotic hand holds a pan while another stirs.

It's hypnotic to watch; the lifelike movements make for an eerie spectacle. But the spell is broken every time the arms reach a point in the recipe where all there is to do is wait. There's no pacing up and down the counter. No Keith Floyd-esque swigging of wine. The hands return to their starting position, stop, and hover mid-air – dumb, lifeless, awaiting the next instruction from the computer hidden behind the stage.

This is Moley Robotics' concept of the robotic kitchen, on show at CES Asia. It's been a collaborative effort for the past two years, featuring university professors, robotics firms and more, but the movements on show are those of Tim Anderson, winner of *MasterChef* at 26. Their combined labour is already bearing fruit; or, in the case of today's demonstration, crab bisque.

It's the dexterity of the human hand that makes Moley Robotics' project so special, and much of the credit here lies with UK robotics specialist, the Shadow Robot Company. Following 18 years of work, its Dexterous Hand is the distillation of all the firm has learnt about making a robot hand that's more human than machine. It has four fingers and a thumb with 24 joints and 129 sensors, and can be modified with tactile sensors to allow it to feel pressure, micro-vibration and heat. To watch it move is to believe that robots will one day walk the earth, waving and shaking hands just as we do.

These hands have allowed Moley Robotics to genuinely mimic Anderson's every movement: a process achieved with 3D motion-capture gloves and wristbands, a millimetre-identical kitchen and a healthy dash of patience. Finding the very tastiest dish wasn't the sole aim of the exercise: apparently, the recipe was chosen on the basis of the number of repeatable gestures and motions that it has in common with other dishes. At the time of writing, the robot chef has a repertoire of 48 recipes.

Apart from those two giant arms, the kitchen surface is exactly as you'd expect. Ingredients are neatly arranged in an assortment of glass beakers and small bowls. On the raised ledge behind, there are a trio of squeezy bottles filled with truffle oil and other mystery ingredients, a bottle of Noilly Prat, a variety of cooking utensils and a standard electric hand-blender. The robot hands reach out, almost tentatively, picking up each item and returning it to where it was once finished.

The spectacle isn't entirely without artifice: you can't just throw the ingredients into some bowls. Right now, the prototype requires the ingredients to be placed in specific containers, each beaker, bowl and ramekin slotted into a dedicated space.

Again, though, Moley Robotics' vision stretches way beyond the now. Anderson points to the video playing on the strip of TVs along the wall. Here, the robot chef looks more like something from the world of Valve's Portal games, all white plastic and perfect curves. A man selects his favourite recipe on a touchscreen – Grandma's Spaghetti Bolognese - and the arms slide up and down the length of the kitchen surface, delving into cupboards to retrieve ingredients. It cuts away to the final shot, the man carrying the bowl of spaghetti to a table with three others sat waiting, all beaming smiles – his wife, his son, his father. Grandma's dead, as it turns out.

It's an unnerving prospect, but this is a concept that is – if you believe Anderson's enthusiasm for the project – destined to become reality. What if you could get a robot to cook like a Michelin-starred chef in your own home? What if you could record your favourite recipes, upload them, and allow anyone to cook your favourite dish? I doubt anyone would ever order a takeaway again.

A jab in my back from an impatient man's elbow jolts me back to reality and almost spills my crab bisque. It's delicious, but I don't have $72,000 spare, which is the asking price for the MK1001 due in 2017.

I don't even have $15,000, which will buy you the MK3002 due to land a year later.

One day, though, robot chefs might be no more remarkable than a microwave or a toaster. A bittersweet thought swells up: maybe, after I'm gone, my children will replay one of my best-practised recipes, gather together and wait for the robot to begin, the arms and hands a ghostly projection of who I used to be, a tiny shadow imprinted into zeroes and ones and XYZ co-ordinates. Maybe they'll cry a little as they watch. Or maybe they'll just press the button, grab that wine and sit outside laughing, not a care in the world.

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> **“To watch it move is to believe that robots will one day walk the earth, waving and shaking hands just as we do”**

The highs and lows of working from home

Ditching the office means you can sing at the top of your lungs, and no-one will hear



Nicole Kobie is (freelance) Briefing and Futures editor. She bought an "Egloo" to heat via candles. It's cool. Well, warm.

I'm writing this from my home office – also known as the desk in my lounge, which, this being a tiny London flat, is in my kitchen (like a set of high-rent nesting dolls). Looking out of the window, the rain is splattering down, and I'm smug that I no longer need to leave my home to arrive damp at the office following a horrible commute.

Back in November, I went freelance and, bar a few days here and there, have been working from my residence ever since. In the past, if ever I worked the odd day from home, I didn't really enjoy it at all: I missed the chatter and gossip of the office, not to mention the after-work trips to the pub, and it seemed much harder to get my job done without having my colleagues around.

Six months on and I'm a convert, having taken to working in my pyjamas like the proverbial duck to water. Although, in this case, I'm dry.

Rainy days are but one reason I love working from home. In addition to having the freedom to work when I choose (sun just popped out? I'll head out now and pick up work in the evening), I'm around to take in my Amazon deliveries and can even get any chores done during the day – which, I admit, doesn't happen often, but there was that time I cleaned my kitchen sink to a sparkle ahead of transcribing an interview.

I was convinced I'd miss the social side of the office greatly, or at least lean heavily on Twitter to make up for it. While I've found I do still have productivity-murdering tweeting bursts, I've genuinely cut down – although instead I've turned to WhatsApp's web-based IM tool to poke friends when I'm in need of human interaction.

Besides, there are certain upsides to sitting alone: were I in the office, I couldn't abuse my Spotify subscription to repeatedly loop "Let it Go" at full volume – that's the theme song from Disney's *Frozen* for those of you who are currently pretending that you don't already know the song word for word.

There are, of course, downsides. Living in an old building, with no double-glazing, means I'm often freezing – while sash windows look lovely, they lose heat like a toque-less head in a Canadian winter. Because of this, I've explored various methods to keep warm, discovering the heating potential of tea lights: if you circle enough of the tiny candles around you, you'll be amazed at how much heat they give off. Indeed, one ill-placed candle even melted a hole in the edge of my monitor.

Along with the boxes of tea lights, other hardware I've invested in to work from home includes an Ikea-bought laptop station, with the idea I'd stand at it now and then (I don't); an AeroPress coffee maker, because it's incredibly easy to clean; and a spare mouse, so I can leave one in my bag and one on my desk, and not always be wondering where it's crawled off to.

Which brings me neatly onto mobile working. This combines the worst aspects of the office (the noise and the fact that you need to be fully dressed) with home (you can talk to the barista, but he may look at you blankly if you ask him for updates on that work project). And then not only do you have to put up with flaky Wi-Fi, you have to pay for coffee too.

Despite this, cafés always seem to be full of people with laptops. Understandably, they're great for a change of scene, but there's one problem – and I apologise in advance for the subject matter. After a coffee, I often find myself in need of the "facilities". Since I'm there on my own – and this is theft-prone London – I can't leave my laptop unguarded, which means I either have to pack everything up or ask someone to watch it for me, knowing full well that if I've ever been asked to do this I've never actually bothered to lift my eyes to it again.

On the upside, I find I type really quickly when my bladder is about to burst. Now that's something you don't learn about your own productivity when working in an office.

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If technology is deskilling the artisan, what's left of value?

Fear not: even though software can auto-tune our voices, there's still a desperate need for talent



Dick Pountain could have been a guitar hero playing to Wembley, but chose to be *PC Pro*'s Real World Computing editor instead.

After photography, my main antidote to computer-induced trauma is playing the guitar. Recently I saw Stefan Grossman play live at London's Kings Place. He played his acoustic Martin HJ-38 through a simple PA mike, and played it beautifully. Another idol of mine is Bill Frisell, who couldn't be more different in that he employs the gamut of electronic effects, on material ranging from free jazz through bluegrass to surf-rock. Dazzled by his sound, I purchased a Zoom G1on effects pedal from Amazon, and am currently immersed in learning how to deploy its 100 amazing effects.

The theme I'm driving at here is the relationship between skill, discipline and computer assistance. There will always be neo-Luddites who see the PC as the devil's work that destroys all skills, alongside pseudo-modernists who believe that applying a computer to any banal material will make it into art. Computers are labour-savers: they can be programmed to relieve humans of certain repetitive tasks and thereby reduce workload. But what happens when that repetitive task is practising to acquire a skill such as painting or playing a musical instrument?

> **"Does giving more and more people cheaper,even free, artefacts trump paying those who produce it a decent living?"**

The synthesiser is a good example. When I was a kid, learning to play the piano took years, but now you can buy a keyboard that lets you play complex chords and sequences after merely perusing the manual. Similarly, if you can't sing in tune, then an auto-tune box will fudge over your failings. Such innovations have transformed popular music, and broadened access to performing it, over recent decades. Does that mean it's all rubbish? Not really, it's only around 80% rubbish, like every other art form. The 20% that isn't rubbish is made by people who still insist on discovering all the possibilities and extending their depth, whether that's in jazz, hip-hop, R&B, dance or tin-pan alley.

Similar conflicts are visible to computer programming itself. I've always maintained that truly *great* programming is an art, but the majority of the world's software can't be produced by great programmers. One of my programming heroes, Professor Tony Hoare, has spent much of his career advocating that programming should become a chartered profession, such as accountancy – in the interest of public safety, since so much software is now mission-critical.

What we have instead is the "coding" movement, which encourages everybody to start writing apps using web-based frameworks. My favourite headline in *The Guardian* last month was "Supermodels join drive for women to embrace coding". Of course it's a fine idea to improve everyone's understanding of computers, but such a populist approach doesn't teach the difficult disciplines involved in creating safe software. It's more like assembling Ikea furniture, and if that table-leg has an internal flaw, your table is going to fall over.

Most important is the political-economic aspect to all this. Throughout history, up until the last century, acquiring a skill such as blacksmithing, medicine, singing or portrait painting led to some sort of a living income, since people without that skill would pay you to perform it for them. Computerised deskilling now threatens that income stream in many fields. The arguments between some musicians and Spotify revolves around a related issue, of the way massively simplified distribution reduces the rates paid.

We end up crashing into a profound contradiction in the utilitarian philosophy that underpins all our rich Western consumer societies, which profess to seek the greatest good for the greatest number: does giving more and more people ever cheaper, even free, artefacts trump the requirement to pay those who produce such artefacts a decent living?

I think any sensible solution probably revolves around that word "decent": what exactly constitutes a decent living, and who or what decides it? Those rock stars who rail against Spotify aren't sore because their kids are starving, but because of some diminution in what most would regard as plutocratic mega-incomes. Some will suggest that market forces will sort out such problems. I've no idea what Stefan Grossman or Bill Frisell earn per annum, but I don't begrudge them a single dollar of it and I doubt that I'm posing much of threat to either of them. Yet.

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Readers' comments

Your views and feedback from email and the web

Flying with the iPad Air

Regarding your podcast discussion about American Airlines flights being grounded by iPad glitches, I hold a long-lapsed private pilot's licence, so I know a little about this subject. The take-off speed of an aircraft varies depending on the weight of the aircraft, which itself varies throughout the flight as fuel is burned. Take-off and landing distances also vary due to a whole host of factors, and weight and balance is, as you can imagine, hugely important.

All this has traditionally been calculated for each flight using pen and paper. I'd imagine that using iPads not only reduces paperwork, but allows data to be transferred wirelessly between the pilots and the dispatcher, enabling turnaround time to be kept to the minimum.

I'm sure American Airlines has vetted its procedures and found that the likelihood of failure is within the bounds of acceptable risk, but there may be some nervous decision-makers at the moment! **Chris Gomez**

Shortcomings of the cloud

I've recently set to work digitising large archives of family video footage and hours of audio recordings, and it's looking as though the storage required will run into the region of 5TB.

I haven't looked in detail at all of the products you reviewed last month (*see issue 249, p78*), but readers should be warned that many cloud services aren't suitable for archiving. In some cases backups are kept only while the backed-up files are also stored on your PC, and the PC is regularly reconnected to the service.

What's more, over my broadband connection it takes me about 10–15 days to upload 1TB to the cloud, and about four days to download it again. It's not hard to envisage situations when one might like to have more rapid access to backup data.

I still see a big advantage in optical storage, especially Blu-ray M-Discs, which are claimed to be incredibly durable. However, a terabyte of data stored in this format would require in excess of 40 discs, so you need to be discerning in what you choose to store in this way. **John Sudall**

Reviews editor Jonathan Bray replies: There's some ambiguity among cloud storage providers: some offer a strictly synchronisation-only service, while others are more geared towards long-term archival. But yes, in either case, online storage will be hamstrung by the speed of your internet connection, so it's a good idea to keep local copies of your most valuable data. No cloud service can match the speed of a NAS, tape or optical drive.

Star letter

I read with interest the PC Probe (*see issue 248, p18*) asking how Microsoft will make cash from Windows 10. You wrote that Microsoft needs to step up the rate of its releases to keep users and businesses hooked – but is that true? None of the friends and colleagues I've talked to are desperate for the next release. Using Windows 8 and the pre-release of Windows 10 means you have to learn to find your way to old features and discover new ones, and has it revolutionised the way we do email, internet and word processing? I don't think so. Fast releases would be fine if they always left a stable working system, but so far few of my experiences with new releases have ended this way. **Hervé Boutin**



This month's star letter wins a 250GB Samsung 840 EVO SSD worth £84. Visit samsung.com



ABOVE Want to archive video footage? Then expect some long uploads

365 problems

Following your cloud storage Labs in issue 249, I decided Microsoft OneDrive would be ideal for my photos, and also give me Office 365 on my newish Windows 8.1 machine.

After many failed attempts to install the software, I gave Microsoft Support remote control of the PC. They eventually decided that they'd need to sort out a Registry problem that was preventing installation of Office, but told me that I'd have to stump up $100 first! I refused, as I consider that an inherent problem should be fixed for free. Looking at the web I see that such Office installation problems are common: searching Microsoft turned up 39,000 references!

I wasted two hours over that, plus a half-hour trying to cancel the subscription, and am now wondering if I'll ever be able to install a version of Microsoft Office. Thank goodness for LibreOffice. Dropbox, here I come. **Neil Savigear**

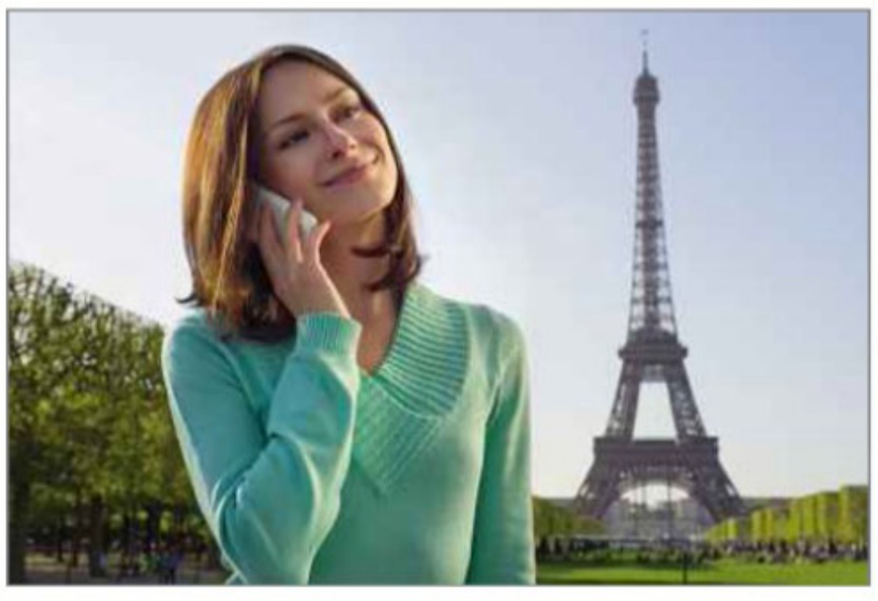
Wherever I may roam

I was interested to read Jonathan Bray's column, "Google's network could be a force for good" (*see issue 249, p25*). My partner signed up for Three when she bought her iPhone and found the "Feel at Home" service convenient when she was at our house in France. But if you spend more than three months in a year abroad then the service stops dead. Your phone is bricked until you return to the UK, so you're in a bit of a pickle if people want to call you.

I'm hoping Google's Project Fi spurs the European telcos to get their act together. I was really hoping that roaming charges would be abolished soon, but that idea appears to have been sidelined. **Crispin Horsfield**

Panda-monium

Some time ago I subscribed to an online support service that provided a lifetime Panda Antivirus subscription as part of the deal. Everything seemed to be fine for a while – until a month ago, when my laptop booted up with a dim screen and didn't behave as it should.



RIGHT Google's Project Fi could result in an end to roaming charges

I was recommended to call at BCS Computers in Torquay to try to discover the problem. After a complete backup and check over, the explanation turned out to be what they called a "Panda-nuke". Apparently Panda had issued an update that has caused not a little bother to a lot of people.

The makeover by BCS Computers entailed a Windows reinstallation and copying my data back to restore my original state, or near enough. I can highly recommend the company. **Philip Mehew**

Deputy editor Darien Graham-Smith replies: Since security software has to constantly update itself, and hooks into your system at a low level, things will go wrong from time to time – in the past, similar glitches have also hit Avira, Kaspersky and Microsoft. Unfortunately, running Windows without security software is a much greater risk. Your best bet is simply to make sure you have a recovery plan.

A day is not enough

Reading your review of the Microsoft Band, I laughed out loud at the line: "Battery life, at least, is decent. A full charge gave us well over a day's use."

> **"I'm wondering why anyone would consider the Microsoft Band with its measly one-day battery life"**

I'm hard of hearing, and I don't always feel my iPhone vibrate when it is in my pocket, so I miss a lot of text messages and phone calls. I tried a cheap Chinese wristband that linked via Bluetooth and vibrated when the phone rang, but the battery was rubbish and it was quickly binned.

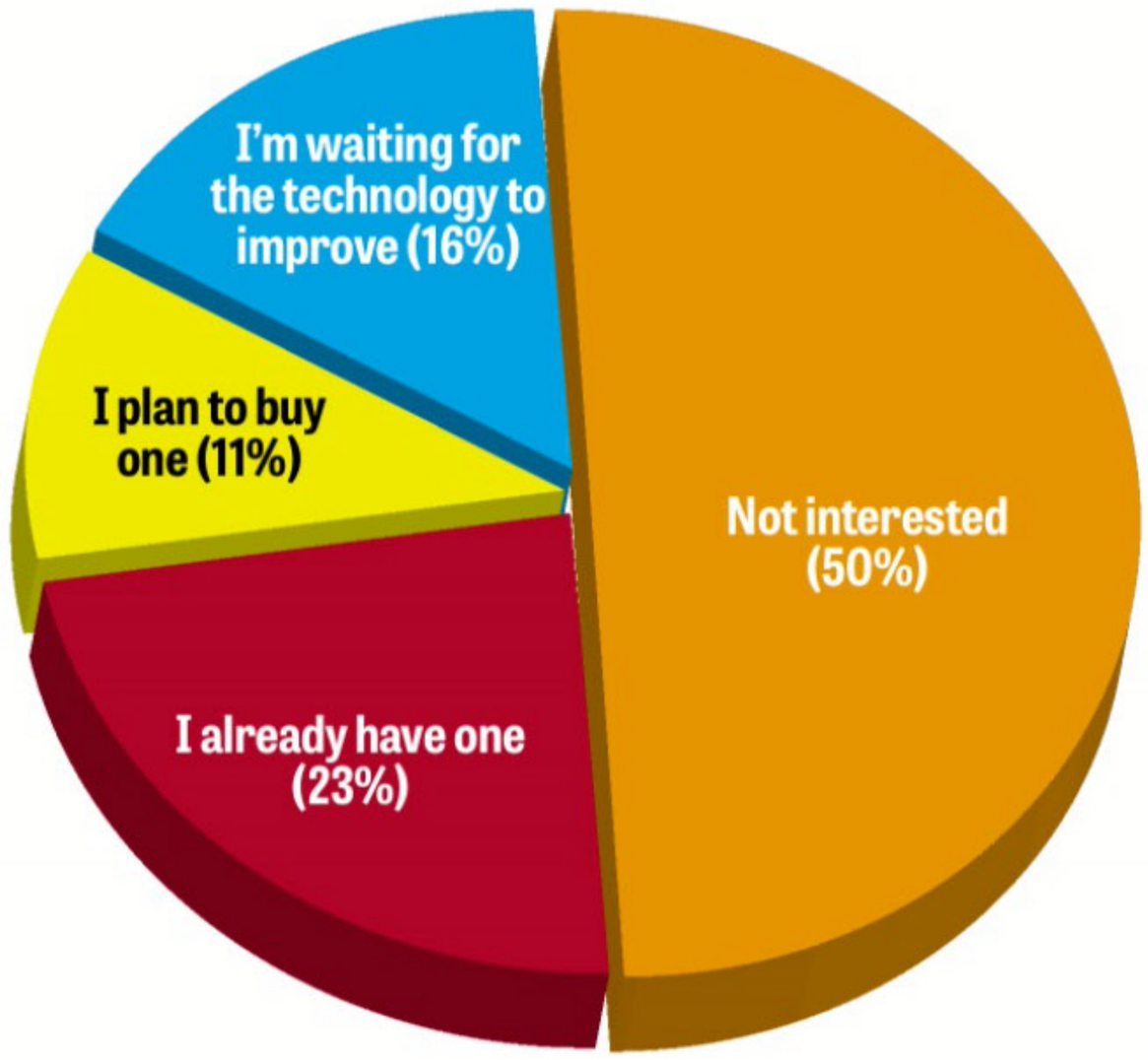
I then read reviews of the Garmin Vivosmart. For about £100 I now have a device on my wrist that does just what I want – and the battery lasts almost two weeks. I'm wondering why anyone would consider the Microsoft Band with its measly one-day battery life. **Dave Wright**

Extended licence

Recently, I thought I'd check the price of upgrading my Kaspersky Internet Security package. Clicking on the upgrade link, I received a message saying that I already had a subscription, which was set to run for 2,147,483,647 days. I've asked WHSmith for a diary for the year 5,883,516, but apparently it's out of stock. This is fortunate, since Kaspersky now says that I'm using the trial version again. **Peter B Thomas**

Readers' poll

We asked: are you planning to buy a smartwatch?



For some, a smartwatch is this year's must-have gadget, but half of our respondents declared themselves uninterested. That doesn't mean the idea is doomed, though: nearly a quarter of you are already wearing a smartwatch of some kind, a fantastic start for an industry still in its infancy.

Of those who expressed disdain for smartwatches, many pointed to the specific shortcomings of today's hardware – in particular, battery life. So as the hardware matures, more capable devices could yet win over the naysayers.

> **"Smartwatches have a good chance of becoming universal, but the price must come down"**

> **"My watch is waterproof and never needs charging. When a smartwatch can match that, give me a call"**

> **"I bought an Apple Watch and it has exceeded all my expectations. It's also made me realise how unfit I am"**

> **"I waste enough time on my phone. Life moves pretty fast; if you don't stop and look up once in a while you could miss it"**

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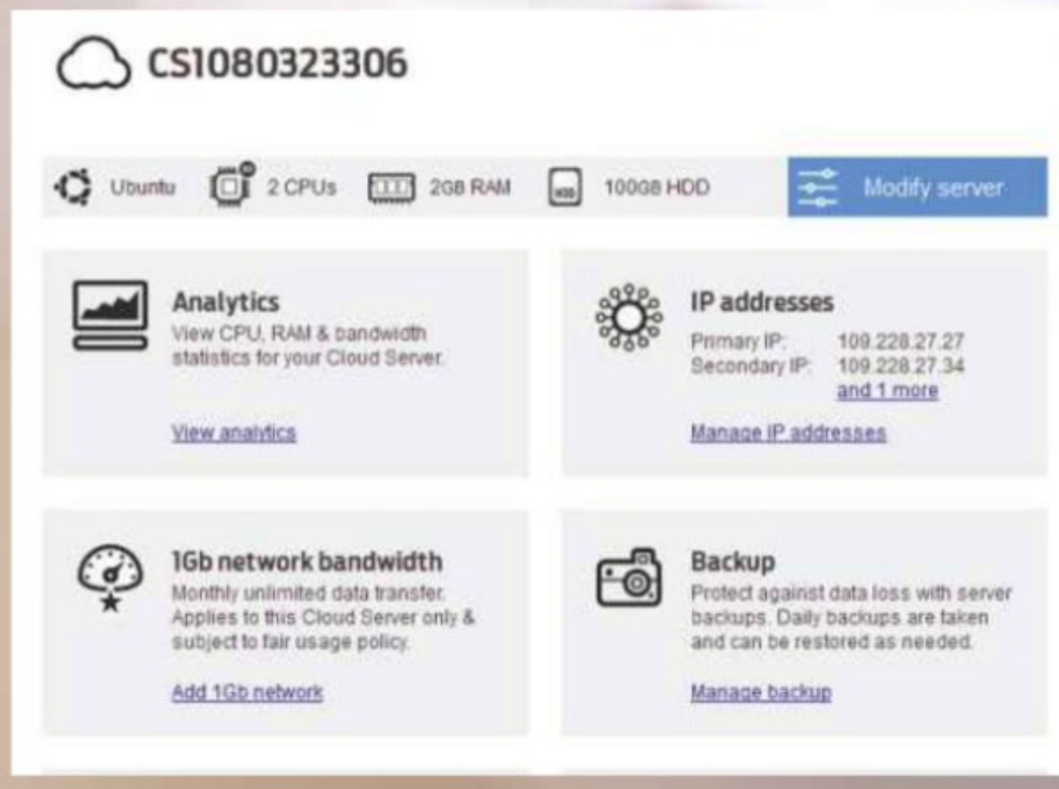
Richard Cullen, Managing Director at bluebox
Fasthosts customer since 2002

Cloud Servers – ultimate speed and resilience

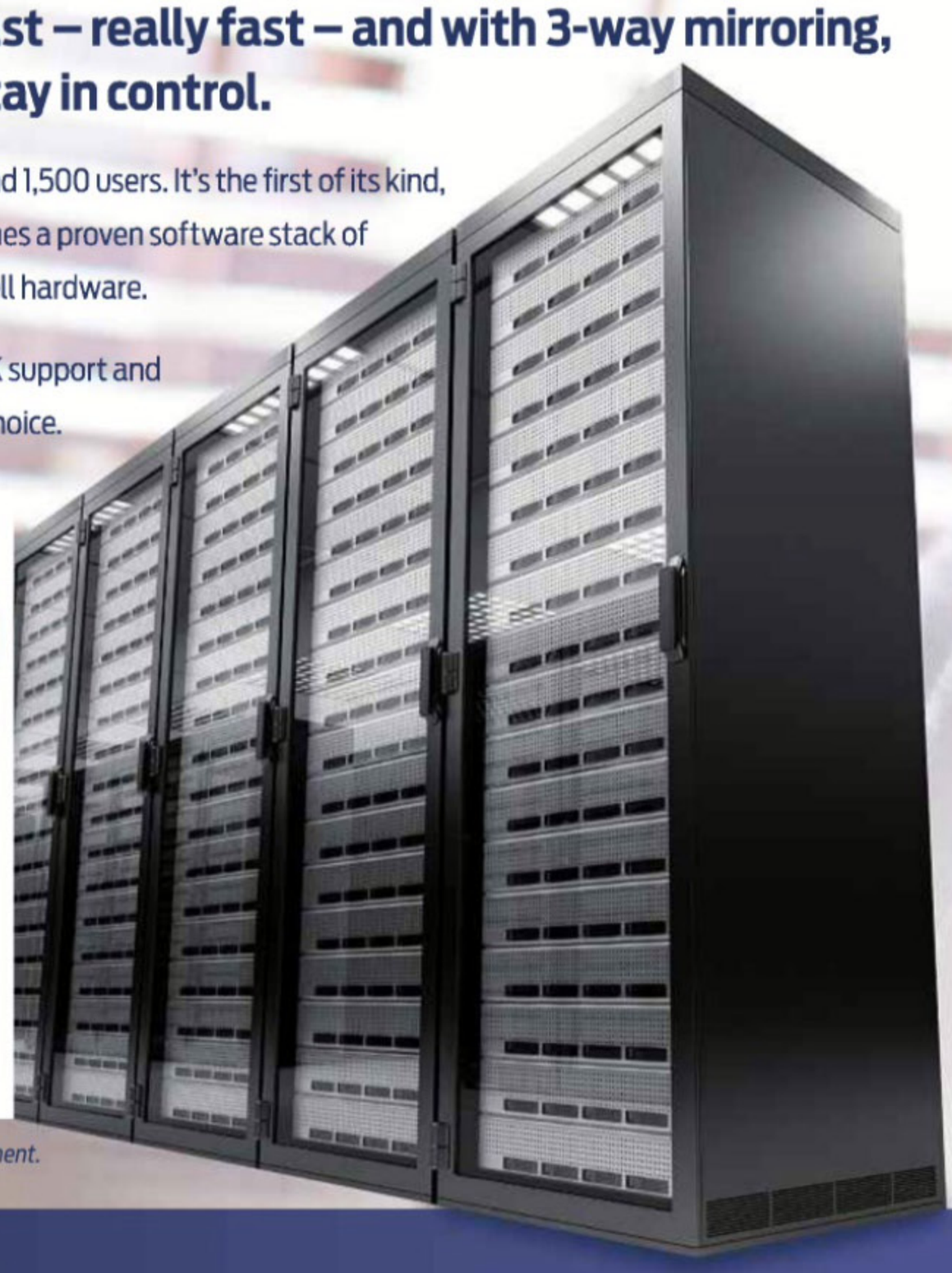
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Prospects

Upgrade your life, business and career with our practical projects and expert advice

Raising funds on Kickstarter
Get your project off the ground with the popular fundraising platform p32

Get started with PowerShell
Take control of Windows with this powerful scripting system p36

Careers
Could a career working with databases be for you? p40

Bring your project to life on Kickstarter

Got an idea for a technology project or product? Professional fundraiser Lise Smith reveals how to find funding on Kickstarter to make it a reality

Kickstarter is the perfect platform for getting your app, service or other technology project off the ground. Recently, products such as the Pebble Time smartwatch have attracted $20.3 million from more than 78,000 backers keen to get the device off the starting blocks, while the Exploding Kittens card game met its $10,000 funding goal in only eight minutes. More than $1.6 billion have been pledged through the site since launch, with a current funding success rate for new projects of around 40%. So how can you ensure that your project ends up in that 40% category with a full funding thermometer?

The first thing to understand is Kickstarter's "all or nothing" funding model. Put simply, this means that if you raise your target sum, you receive the money – but if you don't, you get nothing. This model is intended to motivate backers by giving funding targets some urgency; if you'd rather keep hold of any money you raise, check out alternative platforms such as Indiegogo (**indiegogo.com**) or GoFundMe (**gofundme.com**).

It's also important to be aware that you won't receive 100% of the money pledged. Kickstarter charges a commission of 5% on successfully funded projects, and payment processing costs a further 3-5%. This means that for every £1,000 your project requires, you'll need to raise around £1,100 in total. To see how you can do that, let's break down a Kickstarter campaign step by step.

Setting up an account

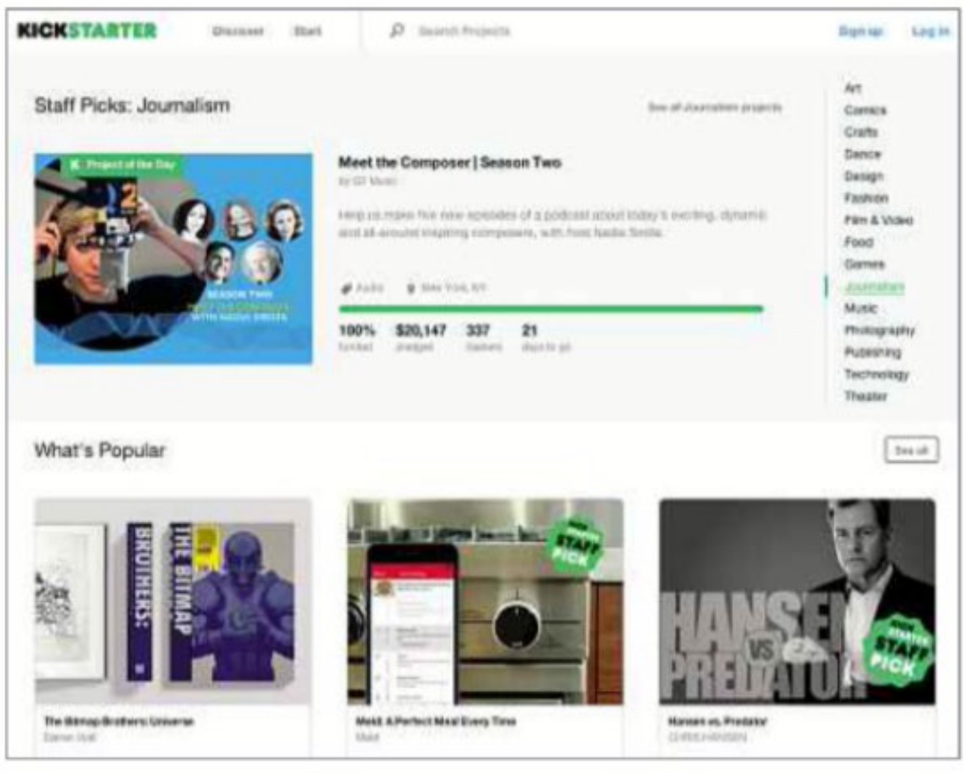
The first thing to do is ensure that your project meets Kickstarter's criteria. That means it must have one or more definable objects – clear goals with a product, event or experience as the end result – and a defined timeline for achieving them. Kickstarter can't be used for general business or charitable fundraising; other platforms such as GoFundMe can help if this is your aim. Check the full list of exclusions at **pcpro.link/250kstarter**.

You should also consider the scale of your project. If it's very long or very complex, consider dividing it into a number of separately funded stages (so that each phase of your campaign has its own funding target and a delivery goal). This can build confidence in your backers as you successfully meet each stage of the project, as well as splitting your funding targets into manageable chunks.



Lise Smith is a professional fundraiser and technology enthusiast

BELOW Many startups have raised funding for projects on Kickstarter



Once you're confident about the suitability and scope of your project, it's time to get a feel for what a successful campaign looks like. Kicktraq (**kicktraq.com**) analyses current and past Kickstarter projects in depth; browse the "Hot List" as you plan your project to see what works and what doesn't. Finally, it's time to set up an account on Kickstarter: to do this you'll be asked for basic information about the project, including your project category and funding target.

Describing your project

Your project page needs to inform potential backers of what your idea is, why they want it, and how you'll go about realising it. When it comes to choosing a title, think SEO: include the project name, but also a few words describing your product or service, so visitors can find and understand it at a glance.

There's no set template for the description, but aim to be clear and concise; think more along the lines of an elevator pitch than a detailed business plan. Avoid excessive technical jargon: you want to appeal

to everyone, not only specialists in your field. It's a good idea to get a friend to read over your project information before you submit it to the site, to check that your message is clear and understandable.

Think about presentation too: Kickstarter's text editor supports headings and bullet points, so make use of these to break up paragraphs and direct your reader's eye to what's important. You can link to a project website for further information, and embed JPEGs, PNGs and other image types. Design drawings, mock-ups and screengrabs can be useful aids to convey a complex or unusual idea. Keep your text fairly light – backers can always contact you through the site to ask questions if they require more information.

Making a video

Most Kickstarter projects include a video, which can be an efficient and engaging way to introduce your project to backers, to demonstrate how your product or service works in practice, and let people know a little about you. There's no need to invest in a professionally filmed video: many successful projects have been shot on a phone camera in somebody's front room.

You can upload footage in almost any major format, but there are a few gotchas to look out for: Kickstarter uses a 4:3 aspect ratio, rather than the more common 16:9 widescreen format, and there's a maximum file size limit of 5GB. This shouldn't be a problem since it's a good idea to keep your video short: two minutes or less is a good length for which to aim.

When it comes to content, footage of yourself (or a member of your team) speaking directly to the audience is more appealing than an anonymous voice-over, but also include images or video footage of your product in development, to help backers visualise the idea.

Setting the right funding target

Setting the right target is key to the success of your campaign, so spend some time considering what your project requires to get off the ground and from where that money is likely to come. Take a look at recent successful campaigns in your area of interest – again, Kicktraq can help you here. Don't just examine the total funds raised but also note the number of backers and the most common sum donated. Together, these will provide a good ballpark figure to aim for and the kinds of rewards to offer.

When your campaign is over, Kickstarter will use payment partner Stripe (**stripe.com**) to automatically collect payments from backers, who will need to enter card details in order to make a pledge. Note that some other crowdfunding platforms require backers to have a PayPal account from which to collect money – check that the payment method used is suitable for your donors.

If you're already a well-known company with an established customer base and a good reputation, you should have no problem reaching potential backers. If you're a small startup or an individual making a first foray into business, your backers are more likely to come from personal contacts: multiply your friends and acquaintances by a typical pledge to get a realistic target figure. See our advice below for tips on how to get the word out and start people backing your project.

Rewards

Kickstarter rewards are the benefits you offer your backers to attract them to your project. They're usually something associated with your project, such as an advance copy of your finished product, sent either physically or via digital download, or merchandise.

For low-level donations, consider offering rewards that are either free or very low cost to produce and distribute. "Digital rewards" are perfect here: that might mean a personalised message of thanks on social media, images of your project in progress, or a thank-you video from your team. If you're distributing physical rewards (including advance or reduced-price copies of your product), triple-check you've built their costs into your funding target, or you may find you're left with a big hole in your budget.

Most Kickstarter creators distribute rewards at the end of a campaign, but there's nothing to stop you posting digital rewards while the campaign is running. This can help to create a buzz around your campaign, especially if you make the reward a video or image that the recipient is likely to want to share online.

Launching the campaign

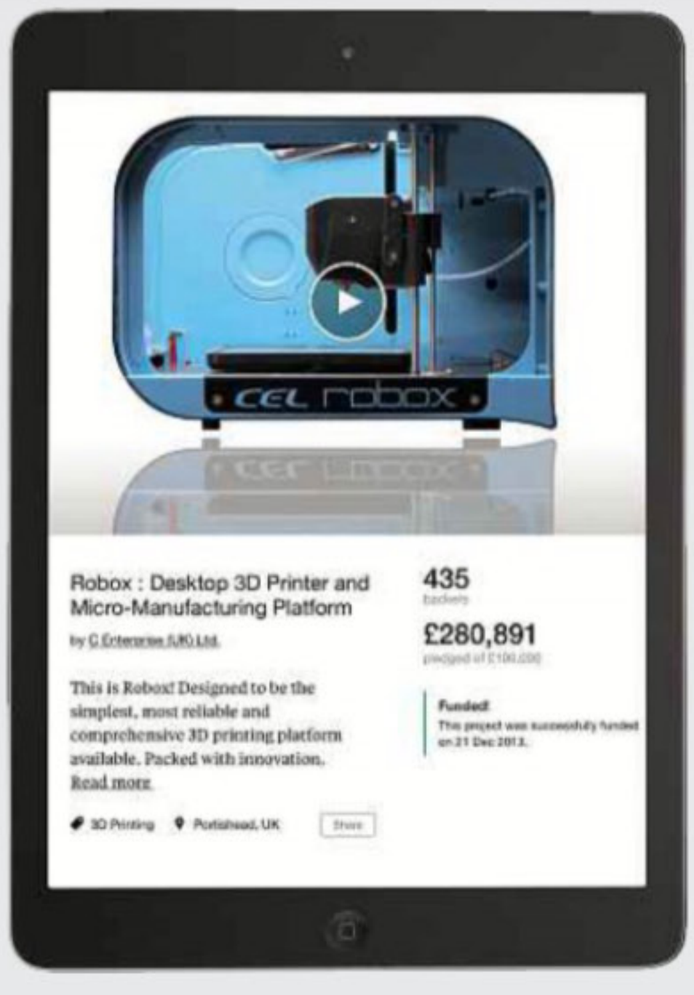
Before you go live, it's a good idea to have an initial group of donors primed (perhaps some good friends, loyal customers or members of your board) to pledge as soon as the campaign goes live. This helps get your funding thermometer off the zero spot and gives your project the sheen of success. Email your most likely backers to let them know when your campaign will launch, and email again when it's live.

This is also the time for a big push on social media. As with all social

4 ways to kickstart your campaign

Kickstarter for iOS/Android (free)

Monitor donations and send campaign updates from wherever you are with Kickstarter's official mobile app. At present you still need a desktop computer to launch or edit your campaign.

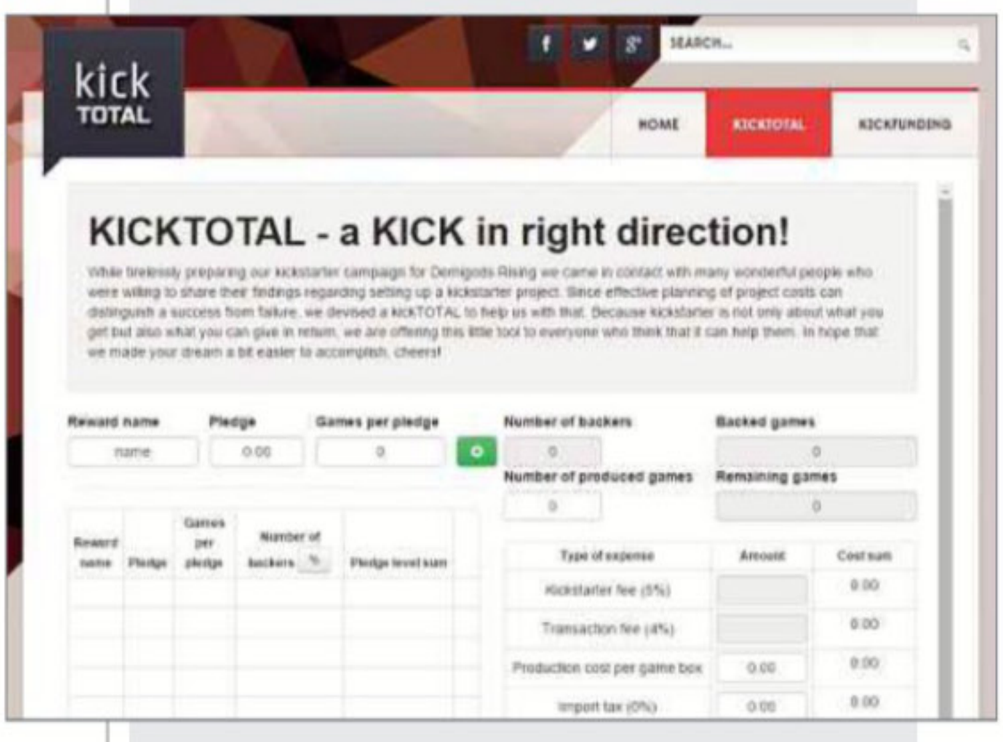


Boomerang for Gmail (unlimited, from $5(£3)/mth)

Craft personal emails and send them to potential backers at the ideal time of day with this email-scheduling tool.

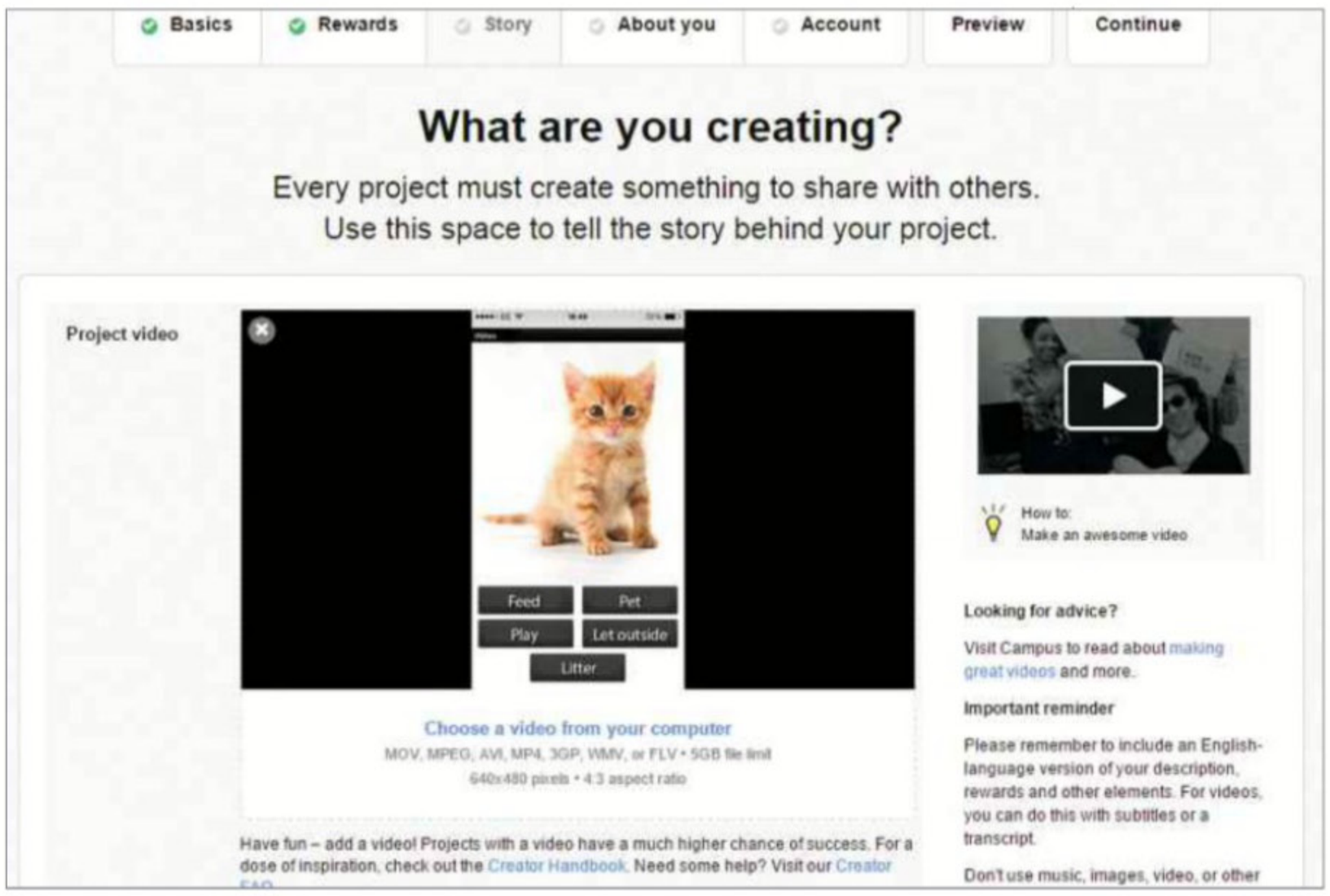
Kicktotal (pcpro.link/250kicktotal)

Hosted by crowdfunding veterans, this handy web service lets you tot up your project's costs, along with fees, the cost of any rewards and expected sales revenue, to ensure your fundraising finances stay on track.



BackerKit ($99(£65)/mth)

If your project attracts very large numbers of backers, BackerKit can help you track backer contacts and manage rewards – including those that aren't offered through Kickstarter.



media ventures, timing is key: choose a time when your target audience will be online and available to click through, read about your campaign and watch your video.

Promoting and updating your campaign

Potential backers may not immediately jump at the opportunity to support your campaign, but repeated exposure can win them over. A daily summary on Facebook is a good way of keeping your project visible, and don't be afraid to ask your backers to share the campaign on their social media – reaching beyond your own immediate circle of contacts is key to getting the Kickstarter ball rolling.

Also consider setting up a dedicated Facebook page for your project where you can post images, videos and acknowledgements from your backers, and invite those who are likely to support you to the group. Share content on your personal feed as well and encourage your team to do the same – support can sometimes come from unexpected quarters!

Genuine communication and real enthusiasm go a long way, so combine scheduled updates with personal posts thanking donors – unless a donor has asked to be anonymous, it's good practice to put a name on Twitter and Facebook, which not only says thank you, but also reminds people that your campaign is running. Don't neglect your Kickstarter campaign page either. When you add an update here, Kickstarter will automatically send it out as an email to existing backers. Advertise when you've hit a milestone (such as 50% funded and 75% funded) to raise confidence in the project going forward, with the aim of forcing floating donors off the fence.

Aside from social media, draw up a list of key contacts (such as existing customers, industry contacts or close colleagues) and plan out regular email contact with them. Tools such as Boomerang and MailChimp are good for scheduling and sending mass emails. If you're targeting particularly wealthy or influential people it's best to craft an individual email approach.

You'll also find support and advice via online forums. As a first port of call, try the Kickstarter forum on Reddit (**pcpro.link/250kstarter2**) – this active forum of more than 25,000 members can help boost interest in your project. Cross-post to other forums related to your project area: enthusiasm from Reddit has been credited in the success of high-profile campaigns including Cards Against Humanity and Exploding Kittens.

Kickstarter's Creator Dashboard will show you a breakdown of daily funding progress and pinpoint from where your web traffic is coming, so you can analyse how effective each email, tweet and Facebook post is to your campaign. If you want to share daily goals with your customers and friends, embed the Kicktraq Mini widget onto your website or forum to show off how well you're doing.

ABOVE Short videos about your product or idea are a great way to engage potential backers

After you've hit your target

If you hit your funding target before the end of your campaign – a common occurrence as the public gets used to the idea of Kickstarter – there's no need to stop campaigning. Now's the time to update your backers and make them aware of your "stretch goals" for any extra money raised. If you show how you'll include extra funds in an updated business plan, chances are you'll continue attracting backers until the end of your campaign.

Nor should the end of the campaign mark the end of your activity. You can continue to post updates on your Kickstarter page to keep backers informed about how your project is developing, and the delivery of any outstanding rewards. If production is delayed or it's taking longer than anticipated to complete the work, let them know why – in general, donors will understand a change of plan, but won't appreciate being kept in the dark.

Finally, good luck and let us know if you decide to start your own firm by emailing **letters@pcpro.co.uk**.

BELOW Kicktraq provides useful information on current and past Kickstarter campaigns



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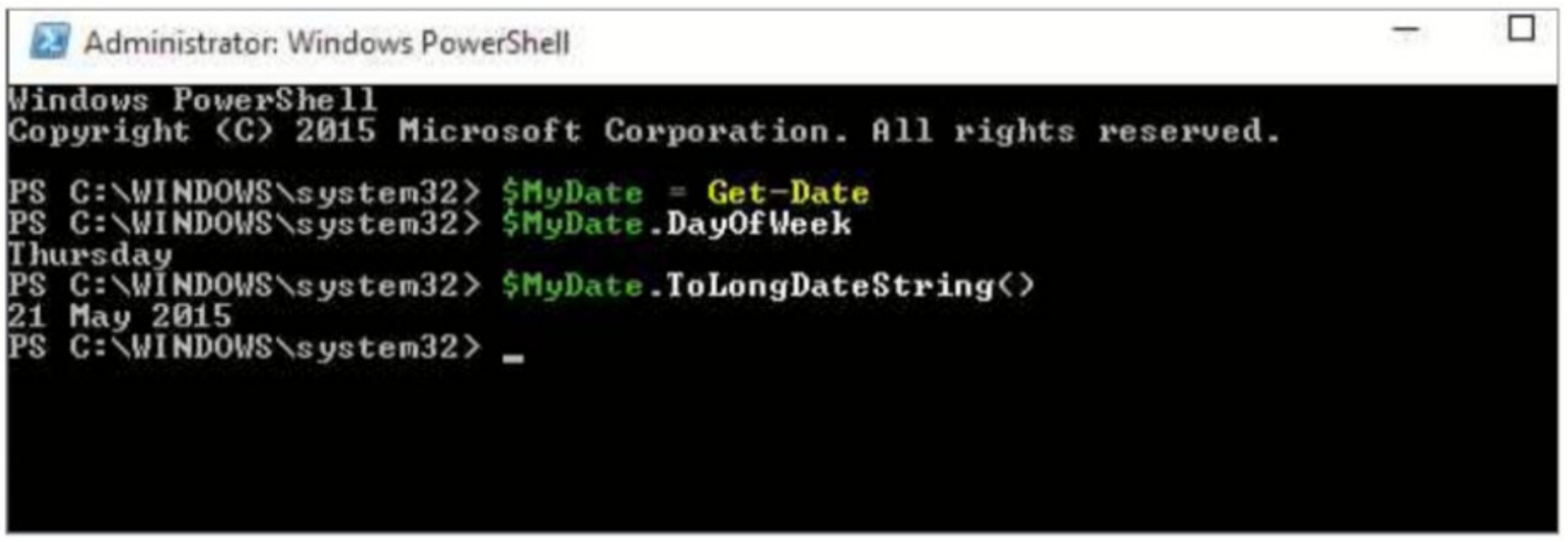
Make Windows admin easy with PowerShell

Windows' next-generation scripting host can save you time and effort when it comes to managing PCs. Jonathan Noble introduces PowerShell

Computer management involves a lot of repetition. Whether you're supporting a multinational corporation, or just helping out friends and family, you probably find yourself doing the same tasks over and over again. You might even have a collection of utilities that you've carefully curated over the years to help you deal with the issues you come across regularly. If this sounds familiar, then one addition to your toolbox that will prove invaluable is PowerShell.

PowerShell is basically a scripting language and an interactive shell. In that way it's similar to the familiar command prompt, or the Windows Script Host that handles JScript and VBScript files. It's more powerful than either, however: there are things that you might want to do in the Windows ecosystem that can only be achieved with PowerShell.

Why's that, you ask? Well, several years ago, Microsoft decided to make PowerShell its preferred administration automation tool. So now, if there's anything being developed inside the company that offers a management interface, that interface will be made accessible from PowerShell.

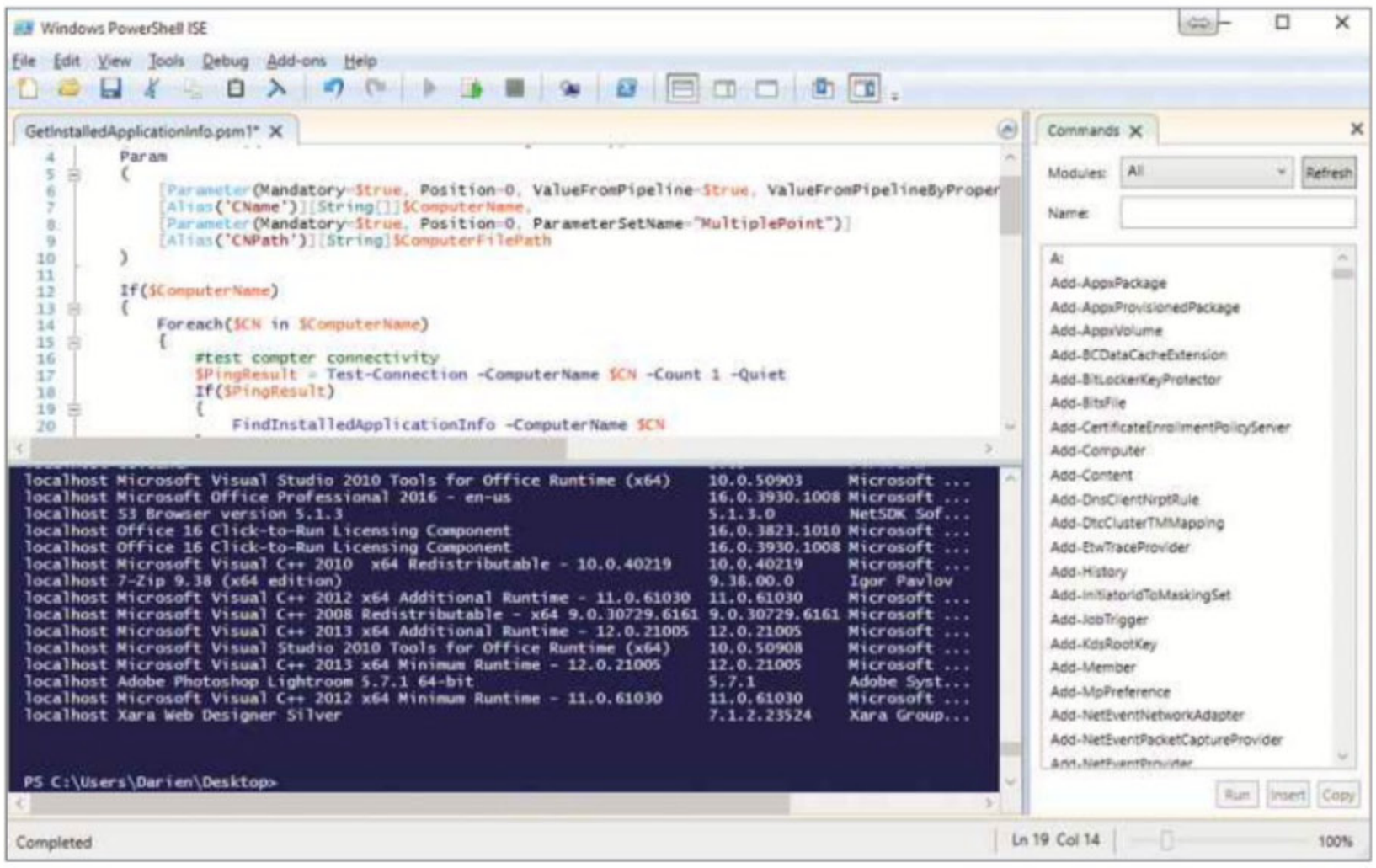


In practice, many product groups inside Microsoft actually develop their PowerShell interface first, and then build a graphical interface on top of that. Some products, such as Microsoft's recently announced Nano Server (for cloud-scale infrastructure workloads) don't have an external interface. So PowerShell is the most versatile, and sometimes only, way to manage OS components.

Inevitably, getting started with PowerShell involves a learning curve.

ABOVE A few simple commands illustrate object-oriented syntax

BELOW The PowerShell ISE is a rich scripting environment



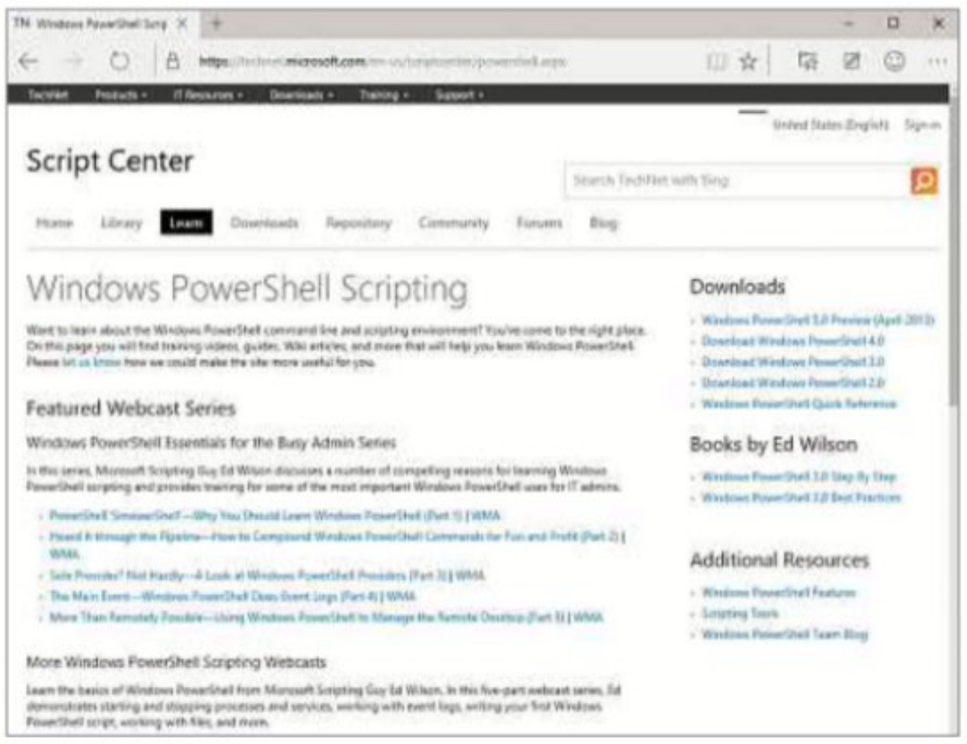
But it isn't difficult: if you find yourself repeating the same processes over and over again, the time it takes to automate the task in PowerShell quickly pays off. A guy I know who was a Microsoft Premier Field Engineer once told me that he loved PowerShell because it gave him more time to spend with his family.

PowerShell syntax

The PowerShell language is object-oriented, and in fact uses the same objects as other languages built on the .NET framework – so if you're already familiar with C# or Visual Basic, you have a head start. If not, you don't need to worry about it.

What you do need to know is that the basic units of functionality in PowerShell are called cmdlets ("command-lets"). Each cmdlet has a name structured as "verb-noun" – examples include Get-Command and Copy-Item. As you can see, the commands are generally understandable in plain English, although there are a few exceptions, such as "ForEach", which is a verb in PowerShell. The language uses a limited number of verbs, so the syntax is quick to learn: if you want to retrieve some information, you know it's always going to be Get-something.

When you launch the PowerShell Integrated Scripting Environment (ISE), you'll see a pane on the right-hand side full of cmdlets, along with some built-in aliases and functions (which are like



ABOVE **There's a wealth of online resources on which to draw**

mini-scripts). This pane can be used to search for valid keywords, and to help you find the command you need. You can also filter the list based on modules – essentially, packages of cmdlets, functions and so forth that relate to a particular task. As you develop your PowerShell skills, and start writing your own functions, you can bundle these together in your own modules, and share them with colleagues or the wider community.

You can also make a list of the cmdlets available to yourself by running Get-Command. This is one of the most useful cmdlets to remember, because it lets you explore the wider PowerShell environment and work out everything else from there. Another important one to know is Get-Help, which provides guidance on using the available cmdlets: for example, to learn more about Get-Command you'd simply enter "Get-Help Get-Command". The first time you run Get-Help without any parameters, it will walk you through the process of downloading local help files for all of the modules and core features, using the Update-Help cmdlet.

Get-Help isn't limited to defining cmdlets; it can tell you about other aspects of PowerShell language too. "Get-Help About_If", for example, will show you how to use the If statement in a script. You can see the full list of topics by running "Get-Help About*" – you'll find content about variables, loops, conditional statements, error handling, operators and many more advanced capabilities.

Using a cmdlet

To see how cmdlets work, let's look at a commonly used cmdlet: Get-Date. Type it at the command line and you'll see today's date. As I said earlier, however, PowerShell is all about objects, so what appears onscreen is actually a representation of a .NET System.DateTime object, which is far more functional than a mere string of text. It comes with a bunch of properties, which include the current time, day of the week and the day of the year, and also exposes a number of methods that we can use for formatting the date in a particular way, for example, or comparing it to another date, or checking whether it falls within a daylight savings time period.

"The PowerShell language is object-oriented, and in fact uses the same objects as other languages built on the .NET framework"

To see how this works, let's load the date into a variable – we'll call it $MyDate – and then access its properties and methods by entering the following commands:

```
$MyDate = Get-Date
$MyDate.DayOfWeek
$MyDate.ToLongDateString()
```

The above commands will output the day of the week for the current date, and then output the whole date as a string with the month as a word.

Collectively, the properties, methods and other features of an object are called its members; if you want to find out what members an object has, you can use – predictably enough – the Get-Member cmdlet. We pass our object to the cmdlet using a "pipeline", which lets you use the output of one command as the input for another. So, to see what members $MyDate has, we'd pipe it into Get-Member as follows:

```
$MyDate | Get-Member
```

This is more or less the simplest possible use of a pipeline, but you can easily create longer pipelines that feed one or more objects between multiple cmdlets:

```
Get-Service | Sort-Object Status |
Format-Table Name,Status
```

In this case, Get-Service outputs a collection of Windows services as objects; these get passed to the Sort-Object cmdlet, which organises them by status (that is, whether the services detailed are running or not) before passing its

Getting started with scripting

To create a PowerShell script, you can open the Integrated Scripting Environment directly from the Start menu (or Start screen if you're using Windows 8). By default it will open with an interactive command line; click the New icon or press Ctrl+N to open a new script-editing pane, into which you can type your code. Here's a sample script for removing multiple Windows Store apps:

```
# When the Gridview control pops up, you can select multiple apps by shift/ctrl clicking
Get-AppxPackage | Out-Gridview -PassThru | ForEach-Object{
  $AppName = $_.name # In a ForEach loop, $_ is the current object
  Remove-AppxPackage -Package $_ -Confirm # The Confirm parameter is a safety net
  # Some built-in apps can't be removed, so let's check that
  If ($?) { # $? is a handy built-in variable to tell you if the last thing worked
    "$AppName was removed."
  }
  Else {
    "$AppName could not be removed."
  }
}
```

You can run or test your script by clicking the "Play" toolbar icon, or hitting F5; a shortcut with which you'll be familiar if you've used Visual Studio. The output appears in the command prompt pane.

When your script is complete and working, it's time to save it. The standard extension for PowerShell scripts is PS1 (although in Windows 10 we're now up to version 5 of PowerShell, Microsoft decided to leave the extension the same after version 1). There's no official standard location for PowerShell scripts, so just put it somewhere convenient. If you begin writing lots of scripts you might want to collect them into a folder and set up a profile for yourself that automatically looks in that folder for scripts: to learn more about this, try Get-Help About_Profile.

Once your script is saved, you can run it by entering its name in the PowerShell command prompt. The first time you try it, though, you'll see an error message: as a security measure, PowerShell scripts are disabled by default. You can change this by entering Set-ExecutionPolicy Unrestricted – but note that you'll need to be running PowerShell as an administrator to make the change.

output to the Format-Table cmdlet, which generates a table containing the name and status of each service. It's worth noting that Format-Table actually changes the type of the objects that pass through it: it outputs a bunch of internal formatting objects that are passed invisibly to another cmdlet called Out-Host, which displays them on the screen.

Knowing the three cmdlets Get-Command, Get-Help and Get-Member can take you a long way. Let's throw a fourth into the mix: Get-PSDrive, which can be used to enumerate the drives on the machine. This naturally includes local hard disks, but there are interfaces to other resources too: the Registry provider, for example, provides access to HKEY_LOCAL_MACHINE and HKEY_CURRENT_USER as PSDrives. This means that you can do cool things like "cd HKLM:\Software", see what's there with "dir" and modify things with Set-ItemProperty. Try running Get-PSDrive on your system to see what comes to the surface – some products install their own providers and you might be surprised at what you have access to.

Aliases and abbreviations

In the example above, you might have noticed that "cd" and "dir" don't follow the PowerShell verb-noun format. These are actually aliases, which are included to help people who are more familiar with using command prompt or Unix-type shells on other systems. The cmdlets they access are called Set-Location and Get-ChildItem, but who wants to do that much typing? If you have a Unix background, you can also use "ls" in place of Get-ChildItem. I'd tell you how you can find a full list of aliases, and how to make new ones, but by now you should be able to work it out for yourself.

PowerShell also lets you abbreviate keywords, as long as there's no ambiguity. As an example, here's a command that accesses the Windows event log, extracts any events of the type "Error", and then pipes the results into table format:

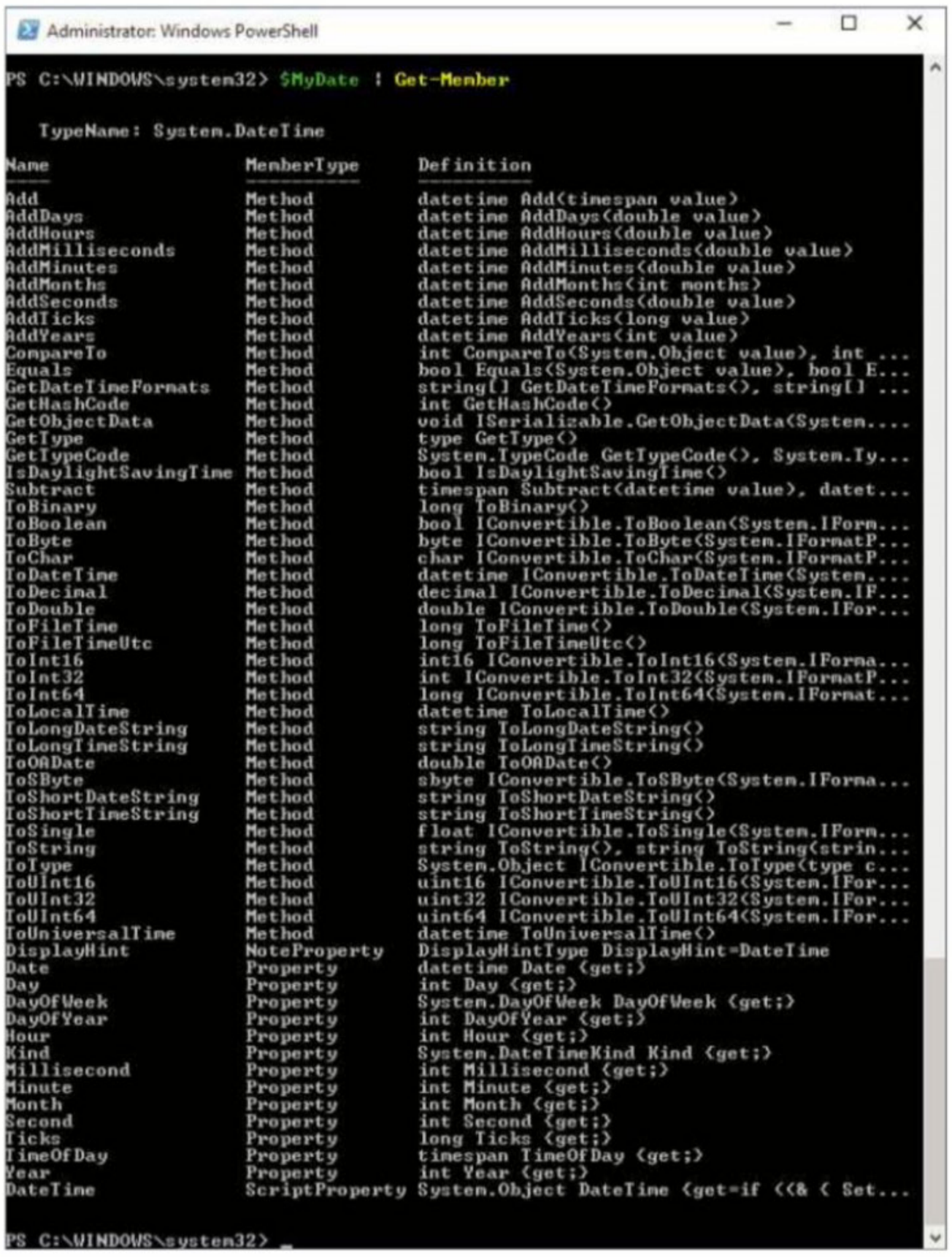
```
Get-EventLog -LogName System
-EntryType Error | Group-Object source |
Sort-Object Count -Descending |
Format-Table Count,Name -AutoSize
```

You could get exactly the same effect by typing the following:

```
Get-EventLog -Lo System -E Error | Group
source | Sort Count -D | FT Count,Name -A
```

The shorter version isn't half as easy to read though!

RIGHT A few simple commands expose the depth of PowerShell



Desired State Configuration

I can't let you go without mentioning Desired State Configuration. DSC is a feature that was added to PowerShell with the release of Windows 8.1, and if you manage Windows servers it's something you need to know about.

Before DSC, PowerShell was imperative, meaning that you ran some commands, or a script, and you got back some results. DSC is a declarative expansion of the PowerShell language that lets you define the state a system should be in, without necessarily specifying how to get there. DSC's Local Configuration Manager can then check periodically whether your system is still in the desired state; if it's not, it take steps to put it back how it should be.

"Even if you're looking after only a few systems, having confidence that critical items are going to stay in the correct state is important"

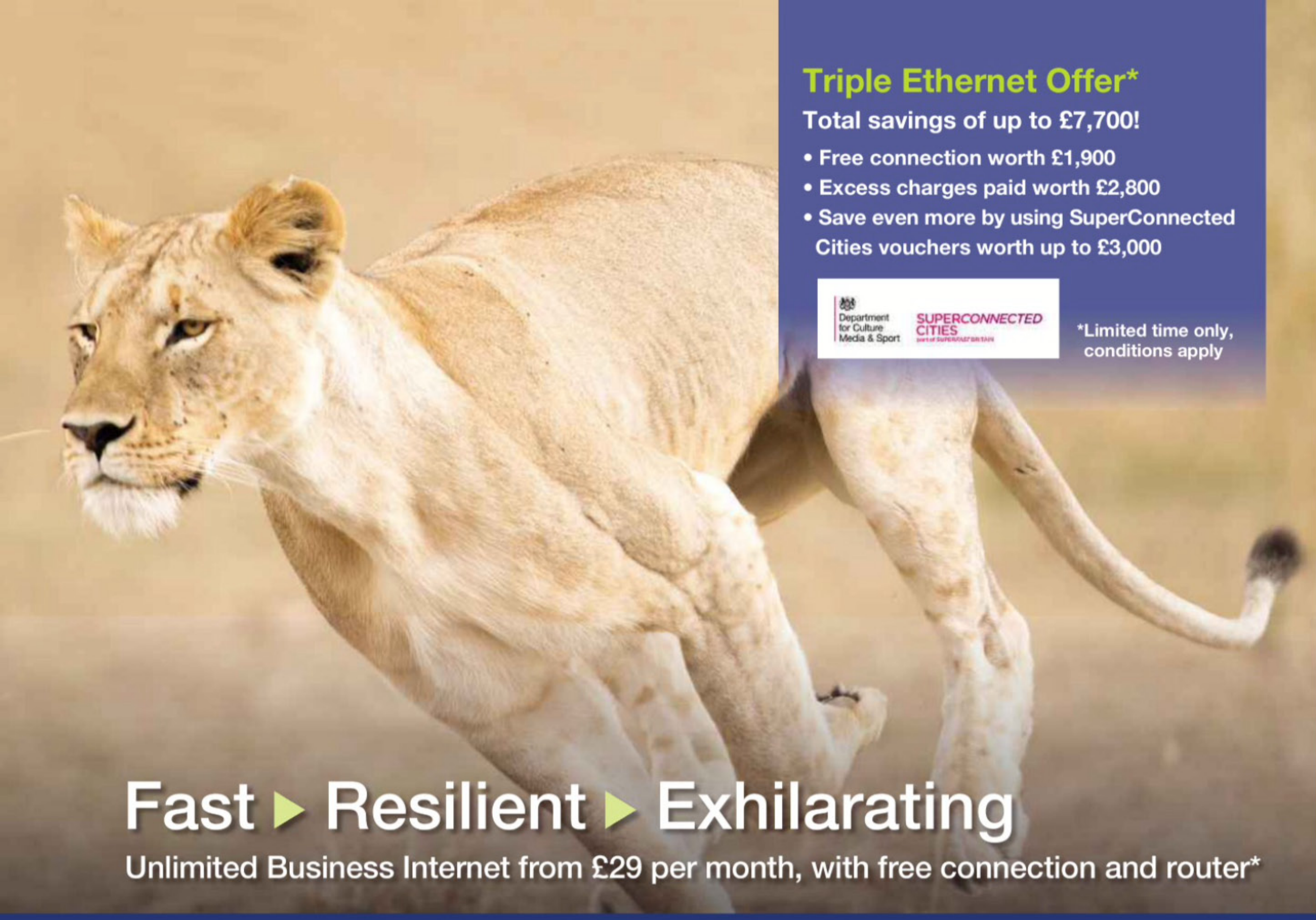
This is an incredibly useful ability, especially if you're managing a large infrastructure, where configuration drift can go unnoticed until it becomes a problem. Even if you're looking after only a few systems, having confidence that critical items are going to stay in the correct state is important too.

Now that you understand the fundamental principles of PowerShell, you can see that there's a huge amount that it can do.

To begin exploring, I suggest you head to **microsoftvirtualacademy.com**, where you'll find some excellent training courses from PowerShell MVP Jason Helmick and Jeffrey Snover, the inventor of PowerShell.

A good place to start is with "Getting Started with PowerShell 3.0 Jump Start" (**pcpro.link/250powershell**). From there you might want to move on to more advanced courses: invest a few hours in learning all the content that's on offer and you'll be in a great position next time you're called upon to administer a Windows system. ●

Jonathan Noble is a five-time recipient of a Microsoft MVP Award for PowerShell. He spends his days automating the IT infrastructure at Newcastle University and his nights dreaming that he was better at basketball. You can follow him on Twitter as @jonoble and read his infrequent articles about tech topics at thetektonic.com.



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Neil Chandler

Database administrator



What is your job?
I design, build, monitor and run relational databases, generally using Oracle, but sometimes with Microsoft SQL Server. I'm working in the financial sector, but almost all corporations use databases, so a database administrator (DBA) might work in any industry.

Some DBAs work on the development side, focusing on design and performance, while others are more concerned with data availability, disaster recovery and storage layouts. In very large organisations, such as tier-one banks, these will be two separate functions; in smaller organisations, one team might be responsible for it all.

What skills do you need?
To build a database, you need knowledge of a business' requirements for availability, performance and so forth. You also need a grasp of the technology: memory access, storage tiers and data partitioning. I'm currently working on a stock-market trading system, which requires rapid response times for some parts.

What does a regular day look like?
Much of the daily routine is a response to: "We've got a problem – can you fix it?" This morning, I've been working on a system from which we wanted to extract the data more quickly. I spent time diagnosing a problematic SQL query, and after making a small change to the system, the data is now coming out in fewer than three milliseconds.

Another thing I did this morning was to ensure that everything was working the way it's supposed to be working: whether backups have run successfully, for example. You may go through a runbook of "Is A working? Is B working?" and so on, fixing anything that isn't working as it should. You can use Oracle's management and monitoring system, Cloud Control, to help with the day-to-day alerting and administration.

Is there a lot of out-of-hours work?
Very much so. This past weekend we had a serious issue come up, so after a 50-hour week I ended up putting in a 19-hour weekend. I think I've been woken at three in the morning in every DBA job I've had. Also, changes to systems may need to take place at unsociable hours, when there's less demand. Larger organisations often have a rota of DBAs, so you might only be on call for one week each month.

There are external activities a DBA could be involved in too, such as the UK Oracle User Group (UKOUG) –a large professional group, where you basically get a whole load of geeks together in a room, talking about Oracle, with presentations by senior DBAs. These are like mini-training courses. Organisations have to pay to join the UKOUG, but there are free groups such as #ClubOracle and Oracle Midlands, which tend to be sponsored by consultancies. There's also an SQL Server user group called SQL PASS.

How did you get into this line of work?
To become a DBA you tend to start as either a server administrator or a developer; I chose the latter. I used to write assembler code on IBM mainframes a long time ago, and then, as often happens in smaller firms, I found myself being asked to take on additional tasks. One such task was Oracle database administration, which I enjoyed more than coding. Rarely do people come into database administration directly from a graduate programme, although it does happen.

£34k
Approximate starting salary

1,798
permanent jobs (itjobswatch.co.uk)

£45k
Average earnings

What's the downside of the job?
As I say, you tend to be very much in demand. At 6pm last night, just as I was leaving the office, one of the managers asked, "excuse me, can you help me with this?" That's very common. After a 19-hour weekend, though, I was none too keen.

Keeping up to date also takes some effort. I've been working on Oracle for more than 20 years, and it's a continual learning process. It changes rapidly, so much so that it scares you.

What advice would you give to someone interested in becoming a DBA?
If you already work in IT, shadowing DBAs would be a good place to start. You can learn a lot that way, and from online resources too; websites such as Ask Tom (**asktom.oracle.com**) and SQL Server Central (**sqlservercentral.com**).

It's also worth getting an industry certification, because that will make you a more saleable commodity. It's a big commitment, however: you have to pass five exams to become an Oracle Certified Professional, and take at least one instructor-led class. Certifications also expire, so you have to renew them every few years. The SQL Server MCSE route isn't any easier.

What's the pay like?
An Oracle DBA in London will happily earn around £50,000 a year – and when they become senior and gain a significant level of expertise, they can have a package in excess of £100,000. But to become a truly excellent DBA, and to earn that sort of money, you'll have to dedicate some of your personal time. ●

Where to start

- **Oracle Database Concepts for each Oracle release – available online, and it's free**
- ***Effective Oracle by Design* by Thomas Kyte**
- ***Oracle Core: Essential Internals for DBAs and Developers* by Jonathan Lewis**



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- Microsoft Windows 7 Pro 64-bit

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The GW-HTX30 marks a giant leap forward in performance thanks to having two 8-core Intel Xeon E5 2640 V3 CPUs. These are partnered with a 4GB NVIDIA Quadro K4200 professional graphics card and 64GB of 1600MHz ECC Registered DDR3 plus a 240GB SSD and 2TB HDD .

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99 things you need to know about Windows 10

Windows 10 is Microsoft's most important operating system release since Windows 95. It's also the most ambitious, bringing new technologies, new ways of working across multiple devices and a whole new upgrade model. Here's everything you need to know, according to the latest information available – so when it's time to upgrade you'll be ahead of the curve.

How to get it

Become a Windows Insider

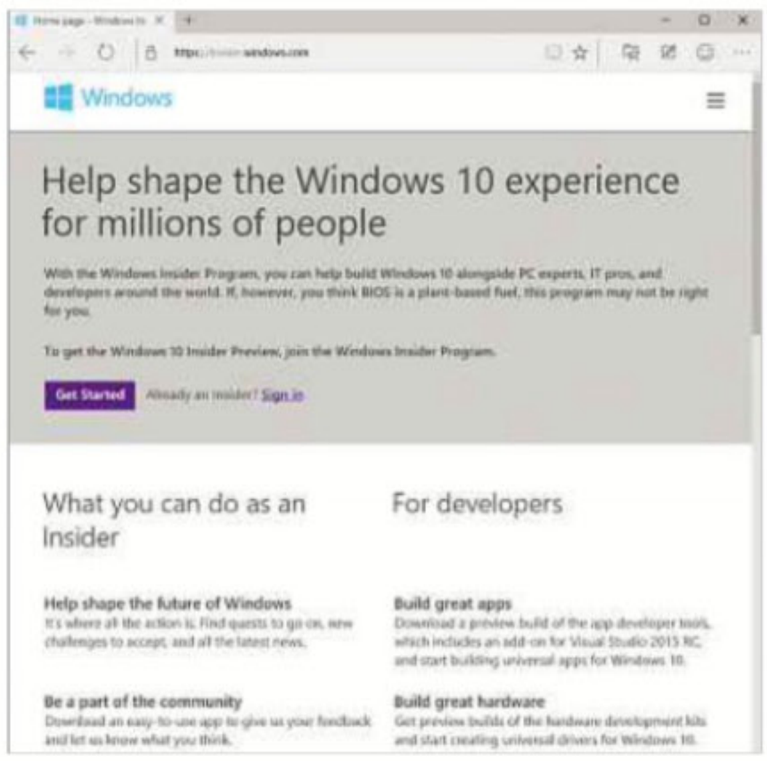
Almost four million Windows users are already test-driving a preview build of Windows 10. You can too, by signing up to the Windows Insider Programme (**insider.windows.com**). Through the Windows Feedback app, Insiders can also submit bug reports to Microsoft and vote on feature requests – so Windows 10 will be shaped by real user feedback.

When is the official release?

At the time of writing, Microsoft hasn't set a firm date for the release of Windows 10, but all the signs are that it will be with us sooner rather than later, with final code potentially provided to manufacturers of PCs and tablets as early as mid-July. That would mean we'd see Windows 10 systems in the shops in time for the late summer "back to school" period.

Windows 10 preinstalled

It's long been a truism that the easiest way to upgrade to a new OS is to buy a new computer with it preinstalled. For Windows 10, Microsoft has confirmed that new devices with screens smaller than 9in will qualify for a free OS licence. That means a lightweight Windows 10 tablet could easily cost less than £100.



A free upgrade for current users

If you don't want to buy new hardware, the great news is that most current Windows users are eligible for a free in-place upgrade. The offer is open to anyone running Windows 7 or 8, and will run throughout the first year of Windows 10's availability. As long as your existing installation is up to date, you'll be able to download the new OS directly via Windows Update.

Short on storage?

Even compact tablets with limited storage should be perfectly able to run Windows 10 – but Microsoft has warned that they might not have enough space to download and install the upgrade. The publisher is "evaluating a couple of options" for working around this – our guess is that you'll need to copy the installation files onto an external USB device.



Upgrading from Vista and XP

Windows 10 is designed to work smoothly on low-powered tablet hardware, so it should be usable even on older Windows Vista or even XP systems. But the upgrade won't be free, and you'll have to perform a clean installation. There's better news for Windows Insiders: Microsoft intends to allow a direct upgrade from the Technical Preview to the final code.

RT no more

Sad to say, tablets running Windows RT won't receive the full upgrade. Evidently, Microsoft has concluded that it isn't worth the effort of porting Windows 10 to the ARM architecture (even though Windows 10 Mobile is designed to run on ARM-based smartphones). There may be a consolation prize, though: a promised final update for RT devices could provide limited support for Universal apps.

Windows-as-a-service

Windows boss Terry Myerson has said that Windows 10 will usher in the age of "Windows-as-a-service". In other words, future OS updates will be rolled out for free as soon as they become available – so there won't ever be a big landmark launch of Windows 11. It's a huge change in the way Microsoft distributes its most ubiquitous product.

Moving up to Redstone

After Windows 10 arrives, it's already been suggested that we'll see a first update in October, adding features that didn't make it in time for the launch. Then a major update codenamed Redstone is slated for summer 2016. Reportedly, Redstone will improve support for new devices such as the HoloLens and Surface Hub – but we'll have to wait and see.

The Insider Programme carries on

Insider Programme members who've enjoyed trying out pre-release code may be ambivalent about the OS being released. But the programme doesn't end on launch day: corporate vice president Joe Belfiore has confirmed that Insiders will be given the option to carry on as pre-release testers for future updates, including Redstone.

How is Microsoft going to make money from Windows 10?

With free upgrades to Windows 10 via lifetime updates, some have wondered how Microsoft will make money from its new OS. A subscription deal is a possibility; Microsoft claims that it plans to offer Windows freely, or very cheaply, to create a market for apps and services.



Free for pirates?

Microsoft's Terry Myerson caused confusion in March by stating that even "non-genuine" installations of Windows 7 and 8 would receive a free upgrade. Microsoft has now clarified that installations upgraded in this way will be flagged as non-genuine – but those upgrading from a pirated installation of Windows 7 or 8 will be offered a cut-price deal on a legit Windows 10 licence.

The little things

Windows Hello, goodbye passwords

Windows 10 includes a new technology called Windows Hello that can identify you biometrically – for example, using a fingerprint reader or iris scanner if your computer has one. It's faster and easier than entering a password. A technology called Passport will let you use your Windows identity to identify yourself to third-party websites and applications.

Compressed system files

The Windows system folder can take up 15GB or more of storage. Windows 10 can automatically compress these system files to save space, expanding them dynamically as needed, to help the OS fit onto low-specification devices.

Updated command prompt

The command prompt harks back to the MS-DOS days, but in Windows 10 it gets a modest update: at last you can freely resize command prompt windows, and select, copy and paste text just as you can in regular Windows applications. You can also adjust the opacity of the window, if you don't like staring at a big black box.

OneDrive selective sync

In Windows 8, the OneDrive Explorer folder displayed all your files that had been

The new Start menu

Look who's back

Perhaps the biggest news about Windows 10 is that the Start menu is back. For Windows 8, Microsoft was insistent that it was gone for good, replaced by the more touch-friendly Start screen. Happily, in Windows 10 the firm has seen sense; for those on conventional laptop or desktop hardware, this updated Start menu is now the default application launcher.

Live Tiles

While the Windows 10 Start menu looks familiar, it actually functions as a standalone Modern app. You can see that in its appearance, and in the styling of text and menus. The Start menu also shows the Live Tiles that formerly occupied the Windows 8 Start screen, presenting dynamic information – from email notifications to news and weather alerts – from enabled Modern apps.

Search box

The familiar search field has gone from the Start menu; now, if you hit the Windows key then start typing, your input is sent to Cortana (*see p47*). In practice, it works just as before – apps and desktop applications appear at the top of the list, and can be launched by simply hitting Return. As Cortana's capabilities evolve, it could end up being more useful than the old Search function.

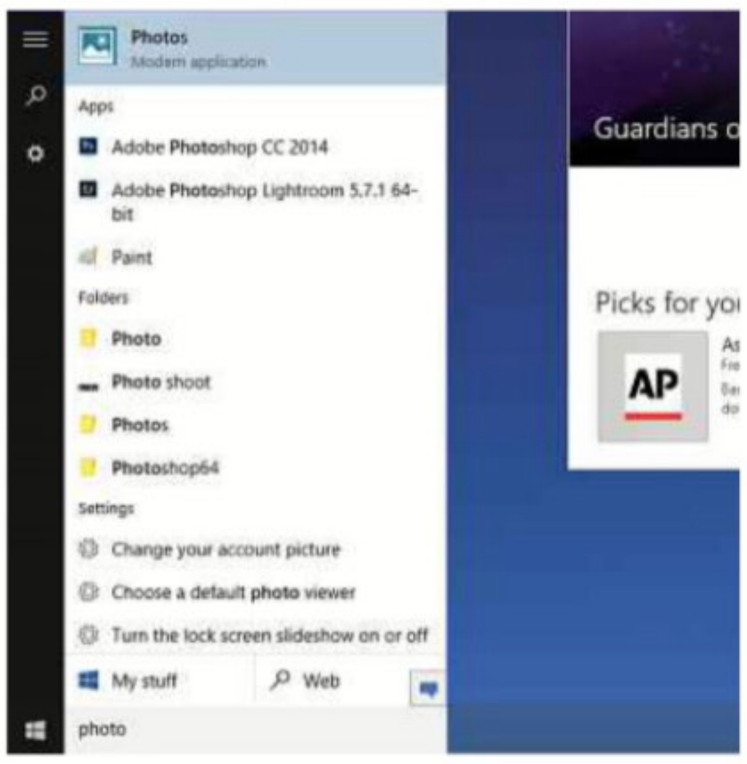


Recent apps

The Windows 10 Start menu offers shortcuts to recently used applications, and those most recently added. Click "All Apps" and you'll see an alphabetical list of everything on your system. It's a bit annoying that this is stuck into a single column, though, while the Live Tiles eat up screen space. Recent documents aren't stored here either – something that could be added in a future release, perhaps.

Resizing the Start menu

The default Live Tile area offers horizontal space for a grid of 4 x 4 medium-sized tiles, with the ability to scroll up and down to view additional tiles. New in Windows 10, you can also resize the menu: drag the upper edge to set the default height, and extend the side across the screen in multiples of four tiles. You can't hide the tile area altogether, however.



Uninstall from the Start menu

Windows' Programs And Features interface is straightforward enough, but it's buried away in the control panel, where it can be a drag to open it up and find the application you want to uninstall. Windows 10 provides an Uninstall link directly on the Start menu, for both desktop and Modern apps – a small but welcome step towards easier housekeeping.

Shut it down

In the original release of Windows 8, the Shutdown and Restart controls were hidden in a hard-to-find Settings pane – leaving beginners unable to figure out how to turn off or restart their devices. In Windows 8.1, Microsoft wisely moved the power button onto the Start screen; in Windows 10, for desktop users, it sits conspicuously at the bottom of the Start menu.

Resizing Live Tiles

For Modern apps, four tile sizes are available – small, medium, wide and large – and you can resize them with a right-click, drag them around and organise them into named groups. You can also pin the apps they represent to the taskbar, or remove them from the Start menu. In an OS where Modern and desktop apps live side by side, the Start menu keeps everything together fairly neatly.

Tiles for desktop apps

As it was in Windows 8, it's possible to pin desktop apps to the Live Tiles area – although they won't show any live information, of course. Only small and medium-sized icons are available, but right-click and you'll see extra "Run as administrator" and "Open file location" options – potentially useful, as these options aren't available from pinned taskbar icons.

Full-screen Start

While we're delighted to see the Start menu back, on a small tablet the old Start screen made a lot of sense. Windows 10 lets you switch to a full-screen interface by clicking the Expand icon at the top right of the menu. The full-screen view, showing apps and tiles, is the default interface in Tablet mode – but you're free to use it in Desktop mode if you wish, and enjoy the best of both worlds.



The little things

uploaded to Microsoft's cloud service – but this didn't necessarily mean they were all present on your computer. In order to save space, Microsoft implemented a system whereby remote files could be stored offline and downloaded as needed. Now it's concluded that this behaviour isn't clear enough to keep users happy – so in Windows 10 it's moved to a simpler model that only shows files that are actually on your hard disk.

Calculator

It's a small change, but a symbolic one: the familiar Windows Calculator tool, barely changed since Windows 95, has been replaced in Windows 10 with a new Modern calculator app. All the familiar options are still available (including unit conversions and Scientific and Programmer modes), but it's a clear illustration of how Modern apps can now fit happily into a desktop workflow.

Print to PDF

Windows has long supported the XML Paper Specification (XPS) – a kind of alternative to PDF – and if you don't have a physical printer connected, then the Print function in Windows 7 and 8 will default to generating an XPS document. The XPS format has never gained widespread adoption, though, and in Windows 10 the default driver is replaced with a new Print To PDF function.

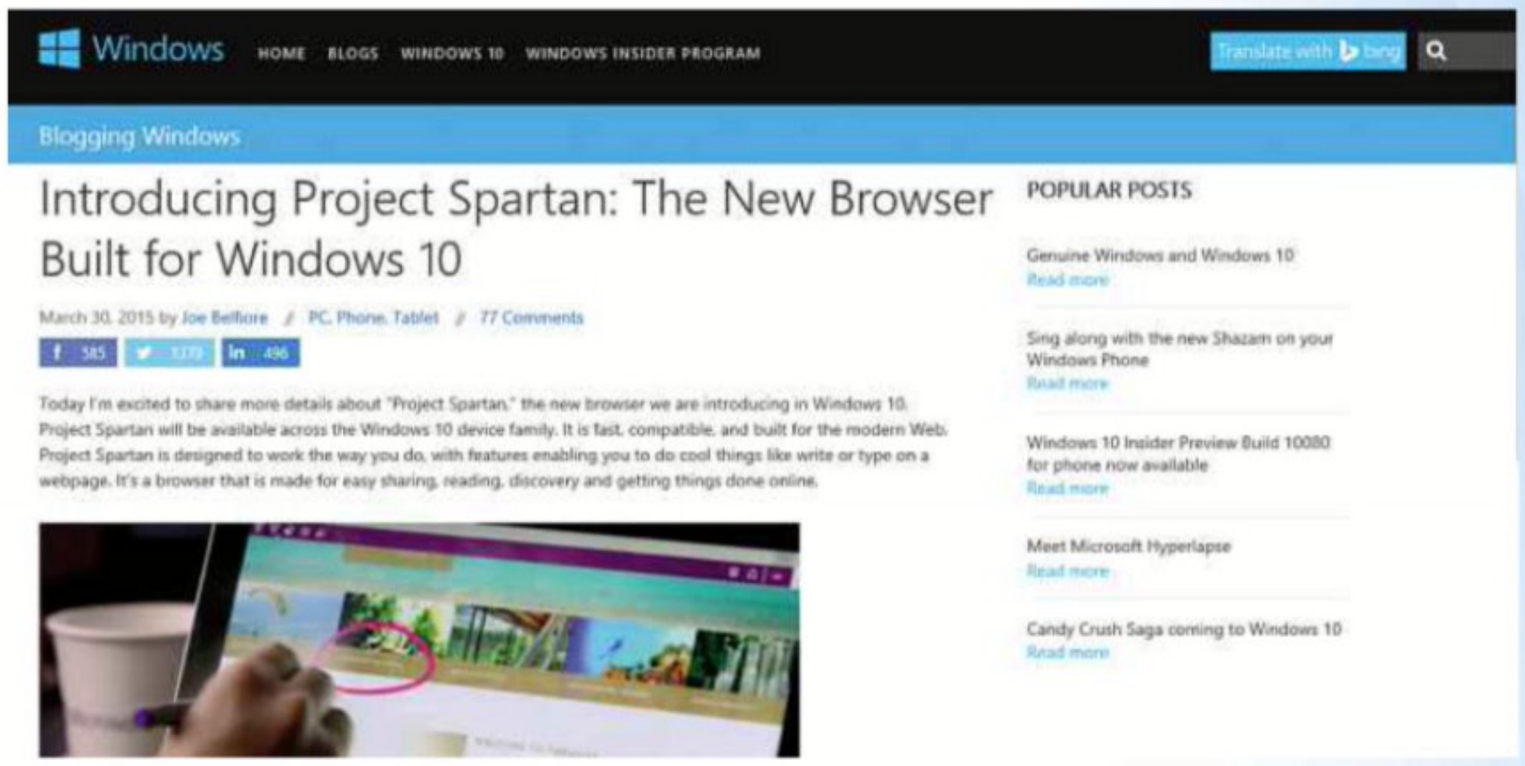
New technologies

Edge browser

New editions of Windows have traditionally brought a new release of Internet Explorer, but Windows 10 replaces it with a new, fast and lightweight default browser – originally codenamed "Project Spartan" but now officially called Microsoft Edge. Its feature set is limited, but since it's a Universal app (*see p48*) it has a very light footprint and works with both laptops and tablets.

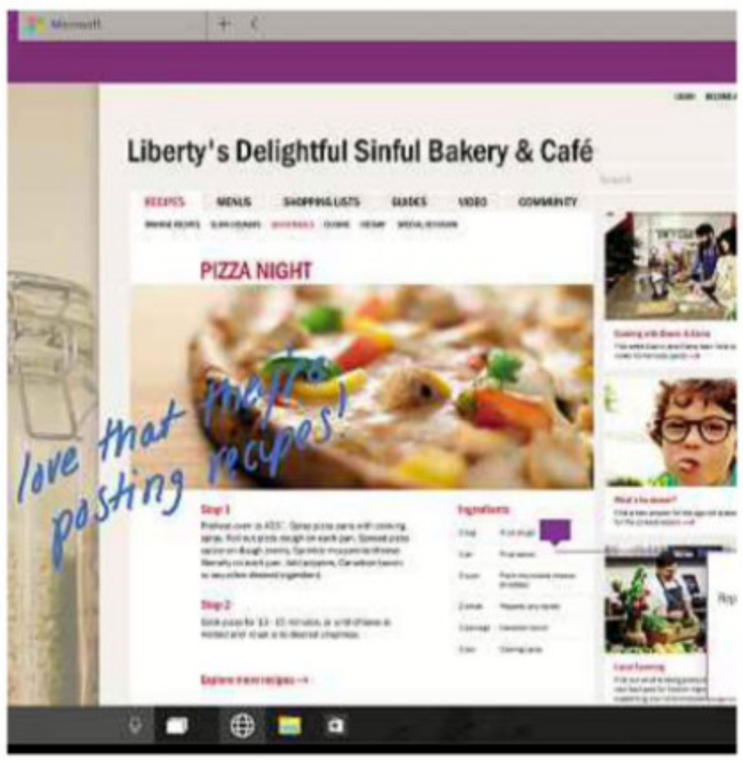
Security on the Edge

Edge also benefits from the sandboxing built into the Universal app framework. As a result, it's far less vulnerable to hackers and drive-by downloads than Internet Explorer ever was. So confident is Microsoft in the robustness of its new browser that it's offering a "bug bounty" of up to $15,000 for anyone who manages to expose a security vulnerability.



The remnants of IE

The Edge icon is a stylised blue "e", symbolising Edge's replacement of the old Internet Explorer. And internally it marks a break from IE: old technologies such as ActiveX and Browser Helper Objects aren't supported. However, some sites still rely on the quirks of IE – so the old MSHTML engine is included as well, enabling Edge to fall back into a legacy mode.



Thin on features

The Edge browser has some interesting new features: the Reading List lets you save pages to read offline (perhaps on a different device), while on a tablet you can use a stylus to annotate web pages and share your notes with others. Currently, though, many features you might take for granted are missing, including private browsing and a searchable browsing history.

The best of both worlds

In online benchmarks, early preview code of Project Spartan proved slightly slower than IE11, giving rise to the idea that the new browser had sacrificed speed for simplicity. The latest builds show progress, however, with Microsoft's new browser outpacing both Chrome and Firefox, providing one argument for giving Edge a try right away.

Cortana

Cortana debuted last year on Windows Phone as a voice-controlled "digital personal assistant" – effectively, Microsoft's answer to Siri. In Windows 10, it retains its natural-language processing abilities, so you can enter commands such as "what's the weather going to be like tomorrow?" or "set an alarm for 7pm" – although we've found results very hit and miss so far.

Talk to me

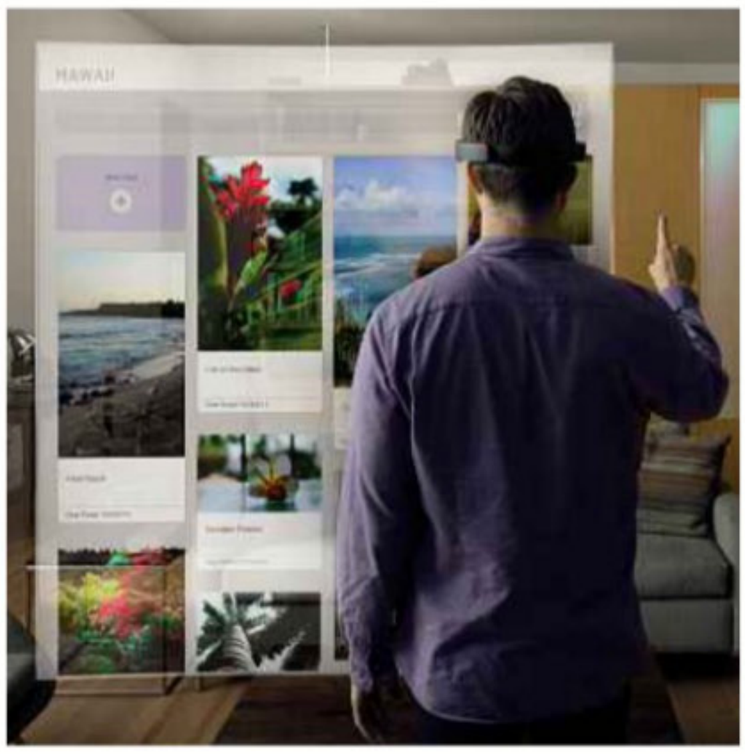
Cortana also retains voice-recognition capabilities: click the microphone icon and you can start asking questions using your device's microphone; Cortana learns your voice over time, although we found accuracy was pretty good straight out of the box. An optional feature called "Hey Cortana" sets the OS into an always-listening mode, so you don't even need to click.

Cortana and apps

Cortana's final trick could prove very powerful indeed, if app developers take advantage of it. Apps can integrate with Cortana so that specific functions can be accessed by voice control. The built-in apps provide an early example of what's possible: instruct Cortana to email a friend and the Mail app should pop up with the address field pre-populated.

Windows Holographic and the HoloLens

Windows Holographic is a new set of tools and APIs in Windows 10 that allows apps to display 3D images on a pair of smart glasses. It could be used for virtual-reality gaming, but the flagship device is the HoloLens, a Windows 10-based augmented-reality visor controlled by voice commands and hand gestures.



A virtual app gallery

The HoloLens has possible applications in fields such as engineering, design and architecture – and it can also create enormous virtual displays. Any Universal app or video file can be overlaid (within the visor) onto a blank wall (in real life). However, the HoloLens isn't fully immersive: the projected display doesn't extend into your peripheral vision.

System requirements

As we've noted, Windows 10 is designed to work on very lightweight hardware as well as more powerful systems. Officially it requires 1GB of RAM for the 32-bit edition – or 2GB for the 64-bit OS – a mere 16GB of storage, and a display resolution of 800 x 600.

Certified tablets

Microsoft has relaxed the design requirements for Windows tablets; the physical Windows button is no longer required for Windows 10 certification, paving the way for some minimal tablet designs – although power and volume buttons are still a must.

Secure Boot is here to stay

As with Windows 8, all computers and tablets sold with Windows 10 will be required to use Secure Boot, making it harder for malware to tamper with the system. In a notable change, however, it's no longer required that manufacturers allow the user to configure Secure Boot themselves. That might prove controversial, as it means we might see Windows 10 devices on which it's completely impossible to install a different operating system.

Windows Spotlight

A new feature called Spotlight allows Windows

Universal apps

Write once, run anywhere

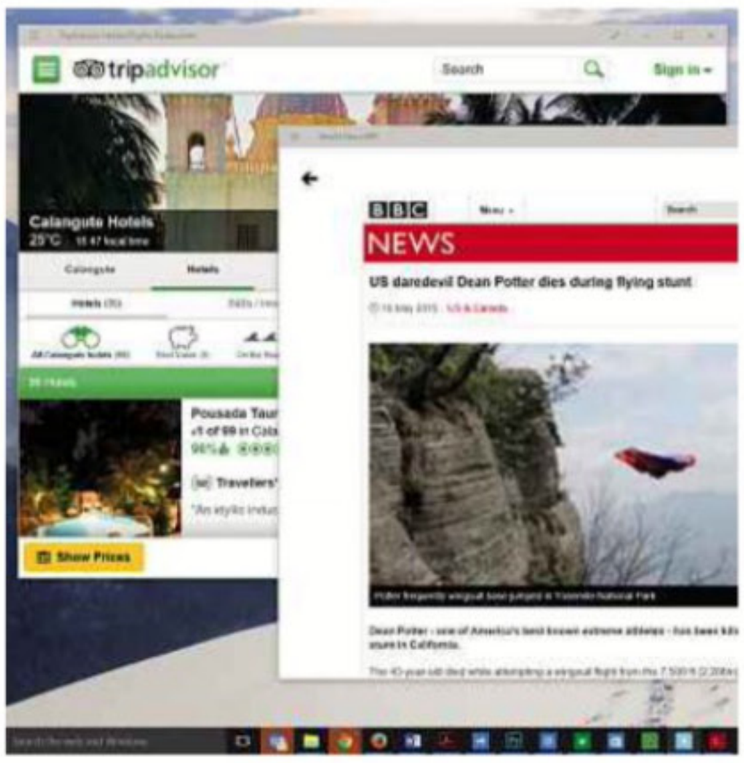
Apps that use Microsoft's new Universal framework should run across all Windows 10 PCs, tablets, phones and other devices, adjusting themselves to suit different screen sizes. The apps look similar to the first-generation Modern apps that accompanied Windows 8; the hope is that enabling them across all your devices will make them more popular.

Office touch apps

To show the potential of Universal apps, Microsoft has rolled out Windows 10 versions of Word, Excel and PowerPoint, with simplified controls to suit touch devices. The apps are free to download; the plan is to bundle them for free with smartphones and tablets, while perhaps charging extra for more capable Office 365-compatible versions.

Apps in windows

In Windows 8, tablet-style apps could only be run in full-screen mode (or in limited split-screen arrangements). When Windows 10 is in Desktop mode, each Modern app opens in its own window, alongside your desktop applications. Trying out and playing with apps feels much more breezy and natural, with no need to keep switching between views to multitask.

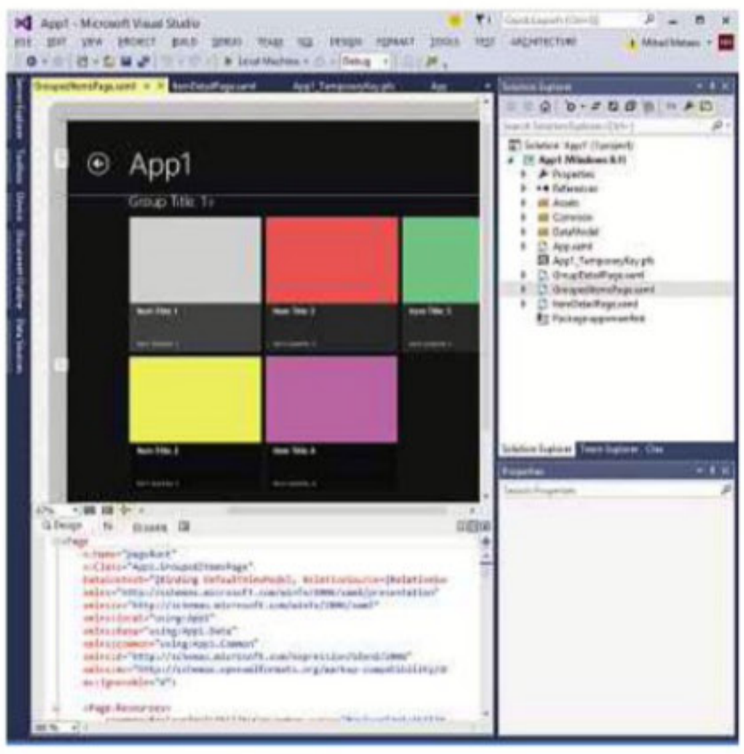


A sharper layout

Updated design guidelines mean that Universal apps should be more attractive and usable than their forebears. Where Windows 8 emphasised big text and white space, Windows 10 allows apps to be laid out more like web pages, with a greater use of links and scroll bars, and no more need for "edge-swipes". As a result, less space is wasted and it's easier to see at a glance what you can do.

A free framework – and not only on Windows

Microsoft's free Visual Studio Express lets amateur developers create Universal apps without paying a penny. And at this year's Build conference, Microsoft revealed Visual Studio code editors for OS X and Linux, so developers on other platforms can also get in on the action.



Porting apps from other platforms

Also at Build, Microsoft unveiled new SDKs allowing established developers to import Android and iOS apps into Visual Studio and adapt them to the Universal app framework. Clearly the company recognises that Windows 10 needs more apps in the Store – and the new SDKs will encourage developers of existing apps to bring them across.

Hosted web apps

Another innovation in Windows 10 is hosted web apps. Like Chrome apps, these are fundamentally HTML5 applications – games, productivity tools or anything else – that can be downloaded and stored locally on your device, so you can use them whether or not you're connected to the internet. It's another measure aimed at helping developers create content for Windows 10.

More purchasing options

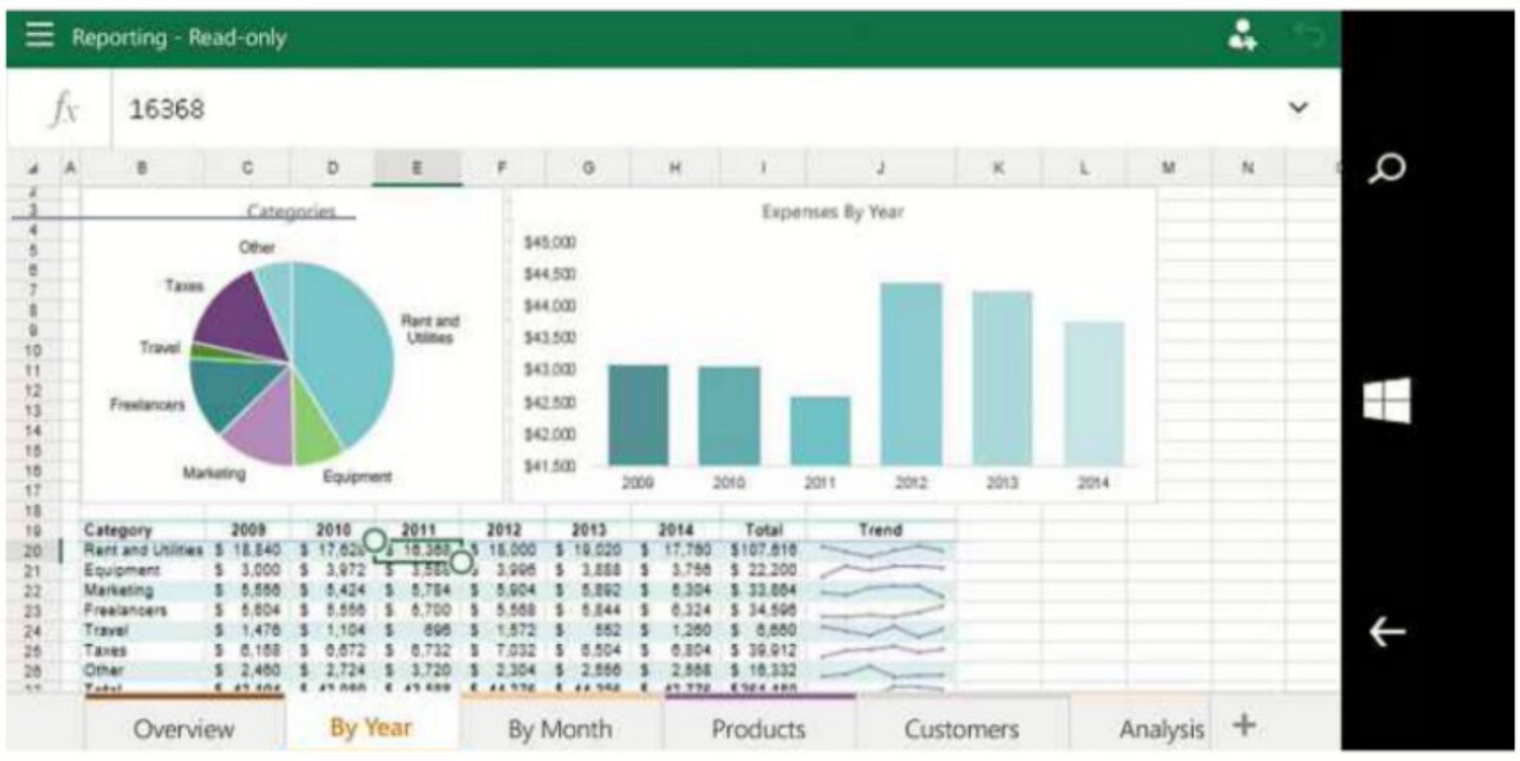
Developers rarely work for free, and Microsoft is promising a very wide range of payment options for the Windows 10 Store, including the ability to sell recurrent subscriptions to services. Developers can choose whether customers will be allowed to buy an app once and run it on all their devices, or whether separate platforms must be paid for individually.

Host your own store

Universal apps are quick to create, sandboxed to minimise security concerns, and able to run on a huge range of hardware, so it's a tempting platform for businesses looking to develop in-house apps. Microsoft plans to let enterprise customers curate their own internal Windows Store, providing bespoke software to authorised visitors.

Beyond Windows?

Since the Universal app framework already runs on ARM, some have suggested it could in future be ported to other platforms, such as Android or OS X. Microsoft hasn't revealed any such plans, but it has said that it wants to "help people do more on the device they choose". With Office apps already available on iOS and Android, the idea isn't wholly far-fetched.



The little things

to show live content on the lockscreen while you're away from your PC. It's been suggested that Microsoft might use this to highlight features of the operating system; others have noted that it could be used for advertising.

Automatically upload images and videos to OneDrive

Windows 10 includes new OneDrive AutoPlay options: when you mount an SD card or attach a smartphone, the operating system can automatically import your pictures and sync them up to your OneDrive account. A similar auto-upload feature was already available in the OneDrive smartphone client, but the idea hasn't previously been supported on the desktop.

No more recovery images

Recovery partitions and images eat up storage space, and not all the devices Windows 10 is aimed at have much to spare. So, in the new OS, you won't need to keep an entire spare copy of the installation files hanging around in case of disaster; Microsoft has said you'll be able to revert your Windows installation to a fresh state using the installed system files. It remains to be seen whether this type of restoration will also get rid of preinstalled "crapware"; we're keeping our fingers crossed.

Desktop improvements

The new Settings app

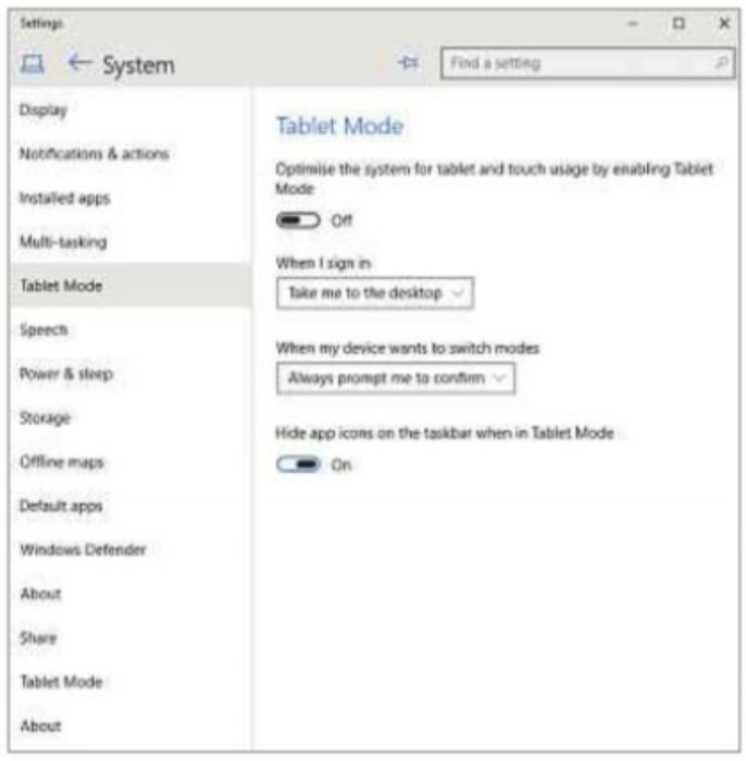
The Windows control panel is a labyrinth. Windows 10 introduces a shiny new Settings app with a cleaner hierarchical interface that helps you discover and access configuration options. It looks a bit like Windows 8's PC Settings app, but it offers many more controls, so you don't need to keep switching back to the old control panel.

The notification centre

In previous editions of Windows, notifications used to pop up and then vanish. Windows 10 collects them together in the new notification centre, for you to review by clicking the icon in the system tray. The panel also offers one-touch shortcuts to let you quickly switch to Tablet mode (*see right*) and access settings such as screen-sharing and brightness.

A smart new look

The Windows 10 desktop benefits from some distinctive visual changes: many system icons have been redesigned, and there are now bigger, softer drop shadows around windows, making it easier to see at a glance what's on top of what. Not everyone is a fan, but next to Windows 8 with its garish indigos and oranges, we think Windows 10 looks more confident and professional.

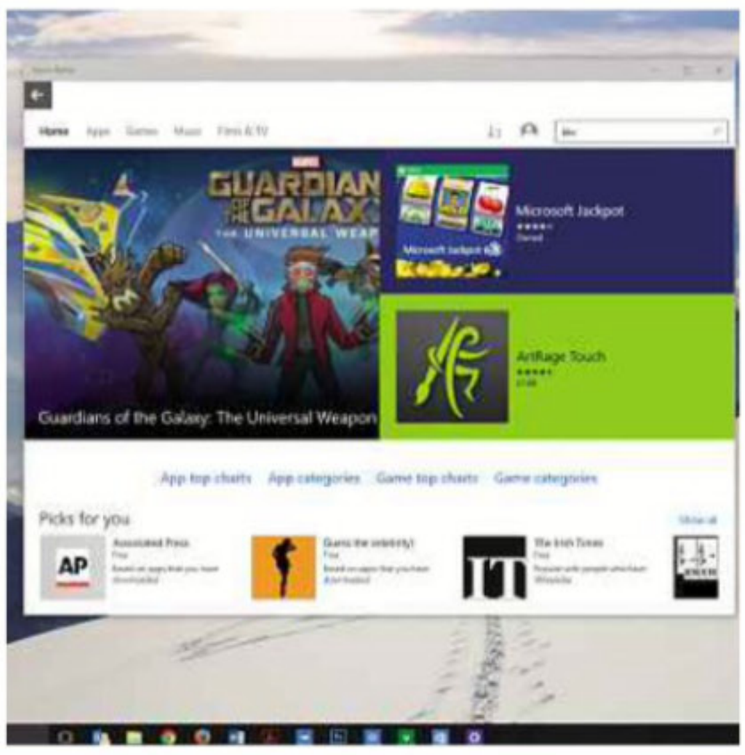


Tablet mode

The ability to switch between the Start menu and a full-screen launcher isn't the only adaptation for tablets and convertibles. The new Tablet mode is the default for devices with touchscreens smaller than 10in: activate it and applications instantly jump up into full-screen mode, with bigger, touch-friendly taskbar icons. Disable it and everything returns to regular desktop scale.

Bye-bye charms

Windows 8 introduced "charms" – a menu of OS and app controls that appeared when you swiped in from the right-hand side of the screen. In Windows 10, the charms are gone, their functions divided up between the notification centre, the Start menu and individual app settings. Microsoft deserves credit for trying something new, but the charms never worked well.



Jump Lists

Originally introduced in Windows 7, Jump Lists provide a simple way to access specific files or functions directly from an app's icon in the taskbar or Start menu. Early builds of Windows 10 lacked this feature, but it's now been plumbed back in, so you can – for example – create a Start menu shortcut that lets you open a specific folder with a single click.

Task View

Click the new Task View button on the taskbar and all your open windows fly into a tiled overview, so you can see what's running at a glance, and click on a thumbnailed window to activate it. In use, it's very similar to OS X's Exposé feature, but that's no bad thing. You can also open the Task View by pressing Windows+Tab – a better use for it than the Flip 3D feature of old.

Multiple desktops

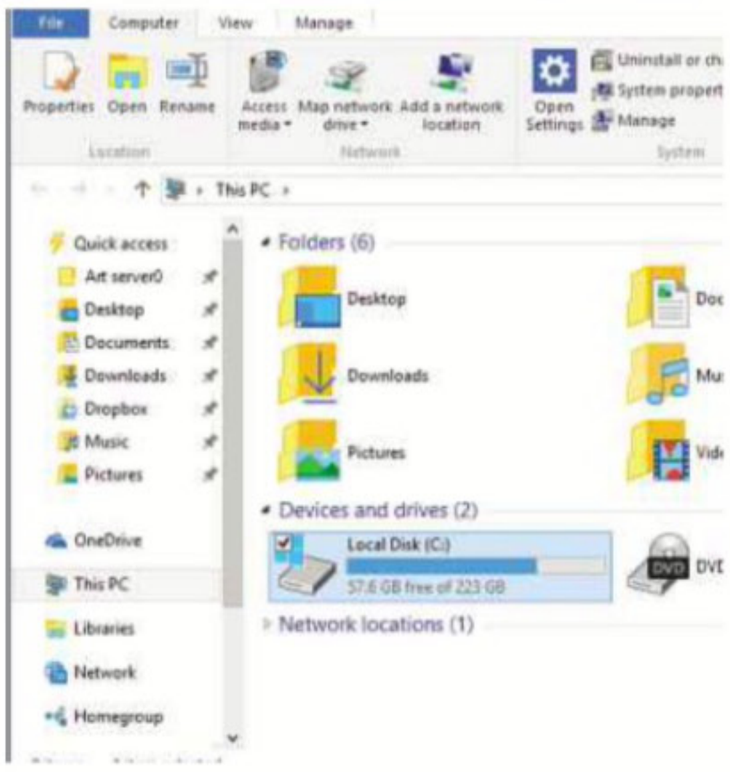
In the bottom right of the Task View, an unobtrusive icon invites you to add a new desktop. Yes, Windows 10 lets you set up multiple desktops, each with its own applications and windows – handy for those who like to set up specific workspaces for different projects. You can switch desktops in the Task View, or by holding down Windows+Ctrl and pressing the left or right cursor key.

Updated network settings

The Network And Sharing Centre, introduced in Windows Vista, has always been a bit of a mess. Windows 10 introduces a new pop-up view for wireless networks, making it easier to see and connect to your chosen network. The pop-up also offers an accompanying shortcut to the network-configuration page in the streamlined Settings app.

Improved snap

Windows 7 introduced a feature called "Aero Snap" that let you dock a window to the side of the screen by dragging it against the edge. Windows 10 improves on this: once you snap a window to fill half of the screen in the new OS, your other open windows are arranged into a Task View-like preview, from which you can easily click on one to make it fill the other side of the screen.



Quick Access

The Windows Explorer has been renamed File Explorer, and the old Favorites list has been replaced by a new list called Quick Access. This may appear to do the same thing, but it includes self-updating shortcuts to the last few folders you accessed – a real time-saver if you're switching back and forth between folders. To pin a shortcut here permanently, simply click the pin icon next to it.

A new look for the taskbar

Windows 10's taskbar icons are more compact than in previous editions of the OS, and open apps are indicated by an underlining effect. We're not fans of the way the active window is represented: its icon gets a slightly longer line beneath it, but that's very hard to notice. In the latest build there's also no way to determine on which desktop an app is open.

New sounds and sound control

A new set of system sounds adds to Windows 10's distinct identity, and it's supported by a new finger-friendly volume widget that drags left and right rather than up and down.

Windows Defender comes on board

Windows Defender has always had a slightly awkward relationship with Windows, not being exactly a standalone application but nor being fully integrated into the OS. In Windows 10, its basic controls have been brought into the main Settings app, making it feel like a more coherent part of the system.

Shrinkable Cortana button

By default, the Cortana search field takes up a good few inches of the taskbar. If your screen is small – or if you just want it out of the way – you can shrink this field to a single icon, or hide it altogether. Even when it isn't visible, you can launch a search by hitting the Windows key and typing.

A more talkative Start menu

We've yet to see this in action, but alongside Spotlight, Microsoft has also indicated that the Start menu might offer suggestions for apps you

Mobile – and more

Meet Windows 10 Mobile

Windows Phone is no more; Microsoft's new OS for phones is called "Windows 10 Mobile". Technically, it's very different to the desktop OS: it's designed for a hand-sized interface, and runs on ARM hardware rather than x86. But the name change emphasises the fact that, with the advent of Universal apps, the whole Windows family now works together.

Integration with desktop

Windows 10 Mobile is all about integration. It introduces Skype as the standard messaging client, for easy synchronisation between phone and desktop, and Edge as the system browser. It syncs notifications with your desktop PC, and it looks more like the desktop too; for example, your wallpaper now shows behind the whole homescreen.

Tap-to-pay and tap-to-pair

Windows 10 Mobile introduces a feature called Host Card Emulation, which should enable tap-to-pay support at a wide range of merchants, similar to what's already offered by Apple and Samsung. There will also be a "tap-to-pair" feature, making it extremely simple to get two Windows 10 devices to connect via Wi-Fi, or to activate screen mirroring over Miracast.



Who gets it?

Similar to what's planned for the desktop, Microsoft plans to roll out Windows 10 as a free upgrade for "the majority" of Lumia phones. That includes even comparatively low-end devices, such as the Lumia 520, which offers only 512MB of RAM. Don't hang out the bunting just yet, though: Microsoft has warned that not every device will support all the features of the new OS.

When does it arrive?

There's no official launch date, but it's almost certain that Windows 10 Mobile won't arrive until some months after the desktop version. Speaking at the Microsoft Build conference, Joe Belfiore confirmed that "phone builds have not been as far along as our PC builds. We're adapting the phone experiences later than we're adding the PC experiences."

But for those who can't wait…

Microsoft has launched an Insider Programme for Lumia users wanting to test pre-release OS builds; 33 handsets are supported. Proceed with caution: the download page reminds testers that the update "could cause your phone to stop working permanently". You can wipe the preview OS and return to Windows Phone 8.1 via the Windows Phone Recovery Tool.



Surface Hub

The Surface Hub is an 84in, 4K interactive whiteboard, designed specifically for Windows 10. It works as a Skype-based conferencing station, a collaborative brainstorming tool and a presentation display all in one. Don't expect to see the Surface Hub until 2016, though – and don't bank on buying one for your bedroom; the huge screen means it's likely to cost upwards of $10,000.

Windows 10 for Raspberry Pi

A £30 development board might seem underpowered for Windows 10 – but Microsoft has announced a special edition of Windows for such platforms, dubbed Windows 10 IoT Core. The idea is to help enthusiasts use Windows to develop "maker"-type projects for the Raspberry Pi, Arduino, MinnowBoard MAX, Hackster.io and other ultra-low-power boards.

Windows 10 on non-Lumia phones?

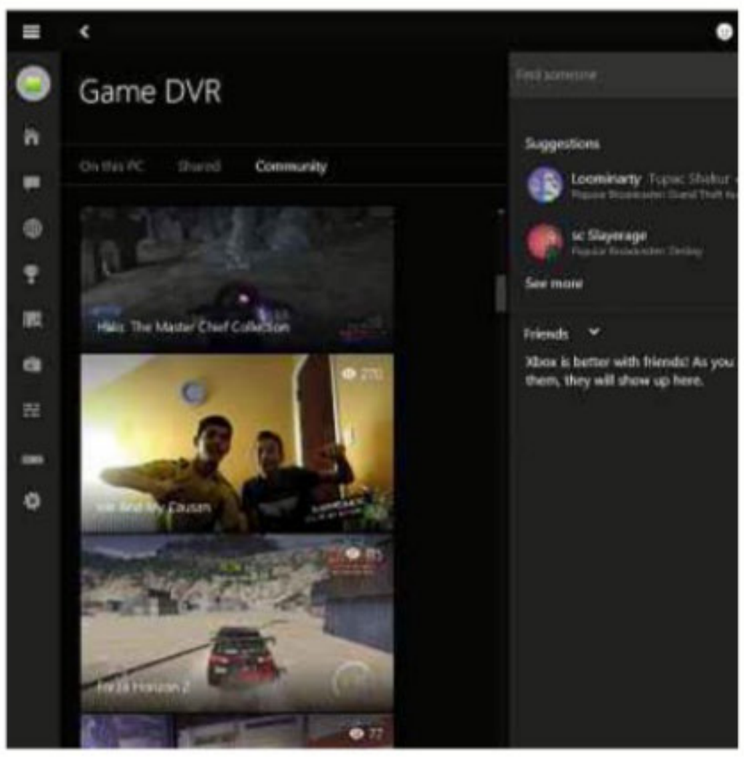
Microsoft hasn't said that Windows 10 Mobile will run on third-party phones, but it has been working with Chinese manufacturer Xiaomi on an experimental Windows 10 ROM that can be flashed onto an Android phone. That might mean Microsoft wants to make it easy for phone manufacturers to install its OS onto existing hardware.

Windows 10, meet Xbox One

Microsoft's games console also has a big part to play in the Windows 10 vision. A future update to the Xbox One will give it the ability to run Universal apps – so you'll be able to play the same games on the big screen as on your phone and tablet, and run other entertainment apps. No firm date has been set, but the update is expected by the end of the year.

Xbox streaming and cross-play

For those who prefer to play on the small screen, Windows 10's new Xbox app supports game streaming from the Xbox One – so you can load up a disc in the front room, then play it on your tablet or desktop. In games that run on both Xbox and Windows, players on different platforms will for the first time be able to compete against one another online.



Game DVR

One final new feature in the Windows 10 Xbox app is "Game DVR", which lets you record and share footage of your own gameplay. This means that if you pull off an amazing stunt, or a flawless victory, you can capture the last 30 seconds of play and share it with the world. It even works with older games, including Steam titles, and you can "Like", "Share" and comment on other players' clips.

The little things

haven't tried, or content you might be interested in. It's all part of the vision of more interactive devices.

Flash in the pan

Windows 10 doesn't stop you from running Adobe Flash if you wish, but the Edge browser offers a global toggle that you can use to disable the plugin – something you might want to do, since it's been associated not only with heavy system demands but also with security risks.

How many editions?

Windows XP came in Home and Professional editions; Vista upped the stakes to six major versions. For Windows 10, we're back to two mainstream desktop editions: Windows 10 Home, which includes all the standard features, and Windows 10 Pro, with extra management and security features. There will also be Enterprise and Education editions designed to serve specific markets, as well as the Mobile and IoT Core editions (*see above*) for different hardware types.

Continuum

Continuum is a fancy name for a simple concept: Windows 10 devices can switch automatically into Tablet mode and back based on what hardware is connected. It's aimed particularly at two-in-one devices, which you might want to use as a regular laptop or as a tablet.



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PRICEWATERHOUSECOOPERS

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And finally...

New three-finger gestures

For touchpad users, Windows 10 introduces a range of new three-finger swipe gestures. Swiping upwards with three fingers from the desktop brings up the Task View; swiping to the left or right with three fingers lets you switch between virtual desktops. If you've used OS X's Exposé and Spaces features then – not to put too fine a point on it – you'll be right at home.

DirectX 12 and WDDM 2

Microsoft's gaming API hasn't had a full version update in five years, but Windows 10 introduces DirectX 12, as well as a new edition of the Windows Device Driver Model that allows developers to take more control and reduces CPU load. Together, the two technologies promise dramatically better 3D performance on low-power hardware.

Codecs galore

Audiophiles and video enthusiasts can celebrate: Windows 10 includes native support for FLAC lossless audio and Matroska video, so there's no need to mess around with third-party codecs. FLAC was released in 2001, and the Matroska project was started in 2002, so it's a case of better late than never.

What's in a name?

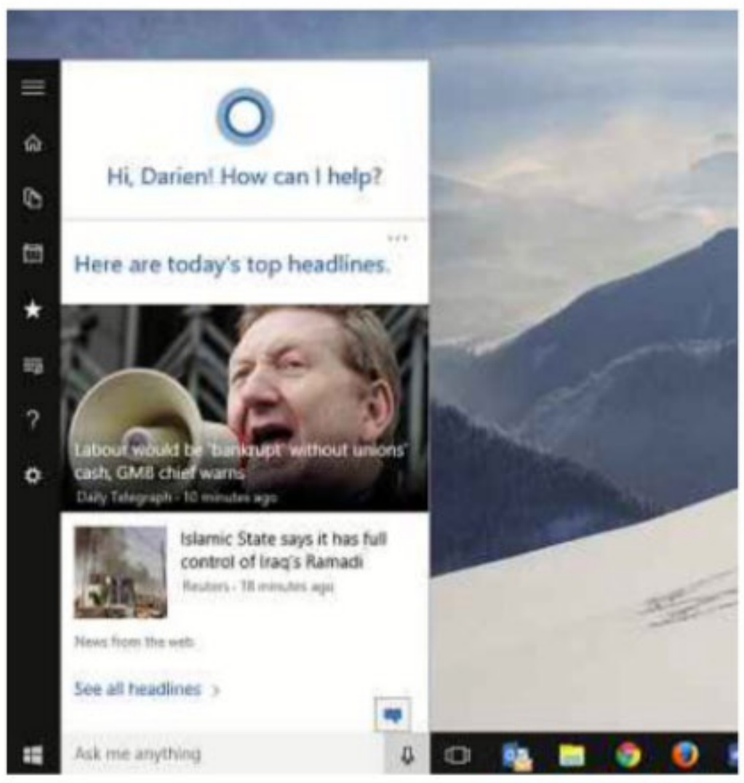
It's well known that Cortana is named after a character from the Halo game series; what you might not know is that Windows 10's working codename was Threshold, after a planet in the same universe. The Edge browser's working title "Project Spartan" is another reference to the game series, in which elite space soldiers are known as Spartans.

Predictive text

Borrowing a leaf from the old Windows Phone book, the onscreen keyboard in Windows 10 features predictive suggestions that pop up along the top of the window as you type. For those working on fiddly smaller keyboards, we can see this being a hugely popular addition.

Carrier payments for all

To help make a success of the Windows Store, the company has been working with mobile operators to allow customers to buy apps and in-app purchases through their phone bills, rather than needing to register a credit card. That might not seem like a big deal to us Westerners, but if it helps Microsoft gain a foothold in countries where credit cards are less ubiquitous, the effects could be global.



Get set for OneGet

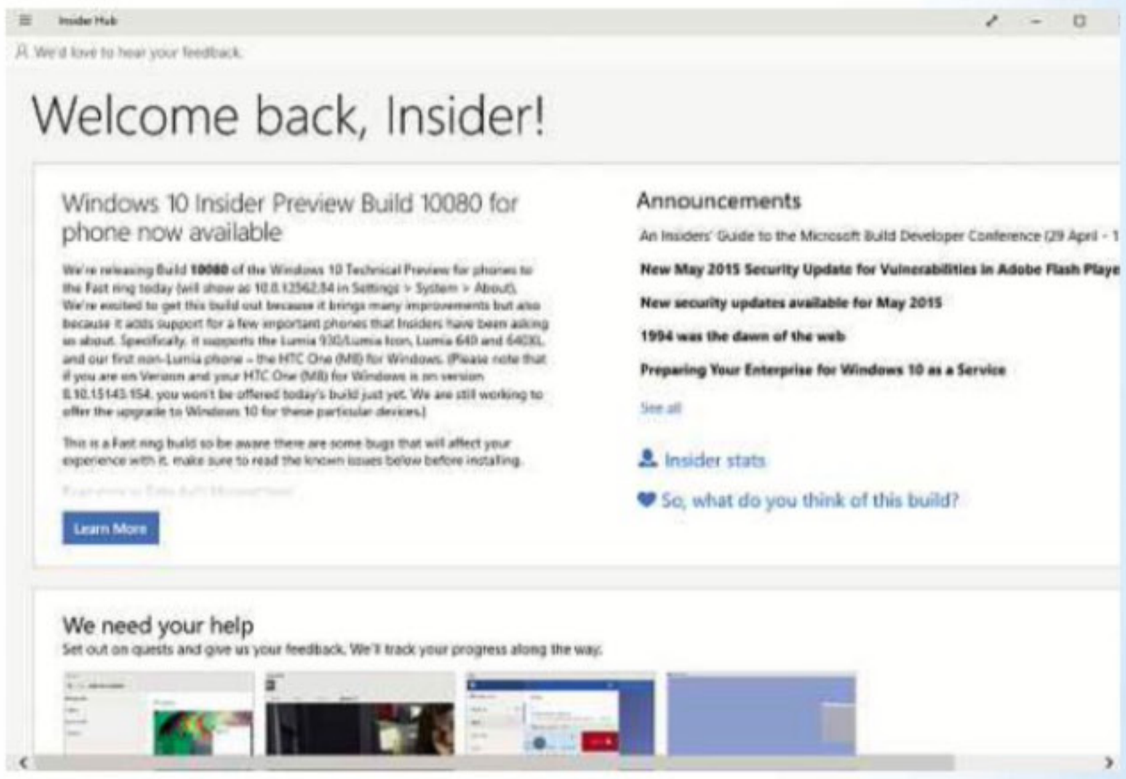
Applications can be installed and removed in the familiar way in Windows 10, but the new OS also introduces a PowerShell-based package manager called OneGet, which enables system administrators to write scripts that locate, download and install desktop software from an online repository. It's a capability that Linux has had for decades; now Windows managers can greatly speed up and simplify software rollouts. The technology can be retrofitted onto Windows 7 and 8 clients too.

The Insider Hub

Windows 10 Insiders don't just get access to preview builds of the OS; they also get a dedicated app, called the Insider Hub, sharing news and feedback about the latest developments. To encourage testers to put the OS through its paces, Microsoft has engaged in "gamification": Insiders can unlock achievement badges for trying out various features of the OS, and there are simple "quests" to be completed too, such as trying out screen-snapping and using new touchpad gestures.

Saving space on compact tablets

Windows 8 wasn't originally designed for compact tablets – that's what Windows RT was supposed to be for. Windows 10, on the other hand, adapts itself automatically to smaller screens. On a device with an 8in or smaller display, Start menu tiles are drawn larger, while items such as the File Explorer and Settings are moved away behind a menu to minimise clutter. There's also a system-wide "back" button, as found in Android, to help you navigate between open windows.



Is your device healthy?

A new security feature in Windows 10 monitors the "health" of your PC, and can even prevent you from accessing applications and websites from a system that doesn't meet a certain security standard – for example, one without up-to-date antivirus provision, or without current Windows Updates installed. It's principally aimed at businesses seeking to enforce a security policy. As with OneGet, it will be possible to install the feature on older clients too.

Goodbye Patch Tuesday

As part of Microsoft's move to "Windows-as-a-service", the company has formally announced an end to Patch Tuesday. Consumer devices running Windows 10 will get system updates as soon as they become available – and thanks to the increasingly modular design of the OS, it should only rarely be necessary to restart Windows in order to install them.

Three branches

Constant updates may be fine for individuals, but businesses won't want their OS platform to keep changing. Taking a leaf from Ubuntu's book, Microsoft plans to create "long-term support" (LTS) business builds of Windows 10, which will receive only critical updates and otherwise remain stable for ten years. It will also offer a "Current Branch for Business" option, which will allow administrators to decide whether to roll out new features, or whether to hold them back.

Tipping the scale

Windows 10 lets you set display scaling on a per-screen basis – so you can hook up your compact laptop to a 4K desktop screen, drag windows back and forth between the two, and get the best image quality from both. Sadly, this doesn't mean scaling problems will vanish entirely – that requires software developers to ensure their applications scale properly. But it's a step in the right direction.

RIP Media Center

Finally, a piece of sad news: Microsoft has confirmed that the much-loved Media Center application, already a mere optional extra in Windows 8, will disappear altogether in Windows 10. Presumably we're supposed to use Xbox One or smart TV hardware instead, but that will be scant consolation to the Media Center faithful. Microsoft has said that it will be possible to play DVDs on Windows 10 – but it hasn't revealed how.

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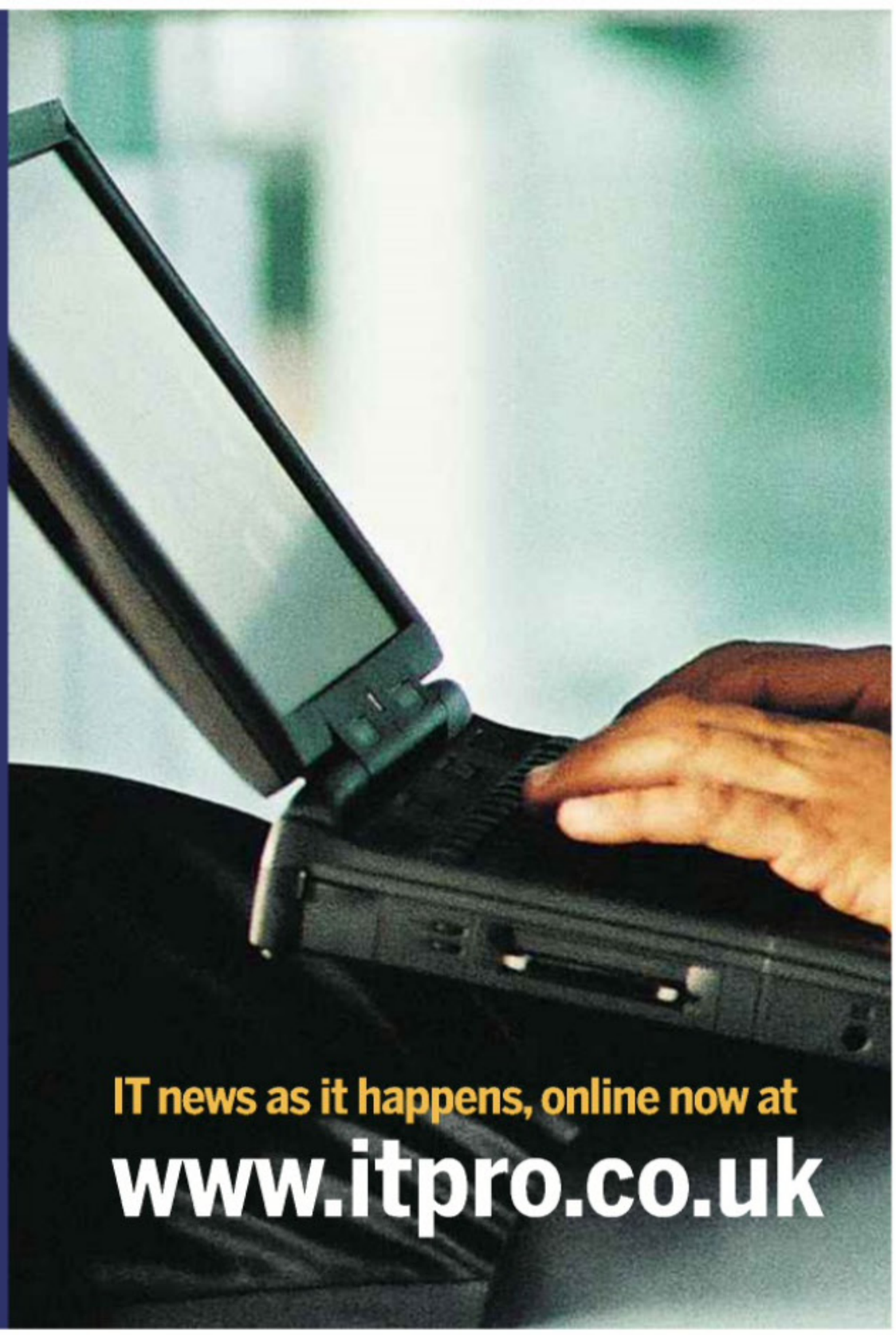
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WHY MULTITASKING COULD BE HARMING YOUR HEALTH

Is the ability to multitask a desirable skill or is it robbing you of your inherent productivity – and wellbeing? Barry Collins investigates

An admin assistant for a legal firm, a counsellor for a Catholic charity, a concierge for a major hotel chain, and a live-chat agent for a website called TheLandOfNod.com. These vacancies being advertised on an internet jobs site don't have much in common, except one key phrase in all of their job descriptions: "must have the ability to multitask".

Being able to juggle multiple tasks simultaneously is conventionally seen as a positive trait, the kind of quality you'd list at the top of your LinkedIn profile. You want your prospective employer to know you're not going to crumble when you have six things to complete by 5pm, your email inbox is pinging every minute of the day, and the phone on your desk is ringing incessantly. Indeed, in these days of Twitter, Slack, SMS, Snapchat, email, Gmail, Facebook, Yammer and countless other distractions, it's almost a prerequisite to be able to concentrate on more than one thing at a time.

But is it really a desirable quality? Or is multitasking a euphemism for inefficiency? There's a growing school of thought that says humans are appalling multitaskers; that we achieve far more when we focus on completing one job at a time. Indeed, some research suggests that we pay a heavy mental price for even attempting to keep several plates up in the air simultaneously, and that it could impact on our cognitive and emotional wellbeing. It could even be changing the physical structure of our brains, with unknown consequences.

When modern technology seems to demand that we multitask more than ever before, is it any wonder we're struggling to cope?

The data onslaught

Modern life is relentless. The sheer quantity of information we deal with on a daily basis far outweighs anything previous generations have faced, according to Daniel J Levitin, author of *The Organized Mind: Thinking Straight in the Age of Information Overload*. "Just trying to keep our own media and electronic files organised can be overwhelming," Levitin wrote. "Each of us has the equivalent of over half a million books stored on our computers, not to mention all the information stored in our cell phones or in the magnetic stripe on the back of our credit cards. We have created a world with 300 exabytes (300,000,000,000,000,000,000 pieces) of human-made information."

"In 2011, Americans took in five times the information every day that they did in 1986 – the equivalent of 175 newspapers," Levitin added. "During our leisure time, each of us processes 34GB or 100,000 words every day."

And while your daily data diet might just squeeze onto the storage of a smartphone, your brain's "processor" is



Every status update you read on Facebook, every tweet or text message you get from a friend, is competing for resources in your brain

nowhere near as powerful as the one inside a Samsung Galaxy S6. "The processing capacity of the conscious mind has been estimated at 120 bits per second," Levitin claimed, citing two estimates made of the brain's capacity by psychology professor Mihaly Csikszentmihalyi and Bell Labs engineer Robert Lucky, who arrived at independent figures within an order of magnitude of one another.

You don't need a calculator to realise that this doesn't give the brain anywhere near enough "bandwidth" to cope with the 34GB of leisure data Levitin claims we processed earlier. But even if the stats have the whiff of manure, there's a ring of truth to Levitin's claims that we struggle to cope with the modern-day data onslaught.

"Our brains do have the ability to process the information we take in, but at a cost," he wrote. "We can have trouble separating the trivial from the important, and all this information processing makes us tired. Neurons are living cells with a metabolism; they need oxygen and glucose to survive, and when they've been working hard, we experience fatigue. Every status update you read on Facebook, every tweet or text message you receive from a friend, is competing for resources in your brain with important things such as whether to put your savings in stocks or bonds, where you've left your passport, or how best to reconcile with a close friend you've just had an argument with."

Levitin suggests that instead we should focus on one job at the time and not strive for the mythical productivity of the multitasker. "We need to blinker ourselves, to better monitor our attentional focus," he said in an interview with *The Guardian*. "Enforced periods of no email or internet to allow us to sustain concentration have been shown to be tremendously helpful. Also, prioritising tasks is very important. So many of us find that while we're working on one task, a nagging voice pops up in our heads saying we should be doing something else. If you explicitly prioritise your to-do list, you know that whatever you're working on now is the most important thing you should be doing."

Bombarding the brain

Levitin is by no means a lone crank with a book to sell. There have been several academic studies that highlight the detrimental effects of multitasking. A 2009 study at Stanford University split 100 students into two groups: those who regularly multitask with different media (email, instant messaging and so on) and those who don't.

ORGANISE YOUR MIND IN 4 STEPS



Use low-tech brain extenders

While researching his book, Daniel J Levitin was surprised to find how many high-flyers carried around notepads or index cards. "Many busy and effective people say that there is something [...] visceral in using physical objects, rather than virtual ones, to keep track of important things," he wrote.



Make a to-do list

"When we have something on our minds that is important – especially a to-do item – we're afraid we'll forget it," said Levitin. "Writing things down conserves the mental energy expended worrying that you might forget something."



Weed out distractions

Levitin discovered that successful people divided up "useful versus distracting knowledge". Sort email and documents into batches that need to be dealt with right away, things that are important but can wait, things that are unimportant and can wait, and junk. Or, go for just two categories: things to keep, and rubbish.



Lighten the load

"The most fundamental principle of the organised mind... is to shift the burden of organising from our brains to the external world," said Levitin. Don't waste thought on trivial matters such as where you left your keys. Put a key hook by the door, for example, to "reduce the burden on your conscious brain".

Adapted from Levitin's book, *The Organized Mind: Thinking Straight in the Age of Information Overload*

In one test, the students were shown sets of two red rectangles, either on their own or surrounded by varying numbers of blue rectangles. Each configuration was flashed twice, with participants having to determine whether the two red rectangles in the second frame had shifted position from those in the first. Even though they had been told to ignore the irrelevant blue rectangles, the multitaskers struggled to do so, scoring more poorly than the students who weren't avid do-it-alls. "They're suckers for irrelevancy," said communication professor Clifford Nass of the multitaskers. "Everything distracts them."

Indeed, the multitaskers performed worse in each of the three tests set during the Stanford study. "When they're in situations where there are multiple sources of information coming from the external world or emerging out of memory, they're not able to filter out what isn't relevant to their current goal," said Anthony Wagner, an associate professor of psychology at Stanford. "That failure to filter means they're slowed down by that irrelevant information."

Last year's Human Era At Work study, conducted by The Energy Project and *Harvard Business Review*, found that fewer than one in five employees felt they had the ability to focus on one thing at a time. That "problem" is particularly apparent in hi-tech firms: a study conducted by Gloria Mark from the Department of Informatics at the University of California found that tech workers spent on average just 11 minutes on any given project and only three minutes per task.

"Surprisingly, our results show that interrupted work is performed faster," the research paper claimed. "We offer an interpretation. When people are constantly interrupted, they develop a mode of working faster (and writing less) to compensate for the time they know they'll lose by being interrupted. Yet working faster with interruptions has a cost: people in the interrupted conditions experienced a higher workload, more stress, higher frustration, more time pressure and effort. So interrupted work may be completed faster, but it's at a price."

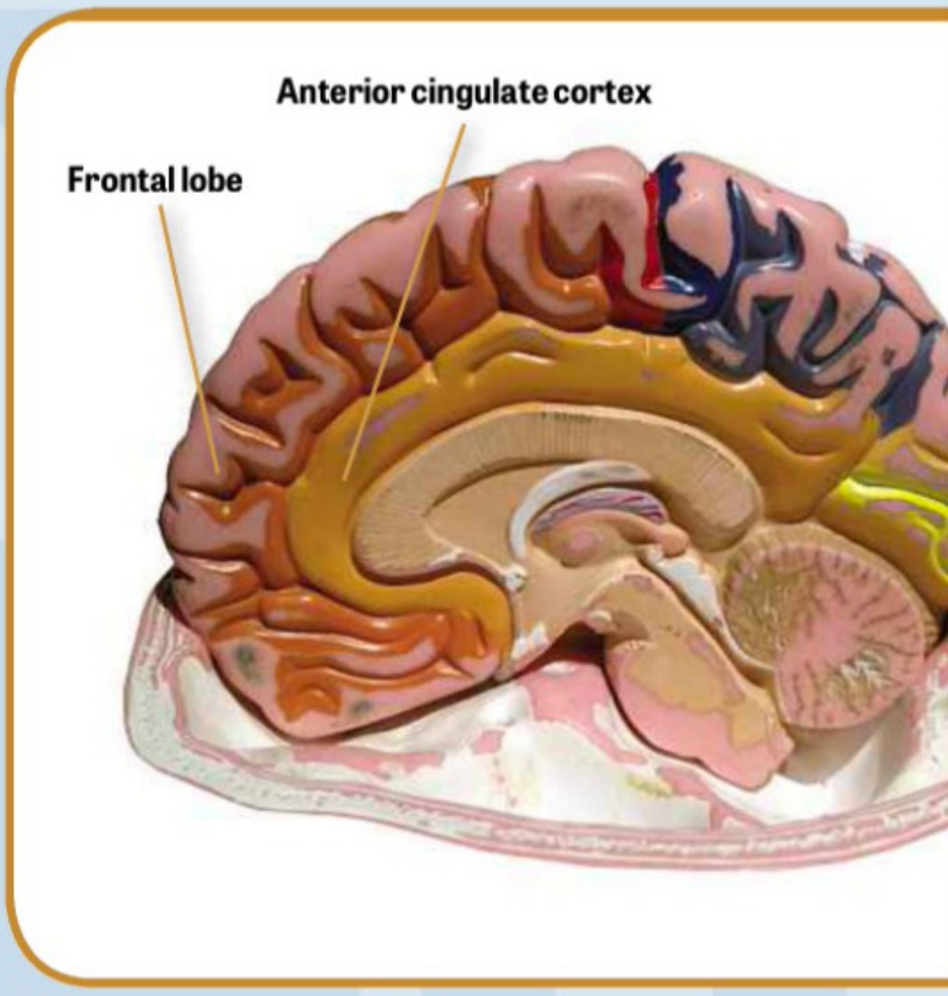
That price might even be a temporary loss of intelligence. A 2005 study conducted by the Institute of Psychiatry at the University of London and sponsored by HP – a firm that has reason to espouse the gains of new technology, not lambast it – found that workers distracted by incoming email and phone calls saw a ten-point drop in their IQ. That's twice the impact of smoking marijuana, according to the Institute.

Brain training

There's even evidence to suggest that multitasking could have a long-lasting impact. Last year, researchers from the University of Sussex used MRI to scan the brains of 75 adults. Those who claimed to regularly multitask using smartphones, PCs and televisions were found to have smaller grey-matter density in the anterior cingulate cortex, the region of the brain responsible for cognitive and emotional functions. The researchers were at pains to stress that their research revealed a link, not causality: it isn't clear if multitasking changes the brain's structure or if those with less dense grey matter are simply more attracted to multitasking.

Neuroscientist Kep Kee Loh, one of the joint authors of the study, believes that "both perspectives are equally likely", but also points out that the internet makes a natural habitat for multitasking. "Increased engagements in these behaviours over time would definitely alter our cognitive mechanisms, since our brain structures are highly plastic to training and experiences."

So could the human brain evolve to cope better with multitasking in the future, we asked? "I believe that the human brain will evolve to cope with the demands imposed by this new environment. The big question is how."



Other experts are similarly convinced that the brain can be reshaped, and even trained, to better handle multitasking. "When we engage in more than one act that commands attention, there's competition between them for resources – and there's a cost," said Dr Adam Gazzaley, who founded his own cognitive neuroscience research lab at the University of California. "They compete with one another. We don't have a high-level ability to cross-process tasks."

He spoke to *PC Pro* on his way to a talk he was giving at a health conference in London, where he was explaining how video games can be used to train people to better handle multitasking. "We challenge different neural processes using games mechanics," he said. "The fundamental concept of plasticity is that the brain has the ability to change at every level."

Gazzaley believes companies may one day send their staff for brain training, so that

they're better equipped to multitask. "Our goal is to think about how to drive these [brain-training] tools at a very high level," he said.

Welcome distraction

Not everyone believes that multitasking is a modern evil. Some believe that building in distractions can actually improve productivity. Pete Trainor is the director of human-centred design at Nexus, an agency that has helped clients such as RBS and NatWest to optimise websites and digital services. Trainor says that he'd encourage multitasking: "It's a thing called split-brain cognition," he told *PC Pro*. "The brain is actually programmed for multiple tasks, multiple forms of information; it's actually good for the brain."

Trainor believes that Levitin's advice to focus solely on one job at a time could be counter-productive, as the brain simply turns over the same problems again and again, becoming dulled by the repetition. "When people are blitzing through a problem that they're trying to solve, they can often overlook the thing that's most prevalent, the thing that's right under their nose," said Trainor. "The brain recalls moments and memories subconsciously when it takes a break from the task on which you were consciously focusing. It's an interesting phenomenon. It's why people have those middle-of-the-night eureka moments. A complete distraction often helps you remember something that you've previously done or helps you solve a particular problem."

Even doing something that would traditionally be regarded as concentration-sapping, such as putting on music while you're at work, can improve both the speed and quality of your output, according to Trainor. He tells of a test he performed last year for banking clients, in which he asked two groups of people to fill in a long, complex application form for a financial product. One group was told to just get on with filling out the form, the second group was encouraged to put their favourite song on the stereo while they filled out the same form.

"The people that we encouraged to put on their favourite song, who were listening to Robbie Williams, for example, actually completed the application form more quickly and with fewer errors," Trainor claimed. "The distraction of having something else in the room with them introduced a happy memory while doing what is an unhappy task. A positive distraction got them through the [tricky] application form they were filling in."

Trainor's firm, Nexus, may apply these findings to future site designs. Imagine that analytics show that a customer has been stuck on a particular question of an online form for the past ten minutes. Why not pop up a link to play Angry Birds for five minutes to help them clear their mind and come back to the form refreshed, rather than leave them staring at the screen for another 20?

Trainor concedes that having to perform several tasks of the same type simultaneously – as you might do in a typical office job – could lead to cognitive overload and stress. But he believes counterbalancing a boring task with a more pleasurable activity has definite benefits.

Finding the right answers

The problem with all of these theories – be it Levitin's single-task approach, the University of Sussex's link between multitasking and altered brain shape, or Trainor's advice to stick on *Sergeant Pepper* while filling out your tax return – is that we still don't know enough about the inner workings of the brain. Nobody can say definitively whether the brain has the "bandwidth" to cope with several jobs at once, nor whether the brain is shaped by multitasking – or whether our ability to multitask is determined by the shape of our brain.

"I believe that in the next ten years, we might get closer to finding out the reality, because they're starting to dig deep into neuroscience," said Trainor. "Psychologically, you can track stuff. We can empirically see that a distraction helps someone fill out a form, but there's no way you can possibly say filling out that form uses only 1.1% of their brain capacity. You can't do it."

Until then, our best advice is to take heed of the warnings and test which ways work best for you. If you want a simple solution now, try our steps to an organised mind (*see p56*) to help you through the day.



Those who claimed to regularly multitask using smartphones, PCs and TVs were found to have smaller grey-matter density in the anterior cingulate cortex

MULTIPLE MONITORS: GOOD OR BAD?

There are opposing schools of thought as to whether using multiple screens helps productivity. Studies commissioned by, you've guessed it, monitor manufacturers claim that two screens help us get more done than one. A 2008 University of Utah study commissioned by NEC found that workers were 44% more productive on text-based tasks with dual-screen setups; subsequent Dell-sponsored studies have shown likewise.

Others, such as University of California professor Gloria Mark, view multi-screen setups as a "double-edged sword", making certain tasks easier, while also providing more space for unwanted interruptions. "Most people have their email up on the second screen," she told *The New York Times*. "And, of course, when anything comes in, it's a great source of distraction."

Daniel J Levitin suggests a middle ground: setting up different screens, or even different computers, for different purposes. The hippocampus is the part of the brain that remembers where important things are: "One way to exploit the hippocampus' natural style of memory storage is to create different workspaces for the different kinds of work we do," he suggests.

He says it's best to have one dedicated to personal activities and one for work, each with different desktop patterns "so that the visual cues help to put you in the proper place-memory context, of each computer's domain". The virtual desktops being added to Windows 10 could conceivably achieve the same effect.



VIRTUAL REALITY

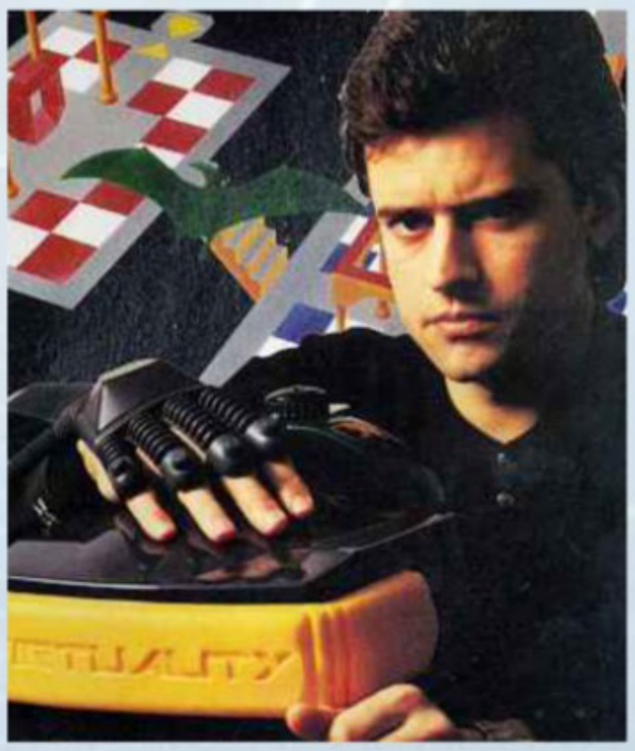
THE TIME HAS COME

The once-bitten, twice-shy Jack Schofield thought VR was pure hype. Here, he reveals why the virtual revolution could be just months away

It's been almost 30 years since Dr Jonathan D Waldern founded a tiny company called W Industries to develop a "virtual-reality" system – which included a head-mounted display (HMD), data gloves, a tracking system, and associated software. I still have vivid memories of making a trip to Bristol to try a prototype. How could I refuse an invitation to experience the future?

Later, in 1993, the company – now called Virtuality – was floated on the London Stock Exchange. Its shares shot up from 170p to 315p on the first day, making Waldern a multimillionaire. By this time, the firm had marketable games such as Dactyl Nightmare, in which you battled a green dinosaur, and Grid Busters, a robot shoot-em-up. If you're of a certain age, you may have played such games in London's Trocadero, or the Embarcadero in San Francisco, or in similar arcade malls in the USA, Japan or Australia. If you'd been pre-sold VR by science fiction – such as William Gibson's *Neuromancer* – you had to have a go.

But the technology never made it further than those early games. Virtual reality crashed and burned.



LEFT Virtuality gave us a taste of VR back in the early 1990s

BEFORE ITS TIME

The basic strategy had seemed sound: consumers would experience VR in malls and arcades, and this would encourage them to buy their own headsets. But the games business failed to deliver. Atari planned to release a Virtuality-based headset to go with its Jaguar games console, but pulled out. Sega promoted its $200 Sega VR headset for the Mega Drive console at the Consumer Electronics Show (CES) in 1993, but it was never launched. At CES in 1995, Nintendo launched a monochrome VR system called Virtual Boy. It soon wished it hadn't, though: Virtual Boy flopped, and was cancelled the following year.

Virtuality then did deals with Philips and Japan's Takara to launch a $299 Scuba headset, which was released in 1997 and apparently sold more than 55,000 units. Impressive for a system with a 320 x 240 resolution, but as an Amazon reviewer noted: "Today, it's all too clear that Philips totally dropped the ball here and basically released a product that wasn't ready for prime time."

Did the first wave of VR arrive before its time? Yes. Is now the time? Maybe. The industry's hopes are focused on December 2016. Starship's Paul Hollywood, who has been developing VR and video-game software for decades, told me: "Christmas 2016 is going to be the first VR Christmas. You'll have the

"If you'd been pre-sold virtual reality by science fiction – such as William Gibson's *Neuromancer* – you had to have a go. But the technology never made it further. VR crashed and burned"



headsets on sale and there'll be a wave of content."

Whether there'll be a second VR Christmas remains to be seen, but billions of dollars are being invested in anticipation, such as the $2 billion that Facebook boss Mark Zuckerberg paid for Oculus VR last year. That's a chunky sum of cash for a firm that started on Kickstarter and has yet to launch a consumer product, but it reflects VR's status as the current golden child of technology.

Last year, a Sophic Capital report, "Virtual Reality: A Virtual Goldmine for Investors", suggested the VR market could be worth $7 billion (around £4.5 billion) – $2.3 billion in hardware and $4.7 billion in software – by 2018. It also predicted headset sales would grow from 200,000 to "about 39 million over five years".

Gartner research director Brian Blau has also predicted that "virtual worlds will have transitioned from the fringe to the mainstream" by 2018, and that more than 25 million HMDs will have been sold. This doesn't include phone-based headsets or non-electronic models such as Google Cardboard. Blau doesn't expect a rapid take-up because of a shortage of mainstream content, but he does expect that there will be more action in the next 18 months than in the past 18 years.



ABOVE This isn't the first time we've been flogged VR: anyone remember the Sega VR headset?

I confess to a feeling of *déjà vu*. Today, we have another garage-style startup that has made its founders rich, except it's called Oculus VR rather than Virtuality. And we still think gamers will kickstart sales of HMDs, only this time our hopes are pinned on the Oculus Rift, HTC Vive, and Sony's Project Morpheus, rather than Nintendo, Sega and Atari.

But there are two important differences this time. The first is that we have almost ubiquitous high-speed communications of the sort that didn't exist in the dial-up world of the 1990s. Today, we can stream VR data from almost anywhere in the world, rather than getting it on a games cartridge or a CD-ROM. Real-time conferencing, 3D commerce and virtual tourism are real possibilities, even if we no longer want to set up virtual homesteads in Second Life.

The second major difference is that, thanks to more than 30 years of Moore's law, we now have so much computer power that even a mobile phone can create a good VR experience.

VR KIT: WHAT'S OUT, WHAT'S COMING

With around 18 months to go before Christmas 2016, numerous VR systems are being prepared for launch. Here's our guide to the main contenders

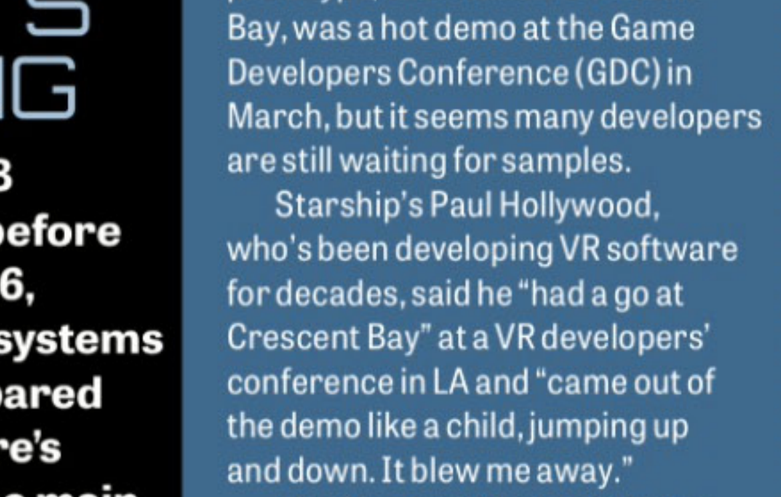
Oculus VR

DUE 2016 for "Crescent Bay"
LIKELY PRICE £500-£600

Oculus Rift has the highest profile of any VR system, thanks to its $2.4 million Kickstarter – and the small matter of Facebook buying the company for $2 billion. It's currently supplying $350 Rift headsets with Development Kit 2 (DK2). The latest prototype, codenamed Crescent Bay, was a hot demo at the Game Developers Conference (GDC) in March, but it seems many developers are still waiting for samples.

Starship's Paul Hollywood, who's been developing VR software for decades, said he "had a go at Crescent Bay" at a VR developers' conference in LA and "came out of the demo like a child, jumping up and down. It blew me away."

The Crescent Bay headset has two screens – one for each eye – and is connected to a powerful computer by video and USB cables. The PC knows what you're doing because a small positioning camera, much like a webcam, picks up signals from infrared LEDs mounted on the headset (think Wii controllers). The headset also features an "Adjacent Reality Tracker" (ART), which includes a magnetometer, a gyroscope and an accelerometer. The ART captures even small head movements.



Oculus VR has a classical idea of immersive VR, ripe for gaming. According to chief executive Brendan Iribe, Crescent Bay "allows for sustained presence – for you to achieve the impossible and believe you're in another world". Facebook boss Mark Zuckerberg seems to think of it more as a social platform, but a Facebook Live (à la Xbox Live) service could cover all bases.

Oculus VR hasn't confirmed details of the launch, but we do know it plans to have pre-orders open at the end of this year, with a shipping deadline of Q1 2016. It will require a higher-end PC to run, with the total package coming to around $1,500 (£981), according to Iribe.

Samsung Gear VR

DUE On sale now
PRICE £200

Samsung is already offering the Oculus-based Gear VR system, where the two virtual screens are provided by a single 5.7in Galaxy Note 4's 2,560 x 1,440 display. (Oculus used a Galaxy Note 3 screen for its Rift DK2.) A newer version of the Gear VR uses a Galaxy S6 smartphone, with a Note 5 version predicted for later this year.



Since the smartphone drives the display, users aren't tethered to a PC. The Gear VR lacks a positional tracking system, and you control its menu system by tapping the side of the headset. There are some games, but the system is also being used to view movies – Samsung offers a Milk VR movie service in the US. Then there's the promise of virtual tourism and even a virtual cookery course, in the form of Starship's CyberCook. Either way, all the developers I talked to rate the Gear VR very highly.

HTC Vive

DUE November 2015
LIKELY PRICE £200

Valve, an established games software company, recently unveiled its Vive VR headset, produced in conjunction with Taiwanese phone manufacturer HTC. The Developer Edition headset has two 1,200 x 1,080 displays, which HTC says can deliver "photorealistic imagery".

Like the Oculus Rift, it's fed by a PC. It also uses two small Lighthouse laser-tracking base stations for high-precision room mapping and location tracking, so the user can

Waldern's first system was based on the Commodore Amiga, which had sophisticated graphics chips but limited resolution, to say the least: if your eyesight was that bad, you'd be legally blind. Today's VR systems are a world apart. In terms of games, it's somewhat like comparing id Software's original Wolfenstein 3D (1992) with Wolfenstein: The New Order (2014).

There is, of course, another point to this comparison. In August 2013, id co-founder John Carmack, the father of first-person shooters, joined Oculus as chief technology officer. He's worked on both the Oculus Rift and the related Samsung Gear VR, and to quote VR evangelist Dan Page from Opposable Games: "if John Carmack's got something to do with it, it's going to be good. The guy's a wizard."

More new systems could appear, but at present it looks like Christmas 2016 will be a straight fight between the Oculus Rift and HTC Vive, with Morpheus picking up PS4 users. Oculus VR has Facebook money, but the HTC Vive could get a head start if it launches this year. Ordinary consumers could go for Samsung's Gear VR as a relatively painless way to explore VR – the catch being that the cheapish headset requires an expensive Samsung phone.

GAMES AND AFTER

Oculus Rift, HTC Vive and Sony Morpheus are all targeted at gamers, because gamers are the most visible market for VR. This is both a blessing and a curse for a technology that wants to take over, or replace, the world. "I expect VR to be huge hit with PC gamers, but that's a niche," said Page. "Reaching everyone who owns a high-powered PC isn't going to be seen by some people as a mainstream success. And there are so many other uses for VR in engineering, medical applications, training, experiential marketing and all sorts of fields."

"Reaching everyone who owns a high-powered PC isn't going to be seen as mainstream success. There are so many other uses for VR in engineering, medicine, training and marketing"

It may also be harder than some expect to crack the gaming market. Many games are already interactive and in 3D, so the transition looks easy. "That may be naive," said Gartner's Blau. "You're taking a keyboard and mouse and changing to some other kind of controller, and we don't even know what that controller is yet. The UI was made for 2D, even though the game worlds are 3D, and that may not make the leap either. If it's not a good experience, people aren't going to buy: it doesn't matter how good the hardware is."

As Dan Page says, the problem isn't creating a virtual-reality experience, it's creating a *good* virtual-reality experience. That was something Virtuality and others learned in the early 1990s: you can blow people's

move in a space up to 15ft square. It uses "context-aware" SteamVR handheld controllers, which you can see as hands (or anything else) in your virtual world. VR applications will be distributed via SteamVR.

Many of the people who tried Vive at Mobile World Congress or GDC 2015 raved about it, and it seems to be a significant advance



on Oculus Rift DK2. Dan Page from Opposable Games wrote a blog post about it: "We've tried the HTC Vive and it's absolutely mind-blowing." Visit **pcpro.link/250vive**.

Oculus has the recognisable brand, but Valve may have a better system, plus more than 125 million game-playing customers. The Vive VR could go on sale this November.

Razer OSVR

DUE 2016
LIKELY PRICE Under £200

Razer, a games hardware company best known for its mice and keyboards, has developed an open-source virtual-reality headset known, obviously, as OSVR. Both the hardware and software are open



source, so this could be a quick route to market for third parties if VR actually takes off. In that sense, OSVR is a bit like Android.

Razer plans to ship a $200 Hacker Dev Kit this summer, and claims developers will be able to use it to develop software for other VR systems as well. It will support the main game engines, including Unity 3D, Unreal Engine 4 and HeroEngine.

Sony Project Morpheus

DUE 2016
LIKELY PRICE £200-£300

Sony plans to enter the VR market with Project Morpheus, which uses a PlayStation 4 games console to drive the display. The latest Morpheus headset has nine LEDs, which provide location information via a PlayStation Camera. For its GDC 2015 demos, Sony used an extra box linked to the PS4 to drive the headset, but it's not clear whether this will be part of the final system. Either way, Morpheus is due to appear in the first half of 2016.



Microsoft HoloLens

DUE Unknown
LIKELY PRICE £500+

While Microsoft doesn't plan to enter the VR market, at least as far as we know, earlier this year it revealed an "augmented-reality" (AR) headset called HoloLens. This doesn't take you into a virtual world, but adds graphical objects to your existing reality. Of course, you



can end up in a VR world if the augmentations obscure the real world. For example, an app that Microsoft developed with NASA enables space scientists to walk around a simulation of the surface of Mars.

The HoloLens headset is self-contained and, if it ever appears, will be driven by a built-in PC running Windows 10. Hypothetically, Microsoft could also provide location tracking via Kinect. However, the HoloLens that Microsoft showed in January looked like a prototype, and again, I'd bet against a commercial version appearing this year.

Google Glass "version two"

DUE Unknown
LIKELY PRICE Unknown

Google has already had a go at augmented reality with its Google Glass project, which wasn't a huge success. Reports suggest that it's working on version two in partnership with traditional glasses makers. In April, the chief executive of Luxottica – the biggest eyewear manufacturer in the world – told investors that version two of Google Glass will be coming soon, while hinting that it's all leading up to "version three".



Google has also launched Google Cardboard, which is a cheap and cheerful way of turning a smartphone into a VR headset. In the conversations I've had with VR developers, nobody has been out to knock Cardboard, but nor have they taken it too seriously. Paul Hollywood said: "It's very interesting, but it's a toy."

socks off with a short demo, but it's much harder to develop a game they'll want to play every day.

Unfortunately, even with all the technical improvements, VR still has limitations. One is the feeling of nausea or motion sickness caused by what AMD's LiquidVR spokesperson calls "motion-to-photon latency". This is caused by a delay between you moving your head and the scene updating. You may also feel disorientated if the scene changes rapidly but you haven't moved your body. "A roller-coaster simulation can make you feel terrible because you're sitting still," said Starship's Hollywood. "You need something like a cockpit to give you a reference point so you can have movement going on around you."

These are the sorts of things VR game developers have to worry about: they don't want to make too many people sick.

A WIDER AUDIENCE

Developers in other areas are hoping gamers will popularise VR, and thus make headsets widely available. For example, Plextek Consulting's Collette Johnson is working on a medical training system for the UK's Ministry of Defence, which has specified Oculus Rift for training soldiers on a virtual battlefield. "The gamers will drive [adoption]," she said. "We want them to drive it, because they'll buy big numbers and normalise VR for a wider market."

Hugo Pickford-Wardle, chief innovation officer at Matter, takes a similar view. He sees gamers as early adopters of cutting-edge technologies. When they buy headsets, "it makes VR available to the rest of the family, where people can use it as a Skype alternative or for shopping in a virtual mall," he said. "It's almost a trojan horse."

In the short term, the Samsung Gear VR may turn out to be an effective trojan horse. "You can take it down to the pub, pass it around and show very high-resolution, very low-latency VR to people without having to lug a big PC around," said Opposable Games' Dan Page. "The 360-degree movie content is a really easy way to show people just how special VR can be."



Sony's Project Morpheus headset works with the PS4 console

"We're just starting to scratch the surface of the true power of virtual reality. It's not a video-game peripheral. It connects humans to humans in a way I've never seen before"



BELOW Facebook's $2bn acquisition of Oculus points to the potential size of the VR market

Samsung is certainly trying to bring Gear VR experiences to a wider (and more upmarket) audience. For example, in a three-month trial with Qantas, Samsung is providing headsets in First Class lounges in Sydney and Melbourne airports and "in the First Class cabins on select A380 services". Passengers will be able to watch movies on the headsets, and enjoy "VR experiences". Expect more companies to try this sort of thing while it has PR value.

Samsung also used Gear VR headsets at the World Economic Forum in Davos to show "more than 130 global leaders and dignitaries" a UN-backed film directed by Chris Milk about a 12-year-old girl living in a Syrian refugee camp in Jordan. Milk showed clips from the film in a TED talk titled "How virtual reality can create the ultimate empathy machine". In that, he said: "We're just [starting] to scratch the surface of the true power of virtual reality. It's not a video-game peripheral. It connects humans to humans in a way I've never seen before." You can view the talk at **pcpro.link/250ted**.

Milk fan Simon Sparks, co-founder of immersive video producers Yoovi, thinks that 360-degree VR movies could become really popular "because they can take you somewhere you never thought possible", whether that's on stage at a concert, the bottom of the ocean or the surface of the moon. "They're filmed with rigs covered in GoPro cameras – they seem to be the weapon of choice – then stitched together," he said. (On 28 April, GoPro bought Kolor, a French company whose software allows users to stitch together photos or videos to create immersive views.)

But as an AMD spokesperson reminded us, capturing an immersive audiovisual experience is just the start. To achieve "full presence" in another environment, we also need "touch and other stimuli such as temperature, kinaesthetic sense and balance". But since VR headsets have yet to take off, it may be too soon to start thinking about VR body suits. ●

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Reviews

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Microsoft Surface 3

Microsoft shrinks the Surface Pro 3 and cuts the price, delivering a capable, high-quality hybrid

SCORE ★★★★½

PRICE 64GB, £349 (£419 inc VAT); 128GB, £416 (£499 inc VAT); 4G pricing yet to be confirmed **from microsoftstore.com (pcpro.link/250mssp3)**

Let's take a moment to mark the passing of Windows RT. As the Surface 2 – Windows RT's swansong – trudges to an early grave, haunted by the spectre of embarrassing sales figures, the Surface 3 is tasked with getting Microsoft's Surface family back on track. And it looks like it might just have succeeded. With full-fat 64-bit Windows finally taking the place of the departed RT, Microsoft has redeemed itself by creating one of the best Windows tablets yet.

The Surface 3 impresses from the off: it's just as classy and lovingly crafted as we've come to expect from Microsoft's Surface brand. There's the same VaporMg metal construction – all bevelled edges, elegant straight lines and brisk curves – as previous models, and it feels solid and tautly constructed. It turns out that a miniaturised Surface Pro 3 is a very lovely thing indeed.

The Surface 3 is just as attractive as its big brother, then, but it has its own talents. Far easier to grab and carry around in one hand than the Pro, the Surface 3 is a device that demands to be taken everywhere.

PC PRO RECOMMENDED



Sure, it's not as portable as an iPad Air 2, but at 9.3mm thick and weighing 622g, it's light compared to many full-sized Windows tablets. Clasp on the optional Type Cover and the pair weigh in at a creditable 884g – a combination that's a touch lighter even than the 923g of the new Apple MacBook.

All the features in a smaller case

Microsoft has done a cracking job of shrinking the Surface 3 without diluting the qualities that made the Pro so special. Retaining the 3:2 display ratio employed on the Surface Pro 3 is a masterstroke: there's no doubt that a taller, squarer-shaped screen makes for a more spacious, usable display in both portrait and landscape orientations. It's a canny choice for a hybrid device designed to flit seamlessly between tablet and laptop roles.

The kickstand hinge isn't infinitely adjustable as it is on the Surface Pro 3, instead offering three positions from which to choose. This is no great loss, however, with two of the positions suitable for working at a desk, and the third ideal for use on your lap. In the crush of a commuter train or economy aeroplane seat, the Surface 3 remains an accommodating travel buddy.

Likewise, the slightly smaller Type Cover is superb, with keys that are exactly the same size as that of the Surface Pro 3's version. Microsoft hasn't worked some TARDIS-like magic here; there's simply a smaller border around the cover's edges.

Just like its big brother, the smaller Type Cover uses magnets to snap into place along the Surface 3's lower bezel, a feature that tilts the keyboard forward a touch, making it more comfortable to type on whether it's sat on a desk or your lap. Even the slightly shorter touchpad works well, something you can't always take for granted on smaller Windows devices. It's a shame you still have to pay £110 extra for the Type Cover, though.

Thankfully, Microsoft hasn't been tempted to adopt Apple's less-is-more approach to connectivity. There's still 802.11ac Wi-Fi, Bluetooth 4, a full-sized USB 3 port, mini-DisplayPort, a 3.5mm headphone jack and, hidden away beneath the kickstand, a microSD slot. One major change is that the Surface Pro 3's magnetic charging socket has made way for a micro-USB port: a charger is bundled in the box, but the big news is that the Surface 3 can now be charged from any USB source.

Display quality

It's the display that clinches the deal. Although it's smaller than the Surface Pro 3's display, the Surface 3's 10.8in, 1,920 x 1,280 screen is every bit as crisp. That's because the pixel density of 216ppi is identical. Quality is stupendous, with colours popping off the screen without ever veering into oversaturation. There's no need to reach for measurement hardware to see that the Surface 3's display is very good indeed.

In fact, testing reveals it to be superior to that of the Surface Pro 3. It's brighter, reaching a maximum of 403cd/m², and the contrast ratio of 833:1 is a touch better, too. Colour accuracy is superb, the IPS display dredging up an impressive 97% of the sRGB colour gamut – again, a better result than the Surface Pro 3 – while colour accuracy is near perfect, the Surface 3 delivering an average Delta E of 1.81 and a maximum deviation of 3.38.

The only weakness is the Surface 3's backlighting. Just as with previous models, there's a telltale glow of leakage around the panel's edges, and the backlighting is by no means perfectly even.

Touchscreen and the Surface Pen

It might seem like heresy to cover such a beautiful display in smudges and fingerprints, but the Surface 3 urges you to do exactly that. The touchscreen supports ten-point multitouch, and provides a silky-smooth feel that allows fingers to glide across the display. It works superbly.

The Surface Pen remains excellent. It's exactly the same as the one supplied with the Surface Pro 3. The pressure sensitivity works wonderfully in sketching and painting apps such as Fresh Paint, and functions just as effectively for handwriting and inking applications. It's comfortable to hold, with the matte finish providing the right amount of grip.

There are some annoyances: with the Surface 3, the Pen is a £45 optional extra, and there's still nowhere on the tablet itself to dock it. One option is to use a stick-on loop of fabric that attaches it to the Type Cover, as with the Surface Pro 3, but Microsoft now has the cheek to charge £4.50 for the add-on. Happily, it's just as effective to simply clip the Pen to the top edge of Type Cover.

ABOVE The Surface 3 is only 9.3mm thick, making it easy to carry around, and connectivity options are good too

"In the crush of a commuter train or economy aeroplane seat, the Surface 3 remains an accommodating travel buddy"

Price, specs and performance

The Surface 3 comes in two flavours. For £419, the base model provides 64GB of eMMC storage and 2GB of RAM. Spend an extra £80 and the £499 model boosts up to 128GB of storage and 4GB of RAM. Models with integrated 4G are on the way, too, but pricing and dates haven't yet been confirmed.

Whichever model you choose, the Surface 3 is powered by Intel's latest generation of Atom processor: the quad-core 1.6GHz Atom x7-Z8700. This marks the debut of Intel's Cherry Trail platform, which takes the existing 22nm Bay Trail architecture, shrinks it down to a 14nm process, and

BELOW The Surface Pen remains as effective as before, working equally well in painting and handwriting apps



tacks on an upgraded GPU based on Intel's Broadwell-class HD Graphics cores.

Even with the new CPUs, performance is the Surface 3's biggest compromise. To be fair, this isn't entirely due to the limitations of the fanless processor. The slow eMMC storage plays a part, too, forcing the Surface 3 to a crawl once you start pushing it. The occasional slowdown isn't a killer blow, but there's no getting away from the fact that this is a low-powered device best suited to modest workloads and light multitasking.

Needless to say, the Surface 3 struggled with the more intensive parts of our tough new benchmark suite, but the results clearly outline where its weaknesses and strengths lie. A score of 28 in the image-encoding tests put the Surface 3 a long way behind the 1.1GHz Core M-equipped Apple MacBook, which scored 60. However, the Surface 3's quad-core Atom evens the score in the video-encoding benchmark, its four cores nudging past the Core M's dual-core, Hyper-Threaded CPU with a result of 26 to the MacBook's 24. Multitasking was a wash: both the MacBook and Surface 3 scored 3.

The Surface 3's Top Trump is battery life. Its Atom x7 sips a mere 2W of power, and despite the bright IPS screen, we found it easily capable of lasting the whole day. In our 720p video-rundown test, with screen brightness at 120cd/m² and Wi-Fi turned off, the Surface 3 lasted 11hrs 36mins. That's very good for a Windows tablet, and not too far behind the Apple iPad Air 2, which lasted 12hrs 46mins in the same test.

Everything else

Microsoft hasn't skimped on any of the more minor elements. The cameras are excellent: by tablet standards, the front-facing snapper has an unusually high resolution of 3.5 megapixels, and while pixel count is no mark of quality, it serves up crisp, lifelike selfies and video chats. The rear-facing 8-megapixel camera is surprisingly capable, too, capturing decent detail with a pleasingly natural colour balance.

Both are helped by the Camera app's new burst mode, which lets you choose the best out of ten photographs, shot in rapid succession. When it comes to quickly grabbing an image and sharing it with others, the Surface 3 is in its element.

The pair of speakers – one mounted either side of the display – are pretty good too. Some distortion sets in at maximum volume, but there's just enough mid-range presence to make both music and speech clear and pleasant to listen to. They're better than the iPad Air 2's speakers, delivering audio with far more presence and stereo separation, and their positioning means they're less easy to muffle by accident.

Verdict

Compared to the slew of budget-priced Windows tablets on the market currently, the Microsoft Surface 3 looks expensive – stratospherically so considering it's only powered by an Atom CPU.

However, this device is in a completely different class to your average budget Windows tablet. Everything – from the display to the cameras, the build to the battery life – is a cut above. No two ways about it, the Surface 3 stacks up against the best premium tablets from any manufacturer, Apple included.

The optional extras do see the prices rack up pretty quickly. The cost of the base model rises from £419 to £574 once you factor in a Type Cover and Surface Pen, but in fairness that's still cheaper than a similarly equipped iPad Air 2. And, don't forget, the Surface 3 can run Windows applications, has a slightly superior display and does a better impression of a compact, lightweight laptop as well. It even comes bundled with a year's subscription to Office 365 Personal; another small but welcome bonus.

There are negatives, however, not least the fact that, despite all the tweaks, Windows 8.1 remains a mediocre tablet OS: the app store is an embarrassment, and the interface can feel awkward on a small, high-DPI screen.

When the free upgrade to Windows 10 arrives, however, the new Surface promises to come into its own. The Surface 3 is the iPad rival Microsoft was trying to make all along, and finally the company has got it right. Now all we need is Windows 10. **SASHA MULLER**

ABOVE **The quality of the 10.8in screen is superb, with colours popping off the display**

+ Fabulous display, comprehensive connectivity and impressive battery life

– Performance can't match the Surface Pro 3; pricey

SPECIFICATIONS

Quad-core 1.6GHz Intel Atom x7-Z8700 • 2GB RAM • 64GB eMMC storage • 10.8in 1,920 x 1,280 touchscreen • mini-DisplayPort • microSD • USB 3 • 802.11ac Wi-Fi • Bluetooth 4 • 267 x 9.3 x 187mm (WDH) • 1yr RTB warranty • 622g



RIGHT **The adjustability of the kickstand and the angle of the Type Cover make for a comfortable typing position**



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Apple Watch

The long-awaited Apple Watch is here, and it's the best smartwatch for every iPhone owner

SCORE ★★★★½

PRICE 38mm Apple Watch Sport, £249 (£299 inc VAT) from apple.com/uk (pcpro.link/250watch)



Appraising a first-generation Apple product is one of the hardest things a reviewer can do, and the Apple Watch is a perfect illustration of why. You look at the specs; you look the price; you look at what it does; and you end up giving it a mediocre review because, on the face of it, competing products seem to offer so much more. Then Apple goes ahead and sells millions of them, and suddenly it's setting the agenda for the whole industry. You end up looking like an idiot for missing what – with hindsight – ought to have been obvious.

Just as the iPad wasn't the first tablet, the Apple Watch isn't the first smartwatch. But just like the iPad before it, I think it will be the device that sets the pace for everyone else. I tested the 38mm "Space Grey" Apple Watch Sport – the cheapest version available, but still costing £299. You can pay a lot more for an Apple Watch if you want to: choose the larger 42mm version of the Sport and you'll pay £339. Go up a level to the steel Apple Watch and you could be parting with up to £949, depending on your choice of strap. If you're rich enough to even consider the Apple Watch Edition, you probably won't care that prices range from £8,000 to £12,000.

Hardware and design

Whichever model you choose, you're going to get substantially the same Watch; internally, they all use the same core hardware and offer exactly the same features. What's different is the materials used for the case and the screen. The Sport uses anodised aluminium for the case and scratch-resistant glass for the screen; the next models up swap to hardened stainless steel and sapphire crystal; and the Edition takes things up a notch to a unique-to-Apple 18-karat gold.

Like most Apple products, the Watch feels like it's been designed and put together with a lot of care. It's the first smartwatch I've tried that I'd choose to wear not simply for the technology, but because it looks great. Putting it next to the Motorola Moto 360, for example, makes the Android Wear device look chunky and old-fashioned – even though there isn't a huge difference between the actual thicknesses of the two.

The Apple Watch has two physical controls. The first – a button on the right edge – simply brings up a list of your favourite contacts, from which you can quickly call someone or send them a message. (This includes not only text messages and iMessages, but also some new Watch-specific modes of communication, which I'll come back to shortly.)

The other control is much more interesting, and ends up as the heart of how you work the Apple Watch. Dubbed the "Digital Crown", it looks and feels like a normal crown used to adjust the time or wind up a mechanical watch. On the Apple Watch, however, you rotate it to scroll up and down lists of onscreen content. Pressing it takes you back to the watch face or app homescreen, while pressing and holding it invokes Siri.

ABOVE The Apple Watch is the most stylish smartwatch on the market

The insight behind the idea is simple: scrolling with a finger across a small screen obstructs the content, making it harder to see what you're looking for. So, while you can use your finger to scroll if you wish, the Digital Crown is the default option.

If you've used a smartwatch before, this takes some getting used to. I had to spend a couple of days reminding myself not to swipe my finger across the screen – but once I'd familiarised myself with the Digital Crown, I found it worked perfectly.

The screen itself is a high-quality AMOLED display. Although I'm old enough to need to squint occasionally when reading, I found it perfectly comfortable in use, and easy to

✚ Beautifully designed and well thought through; Taptic Engine works very effectively

➖ Battery life is one day; it's pricey; only works with an iPhone

read even in bright sunlight. The resolution is 272 x 340 on the 38mm model, and 312 x 390 on the 42mm one, both of which translate to perfectly sharp text and graphics at normal watch-viewing distances.

Like the trackpad on the new MacBook and MacBook Pro models, the Apple Watch screen supports "Force Touch". This means you can tap on the screen to do one thing, then push harder to do something else. It feels as if you're pressing through the screen, which is a little weird at first, but something you very quickly get used to. Doing this in apps activates additional options, such as dismissing all alerts.

Meanwhile, the underside of the Watch plays host to another innovative haptic technology, which Apple calls the "Taptic Engine". Simply put, this alerts you to incoming messages by generating a short vibration that feels like being discreetly tapped on the wrist – the ultimate in unobtrusive notifications.

Also at the back of the watch body sit sensors that check your heart rate. In theory you're monitored continuously; in practice, in order to save power, the Watch only checks your heart rate every few minutes, unless you've explicitly told it to track an exercise session. I compared the Watch's pulse measurements to my own manual count, and found it to be accurate to within a handful of beats per minute.

Pairing the Apple Watch with an iPhone for the first time is a gloriously straightforward experience. There's no fiddling around with Bluetooth: the Apple Watch displays an animation on its screen, and all you have to do is point your iPhone's camera at it to pair the devices.

Faces and complications

Creating a user interface for a screen you wear on your wrist is a major challenge. It certainly isn't as simple as replicating a smartphone UI. The Apple Watch front-end centres around the watch face, and there are numerous designs to choose from, including classic utility faces, modern-looking faces, and others that are more abstract. There's even a rendition of the classic Mickey Mouse face, complete with Mickey tapping his foot every second.

Every one of these watch faces is a thing of beauty, and most of them can be customised with "complications" – a traditional watchmaking term referring to anything that "complicates" the watch face, such as timers, date displays and so on. On the Apple Watch, complications are widgets showing information such as the weather, calendar events, a stopwatch or the phase of the moon. You can choose which of these to show in any of the available "slots" on your chosen watch face.



BELOW **Sensors on the rear of the Watch monitor your heartbeat**

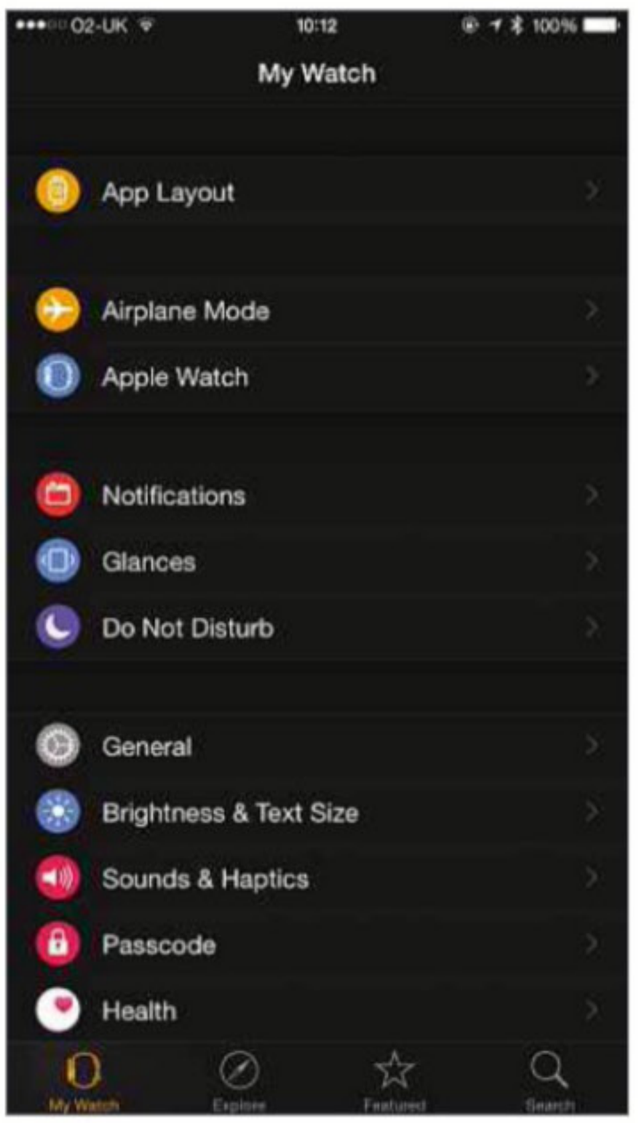
Complications can be customised to an extent: you can choose the number of digits shown on a rotary-dial-style face, for example, and the colour of its hands. What you can't do is create your own. You're limited to customising what Apple provides: even developers are forbidden, at this point, from producing new watch faces and new complications.

If you're coming from the free-for-all world of Android Wear, not being able to have a custom watch face will probably seem frustrating. But there may be good reasons for Apple's's locked-down approach. When you look at the supplied faces, it's evident that they've all been designed to maximise the amount of black on the screen, and to minimise the number of coloured pixels. Since black AMOLED pixels draw no power, it's safe to assume this is a deliberate move to minimise power drain.

Apple's history (and in particular the evolution of the iPhone) suggests that it will ultimately allow more freedom to developers. For now, I think the company has made a sensible trade-off: battery life is clearly a high priority for Apple and its customers.

Apple Watch apps

When you press the Digital Crown to access the Apple Watch homescreen, you'll see small round icons representing the various apps on offer. On first seeing this I expected to experience problems hitting the right icons, but the touch targets are well optimised: in several weeks of use, I didn't hit a single wrong button. On a 38mm screen, that's impressive.



ABOVE **Configuration options are accessed on your iPhone via the Apple Watch companion app**

The built-in apps themselves are something of a mixed bag. They can access your personal data and settings from the iPhone, but what they actually do with them tends to be quite basic. For example, you can view your favourite images in the Photos app, but you can't edit or share them. Similarly, the email app is read-only. Weather delivers much the same information you receive on an iPhone, merely tailored to the smaller screen.

The Messages app is a better demonstration of the Watch's potential: it's capable of using Siri for dictation, allowing you to initiate and reply to text messages. More than this, it also lets you send finger-doodles and taptic prods to other Watch owners; you can even share your heartbeat with an intimate contact.

If Apple's own apps are of varied usefulness, third-party apps are even more limited. In fairness, Apple Watch developers have had very little time to feel out the capabilities of the device, and almost no-one has any experience of how users want to interact with a screen of this size. Already, we're hearing about developers who dived into Apple Watch on day one and are now redesigning their applications in light of lessons quickly learnt.

The good news is that there's plenty of potential here. The Watch itself may have limited processing power, but this isn't a problem since very little code has to execute natively on the device. Apple Watch apps actually run mostly on your iPhone, with the Watch simply handling the display and controls.

However, this does mean that if your Watch isn't within range of the iPhone, many apps won't work. But that's not as limiting as it may sound: the Watch communicates with the iPhone not only via Bluetooth, but also Wi-Fi. This means that even if your Watch is out of Bluetooth range of the iPhone, as long as the two are on the same network, everything will continue to work. If you're in a home or office with a single logical network, you can leave your iPhone on the desk and your Watch will keep working anywhere around the building.

With the Watch so reliant on the iPhone, there is a danger that we could end up with growing amounts of data constantly flying back and forth between the two devices, slowing things down. To cut down on wasteful back-and-forthing, Apple says that applications that run directly on the Watch itself will start to appear "later in the year" – although it hasn't yet released details of how this will work, or what capabilities will be open to third-party developers.



As well as opening from the homescreen, apps can be quickly accessed via what Apple calls "Glances". Simply put, a Glance is a single-screen interface that gives you the core information and features of an application. To access Glances, you swipe upwards from the bottom of the watch face: you'll immediately see a page of information and controls related to one of your favourite apps. For example, a Glance for a podcast player might show the details of the podcast that's playing currently, along with controls for skipping forward or back. A Glance for a weather app might display the forecast for your current location.

You can switch between app Glances by swiping left and right; up to 20 Glances can be active at once. Given that you have to swipe between them, this is probably a sensible limit.

ABOVE The Watch tracks your progress towards your movement, exercise and standing goals

Fitness

Apple has strongly promoted the Watch as a fitness device, and it comes with two applications dedicated to supporting an active lifestyle: Activity and Workout.

As the name suggests, Activity is designed to encourage you to be more active. It tracks your progress towards daily activity goals in three categories: movement, exercise and standing. The movement goal you can set yourself, as a target in calories; the exercise goal is set at 30 minutes per day of brisk activity, such as jogging, working out or playing sport. The standing goal simply requires you to stand up for a few minutes each hour, in each of 12 hours during the day. As the day goes on, a concentric-ring display shows your progress towards each goal – red for movement, green for exercise and blue for standing.

Clearly, Activity isn't intended for hardcore exercise bunnies. But for people like me, who simply need a bit of a nudge towards a more active lifestyle, it works well.

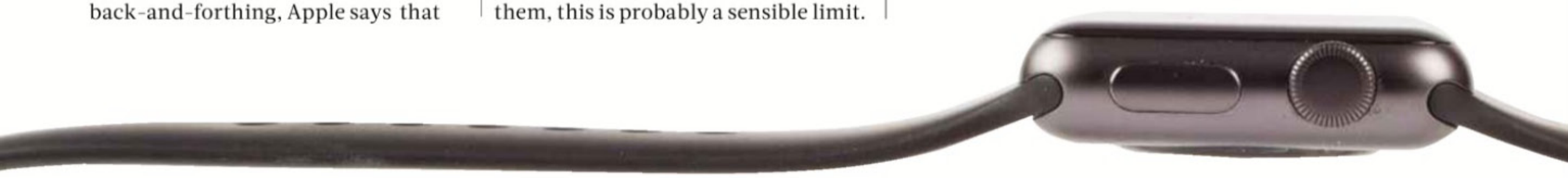
Workout, meanwhile, is about logging specific exercise activity. You can select from common types of workout such as running, walking or using an elliptical trainer or rowing machine. You then set yourself a goal, in terms of calories or time, and away you go. The Apple Watch logs what you do, and provides encouragement along the way by telling you when you've hit 50% of your goal. It's basic, but it works effectively.

All the data from these two fitness apps, along with the number of steps you've taken each day and your heart rate, are fed into the Health app on your iPhone. This means the data can also be made available to other apps on your phone to which you've given permission.

"Already, developers who dived into the Apple Watch on day one are redesigning their apps in light of lessons quickly learnt"

In addition to the built-in offerings, there's already a good selection of third-party fitness apps on the Apple Watch, from well-known brands such as Runtastic and Strava, plus more specialised apps such as FitStar Yoga and Hole19 for golf. The one limitation is that, since the Apple Watch lacks a built-in GPS receiver, it needs to be in range of your iPhone to fully track your motion. It can track your steps and heart rate without the phone to

BELOW The Apple Watch is controlled via a single button and the Digital Crown



hand, and it will make a guess based on previous data of the distance you've walked or run – but unless you're carrying the iPhone with you, you can't accurately track your distance or route.

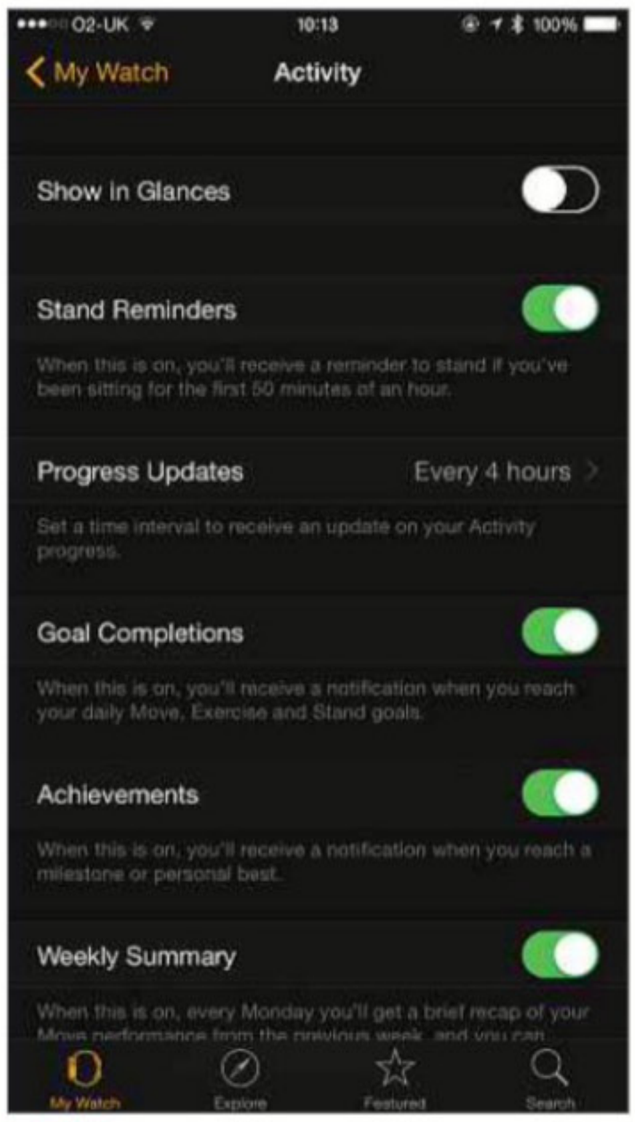
The Apple Watch isn't an iPhone owner's only choice for fitness tracking. There are several more fitness-focused devices out there, including the iOS-compatible Basis Peak (*see p72*), which offers automatic exercise tracking and a wider range of metrics, such as skin temperature and perspiration levels. But for everyone except the most dedicated fitness fanatics, the Apple Watch is a more tempting all-round proposition. It's easy to use, it tracks and analyses your activity in an intelligible way, and it's extensible by third-party apps.

Battery life

Before its release, there was some controversy over the Apple Watch's potential battery life. The rumour was that in active use it would last only a few hours per charge, implying that you'd need to charge the Watch multiple times per day.

The good news is that real-world experience – backed up by our standard battery tests – confirms that the Watch can easily make it through a whole day. On average, I found I had around 30-40% battery power remaining at the end of each day of use. That means you'll normally want to charge the Watch every night, using the inductive charger supplied – but if you forget, it will happily keep running into the following day. Apple says you can top up the battery from zero to 80% in around 90 minutes, or to 100% in around two-and-a-half hours.

It's worth noting that these figures are for the 38mm Apple Watch, which has a 205mAh battery. The 42mm version may well last longer, as Apple advertises that it has a bigger battery, although we don't yet know exactly how much bigger.



ABOVE The Activity app uses goals and achievements to encourage you to stay active

Verdict

The true test of any personal device is simply whether or not you miss it when it isn't there. In the case of the Apple Watch, after just a few days of continual use I came to expect it to be on my wrist at all times.

It's also changed my behaviour. Before trying the Apple Watch, I feared that it might be a distraction that tied me constantly to my phone. In the event, I found the opposite to be the case: being able to glance down at notifications meant I was able to quickly triage them from the wrist, and didn't need to dig out my phone as often.

Is it the best smartwatch available at present? If you have an iPhone, the answer is a clear "yes". It's not cheap, but you're paying for a high-quality product that integrates incredibly well with the whole Apple ecosystem.

In fact, the Apple Watch is a more complete product than the first iPhone. It's certainly ahead of anything running Android Wear in terms of design. The Pebble Steel and forthcoming Pebble Time may be stronger rivals for your cash, with superior battery life to anything else and effective notifications systems – but they lack the design finesse of Apple's digital timepiece and its fitness-tracking features.

Ultimately, at the moment the Apple Watch remains an accessory to the iPhone, albeit a beautiful and interesting one. Should you buy one? If you have an iPhone and have the money, you won't regret it. But how much use you'll get out of it remains to be seen. **IAN BETTERIDGE**

SPECIFICATIONS

38mm model: 272 x 340 AMOLED display • optical heart-rate monitor • accelerometer • gyroscope • IPX7 water resistance • Bluetooth 4 LE • 802.11n Wi-Fi • 1yr RTB warranty • watch body only, 34.9 x 12.2 x 38.6mm (WDH) • 48g (including Sport strap)

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Basis Peak

With an intriguing, hands-off approach to fitness and sleep tracking, the Basis Peak forges its own path

SCORE ★★★☆☆

PRICE £142 (£170 inc VAT) from amazon.co.uk (pcpro.link/250basis)



Every small tech company dreams of piquing the interest of a giant such as Intel – and Basis has made that dream a reality. Intel was so enthralled by Basis' original vision of the activity tracker, the Basis B1, that it snapped up the company for its new Devices Group. Now Basis has unleashed the Basis Peak – a device it describes as "the ultimate fitness and sleep tracker".

That's quite a claim, but the Basis Peak is different to its rivals: this is a fitness tracker in the purest, most hands-off sense. A clutch of sensors monitor your vitals continually, and this stream of data allows the Peak to recognise sleep patterns, bike rides and runs – all without any intervention. Strap it to your wrist and you can get on with your day without giving it a second thought.

The Basis Peak's simplicity makes a refreshing change from more hands-on devices. Start walking, running or cycling with it on your wrist, and after a few minutes the monochrome 1.2in LCD changes from the clock to a more informative screen, showing the elapsed time, calories consumed, your heart rate and the current time. There's no learning curve to speak of, no button presses required – it just works.

Design

Rather like the company's first tracker, the B1, the Peak's design is more functional than fashionable. It's available in matte black, or light silver with a gloss black surround and white strap. There's no getting around it, however: at 13mm thick, the Peak is more chunky wearable than stylish sports watch.



Flip the Peak around and the rear is where all the magic happens. Four metal contacts are dotted around a central bank of sensors, all of which work in unison to measure heart rate, skin temperature, perspiration and the number of steps taken. Take off the Peak and a pair of blindingly bright-green LEDs flash insistently in search of a heartbeat.

Despite its bulk, comfort isn't an issue. Where the Microsoft Band constantly digs and snags, the Peak's thick, soft rubber straps make it a genuinely all-day, every-day wearable. It held fast through a fortnight of runs and bike rides, on- and off-road. And since the Peak is waterproof to 50 metres, you don't even have to worry about taking it off in the shower.

Thanks to that power-efficient monochrome LCD screen, the Basis Peak also has one huge trump card over other devices: battery life is very good indeed. In several weeks of use, the Peak lasted between two to three days before its display pinged up a "Charge Me Now!" message. It charges quickly: magnets in the little charging puck hold the watch firmly in place, and it reaches 90% capacity in a couple of hours.

ABOVE **The Basis Peak monitors your vitals and tells the time – but notification support is basic**

The interface

Basis has adopted a stripped-down approach to the Peak's interface. Just like an increasing number of wearables, the Peak captures an overwhelming amount of data, but the watch displays only the essentials – this isn't a device for fitness geeks that want to view every possible statistic on their wrist.

"The stream of data allows the Peak to recognise sleep patterns, bike rides and runs – all without any intervention"

Most of the time, the clock remains front and centre; a tap of the screen toggles the date on and off. You can check your heart rate by swiping the screen to the left, and swiping down from here provides the daily totals for steps taken and calories burned. Swipe right again, and it's possible to peruse a summary of the day's recent activities by scrolling up and down. Meanwhile, you can tap the screen during a run or ride to toggle the main display between current heart rate and total calories burnt.

There's notification support, too, with alerts for phone calls, email, text messages and calendar entries popping up onscreen as your

LEFT **Bright-green LEDs on the rear of the Basis Peak flash in search of a heartbeat**

✚ Recognises activities automatically; UI is simple and straightforward

➖ Notification support is crude; heart-rate tracking drops out

phone receives them. The way it works, however, is basic. Notifications only appear for five minutes before disappearing permanently, and you can't save or reread messages. It also appears that third-party email clients aren't supported on iOS.

Another quirk is that the screen's backlight is manually activated. You need to swipe upwards on the right of the display to turn it on, and swipe down to turn it off, and it often takes a few attempts to do so – the touchscreen can be frustratingly unresponsive.

The Peak can also be a touch buggy. Our first review unit failed to pair at all, refusing to upload the firmware or restart. Our second unit refused to connect to our iPhone 6 Plus a few times, with the only fix being to restart the watch manually. While this is a fairly quick process, it's disappointing on a £170 device. Another more minor niggle is that if the Peak runs out of battery, it forgets the time and date; you have to manually reset the clock using the smartphone app.

In addition, the Basis Peak lacks pedometer-based distance tracking, and a GPS for that matter; this isn't a fitness device that cares about how fast or how far you go. If that's essential for you, then the only option is to pair the Peak with a smartphone app such as Strava – in this scenario, the Peak acts as a glorified Bluetooth LE heart-rate sensor, the screen constantly displaying your heart rate in a large, easily legible font. Even here, though, it isn't without issue: however you use the Peak, the heart-rate sensor has the annoying tendency to drop in and out.

Setup and features

While its limitations may disappoint some, the Peak is elegant in its simplicity. All the data captured by the Peak flows into the cloud via the smartphone app, which is available for both iOS and Android. Once synced, it's possible to view all your activity data either on the app itself, or via a browser in Basis' online portal. By default, the graphing functions detail heart rate, steps taken and calories burnt, but it's also possible to toggle skin temperature and perspiration rate – although frankly, it's difficult to see why anyone would need to know all this.

One of the Peak's best features is the ability to set Habits in the app. These include goals such as getting up or going to sleep at consistent times, burning a preset number of calories per day, or even just getting up and walking around now and again. You can tailor these goals to suit, and completing them successfully earns points that allow you to add extra Habits to the list.



ABOVE **This is no sleek smartwatch – the Basis Peak has a far more chunky design**

The sleep tracking is impressively thorough. The Peak monitors when you drop off and wake up and analyses how much of your night is spent in REM, deep and light sleep states, as well as how many times you toss and turn, and interruptions such as popping downstairs to get a drink.

The Peak's app balances these results to give you a sleep score in percentage form. While this may sound gimmicky, it works surprisingly well: over three weeks, the worst sleep ratings directly correlated with the arrival of a nasty cold, and high ratings correlated with the sensation of genuinely having slept very well indeed.

The only downside? Sitting very still at a desk, in the cinema or while watching TV may be enough to trigger the Peak into thinking you're having a nap. Basis' sleep algorithm clearly isn't infallible.

Verdict

It all makes for a very curious wearable. For true fitness fanatics, the Basis Peak is unlikely to hit the spot. The inability to export data to other apps or record GPS-tracked rides and runs – not to mention the lack of any speed, pace or distance information – make it incapable of replacing more fully featured devices, such as the Microsoft Band or Garmin Vivoactive.

Meanwhile, those wanting a do-it-all fitness wearable and smartwatch may be put off by the crude notification support. In truth, £170 seems a lot to pay for what you're getting here, especially since much of the data captured doesn't seem to serve much purpose.

Despite all this, there's something intriguing about the Peak. At its best, it's a fuss-free way of tracking your daily habits and changing them for the better, and the sleep tracking seems pretty accurate too. There's no getting away from the sense that the Basis Peak is a hi-tech toy rather than an essential fitness wearable, but if your focus is more geeking out than bulking up, then it may hit the spot. **SASHA MULLER**

SPECIFICATIONS

1.2in monochrome touchscreen • optical heart-rate monitor • 3-axis accelerometer • galvanic skin-response sensor • thermal sensor • water resistant to 5ATM (IP68) • Bluetooth 4 LE • iOS and Android compatible • 1yr RTB warranty • watch body only, 42 x 13 x 44mm (WDH) • 48g (including strap)

Slingbox M1

A clever piece of kit, but Sling has been bypassed by the world of on-demand and catch-up TV



SCORE ★★☆☆☆

PRICE £108 (£129 inc VAT) from turbosat.com (pcpro.link/250sling)

The Slingbox M1 is not your everyday TV streamer. Instead of delivering catch-up content from online sources direct to your TV, the Slingbox allows you to take remote control of an existing cable or satellite box and stream its content to your laptop, tablet or smartphone.

It sounds exciting at first. A thing you'd want to do, just because. But what are the practical benefits – if you're not in a position to splash £129 just for the sake of it?

Well, there are a few applications. If you're the type who hoards recordings of movies on your set-top box, for instance, the Slingbox M1 provides a way of accessing these recordings quickly and easily from any device, anywhere on the planet.

It's also useful for live sports: if you want to watch the big match while you're away, it should offer a better way of doing it than trawling the internet for a dodgy stream. And if you're desperate to catch something on live TV before your Twitter stream gets clogged with spoilers, it's good for that too.

Setting it up is simple enough: plug the M1 into the video and audio outputs of your set-top box, and connect the outputs on the Slingbox to the corresponding inputs on your TV. This allows the box to intercept the signal, encode it ready for streaming, and pipe it over the internet, or your local network, to your laptop, tablet or smartphone.

Video connections are made via composite or component cables (HDMI won't work due to HDCP restrictions), the box connects to the internet via dual-band 802.11n Wi-Fi or Ethernet, and control over your box is provided via an IR blaster integrated into the rear of the Slingbox. (The box also ships with an extender you can stick to the front of your set-top box if the integrated transmitter doesn't work with your setup.)

Once you've set up an account on Sling's website, you're good to go. Sling provides apps for all the major mobile operating systems, including a Modern app for Windows. These apps even support Google Cast, so you can send content directly to a TV via a Chromecast. The simplest way to connect to your Slingbox, however, is to install either the Windows or OS X desktop application.

In general, the system works well. I hooked up the Slingbox M1 to an ageing Virgin Media HD box and found streaming from my house in north-east London to my parents' place in Wimbledon Park was reasonably stable, and quality surprisingly high. I did experience the occasional bout of buffering, and sometimes the quality dropped, but by and large the stream was perfectly watchable.

The Slingbox M1 will stream at resolutions up to 1080p if you're using component connections (with composite connections you're limited to standard definition). Just bear in mind that the quality it delivers in real-world use will vary depending on the speed of the connection, in particular at the upload end. In the test above, my uplink speed was 3Mbits/sec, so it clearly doesn't need a huge amount of bandwidth. However, it stands to reason that if your broadband connection isn't reliable or speedy enough, the Slingbox M1 isn't for you.

The remote-control aspect of the system is more hit and miss.

ABOVE Simply connect the Slingbox to your set-top box to enable streaming

To change channels, or browse your recordings, Slingbox's software provides a virtual, onscreen remote control, which mimics not only the layout, but the exact appearance of your set-top box's remote control. This means it's pretty easy to get to grips with; on my box, however, I found it terribly unresponsive. Clicking buttons to navigate around often involved a lag of between three and four seconds before that action was reflected onscreen. This makes browsing long lists of recordings or the programme guide a real pain, and fast-forwarding through the ads feels a little like playing pin the tail on the donkey.

"The Slingbox allows you to take remote control of an existing cable or satellite box and stream its content"

More irksome than this is Sling's policy on pricing. The box itself isn't cheap to start with. At £129, it's more than four times the price of a Chromecast, and then you have to pay for the apps on top. They're not cheap, either, at around £11 each. And while the Windows and OS X desktop software is free, it hosts irritating ads when the app's not full-screen.

+ Works pretty well considering what it's being asked to do

− Ads in desktop apps; mobile apps are expensive extras

All of which is a shame, because the hardware does the job as well as can be expected. Remote control is a touch laggy, but given a fast enough internet connection, picture quality is perfectly acceptable. If you're already paying for a comprehensive cable or satellite TV service, it's a great way of making the most of that subscription, and it may be the only way for die-hard sports fans to get their fix when travelling.

If you're tempted by the Slingbox M1, however, I'd advise you ask yourself one key question before you splash out: "How often would I use it?" The answer is unlikely to be enough to justify the £129 price tag. **JONATHAN BRAY**



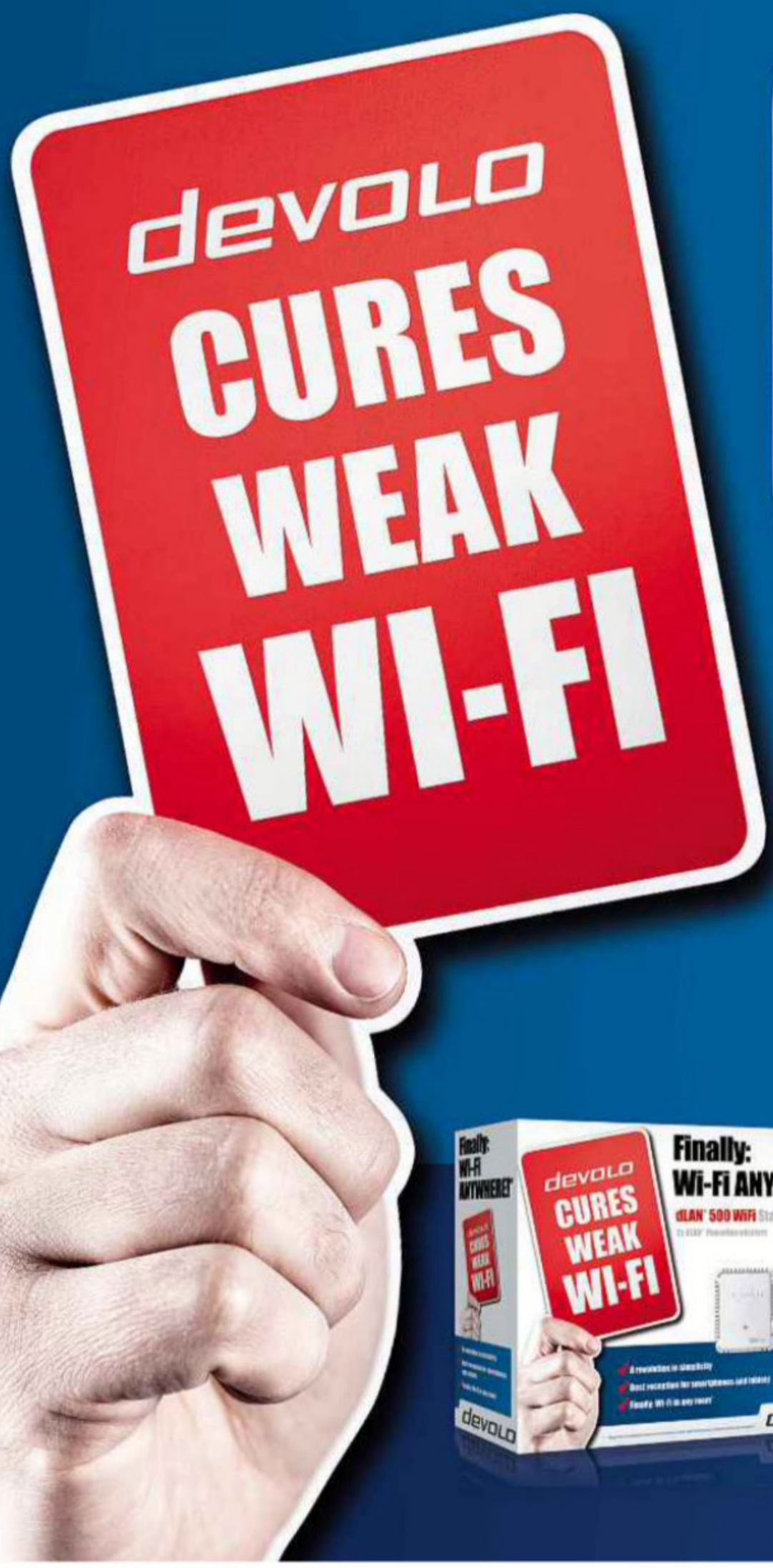
BELOW Video connections are made via composite or component cables

SPECIFICATIONS

Up to 1080p resolution • component and composite video out • IR • dual-band 802.11n Wi-Fi • 10/100 Ethernet • 1yr RTB warranty • 179 x 110 x 42mm (WDH)

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The Network Innovation

LG G4

LG's new flagship takes aim at the Samsung Galaxy S6 – and pulls off an impressive coup

SCORE ★★★★★

PRICE SIM-free, £415 (£498 inc VAT) from handtec.co.uk (pcpro.link/250lgg4)

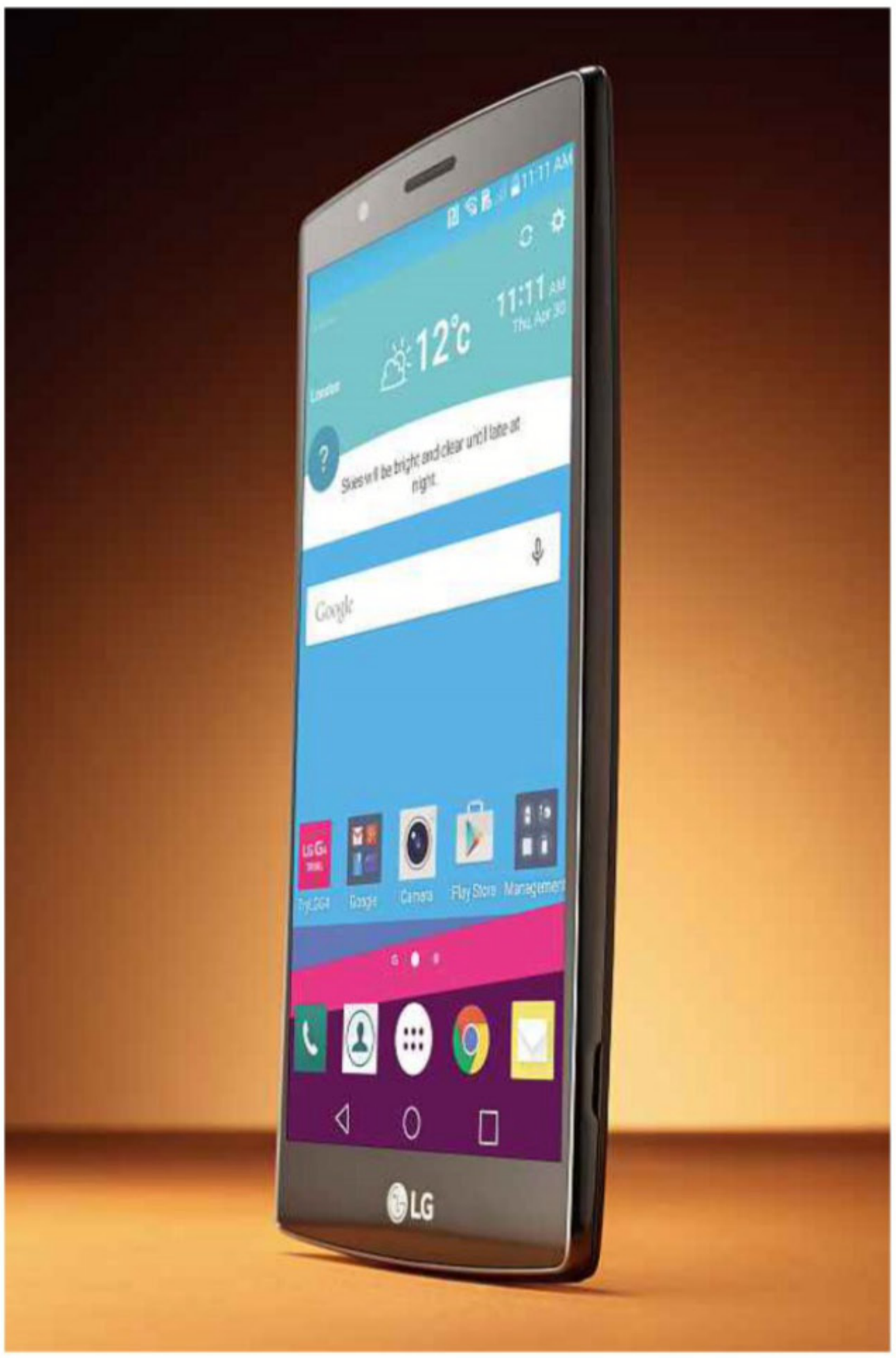
Different people want different things from a smartphone. Some value appearance and design above all else. Others want the fastest performance. A fair number, however, value the practical things in life, and it's these folk who will be looking closely at the LG G4: of the current generation, it's the only major smartphone with both a microSD slot and a removable battery. The question is, does the rest of it pass muster?

In its basic shape and controls, the G4 breaks no new ground. The rear is still gently curved and fits in your hand nicely. The volume and power buttons still reside in the centre of the rear panel, just below the camera lens.

The overall dimensions haven't changed much either. The LG G4 is slightly taller and wider than the G3, at 76 x 9.8 x 149mm, but this isn't as obvious to the naked eye.

One change you might notice is the new "Slim Arc" screen, which curves slightly from top to bottom – a bit like LG's G Flex models, but much subtler. The leather backing is distinctive, too: there's a range of different-coloured designs available, all of which are fetching, with precise, close stitching running down the centre and the G4 logo embossed into the bottom-right corner. Depending on the colour you choose, there's even some variation in the character of the leather, with a smooth, close-grained briefcase finish on the brown and burgundy versions and a coarser grain on the pale blue, black and tan models.

A slightly cheaper range of plastic designs is offered too, in shades including a glossy "ceramic" white and titanium grey, with a subtle diamond pattern moulded into the shell. But we suspect most customers will go for the leather finish, which looks and feels very nice indeed: the black version in particular is fabulous.



Specifications and display

It wouldn't be a flagship launch without a bump in specifications, so it's no surprise to see an upgrade to the internals. But LG is doing things differently from the competition, opting for Qualcomm's six-core, 64-bit 1.8GHz Snapdragon 808 SoC, backed by an Adreno 418 GPU, 3GB of RAM and 32GB of storage. Other specs include dual-band, dual-stream 802.11ac Wi-Fi with MU-MIMO, Cat9 4G with download speeds of up to 450Mbits/sec, Bluetooth 4.1 and NFC. What you don't get is any kind of waterproofing or wireless charging, but the latter can be added via an optional replacement back.

The CPU's six cores are split in a dual-core/quad-core arrangement, running at 1.8GHz and 1.44GHz. Overall performance compares surprisingly well with the HTC One M9: in the single-threaded Geekbench 3 benchmark, the G4 scored 1,134 versus the M9's 838, and its multi-threaded score of 3,501 was a mere half-step behind the HTC's 3,677 – despite having only half as many cores for intensive tasks.

It isn't all good news. In the GFXBench 3.1 gaming test, the G4 achieved only half the frame rate of HTC's handset – probably in part owing to its high-DPI 1,440 x 2,560 screen, which is more demanding to drive than the M9's 1080p display. It's also worth noting that the Samsung Galaxy S6 easily bested both phones in the Geekbench test, and placed squarely between the two in GFXBench. But it's possible to get too hung up on such figures: in everyday use, the G4 feels perfectly responsive, and we haven't yet found a game that fazes it.

Elsewhere, battery life is an improvement on last year's G3 – something LG credits to a number of changes, including a more efficient display technology. The G4 uses what LG calls "N-type liquid crystals", which allow more light through so that a lower-power backlight can be used.

In practice, we found that streaming a 720p video in flight mode, with the screen set to a brightness of 120cd/m², drained the G4 at 6.3% per hour; audio streaming over 4G drained it at 3.6%. That doesn't quite match the Samsung Galaxy S6's figures of 6% and 2.8%, but it's better than the HTC One M9 (9.7% and 2.6%). And since the battery is user-replaceable, you have the option of buying a spare, or even a third-party high-capacity replacement.

With a top brightness of 476cd/m², the G4's screen is far from the most eye-searing we've measured, but LG claims that it's capable of producing a wider range of colours than other phones – in conformance to the DCI (Digital Cinema Initiatives) standard, rather than sRGB or Adobe RGB. In practice, we found that the G4 covered 97.9% of the sRGB gamut, which is impressive, and produced a rich tapestry of greens and reds.

The accuracy of those colours is tough to assess, since even with automatic brightness adjustment turned off, the backlight level varies automatically depending on what's displayed onscreen. What we can say is that the LG G4's display has plenty of impact, is as crisp as anyone needs, and produces colours that really leap from the screen.

ABOVE The G4's Slim Arc screen adds a subtle curvature to an already attractive design

PC PRO RECOMMENDED

"We suspect most customers will go for the leather finish, which looks and feels very nice indeed: the black version in particular is fabulous"

Cameras

Smartphone cameras have been constantly improving of late, and LG keeps pace here: the G4 ups the resolution to 16 megapixels from the G3's 13 megapixels, and widens the

aperture to f/1.8, just outdoing the f/1.9 aperture on the Samsung Galaxy S6's rear camera. What this means in practice is that more light hits the sensor, so you can use faster shutter speeds and/or lower ISO sensitivity settings. The end result is sharper pictures with less noise.

LG hasn't stopped there. It's also improved the G3's optical image-stabilisation (OIS) system, adding "Z-axis feedback" this time around. The laser-assisted autofocus from the G3 remains in place too, helping the camera produce sharp photos quickly, while a new colour-spectrum sensor is used to measure ambient light and set the white balance and flash temperature accordingly.

Since the core specifications of the G4's camera are almost identical to those of the impressive cameras on the Samsung Galaxy S6 and S6 edge – both 16-megapixel units with an f/1.9 aperture, 1/2.6in sensor, OIS and phase-detect autofocus – LG's new flagship ought to deliver a decent-quality snap. And that it certainly does: in daylight, photos are well exposed and crisp. The autofocus system works well when shooting from the hip, and general image quality matches the Samsung.

In low light, the G4's camera even beats the S6's in some respects, delivering sharper, less noisy images, but we found the LG didn't always choose the correct white balance. Under fluorescent strip lights, for instance, white and light-grey shades were tinged with yellow. So much for the colour-spectrum sensor.

Happily, it's possible to rescue such images if you switch to the phone's manual mode and choose to shoot in raw (DNG format) as well as JPEG. This also gives you fine control over shutter speed, white balance, ISO sensitivity, exposure compensation and focus. There's even an auto-exposure lock facility, so you can make sure the settings don't change from one shot to the next. It's a pity that LG doesn't extend this level of control to video capture, which remains automatic-only.

Meanwhile, the front camera, as is the current trend, is a high-resolution, 8-megapixel unit, and a host of enhancements have been made to the camera software. We like the way you can now double-tap the volume-down button while the phone is in standby to open the camera directly and take an instant shot.

There's also a rather gimmicky "gesture interval shot" selfie mode. Simply put, this lets you take a sequence of shots two seconds apart by opening your hand and clenching your fist in front of the camera a couple of times.

New software features

Predictably, the G4 brings a raft of updates to LG's custom UI overlay, which runs on top of Android 5.1. None of these is particularly groundbreaking: the biggest new feature is the Smart Bulletin service, which – with a swipe left from the homescreen – brings up a card-based view presenting notifications from a handful of preset apps, such as LG's Health app, the calendar, the QRemote app and a few others. You can customise the view by dragging elements around and enabling or disabling various services, but you'll probably just want to turn the whole thing off.

LG has also upgraded the Gallery app: it now has a feature called "Memories", which automatically organises your photos and videos into event-based albums – a bit like Google Photos does with its Stories feature, only offline. Potentially more useful is the "Timeline" feature, which brings up an overview of all the photos you've taken in a given day, month or year, as a stream of tiny thumbnails in one or several large blocks.

LG's Google Now-esque "Smart Notice" system has been improved too: now, purportedly, it has the ability to learn from your "lifestyle and usage patterns". We're not convinced by this: during our testing it seemed mainly to present weather-based advice, such as "It will rain today starting in the afternoon. Be careful on the road." This particular gem was delivered on a day when I'd travelled by train to work.

However, owners of newish Volkswagens may appreciate the G4's support for MirrorLink entertainment and navigation systems. Google's Docs, Sheets and Slides apps come preinstalled too, and you get 100GB of Google Drive space, free for two years, when you first sign in to the service using the LG G4.



ABOVE The camera is one of the G4's great strengths, producing clean, sharp images

✚ Great camera, fantastic screen, a removable battery and comes with an attractive leather option

▬ A little chunky, and not as slim or light as key rivals

BELOW The plastic-backed models have a clean style and a slightly lower price



Verdict

While we're not bowled over by the software, it hasn't dampened our enthusiasm for the LG G4. It's incredibly hard to be different in the smartphone world, but with some bold design choices LG has managed to pull it off.

Critically, it hasn't compromised performance, battery life or camera quality, and retaining both a microSD slot and a removable battery means the G4 will appeal to a whole tranche of customers for whom flexibility is most important.

Contract prices aren't cheap right now. You'll be paying at least £35 per month for a free phone on contract, which is around the same as you'll pay for a Samsung Galaxy S6. SIM-free prices aren't too bad, however, starting at £500 for the plastic-backed edition, ramping up to around £520 for the leather one. This suggests that contract prices should settle to a notch below Samsung's flagship.

So, while the Samsung Galaxy S6 remains the price-no-object smartphone of choice, the LG G4 is a great option for everyone else. It's a stylish, capable smartphone, and one that – refreshingly – does things a little differently. **JONATHAN BRAY**

SPECIFICATIONS

Six-core 1.8GHz/1.4GHz Qualcomm Snapdragon 808 SoC • 3GB RAM • 32GB storage • microSD slot • 5.5in 1,440 x 2,560 IPS display • 16MP/8MP front/rear cameras • 802.11ac Wi-Fi • 4G • 3,000mAh Li-ion battery • Android 5.1 (Lollipop) • 1yr RTB warranty • 76 x 9.8 x 149mm (WDH) • 155g

Dell Chromebook 11 (2015)

It's not pretty, but this year's Dell Chromebook 11 is sturdy, practical and – best of all – cheap

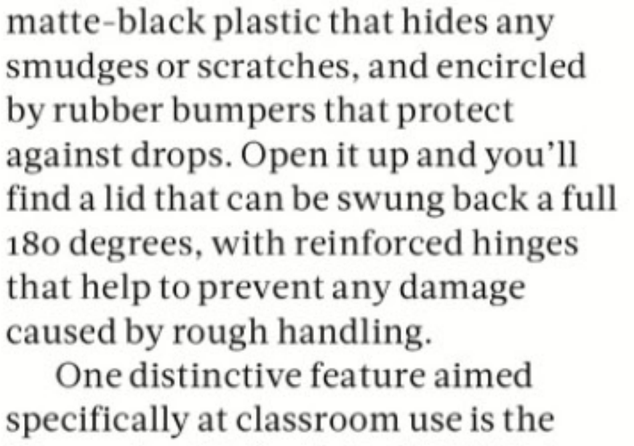
SCORE ★★★★☆

PRICE £189 (£227 inc VAT) from dell.co.uk (pcpro.link/250dell)

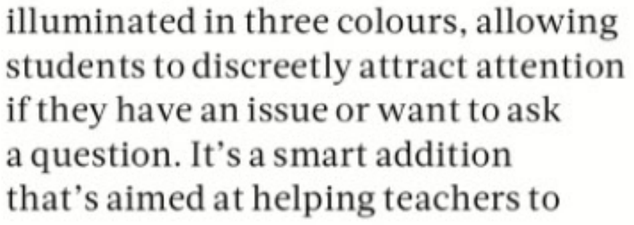
There are times when good looks and sleek design must take second place to practicality – situations when tough is more important than pretty. So it is with the 2015 edition of the Dell Chromebook 11. It may not be stylish, but it's unfussy and practical, and for the target market – the education sector – that's exactly what's needed.

That's not to say that Dell has skimped on design. The manufacturer says the laptop has passed US Military Standard testing, and while you're unlikely to need to use it under enemy fire, that sturdiness means it's more than equal to the knocks of student life. It's covered in solid-feeling matte-black plastic that hides any smudges or scratches, and encircled by rubber bumpers that protect against drops. Open it up and you'll find a lid that can be swung back a full 180 degrees, with reinforced hinges that help to prevent any damage caused by rough handling.

One distinctive feature aimed specifically at classroom use is the Chromebook's "activity light". Set into the corner of the lid, facing outwards, this light bar can be illuminated in three colours, allowing students to discreetly attract attention if they have an issue or want to ask a question. It's a smart addition that's aimed at helping teachers to encourage less confident students to contribute in class.



ABOVE The "activity light" indicates if a student needs help or has a question for the teacher



The sensible theme continues with the keyboard. The keys feel springy and responsive, and the layout is good too. However, we can't say the same for the touchpad: the integrated buttons are annoying to use when cutting, pasting, dragging and dropping between multiple windows.

As for ports, there's HDMI 1.4 out, one USB 3 and one USB 2, plus you get an SD slot and 3.5mm headset jack. There's also a 720p webcam, dual-band 802.11ac Wi-Fi and Bluetooth 4 for a pretty comprehensive wireless-connectivity setup.

As with last year's Chromebook 11, the weakest part of the package is the screen. The 1,366 x 768 TN panel is dull: it suffers from poor vertical viewing angles and a low maximum brightness of 239cd/m² – which could make it hard to read in a sunny classroom – and a drab contrast ratio of only 306:1.

Under the hood is a 2.6GHz dual-core Intel Celeron N2840, backed by 4GB of RAM and 16GB of storage. This Celeron is based on the Bay Trail-M architecture, and as a result isn't quite as powerful as last year's model, which used the Haswell-based Celeron 2955U. It completed the SunSpider JavaScript test in 526ms and scored 1,453 in the Peacekeeper browser test, placing it close in performance to the midfield Asus Chromebook C200.

Still, the nature of Chrome OS and the fairly low-power, browser-based tasks that run on it mean this isn't a huge problem, and it feels responsive and smooth in day-to-day use. The laptop starts up in seconds, and even with 15 tabs open, we experienced very little slowdown.



ABOVE Sturdy and practical – the Chromebook is ideal for student life

The Chromebook 11 performed well in our battery testing, lasting 7hrs 35mins with a constant video loop and screen brightness of 120cd/m² – more than enough to get through a school day.

The speakers are good too: there's some distortion when you push the volume over 80%, but overall the sound is surprisingly loud, and clear enough to fill a classroom.

Overall, the Dell Chromebook 11 remains an excellent device for those who need a well-priced, practical laptop. It's light enough to carry around and rugged enough to handle a beating, and the price remains reasonable, at £227 for the non-touch version with 4GB of RAM, £275 for the 4GB touchscreen version and £200 for the non-touch version with 2GB of RAM.

"The lid can be swung back 180 degrees, with reinforced hinges that prevent any damage caused by rough handling"

If you're looking for a more stylish laptop, the similarly priced Toshiba Chromebook 2 or the HP Chromebook 11 make good alternatives. But neither combines toughness and practicality like Dell's rubber-encased Chromebook 11. **THOMAS McMULLAN**

✚ Rugged, practical and thoughtfully designed, with decent battery life

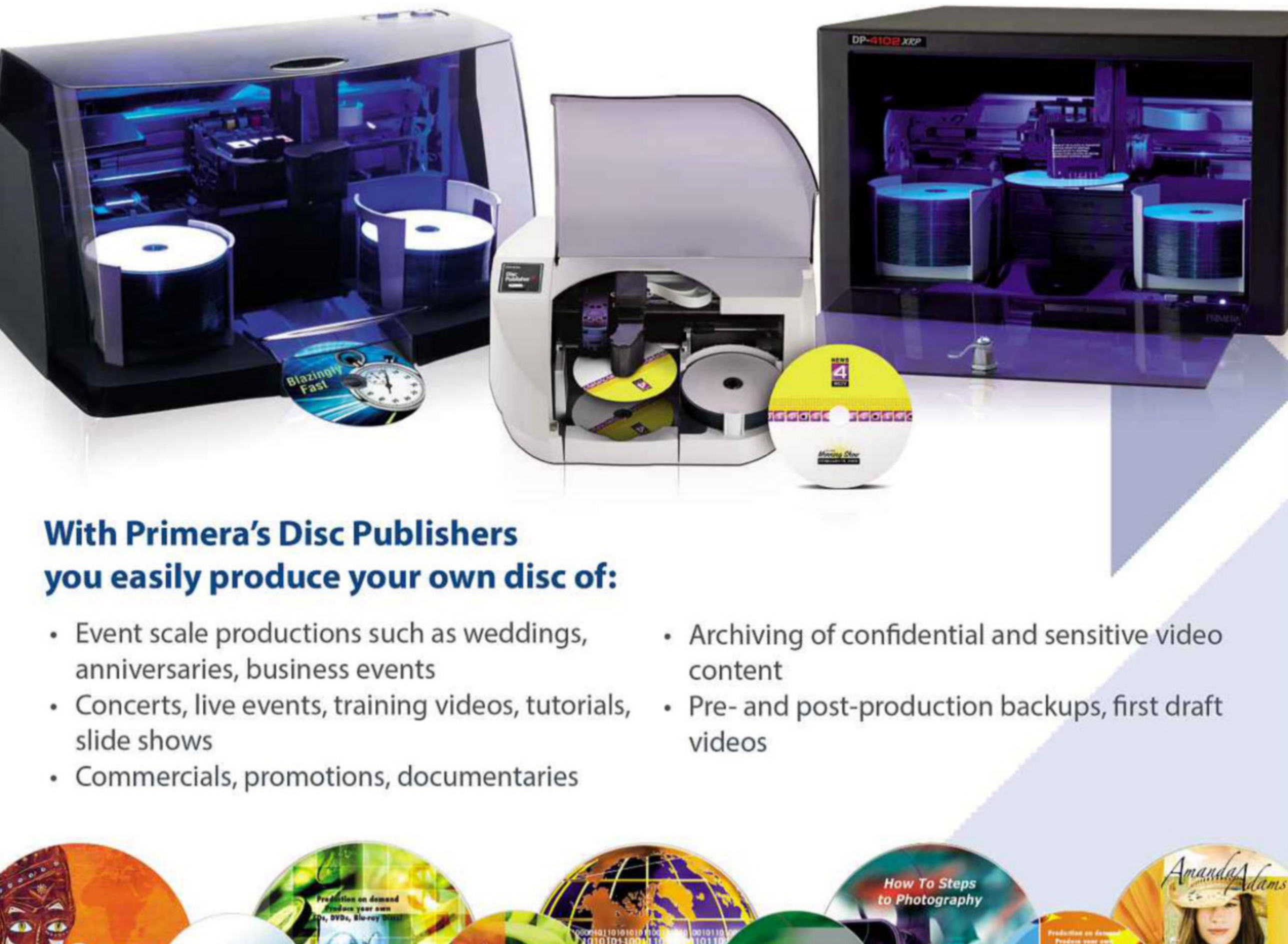
— Disappointing display quality; irritating touchpad

SPECIFICATIONS

2.6GHz Intel Celeron N2840 • 4GB RAM • 16GB storage • SD slot • 11.6in 1,366 x 768 display • 720p webcam • 802.11ac Wi-Fi • 43Wh three-cell Li-ion battery • Chrome OS • 1yr NBD warranty • 297 x 217 x 23mm (WDH) • 1.2kg (1.7kg with charger)

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EXTEND YOUR WI-FI

You don't have to buy a new router to kill dead spots in your home network: an extender can do the job for less

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Whether in the home or in the office, Wi-Fi connectivity is now crucial. We're using it to hook up laptops to the internet for work and play; to connect our tablets, set-top boxes and smart TVs to our favourite streaming services; to keep our mobile devices online and our apps continually updated.

Like electricity, we notice the network most when it's not there, and just as nobody wants a room without a plug socket, so we now want Wi-Fi everywhere, in the office and around the house. In fact, we're coming to expect Wi-Fi connectivity outside as well. We want to be able to sit in the garden and still receive our email, listen to Spotify, stream movies via Netflix and browse the web.

But there's a problem. For most people, the key part of all this wondrous connectivity – the humble wireless router – must be located near the fixed point where the broadband connection enters the building, and this may not be the best position from which to spread Wi-Fi throughout the house. What's more, neighbouring Wi-Fi networks can affect range and performance.

So what's the best way to fix this? You can upgrade your router to a more capable model supporting the latest 802.11ac standard and ensure you make the most of the 5GHz spectrum, which is less cluttered, but this solution is no guarantee of a decent connection everywhere. Not every device supports 802.11ac or the 5GHz band, and the higher frequency itself isn't a silver bullet, since it typically has a more limited range than 2.4GHz and is often affected by intervening barriers.

This is where wireless extenders come in. They take the signal from your router and spread it outwards from a new location, improving coverage and ensuring connectivity where you need it most. Best of all, they're usually cheaper than upgrading to the latest, greatest router.

Choosing an extender

Mainstream Wi-Fi extenders come in two main forms. First, you have repeaters: these take the Wi-Fi signal broadcast by your router and



extend it outwards, while taking the Wi-Fi signal from connected devices and sending it back the other way.

They come in single-band 2.4GHz and dual-band 2.4GHz and 5GHz varieties, not to mention variants of the latest 802.11ac standard, including AC750, AC1200 and AC1900. As always with wireless kit, the numbers here aren't all that useful: they refer, confusingly, to the maximum bandwidth the product supports across both bands. An AC1200 extender, for instance, will top out at 867Mbits/sec while running an 802.11ac network in the 5GHz spectrum, with a further 300Mbits/sec available simultaneously over the 2.4GHz band.

Power to the people

The alternative is a powerline extender kit. Here, one unit connects to your router via Ethernet, and uses your mains electricity cabling to extend the wired network to a second device that plugs in where you need connectivity. In a straight powerline implementation, the latter has an Ethernet port for your PC, but wireless extender kits add an access point so wireless devices can connect.

It sounds like the ideal solution, but as with wireless extenders, you need to be aware that there are some major limitations. There's a big and not unjustified hoo-ha about how powerline networking can create radio interference, spoiling things for amateur radio enthusiasts. And whether or not you achieve usable speeds depends on the age and health of your mains cabling. Still, given ideal circumstances, it can be an effective way of getting a signal to places where even the most powerful extenders can't reach.

"Whether or not powerline gives you usable speeds depends on the age and health of your mains cabling"

There are a few key points to note here. First, a repeater won't give you faster Wi-Fi than your existing router; connect an AC1900 extender to an 802.11n router and the connection to your original network will still only be at 802.11n speeds.

Second, the quoted speeds are theoretical maximums. Whether you're talking about 500Mbits/sec powerline or 867Mbits/sec 802.11ac, it's unlikely you'll ever reach those figures unless you're connecting from only a few metres away in near-perfect conditions. The fact that a repeater or extender will usually be further than a few metres from your router, with a further gap between it and your device, only makes those speeds more unreachable.

Third, the vast majority of repeaters are hamstrung by the vagaries of Wi-Fi itself. Unlike Ethernet, Wi-Fi is a half-duplex networking technology; a device that's transmitting can't receive at the same time, so each transceiver on the network alternates rapidly between the two. A repeater then has








	RECOMMENDED				RECOMMENDED	
	Asus RP-AC52	BT Dual-Band Wi-Fi Extender 600	D-Link DAP-1520	Linksys RE4100W	Linksys RE6500	
Overall	★★★★☆	★★☆☆☆	★★☆☆☆	★★★☆☆	★★★★☆	
Pricing						
Price (inc VAT)	£47 (£57)	£33 (£40)	£21 (£25)	£37 (£45)	£54 (£65)	
Supplier	amazon.co.uk	shop.bt.com	ebuyer.com	dabs.com	amazon.co.uk	
Warranty	3yr RTB	3yr RTB	2yr RTB	1yr RTB	1yr RTB	
Core specifications						
Standard	AC750	N600	AC750	N600	AC1200	
Maximum rated link speed 802.11ac/n	433/300Mbits/sec	N/A / 300Mbits/sec	433/300Mbits/sec	N/A / 300Mbits/sec	867/300Mbits/sec	
Dual-band	✓	✓	✓	✓	✓	
MIMO stream configuration 802.11ac	2x2	2x2	2x2	2x2	2x2	
MIMO stream configuration 802.11n	2x2	2x2	2x2	2x2	2x2	
Antenna placement	Internal	Internal	Internal	Internal	External	
LAN ports	10/100	10/100	✗	10/100	3 x Gigabit Ethernet	
USB/eSATA ports	✗	✗	✗	✗	✗	
Beamforming	✗	✗	✗	✗	✗	
256-QAM on 2.4GHz	✗	✗	✗	✗	✗	
Security & setup						
Security types	WPA2; WPA	WPA2; WPA	WPA2; WPA	WPA2; WPA	WPA2; WPA	
Parental controls	✗	✗	✗	✗	✗	
WPS button	✓	✓	✓	✓	✓	
Positioning assistance	✓	✓	✓	✓	✓	
Browser-based setup	✓	✓	✓	✓	✓	
Use existing SSIDs/create new SSIDs	optional / ✓	✓ / ✗	optional / ✓	✓ / optional	✓ / optional	
Access point mode	✗	✗	✗	✗	✗	
Physical features						
Power switch	✓	✗	✗	✓	✓	
Dimensions (WDH)	54 x 31 x 85mm	71 x 77 x 121mm	58 x 34 x 92mm	68 x 64 x 102mm	152 x 107 x 28mm	
Ethernet cable supplied	✗	✓	✗	✗	✓	
Additional features	Audio streaming; LED nightlight; touch panel	✗	✗	✗	Audio streaming	

to repeat each transmission, adding another step to the communication.

The end result is that, most of the time, a connection using a repeater will be significantly slower than one made direct to a router. However, some of the more recent 802.11ac extenders mitigate this by using both the 2.4GHz and 5GHz Wi-Fi bands, receiving data on one and pushing data out on the other. This helps them maintain higher speeds.

Antennas also play a critical role. Whether internal or external, each extender will have an array of antennas, each one providing a stream over which it sends or receives data, with more streams equating to more bandwidth. The speed of an extender is to some extent defined by the number of antennas, and by their size and signal gain. An AC1750 router, for instance, must have three antennas.

Finally, positioning is crucial. In an ideal world, you'd place a wireless extender halfway between your router and your target device with a steady, strong signal from both; in the real world, this is difficult to achieve, what with the average house or flat having to contend with walls, floors and other sources of RF interference and attenuation.

What you need, then, is to find the optimal position. We did a lot of experimenting before and during testing, and found that moving the extender from one position to another could see speeds drop by more than 50%. As a general rule, the closer you position the extender to the router the better, even if it makes the onward connection slower.

Some extenders have built-in indicators to help you get the best position, or work in concert with a dedicated smartphone app to do the same. Third-party Wi-Fi monitor apps for smartphones and tablets can also help you find the best position for your extender.

Further considerations

Extenders vary in terms of features. Some offer basic Wi-Fi only, while others include multiple 10/100 or Gigabit Ethernet ports, wireless audio-streaming features or an access point mode, where it can plug into your existing router and replace or enhance your Wi-Fi network.

Some go even further, with USB print and file server functions. These may seem like overkill, and not the kind of thing you want from a little box in your living room or spare bedroom, but they could make your Wi-Fi network more useful.

Finally, consider the form factor. The majority of extenders and almost all powerline kits are all-in-one units that plug directly into a mains socket. This keeps them neat and unobtrusive. However, models with a separate power supply have an advantage in that you can move the extender around to get a better signal and avoid signal-spoiling obstacles.










	LABS WINNER					
	Netgear Nighthawk AC1900 Extender	Netgear WN3000RP	TP-Link RE210	TP-Link TL-WPA4230P	Trendnet TPL-410APK	ZyXEL WRE6505
	★★★★★	★☆☆☆☆	★★★☆☆	★★★☆☆	★☆☆☆☆	★★★☆☆
	£108 (£130)	£25 (£30)	£37 (£44)	£65 (£78)	£37 (£44)	£40 (£47)
	broadbandbuyer.co.uk	pcworld.co.uk	dabs.com	dabs.com	shop.bt.com	amazon.co.uk
	2yr RTB	2yr RTB	3yr RTB	3yr RTB	2yr RTB	2yr RTB
	AC1900	N300	AC750	N300	N300	AC750
	1,300/600Mbits/sec	N/A / 300Mbits/sec	433/300Mbits/sec	N/A / 300Mbits/sec	N/A / 300Mbits/sec	433/300Mbits/sec
	✓	✗	✓	✗	✗	✓
	3x3	2x2	2x2	2x2	2x2	2x2
	3x3	2x2	2x2	2x2	2x2	2x2
	External	External	External	Internal	Internal	Internal
	5 x Gigabit Ethernet	10/100	Gigabit Ethernet	3 x 10/100	2 x 10/100	10/100
	USB 3	✗	✗	✗	✗	✗
	✓	✗	✗	✗	✗	✗
	✓	✗	✗	✗	✗	✗
	WPA2; WPA	WPA2; WPA	WPA2; WPA	WPA2; WPA	WPA2; WPA	WPA2; WPA
	✓	✗	✗	✗	✗	✗
	✓	✓	✓	✗	✓	✓
	✓	✓	✓	✗	✗	✓
	✓	✓	✓	✓	✓	✓
	optional / ✓	optional / ✓	✓ / ✓	optional / ✓	optional / ✓	optional / ✓
	✓	✗	✗	✓	✓	✓
	✓	✓	✓	✗	✓	✓
	174 x 31 x 252mm	55 x 34 x 67mm	75 x 54 x 94mm	58 x 36 x 102mm/64 x 42 x 126mm	58 x 59 x 70mm/ 70 x 65 x 100mm	62 x 47 x 91mm
	✗	✗	✓	✓	✓	✓
	DLNA server; printer sharing	✗	✗	✗	✗	✗

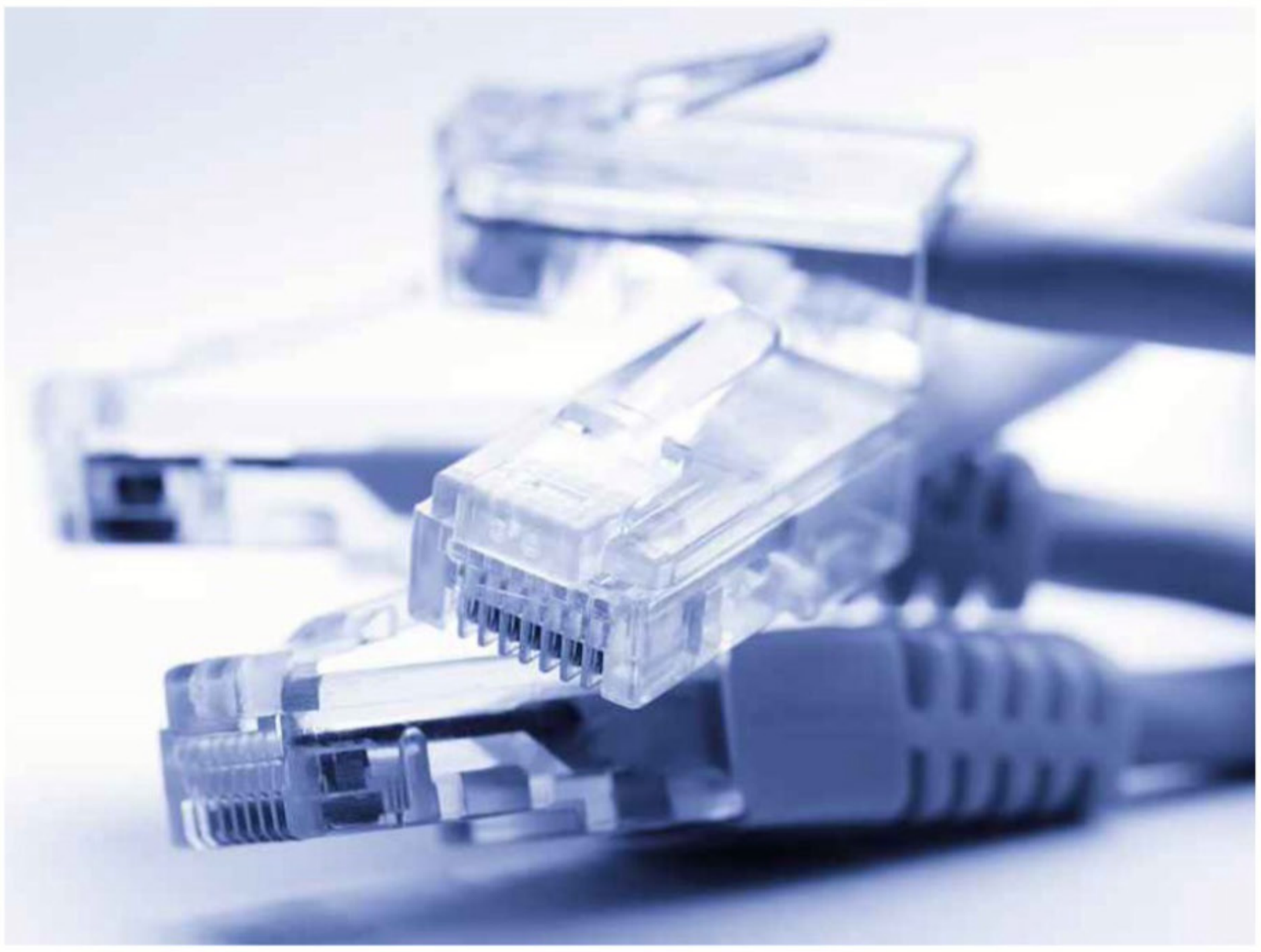
What's the most effective way to boost your network?

Killing dead spots, extending your range, boosting speeds – there are many reasons to upgrade your home or small-office network. We explain how

Stronger signals and longer range might be at the heart of many home and small-office network upgrades, but more of us are pushing our networks harder than ever before.

Not only do we have more connected devices at home, but those devices are demanding more bandwidth. It's true to say that, with services such as audio and video streamers, Skype and cloud-based applications, your broadband connection is a more likely bottleneck than the 802.11n connection to your router. But what if you have several of these services running concurrently, or you want to stream HD or 4K video inside the home? What if you want to try streaming between a gaming PC or console and a lightweight laptop or tablet – already an option with Steam and the PlayStation 4, and coming soon to the Xbox One?

If you're running up against the limitations of your network – either in terms of speed or range – then you have several options. Here's how they stack up.



Install a wired network

The ideal way to set up a future-proofed network for high-bandwidth applications is to use good old Ethernet. Gigabit Ethernet ports are now built into many laptops and PCs, and Ethernet is still the best route for optimal performance from media streamers, NAS drives, games consoles and the like. You get full-duplex performance and a guaranteed speed independent of distance, and your existing router may already have Gigabit ports built in. If not, you can connect an affordable Gigabit switch. You'll only find the 100Mbits/sec connection on your router a bottleneck when traffic moves from the local network out to the internet; your PCs, storage devices and media streamers can still communicate with each other at Gigabit speeds.

The downside is that installing a wired network is a lot of work, and if you don't have an easy way to run the cabling through walls and floors, then you may need to call in an electrician. And while the cabling itself doesn't have to be expensive – 100m of unshielded CAT-5e or CAT-6 can be had for £25 to £50 – you'll also need Ethernet wall plates, back boxes and socket modules to finish the job. For some households the investment in time, money and effort will be worth it, but not all.

"The ideal way to set up a future-proofed network for high-bandwidth applications is to use good old Ethernet"

Powerline

Powerline networking piggybacks a data connection on your existing mains cabling, and is an easier and relatively affordable way to set up a hardwired, point-to-point connection. You can now buy 500Mbits/sec kits for less than £50, with single units cheaper still. New models push maximum speeds up to 1.2Gbits/sec and 2Gbits/sec, with wireless access points (APs) that support the newer 802.11ac standard. Powerline is ludicrously easy to configure, and usually faster and more reliable at a distance than a conventional Wi-Fi network. In situations where Wi-Fi lets you down, powerline may be able to deliver.

As we mention elsewhere, though, powerline speeds should be taken with a pinch of salt. Performance will degrade over distance, and the quality of your household power cable and interference from other appliances and devices connected to the mains also affects speed. What's more, many 500Mbits/sec devices only offer 100Mbits/sec Ethernet ports, meaning that even with an optimal connection, 100Mbits/sec is as good as things will get.

That said, powerline speeds can compare favourably with 802.11ac extender speeds. Alongside the wireless extenders, we tested a straight powerline kit – the TP-Link AV1200 (£78 inc VAT) – and found it reached speeds of 28MB/sec in our mid-range tests and 5MB/sec to our remote garden office. Only the Labs-winning Netgear Nighthawk AC1900 was able to establish a connection in the latter location.



ABOVE
Powerline kits can often reach areas that Wi-Fi extenders can't

There are reasons to avoid powerline, however. Ham radio enthusiasts hate it, because the equipment generates a radio signal that interferes with some available radio bands. What's more, there are reliability issues with some powerline kit. *PC Pro* contributor Paul Ockenden has written about the failure rate of some adapters (**pcpro.link/250homeplug**), and anecdotal evidence suggests that if a powerline product stops working, no amount of reconfiguring and synchronising can get it to work reliably again.

Failures to sync can also result in annoying trips around the building, and sometimes two units from the same manufacturer will suddenly fail to connect. This doesn't make powerline a bad solution, but you need to keep that in mind.

Wireless extenders

We won't say too much about extenders here in a Labs that's devoted to their testing, but they're not a miracle fix for an ageing network. You'll always be limited by the speed of your existing Wi-Fi network, so even if your laptop or Wi-Fi adapter supports 802.11ac, as does your chosen extender, the connection between the extender and an 802.11n router will be a bottleneck.

What's more, your range may be limited by the fact that the extender usually needs to stay quite close to the existing router. Extenders excel in two areas: stretching the wireless network so that it covers unserviced areas of the home – albeit usually at reduced speeds – and expanding the reach of a high-speed 802.11n or 802.11ac network so that you can still attain exceptional speeds in an adjacent or nearby room.

Wireless access points

If you're more concerned about improving speed than extending the range of your network, then a new wireless AP could be the answer.

Connecting to your router through a Gigabit Ethernet connection, it's possible to augment or replace a router's existing wireless network with a new one, based on a faster standard. In this way, you can upgrade to 802.11ac without ripping out existing hardware.

Wireless APs are often designed to cope with more simultaneous connections, improving network performance in a home brimming with smartphones, tablets and wireless media streamers.

The downside? They can be expensive, sometimes more so than a router of the same standard with more features. In fact, many routers can be switched to an access point mode, while some wireless extenders can work as an AP instead. If you're tempted, check that there isn't an extender or router that could handle the same job for less.

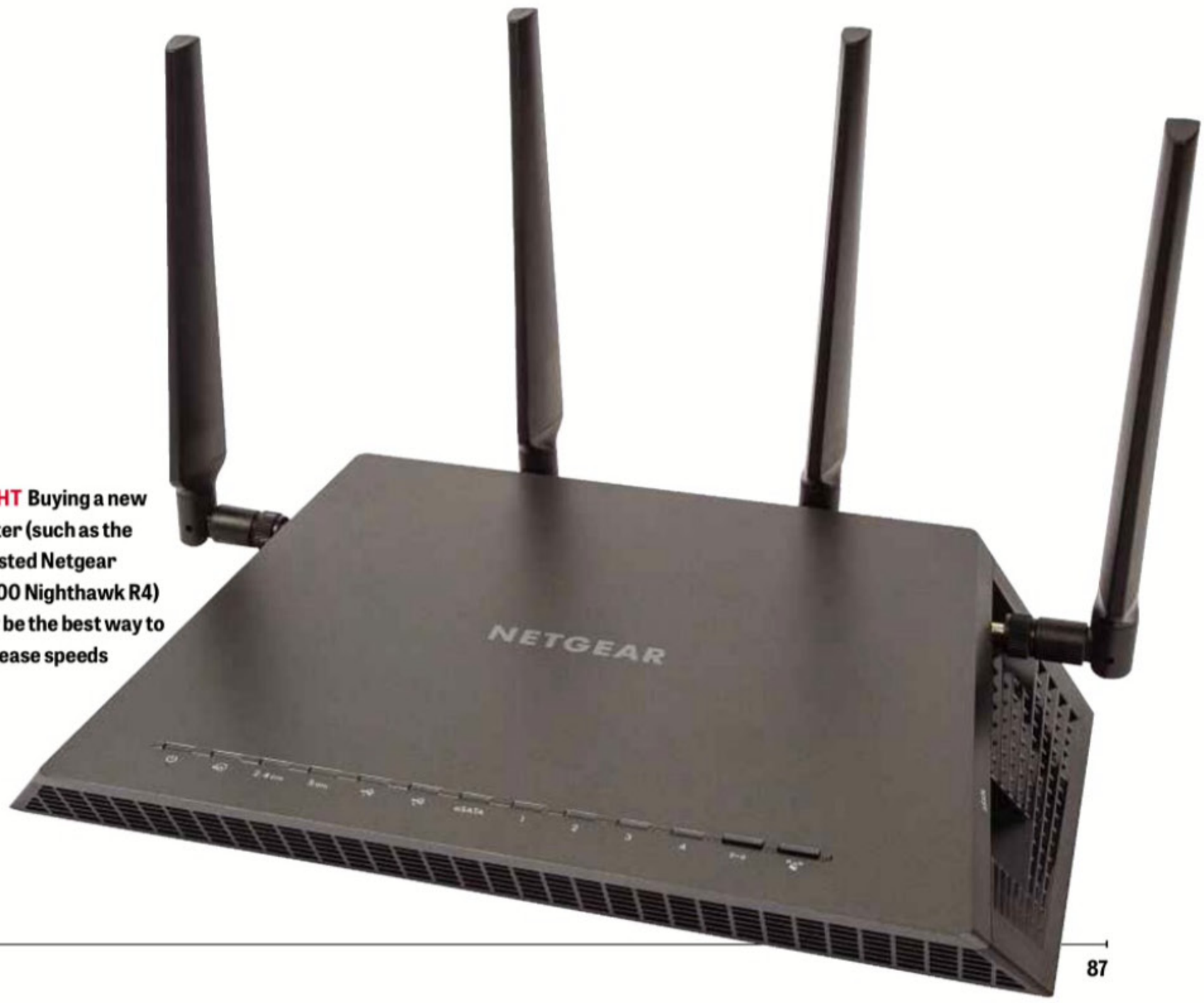
A new router

Arguably, the most positive move you can make is to buy a new router. The 802.11ac market is maturing nicely, and it's easy to find an affordable model that will net you faster speeds and better range. Our A-Listed Netgear R7500 Nighthawk R4 or the low-cost D-Link DIR-868L can provide speeds in excess of 75MB/sec at close range and 45MB/sec at distance. There's a possibility that former Wi-Fi dead zones might open up for business.

Again, you need to be realistic. Connections on the 5GHz band suffer less from interference, but struggle more to penetrate walls and cover longer distances than those on the 2.4GHz spectrum.

You may be able to establish a connection in the distant corners of your home, but without an extender it might not be particularly speedy. In the location of our mid-range test, we struggled to achieve speeds of more than 1MB/sec using only a direct connection to an AC1900 router. With the Netgear Nighthawk AC1900 working, we reached 20.2MB/sec. On the other hand, a shorter-range test through 8m and two brick walls saw the router hit 29MB/sec versus the extender's 24.6MB/sec.

Finally, it's worth remembering that simply adding an extender or upgrading a router won't necessarily enhance range or performance unless you invest in additional network kit. If your laptop or PC doesn't support 802.11ac, you'll need new adapters, and neither USB adapters nor PCI Express cards come cheap.



RIGHT **Buying a new router (such as the A-Listed Netgear R7500 Nighthawk R4) may be the best way to increase speeds**

Linksys RE6500

Not the fastest in all scenarios, but a versatile extender that's packed to the brim with features

SCORE ★★★★½

PRICE £54 (£65 inc VAT) from amazon.co.uk (pcpro.link/250linksys)



There are two things that might put you off the Linksys RE6500. The first is that it's a little more expensive than most 802.11ac extenders, coming in at just under £75, while rivals are available for £45 to £60. Second, it isn't a neat all-in-one unit that plugs into a mains socket, but a device that looks a little like a scaled-down router, complete with its own power supply.

On the first point, we'd argue that the RE6500's features and performance make the extra expense worthwhile. On the second, it's still very compact and discreet, while the separate power supply gives you valuable flexibility on positioning. Place it on a bookshelf or windowsill or, better still, mount it on a wall, and you'll probably get a better signal than rivals stuck in a plug socket down near the floor.

In terms of features, the RE6500 comes second only to the Netgear Nighthawk AC1900. It's an AC1200 extender, giving you up to 300Mbits/sec of bandwidth on the 2.4GHz band and up to 876Mbits/sec over 5GHz, and both are available concurrently.

This is supported by a 2x2 antenna array and cross-band technology, allowing the RE6500 to receive on one band while transmitting on another for faster speeds than a conventional half-duplex Wi-Fi connection.

In addition, it has four Gigabit Ethernet ports and a 3.5mm audio output. Connect a pair of speakers or some headphones and you can stream music to the extender as if it were a Windows Media Center Extender or a DLNA-compliant media player. It's nowhere near as slick as a Sonos system, but it's a simple, functional way of playing music from a tablet, smartphone or laptop.

Setup could be easier. Linksys' quick-start guide covers connecting to the RE6500's temporary network and running through the configuration wizard, but there's no mention of how to configure WPS, which the RE6500 does support.

The login page opened first time on Internet Explorer, but it wouldn't open in Chrome without the extender's URL being manually entered. WPS works perfectly well, but we found that having the same SSIDs in play for both the router and extender seemed to lead our test machine to connect direct to the former rather than the latter – a problem we didn't encounter with other extenders. With different SSIDs in place, everything worked fine.

There's precious little help available for positioning, either. The box talks of a configuration app, but we couldn't find it on the Apple App Store or Google Play, and it isn't mentioned in the quick-start guide either. The guide simply tells you to place the RE6500 halfway between your router and your PC or device, which isn't always the ideal location for an extender: you may need to place the device closer to the router to get a reliable connection. The only indicator on the device (aside from the Ethernet socket LEDs) glows steady when the extender has a solid connection and pulses when it doesn't.

ABOVE The Linksys looks a little like a scaled-down router

PC PRO RECOMMENDED



BELOW A 35mm audio output allows you to stream music to the extender

The good news is that none of these niggles is a deal-breaker. With a little experimentation, we managed to find effective spots for both our tests, and if you're struggling, third-party Wi-Fi analysis tools can help. The RE6500 was a consistently good performer in our mid-range tests, scoring just behind the Netgear, Asus and ZyXEL AC extenders in the 5GHz band and ahead of the latter two for 2.4GHz 802.11n. What's more, the RE6500 held up better in our long-range tests, where it jostled with the Nighthawk for supremacy.

It might not be the last word in speed, then, but this isn't always the most important consideration when choosing a wireless extender. For features, long-range solidity and value, this is the best mainstream extender on test.

Netgear Nighthawk AC1900 Extender

Superb features and performance justify the Nighthawk's premium price

SCORE ★★★★★

PRICE £108 (£130 inc VAT) from broadbandbuyer.co.uk (pcpro.link/250netgear)



Even the most cursory glance will tell you that the Netgear Nighthawk AC1900 is no ordinary wireless extender. For a start, it looks more like a router, with a 252 x 174mm footprint and three sizeable antennas sticking out at the back. You can use it in its horizontal orientation or place it vertically on the supplied stand, but either way it's a formidable piece of networking kit, with a distinctive, angular design.

What's more, that design has been thought through. The single USB 3 port is accessible at the front, with five Gigabit Ethernet ports around the back. Admittedly, it's a little odd that the WPS button is smaller than the power button and located on the rear, but you'll need it only when adding new devices to the network.

To call the Nighthawk AC1900 Extender (model number EX7000) highly specified would be an understatement. For a start, it supports the high-end AC1900 variant of 802.11ac, giving you up to 1,300Mbits/sec of bandwidth on the 5GHz band and up to 600Mbits/sec on the 2.4GHz band, provided you have a TurboQAM-compatible wireless adapter with a 3x3 antenna array. These are still in short supply, however, with only PCI Express desktop cards available at the time of writing. The antennas are also SmartBeam-compliant, so the extender can focus its available power for additional speed at longer range.

Then we come to the features. A single USB 3 port supports printers and external hard disks, with the option to use the Nighthawk AC1900 as a DLNA-compliant media server. Gigabit Ethernet allows you to connect smart TVs, media streamers, NAS drives and games consoles to the extender and make the most of its connection speeds. You can use the extender as an access point, replacing your existing wireless network, and the configuration options even stretch to such advanced features as parental controls.

Setup is almost flawless, with a well-designed, easy-to-follow wizard that guides you through finding your existing networks, and building and securing the 2.4GHz and 5GHz extended networks. Our only complaint, and it's a minor one, is that you're forced to sign up with an email address and password – an unnecessary step for a hardware installation.

Positioning the router is also very easy. Both the 5GHz and 2.4GHz bands get their own small signal-strength meter, and you can plug in the Nighthawk AC1900 and move it around until you achieve acceptable levels. One advantage of this extender's sheer power is that it's much less fussy about placement than some of its rivals. Move it further away from your router and it still holds a stable link.

Performance is exceptionally good. Even on the 2.4GHz band we hit speeds of 12.8MB/sec in our mid-range tests, with that increasing to 17.9MB/sec and a storming 20.1MB/sec with 5GHz 802.11n and 802.11ac connections. And while these speeds fell in our long-range tests, they were still acceptable and ahead of any rival extenders.

ABOVE The distinct, angular design has been well thought through

What's more, the Nighthawk AC1900 was the only extender to get a stable signal down to a remote outside office on our premises, maintaining a speed of 5.2MB/sec. Frankly, it's wasted on simply stretching a wireless network to the back garden, but if that's what you want, it's more than capable of the job. Just be aware that its full 802.11ac speeds still only really apply at close to medium range. On the same floor as our router, across 8m of distance and through two brick walls, we could transfer files at a speed of 25.6MB/sec; not as fast as a direct connection to the router (29MB/sec), but not far behind.

This is an expensive extender, and for many users it will be overkill, but if you want maximum speed and range it's by far the best way to go.

PC PRO LABS WINNER



RIGHT As well as fast wireless, the Nighthawk has five Gigabit Ethernet ports

Asus RP-AC52

A versatile, compact extender that's easy to position and delivers some handy extra features

SCORE ★★★★½

PRICE £47 (£57 inc VAT) from amazon.co.uk (pcpro.link/250asus)

While some extenders are happy to compete on price and performance, Asus is focusing on product design and innovative features. On paper, the RP-AC52 is just another wall-plug AC750 extender with built-in Ethernet, but it has a compact, angular design and interesting, pseudo-quilted finish to distinguish it.

You also get audio-streaming features and a built-in nightlight, activated by a configurable touch panel at the front. Plus, if a soft glow doesn't do it for you, you can also connect the RP-AC52 via Ethernet to a wired network and use it as a wireless access point.

Not all of these features work brilliantly, however. The Ethernet is 10/100 rather than Gigabit, while audio streaming requires Asus' own AiPlayer Android app for streaming tracks from local storage and network sources, which must be DLNA-compliant. You can get radio if you install the XiiaLive internet radio app, but this is a paid-for extra.

Setup isn't the RP-AC52's strong suit, either. Asus' browser-based routine feels a little clunky in comparison to that of TP-Link and Linksys, although you can use WPS. By default the extender assigns new SSIDs with "RP" suffixed, but you can simply replicate the existing SSIDs if you wish.

Locating your extender is a different story. Blue bars stretching left and right of centre indicate 2.4GHz and 5GHz signal strength respectively, delivering a smart, at-a-glance impression of whether your extender is in the right place, too close or too far away.

Luckily, performance is pretty good. The Asus hit a respectable 14.5MB/sec on the 802.11ac network in our mid-range test, and still delivered credible results across the 2.4GHz and 5GHz bands in the long-range test.

For performance and features, we'd opt for the Linksys RE6500, but if you want a versatile, almost-pocket-sized extender for the home or office – one you can plug in and forget – then the RP-AC52 could be for you.



ABOVE The Asus has an interesting pseudo-quilted finish

BT Dual-Band Wi-Fi Extender 600

Easy to use, but this extender's performance is disappointingly weak at long range

SCORE ★★☆☆☆

PRICE £33 (£40 inc VAT) from shop.bt.com (pcpro.link/250btwifi)

If the BT Dual-Band Wi-Fi Extender 600 gets anything right, it's the fact that it's easy to position. Plug the extender into a power outlet and, once it connects to your network, five LEDs coloured red, amber and green indicate whether you're in a good spot, too close or too far from your router. It doesn't get any easier than this.

Setting up the device is just as simple. The bundled quick-start guide pushes you towards a WPS-based routine, and when we tried it both the 2.4GHz and 5GHz bands connected on the first attempt. There's also a browser-based wizard for those whose routers don't support WPS, or if you prefer to disable the feature for security reasons.

The downside of all this simplicity, however, is a lack of configuration options. BT's extender replicates the SSIDs of your existing networks with no option to change them. And BT's advice if you want to make sure you're connecting to the right network? Switch off the extender and see if the signal strength decreases.

If you're simply extending an existing dual-band 802.11n network in a small house, this device should have you covered. It reached speeds of 10.8MB/sec in the 2.4GHz band and 12.8MB/sec in the 5GHz band in our medium-range tests.

Sadly, it struggled over longer distances, partly because its optimum position is fairly close to the router, and it loses the connection if moved too far away. In our long-range tests, it managed only 1.5MB/sec on the 2.4GHz band, and over the 5GHz band we were unable to get a stable connection long enough to test.

Nor is it the most discreet or feature-packed extender. Designed to fit in with existing BT Home Hubs and set-top boxes, it's a little larger than most of the wall-plug models, and the indicator lights are overly bright and distracting to the eye.

It's one of the most affordable extenders on test, but the single Ethernet port is a bog-standard 10/100 effort, and it lacks the media-streaming features of the similarly priced Linksys RE4100W.

Given that the latter is a faster performer, both at medium range and long distance, the BT Dual-Band Wi-Fi Extender 600's only advantage is ease of use. Unfortunately, that isn't enough to gain it a recommendation.



ABOVE Red, amber and green LEDs make it easy to find the perfect position

D-Link DAP-1520

Cheap for an 802.11ac wireless extender, but performance simply isn't strong enough

SCORE ★★☆☆☆

PRICE £21 (£25 inc VAT) from ebuyer.com (pcpro.link/250dlink)

D-Link's DAP-1520 seems miraculously good value, sporting dual-band 802.11ac support at a price you'd expect to pay for a single-band 802.11n product.

There are signs it's been stripped back to hit this price point, though: it's the only extender on test without an Ethernet port, and the exterior design is very basic. However, if all you want is a wireless signal in an upstairs room, this might not bother you.

Intriguingly, the DAP-1520 can be set up through either a browser-based control panel or through D-Link's mobile app. The former approach involves logging on to a temporary network and entering a WPA password before you can do anything, so it's not quite as simple a process as it could be.

The app makes setup a little easier, and may also come in handy if you don't have a laptop or PC nearby. By default, the process sets up new SSIDs for the extended 2.4GHz and 5GHz networks, although it's easy enough to change this later on, should you wish the network names to duplicate the existing ones.

Neither the app nor the extender's onboard LED indicators make it particularly easy to find an optimal position, although a green LED lights up when there's a stable connection to the router. The D-Link failed to recognise our 802.11ac network on the first attempt, but it worked well enough once we'd overcome that hurdle.

At medium range, the DAP-1520 is a mediocre performer, hitting its highest speed – 11.4MB/sec – on the 2.4GHz band rather than the 5GHz 802.11n or 802.11ac network. Only at close range is there any advantage to the 802.11ac support – and your router probably has a stronger signal there anyway.



ABOVE The D-Link's basic design reflects its budget price

At longer distances, the D-Link was almost useless: slow on the 2.4GHz band and unable to complete our set of tests in the 5GHz band over either 802.11n or 802.11ac. What we're left with is a money-saving option for smaller premises, but one that isn't particularly effective in larger spaces.

Linksys RE4100W

Speedy performance and audio streaming make the Linksys an affordable choice

SCORE ★★★☆☆

PRICE £37 (£45 inc VAT) from dabs.com (pcpro.link/250linksys2)

Linksys' compact dual-band 802.11n extender is notable for its ability to double as a wireless audio streamer. But where the similarly featured Asus RP-AC52 targets Android devices running specific Asus and third-party apps, the Linksys works as a DLNA-compliant media extender, and even works with the "Play To" button in Windows Media Player. Hook up a pair of speakers and you have a simple wireless music system as well as an extended Wi-Fi signal.

This aside, the RE4100W is short on exciting features. It's a compact and unobtrusive device, but its one and only Ethernet port is a basic 10/100 effort, and its single LED gives precious little help when you're trying to find the optimum position for your new extender. The quick-start guide simply advises you to place the extender halfway between your router and the target dead zone. However, in many situations this isn't the best advice – you'd be better off using trial and error or downloading a third-party Wi-Fi analysis tool for your smartphone.

Setup could be easier, too. The quick-start guide covers linking through to the extender's temporary network and running the browser-based wizard from there, but there's no mention of WPS configuration, which the RE4100W supports.

On the plus side, the browser control panel does include some more sophisticated features, such as site survey, log and diagnostic tools, so it's worth revisiting later. You also get a choice between using your network's existing SSIDs or establishing new ones for the extender.

If you're happy with your existing 802.11n network, then the RE4100W can help you extend it and still achieve decent speeds. In our tests, it reached 13Mbits/sec on the 5GHz spectrum at medium range, and you can still get a half-decent signal and workable transfer speed at longer range as well.



ABOVE The Linksys RE4100W is compact and unobtrusive

For future-proofing or high-speed networking in closer proximity, the Asus RP-AC52 is a better choice, while our Labs winner, the Netgear Nighthawk AC1900 Extender, will get you better features and performance, albeit at a higher price. However, if your budget is limited and 802.11ac support isn't a priority, then the RE4100W is a sensible, cost-conscious choice.

Netgear WN3000RP

A simple, low-cost extender that's limited by slow speeds and its 2.4GHz-only specification

SCORE ★☆☆☆☆

PRICE £25 (£30 inc VAT) from pcworld.co.uk (pcpro.link/250netgear2)

It's one of the cheapest extenders around, and it hails from one of the most established networking brands – but unfortunately, the price of Netgear's WN3000RP is reflected in its specs. This is a simple, single-band 802.11n extender with a single 10/100 Ethernet port, two external antennas and not much else. On the plus side, it comes wrapped up in a very small and unobtrusive wall-plug design – it's quite likeable if you're not upset by the sight of aerials.

In theory, setup should be simple, but we were unable to persuade the WN3000RP to connect to our router through the magic of WPS, and had to resort to a clunky browser-based wizard. While not as user-friendly as Linksys' setup process, this worked fine, connecting to the existing network and creating a new SSID. The firmware is still accessible through a browser after setup, providing access to basic configuration, security and status screens.

You receive a bit of help to find the optimal socket for the WN3000RP, with one red/amber/green indicator covering signal strength between the router and the Netgear, and another covering signal strength between the extender and your device. Running on the 2.4GHz band, the WN3000RP is happier to work in more locations than many extenders; good news when you need your signal to reach further away.

Given the specs, it's no surprise that the WN3000RP is sluggish. At medium range on a 2.4GHz 802.11n connection, it's on the slow side of average, and the 5GHz spectrum is, of course, off-limits.

Longer-range performance is worse: files transfer more slowly than with any of the dual-band extenders bar the D-Link DAP-1520 or BT Dual-Band Wi-Fi Extender 600.



ABOVE The Netgear is unobtrusive, but it's let down by its performance

As a result, while the price may be tempting, you'd be best advised to look elsewhere. Not only is single-band 802.11n a poor choice when new dual-band devices might be entering the home or office, but faster dual-band and even 802.11ac extenders can be found for the same price or just a little more.

TP-Link RE210

Gigabit Ethernet and steady long-range performance rescue an otherwise lacklustre extender

SCORE ★★★☆☆

PRICE £37 (£44 inc VAT) from dabs.com (pcpro.link/250tplink)

The TP-Link RE210 has one advantage over rival wall-plug 802.11ac extenders: it offers a Gigabit Ethernet port, where most stick to a basic 10/100 connection. Don't get too excited: the connection between the extender and your 802.11ac router will still be a bottleneck, but at fairly close range this could double as a wireless bridge.

The quick-start guide recommends a WPS setup, which works perfectly well. Using the browser-based wizard gives you more options, however, including the choice of separate SSIDs for the extended 2.4GHz and 5GHz networks. Otherwise, the control panel is functional but spartan, with basic LAN and WLAN configuration pages, update tools and a status page.

As far as finding the optimal location goes, TP-Link could make it a lot easier. The guide advises you to place the extender halfway between your target device and the router, and closer to the router if the signal isn't strong enough. You then need to use a combination of the WPS and 2.5GHz/5GHz LEDs to assess signal strength. The latter two simply indicate whether you're connected, while the WPS LED lights green, orange or red according to the signal. The Asus and BT extenders make it far easier to find the sweet spot.

The TP-Link is a better performer at distance than it is at closer range. In our medium-range tests, 802.11n 2.4GHz speeds topped out at an average 10.4MB/sec, and dropped in the 5GHz band to 7.9MB/sec. Its 802.11ac speeds are faster than that, at 9MB/sec, but it's still a long way behind the Asus RP-AC52 and ZyXEL WRE6505. However, in our long-range tests it held up better than both, maintaining faster speeds on both the 2.4GHz and 5GHz bands, although still crawling along on an 802.11ac network.

So, if range is more important than bandwidth, the TP-Link is a reasonable choice. However, as with most extenders on test, speeds



ABOVE Unusually for a wall-plug extender, the TP-Link includes a Gigabit Ethernet port

falter as soon as the extender is moved too far from the router. With its dual antennas, it isn't the most discreet or attractive device, but it's affordable and reasonably effective at long range.

TP-Link TL-WPA4230P

An affordable and relatively easy-to-use powerline wireless extender that's bulky but solid

SCORE ★★★☆☆

PRICE £65 (£78 inc VAT) from dabs.com (pcpro.link/250tplink2)

If you're looking for an unobtrusive way to bring wireless to your home or office, the TL-WPA4230P isn't it. As with all powerline kits, one unit plugs in near your router and the other sits where you need the connection. The second unit is a bit of a monster, though: 6cm wide, 12cm tall and almost 5cm deep, with a thick black rim that accentuates its size.

Still, at least that real-estate is put to good use, with a passthrough power socket and three 10/100 Ethernet ports provided. Supplying 10/100 rather than Gigabit Ethernet ports might seem a false economy on a device that claims 500Mbits/sec speeds over your mains cables, but real-world performance means it's unlikely to be an issue at any distance.

Powerline kits just work, and the TL-WPA4230P is no exception: we had connected the router to the extender in minutes. On the wireless side, however, TP-Link needs a WPA key that's only printed on the reverse of the extender, requiring you to disconnect it in order to type the key in. The browser-based configuration routine that follows is fuss-free, using the preconfigured SSID by default.

Wireless connectivity is limited to 2.4GHz 802.11n – a shame, given the increasing number of devices that support 5GHz or 802.11ac. This puts two potential bottlenecks in your network: the speed your house or flat's mains cabling can support, and the limited speed between the extender and your wireless device.

Although the extender employs the 500Mbits/sec standard, we didn't reach speeds anywhere near that in our tests: the TL-WPA4230P could manage only 11MB/sec at mid range and 4.9MB/sec at long range. That matches wireless 802.11ac devices, and is a marked improvement on the Trendnet TPL-410APK. However, those expecting 300Mbits/sec in the distant corners of their home should keep their expectations in check: even with a wired Ethernet connection to our PC from the second extender, we saw speeds of only 11.6MB/sec.

However, powerline is still the most effective option when you need to drag the network to an outside office or faraway room, and the TP-Link kit is an affordable and relatively easy way to get it.



ABOVE At 6cm wide, 12cm tall and almost 5cm deep, the second unit in the kit is chunky

Trendnet TPL-410APK

A functional powerline extender kit, but it isn't particularly speedy or easy to set up

SCORE ★☆☆☆☆

PRICE £37 (£44 inc VAT) from shop.bt.com (pcpro.link/250trendnet2)

The most appealing thing about the Trendnet TPL-410APK is, unquestionably, its price. For £44, you get a two-part 500Mbits/sec HomePlug AV powerline kit with a 300Mbits/sec 802.11n Wi-Fi extender built into the second unit.

Since the latter also packs in a pair of 10/100 Ethernet ports, the Trendnet has potential as a basic plug-and-play option for streaming media to a remote bedroom or hooking up a small outside office.

The appeal starts to wane when it comes to setup, however. The powerline part is simple enough: simply plug in one unit near your router and connect the Ethernet port, and the Wi-Fi unit where you're in need of coverage. Unfortunately, you then need to connect to the Wi-Fi network using a WPA2 password, which Trendnet unhelpfully prints on the rear of the unit, below the plug.

To make this worse, the password on our sample was tiny, blurred and almost illegible, requiring a magnifying glass and three attempts before we managed to get it right. And while there is a WPS button, we couldn't make a connection this way on either of our two test machines.

With this obstacle sidestepped, things proceed more smoothly. By default the Trendnet uses its own SSID, although you can change this to your router's if you want more seamless coverage. We'd also advise you change the password so that you can leave the magnifying glass behind.

As with any powerline setup, performance will depend as much on your home's wiring as it will on the units themselves, and you won't get within touching distance of the headline figures. On the positive side, there's no need to find a sweet spot between the router and dead zone as you do with wireless-only extenders.

As for performance, it isn't all that impressive. The Trendnet hit 6.7MB/sec in the mid-range test, and it wasn't any faster over a wired Ethernet connection. In our setup, the powerline speed was clearly the limiting factor. At longer range, speeds fell to only 3.5MB/sec; acceptable for a 2.4GHz extender, but not exceptional.

Overall, then, while the Trendnet TPL-410APK has value on its side, there's little else to tempt.



ABOVE Trendnet's two-part kit has an 802.11n Wi-Fi extender built into the second unit

ZyXEL WRE6505

An excellent performer in smaller homes and offices, but let down by its long-range performance

SCORE ★★★☆☆

PRICE £40 (£47 inc VAT) from amazon.co.uk (pcpro.link/250zyxel)

ZyXEL's 802.11 AC750 extender is one of the smallest and lightest on test; it isn't going to win any design awards, but you'll hardly notice that it's there. On the downside, it's also a bit short on exciting features.

The presence of a single 10/100 Ethernet port puts it ahead of the D-Link DAP-1520, as does an access point mode, but you won't find more than simple connectivity here.

The easiest way to get set up is to use WPS to configure the extender, in which case it's automatic, with new SSIDs created for the extended 2.4GHz and 5GHz networks by default. The browser-based configuration feels like a fallback option, although it exposes more configuration and status tools for advanced users.

Positioning is a case of using the colour-coded LEDs to gauge signal strength in each location, with green for good, red for rotten, and amber for somewhere in between. We like the ability to configure the WRE6505 to prioritise either speed or range. This helps if distance matters, as it does in our long-range tests.

Its 2.4GHz performance isn't up there with the best, either at medium or long range. The ZyXEL struggles to maintain the pace with all but the cheapest extenders. Switch to the 5GHz spectrum, however, and it's a different story. The ZyXEL punches above its weight at medium range, with bandwidth averaging out at 16.8MB/sec on an 802.11n connection and 18.3MB/sec over 802.11ac.

Sadly, the WRE6505 struggled at long range. While it maintained steady 802.11n and 802.11ac connections, unlike some of its rivals, speeds of 0.8MB/sec and 0.9MB/sec are okay for basic email and web browsing but little else.

For smaller premises with 5GHz networks, the ZyXEL WRE6505 is a bit of a bargain, getting you excellent 802.11n and 802.11ac performance at an affordable price. If range is more important to you, however, then this wouldn't be our pick. The Linksys RE6500 is a better choice if you have more room in your budget, while the Asus RP-AC52 outperforms it at long range for a similar price.



ABOVE It's possible to configure the ZyXEL to prioritise either speed or range

View from the Labs

The best Wi-Fi extenders can improve the performance and range of your network, says Stuart Andrews – but you should manage your expectations

Are there any specifications as confusing as the numbers printed on the outside of wireless networking products? Promotional messages on boxes and in adverts talk of speeds of 300Mbits/sec, 600Mbits/sec or 1,300Mbits/sec, but try connecting to a router in anything other than optimal laboratory conditions and you'll find real-world bandwidth falls a long way short of the mark.

Throw distance into the mix and those real-world speeds fall further, while with Wi-Fi extenders, the headline speeds grow even sillier. The box still says 300Mbits/sec, 600Mbits/sec or more, while actual throughput inside your home may be as low as 70Mbits/sec.

That's why it's smart to be realistic about your expectations. Buying an extender won't see you backing up files to a NAS drive at 300Mbits/sec if you're working from a back bedroom that hasn't previously been able to get a signal. You still might not be able to get a stable connection in a distant upstairs room or the summer house at the bottom of your garden.



Stuart Andrews is a former reviews editor and regular contributor to *PC Pro*

Whatever manufacturers claim about extending range or improving bandwidth, extenders can't work miracles. In fact, you may find your new 802.11ac router delivers the best performance where you need it on its 802.11n 2.4GHz channel, while the 5GHz AC750 channel provides the most advantage in areas where your router already delivers a high-quality connection.

What the best extenders can do is further the reach of your network. Netgear's Nightshawk AC1900 Extender provided us with solid, high-speed connectivity in a room that our AC1900 router could barely reach. The same goes for the Linksys RE6500, Asus RP-AC52 and ZyXEL WRE6505.

"Whatever manufacturers claim about extending range or improving bandwidth, extenders can't work miracles"

Sure, 130Mbits/sec (15.5MB/sec) isn't 1,300Mbits/sec, but it's fast enough for most applications. Many of our uses require more modest amounts of bandwidth, and often the biggest bottleneck is the broadband connection. What's more, 130Mbits/sec is much better than you'll see from a range of supposedly 500Mbits/sec powerline kits that are hamstrung by a 100Mbits/sec Ethernet port.

That's not to denigrate powerline adapters, though, since they also have their place. We originally planned to test long-range bandwidth in a home office located 20m from the router. Unfortunately, only one pure wireless extender could get a signal, and even that one – our Labs winner – couldn't manage anything faster than a crawl.

This office has been served by powerline networks for five years, and will continue to be served by them for the near future. After all, a slow connection might be disappointing, but it's better than none at all.

Results & how we test

All the extenders on review in this Labs were tested in a carefully controlled domestic environment, enabling us to compare the products objectively.

We first connected each extender to a network powered by a Linksys EA6900 AC1900 router. To this network, we then connected two desktop PCs, one plugged via Gigabit Ethernet into the router, and one connecting to the extender via a triple-antenna 802.11ac AC1900 PCI Express card.

Both PCs were fitted with SSDs to ensure no bottlenecks on that count. With the router and PC 1 downstairs, we set up PC 2 12m away upstairs, where wireless signal strength is normally weak.

We then connected each extender in turn, and transferred 500MB video files from one system to another, measuring real-world transfer speeds over 2.4GHz, 5GHz 802.11n and 5GHz 802.11ac connections.

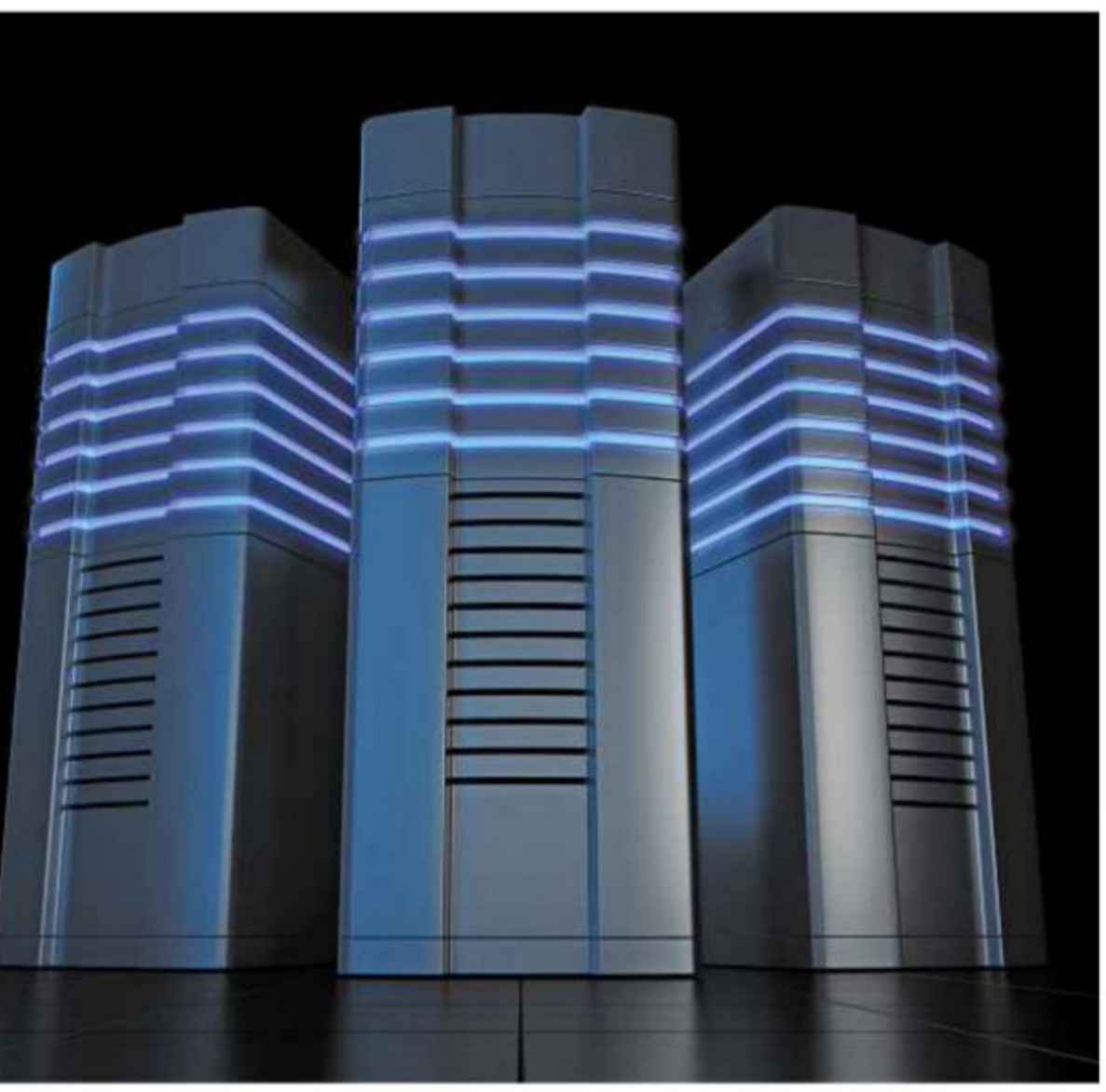
We then repeated the test at longer range in a garden building 20m from the router, using a laptop fitted with an SSD and a dual-antenna USB AC1200 adapter, giving a set of mid- and long-range test results. We've presented the results in the table below, colour-coded to help you spot the fastest and slowest products. ●



	MID RANGE (MB/SEC)			LONG RANGE (MB/SEC)		
	2.4GHz	5GHz (802.11n)	5GHz (802.11ac)	2.4GHz	5GHz (802.11n)	5GHz (802.11ac)
Netgear Nighthawk AC1900 Extender	12.8	17.9	20.1	7	5.7	5.9
Linksys RE6500	13.5	13.4	12.8	4.4	6	5.8
ZyXEL WRE6505	8.8	16.8	18.3	3.8	0.8	0.9
Asus RP-AC52	10	11.9	14.5	3.6	3.3	3.4
TP-Link RE210	10.4	7.9	9	4.5	3.4	1.6
D-Link DAP-1520	11.4	8.2	9.2	2.3	WNC*	WNC*
Linksys RE4100W	11.2	13	N/A	3.5	3.3	N/A
BT Dual-Band Wi-Fi Extender 600	10.8	12.8	N/A	1.5	WNC*	N/A
TP-Link TL-WPA4230P	11	N/A	N/A	4.9	N/A	N/A
Netgear WN3000RP	10.8	N/A	N/A	2.7	N/A	N/A
Trendnet TPL-410APK	6.7	N/A	N/A	3.5	N/A	N/A

*WNC – would not connect

Choose the right tower server for your business



If your business is growing fast, it might be time to invest in a purpose-built, dedicated system to run your IT services. Dave Mitchell explores the options

Small businesses on the road to collaborative computing will find a modern tower server can satisfy all their demands – and more. It's the ideal form factor, since it's available in a variety of sizes to suit the space at hand, and the latest models pack in some remarkable hardware specifications.

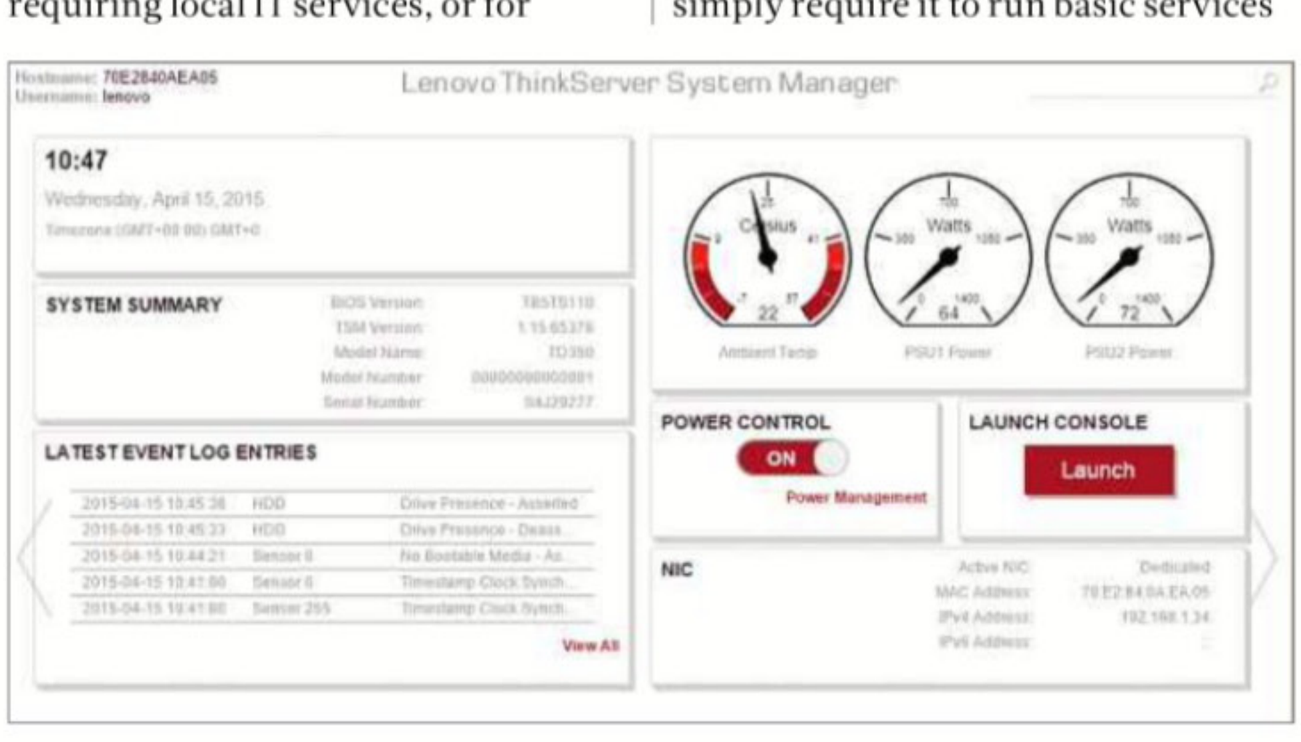
A tower can also be the right option for remote and branch offices requiring local IT services, or for established businesses looking to upgrade their older hardware to items more powerful. This month, we look at five tower solutions from the biggest names on the market, comparing features and capabilities to help you make the right choice.

Look to the future

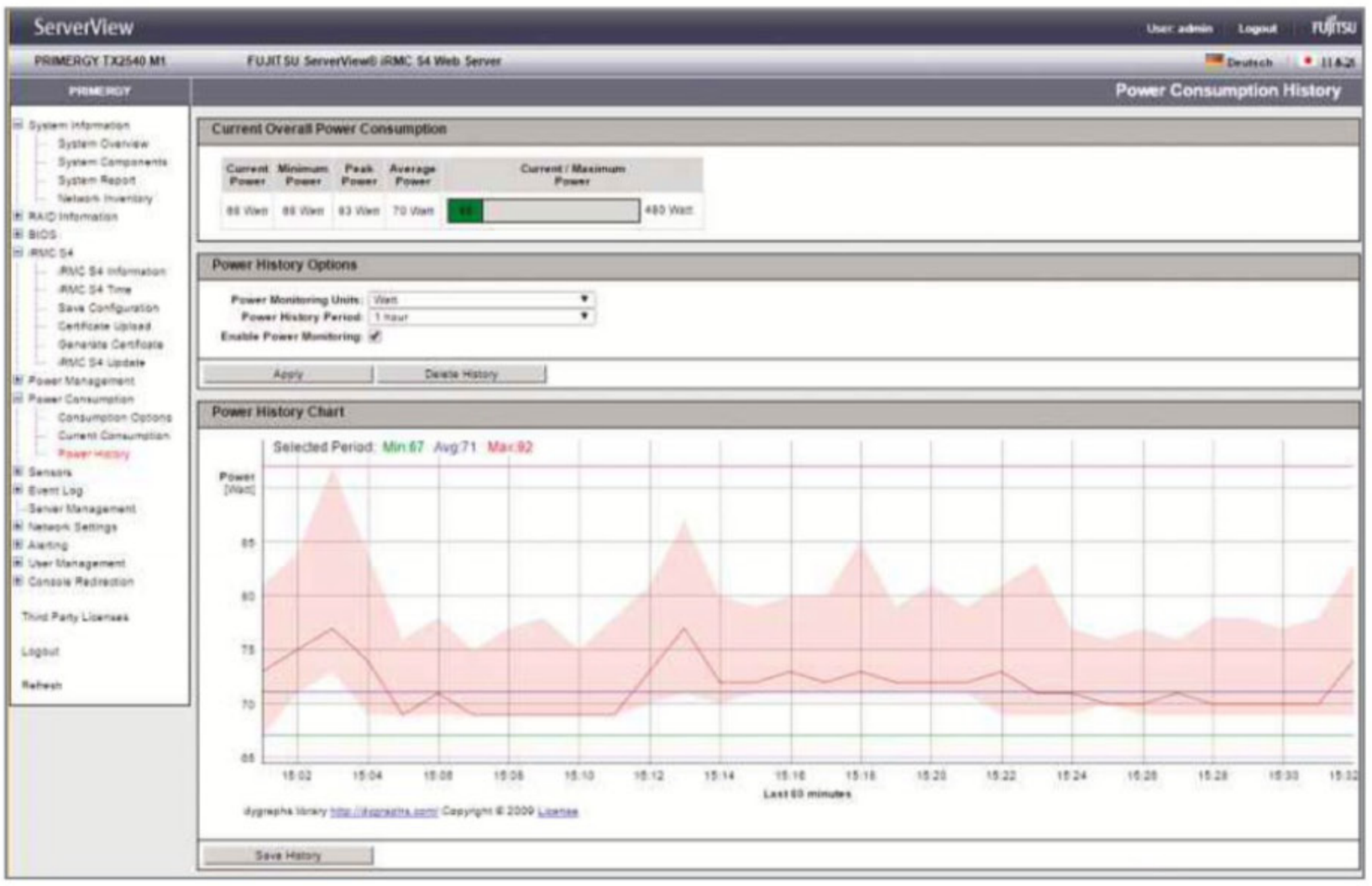
Before you invest in a server, consider exactly what you need it to do. If you simply require it to run basic services such as file, print and messaging for a small user base, then a low-cost, single-socket server will suffice. Be warned, though: you could be compromising your future, as these desktop-sized systems have limited expansion capabilities.

It's important, therefore, to consider not only what the server can do now, but how easily it can be upgraded in the future to keep up with demand. Paying extra now will allow you to reap savings as your business grows. For example, a dual-socket server allows you to start small with one processor and add another when the need arises. The same applies to memory: choose a system with plenty of slots, and as your applications become bigger, or as you want to run more services, you can simply add more memory modules to keep everything running happily.

Perhaps the most important consideration is internal storage, as this tends to be consumed faster than anything else. Tower servers excel in this department, as they're made to



LEFT Lenovo's new TMM provides vastly improved remote-management features



serve it up by the bucket-load – some of the models we've looked at on the following pages can support up to 32 drives. Even if you don't need quite that many, choosing a model with plenty of spare bays, or one that can have extra drive cages added, will pay dividends later on.

RAID, meanwhile, is a given; all good tower servers will have an embedded controller on the motherboard or an additional PCI Express card. Just check the number of hard disks that the controller can support; it will be a pain if you want to add more storage only to find you have to buy another RAID card as well.

Which CPU?

Entry-level towers generally use Intel's E3-1200 v3 Xeon processors, but if you want support for dual sockets you'll need to use E5-2400 or E5-2600 Xeons. The former are cheaper: their motherboards cost less to make, as they have only one inter-socket QPI link for high-speed communication between CPUs and RAM, and support for 12 DIMM slots as opposed to 24.

For Intel's E5-2600 v3 Xeons, prices are starting to fall, but the top-end models can still cost more than a small server. Save money by opting for a model that doesn't go beyond what you need: a 2.3GHz 14-core E5-2695 v3 Xeon costs up to £2,000, whereas a 2.3GHz 10-core E5-2650 v3 will be less than half this.

What about AMD? Sadly, a lack of server CPU development long-term hasn't won it many fans. For this month's reviews we left it to server vendors to choose a processor architecture: the fact that not one wanted to supply an AMD model says it all.

Silence is golden

Towers aren't only more expandable than rack servers – they're quieter too: their roomy chassis' make air flow easier to manage. Normally there will be a large air shroud placed over the processor and memory, to direct air to where it's needed. This means fewer fans are required, thus reducing noise: all five of the servers we reviewed this month were so quiet that we had to turn off most other equipment in the lab to hear them.

In addition, keeping an eye on a server's vital signs won't involve delving inside it. All the systems on test have an embedded controller that links to the motherboard's sensors and lets you monitor their values in a remote web console. Specific features vary across different vendors; Dell's iDRAC8 and HP's iLO 4 are the best. Supermicro offers a more basic set of monitoring tools but includes remote control as standard, while the blue chips all require a licence upgrade to activate this.

ABOVE The Fujitsu Primergy's embedded iRMC S4 chip provides historical graphs of server power usage

Get off the floor

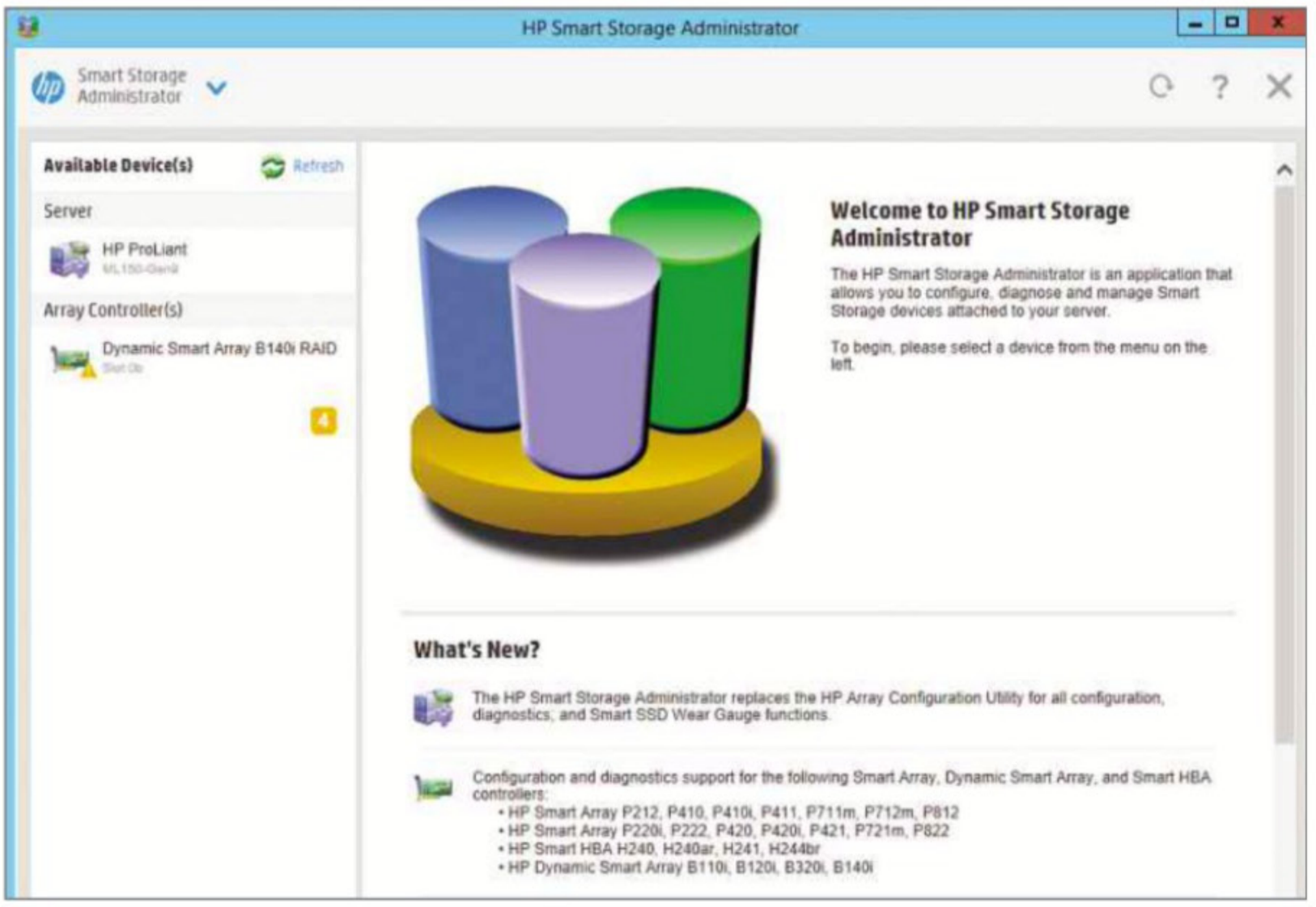
While it might be tempting to tuck your tower server away under a desk, we advise against this practice. One business we worked with ran all its office finance and billing software on an under-desk server that sat there for years, sucking up carpet fibres and dust. It wasn't maintained, or even cleaned, and eventually it had become so clogged up that the hard disks overheated and failed.

This brings us to our next bit of advice. Your server is a central repository for all your business-critical data, so make sure it's backed up. Check out our cloud backup buyer's guide (*see issue 243*) for some top-value solutions – or wait until next month, when we'll look at a range of on-site backup appliances.

Unit for unit, a rack server can provide better compute density than a tower model. But for a business that doesn't need dozens of servers, a tower is actually more space-efficient, as it doesn't require housing in a cabinet – and its versatility means it can stay the course as you grow.

Since no two businesses will have the same requirements, this month we've rounded up five towers to suit a variety of budgets and workloads. They share many common features, however, including dual CPU support, generous storage capacities and plenty of scope for expansion. Read on to see how to make your business a towering success.

BELOW The HP ProLiant's Smart Storage Administrator gives direct access to its RAID controller



Broadberry CyberServe XE5-408S v3

Ideal for SMBs on a tight budget, the CyberServe is a powerful tower with a tempting price

SCORE ★★★★½

PRICE £2,738 exc VAT from broadberry.co.uk



Broadberry Data Systems has built its business on offering affordable alternatives to the blue chips, and the CyberServe XE5-408S v3 packs in dual E5-2600 v3 CPUs and a heap of memory at a price SMBs will love. The quest for value sees a few compromises, but everything you need to run a wide range of IT services is right here.

On turning on this tower server, the first thing you'll notice is how near-silent it is, thanks to Supermicro's new 865W super-quiet PSU. It's impressive when you note the four hot-swappable internal fans sitting behind the drive bays, and another fixed 9cm fan at the rear.

In the storage department, the CyberServe offers eight hot-swap SAS/SATA LFF bays at the front. That's comparatively few by tower standards, but the price includes two 4TB SATA drives, and you can order the system with eight SFF bays. For SAS support, Broadberry offers a range of PCI Express RAID cards; as supplied to us, the server uses the embedded RAID on the Intel C612 chipset, which supports mirrors, stripes and RAID5. The drive backplane has eight interfaces that must be cabled separately to the embedded ports on the motherboard, although Broadberry has done well to keep everything neat and tidy.

Processing power is impressive: the CyberServe sports a pair of powerful 2.4GHz E5-2630 v3 Xeons. These 8-core chips have all the Intel goodness you need, with support for Hyper-Threading and Turbo Boost 2, which allows them to step up to 3.2GHz when the workload increases.

The price includes 64GB of DDR4 memory, with the resident CPUs supporting speeds of up to 1,866MHz. The 16 memory slots offer expansion for up to 512GB of RDIMM; if your pockets are deep enough for 64GB LR-DIMMS, you can double this to 1TB.

The Supermicro SC743 chassis accepts one fixed PSU, which is easy to replace in the event of failure. Overall power consumption is low, thanks to the modest 85W TDP of the two Xeons: we measured a draw of 86W in idle and 225W under maximum load.

We can't fault build quality either: the chassis is sturdy, and the front and side panels can be key-locked shut for added security. On the inside, all cabling is tucked neatly out of the way and the CPUs and memory are covered by a solid plastic air shroud.

ABOVE Respectable upgrade potential for the price makes the CyberServe XE5-408S v3 a good-value option

PC PRO RECOMMENDED

Dual embedded Gigabit ports come as standard; you can opt for the X10DRi-T variant of this motherboard if you want two embedded 10GBase-T ports. When it comes to remote management, the CyberServe can't match HP or Dell for features, but its embedded RMM chip does have a dedicated network port and provides plenty of useful data about critical components. You can power the server up and down, reset it remotely, view sensor data for the CPUs, memory, fans and voltages, and link their readings to email alerts.

Usefully, you also get full KVM remote control and virtual-media services as standard – features for which all the blue chips charge extra. Supermicro's SuperDoctor 5 software is included, and uses the local Windows SNMP agent to monitor the server. Its cheerful UI provides graphs and speedo dials for fans, temperature and voltages, and can also issue email alerts.

"For remote management, the CyberServe's embedded RMM chip provides plenty of data on critical components"

The CyberServe XE5-408S v3 isn't as storage rich as Dell's T630 or Lenovo's TD350, but overall it offers respectable expansion potential, and can't be faulted for processing power. SMBs looking for a capable tower server at a low price will struggle to find better value elsewhere.



LEFT The Broadberry CyberServe's SNMP monitoring utility provides a cheery interface packed with status dials

SPECIFICATIONS

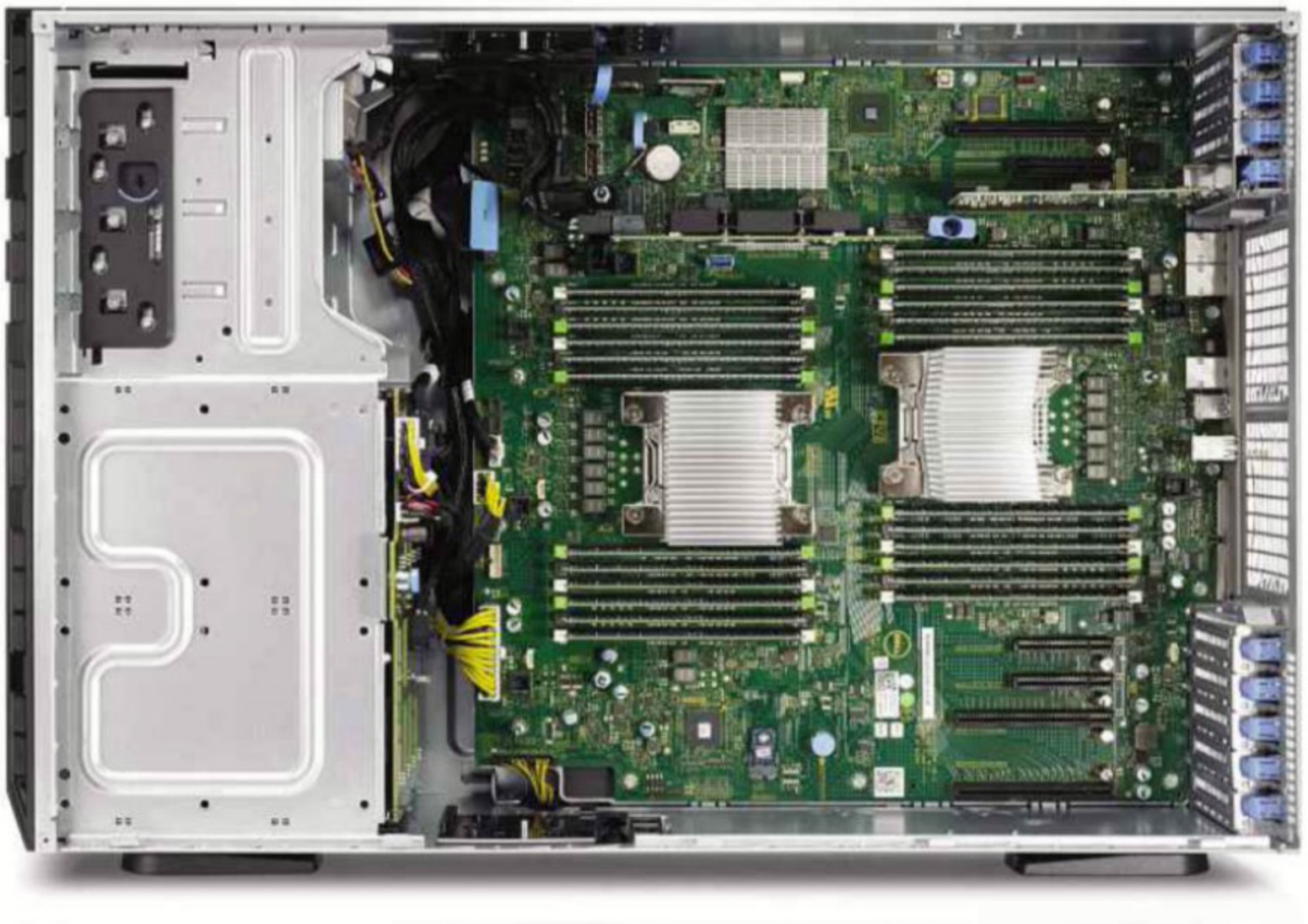
Supermicro SC743 tower chassis • Supermicro X10DRi motherboard • 2 x 2.4GHz Intel Xeon E5-2630 v3 • 64GB 1,866MHz DDR4 (max 1TB) • 2 x 4TB Seagate SATA LFF hot-swap drives (max 8) • Intel C612 SATA controller (supports RAID0, 1, 5) • 6 x PCI-E (with 2 CPUs) • 2 x Gigabit Ethernet • 865W fixed PSU • Supermicro RMM with 10/100 Ethernet • 178 x 648 x 452mm (WDH) • 3yr on-site NBD warranty

Dell PowerEdge T630

It's pricey, but this classy tower server is capable of handling anything your business might throw at it

SCORE ★★★★½

PRICE £7,832 exc VAT from dell.co.uk



Everything about Dell's mighty PowerEdge T630 exudes quality. The industrial-strength chassis, huge expansion potential and massive capacity mark this out as a server that can go where others fear to tread.

One particular strength is storage capacity. We were supplied with the 32 SFF version, but you can opt for the 18 LFF model instead; Dell also offers a single 16 SFF model, and the T630 can handle up to four PCI Express SSDs that can be mixed with eight LFF or 16 SFF drive bays.

RAID choices begin with the embedded PERC S130, which can handle up to eight hot-swap SATA drives with software-managed RAID0, 1 and 5 arrays. We tested the top PERC H730P RAID card, which ups support to 12Gbits/sec SAS drives and offers a hefty 2GB of battery-protected DDR3 cache.

SSD caching is available too, but Dell has dropped LSI's embedded CacheCade feature. Costing around £265, the SanDisk DAS Cache option is now implemented as an OS driver, managed via an MMC snap-in and supporting read and write caching.

The T630 also has one of the biggest memory capacities in town, with 24 DIMM slots supporting up to 768GB of DDR4. Power is versatile: alongside the dual 750W Platinum PSUs in our review system, Dell offers 495W, 1,100W and 1,600W Platinum, 750W Titanium or 1,100W DC versions, all sharing a common form factor.

On the CPU front, our system was supplied with a pair of 14-core 2.3GHz E5-2695 v3 Xeons – a hefty duo that accounts for a large portion of the total price. With their 120W TDP, these proved rather thirsty: we measured the system pulling a reasonable 120W in idle but peaking at 390W under maximum load. You can reduce this by choosing from a wide selection of lower-TDP CPUs, which will cut the cost as well: stepping down to more mainstream 10-core 2.3GHz E5-2650 v3 Xeons will save you nearly £2,500.

Even with high-end processors, the PowerEdge T630 gets away with only two hot-plug fans at the rear of the air shroud, making the unit whisper quiet. If you want fan redundancy, you'll need the optional four-fan module; this is also required if you want to use 18 LFF drives, or to install graphics cards or PCI Express SSDs.

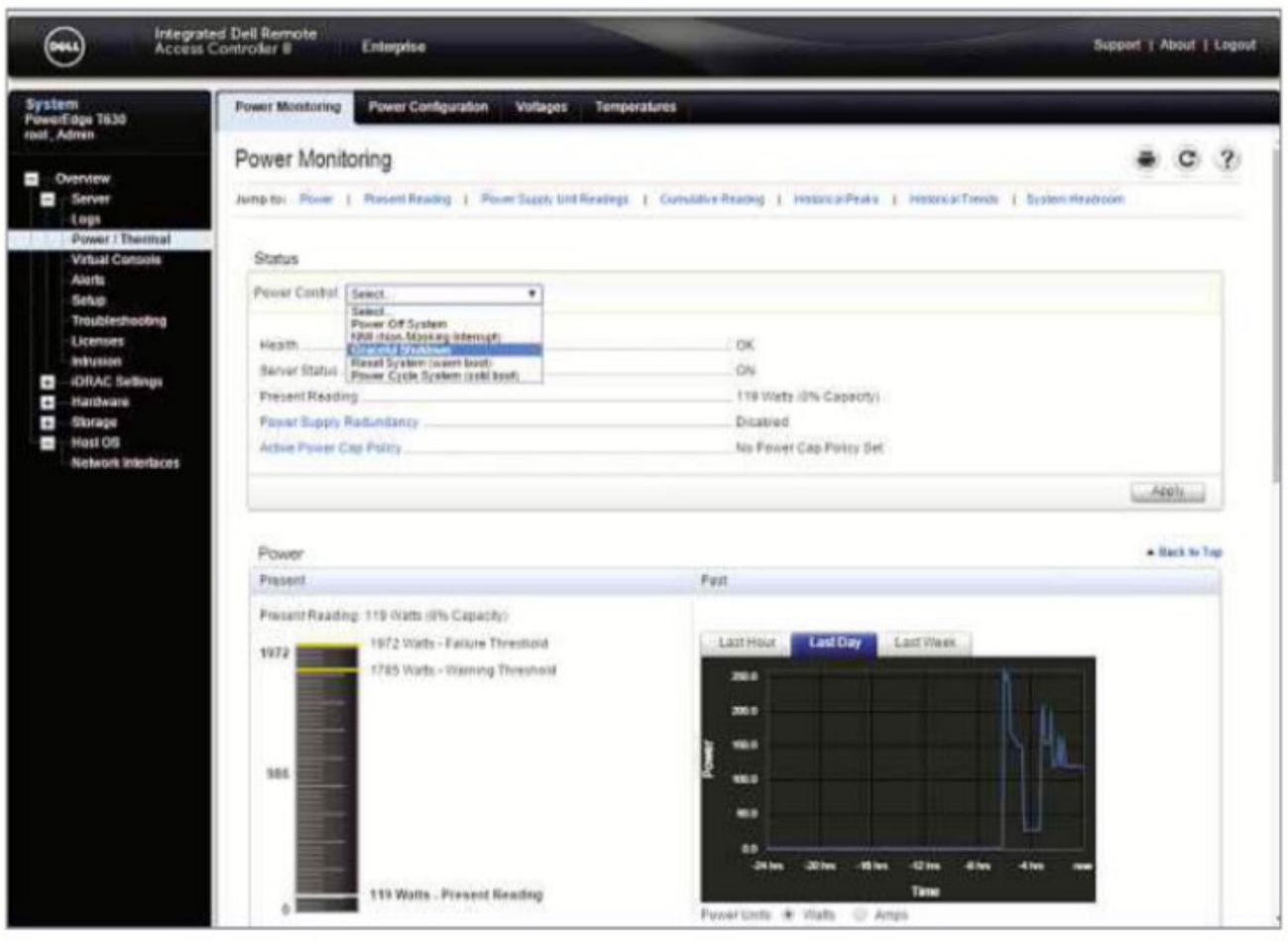
ABOVE The Dell PowerEdge T630's roomy interior provides plenty of room for upgrades

The spacious interior of the case offers plenty of room for upgrades. The RAID card is neatly tucked away at the top of the motherboard, and there's a slot above this for Dell's dual SD card controller, which adds hypervisor redundancy by mirroring them in hardware. Seven PCI Express slots offer plenty of room for more network ports, should the standard dual Gigabit Ethernet not satisfy.

"The T630 has one of the biggest memory capacities in town, with 24 DIMM slots supporting up to 768GB of DDR4"

Dell's iDRAC8 controller gets its own Gigabit port, too, offering an informative interface that also provides direct access to the RAID card for storage configuration. Dell's OpenManage Essentials provides agent-free monitoring for SNMP and WMI-based devices, along with network discovery and inventory. Usefully, it links up with any iDRAC card to provide monitoring and alerting for multiple servers from one console.

The top E5-2600 v3 Xeons certainly push up the price, but then the Dell PowerEdge T630 is a big server for big jobs. You can tailor it to suit a budget, but its natural constituency is businesses that need plenty of power, masses of storage and room to grow.



LEFT The iDRAC8 controller keeps you posted on server power consumption

SPECIFICATIONS

Tower chassis • 2 x 2.3GHz Intel Xeon E5-2695 v3 • 64GB 2,133MHz DDR4 1.2V (max 768GB) • 2 x 300GB SAS 10K SFF hard disks (max 32) • Dell PERC H730P 12Gbits/sec SAS/2GB cache/BBU (supports RAID0, 1, 10, 5, 6, 50, 60) • 7 x PCI-E (with 2 CPUs) • 2 x Gigabit Ethernet • 2 x 750W Platinum hot-swap PSUs • Dell iDRAC8 Enterprise • 220 x 700 x 443mm (WDH) • 3yr on-site NBD warranty

Fujitsu Primergy TX2540 M1

The specification is basic, but the Primergy offers plenty of room to expand and is good value too

SCORE ★★★☆☆

PRICE £1,949 exc VAT from fujitsu.co.uk



If you're looking for a good value, general-purpose tower, Fujitsu's Primergy TX2540 M1 hits the mark. Support for Intel's lower-cost E5-2400 v2 Xeons keeps the price down, while still providing enough horsepower to cope with a wide range of IT services.

Our review system was fitted with a single 2.2GHz E5-2420 v2 CPU, offering six physical cores and a 2.7GHz turbo mode. Its low 80W TDP makes for a power-efficient system: we measured a draw of 67W in idle, and only 107W under extreme load.

As your demands grow you can add a second CPU and, while there isn't as much headroom for memory as offered by the latest E5-2600 v3 servers, RAM can be pushed to 192GB. Fujitsu offers plenty of power choices: alongside the dual 450W Platinum supplies in our system, there are 800W Platinum and Titanium options.

Standing tall at 456mm, this well-built tower offers space for eight LFF or 24 SFF drives. You can start small with a quad LFF drive cage, which uses the onboard RAID controller; our system had an eight-bay SFF cage at its base, wired up to a D3116C PCI Express SAS RAID card. This can handle up to eight SAS/SATA drives, has 1GB of cache, and supports all the usual RAID suspects including 6 and 60 – but if that doesn't suit, Fujitsu offers a range of alternatives.

Along with the requisite drive cages, upgrade kits include a SAS expander card that extends support for all 24 SFF drives to the existing RAID card. We like the option of increasing storage without having to invest in an additional controller.

Internal cooling is supplied by four hot-swap fans, and as part of Fujitsu's Cool-Safe concept, honeycomb air grilles are used throughout the server to improve airflow. Fujitsu claims this server is silent; although it wasn't noisy, we were distinctly able to hear the hum of airflow at close range. It's also worth noting that the TX2540 M1 lacks Fujitsu's Advanced Thermal Design features, and so is limited to a maximum ambient temperature of 35°C, rather than the 40°C of more upmarket servers.

ABOVE The TX2540 M1's spacious interior can house eight LFF or 24 SFF drives

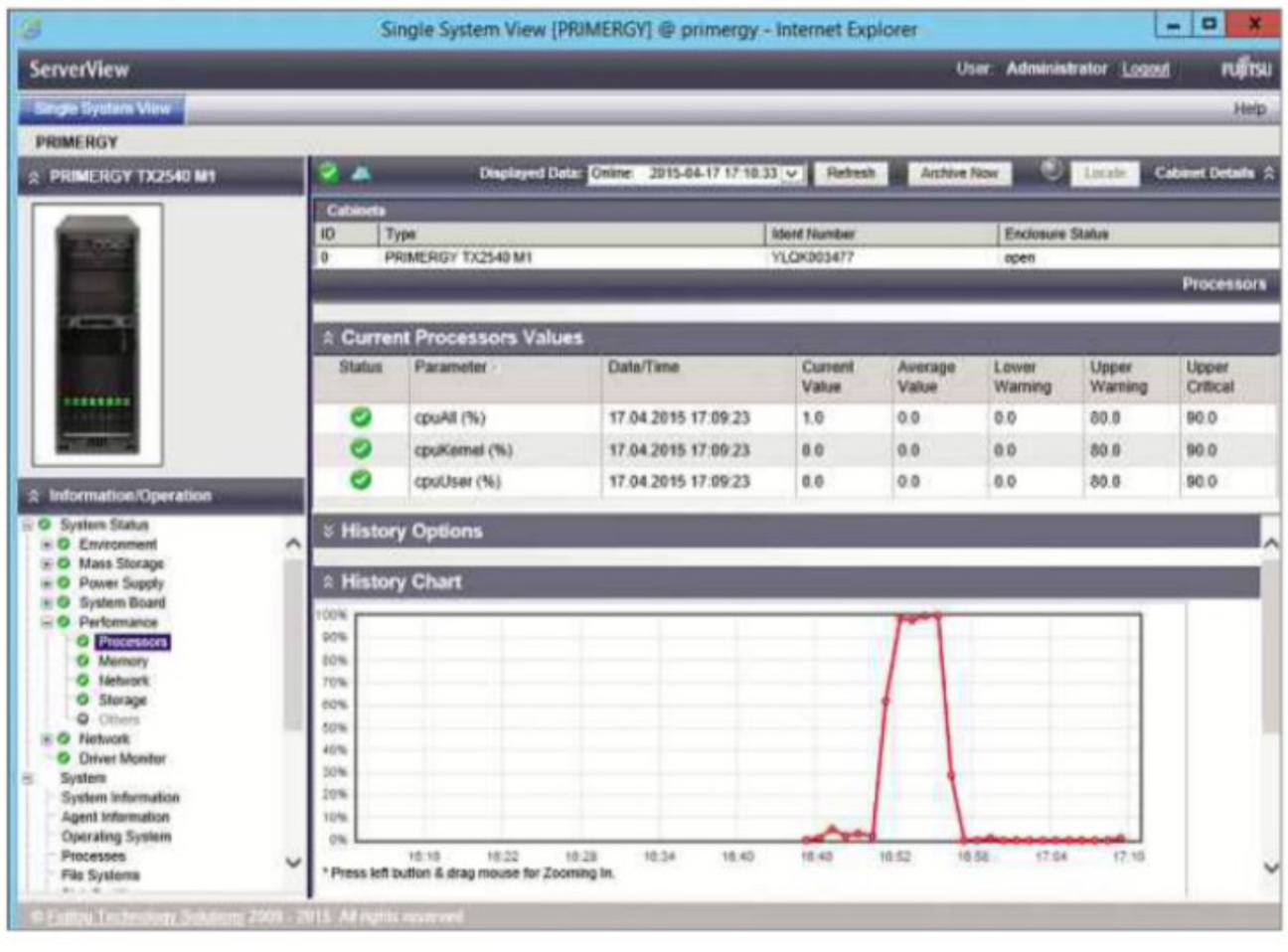
Fujitsu's ServerView Suite provides centralised monitoring and management for all Primergy servers. It lists all hardware components and their status, plus performance tables and power-usage graphs. Hardware inventory is gathered, errors or failures can be linked with alerts, and the RAID Manager utility provides direct access to the array controller.

To install an OS we had to boot the server from Fujitsu's ServerView disk; the setup process was smooth enough for us to get Windows Server 2012 R2 loaded in less than an hour.

"As part of Fujitsu's Cool-Safe concept, honeycomb air grilles are used throughout the server to improve airflow"

The server also features Fujitsu's embedded iRMC S4 controller, with a dedicated Gigabit Ethernet port for remote monitoring. A tidy web UI provides plenty of information about critical components, along with a handy set of graphs showing power consumption over periods ranging from one hour to a year.

Not all SMBs need the power of Intel's high-end Xeon CPUs; for many, the expandable, affordable Primergy TX2540 M1 will be a good fit. Best of all, Fujitsu is offering a £300 discount off the regular price of £1,949 exc VAT until the end of June, making it even better value.



LEFT Fujitsu's ServerView displays how your CPUs are holding up

SPECIFICATIONS

Tower chassis • 2.2GHz Intel Xeon E5-2420 v2 (max 2) • 16GB 1,600MHz DDR3 RAM (max 192GB) • 3 x 1TB SFF NL-SAS drives (max 24) • Fujitsu RAID SAS 6Gbits/sec/1GB (supports RAID0, 1, 10, 5, 6, 50, 60) • 5 x PCI-E 3 (with 2 CPUs) • 2 x Gigabit Ethernet • Fujitsu iRMC S4 Standard with Gigabit • 2 x 450W hotplug PSUs • 177 x 651 x 456mm (WDH) • 3yr on-site NBD warranty

HP ProLiant ML150 Gen9

A top tower for small businesses, offering oodles of features at a very low starting price

SCORE ★★★★★

PRICE Model 776274-031, £853 exc VAT from hp.co.uk



It may be small, but HP's ProLiant ML150 Gen9 packs in a remarkable range of features for the price. It supports dual Xeon E5-2600 v3 CPUs, and can take up to 512GB of fast DDR4 memory, with 60TB of storage.

Of course, all that doesn't come as standard. HP's Gen9 mantra is buy now, upgrade later, and for review it supplied us with the most basic preconfigured model: a single 1.6GHz E5-2603 v3 Xeon, 4GB of memory and one (unpopulated) quad LFF, cold-swap drive bay. We tested with four 500GB SATA drives, but you can choose from a selection of storage configurations. An extra four-drive cold-swap bay can be added too, and the server's embedded Dynamic Smart Array B140i RAID controller comes with a spare connector for it.

If you don't mind losing the 5.25in bays up above, the B140i also lets you add two more LFF SATA drives for a total of ten. If you want more, you can add HP's H240 PCI Express RAID card, which supports eight hot-swap 12Gbits/sec SAS SFF drives – or go for a P840 card and max out at 16 drives.

Whichever storage package you opt for, you'll find deployment a doddle with HP's Active Intelligent Provisioning tool. We selected this from the boot-up menu, ran through the quick-deploy wizard and had Windows Server 2012 R2 loaded up in 30 minutes.

Server-monitoring tools are in abundance: the System Management Homepage browser interface provided basic local server monitoring, while HP's Insight Control offers complete network systems management. The jewel in this server's crown is its embedded iLO 4 controller, which shares access with the first Gigabit Ethernet port and offers some of the best remote-monitoring tools around. An iLO 4 Standard licence is included, providing agentless monitoring. It also has direct access to HP support, but an Essentials or Advanced licence is needed for features such as OS remote control and advanced power monitoring – and for the Federation tool, which allows multiple ProLiant servers to be viewed from one console.

Build-wise, the ML150 Gen9 is a winner, with a solid, lockable metal chassis that houses a well-designed interior. The important bits are easily accessible for upgrades, and the memory and CPU sockets are covered by a sturdy, removable air shroud. The entry model comes with a pair of cold-swap cooling fans, and a third module will be shipped with the second CPU enablement kit. Even with all of these in place, the ML150 is a quiet customer.

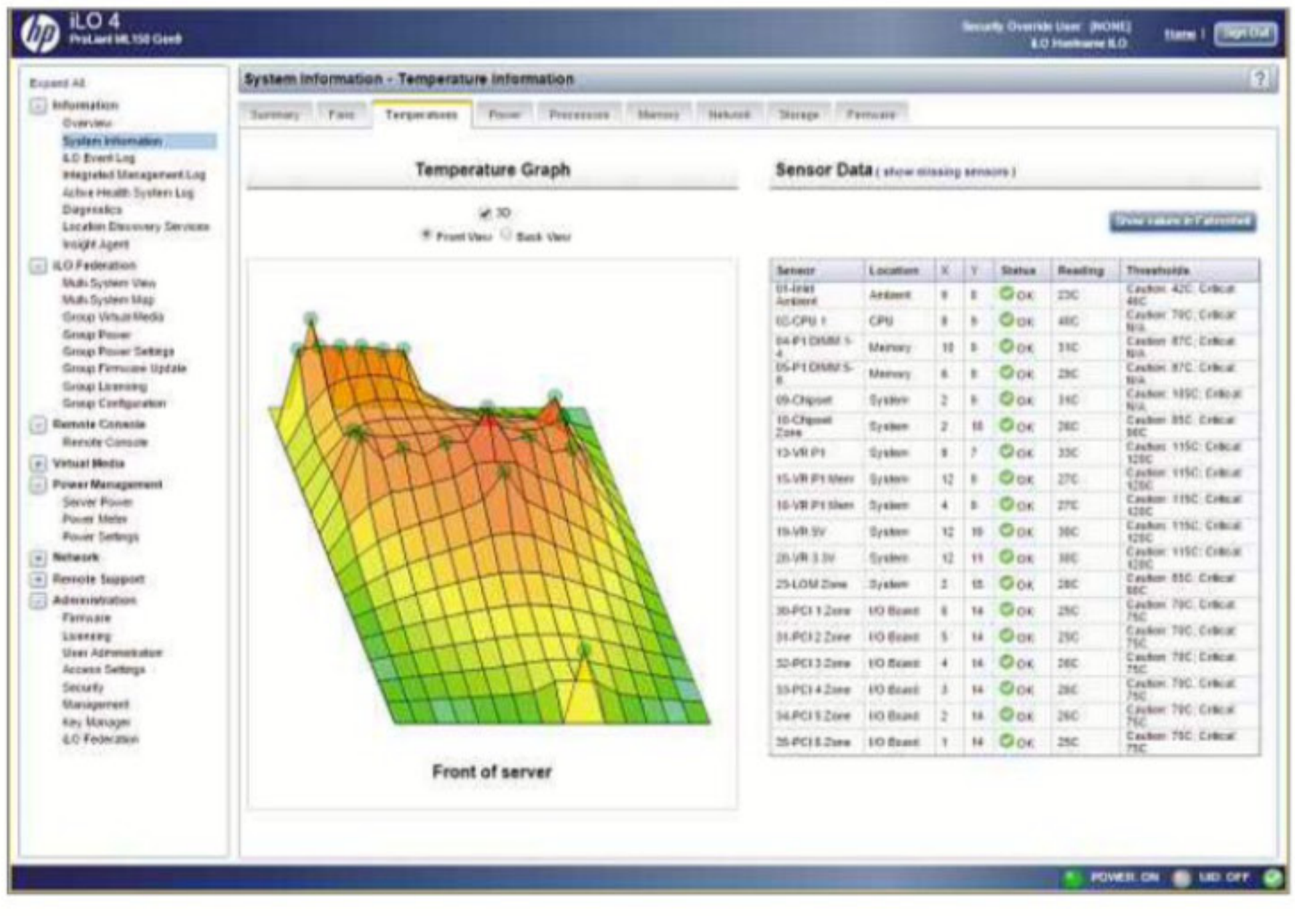
ABOVE The ML150 Gen9's solid chassis can house up to 60TB of storage

PC PRO RECOMMENDED

In single-CPU use, five of the PCI Express slots are active; adding a second gives you all six. HP offers dual-port Gigabit Ethernet and 10GbE adapter cards. For virtualisation, the motherboard has a microSD slot for booting into an embedded hypervisor. The base price includes a single 550W fixed PSU, but you can upgrade to dual 800W PSUs with the RPS backplane option. Power consumption is commendably low; our system drew 53W in idle and only 80W under maximum CPU load.

"The jewel in this server's crown is its embedded iLO 4 controller, which offers some of the best remote-monitoring tools around"

Forward-thinking IT managers will love the ProLiant ML150 Gen9. It lets you start small, but offers great scope to upgrade when the time comes. There really is nothing we can fault it for, making it our tower server of choice for small businesses.



LEFT HP's iLO 4 delivers agentless monitoring of your server

SPECIFICATIONS

Tower chassis • 1.6GHz Intel Xeon E5-2603 v3 (max 2) • 4GB 2,133MHz DDR4 RDIMM (max 512GB) • HP Dynamic Smart Array B140i (supports RAID0, 1, 10, 5) • no HDDs included (max 10 LFF/16 SFF) • cold-swap four-bay backplane • 2 x Gigabit Ethernet • 6 x PCI-E 3 (with 2 CPUs) • 2 x cold-swap fans (max 3) • 550W cold-swap PSU • HP iLO 4 Standard • 200 x 630 x 432mm (WDH) • 3yr parts/1yr on-site NBD warranty

Lenovo ThinkServer TD350

A radical redesign and generous hardware package for the price make the TD350 a strong player

SCORE ★★★★½

PRICE £5,642 exc VAT from serversplus.com



Lenovo acquired IBM's System X server portfolio last year, but this hasn't stopped it developing its own ThinkServer range. In fact, the new fifth-generation ThinkServer TD350 represents a complete refresh in all the important areas.

It starts with systems management, where the new ThinkServer Systems Management (TSM) subsystem at last remedies the deficiencies of Lenovo's previous attempts. Its web console is more informative, and opens with a firmware and event-log summary, temperature and power speedo dials, plus links for power controls. A second page lets you secure TSM access, browse audit logs and activate remote-access firewall rules. You can monitor sensor data for temperatures, voltages and fans, and link platform-event filters with email-alert policies.

The remote firmware upgrade feature is particularly useful, allowing you to update the server and system manager components from the console. We recommend the £38 TSM Premium module, which plugs into a slot on the motherboard and enables the virtual console feature.

OS deployment is also easier than it used to be: Lenovo's embedded ThinkServer Deployment Manager provides tools for platform updates plus storage configuration, helping us to load Windows Server 2012 R2 in less than 30 minutes.

The TD350 brings a hardware refresh too. It's more solidly built than Lenovo's previous towers, and storage capacity is boosted to 15 LFF or 32 SFF drives. It also features Lenovo's AnyRAID, which extends the TD350's PCI Express bus to a mid-plane card fitted directly behind the drive bays. The AnyRAID adapters snap in to the mid-plane card and Lenovo offers three options starting with the 510i, which supports eight 6Gbits/sec SAS drives, mirrors and stripes; plus it can be upgraded to RAID5 and 50.

Our test model featured a high-end RAID 720ix adapter, which supports 12Gbits/sec SAS drives, RAID6 and 60, plus a 1GB read-only cache. Add the 4GB flash module and you can play with LSI's CacheVault, CacheCade and FastPath features for improved storage performance. The 16-drive server can be upgraded to 32 SFF bays on demand; the kit includes two more eight-bay hot-swap cages, a dedicated 720ix AnyRAID adapter and a PCI Express SAS interposer card.

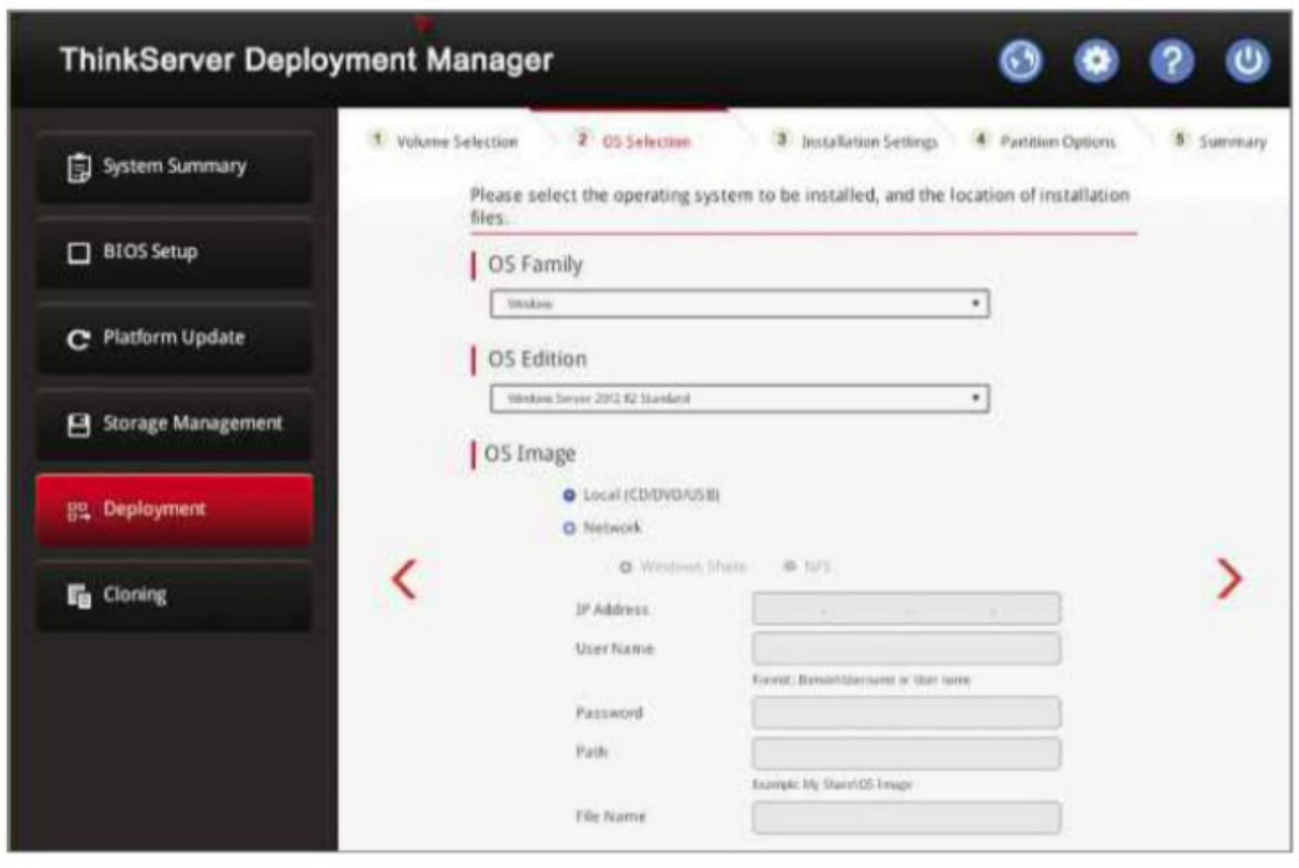
ABOVE There's room for up 15 LFF or 32 SFF drives in Lenovo's solidly built tower

An optional dual SD card module can also be used as a boot device, although it connects via the USB bus so can only be RAIDed within the OS. You can add a dual M.2 flash module, too, which has capacitor protection and support for hardware-managed mirrors.

Our review system came with dual eight-core 2.6GHz Intel Xeon E5-2630 v3 processors, a decent 64GB of DDR4 memory (expandable to 512GB) and even five 300GB SAS SFF hard disks. Idle, we measured a draw of 124W, which peaked at 246W under heavy load.

"The new ThinkServer Systems Management subsystem at last remedies the deficiencies of Lenovo's previous attempts"

This new generation of ThinkServers transforms Lenovo from an also-ran to a real contender in the server market. The TD350 tower packs in a powerful set of core hardware, with a range of innovative new features and good upgrade options. It's easy on the noise and power consumption too, making it well suited to a wide range of businesses. ●



LEFT Lenovo's servers are much easier to deploy thanks to the new ThinkServer Deployment Manager

SPECIFICATIONS

Tower chassis • 2 x 2.6GHz Intel Xeon E5-2630 v3 • 64GB 2,133MHz DDR4 RAM (max 512GB) • 5 x 300GB Seagate SAS SFF (max 32) • Lenovo AnyRAID 720ix 12Gbits/sec SAS/1GB/BBU (supports RAID0, 1, 10, 5, 6, 50, 60) • 7 x PCI-E 3 (with 2 CPUs) • 2 x Gigabit Ethernet • Lenovo TSM Premium with Gigabit Ethernet • 2 x 750W hotplug PSUs • 251 x 686 x 459mm (WDH) • 3yr on-site NBD warranty

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Inmarsat IsatHub

Subscriptions are costly, but you won't find an easier way of staying in touch when you're far from civilisation

SCORE ★★★★½
PRICE Unit only, £695 exc VAT
from ashburysatcom.co.uk



Inmarsat's IsatHub can keep you online from almost anywhere on the planet. Combining 802.11n Wi-Fi with satellite internet access, it will work with any wireless-enabled device, and supports standard voice and SMS services as well.

Strictly speaking, IsatHub itself is the communications service, which uses the Inmarsat-4 and Alphasat satellites to cover the US, Asia and Europe (only the poles are beyond its reach). The actual hardware is the Wideye iSavi hotspot, which is manufactured by AddValue. Weighing 900g, it's solidly built, with an IP65 rating that indicates it's dust-proof and can handle low-pressure water jets from any direction.

Setup proved simple. After turning on the iSavi, we found it took around three minutes to acquire a GPS fix. Once the receiver knew where it was, the four LED direction arrows flashed to show us how to orientate it to link to the satellite network. These can be difficult to see in bright sunlight, but the pointing-assist tool in the iOS Control App on our iPad helped us to position it correctly. The Inmarsat satellites are in geosynchronous orbits, so once a link has been established, it remains connected.

Of course, the need for a clear line of sight to the satellites means the iSavi can't be used indoors, or even in secluded outdoor areas. Connecting from our office roof wasn't a problem, but when attempting it in the garden we found we had to keep the receiver well away from the house and trees, which otherwise blocked the signal.

This in turn means that, while it can be run from the mains, it's more likely you'll be powering the iSavi with the battery pack, which clips onto the side of the receiver and doubles as a stand. There's no USB charging port, but you can use optional car or solar-panel chargers to top it up while out and about. In use, we found battery life was surprisingly good – we never got less than three-and-a-half hours from a fully charged pack. We also inadvertently tested the IP rating, as we forgot the iSavi was outside during a heavy downpour; happily, it shrugged off the deluge.

IsatHub's data transfer rates of 384Kbits/sec downstream and 240Kbits/sec upstream may not seem much, but they're more than 100 times faster than Iridium's Go service. Subscriptions are pricey, though: after the £15 sign-up fee, the basic package offers a mere 10MB of data and 10 minutes of voice calls per month for £36. Extra data is charged at £2.50 per megabyte, and within two hours of browsing we found we'd already run up around £90 in overage fees. A more flexible 500MB package, including an hour of voice calls, costs £1,152 per month, with additional data charged at £2 per megabyte.

The iSavi has a web interface that, along with showing signal strength and GPS co-ordinates, provides access to wireless, firewall and URL-filtering settings. We were able to use it to send SMS text messages to mobiles with our GPS location appended, and to view incoming texts as well. You can also use dedicated Android and iOS apps on connected devices to access most of the important settings, including customising firewall rules and changing wireless settings. The free Voice App lets you make calls; contacts can be imported from your mobile device, and in practice we found that calls placed over Inmarsat's dedicated voice line were perfectly clear. As usual with a satellite link, a slight one-second lag was noticeable, but it didn't cause any problems.

As long as you're careful with your data usage, the Inmarsat IsatHub iSavi package is ideal for staying in touch from wherever you are. We found it simple to operate, and it works with any wireless device, making it more versatile than most other satellite hotspot solutions. **DAVE MITCHELL**

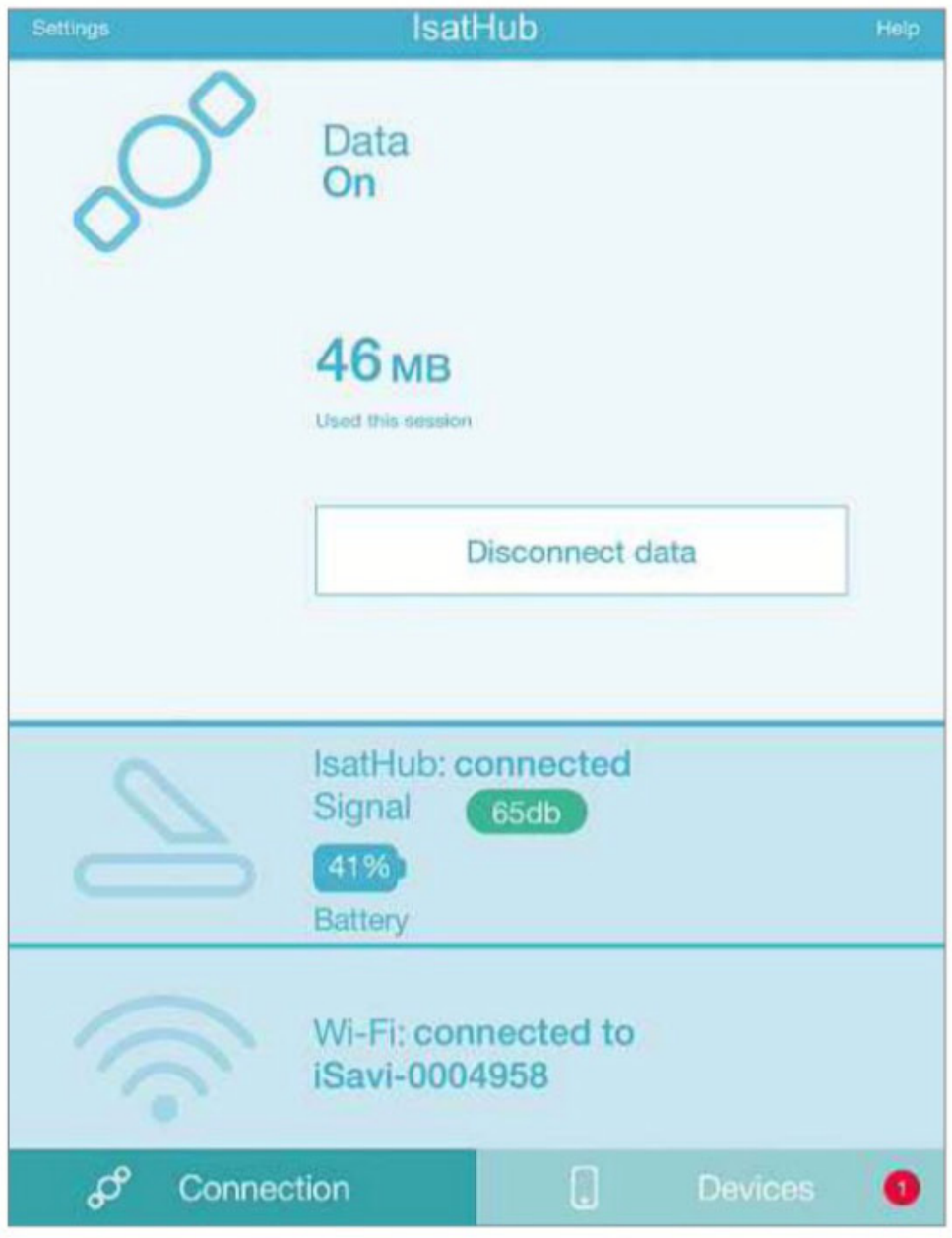
ABOVE Simple to operate, the IsatHub provides the means to stay in touch via voice calls and text messages

PC PRO RECOMMENDED

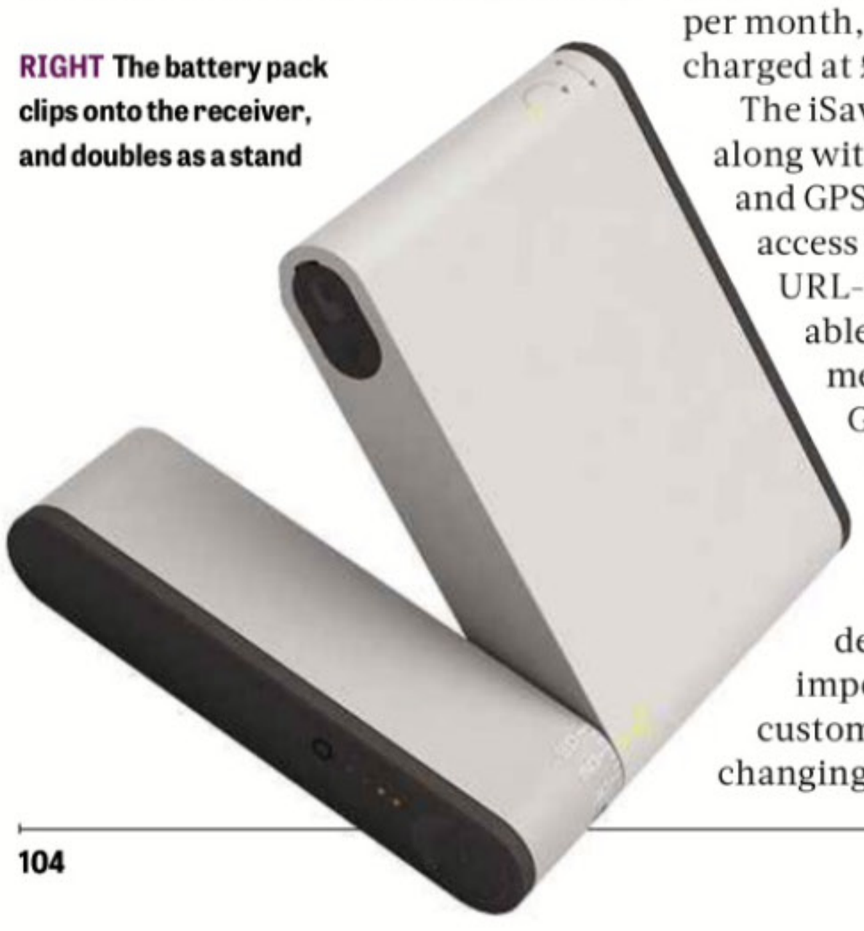
BELOW Inmarsat's free Control App is handy for monitoring signal quality and controlling data usage

SPECIFICATIONS

Inmarsat satellite receiver • 802.11n wireless AP • WPA2 encryption • 3,000mAh battery pack • mains battery charger and plug kit • Control App and Voice App for Android & iOS • web browser management • 1yr warranty • carry bag • 180 x 170 x 30mm (WDH) • 900g



RIGHT The battery pack clips onto the receiver, and doubles as a stand



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THE BUSINESS QUESTION

Is it time to switch to hosted email?

Migrating to an off-site solution could save you both time and money, explains Darien Graham-Smith

Email is an indispensable business tool, but that doesn't mean your office needs its own email server. Hosted email can provide a reliable and cost-effective alternative, whether your business is a tiny start-up or a thousand-seat business. Microsoft's Office 365 is the most popular service available, although there are alternatives, such as Google Apps for Work.

The advantage of hosted email

If you already have a working email system, you may not see an urgent need to make a change. But email isn't a service where you want to wait until something goes wrong to take action.

"It's easy to set up an Exchange server," Craig Cotter, brand director at Heart Internet told us. "And it's simple to just leave it running. But one day your Exchange server stops working, and if you don't have redundancy, your email is gone. Even if you do have redundancy, you might end up with an Active Directory problem. These are issues that require a full-time Windows system administrator or Exchange expert to fix."

It's a problem of which IT professionals are well aware. Joseph Woodhouse, an IT manager at Redgate – a development house making software for IT professionals who work with SQL Server, .NET and Oracle – explained that his business had chosen to make the switch in order to free up that staffing requirement.

"We have a small IT team," he explained. "With hosted email we don't have to manage and maintain the infrastructure, so that's one less thing to worry about. It frees up our system administrators to work on more valuable things that they can contribute to the business."

This doesn't mean that switching to hosted email benefits only the IT department. On the contrary, the biggest advantage can be to small companies that lack such an in-house function. "Small companies in particular tend not to have a full-time Exchange expert," noted Cotter. "So when something does go wrong, they have to hire someone for a few hundred pounds per hour, on a per-incident basis. By the time the issue is fixed, they'll have spent more than their yearly IT budget for email."

Mark Gardner, IT consultant at the Ffestiniog Railway Company, explained that the Welsh heritage railway had chosen hosted email specifically to avoid that scenario.

"Ours is a very small business," he explained. "Our business isn't IT, and we have limited IT resources. Until recently, we were running on a failing Exchange 2003 installation, so we needed to move to something more stable. Switching to Office 365 hosted email let us do that, and at the same time enabled us to reduce the impact on our resources."

Gardner's mention of Exchange 2003 brings up another benefit of subscription services: you no longer need to worry about keeping software up to date. "Upgrades are challenging, so in many cases organisations simply don't upgrade," said Cotter. "And so sooner or later, these pieces of software reach end-of-life. In July, we have Windows Server 2003 hitting end-of-life, and a lot of organisations will still be running that." From a business standpoint that's an unacceptable security risk.

Making the switch

You might expect that migrating a service as fundamental as email will be a major project. In practice, it can be surprisingly straightforward.

"We experienced very little upheaval," said Gardner. "The hosted email is a completely different, completely parallel service, so there's no problem there. The only issue was that we changed our domain name at the time – that was the biggest bit of aggravation we faced. That was our own fault, however."

Meanwhile, Redgate chose a staged migration to ensure a smooth transition. "We created a group nicknamed 'trailblazers'," Woodhouse told us. "That was about 30 people or so, from all over the business. We migrated them first and collected as much feedback as we

"We experienced little upheaval: the hosted email is a different, completely parallel service, so there's no problem there"

could based on their experience, then started scheduling small groups of people to migrate."

In fact, the few hitches the company did hit were chiefly to do with administration. "There were definitely some challenges in terms of understanding the renewed licensing model," said Woodhouse. "It isn't a straightforward transition from licence to subscription." A few housekeeping issues cropped up too: "We had to rewrite some of our scripts to handle things that had been automated previously, such as when someone starts or leaves the company," revealed senior system administrator Jonathan Masefield. "But it isn't a major job."

"There's a bit more latency than with something hosted on-premise too," added Woodhouse. "It's not a huge difference, but staff such as PAs and receptionists – who rely heavily on calendaring – notice it."

Another difference to be aware of is the constantly refreshing nature of cloud services. "The portal does change from time to time," said Gardner. "There have been one or two surprises, and with a user base that isn't always terribly computer literate, that kind of simple change is difficult to handle – particularly when it comes as a surprise, as has been the case with each update so far."

Risks and caveats

When entrusting a business-critical service to a third party, questions of support and reliability will inevitably loom large. "Do your research beforehand," warned Cotter. "Don't go with a fly-by-night vendor."

Those that have made the switch, however, have no regrets. "Office 365 has a 'three-nines' service-level agreement," said Woodhouse. "And we've invested in a failover service through Mimecast, so if we were to lose the Microsoft platform for any period of time, we could carry on sending and receiving emails through a different service."

It's also worth considering the legalities of letting a third party handle your email. "Some businesses may be concerned about having confidential email handled by a hosted service," noted Woodhouse. "They might need to take into consideration the location of the data." Gardner agrees: "At the end of the day, we're not happy with the idea of data being outside of the country," he told us. "But the benefits outweigh everything else in that respect for us."

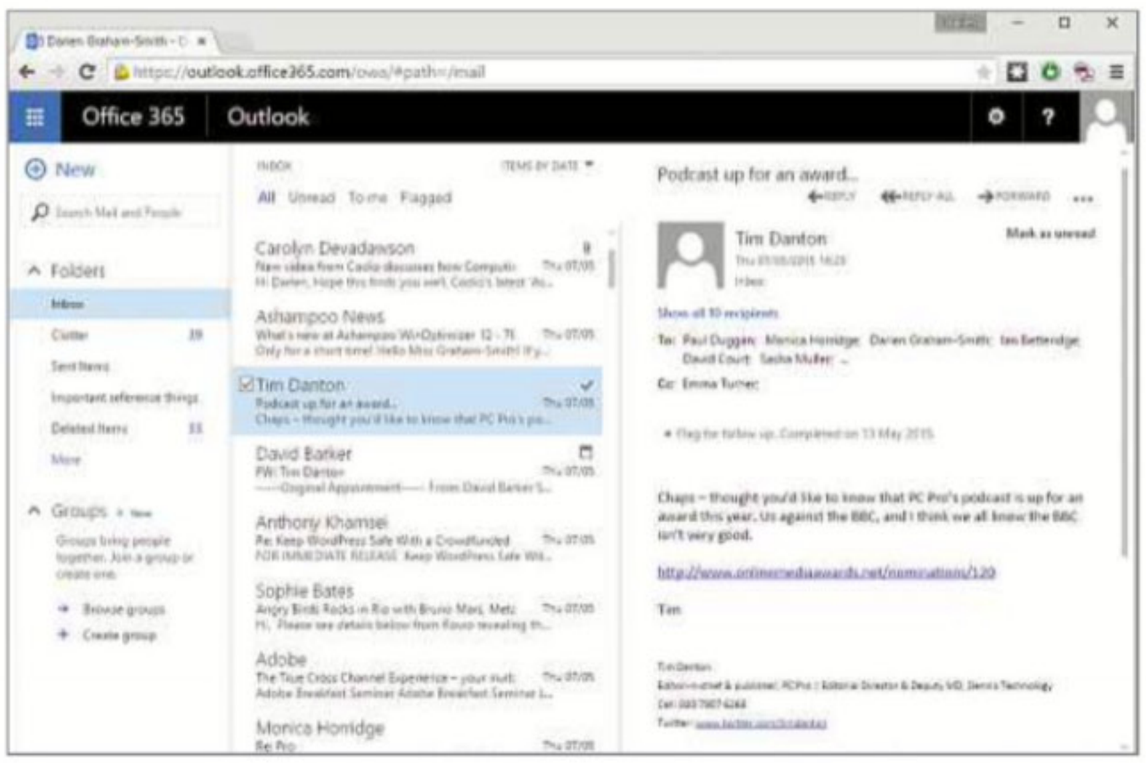
One concern that can be allayed is the fear of losing your archives if your service is discontinued for any reason. "If you're using Exchange, you can have local backups of your mailbox," explained Cotter. "Even when you're using a hosted solution, those can be uploaded to another Exchange system. So if, for whatever reason, a provider does go for the nuclear option then, provided you've kept a local backup, things are never completely out of your hands."

Is it time to switch?

So, is it time for your business to move away from local email? All of our experts agreed: unless there's something exceptional about your organisation, the answer is almost certainly yes. "If I were to start a business now, I'd probably go with Google Apps or hosted Exchange right from the start," commented Cotter. "It's much lower risk, for a much lower initial outlay, and it gives me freedom to move easily."

Woodhouse agreed: "If I were starting from scratch, building an IT service or business, this is where I'd start. The cloud is exactly where email and calendaring should be. I see no advantage to running it locally."

"I can't see the point in maintaining your own local email system, irrespective of the size of your business," echoed Mark Gardner. "The benefits are probably greater for a smaller business than a larger one, but now that we've migrated, we get simplicity and reliability – and we no longer need to employ that skilled resource. It's been a good news story for us all round." ●



ABOVE Hosted email lets employees keep in touch from any device, with no need to install and manage dedicated client software

"If you're using Exchange, you can have local backups of your mailbox, so things are never completely out of your hands"



The expert view Steve Cassidy

It's clear that moving services into the cloud can work wonders for a business. If you fit into the expectations of the marketplace then migrating is a slick, smooth process providing plenty of benefits.

It helps to be a history-free start-up, though. If you have lots of baggage, or lots of internal procedures built on structures that are out of favour, then moving can be a bigger deal. That's why the big brands are no longer pushing an all-cloud mindset. Both Microsoft and VMware have recently stopped talking about pure off-premise cloud resources, and are talking about "hybrid" cloud instead.

If you haven't encountered it, this is a rather loose term for a system that ties together your old on-site kit with your new off-site cloud portfolio. If you're not sure whether you need to think about a hybrid solution, a good place to start is to determine how much email you need to store. Ignore the advertised upper limits for online cloud-based email storage: providers will happily quote the sky as the limit, without addressing the question of how long it might take to actually upload all your data. One client of mine paid handsomely for one of the leading cloud services. Then they started trying to work out how long it would take their 23TB email archive to transfer at a rate of about six messages a minute. One wag estimated the completion time at around 30,000 years.

In fact, I'd say the breakpoint appears to be about 10GB. While this might sound a lot, if you've been in business for some time, you may have got there without trying very hard at all. On my own, I'm on about 6GB, going back as far as the year 2000. Once you reach that sort of level, hybrid starts to look pretty attractive, especially when you factor in the huge collapse in hardware costs since the days when Exchange 2003 ruled the roost.

It's also a good idea not to bet everything on an unscrupulous hosting provider that might be keen to get you into a position from which it's difficult to leave. Look at the skills market nowadays – the demand isn't for old-school Exchange administrators; it's for digital presence administrators, schooled in the technical and contractual aspects of moving away from a flaky or difficult provider. I've had clients that have tried, and left, three different hosted-email companies.

To be clear, now that the hosting business has settled into an observable, understandable pattern with known strengths and weaknesses, my advice is certainly to embrace hosted email. Just don't keep it as your only option. Invest in another domain, or set up some more complicated split between on-premise and off-premise services. Don't let the cloud be your only basket for increasingly important emails.

Privacy policies

Davey Winder explains why a short legal statement could save your business a lot of trouble



A privacy policy? What's that then?
Simply put, a privacy policy is a statement published on your website that provides details on the information you collect about those who use that site, who gets access to this information and the purpose for which it will be used. You know – the "we may share your information with third parties for marketing purposes", or "we never sell your personal information to anyone" stuff. Exactly what goes into this policy will depend on the applicable law covering the website in question.

Does my site really need one?
In this post-Snowden world, there's far more understanding about online privacy than there used to be – and more paranoia too. According to a recent YouGov survey, some 72% of UK consumers are concerned about their private information online (see **pcpro.link/250cheat**). Placing a link from every page on your site to your privacy policy can go a long way to reassure potential customers and clients. Think of it as a declaration that you take privacy seriously.

No, I mean: does the law say I need one?
A data-protection notice is required by law for any UK-based website that collects personal data – including email addresses, for example – unless the purpose of that collection is obvious and apparent. In effect, this is a privacy policy statement, since it includes details of who collects what and for what purpose.

In the US, there isn't a federal regulation covering privacy policies, although the Federal Trade Commission does prohibit unfair or deceptive marketing "practices" and so most US website owners publish a policy to avoid falling foul of this. There are also federal laws, such as the Children's Online Privacy Protection Act (COPPA), which require a privacy policy for information about, or targeted at, children under the age of 13.

What about cookies?
EU E-Privacy Directive Article 5(3) requires "prior informed consent" for cookie storage and access, so simply including cookie details in your privacy policy isn't enough. That's why you get those pop-ups when you visit a site for the first time. However, explaining what cookies are and how the user can opt out of them makes things clearer for your visitors.

Another necessary evil then?
If you're thinking of a privacy policy as a "necessary evil" then you may need to rethink the way you do business online. It isn't a necessary evil – it's just necessary.

So how do I go about creating one?
A good privacy policy should be understandable by everyone. In fact, a good privacy policy should be designed in the same way as your website: easy to access, intuitive and welcoming. But don't oversimplify, because your privacy policy is also a legally binding statement. Don't claim "we will not share your information with any third party" unless you're sure of that fact. What about your hosting company, for example? Or what about the advertising system and payment processors you use?

So while legalese is to be avoided, it makes sense to have your draft policy checked by a data-legislation-savvy lawyer to ensure you haven't made any silly mistakes.

What about using one of those free templates from the interweb?
Don't. There's no such thing as a perfect one-size-fits-all solution; when you think about it, how likely is a templated policy to perfectly fit your business practices? And can you be certain it won't expose you to potential legal potholes?

"A data-protection notice is required by law for any UK-based website that collects personal data – including email addresses"

Okay, I've got it. So once I've done all that I can forget about it?
Absolutely not. Although the point is often overlooked, a privacy policy is only any good if you adhere to what it says. Your statement of intent needs to be backed up by a commitment to enforce it. Work with those responsible for your data security positioning to ensure that they can deliver on your privacy promises. Remember, too, that your privacy policy has to be dynamic, and will need to be updated if your information collection practices change. ●

The jargon

Cookie A text file stored on your device (via the web browser) and accessed by a server, enabling websites to remember information such as user preferences and site navigation memory.

DPA The Data Protection Act (1998), which determines how data may be "processed" in the UK.

EC Directive Used as a blanket term to refer to the EU Privacy and Electronic Communications Regulations that cover the collection and use of personal information online.

Processing The collection, recording, transmission or use of data collected. Even deletion is counted as processing.

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JON HONEYBALL

"Microsoft clearly knows how deep a black hole it created with Windows 8 and is determined to crawl out of it"

Microsoft demonstrated some technical wizardry at Build 2015, but will it be enough to solve all the company's problems?

Microsoft unveiled more details about its Windows 10 plans at its recent Build conference (*see our feature on p44 for a full rundown*). Many were reportedly enough to make the audience gasp, and to fill the blogosphere with an outpouring of extreme geek love.

Let's look at the upside first. Microsoft clearly knows how deep a black hole it created with Windows 8 and is determined to crawl out of it using Windows 10 as a ladder. As I've said before, many – even most – of the stupid mistakes that happened in Windows 8/8.1 are being addressed in 10, which can only be a good thing. It's too late to discuss how and why Windows 8 happened the way it did: that's for lecturers at business schools to pontificate upon to future students (which is, coincidentally, where Mr Steven Sinofsky went after Microsoft – he's an "executive in residence" at the Harvard Business School).

Let's put aside the fact that current builds of Windows 10 are still extremely wobbly, and that an awful lot is changing in what appears to be almost undue haste so late in the development cycle. The OS is due to slip out of the doors very soon, and I can't remember any major build of Windows that was still so reminiscent of a jelly in an earthquake at this point – hopefully everything will come together. I hear that the traditional post-release-update excuse is being polished ready for battle in the second half of this year, and things that are just not finished will appear in dribbles over the coming months.

There were a couple of bombshells at Build, though. First is the arrival of "bridges", which are technology systems that enable you to run all sorts of things as native Windows applications, or native Windows Mobile applications depending on which bridge you care to stroll over.



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If you have Android application code, then this can be run on Windows Mobile. To take proper advantage of underlying Windows Mobile capabilities such as Live Tiles, you'll need to make a few nips and tucks to your codebase, but the idea is that you can bring in an Android app and it will run on your Windows phone, which is undoubtedly very clever stuff indeed.

The next one to wow the crowd was the ability to take iOS application source code and recompile it for Windows, both phone and desktop. In essence, Microsoft has built a code compiler for Objective-C that squirts out native Windows code. No-one has mentioned officially what will happen to those developers who have moved on from the ancient Objective-C to the far more modern Swift language, but rumours suggest that Microsoft will provide a cross-compiler for this too. This is also very clever indeed, just like the Android support: making these things work needs some serious magic to happen in the background.



BELOW Microsoft's Build announcements caused an outpouring of geek love

As one example, your Android app won't have Google's services to call upon, so Microsoft is building in a software layer wherein calls to those services will be morphed into calls to Microsoft services – so instead of getting Google Search, you'll get Bing (if your sphincter is starting to pucker up at the very thought of this, you're not alone). Both these bridges have been hailed in the most gushing terms as incredible and daring pieces of work, and just the sorts of thing that a post-Ballmer, reinvigorated Microsoft would be and should be doing. I'm way more cynical than that, however.



Jon Honeyball
Opinion on Windows, Apple and everything in between – p110



Paul Ockenden
Unique insight into mobile and wireless tech – p113



Eileen Brown
Even the tech-savvy can have their websites hacked – p116



Davey Winder
Keeping small businesses safe since 1997 – p118

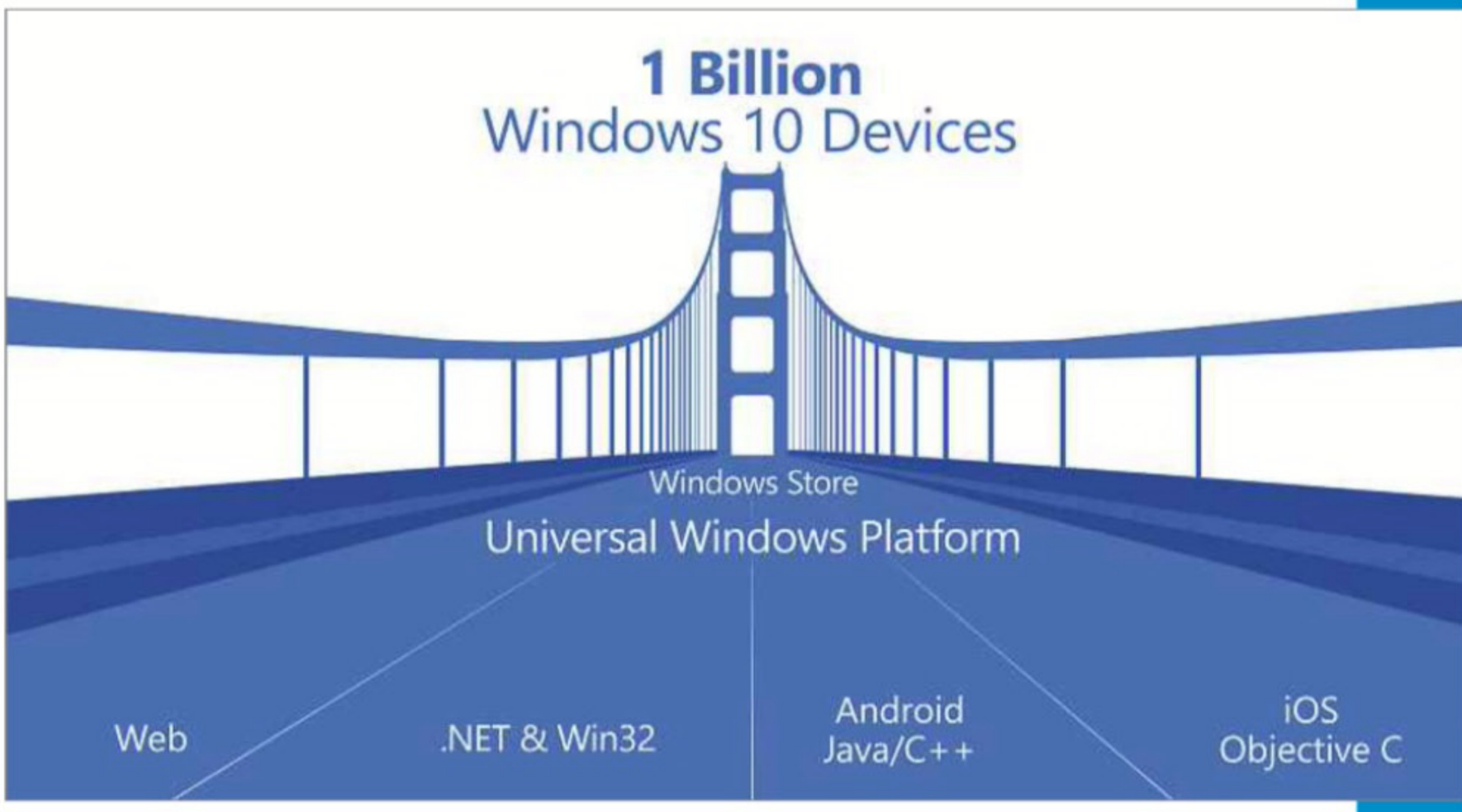


Steve Cassidy
The wider vision on cloud and infrastructure – p120

Let's take the cross-compilation issue first. This sort of recompilation to a different OS has been tried many times before and has never worked well. Think back to the days of OS/2, and its attempt to run native Windows code. Didn't work then, doesn't work now. Or rather, it works fine in a few carefully crafted demo applications – but the devil is always in the detail. The claim coming from Microsoft is suitably bullish. If you're an iOS or Android developer, then writing an application for Windows (or Windows Phone) is currently a rewrite job, and hence a lot of work. These technologies will give you a leg up by dramatically reducing the work required to get something going, almost down to nothing.

But let's look at the numbers. The first rule of retargeted code is that it's never as simple as it seems. For starters, you have to debug and support another platform, which you'll be doing through a smoke-and-mirrors layer provided by Microsoft. This layer won't be perfect, and you'll quite quickly end up working around multiple issues. Yes, you have a product up and running, but at what real cost? And is it worth it when, in the case of Android apps running on Windows Phone, we're talking 3% of market share? If you're already a successful app vendor on Android, why would you take on this additional headache for such a small sales uplift, even if it is simpler than doing a ground-up rewrite? The advantage of a ground-up rewrite is of course that it's native to the target platform, and so can take full unfettered and unfiltered advantage of its services.

Now let's look at the iOS issue. First of all, Microsoft doesn't control the underlying OS, and has no meaningful access to its codebase. We're on iOS 8.3 today with 8.4 in beta, and at the forthcoming Worldwide Developers' Conference we'll likely see early versions of iOS 9. Now let's add to the pot Apple's exceptional ability to persuade its users to move up quickly to the latest version of its OS. Back in February Apple announced that iOS 8 was running on 73% of all iOS devices, and that was only months after its arrival. It's clear that, unlike Windows users, iOS users move and move rapidly, and hence will move to iOS 9 just as fast.



Let's also not forget the lock that Apple has over its developer community. Want your app to stay in the Apple App Store? Then keep up with the latest technologies and standards. If you're not 64-bit, you're about to become history. Once again, Apple has huge power over its developers, and has proven to be ruthless in getting apps optimised for iOS 8. This ruthlessness is sure to continue with iOS 9. So we have an application environment that's moving fast and isn't under Microsoft's control; an OS environment that's moving just as fast; and an Apple willing to do whatever it can to protect that. It certainly won't let its developers lag behind the pack just to keep their older codebases alive, in order to fit in with wherever Microsoft has got to by that point in time.

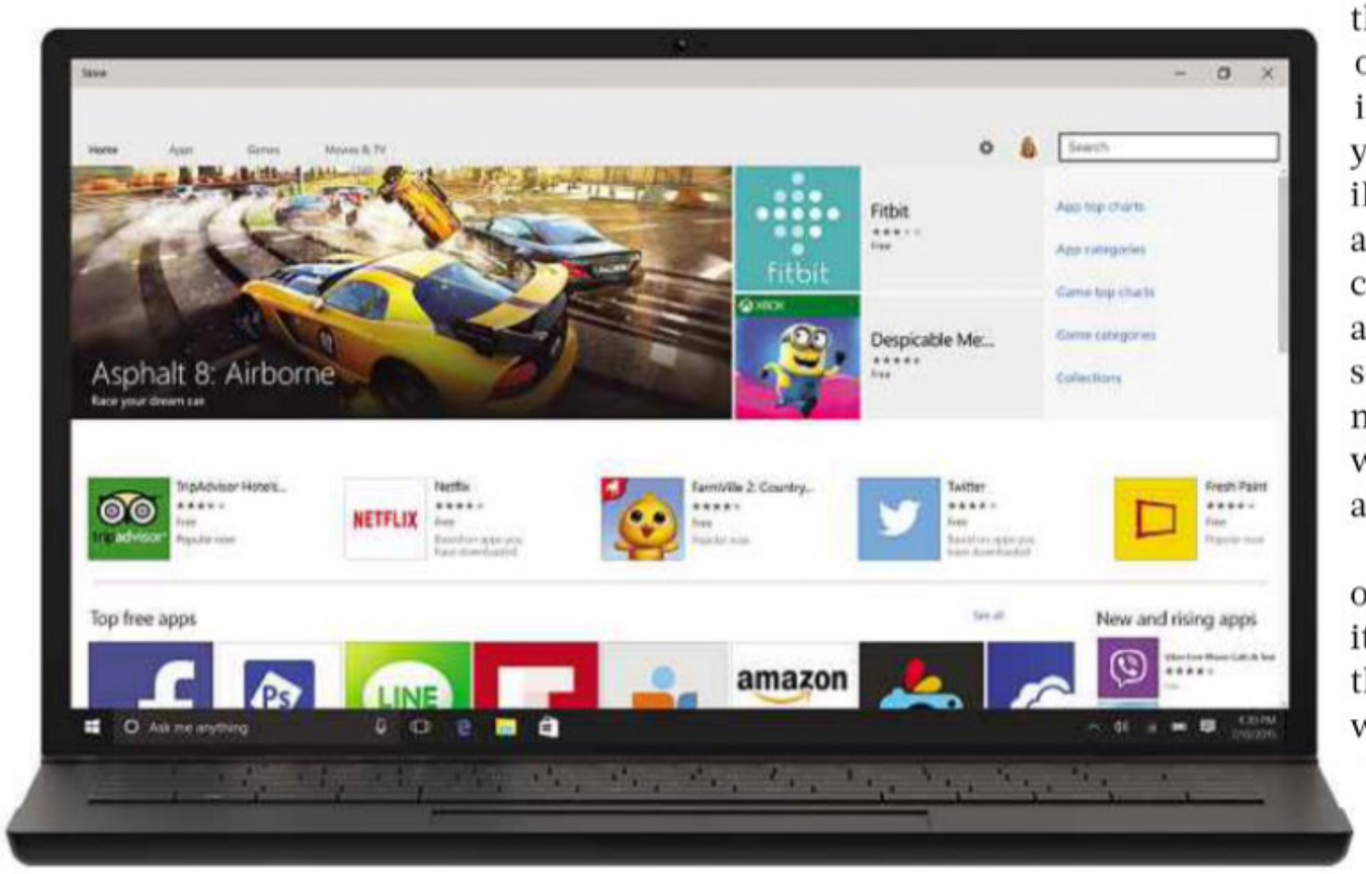
Finally, let's not ignore the implications of all this for battery life. What will happen to any real application running on a Windows phone or tablet when it's ported across using these technologies? Battery life is everything, and even the smallest of slips can and will decimate the battery life for your users. No, the problem with all of this stuff is that it's "geek porn", as the Americans like to call it. It's hugely interesting to developers because they love talking dirty, but the businesspeople backing those developers will be wary, while end users simply won't care.

ABOVE The ability to run Android and iOS code on Windows is truly impressive – but will developers jump?

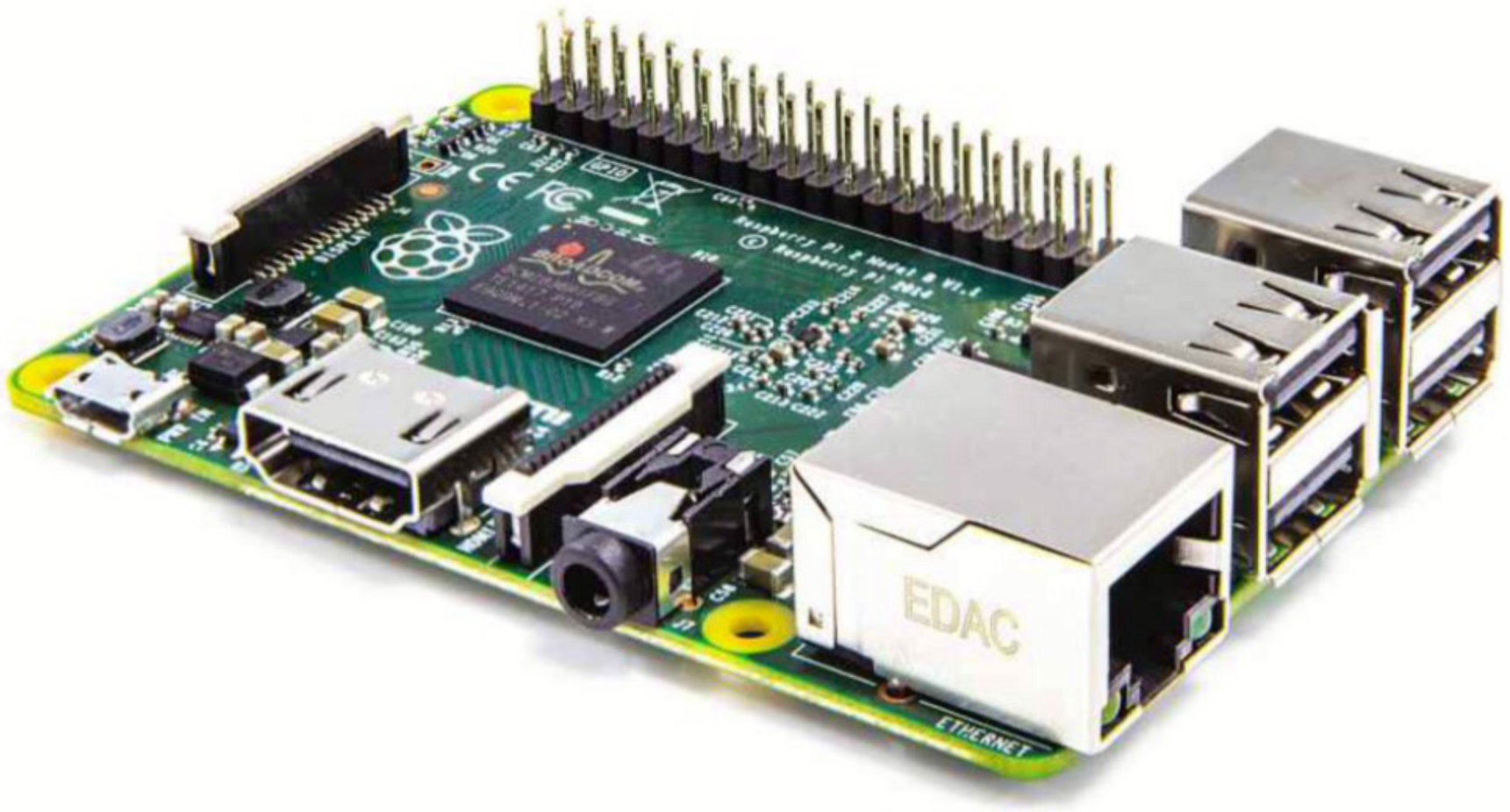
"Microsoft is doing what it thinks it does best, creating technical solutions that make bloggers drool"

Here's their choice: there's a bunch of Android apps you want to use, so you can either buy that new Samsung/Nexus/HTC today and have them run just fine, or you can buy a Windows Phone and have those same apps work to some degree, with unknown and untested consequences on critical items such as battery life. That was an easy decision wasn't it? Or, if you're thinking of buying an iPhone or iPad, and have a bunch of iOS apps you want to use: you can either buy that new iDevice today and have the apps work just fine, or you can buy a Windows tablet and have those apps turn up sometime in the future, or not, when they might run well, or not. Well, that was another easy decision...

The really startling aspect of this technology is that it's Microsoft doing what it thinks it does best, creating wizardry for developers. Technical solutions that make bloggers drool. Unfortunately, think



BELOW Microsoft has failed to get developers to engage with the Modern interface at all



about what's actually happened. The company has singularly failed to get developers to engage at all with the touch interface of Windows 8.x. The failure of engagement with developers for Windows Phone has been even more catastrophic. All the market volume is in Android apps, and all the money is in iOS ones. So now it's offering up these porting tools with a pleading look in its eye, as if to say "look, we're doing everything we can to make things easier for you, please would you just even take a look?" That, ladies and gentlemen, is how deep the hole is. Developers for Windows touch tablets and Windows Mobile just aren't there. They're not listening. That boat has sailed.

It's truly galling to watch this from a company that has taken developers to the very heart of its being. It brought such wonderfully empowering technologies as Visual Basic to the market; brought Visual Studio and the whole runtime thing to fruition; excelled at language development and API innovation; even set the high water mark for application programmability with Visual Basic for Applications. And now it's essentially reduced to begging, which isn't nice to see.

Windows for Raspberry Pi 2

I love the Raspberry Pi platform. It's cute, does what it says on the tin, and is the embodiment of a distillation of good thinking down into a board that can almost fit in a matchbox. Some months ago I raved about how I could run Wolfram's Mathematica on a Pi, connected to my television via an HDMI cable. Now Microsoft has shipped an early build of Windows 10 for Pi 2, and I should be joyful. I should be shouting from the rooftops. But I'm not, and I'm curious to analyse why.

I think the problem comes back to that great big bear rampaging in the background – Microsoft's licensing policy. Yes, Windows 10 is going to be free for a year, and that's a good thing in so far as it will hopefully entice people to get up to date. But fees will kick in after that year. If you're a business user, Microsoft already has you by the short and curlies, and niceties such as "free upgrades for a year" certainly don't apply to you. This whole Internet of Things (IoT) concept is brilliant and hugely empowering, but follow the money. Do you think for one moment that Windows 10 on a Raspberry Pi 2 will be free to business users? Or for any sort of real work? Of course not.

That isn't the Microsoft way: it has to charge someone, and the great justification has always been the business case. It's like business rates in the UK. I really don't understand why I have to pay ten times as much in business rates to Huntingdonshire District Council as for my household rates, but I don't have a choice – they send the bill, I have to pay it. It's just like that with Microsoft's licensing. So I'm becoming quite cautious about IoT, and how it will be implemented and paid for. A little more openness here would be a very good thing. Are they really going to make it free for any user, in any context? No, I can't believe that. And if they're saying that now, will they stick to it?

ABOVE I should be excited about the release of Windows for Raspberry Pi, but I'm not

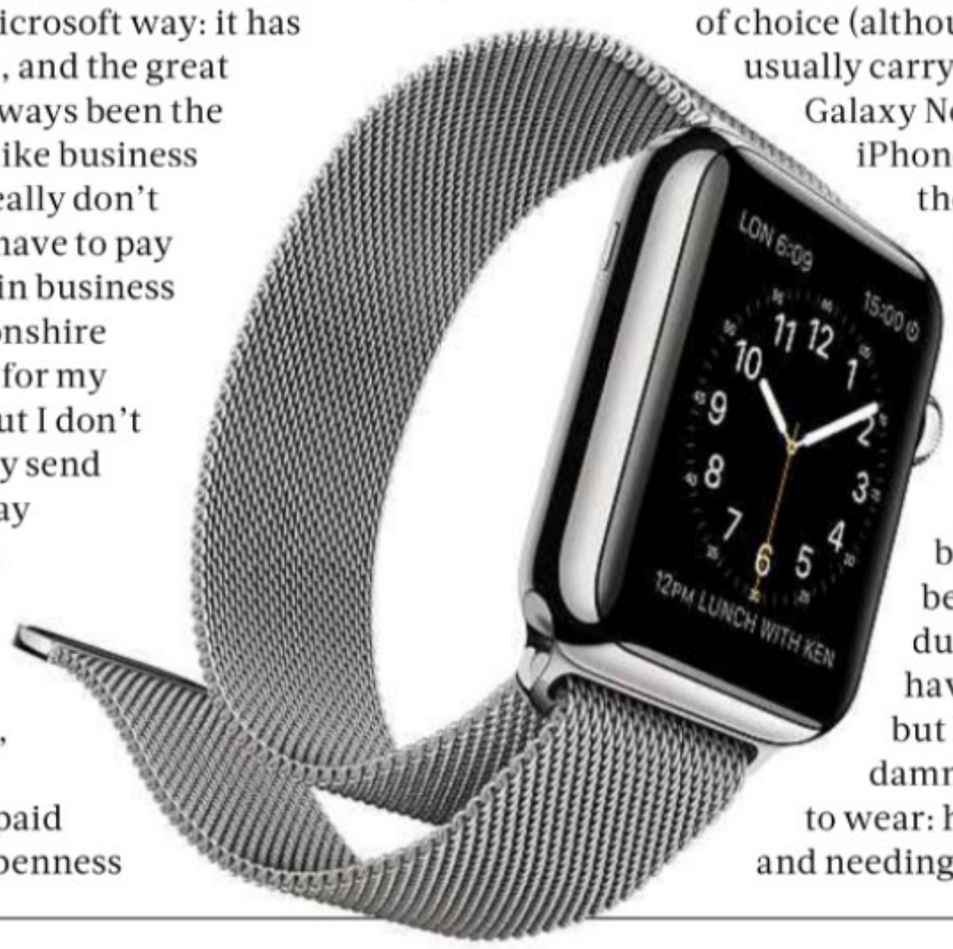
Azure and Cloud

One place where I have only admiration for Microsoft is its implementation of cloud services, specifically Azure. The company is taking well-considered steps there, and growing the business furiously fast. Every time I look the price seems to have come down and the capability gone up. And it's not scared to talk about data storage on a petabyte scale, and of this being applicable even to medium-sized businesses. I can't personally foresee any reason to move back to on-premise servers and Exchange Server. I have fast-enough internet connections now, the reliability of which is excellent. Office 365 has proved a superb solution, despite a few potholes in the road along the way. (Let's not talk about OneNote for Business for Mac, or my blood pressure will rise.) Kudos to the Azure team for continuing to press forward and not being frightened to innovate and compete head-on with the likes of Amazon and Google.

Apple Watch

I can't close this month without a mention of the Apple Watch (*see PC Pro's full review, p68*). I own, and have used, just about every smartwatch. I like the Pebble, as it's cute and answers a core need for notification services on the wrist. It's cross-platform and does what it claims – I could be happy with it as a simple notification system. I didn't get on with Motorola's 360, since it only worked with Android, which isn't my well-worn mobile platform of choice (although I'll confess to usually carrying both the Samsung Galaxy Note 4 and the Apple iPhone 6 Plus with me, with the 6 Plus as my primary device). It just didn't click with me.

BELOW I've used every smartwatch out there, and the Apple Watch is the best



I bought a Microsoft Band when it went on sale in the UK in early April, but that lasted barely a week before being consigned to the dusty shelf. Maybe I have odd-shaped wrists, but I found the thing damnably uncomfortable to wear: hard and inflexible, and needing to have its display

pointing downward to be usable at all – with the display uppermost, everything was pointed in the wrong direction. Notification services were adequate, and it's also cross-platform, but the discomfort made me discard it.

The Apple Watch is different. Within a few days I had almost 40 watch-enabled apps running on it, all doing interesting and useful things (although I'll draw a veil over the Tamagotchi applet). After a week I forgot to put the Watch on one morning, and for the rest of that day I was actively missing it. That's the sign of an interesting and engaging product. I charge it every night, but today is no different from usual: after around ten hours of my work day I still have 76% of battery life left.

It's the applications – the sheer flood of them – that make the Watch different. I'm able to personalise my Watch in a way that's similar to a smartphone, and that's the key differentiator. If you only want basic notifications, then the Pebble is your friend. If you want a whole different thing, the Watch is king. And Apple is following the same cautious path that it took with the early days of iOS. Developers can't write fully standalone Watch apps yet, but that will come once Apple has the confidence that it can police them properly, and that developers have the right tools to ensure a quality user experience. This is a platform that will develop at a very rapid pace, and it's going to be fascinating to, er, watch.

Colour calibration

If you need to colour-calibrate your screens, there's a new (to me) kid in town, and that's SpectraCal CalMAN. I've followed this tool for a while and recognised the strength it has on desktop monitors, TVs and projectors, but I also wanted to be able to measure Android and iOS mobile devices. Now they've released their Android tool, and the iOS one is in final testing. There's truly comprehensive capability here, and it can do just about anything you might want or need. There are free and cheap versions, all the way through to a full lab-spec measurement platform. I've bought the full kit and am very impressed with it so far. Recommendation is mandatory.

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PAUL OCKENDEN

"OnePlus hardware and Cyanogen software made for a fine marriage. Or so it seemed..."

A combination of high-end hardware and popular software made the Chinese OnePlus One a "flagship killer" – but all was not well at home

I've been castigated by a few readers because of my failure to revisit the OnePlus One handset following a promise to do so in my "China phone" column three months ago. There's a reason for my tardiness, however: as I hinted back in issue 247, big things were afoot at OnePlus, and so I should probably rewind the clock to look at a few factors that have got us to where we are today.

The OnePlus One was launched in April last year. Sales were slow, not through a lack of interest but because the manufacturer deliberately held back inventory, selling on an "invite-only" basis. I'll get to the specs in a minute, but crucial to this project was a tie-up with Cyanogen Inc, which provided the CyanogenMod version of Android that runs on the device: the handset even had Cyanogen's logo on the back. The combination of OnePlus hardware with Cyanogen software made for a fine marriage. Or so it seemed, until things started to go wrong shortly after the honeymoon.



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BELOW The OnePlus One used to have the Cyanogen logo on its back cover, but this has been removed in recent shipments

You see, Cyanogen had been "cheating" on its partner (for any lawyers reading, I use that term purely for dramatic impact) and signed a deal with India's Micromax Mobile behind OnePlus' back, giving it exclusive rights to sell Cyanogen-branded products across that huge subcontinent. This was a market that OnePlus was obviously very keen to enter, so it must have been an unpleasant surprise when Micromax took out an injunction halting sales of the OnePlus One in India.

The love-in was over. The companies began trading insults, and now I think it's safe to say they're on their way towards a divorce. The Cyanogen logo has even been removed from the back of recent handsets. In fact, the whole Cyanogen Inc project is itself now mired in controversy.

CyanogenMod started out as an "enthusiast-developed" version of Android that adhered both to the letter and spirit of the open-source ethos, but in 2013 its founder Steve Kondik announced the setting up of Cyanogen Inc with venture-capital funding. The idea was to create an enhanced market for the software – hence those deals with OnePlus, Micromax and more – but many of the people who had contributed to CyanogenMod felt this was a betrayal of the community nature of the project, and were against the apparent commercialisation of their work.

As if that weren't controversial enough, in January this year it was announced that Microsoft had made a huge investment in the company, and in April a far more strategic alliance was trumpeted that included the bundling of Microsoft's apps with future versions of Cyanogen Inc's OS. I can only imagine the expletives uttered by many of the open-source collaborators when they heard about this deal: many of them see Microsoft as everything that's wrong with the world of software.

So where are we now? Well, rather than get stuck with hardware but no

software, OnePlus has created its own version of Android called OxygenOS, which it achieved by hiring the key people behind the highly respected Paranoid Android distribution. It's a fork from Lollipop, with a set of quite light and subtle changes, and it's specifically geared towards the OnePlus One (and also the OnePlus 2, which should arrive later this year).

However, putting OxygenOS onto an existing OnePlus handset isn't exactly a consumer-friendly operation: it involves unlocking the bootloader; then flashing a recovery such as TWRP onto the device; booting into recovery mode; wiping device caches; flashing new firmware; rebooting; recreating things such as email accounts that aren't backed up by Google; and finally reinstalling any applications that weren't downloaded from Google Play. That's an obstacle course at which even the most technically minded user might balk.

This brings me neatly on to option two, because despite their epic falling-out, Cyanogen is still under contract to provide OS updates for the OnePlus One, and that's exactly what it's done with CyanogenMod CM12S. Again, it's a forked version of Lollipop, but with many more bells and whistles this time. It's more customisable than standard Lollipop, features better privacy protection, an enhanced email client, productivity tweaks to its user interface and controls... I could go on, but it's quite a long list. The great advantage of CM12S, however, is that it's available as an over-the-air (OTA) update for existing devices, without any messing around unlocking bootloaders and flashing recoveries. It probably even passes the "could your nan do it?" test.

After having tried both OxygenOS and CM12S, I can say that they're both very good, but I prefer the latter. I've come to rely on some of CyanogenMod's added bells and whistles. In particular, the camera app in CM12S is far better than the one in OxygenOS, and the themes engine is great for people who like to personalise their phones. I'm sure some will prefer the more lightweight OS from OnePlus, but I'm sticking with its one-time partner for the time being.

Flagship killer

That's enough about the software – what about the hardware? When OnePlus One was launched, the company rather arrogantly billed it as its "flagship killer", pitching it against the best that the likes of Samsung, HTC and Sony had to offer. On paper this comparison kind of works, since the specification is very good and its price is exceptional. It costs £270 for a 64GB phone, which was stunning value at the time and is still reasonable today. A year down the line, the device struggles to maintain "flagship killer" status, if only because new flagships have arrived, but it's still capable of mixing with the big boys. I'd say it's a good equivalent to the Samsung Galaxy S5 or the HTC One M8.

One area in which it shines is build quality: its mock-sandstone back cover and solid construction make it feel as if you have a premium device in your hand. It's hard to quantify or put into words, but it just feels like quality kit. Even the packaging has a premium feel, and the USB cable isn't the usual cheap tat. Battery life is great too.

One possible weakness is that, although the phone is 4G-capable, it doesn't support LTE band 20 (800MHz). What this means here in the UK is that you can't get 4G on the O2 network, since that's based exclusively on band 20. You'll also receive only partial coverage on Vodafone, which uses band 20 for its core network, but offers 7 (2,600MHz) in some built-up areas. You'll be fine on Three and EE, since neither use 20 for their core network: Three employs band 3 (1,800MHz) and EE uses both band 3 and 7. Does this matter? Maybe not, depending where you live. When 4G was first launched in the UK it was blazingly fast, but for many it's now probably only on a par with what you'll get using the faster variants of 3G such as DC-HSPA+.

You no longer need an invite to buy the OnePlus One; you can order it directly from the website, and it usually ships quickly. When the OnePlus 2 launches later this year, I expect the invite-only system to be reinstated, partly because it helps manage production, but also because it imbues the phone with, if not cachet, at least hype. OnePlus One invites were selling on eBay for up to £50, which is ridiculous given the price of the phone. If you currently have a bit less than £300 to splash on a phone, and if you're a user of EE or Three, you can't really go wrong with a 64GB OnePlus One (I'd ignore the cheaper 16GB model; there's really no point).

"It's hard to quantify or put into words, but the OnePlus One just feels like quality kit"



BELOW Even the OnePlus' data cable has a premium feel

Increase your megapixels

Let's stick with the OnePlus One for a bit longer and look at its onboard cameras – in particular, the rear-facing one that, although not spectacular, is capable of taking some extremely good photos. It sports a 13-megapixel sensor, which isn't up there with this year's flagship phones, but will be ample if you're not doing severe crops. It wasn't so long ago that camera reviews were telling us no-one needed more than four megapixels!

More important than megapixel count is the sensor and lens quality: the OnePlus One has a Sony Exmor IMX214 sensor, while its six-element lens features a class-leading f/2 maximum aperture, meaning it's great at taking photos in low light. The only thing missing is optical image stabilisation (OIS), but on many phones that can be more of a marketing gimmick than a useful facility. If your current phone has OIS, compare the images taken with it on and off – there probably isn't much difference. Its effect might be more noticeable if you shoot video, but it's relatively easy to add stabilisation in post-processing: you'll find a number of tools that make a good job of this, some of them even for free.

If you're running OxygenOS, Google Camera is the default camera app. It's perfectly competent, but the Cyanogen app you get with CM12S is far more flexible, offering better creative control and ultimately delivering better-quality pictures. (You can load Google Camera onto a CyanogenMod phone if you'd like to test the difference.) Google Camera does offers a couple of options missing from the Cyanogen app, though, one of which is the Lens Blur mode. While the name suggests movement, what it actually does is help to isolate the primary subject of your photo and blur out everything else (and it's very

good at it). The other feature is Photo Sphere, which is more appropriately named since it enables you to create 360-degree images. You can even contribute these to the Street View facility of Google Maps – to show the inside of your business premises, for example. If you're not interested in either of those options, however, then the Cyanogen app wins hands down.

But what if I told you there was another app that could increase the resolution of your camera to 50 megapixels? You'd probably laugh at me and quote the laws of physics, lecturing me on how it's impossible to create more detail than is captured, and that the only way to get 50 megapixels from a 13-megapixel sensor is by interpolation, which is usually a very bad thing. Except that this time it's true. Chinese manufacturer OPPO has its own Android variant called ColorOS. This includes some interface tweaks and its own set of apps, one of which is a particularly clever camera app. OPPO phones aren't as well supported as OnePlus units here in the UK, but some enterprising developers have ported this camera app to the OnePlus One. The key is that the OnePlus One and OPPO's own Find 7 phone both use the same Sony image sensor.

The ColorOS camera app cleverly squeezes 50 megapixels from the 13-megapixel sensor without interpolation. Although this may sound like magic, it's actually quite simple: the app takes a series of ten images in quick succession, so you don't really notice much of a delay. It then selects the best four of these shots and stitches them together to create a huge 8,160 x 6,120 composite. It selects the four shots by looking for tiny movements – with the best will in the world, it's impossible to hold the phone perfectly still while it takes the consecutive shots – then analysing this movement and selecting three shots in which it can see the data that falls "between" the pixels of the first one. In effect, it exploits camera shake to scan the scene. This is such a simple trick that I'm astonished it isn't more common on other phones, or even in grown-up cameras.

If you want to install the ColorOS camera app on your OnePlus One, there are plenty of guides available online, including videos on YouTube,



but the first post in the thread at **pcpro.link/250coloros** probably explains it best. Essentially you download the app itself, then download and install the app's plugins, and finally install the HD picture plugin from within the app. You do this by firing up the camera app, tapping "Add Apps" and selecting "HD Picture", which you'll see following some Chinese writing. To use it, again open the Plugins folder by swiping up from the bottom of the screen, then tap HD Picture – and that's it. You'll experience a small delay when you take each photo as the app takes its rapid sequence of shots and merges the best four, but I'm sure you'll be impressed with the results.

Oh Oh!

Finally a tip that might help you in a situation where you're given a code to type into a website, but the site refuses to accept it. In my case it happened when my local BT green cabinet was upgraded to FTTC; at the time I was upgrading, I also decided to switch provider. My old ISP provided a MAC key (used to migrate broadband from one provider to another, a bit like the PAC you get when you change mobile phone providers), but the new company rejected it, saying the code was invalid. I checked back with the old provider, which confirmed the code was correct, then the new one checked again and insisted it wasn't. I was in a horrible stalemate situation.

After plenty of head-scratching, I realised that the last part of the code should be NE21O, as opposed to NE210. See the difference? It's probably quite obvious in the font used for this column, but to the person from the old ISP who originally read me my MAC key it wasn't, and neither was it to me when I read the letter I received a few days later. That last character looked like a zero rather than capital O to both of us, especially when following two digits: the human brain just wants to parse the code as xxnnn rather than xxnnx. Once I'd spotted this problem I amended the order and everything went through just fine, but I think there are lessons for several different groups here.

ABOVE A very clever Chinese app can increase your phone's camera resolution to 50 megapixels – no, really

"This is such a simple trick that I'm astonished it isn't more common on other phones"

First, a lesson for people designing systems that use codes such as this one: avoid easily confused characters in your codes. Zero and upper case "O" obviously, but one "1" and lower-case "l" can also be confused, and if these codes are being printed onto packaging using a dot-matrix printer (as you'll often find with promotions on groceries) you should also avoid "B" and "8" since these can look similar, as can "2" and "Z".

The second lesson is for the programmers who write the code behind the web forms that accept these codes: if you know the format of a code should be xxnnx then validate it as such, so that if a user makes a mistake, you can supply a meaningful error message explaining the expected format and which character of the code is wrong. You might even hint to check those easily confused characters mentioned above.

Finally, the lesson for us poor users of these systems: if the system designer has been too inept to anticipate such problems, and the website programmer too lazy to properly validate your input, then be aware of the potential gotchas that these confused characters can cause. Having said that, even old hands at this stuff sometimes get caught out. Mumble, grumble...

@PaulOckenden

EILEEN BROWN

"I couldn't get to the site to find out what files had been modified. I started to panic"

Think you're immune to website hacks because you have some technical knowledge? As this tale of WordPress woe demonstrates, no-one is safe...

I discovered that my site had an issue. Running a workshop for a group of small businesses and entrepreneurs, I was showing attendees how to get images to the top of Google and Bing. Correctly formatting the image, using descriptive titles, and adding well-formed Alt tags will help pages climb in search results – something that many web designers forget to do when adding images to a client's site.

Part of my demonstration includes carrying out a search for an image with the term "Amastra kitten", "Clyde kitten" or "Eileen Brown kitten". This usually brings up an image of my ginger kitten Clyde to the top of Bing and Google. Then the shock: in the search results, Google had marked that my site, Amastra.com, "may be hacked". This isn't what you want to see when you're standing in front of a group of strangers, offering them tips and hints about websites.

Having finished the session – luckily, minus any further mishaps – I visited my homepage and was relieved to see that there was no obvious issue with the site. That is, until I tried to log in. I checked Google Webmaster Tools and could see a couple of anomalies. In early February, there had been a spike in activity, with visits to my site having significantly increased. This seemed odd, as I'd been too busy with work to log in to the WordPress dashboard at the start of the month.

Looking at the Google Webmaster Search Queries tab, I noticed that a number of queries, completely unrelated to what I usually blog about, had appeared in the results. "Naked mum tumblr", "hermes belt", "louis vutton duffle bag replica uk" – something was most definitely up.



Eileen Brown is an author and social media advisor who helps businesses build their brands and create thriving communities. Join her on tsu.co/eileenb

@eileenb

"Failing to upgrade my site to the latest version of WordPress was a grave error"

Upon trying to log in to the WordPress admin page I was redirected to another page on the site. Requesting a new password wouldn't work, so I couldn't get to the site to find out what files had been modified. I started to panic. Without access to the admin console, I was stuck.

I logged in to my website through my hosting provider and had a look through the file structure. Sure enough, there were a couple of files that had been modified around the time that my site views began to rise. These included a few that looked like Google Analytics HTML files. Plus, according to the date on the site, the web config folder had changed recently.

A little more investigation suggested there was a problem with the WEB.CONFIG file placed on the root of the site. This may have been my hosting provider placing it there to account for any change in its server configuration. I wasn't aware of any recent changes. In order to get the website to give me admin access, this file needed to be disabled.

Disabling the WEB.CONFIG file meant that normal access to the site appeared to work again, except for the text permalinks of each page. These had to remain as WordPress default links until the file was changed.

Further investigation showed that the issue had probably occurred as a result of spam robots accessing the database through comments on posts. I hadn't set an age limit on comments and, through a lack of confidence with WordPress, I hadn't upgraded to the latest version of the software when prompted. My inertia had led to my site experiencing a URL injection attack.

Under attack

URL injection attacks contain URLs that appear off the root of the site and are posted with the intention of spamming search results. Search queries for terms such as "cheap Christian Louboutin shoes" meant that the URL, hidden away on my site, had added domain relevance and therefore importance to these spam sites. This was depressing – the first website hack I'd ever experienced.

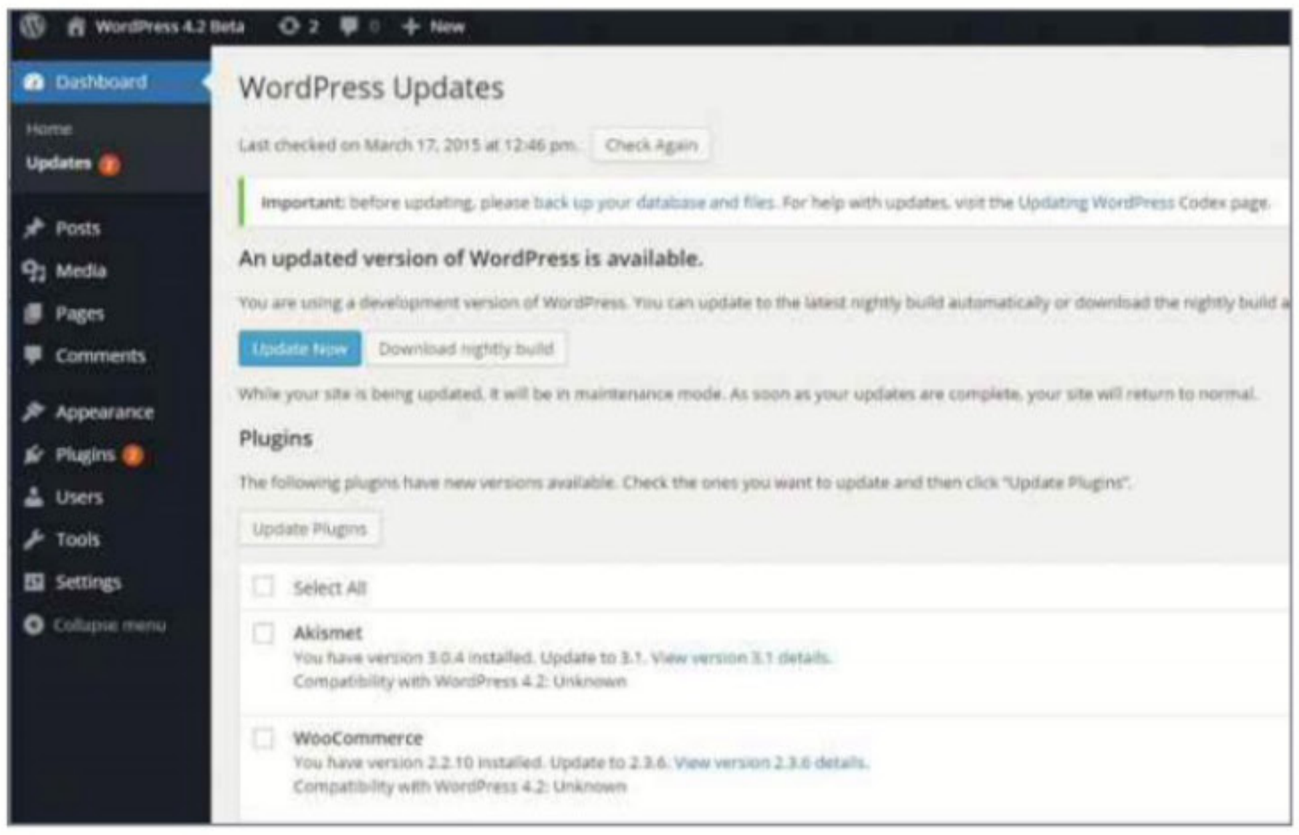
According to BuiltWith, more than 48% of sites across the web run WordPress – which amounts to more than 15 million self-hosted sites. Its popularity makes it a prime target for attackers, which is worrying for business owners such as myself, who don't have enough PHP or WordPress knowledge to quickly fix something that has gone awry. Only two million of these sites are running WordPress version 4.2 – the latest release – leaving the rest vulnerable to anything a hacker cares to send their way.

In hindsight, failing to upgrade my site to the latest version of WordPress was a grave error. Missing this upgrade had potentially given any hacker time to run a script



ABOVE RIGHT This is exactly what you don't want to see when in the middle of a demonstration

RIGHT That sudden leap in traffic could only be due to one thing: an attack



LEFT A failure to update the software had resulted in Amastra.com becoming a prime target for hackers

BELOW At last, the all-clear, but not before a lot of stress and wasted hours

across sites that hadn't been updated. Even if I had upgraded within a day or so of the 4.2 release becoming available, it might still have been too late to do anything. Zero-day exploits are becoming more and more common.

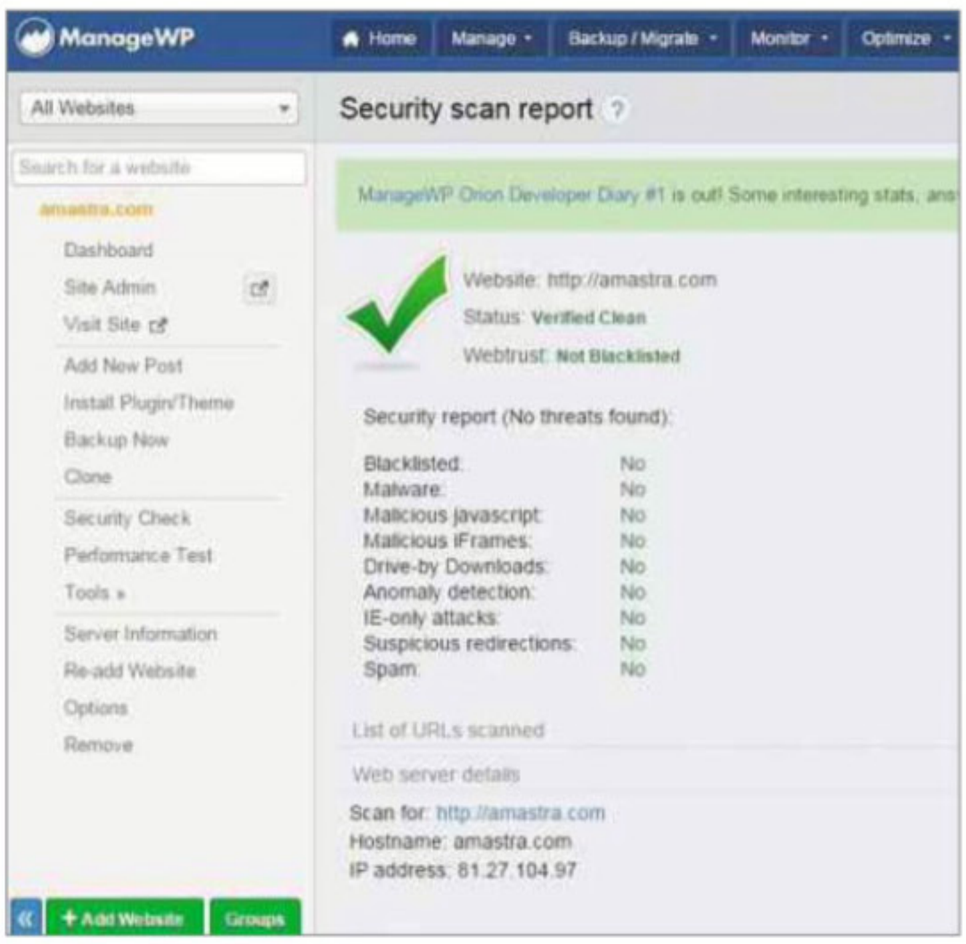
Fixing the site didn't seem straightforward, so I enlisted the help of my website designer. The whole website needed to be cleaned up, since there seemed to be some odd files in one of the root WordPress folders. We installed a scanning plugin, Wordfence, to try to get to the bottom of the issue.

Security plugins such as Wordfence and BulletProof are useful to protect your site against threats. They start by checking if the site is already infected by running a deep server-side scan of the source code, including core files, themes and plugins. Wordfence then goes on to compare each file to the official WordPress.org repository and checks each version. Then it secures the site, provides protection against known vulnerabilities such as Heartbleed, and caches files to improve its performance.

If you have administrative rights to the site, you can view the progress of the scan by logging in to the WordPress Dashboard and looking at the Wordfence tab. My ManageWP console shows that all is now clear.

After running the scan for a week, the plugin brought up only one recommendation to follow. It looks like we'd have to do a full database restore and update all of the content since the go-live date – just to make certain. How frustrating.

My delay in updating the WordPress site, not making sure that my Akismet plugin was up to date, and various other errors have cost me dearly. Not only have I wasted hours trying to chase down the issue, I have wasted my web designer's time. I've lost credibility with my clients, who have questioned what's wrong with my site; I can't embroider the truth. I have held my hands up and learned a salutary lesson from my reluctance to carry out any modifications to software I didn't know well.



On the bright side – and this is the only bright side I can find – it does mean I can talk about website hacking with first-hand experience, and help ensure my clients don't make the same mistakes.

Lessons learned

The first lesson to learn is never to be complacent. I've been using WordPress.com to blog for more than a decade and felt confident in it. I used to post using an old copy of Windows Live Writer and didn't have to worry about spammy comments or SQL injection attempts. I managed my old website using Expression Web and knew enough basic HTML code to be able to update the site occasionally.

It was simple, but I was also aware that many small businesses used self-hosted WordPress. The benefits are clear: ad revenue and detailed analytics go directly to the business site instead of to another platform such as WordPress.com. Fear of the unknown and a lack of PHP knowledge had kept me away from self-hosted WordPress. But, after six years as a consultant I took the plunge. Four months later, my site was hacked.

What could I have done better? I could have installed a few plugins on to my site to prevent this from happening in the first place. I should have installed the UpdraftPlus plugin for WordPress as soon as my site went live. This would have taken snapshots of my WordPress site before I had made each change and uploaded them to a cloud service such as Amazon Web Services, Dropbox or Google. I could have scheduled backups to run daily, which would have allowed me to roll back the site to the day before the hack occurred.

The 404 notifier plugin should also have been installed. This would have enabled me to see which pages had been moved on the site, and alerted me to which pages no longer consisted of "pretty" URLs but were filled with URLs that looked like "?p=148" type links instead.

I should have monitored Google Webmaster Tools every week, instead of on an ad hoc basis. This would have shown me within a few days that my site visits had jumped significantly, and allowed me to remedy the situation before Google flagged my site as being hacked.



ABOVE Here's what people should have seen when they typed "Amastra kitten"

Most important of all, I should have updated the WordPress core files as soon as I was able to. I'm really efficient at patching all of my other PCs and updating my tablets and mobile devices. Why did I let this one slip? Years of using WordPress.com has made me complacent. I had trusted my site built on Expression Web a bit too much.

And that's the real lesson: complacency. I wasted ten days of effort and stress on software I didn't understand well enough to be comfortable using, but rather than put protection in place, I allowed it to slip to the back of my mind and hoped everything would be fine. That's one mistake I won't repeat.

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DAVEY WINDER

"Can you rely upon TrueCrypt to do what it says, which is to protect the stuff you encrypt from prying eyes?"

With developer support for the encryption tool abandoned, would businesses be wise to still entrust their security to TrueCrypt?

There's no shortage of encryption technology out there, and this has been true since Phil Zimmermann first created Pretty Good Privacy (PGP) and released its source code into the public domain in 1991. PGP was the first public-key crypto program to gain worldwide popularity, but by 2004 TrueCrypt had taken over as the encryption solution for many individuals and business users.

The open-source nature of its code; the full-disk encryption on offer for free; the huge community of users; its "volume within a volume" plausible-deniability option; the fact that it's tried, tested and, above all, reliable and secure mean that for ten years it's ruled the roost. Despite the last release being version 7.1a in 2012, it looked as though TrueCrypt might remain as popular for the next ten years. Until 2014, that is, when its developers shocked the security community with the following announcement on their homepage:

"WARNING: using TrueCrypt is not secure as it may contain unfixed security issues. This page exists only to help migrate existing data encrypted by TrueCrypt. The development of TrueCrypt was ended in 5/2014 after Microsoft terminated support of Windows XP. Windows 8/7/Vista and later offer integrated support for encrypted disks and virtual disk images. Such integrated support is also available on other platforms... You should migrate any data encrypted by TrueCrypt to encrypted disks or virtual disk images supported on your platform."

No other reason was offered as to why support for TrueCrypt was being abandoned, or how it came to contain unfixed security issues. Not everyone trusts the full-disk encryption built into vendors' OSes, probably even less so since the Edward Snowden revelations shone a torch into the murkier corners of state snooping and corporate co-operation. Indeed, one of the longer-running conspiracy theories surrounding the "death" of TrueCrypt has been that the security agencies had requested a backdoor be built into the software, but its developers refused and preferred to pull the plug (silently, it's suggested, because a gagging order prevented public disclosure for national security reasons). Perhaps – it is what it is, and that is dead so far as ongoing support is concerned. But does that really mean it's now unsafe to use?



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@happygeek

"It's wrong to assume that just because developer support for a well-regarded product comes to an end, it becomes untrustworthy"

Is TrueCrypt safe?

I'm a fan of security expert Steve Gibson, who back in the day coded some useful security test utilities such as LeakTest (for firewall security leaks) and "UnPlug n' Pray" (to disable the insecure Windows XP UPnP feature). Although Steve has been quieter recently, I'm inclined to agree with him that it's wrong to assume that just because developer support for a once well-regarded product comes to an end, it immediately becomes untrustworthy. If TrueCrypt 7.1a was trusted for two years prior to that announcement, why not after? It probably depends from where you're approaching this: businesses will be risking their arm by using a security product that not only doesn't offer support, but actually comes with a warning not to use it; for consumers it's less clear-cut, although if you can't afford a BitLocker-compliant version of Windows then your choice may be somewhat forced. It all comes down to assurance in the security model: can you rely upon this product to do what it says, which is to protect all that you encrypt from prying eyes?

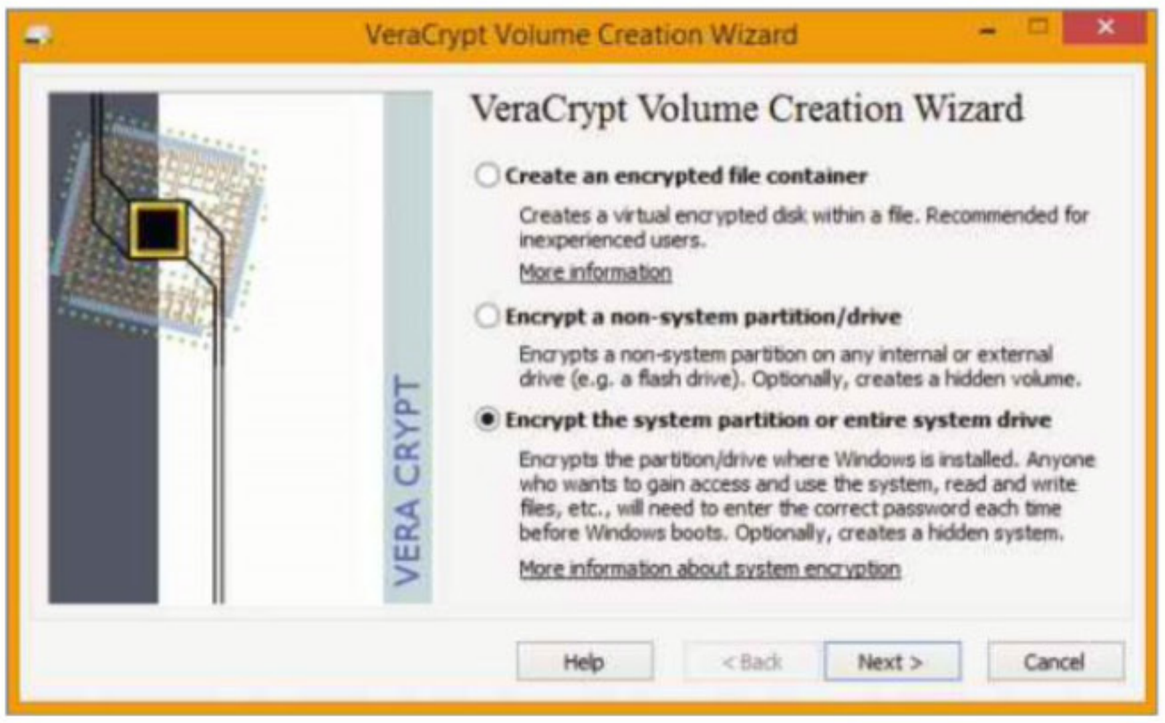
Assurance (or otherwise) for TrueCrypt users comes via an independent security audit that was recently completed. The full "phase II" audit report can be found at **pcpro.link/250report**, but I can sum up its conclusions as pretty much a "pass".

The auditors, NCC Cryptography Services, concluded that TrueCrypt is a "relatively well-designed" piece of software that contains no evidence of design flaws severe enough to make it inherently insecure, including any backdoors. However, a few concerns were raised: most importantly, in relation to the random number generator (RNG) in the Windows version, which makes the keys for encrypting TrueCrypt volumes.

This RNG was based upon a well-known legacy design from Peter Gutmann (whom regular *PC Pro* readers will have heard me praise for his secure data-erasure algorithm), but TrueCrypt can, in a certain set of circumstances, generate keys with it even when the CryptoAPI has failed. The chances of this causing a breach in the real world are slim, but slim chances can still punch a hole in your security posture. Without ongoing support, such design flaws can't be corrected once discovered. The auditors also identified risk related to "cache timing attack" resilience, which could potentially be used in a shared-machine environment, such as the cloud, to facilitate side-channel attacks. Once again, something you'd expect to see fixed by a point upgrade once discovered.

So does this answer the question over whether it's safe to continue using TrueCrypt? Although the audit revealed no huge vulnerabilities, it points to items that really need fixing – and this leads me to suggest that TrueCrypt isn't safe enough.

There are some obvious alternatives, the first of which for enterprise users



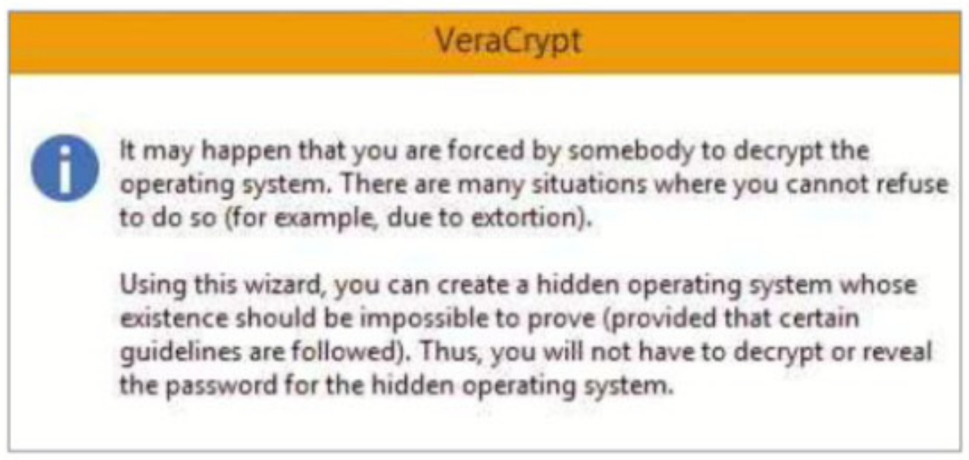
BELOW VeraCrypt is as easy to use as TrueCrypt was, but more secure. Win win!

is BitLocker; less obvious are those based on the open-source TrueCrypt code itself. The beauty of open-source software is that its code can be forked when necessary and a new project kicked off from the existing codebase. Such projects offer the advantages of the original product, while maintaining developer support and fixing any disclosed vulnerabilities. Were I in the market for a TrueCrypt-like solution then I'd be looking in the direction of one particular fork, which is called VeraCrypt.

Sticking a fork into VeraCrypt

While those flaws pointed out in the TrueCrypt audit are fresh in our minds, let's consider how VeraCrypt measures up for security assurance. There's no point jumping from one sinking ship to another, if both are built from the same blueprints and merely have a different captain.

It's true that VeraCrypt hasn't faced the same thorough and very public auditing process as TrueCrypt, and it could therefore contain new flaws of which we're not yet aware, but that's true of any software. So far, however, VeraCrypt has stood up to the considerable scrutiny it's received. Its developers have made it clear that they will not only provide ongoing support, but will also fix all the flaws found in the TrueCrypt audit. Indeed, as I write, the latest update (released 5 April 2015) has fixed one of the reported vulnerabilities, CryptAcquireContext, which is related to the random number generator and thought by most security experts to be the most severe. It's expected that the cache-timing attacks will be fixed too (although the fact remains that neither TrueCrypt nor VeraCrypt is intended for use in multi-user, shared-server environments anyway).



Other good news on the security-assurance front is that, since it launched in 2013, VeraCrypt has sought to address issues discovered by the lead project contributor who audited the TrueCrypt code back in 2012. French IT consultant Mounir Idrassi admits that there were no big surprises, but he felt some small things should change, leading to the birth of the VeraCrypt fork. The main perceived weakness related to the way it transformed passwords to derive keys, which was too simplistic for these days of cloud-powered key-cracking techniques.

Idrassi took a sledgehammer to crack this nut by upping the number of iterations from 1,000 for standard containers and 2,000 for non-system partitions to more than 300,000 and 600,000 iterations respectively. Simply put, this makes it between ten and 300 times more difficult to crack using brute force.

On the downside, it has some impact on the speed of opening an encrypted container, but not so much that you'd notice (and certainly not enough to make you wish your data was less secure). For the record, the latest release has seen volume-mounting times on a 64-bit OS reduced by around 20%.

The other downside was that VeraCrypt used a storage format incompatible with TrueCrypt, making migration less straightforward. That's the price you pay for improved security, however.

Anyway, because VeraCrypt is being supported, its developers tend to listen to user concerns, so from version 1 VeraCrypt enables the conversion of TrueCrypt containers and non-system partitions into VeraCrypt format using "Change Volume Password" or "Set Header Key Derivation Algorithm" actions. You can download VeraCrypt at **veracrypt.codeplex.com**.

Certificated madness makes my heart bleed

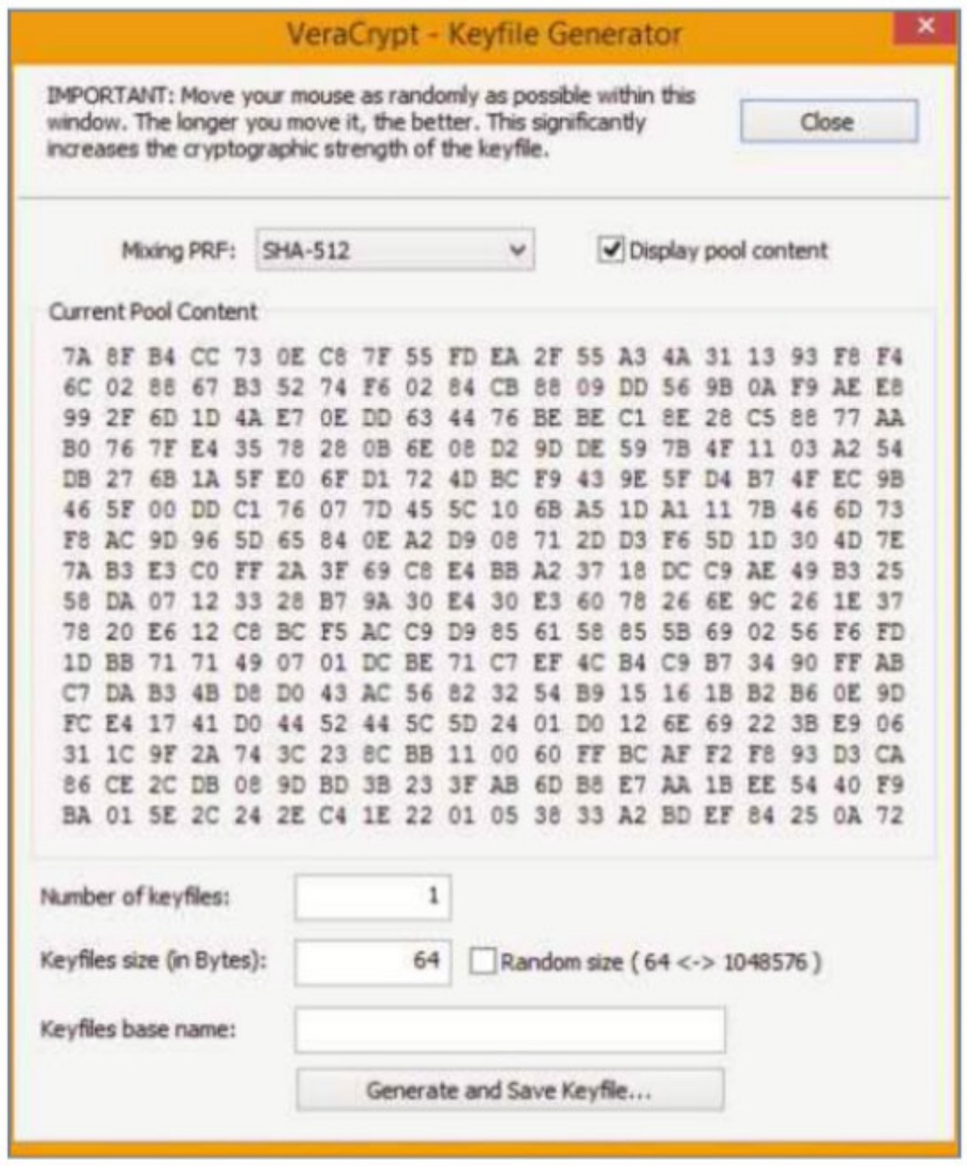
Talking of security assurance and encryption, it's the reason we use secure protocols to connect clients to servers: assurance to both parties that the communication won't be intercepted or otherwise interfered with. Or that's the idea. Secure Sockets Layer (SSL) and Transport Layer Security (TLS), which has now replaced it, serve the same purpose: namely to encrypt and authenticate data travelling across a network between application and server that would otherwise be insecure. TLS – sometimes referred to as SSL 3.1 – is far more secure than SSL, but only if you're using the latest version.

You should also be using security certificates with strong keys, extended validation and so on, all of which combine to strengthen your security but are often overlooked by people who really should know better. Did it surprise me then that, as I write this column, Instagram had just been caught forgetting to renew an expired certificate, with users receiving warnings about unencrypted, non-private connections?

Not really, no more so than Gmail going down over Easter for some users due to another expired certificate. Without that certificate to authenticate smtp.gmail.com, many browsers refused to send any emails, which is of course exactly what they should have done if they couldn't validate the identity of Google's servers.

I mention certificates because they're at the heart of a problem slightly bigger than missed expiry and renewal dates, a problem you probably believed had gone away some time ago: Heartbleed.

It's more than a year since Heartbleed was disclosed to a rather stunned public, a vulnerability at the heart of the OpenSSL crypto library



ABOVE Old tricks to generate keyfiles remain, mouse shakers will be pleased to hear

LEFT Plausible deniability for OS or volume is built in

"There's no point jumping from one sinking ship to another, if both are built from the same blueprints and merely have a different captain"

Continued from previous page

that resulted in data encrypted by SSL/TLS not being protected at all from attackers. The vulnerability itself had been present for years, since the first vulnerable version of OpenSSL (v1.0.1) was released in March 2012. Luckily, the media attention and the immediate release of a fix soon sorted things out. Or at least, it should have done...

Recent research among the Forbes Global 2000 – some of the most powerful corporations on the planet – reveals that around 74% of public-facing servers are still vulnerable to Heartbleed. The reason for this is that, while the patches have been applied, the security certificates haven't been renewed alongside; both steps are required to eliminate the vulnerability.

In the UK, 67% of Forbes Global firms are also still vulnerable. All an attacker has to do is steal the certificate key and they can read every last byte of encrypted data. Until these certificates are replaced, these organisations remain at risk of man-in-the-middle attacks. It appears that these mega-corps, for all their resources, are failing to take this simple action because they believe that the risk has been mitigated via the application of the patch.

The longer systems remain unpatched and certificates aren't replaced, the greater the risk of someone exploiting the vulnerability. C'mon folks, patch your systems, replace private keys and revoke the old certificates – it's the only way to ensure you're safe.

And finally...

Social media firms are having a hard time of it financially at the time of writing: poor profit figures saw the share prices of both LinkedIn and Twitter tumble. This doesn't worry me personally, since I'm far more concerned about which of the big four social networks is best for the small business. Next month I'll be comparing LinkedIn with Facebook, Google+ and Twitter on that basis. In the meantime, if you have a preference for small-business use, drop me an email explaining which you prefer and why.

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STEVE CASSIDY

"I was concerned by the limited knowledge both victims displayed of the simplest defensive measures"

Two tales of woe – one in Hackney, one in Spain – highlight the importance of always having a plan B in place

Say hello to Donny and Marie, two of my friends whose real names I shall be keeping to myself. I know you all love other people's disaster stories – and these ones are rather outside my normal brief – but both their dilemmas posed a serious question about networks, so I'm going to tell them anyway. Donny and Marie were both laptop users of the typical modern kind, lone entrepreneurs linked in to a web of friends and business affiliations mainly by email and partly via social-networking apps. One of them is remarkably well off, while the other is just about making it; one has an ancient Sony VAIO, while the other has a shiny, recent-ish MacBook Pro.

However, the possession is the opposite of what you might expect: it's penniless Marie who spent £1,800 on the MacBook, and rich Donny whose technical background helped him appreciate the shabby-chic appeal of making presentations to multimillionaire investors using a creaking plastic fossil PC. But Donny woke up one morning to discover that his trusty VAIO no longer wanted to boot, while Marie couldn't figure out what her machine was doing. All she could tell me was that its power light was on but there was nothing on the screen. Of course, both had an important meeting just the next day,



Steve is a consultant who specialises in networks, cloud, HR and upsetting the corporate apple cart

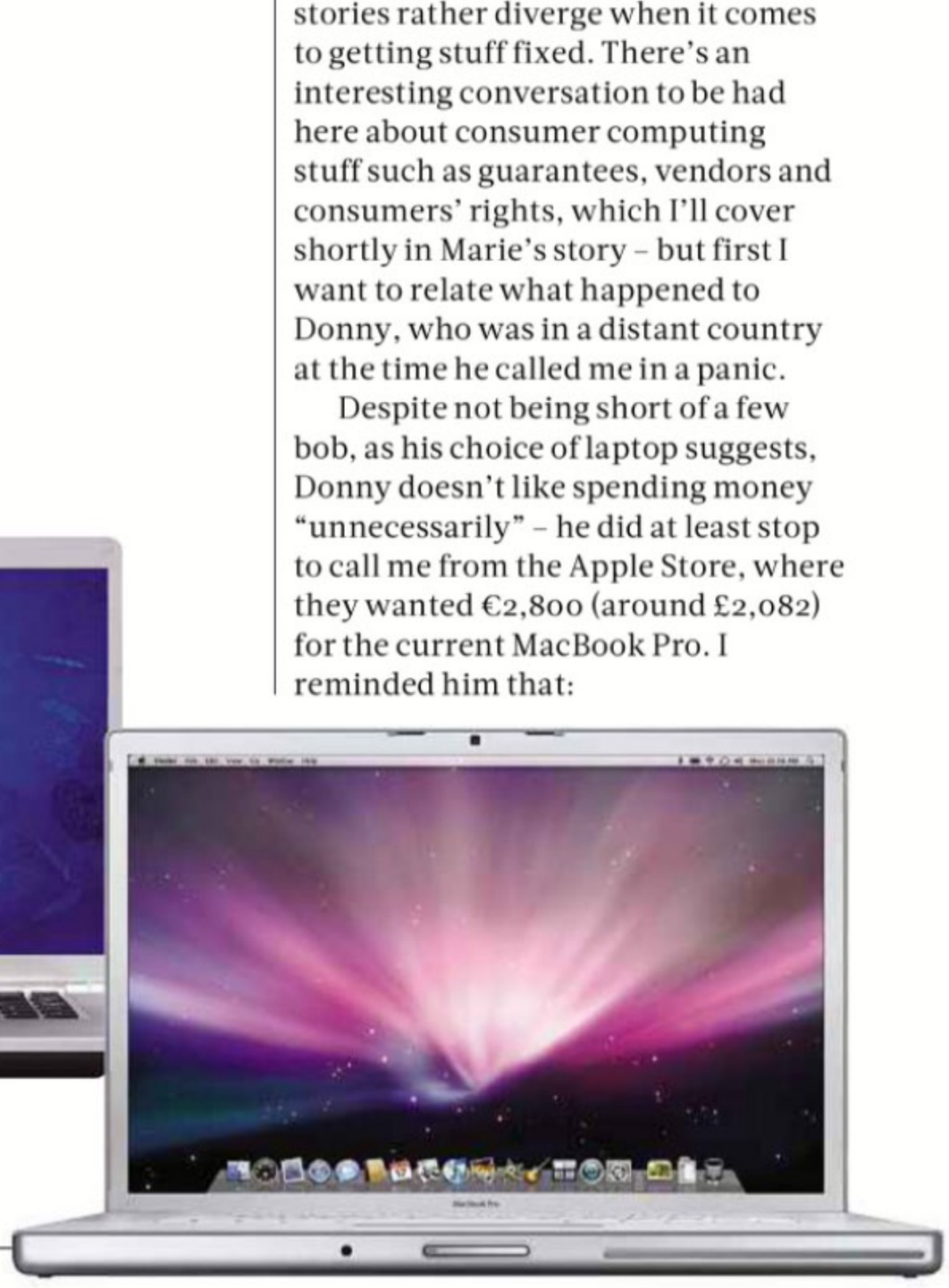
@stardotpro

and both felt that explaining the run-up to said meeting, its impact on their careers, the number of people involved, and the financial implications of not making it, would have an effect on my verdict concerning the state of their laptop.

On my side, I kind of knew the answers before I even asked the question. No, neither of them had an up-to-date backup. Yes, both had cloud accounts but had fallen out of the habit of using them. At the same time, both had been listening to the more extreme opinions about cloud reliability, which meant they'd both – spookily enough – chosen to remain at arm's length from all the automated replicators and instant uploaders of the consumer cloud software portfolio. Of course, because Donny's on a PC while Marie is staring at a black-screened MacBook, their stories rather diverge when it comes to getting stuff fixed. There's an interesting conversation to be had here about consumer computing stuff such as guarantees, vendors and consumers' rights, which I'll cover shortly in Marie's story – but first I want to relate what happened to Donny, who was in a distant country at the time he called me in a panic.

Despite not being short of a few bob, as his choice of laptop suggests, Donny doesn't like spending money "unnecessarily" – he did at least stop to call me from the Apple Store, where they wanted €2,800 (around £2,082) for the current MacBook Pro. I reminded him that:





ABOVE Proper backup measures should be in place whether you have an old Sony VAIO (*above*) or shiny new MacBook Pro (*right*)

a) I had someone on hold on the other line with the same type of crisis on her MacBook, and that therefore this solution didn't automatically lead to the Promised Land.

b) That whatever backups he might have had, restoring them to a MacBook would involve some potentially irresolvable issues over converting files.

c) Did he have any idea just how much new kit I could cram into his home office given that amount as my budget?

I hadn't completely figured it out at that moment, but by the time he was home – and I could talk to him via Skype rather than a costly international call – I had a rough idea: he could get two identical, sensible, business-grade Windows laptops; a fanless and silent managed Gigabit Ethernet switch; and a twin-drive, mirrored NAS box to at least initially provide image backups and sync. Oh, and I could fly out there with said kit, hire a Fiat 500, stay in a hotel overnight and teach him how to use it, then have a day off...

In making this suggestion I was being only mildly facetious, but that's because I had two hand-holding jobs going on at the same time and temporarily forgot that Donny is a techie. We then tiptoed cautiously around the perimeter of a hissy fit. He was annoyed with himself, and suspicious of me for not having realised how far he'd progressed from being "just me and my laptop" to being at risk of dropping an important business deal. Just what was keeping him from working out his next set of moves rationally – namely, to remove himself from this single-machine, dangerous arena and to enter the smooth, slick world of fully backed-up, multiple-access cloud computing?

Mostly it was the deluge of information – a gross excess of it, dating back to all that hardcore, domain-centric, multi-access, hot-desk stuff that still forms the main philosophy of big-business computing – amplified by the din from the new leading edge, a thousand loudly shouted promises of hot new apps. What Donny needed was to restrict his options, to pick a NAS vendor and dive into the reality of making it work for him. Slow down a bit, do some image backups and restore cycles (a spare £50 hard disk in the laptop is vital for this part, but well worth it even if it does no other job for the next ten years). Eventually we found a folder-duplicator app he was happy with, working across USB keys, the NAS box and his laptops without having to drag all the files through flaky, overpopulated Spanish DSL lines to the safety of the cloud. I didn't get a trip to the sun because Donny's need was too urgent. He followed my prescription, though, and I didn't let him know my own backup/restore machine image test wasn't running on a new €700 (around £520) Lenovo but on a Dell Vostro 1520 (whose "Celeron" badge isn't a fair description of its performance) that cost me all of £25 on eBay.

You're all thinking now that surely Marie, penniless in Hackney, must have had an easier ride thanks to her extra spend on a spiffy Apple laptop, yes? But what held her back was that rather than fill her head with terrible techie stuff, she'd put all her faith in Apple: because Macs are easy to use when all is well, she thought they must also be easy to recover when things go wrong. And when I talk about "terrible techie stuff", here's the extent of the problem. I'd advised her to get both a display adapter and a FireWire cable to dig herself out of her disaster, and we then spent quite a lot of time on Skype (without video, but nevertheless able to transmit a wide spectrum of panicky emotions) because one of these cables wouldn't fit any of the holes with those tiny, highly designed icons beside them. She therefore concluded that the advice I'd given was probably untrustworthy and would just make things worse. After much pleading, threatening, cajoling, promising and reassuring, we finally figured out that the Amazon seller she'd bought the FireWire 800 lead from had decided to send her a USB lead instead, on the grounds that it was probably what she really needed anyhow.

This FireWire lead was actually for phase two of her recovery process: she had to keep working, which meant getting a Mac mini so she could let go of the laptop for the period required to fix it. She'd borrowed a standalone screen – although once I saw her living room, I pointed out she could have plugged the mini straight into her flatscreen TV via HDMI – and then verified that it was only the MacBook's display that had died by plugging in the little video adapter tail. Once we knew her laptop was still alive, we ran rapidly through the Migration Assistant, which will move everything from one Mac to another over FireWire, Wi-Fi or a wired LAN. It moves your applications as well as data, even between different versions, by doing the required file conversions as it goes. It's a software tour de force, but not without a few minor niggles that mar its Hawking-like smarts. When I tried it, it lost Aperture (Apple's Photoshop competitor) but not the library of photos, which was nice, even though I now had nothing with which to view them. When Marie tried it, she hit trouble: her thoughts were mostly contained on sticky notes (either physical or onscreen), and these weren't something Apple considered vital for migration between software versions.

I had to lead Marie down the FireWire route because she's one of those home users who won't tolerate cables, but living in Hackney her Wi-Fi is almost too strong, as is that of 20 or 30 of her neighbours. There was no way to tell how long migration would take if it involved a Wi-Fi base station cat fight with 20 streaming Chromecast sessions from the flats across the road. I also wasn't going to let her go back to Amazon and be sent the wrong item again with a pat on the head from some Hong Kong techies.

Eventually, though, I had more success with her in terms of techie adaptation than I'd had with Donny. She had to perform a fairly long-term shift to that hastily purchased Mac mini, since the screen repair to her MacBook was long, painful and expensive. As was getting all her apps over onto the migrated mini: the small shop that sold her the MacBook was being bashful about exactly where the preinstalled Microsoft Office for Mac



ABOVE Apple didn't come to the rescue for Marie in Hackney... but then she hadn't bought from a plush Apple Store

"What held Marie back was that rather than fill her head with terrible techie stuff, she'd put all her faith in Apple"

licence had come from, and hadn't supplied her with any stickered reinstall media. This wasn't a show-stopper, however: I find Microsoft is invariably helpful in re-licensing people who ring up and are ready to pay up to get back to work. It was a red flag, though, when it came to figuring out how long it would be before she was back in action. She'd originally saved more than the cost of another new laptop by shopping outside the Apple dealer ecosystem, but she'd now had to pay almost as much to build a workable interim system before the small shop in question did the right thing and got her machine fully repaired (quite likely by taking it to an Apple Store...).

In short, I was shocked by how emotionally draining both these recovery processes turned out to be. I was concerned by the limited knowledge both victims displayed of the simplest defensive measures, or basic, home-level processes for warm-spare upkeep and testing. As a network person, naturally I went for networked fixes, but it turned out that the usable bandwidth available to the cloud from either trendy Hackney or semi-rural Spain was far less than either of them would have needed to complete a real restore without major assistance from a hardcore techie. I was also staggered by how poorly the roadmap is presented – by either the vendors or people like me – to guide such tiny businesses towards genuinely protecting themselves against nasty shocks. This is why I diverted a little this month by recounting these two parallel tales, so you'll encourage your entrepreneurial friends to take more care with their Plan B decisions, purchases and expectations. And of course to redress the prejudice in their minds about Apple versus PC recoverability!

Cash-on-demand escapes XP

I recently spent an afternoon taking an in-depth look at the world of cash machines (ATMs to the TLA lovers, which is confusing for me since there's also a network protocol called "ATM") courtesy of NCR, which has launched a new platform for ATMs based on Android. Yes, you heard me right, and it sounds scary doesn't it? Mr Winder has been complaining for some time about the relative insecurity of Android, as found in bazillions of flavours on the world's mobile phones, so how can an Android thin client be trusted to look after our bank-card transactions? Not to mention drive the hardened-steel shutter that rises and falls over the cash drawer and card slot on these NCR devices? Precisely by being a thin client, is the easy answer.



ABOVE A new platform for ATMs based on Android? Not as scary a thought as you might expect

Most of the world's 2.5 million ATMs are currently running Windows XP, and this isn't even the worst of it. Quite a few of them got XP only recently, since NT4 and even OS/2 Warp had long, barnacle-like lifespans in this market. The slightly haggard expressions on those NCR team members with XP exposure showed that if anything, things have become worse since those far off, simpler days. The finance industry can't be seen to miss an XP update you see, no matter how it may try to secure the WANs these ATMs sit on – but customers won't stand there watching while an ATM updates itself for 20 minutes. The support teams for ATM deployment face the same kind of contortions and catchup processes to support XP as the education sector. Neither ATM nor school deployment is exactly XP's native turf, and the last few months of the support cycle haven't been happy ones. This in part explains why NCR chose Android.

I quickly discovered, though, that for NCR it wasn't about how much Android can do for the firm, but rather how little. I'd been primed to continue thinking about Windows XP and the support nightmares it still has, even in a thin-client deployment – especially when it comes to supporting specialised hardware at the end of the connection that a thin client has with its host – so it took me some time to understand why NCR was focusing on the cloud portion of the software suite that powers these Android ATMs.

You see, there's the old thin client, and there's 21st-century thin computing. The boundary between what the client does (such as looking after that metal shutter) and what the cloud instances do has shifted out of all recognition for old Windows people. Of course, the client still has to manage a secure channel, but this no longer relies on living forever within a bank's massively protected, pan-galactic VPN. These ATMs can be plugged into any poor-quality internet connection, and will then talk back to the modules they need to link to a bank's internal systems, no matter how ancient or grumpy those may be. This trick alone is justification enough for banks and other large businesses (such as mobile-phone companies) to start thinking about the advantages of an in-branch ATM, even if it isn't their main business. It also raises the prospect of ATMs that make completely different connections depending on what sort of card you put into them, which opens the door to all manner of curiosities such as Bitcoin cash cards, or cards that trigger a remote "under duress" alarm if you type in a special secondary PIN.

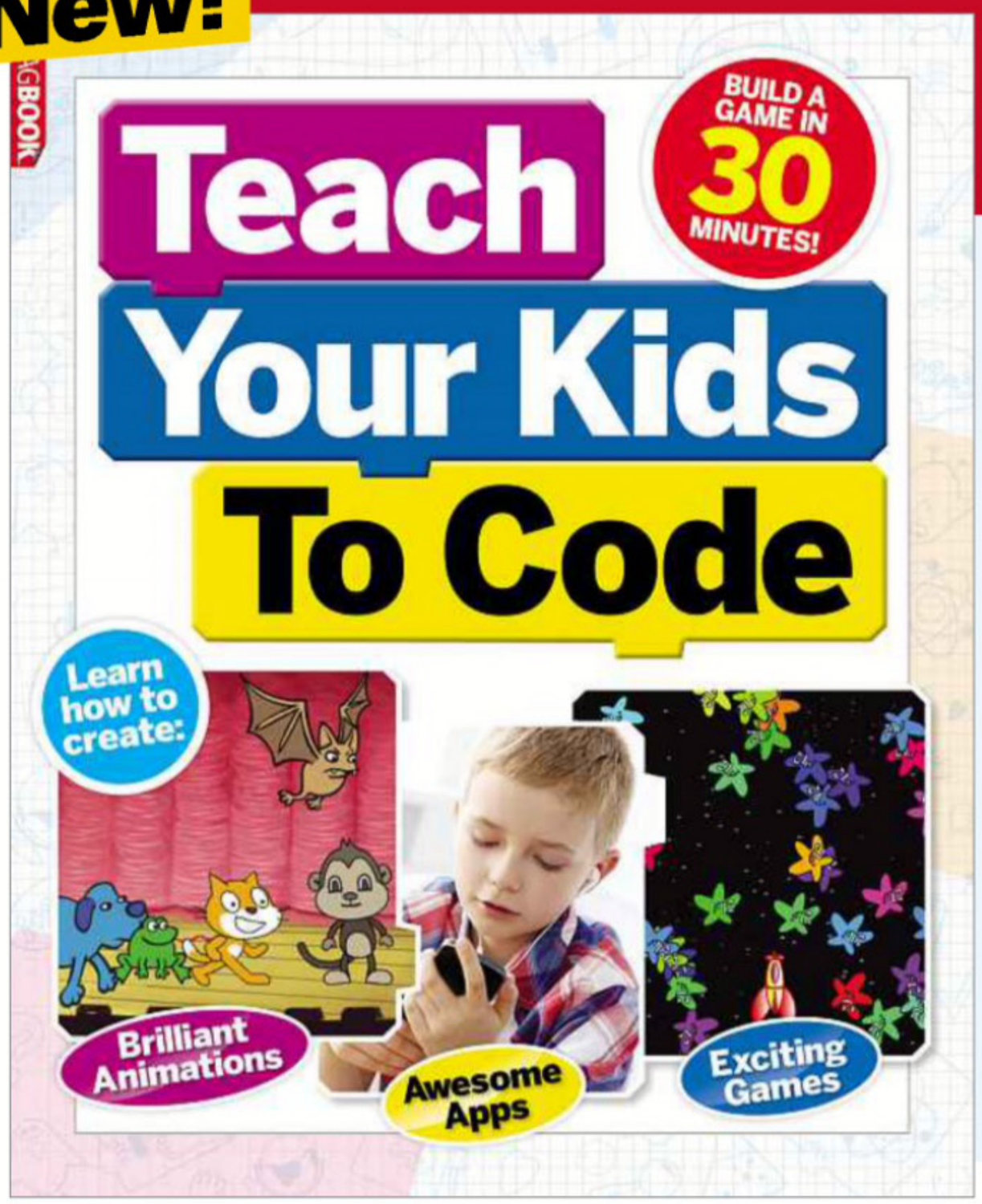
From NCR's perspective, far more work went into the cloud back-end software stack than into the front-end Android device-control software. Linking back into the bank's systems, which expect to converse with a bolshie XP ATM, is a tall order. Whizzy extensions could allow you to, for example, drive the ATM from your phone without ever showing it your bank card, then walk up and grab the money so quickly that people can't see what you're doing. However, this will take a sizeable shift of mindsets, and a readiness to expose internal security systems to external traffic. For me it showed promise, by moving away from Microsoft's thick-versus-thin design paradigm into a far more flexible, software-driven world.

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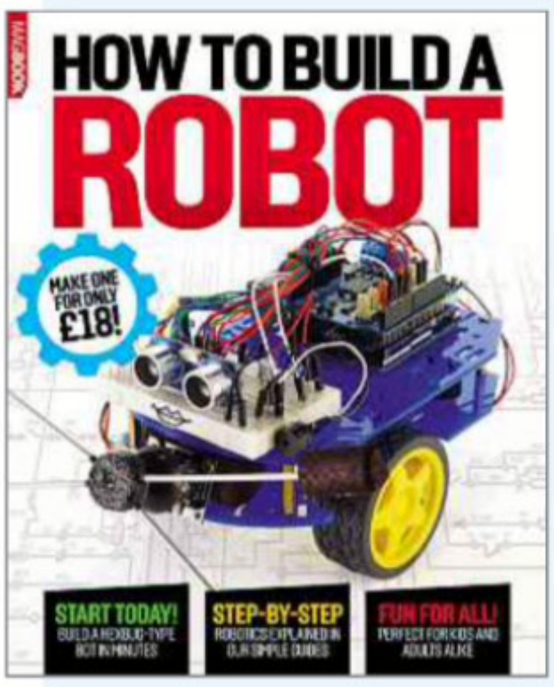
Teach Your Kids to Code

Computer programming is now part of the standard school curriculum, so there's never been a better time to help kids develop their coding skills. This book will show you and your kids how to get started with the basics of programming, and then take that potential further. Read our guide, follow along with the projects and get to grips with the fundamentals of programming, and you and they can learn together. The projects in this book are fun to create – and they're easy to customise too, so young coders can build on what we've put together to stretch their creativity and make their own mark.

> "Fun projects that will see you get to grips with programing fast!"

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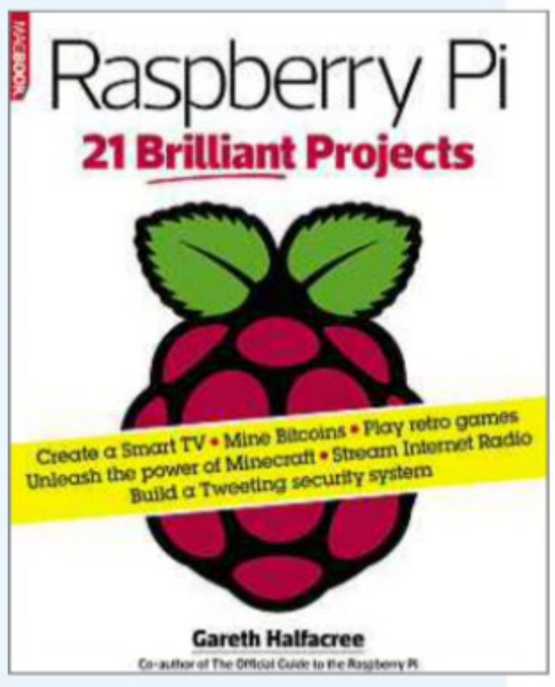


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Futures

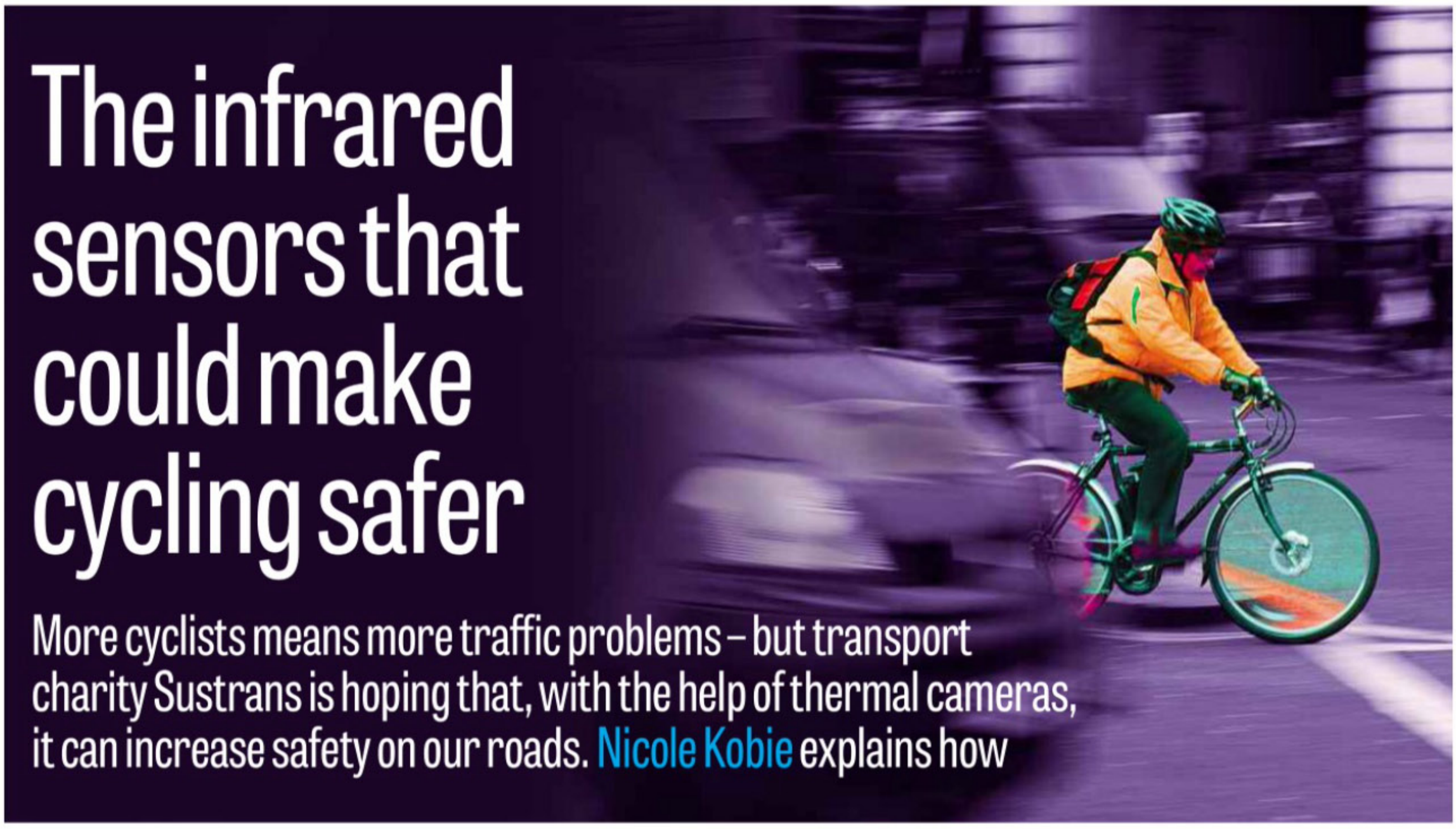
We explore the trends and technologies that are set to shape the future

Will your next home be 3D-printed?
How modelling technology is being used to design and build houses p126

Tesla Powerwall
The domestic battery that saves energy – and money p127

Geek Day Out
Digital masterpieces at the V&A in London p128

The infrared sensors that could make cycling safer



More cyclists means more traffic problems – but transport charity Sustrans is hoping that, with the help of thermal cameras, it can increase safety on our roads. Nicole Kobie explains how

In the UK's major cities, more people than ever before are hopping on their bikes and cycling to work. The number is up 144% over the past decade in central London, and more than 80% in Brighton, Bristol and Manchester, according to the Office for National Statistics.

With more cyclists on the road, it's important to figure out how to give them space to be safe and get around efficiently, without cutting into pedestrian walkways or forcing them to do battle with cars.

Transport charity Sustrans is hoping to provide a solution, and it begins with finding out how many cyclists are actually on the road. The charity will then use the data collected to improve cycle lanes and other road infrastructure.

"We wanted something that could tell us how many people are using the space now, so we can adapt the streets to make them better for walking and cycling," explained Dr Cecilia Oram, project officer at Sustrans.

New York's Times Square faced a similar challenge. "There were quite a lot of incidences of people walking in the carriageway, and therefore there was quite a high rate of accidents," she explained. "They explored how they could model the junctions to make it easier for pedestrians to get across the road and make more space in the carriageway for them."

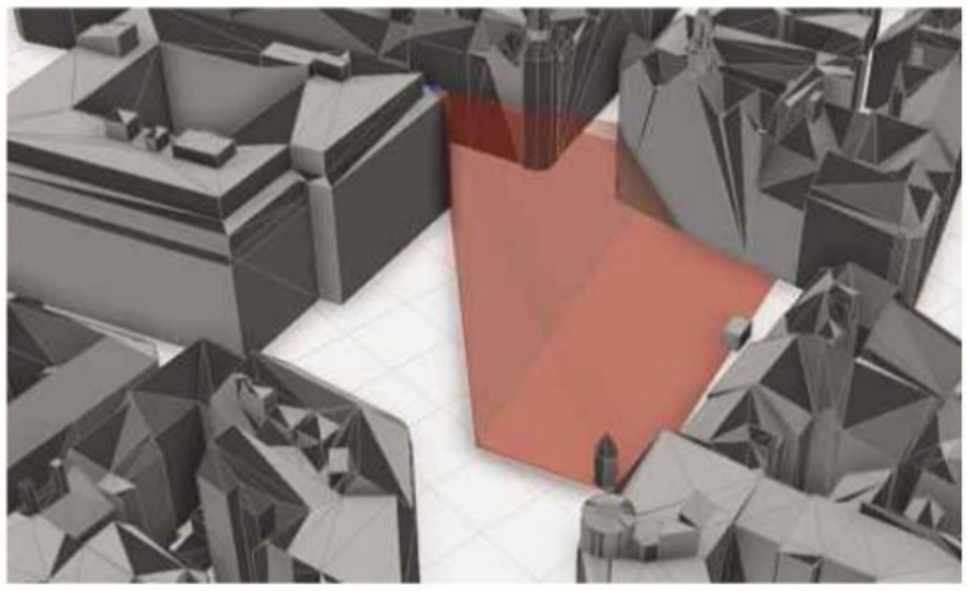
Counting cars and bikes

Simple, right? Not so. While you can easily count cars with a smart strip in the road or via a camera, cyclists and pedestrians are harder to identify. You could use a standard camera and develop an algorithm to distinguish pedestrian from cyclist and understand their movement, but this raises privacy and data-protection issues because individuals can be identified. Indeed, Oram's initial solution was to use CCTV, but privacy concerns put paid to that idea.

Sustrans' new plans make use of a Dutch- and Danish-developed infrared sensor system that can count people without raising data-protection fears. "It's anonymous data; you can't recognise people from the thermal image," she said.

"While you can count cars with a smart strip in the road or via a camera, cyclists and pedestrians are harder to identify"

In addition, it works regardless of the conditions, noted Rikke Gade, an assistant professor at Aalborg University in Denmark, who is developing the system. "It doesn't rely on light at all, so it works both day and night," she said. "It will run 24 hours."



BELOW An elevated vantage point lets the camera view an entire intersection

How it works

The infrared camera is mounted high up over an intersection, busy street or square – it requires such height so that its view isn't obstructed by the many tall buildings in a city. The camera then collects the thermal images, which are analysed by computer algorithms – Gade's speciality.

"It's very hard, because the resolution of the camera is quite low," she said. "It can be only a few pixels that we try to distinguish... We don't always get a good profile of the person, so it can be hard to distinguish between a person, a small car, a cyclist or even a dog. It's an issue we're working on."

The images are also overlaid onto a matrix to fix them in geographic space, so that each pixel in the image can be matched to a real-world co-ordinate. This is the work of Søren Zebitz Nielsen, a researcher at the University of Copenhagen. "You find out what real-world co-ordinate each pixel refers to, more or less, and you do that for eight or 20 pixels. Then you [can build] a matrix between the ground and the image," he said.

Finding answers

All that data lets researchers see a pedestrian or cyclist move into the zone, and track how they use the space. Are cyclists able to flow through intersections, or do they sit dangerously amidst cars, waiting for their turn to cross? Do pedestrians linger in an area, or speed-walk through? The data collected can help answer such questions.

And this isn't only theory: the system is being used in practice. It's already been enlisted indoors at sports arenas to record fans' movements, while in the Netherlands such cameras have tracked intersections where cars and cyclists are forced into close quarters. "They were trying to [capture] situations where cars and cyclists were close to hitting each other," said Gade, referring to a specific crossroads where cars might turn into a lane of cyclists going straight. "These situations where they're close to each other, we were looking at the flow in the car lane and the flow in the cycling lane."

Sustrans now plans to take the work of the researchers and apply it here in the UK. Oram believes it will likely first be tested in Edinburgh – at a location handily near to Sustrans' offices, where a complicated junction has a cycle lane running through it.

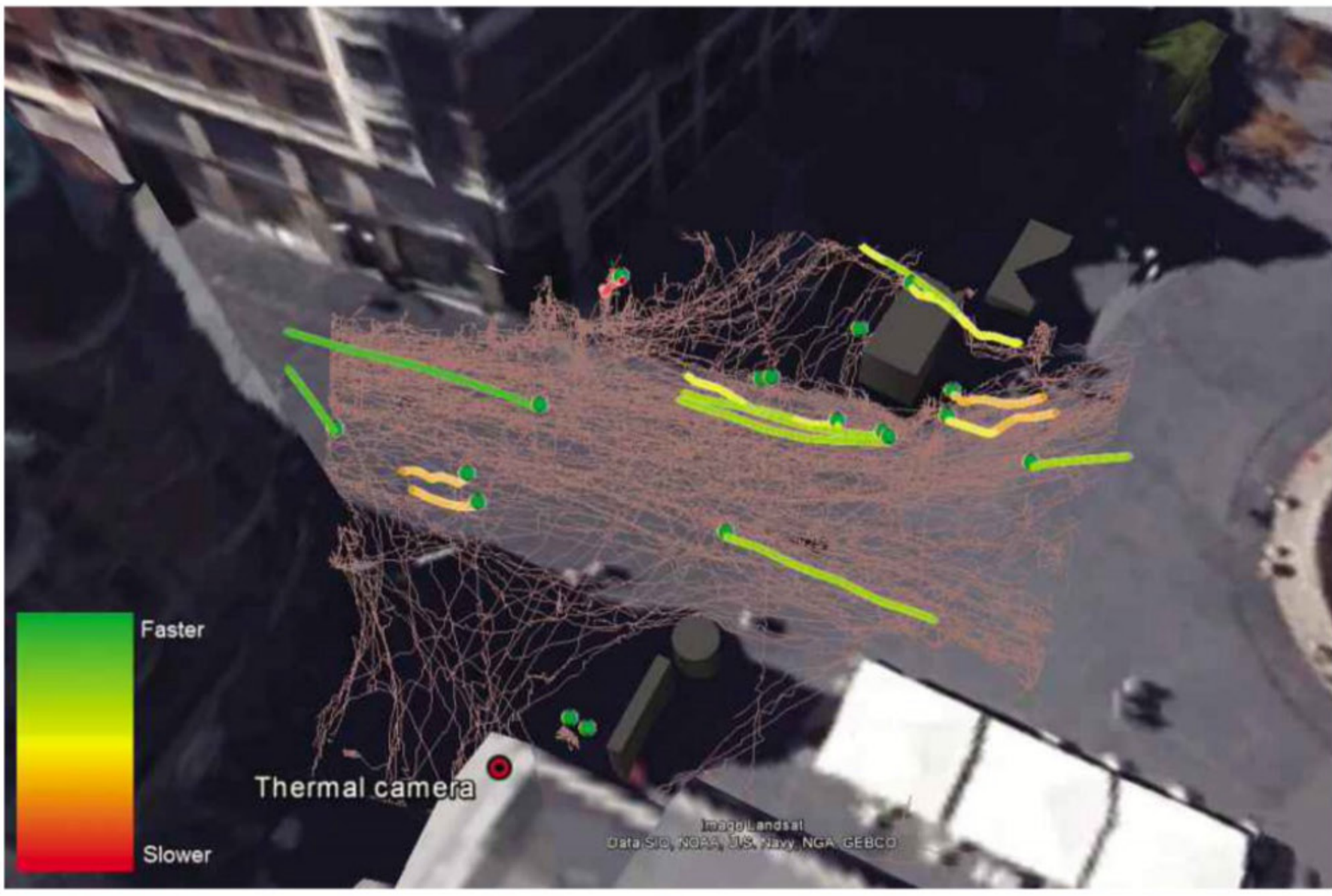
Building smarter cities

The project could give city planners the data to improve streets and communities. "The computer can carry out quite complex analyses of how people are behaving in a public space," Gade added. "It can count the number of people who are lingering in a given space, and tell you how long they're lingering for. This has implications for the economy of those places and how liveable they are," she said.

For example, a camera could show that people are speeding through a particular square, and not stopping at shops or parks in the area. City planners could, say, add benches or trees, or make other minor changes, and then look at the camera data to view their effect – a "feedback loop". If the results are positive, that particular area could be developed by adding more greenery or seating areas in order to make it a more attractive option for people to choose that route, or encourage them to linger longer.

"We'd have the evidence to show people are spending longer here," Oram said, "which would be quite a good case for the changes."

Indeed, while the project is focused on cyclists and pedestrians, Oram said that on a wider level it's about how we think about urban design. "I think there's a case for changing how we think about cities," she said. "Instead of thinking of them as spaces and places and locations, [we could] be thinking of them as actions and interactions and transactions." ●



ABOVE **An infrared camera can track how pedestrians and cyclists use a space**

Images: Søren Zebitz Nielsen; Danish Geodata Agency; GST; Google Earth.



Smart tech gets the green light

A car that can change all red traffic lights to green? Now that is smart –and developers at Newcastle University are currently trialling such a technology in Newcastle city centre.

The device, which attaches to the windscreen of a vehicle, communicates with traffic lights to ensure a smooth, continuous journey. Some vehicles – such as those used by the NHS to transport patients – receive priority, while the rest of us are told to adjust our speed to ensure we see only green signals.

"For example, the system might advise a driver that if they travel at 24mph, they'll hit the next four sets of traffic lights on green," said Phil Blythe, professor of intelligent transport systems at Newcastle University. "In more congested areas, or at particularly busy times of the day, vehicles on key roads might be given priority in order to keep the traffic flowing."

Aside from traffic signals, the system can warn drivers of an accident up ahead, or alert them if someone has jumped a red light at an upcoming intersection. So far, 20 sets of traffic lights and 14 vehicles have been fitted with the experimental technology, with more to follow.

Use 3D printing to build the house of your dreams

Yes, it really is possible to 3D-print a house – and one firm is already producing personalised homes across the UK. We spoke to Facit Homes' managing director, Bruce Bell, to find out how computer-guided manufacturing adds to the house-building process

THERE ARE MANY examples of 3D-printed construction around the world: China is home to the first 3D-printed apartment building, and a 3D-printed estate, complete with swimming pool, can be found in New York. Now, Facit Homes is building a 3D-printed home in London's Highgate. We spoke to managing director Bruce Bell for an insider's guide to the technology.



BELOW Building a 3D-printed home is like putting together a huge puzzle



BELOW Using digital tools allows you to spend more time on the design of a home

How does the technology work? Is it really "3D-printed"?

"People like to use the term [3D printing]," Bell said, but revealed that he tries to avoid it. "But it makes sense in a way, because you're using a computer... and you're getting components that are an exact replica of what you see on the screen. Conceptually, it's the same thing."

However, the actual production techniques employed to build homes aren't the same as those used to print everyday 3D objects. Instead, Facit's architects design the homes in 3D on a computer, and then use those files to build personalised pieces of the housing puzzle, with a computer-controlled blade cutting through wood and other materials to create pieces that are then assembled into the final structure.

Why is this a better way to build homes than standard techniques?

According to Bell, the upside to handing over manufacturing to computers is that they're more precise than the average human builder – although the end product is still assembled by people. "The thing with homes and construction is it's done by hand. And as soon as items are made by hand there's a lot of interpretation... and uncertainty."

He compared the manufacture of homes to other products, from bikes to cars to iPhones, which are designed on a computer, after which the resulting 3D file is passed to machines that "translate" it into an object. "And that's why these products are so good, because they've never been touched by human hands," he said.

"So, for our customers, it's about guaranteeing that they're going to get what we've told them they're going to get. It's cutting out the human interpretation you get in the traditional construction process; it's taking what people see in consumer products and bringing that to the construction industry."

How do your homes differ from standard-built houses?

"It allows us to do more with less, in terms of design and finance," Bell told us. "We can spend more time designing it; focus on details and fabricate items that you couldn't otherwise do using a traditional process."

This includes work on the core of a building, dubbed the chassis, to which other pieces are fitted. Items such as lighting fixtures are built in from the ground up, while insulation, electrics and plumbing have their own separate cavities in walls to ensure that workers are confined to only those areas, interfering with the finished product as little as possible.



Interiors are designed and built digitally too

The interior, too, is designed with 3D precision. "We'll do staircases, kitchens and canopies; all these items have been digitally designed and digitally manufactured."

The house in Highgate features a laser-cut steel staircase and windows that line up with ventilation stacks, while other homes designed by Facit feature built-in under-floor heating, hidden sound systems and underground swimming pools – all impossible in prefabricated homes, or very expensive using traditional methods of construction.

"We can use these digital tools to get something that's super-tailored and built around people's lives," Bell said. "These tools allow us to be flexible and to achieve what people want – as opposed to a building system that might be limited." ●



What is... Tesla's Powerwall?

Elon Musk has been breaking boundaries again: this time he's launching a smart-home battery system that stores cheap or solar energy to be used later

Elon Musk wants us to drive electric cars, travel through supersonic Hyperloop tubes, and spend our holidays in space – and now he's turned his attention to home energy. His company Tesla has unveiled a home battery system called Powerwall that lets you store solar energy to power your home.



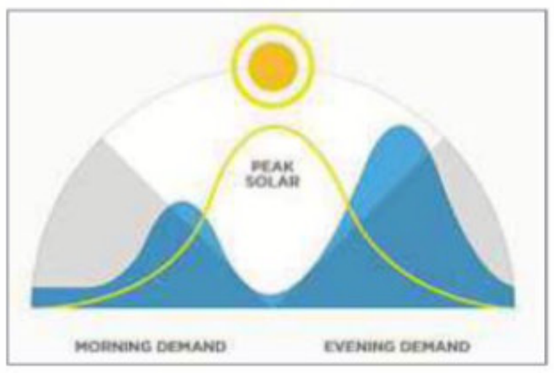
Is Powerwall the future of energy? Musk thinks so – and so do tens of thousands of others who have pre-ordered the battery.

A battery? People are excited by a battery? They are – Musk claims that 38,000 people have already signed up for what is, essentially, a giant rechargeable lithium-ion battery. They're hoping it lives up to Musk's promises of being less battery and more home-energy-management system.

And what makes it so smart? The Powerwall is charged via solar panels, storing energy from sunny mornings to use on grey afternoons or at peak-use times. It also lets users top up from the electric grid, so if your panels aren't pulling in enough power to meet your needs, you can fill up your Powerwall at non-peak times when rates are low for use in the evenings. Hey presto, lower utility bill. Aside from storing solar and load shifting, it's also handy as a backup power source in the event of an outage.

How much will this bill-cutting battery cost? The 10kWh Powerwall costs $3,500 (£2,290) and can hold charge for a week, while the 7kWh version is $3,000 (£1,964) and recharges daily. That doesn't include installation however, nor the cost of installing solar panels. Musk admits the price is too expensive for the mainstream US market, and is clearly hoping to drive it down.

That's a lot for a battery. True, but it really is big: it weighs 100kg and measures 86 x 18 x 130cm, offering up to 8.6A of peak output. The Powerwall can be installed inside or out, working at temperatures between -20°C and 43°C. If you're worried about having a big ugly box



attached to your wall, fear not: Tesla has designers that Apple would envy. The Powerwall is a sleek, shiny rectangle that wouldn't look out of place on a spaceship.

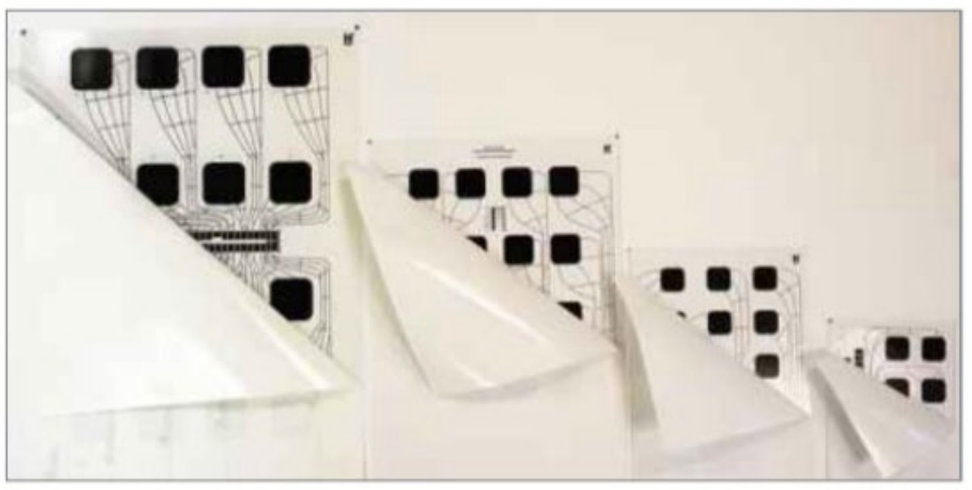
Electricity companies aren't going to like this, are they? Possibly not, but some punters have suggested they may be the means through which many of us get the expensive Powerwall system installed in our homes, much the same way many energy companies give out pricey smart meters, which cut usage but keep us as loyal customers. Plus, Tesla is pushing its batteries to utility firms to help manage their power, and to businesses to avoid peak charges.

When can we get a Powerwall? Deliveries in the US will begin this summer. Tesla is taking pre-orders for the Powerwall in the UK. Find the details at **teslamotors.com/powerwall**.

Crowdfund this!

Our pick of UK tech projects on Kickstarter and Indiegogo

CreatorKit PrintedTouch Stickers

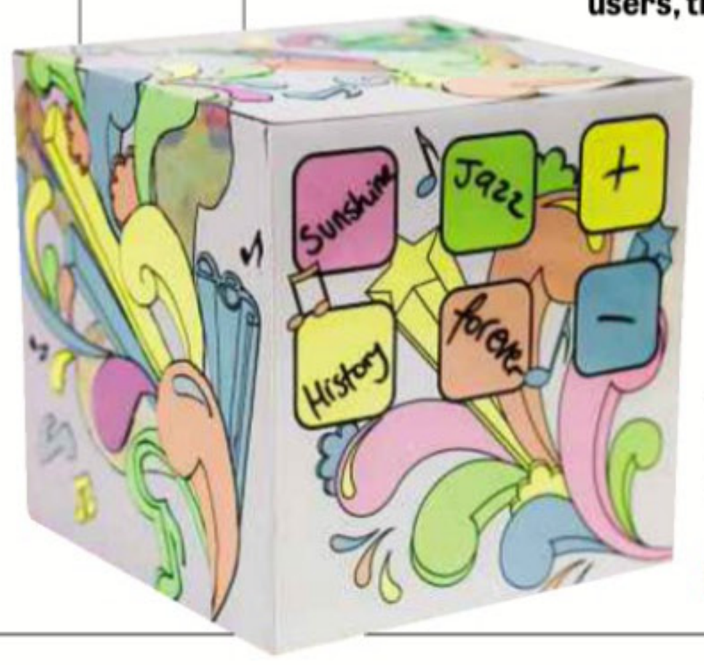


What is it? PrintedTouch stickers feature conductive ink on the rear, enabling you to build interactive devices that play sounds when you press them. It's a great way to teach programming basics to children, and the stickers have also been used to add track samples to posters and album covers. These are stickers you'd actually want to collect.

Why would you want conductive stickers? The technology allows you to make pretty much any surface interactive – so you can make posters that speak when you prod them, or floors that play music when you tap a spot. The CreatorKit bundle includes printed touch stickers, control modules, battery packs and software to set up your program.

How does it work? Conductive ink on the back of the sticker behaves like wires, while the front has capacitive touch sensors. They're sticky on both the front and back, so you can fix them to a surface and add a graphic to the front. To make them play a sound, simply press a control module into the right spot on the sticker along the conductive ink, and do the same with the battery pack and sound actuator, which turns the surface into a speaker. Then, use the software or decide what the sticker will do, such as playing the sound, increase the volume and so on. Save the file to a microSD card, plug that into the control module, and you're done.

How much will it cost? You can try out the system by building your own "piano". For £15, you get stickers with a piano graphic on the front, and a control module that plays key sounds on the back. For your own project, you can buy four page-size stickers and a control module for £22. For more advanced users, the Creator Studio offers more modules and stickers, as well as a line-out to connect speakers, conductive tape and conductive ink for £130.

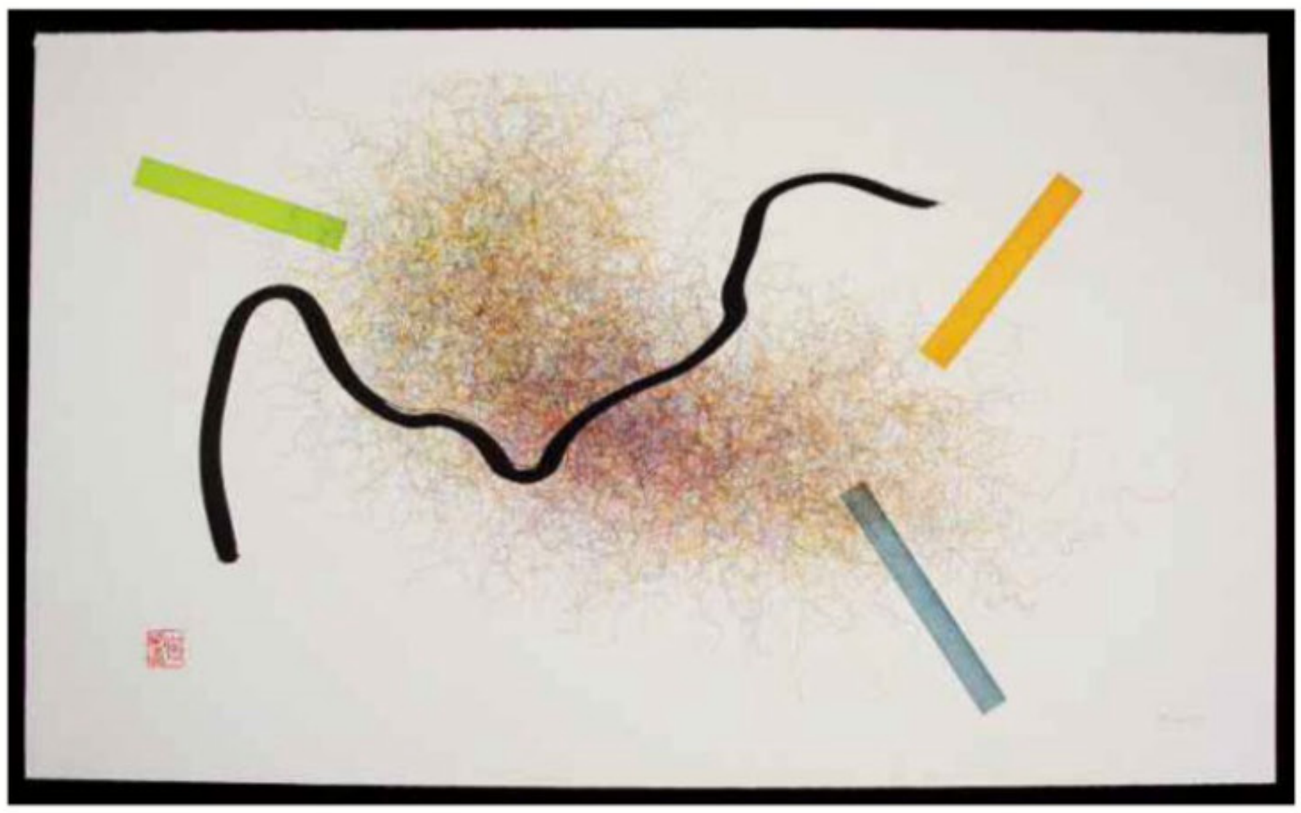


Likely to get funded? At the time of writing, the project had 49 backers pledging £2,257 of the £12,000 goal. Delivery of the PrintedTouch Stickers is expected in September.

Link: pcpro.link/250creatorkit

Geek Day Out: V&A Digital Art

The Victoria and Albert Museum in London is all about design – including a wide collection of works created digitally



LEFT Pathway Series, Bird 2, 1990, by Roman Verostko

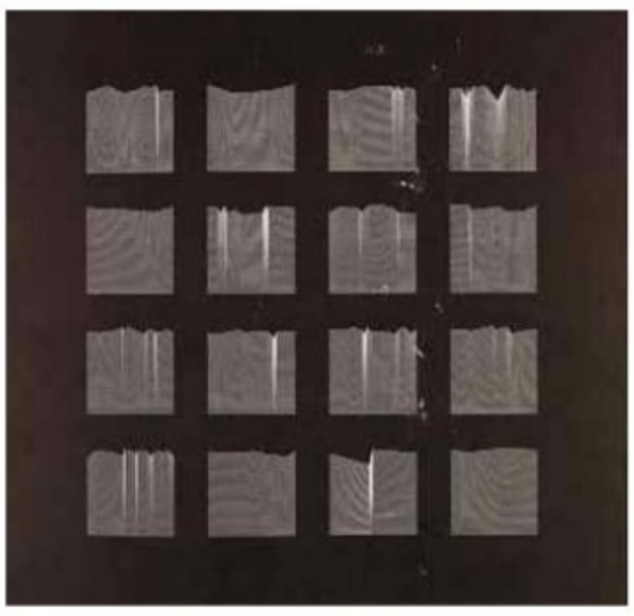
For as long as computers have been around, they've been used to make art – and the Victoria and Albert museum in London has a collection that proves digital expressions are just as intriguing as those daubed in paint.

Started with key acquisitions in the late 1960s, the digital art collection resides in the V&A's Prints and Drawings Study Room, which is open Tuesday through Friday – but this being computer art, you can also view 1,000 pieces from the collection online at **collections.vam.ac.uk**.

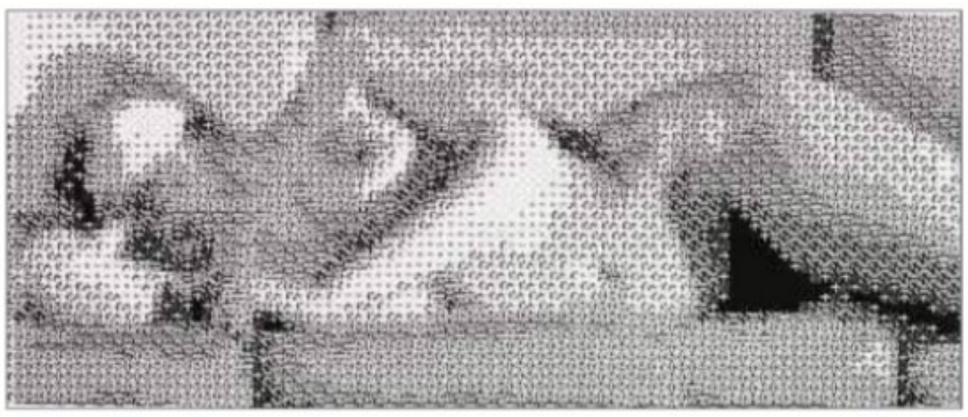
"Visitors are often intrigued to see a set of punch cards made in 1970 by the artist Manfred Mohr," said Melanie Lenz, Patric Prince Curator of Digital Art at the V&A. Mohr wrote his own code for the artworks, storing it on punch cards. Those, alongside the resulting images, are on show.

Another highlight is Studies in Perception, a nude image that was scanned and converted into symbols by Leon Harmon and Ken Knowlton from Bell Labs. "The original printout was 12ft wide and was hung in a colleague's office as a prank," Lenz said, adding that while it was "hastily" removed, it eventually leaked.

"Mohr wrote his own code for the artworks, storing it on punch cards. The resulting images are on show"



LEFT P-32 (Matrix Elements), 1970, by Manfred Mohr



While at the V&A, be sure also to check out the "All of This Belongs to You" exhibition, which features *The Guardian* laptop that the government ordered be smashed to pieces because it held a copy of Edward Snowden's files.

Alongside the collections on show, the museum runs events including a Digital Design Weekend, video game and 3D-printed jewellery classes for teens, and a class teaching how to sketch on your iPad.

Admission to the V&A is free. For more information, head to **vam.ac.uk**.

ABOVE Studies in Perception, 1997, by Leon Harmon and Ken Knowlton

Images: © Victoria and Albert Museum, London

Coming up

TMDs

A new super-thin material could pave the way for flexible electronics and ultra-light displays

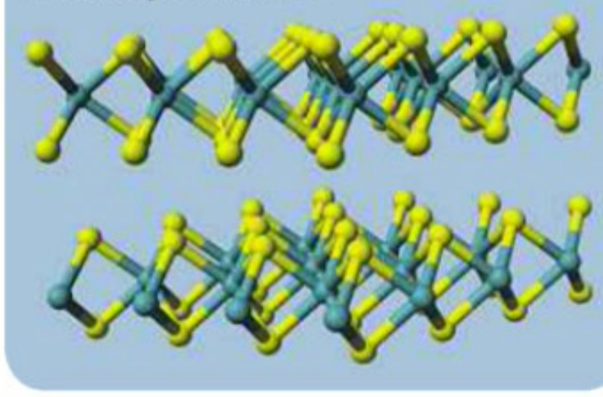
There's a new acronym lighting up the eyes of tech enthusiasts and researchers everywhere: TMD. Transition-metal dichalcogenide – hence the need for an acronym – is a super-thin but incredibly conductive film. How thin, I hear you ask? It's only three atoms thick.

The material isn't new, but previous attempts to make it have suffered from relatively low yields. In a paper published in *Nature*, a group of researchers led by Cornell University's Saien Xie outlined a new process for making the material; this cuts defects down to 1%, meaning it could become commercially viable.

The combination of thinness and high conductivity means TMD makes an excellent material for semi-conductors. Manufacturers could greatly increase transistor density compared to what's possible with current technologies, the researchers said, adding that it "would bring wide benefits for applications in ultra-thin and flexible electronics, photovoltaics and display technology".

"Our work is a step towards the realisation of atomically thin integrated circuitry," researchers claimed in the paper.

TMD isn't the first super-thin alternative to existing semi-conductor ingredients, with graphene the most famous. However, so far none has yet been successfully commercialised. Each success by researchers such as those at Cornell inches the possibility of atomically thin chips ever closer, but given the long lead times involved in making processors, we don't expect to see products on the shelf any time soon.



Coding challenge

Reconstructing a secret code from incomplete information



Keylogger analysis

James Bond movies would be a lot less exciting if he didn't have to travel to an exotic location, break into a secure building, fight off some henchmen and defuse a nuclear bomb. However, the reality is that Bond could probably glean all the intelligence he needs from the comfort of his own keyboard.

If someone can see every key that's pressed on a keyboard, they can capture valuable information and use it for their own gain. This activity is known as keylogging, and there are many ways in which it can be done: for example, by installing a small box between the keyboard and PC that logs every keystroke. A software-based keylogger, which might be installed on a PC via a virus, provides a much less conspicuous method. There are other ways to snoop on someone's typing too: by remotely listening to the built-in microphone on a laptop, for example, it's possible to work out what's being typed with a surprisingly high success rate, since each key makes a slightly different noise. Some governments are now considering switching back to typewriters for their top-secret information to defeat such modern snooping techniques.

When it comes to PC security, banks and other online services have tried to defend against keylogging attacks by asking users to type in a few randomly chosen characters from their password as opposed to all of it. If a hacker captures a large number of successful logins, however, they could still reconstruct the original password.

Let's start with a simple example of how this might be done, by imagining that we've captured the following series of two-character logins:

[c,e] [e,r] [d,e] [c,e] [c,d] [c,o] [o,d] [c,d] [o,r] [c,r]

The first task is to identify all of the letters that have been used (the keylogger will need to run for long enough to ensure that each character in the password has been captured). In this case, the unique characters are [c,e,r,d,o], so we can use that as our starting template.

But in what order do the letters appear? The key is that the first character in each capture appears before the second. So we can tell from the first few captures that c comes before e, e comes before r and so forth. The third capture tells us that d comes before e, so we can rearrange our template to get [c,d,e,r,o]. Reading on, we also discover that the letter o comes before d, so that needs to be shifted too. That leaves us with [c,o,d,e,r], which squares with all the captured key logs and is indeed the whole password. How would we implement this in code? Here's a possible structure:

```
letters_available = empty list
while there is more data
   read in next captured key log
   if any letter is not in the letters_
   available list, then add it
end while

data_shifted=true
while data_shifted=true
   data_shifted=false
   for each set of key logs
         if the order of letters in letters_
         available is not the same as
         in the captured key logs, then
         shift the rightmost letter to the
         left by one place, until it is in the
         correct order
         data_shifted=true
         endif
   end for
end while
print letters_available
```

Things become more difficult if the password has repeating letters, since there's no way of knowing whether it was the first or second instance of a letter that was captured. Perhaps, then, it's a good idea to include repeating characters in your password.

An alternative solution might start by trying to identify the first and last letters. You could do this by examining the captures and looking for a letter that occurs as the first or last character, but not in any other position.

> "Governments are considering switching back to typewriters to defeat modern snooping techniques"

If you're ready for the challenge, we've produced a series of key logs for you to analyse. Each one is based on a real English word that doesn't have any repeating letters. The files can be found at **pcpro.link/250keylog**.

That still leaves the problem of capturing the key logs in the first place, of course. Perhaps breaking in to your target's office and installing a keylogger really is a job for James Bond. **DAVID HUNT**



Ham to the rescue: the earthquake in Nepal reminds Jon Honeyball of radio power

There is a common meme out there that the net was designed to be impervious to a nuclear attack. After all, it stemmed from the American military and university worlds, and keeping the key players connected was necessary as part of the Arpanet design.

So it isn't surprising that many believe it has the ability to cope with anything that's thrown at it. And this is true, up to a point. For example, the protocols that control routing can cope with outages in the links, rerouting around a problem, providing that particular part of the net is set up to do this. This happens at the big hubs, because outages can't be allowed to disconnect whole wedges of the internet in one swoop. It's also true that you could set up a clandestine IP gateway in a rogue state, and ensure that all the traffic continued to get through if a hostile government cut the mainstream lines.

But the reality doesn't quite live up to the "survive nuclear attack" meme. Yes, routing errors occur frequently over the internet, but they're not fixed through some magical self-correcting part of the internet organism; they're mostly fixed by the specific problem being caught and solved. A router port might go AWOL; a restart of the port fixes that problem. Someone unplugs a cable, and decides it's wise to plug it back in.

The bigger the failures, the longer they take to resolve. A digger ripping through a major fibre cable, for instance, would be a rather large setback. I'm told that one of the major bridges across the Thames carries a huge quantity of fibre-optic cable slung under it; a mis-steered barge, or a well-placed terrorist attack, could easily cause a hiccup that would take weeks of work to patch around.

Then there's the other side of the problem, because the internet as you and I know it is only as good as the final connection path. You might have splashed out for fibre-to-the-cabinet, but you'll be disconnected just the same when a truck crashes into the shiny green box.

Things are worse when a major disaster strikes. Not only can all the end pieces become disrupted, but large sections of the core infrastructure can go down too. And then the internet really will be messed up in that location. Power failure is one obvious problem, but can be fixed relatively easily. An earthquake is on a whole different level of problem and solution. The recent terrible news coming from Nepal should underline this. A horrifying death toll, and a disaster that will take a generation to repair. As you'd expect, significant pieces of the internet in that area were simply cut off, which is exactly what you don't need in a time of crisis.

Then I read that ham radio had taken over, the somewhat quaint technology from another era. While the image of the older chap sat in his shed, asking what the weather is in Tokyo, is hard to shake, in reality ham radio is still a very valid and useful technology. I did my exams some 30 years ago, and was given the call sign of G1LMS. To get the licence, you have to pass exams and show a real proficiency for the technology and underlying physics – and understand the legal and technical responsibilities that you have.

Some of this technology is still quite amazing, and can span the globe. Ham radio played a critical part in keeping the UK government informed when the Argentinian forces invaded the Falklands in 1982, for example. On my industrial year from university, I worked with Angus McKenzie, G3OSS, who was a world-renowned radio expert. We even wrote a major technical tome for the Radio Society of Great Britain, and I still cherish my copy.

"While the image of the older chap sat in his shed is hard to shake, ham radio is still a very valid and useful technology"

I moved away from ham radio because I discovered computers and big networks, mainframes, and the early days of Janet and the internet. For a geek like myself, this was a compelling new toy and my interest in ham waned. But the news of how ham radio is still of value in times of real crisis has stirred my memories. Maybe I should contact the authorities and get my licence re-established. It would be fun to be back online as G1LMS.

After all, if the saying is right, then we're only ever a week away from sliding back to the Middle Ages. A cataclysmic loss of electricity, for example, would slide the UK towards the 19th century at a quite worrying rate. Fortunately, we're unlikely to have an earthquake or suffer the same horror as that facing Nepal. But maybe it's my responsibility to polish up the skills I used to have. You never know when they might be useful. Maybe you should look into it too.

As well as being a radio geek, Jon Honeyball is a contributing editor to *PC Pro*. He prefers his ham with a good mustard glaze. Email jon@jonhoneyball.com

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