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Kaby Lake

THE VERDICT

- ✓ Fastest ever desktop CPU
- ✓ Why you should upgrade
- ✓ You'll never need a graphics card again

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BEST PC TECH FOR 2017

- AMD Vega graphics cards
- Intel Optane storage
- HDR gaming screens
- AMD Ryzen CPUs

Acer Swift 7

TESTED

The world's thinnest laptop
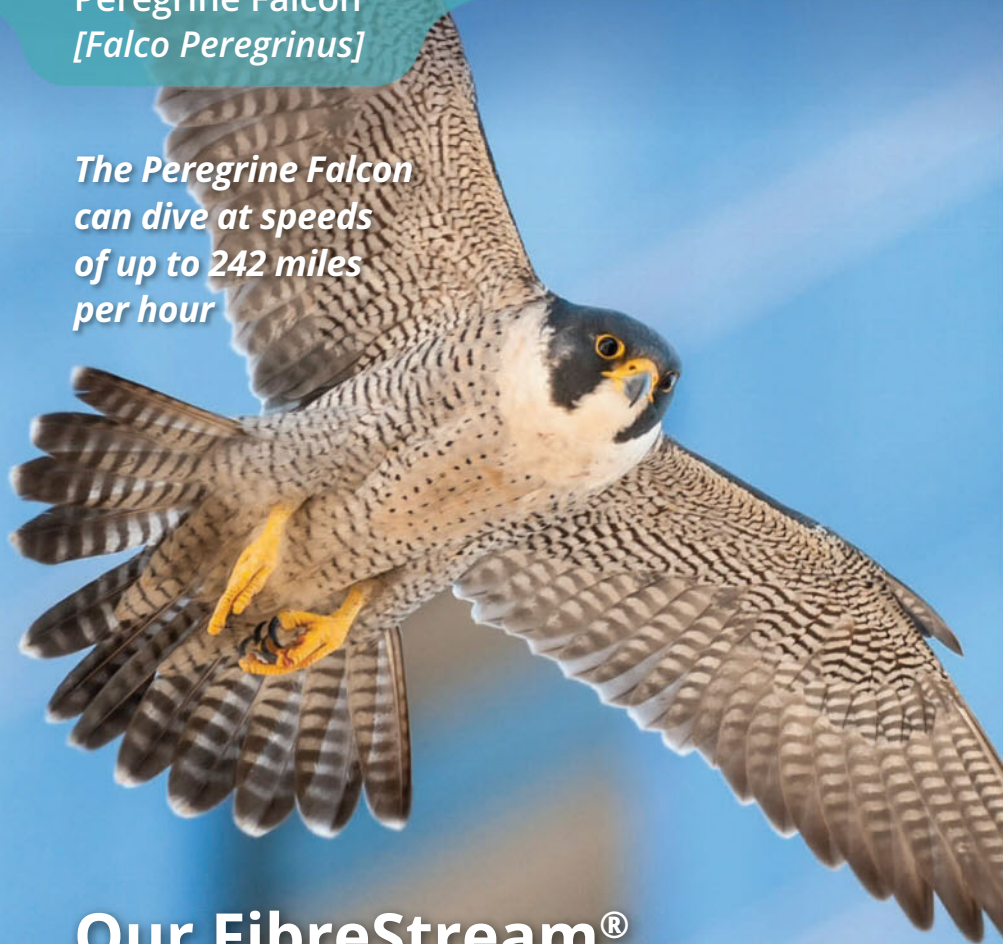
How to install an SSD

Give your PC or laptop a performance kick

MAY 2017

IDG **ISSUE 262**

IDG

JIM
MARTIN

What's on the ho-Ryzen?

Why these are exciting times for desktop PCs

Welcome to the May issue of *PC Advisor*. It feels like it's been a long while since anything exciting happened in the world of desktop PCs, aside from the new Nvidia graphics cards. But even the GTX 1080 – as good as it is – isn't a must-have upgrade if you already had a 980 Ti.

Part of the issue is that it's expensive, and it's hard to justify spending £550+ unless you're also running a triplet of 4K monitors, in which case such a sum isn't so significant.

This is why I for one can't wait to benchmark AMD's brand new Ryzen 7 processors. Unfortunately, you'll have to wait until next month to see how they compare with Intel's latest Kaby Lake chip (our full review is on page 74) as the chips haven't yet arrived at PCA Towers. But AMD's claims show that it is confident it has a winner on its hands, and early indications are that the range-topping Ryzen 7 1800X beats the equivalent eight-core Intel chip (the i7-6900K) while undercutting by over 50 percent: £499 versus £1,049.

There is no eight-core Kaby Lake processor yet, which means that any comparison to Kaby Lake right now has to be against the i7-7700K. That costs £330, which is the same as the Ryzen 7 1700, but it's certainly worth waiting until those benchmark results are in before buying a new PC.

Ryzen isn't the only new product from AMD this year. The next-generation of graphics cards – code-named Vega – is due to launch later in the summer, and you can read more about these on page 82. Plus, on page 58 we've rounded up the best tech we saw at CES that should arrive on shelves over the next 12 months.

You'll find plenty of phone reviews starting on page 30, but the Lenovo P2 stands out this month for its exceptional battery life. Most phones will last a day, or possibly 48 hours with very light use, but the P2 just keeps on going.

Acer's latest laptop is the thinnest in the world, and you can read our verdict on the Swift 7 on page 23. Not everyone needs a millimetre shaved off here and there, and you may not even need to buy a new PC or laptop to get better performance. An SSD is still the best-value route to restoring and improving speed in both PCs and laptops. On page 92 you can see the sort of speed boost you can expect, and we also explain how to install an SSD.

If your current hard drive is full up, we offer some tips on freeing up space on page 102, and it's well worth checking its health using the guide on page 100 to ensure you don't lose any precious files. For those that were accidentally deleted, you can try to recover them using the methods on pages 96 and 110.

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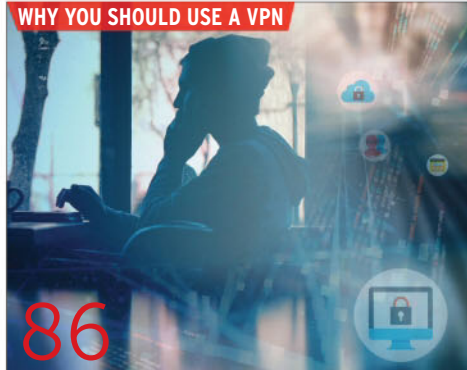
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TEST CENTRE

TOP 5 CHARTS:
BUYER'S GUIDE

Intel's 8th-gen 'Coffee Lake' processors reuse 14nm process as other Core CPUs ease into new tech
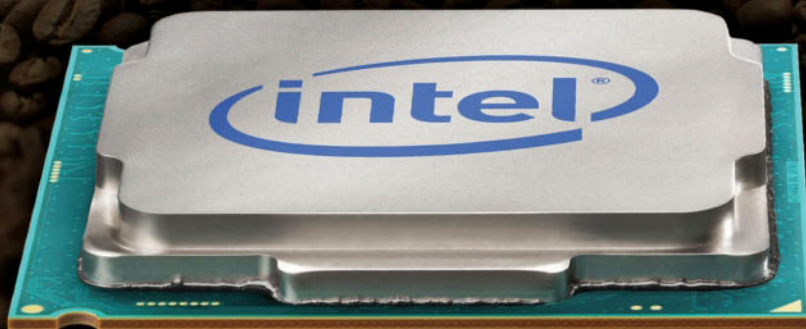
It's time to add 'Cannon Lake' and 'Coffee Lake' to your vocabulary, writes Mark Hachman

Normally, Intel launches one new microprocessor every year. But the firm is quietly signalling that PCs shipped during the holiday 2017 season could feature one of two new designs, using either its aging 14nm process or the upcoming 10nm technology.

The two new names to add to your Intel vocabulary include Cannon Lake, a 10nm chip that Intel showed off at CES, and an unnamed fourth-generation 14nm chip that some are referring to as Coffee Lake. The latter chip is perhaps the most interesting, as it would extend Intel's 14nm chips to a record four generations, following Broadwell, Skylake, and the current Kaby Lake chip.

When Intel added a third 14nm chip 2015, signalling the end of the company's vaunted 'tick-tock' manufacturing process, the industry freaked out. A fourth, then, would be absolutely unprecedented. But Intel already seems to be setting the stage to convince investors and customers that it

can manufacture four straight generations of chips on the same 14nm process without giving up consistent performance improvements, which is what customers care about, after all.

At its recent investor day, Intel said that its eighth-generation Core chips, which should include Cannon Lake and Coffee Lake, will deliver a 15 percent performance improvement over Kaby Lake. That's good enough for most consumers. But enthusiasts

have to wonder where the additional performance will come from, and whether it will open the door to AMD's own rival, Ryzen. There's also a broader question: if Intel's being forced into shipping a fourth 14nm chip, will the same scenario play out within the 10nm generation?

Here's how 2017 shapes up

Intel hasn't made a big deal of the fact that it's pursuing parallel 10- and 14nm

Intel chief executive Brian Krzanich shows off Cannon Lake hardware at its CES 2017 presentation
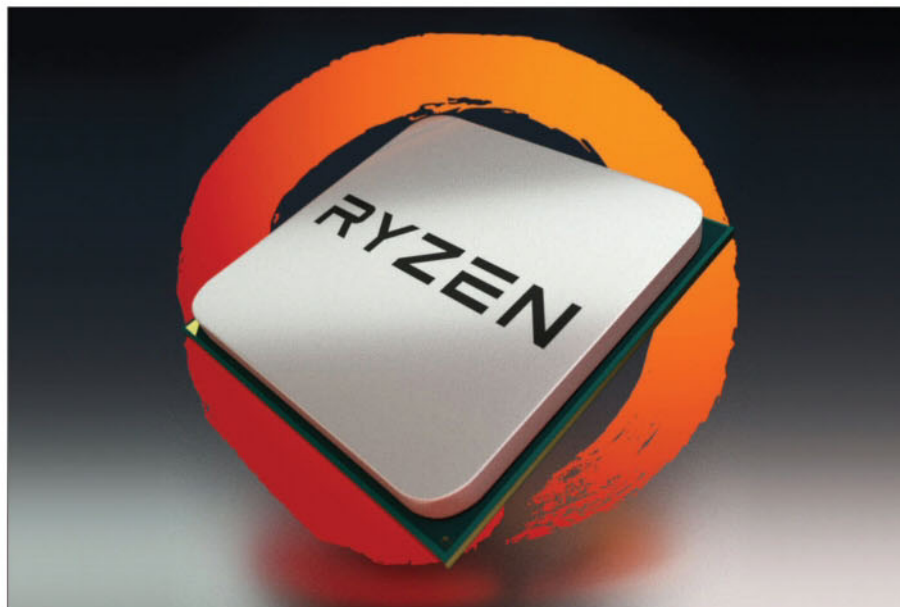
It certainly looks like this could be the summer of Ryzen. How quickly Intel can steal its thunder with Cannon Lake or Coffee Lake remains to be seen

same 14nm process, how can it possibly be any faster than its predecessors?

New technology

Historically, Intel increases its chip performance from product to product in two ways: design and manufacturing. This is the aforementioned tick-tock process; a new change to a chip's design (tick) is followed by a 'process shrink' to an improved manufacturing process (tock). Both methods generate performance improvements. The 'tock' is where Moore's Law enters: the number of transistors in a given area doubles every 12- to 18 months as new manufacturing technologies are developed, giving chips a 'free' performance boost. But given that Intel is leaving its manufacturing process unchanged, doesn't that mean that its 'tock' improvements will disappear?

Not exactly. Over time, both the tick-tock model as well as what it describes has broken down. During the Skylake and Kaby Lake generations, Intel squashed the 'tick' and 'tock' together somewhat, tweaking both the design and the process technology simultaneously.

Even a descriptive term such as '14nm' means has also become more vague. Sources confirmed a tweet by The Motley Fool's Ashraf Eassa, that Intel is using a manufacturing shorthand to distinguish

strategies, but both chips have been finally referred to publicly. At CES, Intel showed off a two-in-one running Cannon Lake, later claiming that it would ship Cannon Lake chips in 2017. Its plan for a separate 14nm chip appeared in a roadmap slide during its recent investor's day, titled 'Advancing Moore's Law on 14nm'. That roadmap included an illustration showing that the company tentatively plans to ship those 14nm, eighth-generation Core chips during the second half of 2017, too.

Perhaps the most interesting aspect of what some are calling a 'split' approach is how Coffee Lake and Cannon Lake are positioned. Intel is believed to be targeting Cannon Lake at more premium niche markets such as low-power ultrabooks, leaving the well-established 14nm process powering Coffee Lake for mainstream notebooks and desktops until the 10nm Cannon Lake comes fully up to speed. That strategy avoids forcing Intel to bet everything on the unproven 10nm process, and allows them to focus on premium, high-margin products, analyst Dean McCarron said—the strategy that helped Intel's client group grow operating profits by 30 percent even as PC shipments declined in 2016.

Generally speaking, here's how 2017 could shape up in terms of CPU releases: Intel's Kaby Lake holds sway until March, when AMD has said that the Ryzen chip will launch. Sometime near the summer – late May, if history holds – Intel should release its high-end Skylake-E chips for gaming PCs. AMD will ship its Raven Ridge chip for laptops and some desktops in the autumn, which is also roughly the time frame to expect Intel's Cannon Lake and Coffee Lake.

How Kaby Lake compares to Ryzen will play an enormous role in AMD's future, but questions will quickly be raised about how the 14nm chip, Coffee Lake, will shape up, too. You may already be asking this question: if Coffee Lake is Intel's fourth chip on the
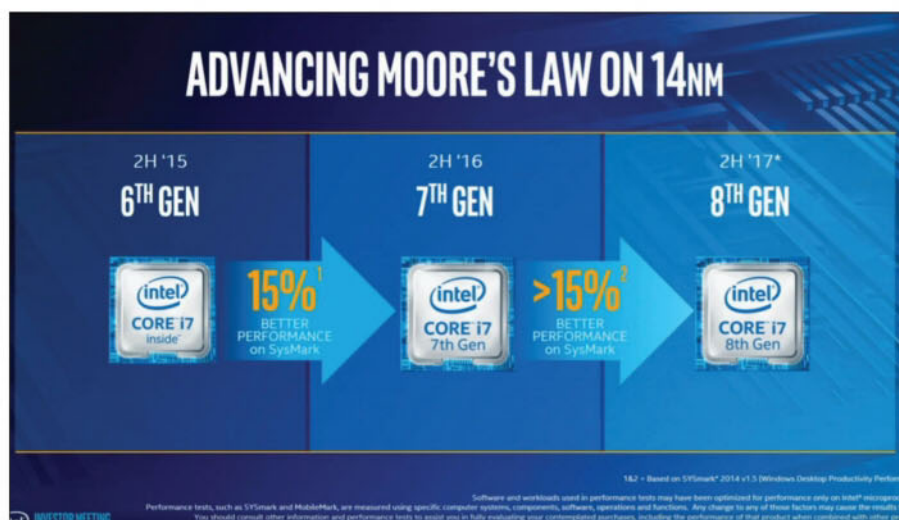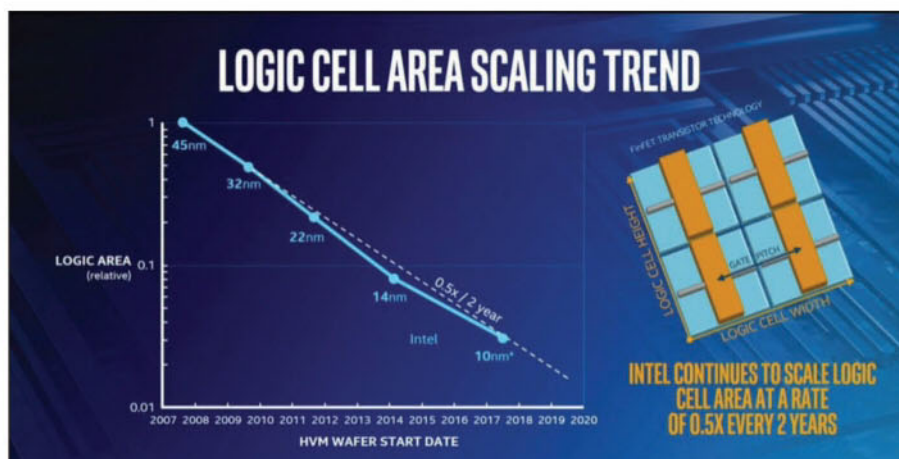
Intel revealed its plans to extend 14nm technology through the eighth-generation Core products at its investor conference

LOGIC CELL AREA SCALING TREND

INTEL CONTINUES TO SCALE LOGIC CELL AREA AT A RATE OF 0.5X EVERY 2 YEARS

between Broadwell/Skylake (14nm), Kaby Lake (14nm+), and Coffee Lake (14nm++). That, plus Intel's shift to a more three-dimensional FinFET architecture, has made identifying each generation by a gate length even more outdated, added Patrick Moorhead, a former AMD fellow and now an independent analyst with Moor Insights and Strategy.

"I actually believe that Intel's 14nm+ is actually closer to other people's 10nm than they get credit for," Moorhead argued.

In his investor day presentation, Murthy Renduchintala, the head of Intel's client chip and IoT business, used a different metric in a bid to clear up the confusion once and for all: logic cell area. Under that metric, he said, Intel has steadily shrunk the logic cell by 50 percent over every two years, and has maintained a steady three-year lead over its rivals.

All of this may sound horribly abstract, but the bottom line is this: Moore's Law has driven the entire computing industry for literally decades. It seems to be slowing down, and in some ways, it is. But Moore's Law is no longer as accurate as it once was, and that inaccuracy masks some of the progress Intel's making.

No easy answer to improved performance

Nevertheless, analysts expect that Intel will turn other knobs when improving the performance of a fourth-generation 14nm chip. Since Intel's roadmap slide confirms that its eighth-generation Core chip runs 15 percent faster than the current Kaby Lake, that implies that Coffee Lake will feature a revised design, analysts say, similar to how the 14nm Kaby Lake chip improves over its 14nm predecessor, Skylake.

The "cheap, dirty way" to improve performance involves adding cache memory, McCarron explained. "Putting more cache in always solves the problem."

What's more likely, though, is that Intel will simply combine a number of small improvements, McCarron said, such as running core clocks slightly higher and adjusting power. For his part, Moorhead said that he believed Intel would bet more heavily on improving the integrated graphics engine. "My gut instinct says that it's a lot of GPU, a little bit of clock [speed], and potentially not a whole lot more instructions per clock" to achieve that 15 percent improvement, he added. Long gone, then, are the days when Intel dialled up the clock speed to dramatically increase performance. As Moore's Law slows, the firm will likely take a little bit here, and a little bit there, to gradually push performance higher.

So which chip should you buy, Coffee Lake or Cannon Lake? Because of the way Intel plans to reportedly split up the two architectures, neither should compete with each directly – at least at first. Remember, Intel's deliberately delaying its 10nm process as part of its 'data centre first' strategy, giving the 10nm tech a chance to ripen on the vine. Eventually, it seems like Cannon Lake and Coffee Lake collide, and then what? At this point, we simply don't know. ⊠

Chips coming by June will herald the next generation of Wi-Fi: 802.11ax

Qualcomm is getting ready to ship sample chips for IEEE 802.11ax, reveals Stephen Lawson

Qualcomm will start shipping sample chips for the next generation of Wi-Fi by June, helping device and network vendors develop products that might quadruple users' speeds and lengthen battery life.

The new silicon uses an early version of IEEE 802.11ax, a specification designed to make wireless LANs more efficient and increase their performance as a result. The formal standard isn't expected to be signed off until late next year, but it's common for some components using a new standard to ship before that step takes place.

This is the next generation of Wi-Fi after 802.11ac, which is already capable of gigabit speeds with the right features and conditions. That technology is still finding its way into consumers' devices and corporate and service-provider networks.

The new 802.11ax standard builds on some of 11ac's tricks and adds some of its own. It's designed to give better performance in tough situations people encounter in the real world, such as environments with competing Wi-Fi networks. Wi-Fi is likely to coexist with – and participate in – an increasingly complex radio environment as advanced LTE and then 5G are deployed.

The specification includes using multiple antennas to send as many as 12 streams of data at the same time, but it also uses technologies from the cellular world, including traffic scheduling, which gets devices on and off the network efficiently, so they don't have to contend with each other as much. This can help cut the power consumption of Wi-Fi by as much as two-thirds, according to Qualcomm. Even users with current 11ac and older 11n devices should

see better performance when they use an 11ax network, according to the company.

Qualcomm called its new product line an end-to-end portfolio because it includes silicon for both ends of a client-to-network connection. The IPQ8074 is an integrated SoC (system on chip) for enterprise access points, service-provider gateways and home Wi-Fi routers. It has four times the capacity of an 11ac part and includes features to cover a wider area and ease harmful interference in areas with many overlapping access points, the company said.

The QCA6290 is an SoC for Wi-Fi devices. It can use both the 2.4GHz and the 5GHz bands at the same time for peak speeds up to 1.8Gb/s, Qualcomm added. It's designed for uses that include 4K Ultra HD video streaming and videoconferencing and in-car Wi-Fi with multiple video streams. ⊠
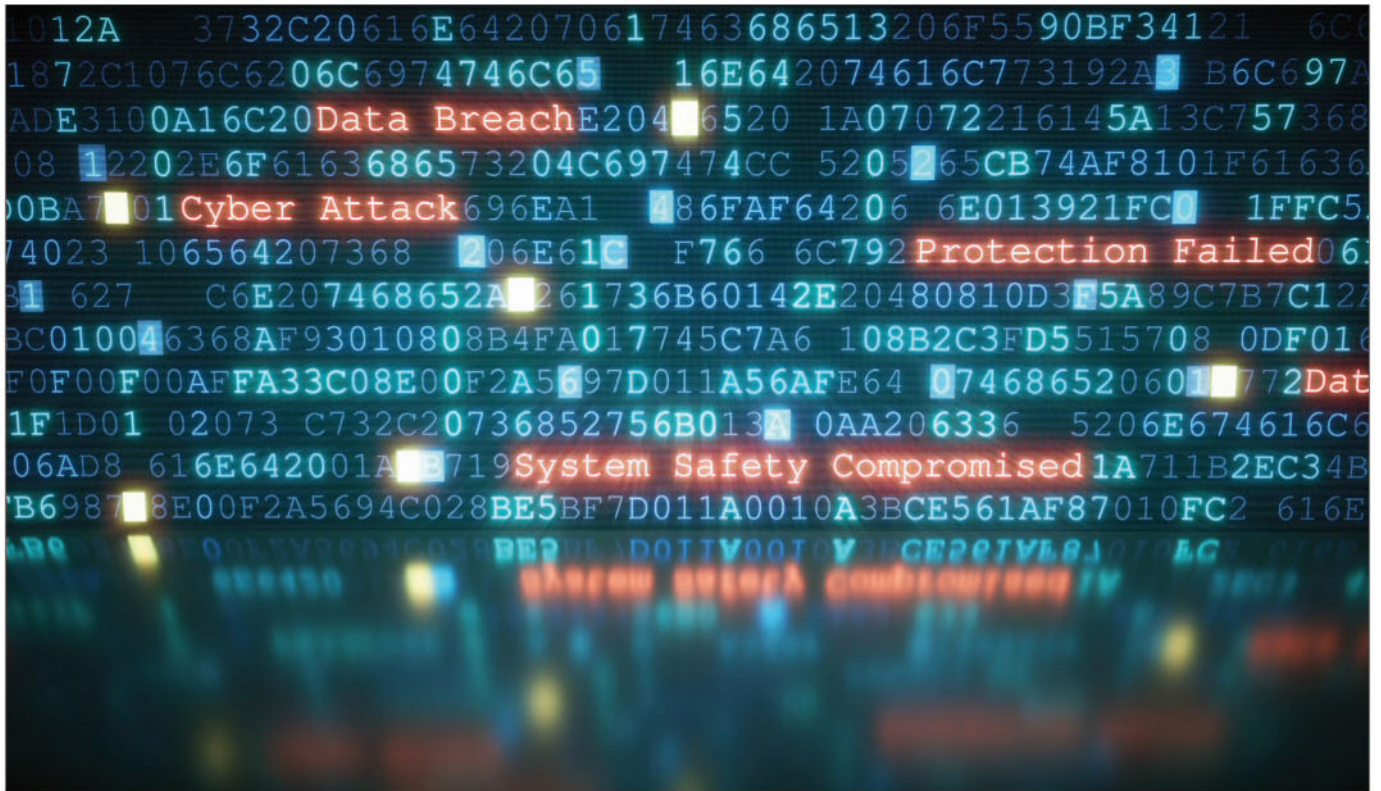
Experts worried about ransomware hitting critical infrastructure

Ransomware continues to be an epidemic for businesses, security experts warn Michael Kan

Expect ransomware to grow more aggressive in the coming years, including higher ransom payments and attempts to go beyond attacking data by shutting down entire computer systems to utilities or factories.

"I see no reason for ransomware to stop," argued Neil Jenkins, the director of the US Department of Homeland Security enterprise performance management office. "It's shown to be effective."

At the recent RSA cybersecurity conference, experts gave a grim outlook on the future of ransomware, which they fear will spread. Through the attacks, cybercriminals have managed to rake in $1 billion in 2016, according to one estimate. The computer infections work by first targeting the victim's data, and encrypting it. The ransomware will then threaten to delete the data, unless a payment, usually in bitcoin, is made.

However, a key concern is that ransomware will start targeting critical infrastructure, added Jenkins. He pointed to the recent example of an Austrian

hotel hit with ransomware that took out its key card system for the hotel doors. Future ransomware attacks might try to lockdown control systems for a water utility, threatening its operations.

Too many important computer systems are also connected to the internet when they shouldn't be, argued Gal Shpantzer, CEO of Security Outliers. Small businesses are also failing to properly segregate their computers from other processes, like a factory assembly line, he said. When a ransomware infection hits, it has the potential to shut down the entire operation.

"That's where ransomware is going to go," Shpantzer added. "I think it's inevitable. People are going to be injured or lose their life. This is starting to affect things that shouldn't be on the internet, or are physically moving."

The hackers behind ransomware infections are also demanding higher and higher payments, some times over $40,000, said Jeremiah Grossman, chief of security strategy at SentinelOne. There have even been a few ransomware cases

where victims had no choice but to pay over seven figures to recover their system, Grossman added, declining to provide details. "Bottom line, it's getting worse out there, and it will continue to do so."

Ransomware infections are already harassing small and medium businesses, according to Robert Gibbons, CTO at security provider Datto. His company conducted a survey that found 60 percent of its partners have experienced one to five ransomware attacks in the last year.

The remainder had experienced over five attacks. "Ransomware is still an epidemic," according to Gibbons.

Experts recommend that businesses and users frequently back up their data and also test to those backups to make sure they work. Security vendors have also published tools that can free computers from some ransomware infections.

When an attack hits, victims may be tempted to pay the hackers the ransom. But Gibbons warned that one out of four times, the hackers still declined to decrypt the victim's data, despite receiving payment. ⊠

Intel now supports Vulkan on Windows 10 PCs

Apollo Lake and Kaby Lake added to the list of chips that support Vulkan, writes Agam Shah

Intel is bringing more options to improve gaming and virtual reality experiences on Windows PCs with official support for Vulkan (API). The cross-platform is similar to DirectX 12, and will work with GPUs integrated into Intel's Kaby Lake, Skylake and Apollo Lake chips.

The firm's support could open the door for Vulkan applications to work on Windows-based VR headsets. Microsoft recently launched VR development kits with tethered headsets at its Game Developers Conference, and later this year, PC makers, including Lenovo, Dell and HP, are expected to release headsets that attach to Windows 10 PCs.

Intel has ramped up the graphics capabilities of its integrated Kaby Lake GPUs, making them capable of 4K graphics. Vulkan will exploit the new features for a better gaming experience.

It's already possible to run Vulkan games on Windows PCs via drivers provided by Nvidia and AMD, but Intel's support for the platform is now official.

Most of the latest Windows games run on closed-source DirectX 12 technology. The open-source Vulkan has many similar features: it takes full advantage of the latest GPUs and CPUs for better graphics. It also uses fewer system resources and can generate images faster.

It's easier to port games from DirectX 12 to Vulkan, which succeeds the older OpenGL set of APIs. Porting games from OpenGL to DirectX was considered time-consuming.
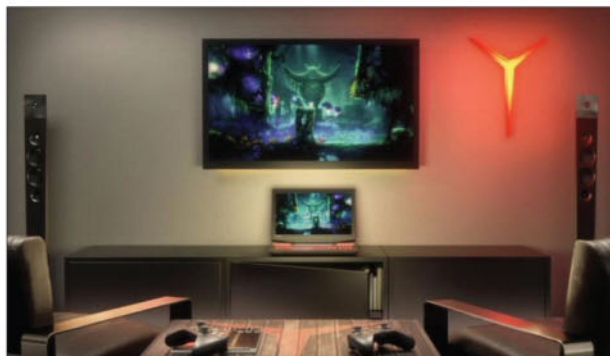
Some premium smartphones such as Samsung's Galaxy S7 also support Vulkan. Games running the platform use fewer system resources and preserve battery life in laptops and mobile devices. It is already seen as a future for gaming on Linux PCs and Steam Machines. ⊠

Google to remove millions of Play Store apps

The crackdown targets apps with questionable privacy policies. Michael Simon reports

Take a look at the digital shelves of the Google Play Store and you're likely to come across a bevy of so-called zombie apps. These typically take the form of a knock-off of a popular game or a sloppy utility that doesn't quite match its description, and they strategically turn up alongside legitimate apps, which makes them hard to spot if you're not doing a forensic analysis of reviews while you shop.

Now it looks like something is finally being done about them. In a letter uncovered by The Next Web, Google has begun warning some developers that one or more of their apps has been flagged for a lack of an adequate privacy policy, a common problem among these sort of hastily published and subsequently ignored apps.

In the message, Google reiterates its policy, which "requires developers to provide a valid privacy policy when the app requests or handles sensitive user information". Such permissions include camera, microphone, account, contacts or phone access, which requires a transparent disclosure of how user data is handled, according to Google's requirements. It's unclear how many letters were sent out, but The Next Web estimates it could affect millions of apps.

This is hardly a new policy for Google, but this push could be the start of a tougher new

application of it. As Google spells out in its developer guidelines: "If your app collects and transmits personal or sensitive user data unrelated to functionality described prominently in the app's listing on Google Play or in the app interface, then prior to the collection and transmission, it must prominently highlight how the user data will be used and have the user provide affirmative consent for such use."

While the lack of a proper privacy policy is most certainly an honest mistake for some developers, it's just as likely that many will ignore this message and face whatever consequences Google has in store for them.

The email urges developers to update their Play Store listings with a valid privacy policy or remove the offending permissions request from the app. It gave a deadline of 15 March to comply with the request or "administrative action will be taken to limit the visibility of your app, up to and including removal from the Play Store".

Google isn't playing around. Developers and users have long complained about the Play Store's somewhat lax rules toward letting these types of apps in, and this could be a sign that Google is finally working to clean things up. The Play Store is littered with apps of questionable repute, and many of them have flown under Google's radar for

Hello Google Play Developer,

Our records show that your app,
with package name
currently violates our User Data policy regarding
Personal and Sensitive Information.

Policy issue: Google Play requires developers to provide a valid privacy policy when the app requests or handles sensitive user or device information. Your app requests sensitive permissions (e.g. camera, microphone, accounts, contacts, or phone) or user data, but does not include a valid privacy policy.

Action required: Include a link to a valid privacy policy on your app's Store Listing page and within your app. You can find more information in our help center.

Alternatively, you may opt-out of this requirement by removing any requests for sensitive permissions or user data.

If you have additional apps in your catalog, please make sure they are compliant with our Prominent Disclosure requirements.

Please resolve this issue by **March 15, 2017**, or administrative action will be taken to limit the visibility of your app, up to and including removal from the Play Store. Thanks for helping us provide a clear and transparent experience for Google Play users.

Regards,

The Google Play Team

too long. This move could negatively impact millions of apps, as well as benefit honest developers, but the effect on users will be even greater, enabling them to seek and find legitimate apps rather than cheap imitations. And by tackling the problem from a privacy standpoint, Google is not only cleaning up the Play Store, it's also recommitting to the security and protection of its users. ⊠
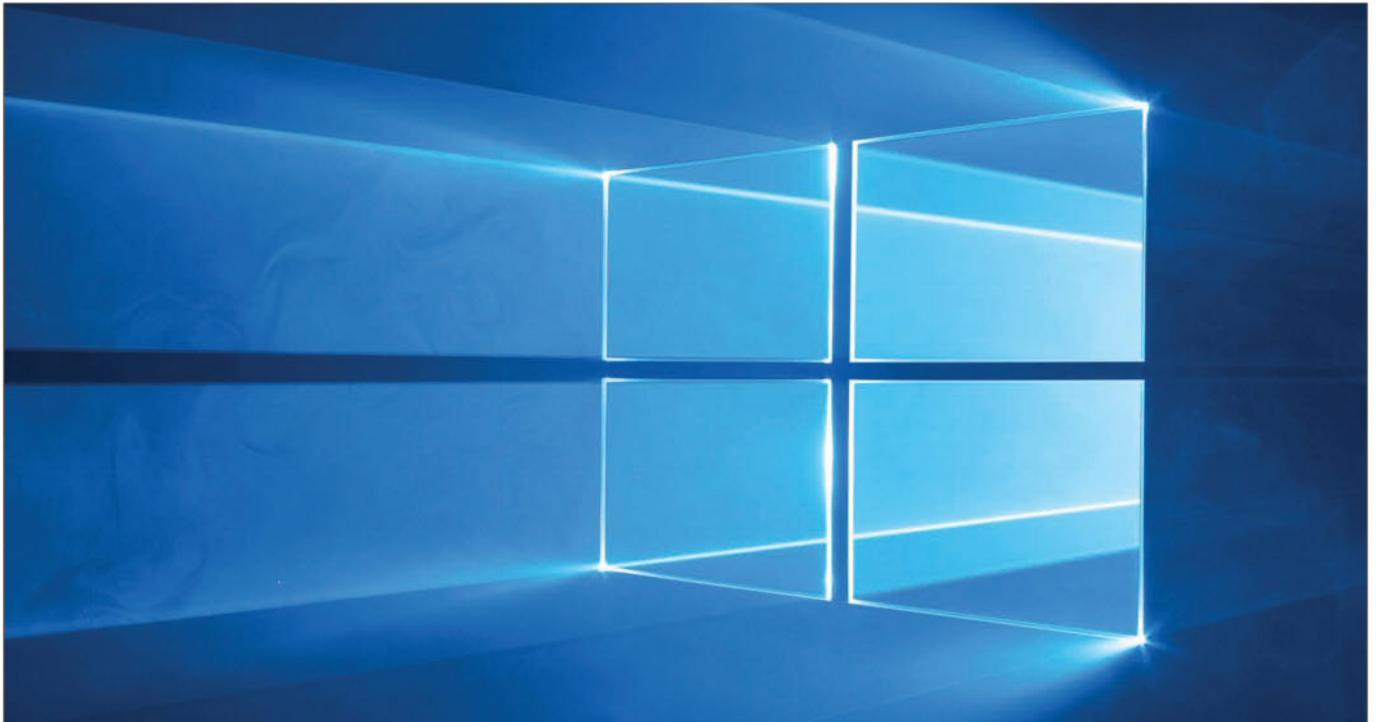
Microsoft teases Windows 10's sleek new look for the future

Project Neon will give your Windows 10 PC a fresh coat of paint later in 2017, reveals Ian Paul

Microsoft is planning a sleek visual refresh for Windows 10, and it quietly teased its first official glimpse of what's coming in the future during its recent Windows Developer Day keynote.

There aren't many details being shared about 'Project Neon' right now – as the refresh was called in earlier leaks – but the new visual look will focus on animations and transitions. The basic concept is "to add fluidity, animation, and blur to apps and the operating system", as first reported by Windows Central. The new design language also hopes to make it easier for developers to create attractive apps.

The design refresh should extend to all Windows 10 devices including PCs and tablets, HoloLens, Xbox, and the few surviving Windows Phones, according to Windows Central.

Twitter user Tom Hounsell shared a clean version of Microsoft's first look at Windows 10's forthcoming design tweaks. The image shown on the livestream had large text overlaid on top of the screenshot (see below).

As you can see this isn't a huge change, but the visual refresh gives Windows 10 a sleeker, more modern feel. The taskbar icons look a little more dynamic and bolder. Cortana is using the icon instead of the search box, though it's not clear if this will be the default look. The clock on the taskbar is also bolder, and the usual notification area icons including the Action Centre are notably absent. The open Groove Music window itself looks more polished and Aero-esque as well, with no title bar to be seen – just unobtrusive options in the app's upper-right corner.

Windows Central says that some of the code for Project Neon is already available in recent Insider Preview builds of Windows 10; however, it's unlikely the visual refresh will be ready in time for the massive Creators Update this spring. Microsoft is expected to share more information about Neon during the Build conference in May. The Creators Update is expected to roll out in late March or early April, followed by a second major update later in 2017. ⊠

Microsoft's first official look at Project Neon
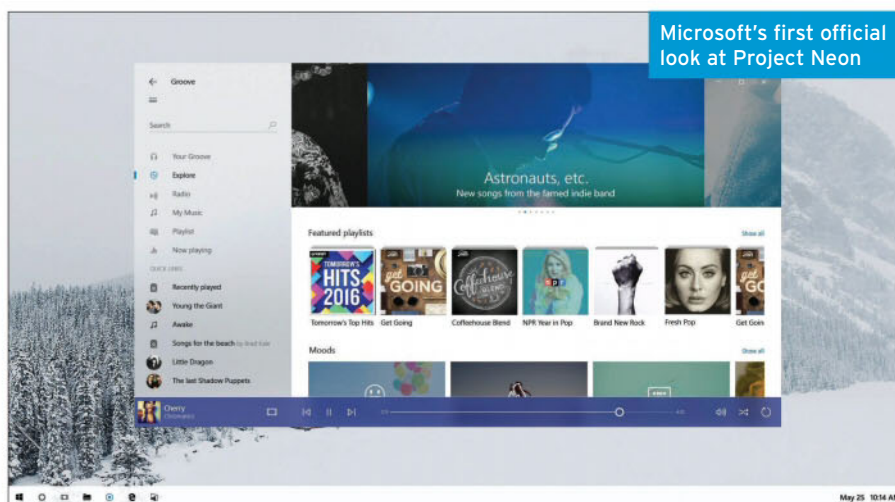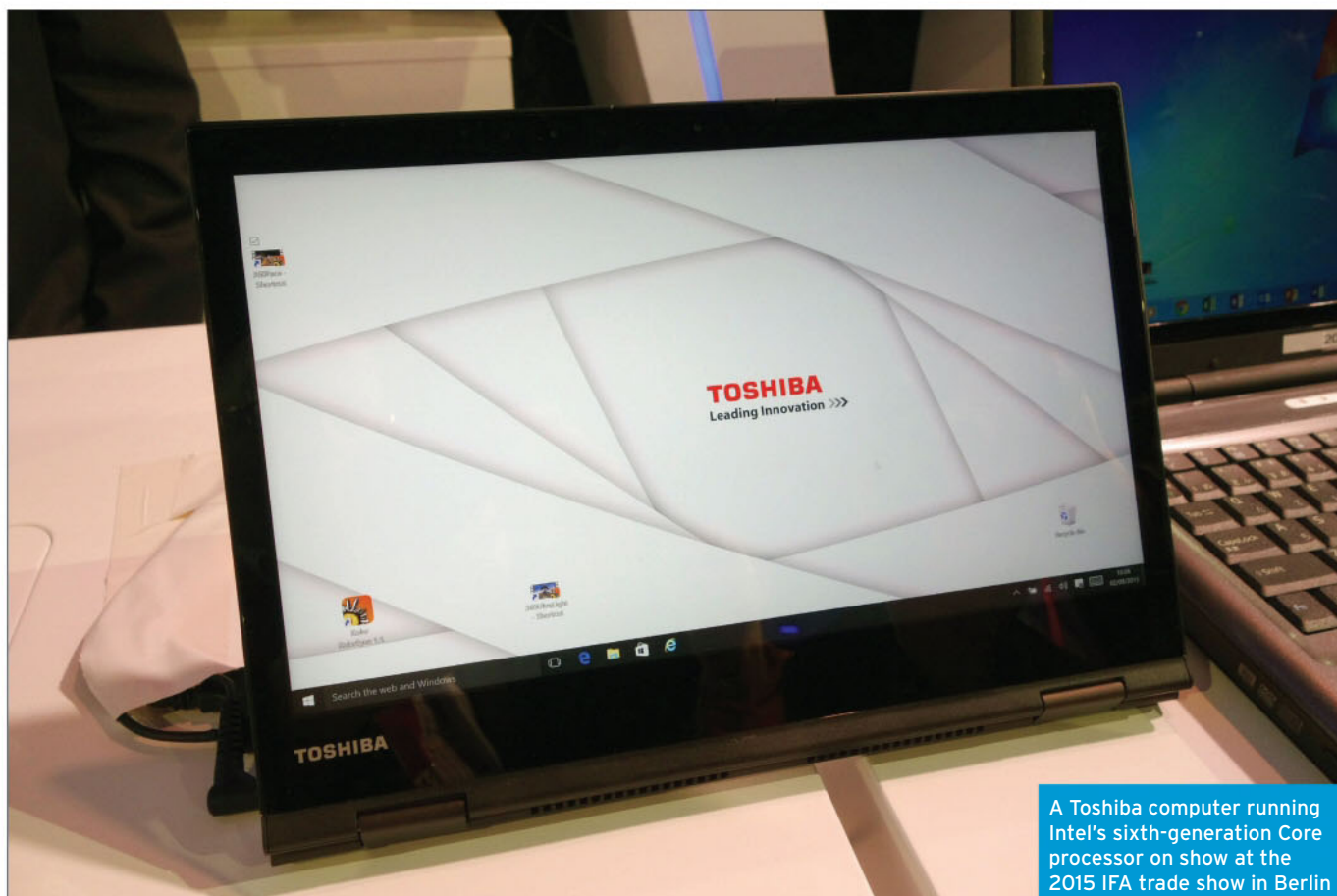
A Toshiba computer running Intel's sixth-generation Core processor on show at the 2015 IFA trade show in Berlin

Toshiba in chaos, but not quitting PCs

Japanese firm selling part of its memory chip business, reports Peter Sayer

Toshiba is more than a laptop maker, but the vast Japanese conglomerate shrunk last month under a wave of bad news. In one day, the company lost its chairman, said it will stop building nuclear power plants, wrote off about $4.8 billion relating to that business, and postponed its fourth-quarter earnings report for a month.

Its financial problems were no secret: it had previously revealed plans to sell stakes in its memory chip and SSD businesses to cover the nuclear write-offs. Last June, it sold an 80 percent stake in its domestic appliances business, Toshiba Lifestyle, for £360 million. Before that sale, it had been planning to develop a series of smart appliances that could link up with its televisions and PCs.

Instead of the final results expected, the company published provisional figures showing negative shareholder equity, and Japanese media reported analyst speculation that the results were delayed because auditors refused to sign off on the accounts. The nuclear write-down, then,

could topple Toshiba, but even if it doesn't, the company could still be forced to sell further assets, perhaps including its PC and laptop business. It's certainly a well-trodden path for Japan's PC makers, and one that Toshiba reportedly has considered before.

Sharp pulled out of the business in 2010 to concentrate on tablets, and Sony sold its Vaio PC business to an investment firm in 2014. That unit now operates as a standalone company under the Vaio name. NEC put its PC business into a joint venture with Lenovo, then sold that company the majority of its stake in July 2016. And last October, Fujitsu said it was discussing a "strategic cooperation" with Lenovo on PC manufacturing.

As for Toshiba, in December 2015 *The Wall Street Journal* reported that the

company wanted to spin off its PC business and had approached other manufacturers, including Vaio and Fujitsu. Those talks apparently came to nothing, and in March 2016, Toshiba announced that it would stop making consumer laptops to focus on the enterprise.

Even if Toshiba sells off its remaining enterprise PC business, it still has fingers in a lot of pies. It makes tablets, TVs, Blu-ray disc players, hard disks and image sensors, and that's just the IT-related activities.

The firm is also involved in power generation, railroads, industrial control systems and something it calls the hydrogen economy, a long-term bid to make hydrogen fuel cells an easy and economic source of electrical energy for isolated homes and island communities. ⊠

Even if Toshiba sells off its remaining enterprise PC business, it still has fingers in a lot of pies. It makes tablets, TVs, Blu-ray disc players, hard disks and image sensors

Tokyo wants to make Olympic medals by recycling old phones

The project seeks gold, silver, and bronze from unused gadgets, writes Martyn Williams

Japan has kicked off a drive to collect old smartphones and other portable gadgets so that they can be turned into medals for the Tokyo 2020 Olympics and Paralympics.

The project was launched by the Tokyo Metropolitan Government with a goal of collecting up to two million used devices to recycle. Gadgets such as smartphones contain small amounts of precious metals in their chips and circuit boards. The quantities are tiny but they are valuable enough to make recovery worth the expense.

In the case of a smartphone there's about 0.048g of gold, 0.26g of silver, and 12.7g of bronze. To make the roughly 5,000 medals that will be awarded in 2020, organisers will need 10kg of gold, 1,230kg of silver and 736kg of bronze. (The amount of gold is much less because those medals are plated and not solid gold).

The campaign is asking the public to turn in used smartphones, digital cameras, video cameras, audio players, portable game devices, remote controls, electronic calculators, GPS units, and AC power adaptors.

While the project will begin small with a single collection point at a convenience store in the Metropolitan Government building, it will go national in April when consumers will be able to donate used gadgets at 2,400 shops of mobile phone carrier NTT DoCoMo. ⊠

Soon your Samsung Galaxy's fingerprint reader will unlock your Windows 10 PC

Fingerprint PC security is within arm's reach. Ian Paul reports

Samsung is telling Galaxy device users they'll soon be able to use their phone's fingerprint sensor to unlock nearly any Windows 10 PC.

The Samsung Flow app currently lets users unlock a Galaxy TabPro S 2-in-1 with the fingerprint sensor on a Galaxy S7, S7 Edge, S6, S6 Edge and Edge+, Note 5 and A7 and A5 devices.

After the Windows 10 Creators Update, however, that login feature will expand to all Windows 10 PCs that have the hardware to support it, as first reported by SamMobile.

"Samsung Flow is compatible with TabPro S now. But it will support all Windows 10 PCs from Windows 10 next major update (estimated early April)," a Samsung representative said in response to a user review on Google Play.

The setup requires the use of the Samsung Flow app on your phone and a special utility installed on the Windows 10 machine to unlock. Unlocking your PC with your Galaxy's fingerprint reader also requires the use of Bluetooth on both devices, and NFC on the smartphone.

The firm's solution is, as the company says on Google Play, a "neat trick", but a native solution would be better. Microsoft added that capability with the Anniversary Update's Windows Hello Companion Device Framework. So far, however, we've seen mostly fitness trackers and security devices such as the Yubi Key take advantage of the authentication feature. Nevertheless, Microsoft has, on several occasions, talked about using Android and iOS smartphones to unlock your Windows 10 PC – most

recently in September during the Microsoft Ignite conference. The company has also been testing PC unlocks with a Windows 10 Mobile authenticator app.

Perhaps the Creators Update will finally bring smartphone unlocks to everyone who has a Bluetooth-enabled PC and phone. If so, that will finally bring Windows 10 up to parity with Chrome OS. ⊠
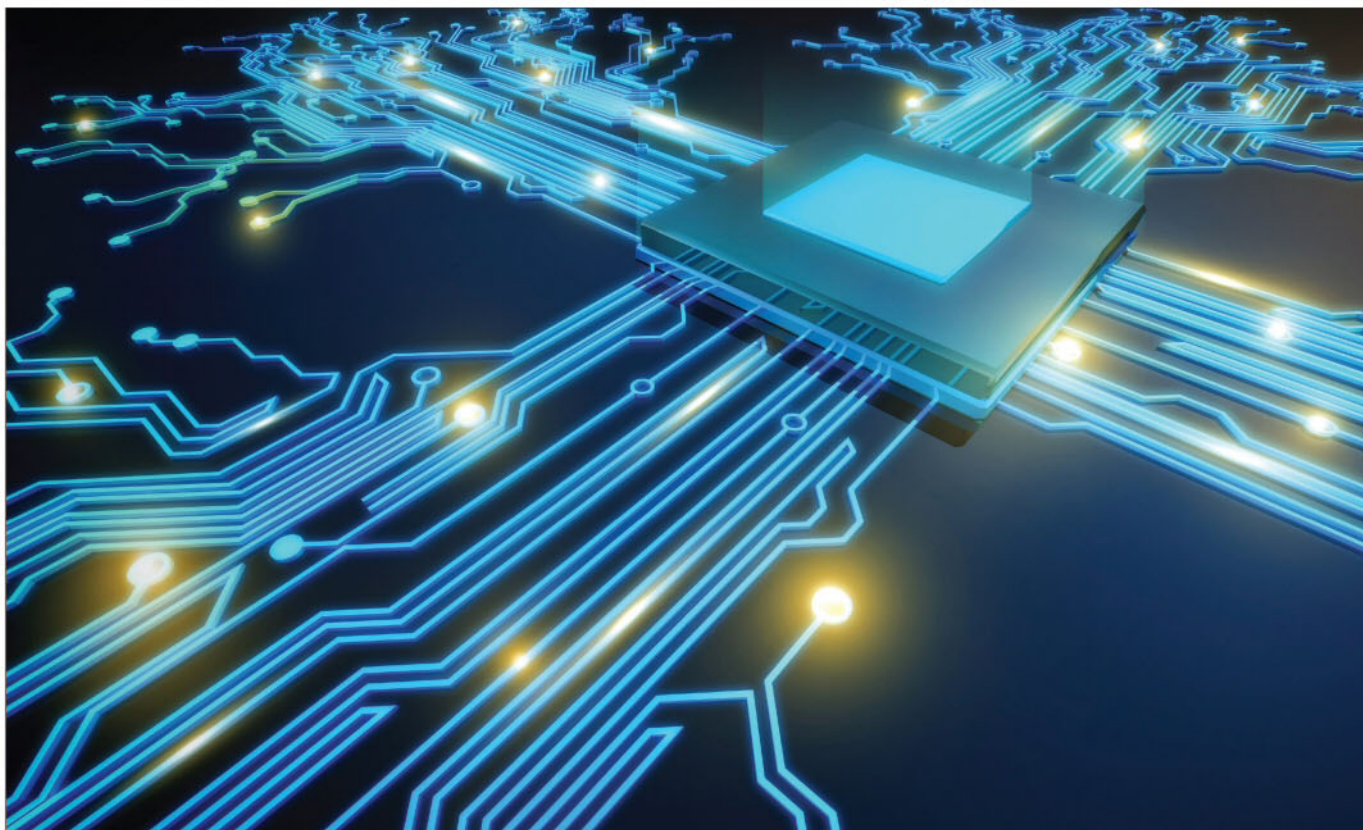
After Ryzen, AMD has no immediate plans to purge its other PC chips

AMD is repackaging its existing chips, from FX to Sempron, for mid-to low-end PCs, finds Agam Shah

AMD's Athlon and Sempron chips may not drum up as much excitement as its Ryzen processors, but customer loyalty has helped them stick around for more than a decade.

So what happens to those and other PC processors such as the A-series and FX when the firm's new Ryzen chips start flooding the market in March? For now, AMD has no plans to make changes to its line-up of existing processors. Instead, they will be regrouped to focus on price-sensitive PC buyers.

Ryzen-based systems are expected to be priced at a premium, competing with Intel's top gaming CPUs. AMD's FX chips will be aimed at budget gamers, while its A-series processors will be targeted at low- to mid-range laptops and Chromebooks.

Unified AM4 socket compatibility helps maintain existing chips and has provided an easy path to Zen-based PC chip upgrade. For example, the AM4 socket supports Zen processors and the recent seventh-generation A-series chips.

Expanding its PC chip line-up will help AMD compete with Intel, from the high- to low end, and it is already gaining in the PC market. The firm had a 13.6 percent share of the x86 chip market in 2016, growing from 12.7 percent in 2015. Intel's share was 86.3 percent in 2016, dropping from 87.1 percent in 2015, according to Mercury Research.

Strong laptop chip shipments in the second half of 2016 and an inventory purge in 2015 helped AMD grow its market share, said Dean McCarron, principal analyst at Mercury Research.

Its most vulnerable chips are Athlon and Sempron, which sit on the bottom rung of the company's line-up. Some brands such as Phenom have died, but Athlon and Sempron have shown amazing staying power thanks to brand loyalty. Those processors will be hard to discontinue overnight. Chips such as the Athlon X4 and FX-4300, which are cheap to manufacture, will keep serving customers' needs and will stay in production for some time to come, argued McCarron.

Also, PC makers need low-end products to segment markets and maintain prices. The price of high-end FX chips helps set a minimum price for Ryzen chips. It also helps retain it as a high-margin product, which is important for AMD in its pursuit of higher profitability.

The low-end chips will also help keep AMD's chip volume active and meet supply agreements. It has an agreement with GlobalFoundries to manufacture a certain number of units each year.

Low-end CPUs are also important to manufacturing. They help write off costs and provide a market for chips with minor defects. It's common for flaws to occur during manufacturing, and affected processors are often are repackaged into low-end parts. This helps reduce inventory and produces revenue from those chips.

AMD can't say it is getting rid of older chips because that would damage partnerships with PC makers and OEMs, argued Jim McGregor, principal analyst at Tirias Research. "They can't displace the entire product portfolio overnight."

At some point, the firm will have to work out which chips to drop. It's likely the those that are most expensive to manufacture will get the boot. ⊠

FOR EVERYTHING
ANDROID

ANDROID ADVISOR

Verdict

The Galaxy Gear is a mixed bag. We love the stylish design and nice screen. It's packed with handy features, but performance and potentially poor battery life are concerns. You can use it with only a handful of Galaxy smartphones, and it's pricey.

version for free will tempt more users to upgrade to the Premium service.

Spotify said users will be able to listen to their playlists and also hit 'shuffle play' to listen to a particular artist's entire back catalogue. The firm has started making available Led Zeppelin's back catalogue, releasing two albums per week.

The firm is also dropping the 10-hours-per-month limit that it had previously imposed on users of its free service.

While Spotify is available on iOS and Android smartphones and tablets, there are no apps for Windows Phone 8 and BlackBerry.

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Specifications
10.1in (1280x800, 149dpi) IPS LCD glossy touchscreen; Windows 10 Home 64-bit; 1.44GHz, up to 1.92GHz Boost Intel Atom x5-Z8350, four cores four threads; Intel HD 400; 4GB SDRAM; 64GB SSD; 802.11b/g/n/ac 1x1; Bluetooth 4.0; 1x USB 3.0 port; 1x Micro-USB; 1x Micro-HDMI; 1x microSD card slot; quad speakers; 2Mp webcam; digital array mic; 3.5mm headset jack; UK tiled keyboard; 30Wh lithium-ion battery non-removable; 259x170x8.2mm (without keyboard); 259x170x13.9mm (with keyboard); 790g (with keyboard); 535g (without keyboard); 1-year RTB warranty

Build: ★★★★☆
Features: ★★★★★
Value: ★★★★☆
Performance: ★★★☆☆

★★★★☆

LAPTOP/TABLET HYBRID

Asus Transformer Mini T102HA

Asus often caters for people who want a £1,000 laptop but have nowhere near that budget. The firm's latest offering is the Transformer Mini T102HA: a low-cost take on the Microsoft Surface Pro 4. It's a laptop with a detachable keyboard, its own kickstand and a stylus. From another perspective, it's just another hybrid, but one with a Surface-flavour twist.

Price
The Transformer Mini T102HA costs £349. That includes the keyboard base, stylus and a one-year warranty. Compare that to the Surface Pro 4 and the huge difference in price is obvious. Microsoft's entry-level model will set you back £749 and the keyboard an additional £109, bringing the total to around £860.

These two hybrids are only comparable in a loose sense though, as the Surface is a lot more powerful and significantly larger. It seems that dramatically undercutting Microsoft is part of Asus's mission statement.

There's also a 128GB SSD version of the Mini T102HA, though as that currently costs £590 it represents a poor-value upgrade.

Design
Considering the low price, Asus has done a great job of holding onto a few hints of higher-end design. The rear is aluminium rather than plastic, for example, and like the Surface there's a smooth-folding kickstand on the back.

This is the main thing that separates the Mini T102HA from older Transformer-series devices, most of which use a keyboard base that the screen slots into. Here, the keyboard is more like a thick, rigid folio cover. It locks onto the display using magnets, and a further set of magnets let the board sit at a slight angle for more comfortable typing.

The keyboard part is fibreglass rather than aluminium, which helps keep the weight down, but its rear is a neat synthetic felt. This doesn't look like a £700 hybrid, but it doesn't seem embarrassingly cheap either. The kickstand isn't as smooth as that of the Surface, but it is easily strong enough to hold the screen at almost any angle. It swivels to around 170 degrees: highly flexible.

At 790g, including the keyboard, the Asus is also light and portable. A 10.1in screen means it's smaller than the 12in MacBook, even though it doesn't have features such as a screen with almost no surround.

There are a few different pros and cons to a Surface-style hybrid like this. Unlike a 360-degree hinge hybrid, the display comes off to function as a proper tablet, and the kickstand means you can lean the device back almost flat and it won't topple over. On the downside, the kickstand feels awkward when resting on your knees and you end up with a keyboard that feels like part of a case.

Connectivity
Asus has taken an old-school approach when it comes to connectivity and doesn't offer a USB-C port. Almost all mobile devices, apart from very cheap models, are likely to feature USB-C in 2017, so sticking with Micro-USB for charging means the Transformer Mini T102HA will date more quickly.

Aside from this though, the connections are smart. There's a USB 3.0 slot, so adding a mouse is a cinch, plus there are Micro-HDMI and microSD ports. It's enough to make the Asus seem like a mini PC rather than the kind of ultraportable that's not really designed to interface with peripherals.

There's also a fingerprint scanner on the rear, used as part of Windows

---

A 10.1in screen means it's smaller than the 12in MacBook, even though it doesn't have 'expensive' features such as a screen with almost no surround

Hello to let you login to Windows 10 without typing a password or code. It gives the Transformer Mini T102HA another feature to show off, but like Windows Hello in general it doesn't end up saving you much time unless you have a longer password. The pad is, however, much pickier about your finger positioning than a phone or Android/iOS tablet scanner. It tended to take us two attempts rather than one to unlock the device.

Keyboard and trackpad

There's a lot of competition if you're out for a slim work machine, the best alternatives being Chromebooks (see our top picks on page 122). One practical issue we

Dragging the stylus across the screen doesn't feel entirely smooth because the nib is basic hard plastic and there is some input lag

encountered is that the keyboard is around 90 percent that of a full size model and until you get used to the new dimensions it will feel a little cramped. This is one of the issues common among 10in hybrids: there isn't room for a full-size keyboard.

There is still a lot to like, though. The fibreglass base is more rigid than the surrounds of some traditional laptops and 1.5mm key travel provides a feel closer to that of a normal keyboard than most tablet add-ons. The key action is basic, less refined and clean than a truly good laptop keyboard. There's also no backlight, though we didn't expect one at this price.

Similarly, the trackpad is a basic rectangle of plastic rather than the textured glass high-end laptops use, but has a nice firm click and while small it doesn't seem undersized relative to the keyboard.

We did, however, have other issues with the Transformer Mini T102HA's pad. For example, it has a tendency to be far too sensitive to the presence of a second finger, often making the cursor suddenly fly across the screen when you click the button, as if you'd also just made a grand swipe across the pad.

For us this is the most annoying part of the Asus. We managed

to improve it by tweaking the Windows mouse driver settings (by stopping light taps on the pad from being registered as 'clicks'), but it seems unlikely many buyers will know how to do this. It's a classic trackpad driver niggle.

Display

The Transformer Mini T102HA also has a 'classic' budget hybrid touchscreen display. Unlike new higher-end models, there's a lot of blank space between the screen and the edge of the device, and resolution is low at 1280x800 pixels. Even at normal viewing distance, you can see pixellation in Windows 10's small fonts. Don't expect the

display quality of a £350 tablet as you'll be disappointed.

In other respects, however, it's perfectly solid. The screen doesn't appear recessed, colours are good for a budget machine and brightness is fantastic. At 410cd/m², it's brighter than a lot of £1,000-plus laptops. This is good news if you want to use the Asus outside, as the glossy top layer causes reflections.

Looking a bit deeper into colour performance, it hits 72.6 percent of the sRGB colour standard. That's not going to give you super-saturated colour, but is typical of a decent-quality budget IPS LCD screen. In person, the Transformer Mini T102HA also seems slightly undersaturated, the deepest reds and blues show up that this is a fairly humble panel.

Contrast also helps keep the screen look lively rather than muted. An excellent 907:1 contrast ratio means blacks appear truly black until you ramp up the screen brightness, and even then they appear slightly grey, which is perhaps better than

them turning blueish. This may not be a screen to show off to iPad Air-owning friends, but in practical terms it has the basics nailed.

The stylus is a AAA battery-powered metal pen that slots into a loop on the keyboard base. It's much more advanced than a basic stylus you might buy for your tablet, with 1,024 pressure sensitivity levels and two buttons that act like L/R mouse buttons. You'll see the cursor on-screen when it's within an inch of the display, too. If you want a hybrid that'll also work as a digital sketchbook, this is one of the best low-cost options. Don't expect iPad Pro-like results, though.

Dragging the stylus across the screen doesn't feel entirely smooth because the nib is basic hard plastic and there is some input lag, a reminder you're using a stylus rather than a real pen. However, remember that an iPad Pro's Apple Pencil alone costs almost a third the price of the whole Transformer Mini T102HA package, so keep your expectations realistic.

Performance

This is not a fast laptop, and like most Intel Atom-powered Windows 10 devices, you do feel slow-down more obviously than in a good cheap Android phone or tablet.

Having used these sorts of devices for years, what continues to annoy us is keyboard input lag. Type something into the Windows search bar or the Internet Explorer address bar and you may have to wait a second as the Asus catches up. Web pages also
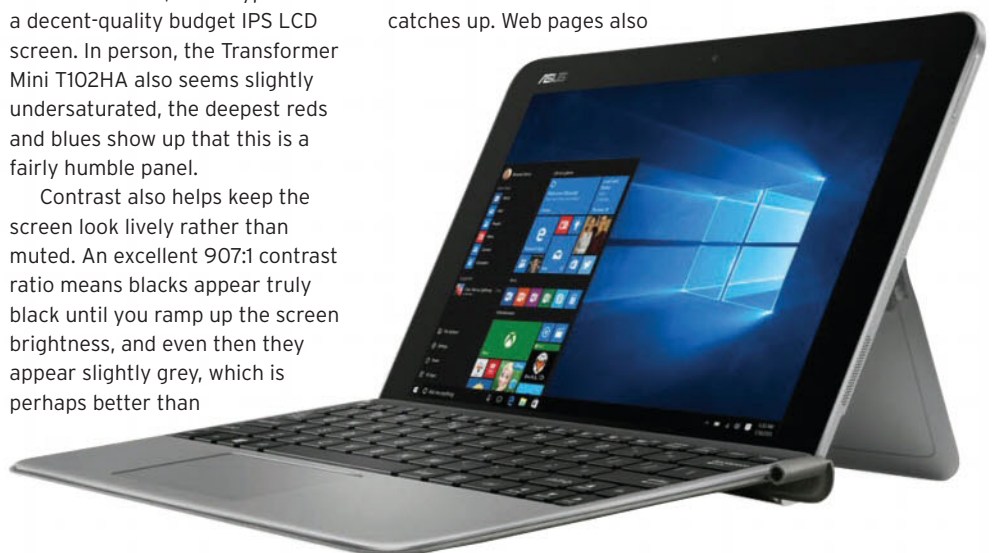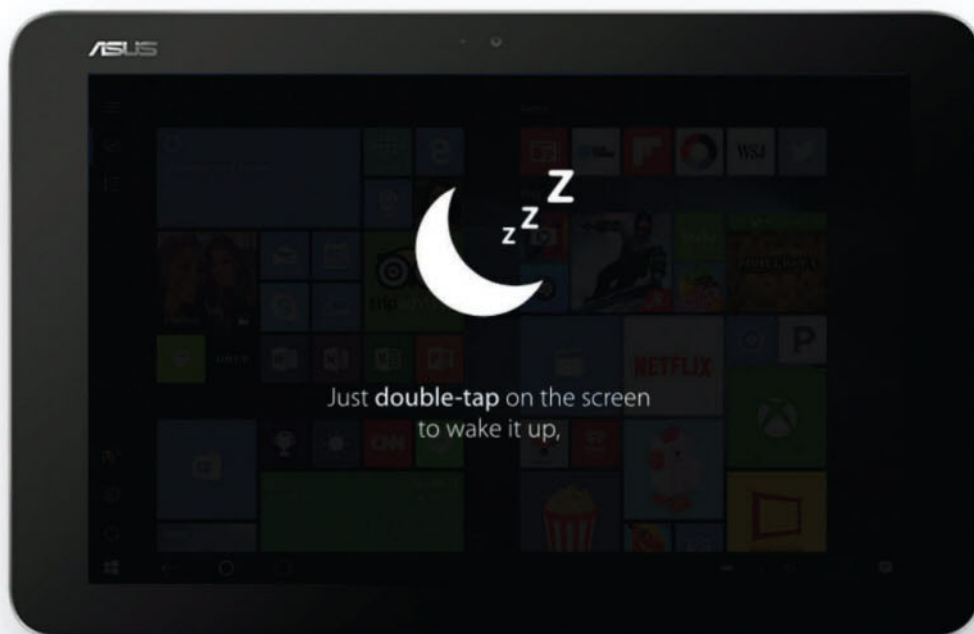
take longer to load than you may be used to as do applications.

However, the Asus still works perfectly well as a light use machine. We could happily use this as a laptop for writing articles and checking emails. Editing photos is, however, a step too far. This also limits the usefulness of the stylus a little if, for example, you want to start creating your own digital art. Add a dozen layers to a complex image and apply some filters and you'll soon find the limits of the device.

That's because it has an Intel Atom x5-8230 CPU rather than a 'premium' Intel Core m or Core i-series one. These are slow, basic processors, clearly shown in the

benchmark results. It scored just 2300 points in Geekbench 4.0 and 1218 in PCMark 8 Home. That's half, or less, of what an Intel Core-series laptop would achieve.

There's also storage to consider. The standard model has a 64GB

SSD, leaving you with around 30GB to actually use. This is slow storage too, not a real solid-state drive. In our tests, we recorded read and write speeds of 144- and 64MB/s respectively, which is likely to become a bottleneck.

Storage capacity may not be a major issue if you only want the Transformer for basic tasks, but it'll quickly get sucked up if you start installing a lot of data-hungry apps or games. We couldn't perform all our usual games tests as the Asus doesn't have enough room for 2013's Thief, for example.

It would be unplayable anyway, as trying the less demanding Alien: Isolation demonstrates. In our tests, it ran at 8fps at 720p with all the visual effects turned down, and 6fps when using the native resolution with effects reinstated. Only very old games will run comfortably.

Thanks to the low-end components, the Asus doesn't need fans, though, making it silent 24/7.

Battery life

Stamina also benefits from CPU style. This is the grade of processor you might see in a phone or tablet and it means the battery lasts for just under 13.5 hours when playing back a 720p video on loop. That's even longer than Asus's own claim of 11 hours. We'd rather have a laptop that lasts eight hours and doesn't lag with basic tasks, but it's still remarkable.

The downside of the battery is charge speed: it takes a few hours. The cable is also disappointingly short, making it tricky to charge while using unless you get an extension cable. It's a tablet-style cable when this is begging for a more laptop-like one.

Audio

The speakers are also tablet-like, with two drivers in the screen part, sitting on the left and right edges. They're good for an affordable

The battery lasts for just under 13.5 hours when playing back a 720p video on loop. That's even longer than Asus's own claim of 11 hours

hybrid, too: loud and not too thin-sounding. A standard 3.5mm jack lets you plug-in headphones or speakers very easily.

Verdict

Buyers are likely to either love the Asus Transformer Mini T102HA or be disappointed by it. Its highs and lows are marked. Don't expect the quality of Microsoft's Surface Pro 4 for less than half the price. While build quality isn't dramatically reduced, general performance is. It's the same old issue with Windows 10 laptops that have Atom processors, making this much slower than a Chromebook or Android hybrid. If, however, you can accept the slower feel, common to everything that runs Microsoft's OS using an Atom CPU, then the T102HA is a handy little machine. Battery life is excellent, the keyboard solid once you become accustomed to its smaller size, and the stylus a fun extra. ⊠ **Andrew Williams**

Specifications
13.3in (1920x1080, 165dpi) LCD glossy with Gorilla Glass 5; Windows 10 Home; 1.2GHz, up to 3.2GHz Turbo Intel Core i5-7Y54, two cores four threads; Intel HD 615 GPU; 8GB RAM DDR3; 256GB SSD; 802.11b/g/n/ac 2x2; Bluetooth 4.0; 2x USB-C 3.1 port; stereo speakers; HD webcam; digital array mic; 3.5mm headset jack; UK tiled keyboard; 41Wh lithium-ion battery non-removable (2770mAh); 325x228x10mm; 1.16kg; 1-year limited warranty

LAPTOP
Acer Swift 7

Build: ★★★★☆
Features: ★★★☆☆
Value: ★★★★☆
Performance: ★★★☆☆

★★★★½

Technology companies love a bit of one-upmanship. The Acer Swift 7 is an ultra-thin laptop, a lot like the HP Spectre but with a price that's slightly easier to swallow. When closed, its thickest edge measures 9.98mm, which makes it the first laptop to be under 1cm thick. A fine achievement, but does it warrant buying one?

Price
In 2016 we saw some scarily expensive laptops, the new MacBook Pro line in particular is pricey enough to suck many bank accounts dry. The Acer Swift 7 isn't cheap, but it does at least slide in just under £1,000. At the time of writing you can find it online for £979, making it a little more affordable than the HP Spectre and £100 cheaper than the closest Dell XPS 13 specification.

There's also only one configuration of the Swift 7 at the time of review: it has an Intel Core i5-7Y54 CPU, 256GB SSD and a 1080p screen. You get a standard one-year warranty, so there's no value added on that front.

Design
The Swift 7's top feature is 9.98mm thickness. That's even slimmer than the 12in MacBook or the HP Spectre. Take the out of its box and it feels like a conventional laptop, though. It's slim and light, but doesn't try to reinvent the laptop in the way the Microsoft Surface Pro 4 did.

There's nothing wrong with that, particularly if you want something familiar to use daily,

but the Swift 7 also doesn't have the ultra-compact style of the Dell XPS 13. There's some space around the keyboard and 'spare' screen surround that makes its width and height conventional. Again, this isn't a bad thing. A solid footprint lets you use the laptop on your knees without it feeling precarious and that 10mm thickness makes it easy to stash in a rucksack or bag. It weighs just 1.16kg, too.

The Acer has an all-aluminium frame, with a black finish on the lid and underside and a much more striking gold inside. As the colour is punchy we would have appreciated a more sober silver or black option, but it still appears tasteful. There are no brushed or textured touches to push it over the edge.

For a laptop this thin, the Swift 7 also feels solid. The keyboard doesn't flex when you press on it and there's only a slight bending of the frame when you hold it by the very edge of the frame.

There are a few little touches that make the design seem slightly less immaculate than a MacBook, such as the way you can tilt the screen so far back the front starts to lift up. However, this may be preferable to the rather limited hinge movement of the HP Spectre.

Connectivity
The Acer Swift 7 is very HP Spectre-like in its connections, though. There are two USB-C ports and a headphone jack. Like many recent style laptops, there's no memory card slot, no HDMI and no full-size

USBs. One of these USB-Cs is also used by the power plug, leaving just the one free while charging.

We're starting to see lots of USB-C connection hubs pop up, so you might want to get hold of one for home use. Photographers and hardcore users should also check out the Dell XPS 13, though. It has an SD card slot and a full-size USB, meaning you won't need to remember to take accessories around with you.

Keyboard and trackpad
One other trait common to an increasing number of super-skinny laptops is a very shallow keyboard. There's more travel than a MacBook, but less movement than an HP Spectre or Dell XPS 13.

While a sound reason to be put off, the laptop does still feel good for long-form typing. It's not clicky but there is a decent amount of resistance to the keys that stops typing from feeling vague.

It's the kind of shallow keyboard we can get on with. However, it doesn't have a backlight, unlike almost every other alternative at the price. At the same price, the Razer Blade Stealth has one that can display any colour of the rainbow.

As laptop users who often end up working in dimly-lit convention halls, we'd find it hard to switch back to a non-lit keyboard. Make sure you won't miss the feature before buying, as plenty of laptops at the price have a backlight.

There are no similar missteps in the trackpad, though. Like

the keyboard, it has a light feel. It's easy to click but with very definite feedback, making quick double-clicks a cinch.

The Swift 7's pad is large too, a rounded-off rectangle that gives you plenty of space for gestures. Its texture is also excellent, using textured glass just like a MacBook or other top-end Windows laptops.

Display

Like the HP Spectre, there's no ultra-high resolution option when buying an Swift 7. It has a 1080p IPS LCD screen with a layer of Gorilla Glass 5 on top providing excellent scratch-resistance. This is the same sort of glass you might see on an expensive phone.

Despite having a glossy, reflective screen, the Acer doesn't have a touchscreen, though. This sort of finish looks flashy, but can become an annoyance when you use the laptop outdoors. However, with top brightness of 368cd/m^2, the display can go bright enough to combat reflections.

Using the laptop as our main work machine, we did notice the conservative resolution as soon as we booted-up the laptop. Icon text looks a little pixellated, and so do smaller characters in websites. Many ultra-slim and stylish alternatives at a similar price use 1080p screens, though.

Display quality is otherwise very good, if not any better than we expect at the price. It covers 85 percent of the sRGB colour standard, meaning colours appear very slightly undersaturated. Coverage of the deeper Adobe RGB and DCI P3

colour standards is unremarkable, at 59.2- and 64.2 percent respectively, so if you're a keen photographer or pro designer, you may want to look for a laptop with a higher-grade screen. For more general use, the display still looks good because of its very solid contrast. At 997:1, it's more impressive than the colour performance, helping the screen appear punchy.

Performance

Acer has taken a rather unusual approach with the processor. Instead of using a normal Core i5 processor, it has an Intel Core i5-7Y54. This is the latest take on Intel's 'Core M' style CPU series, chips designed to use as little energy and create as little heat as possible.

As well has enabling the super-slim design, this lets the Swift 7 get by using passive cooling: heat sinks only. As a result, it's silent, although you will notice some heat in the space above the keyboard when charging or doing anything that gets close to maxing-out the CPU.

Using this sort of processor also means the Swift 7 is less powerful than the much cheaper Acer S13, which uses a conventional Core i-series processor. You won't notice the difference when doing day-to-day laptop tasks. This is seen in some of our benchmark results, too.

In the PCMark 8 Home test, the Acer scored 2234 points, where a normal i5 might score around 2200- to 2400. We got a better result from the Acer S13, but they're in the same class. Similarly, in Geekbench 3.0 and 4.0 it scored 5430 and 5523 points respectively, again very similar to a normal Core i5 Skywell-generation laptop. It's when you start playing games you see the big difference between the Swift 7 and

something like an HP Spectre or Dell XPS 13. The i5-7Y54 has an Intel HD 615 CPU, which is worse than both the Intel HD 620 found in full Core i-series CPUs and the HD 520 of the last generation's set.

Let's compare the Swift 7 with the cheaper Acer S13 to make the difference clearer. Playing Thief at 720p, low detail, you'll get an average of 20.4fps from the S13 but just 14.3fps from the Swift 7. At 1080p, high detail, the S13 manages 5.1fps, the Swift 7 4.5fps.

Results are similarly poor in Alien: Isolation, at 20.5fps (720p) and 10.1 (1080p) where the S13 manages 27.6fps and 12.3fps.

No laptop with an integrated graphics chipset is going to be great for gaming, but the Swift 7 is worse than most at £1,000.

Battery Life

We've seen few of these Core M-style CPUs used in the past year, but it is likely part of the reason why Acer was able to get the Swift 7 quite to thin. It also helps out with battery life. Playing a 720p video on loop at 120cd/m^2 brightness, it lasted eight hours 40 minutes. While not a class-leading result, it's very good given the laptop only has a 2770mAh battery.

Audio

Speaker quality is roughly similar to the better super-slim laptops. It's loud and there's enough bulk to the sound to avoid sounding thin or weak. The best manage to separate out bass notes and give them more weight, and have smoother-sounding treble. However, the Swift 7 sounds good enough to make the speakers usable rather than a high-price embarrassment.

Verdict

Whether the Acer Swift 7 is the right laptop for you depends on how much you care about its 10mm thickness. If you don't mind adding a millimetre or five, you can get laptops with more power and better connectivity for the same price. Hardcore users take note. However, if you like the look and the slim frame means a lot to you, this is a very solid option. A great trackpad and slim but decent keyboard make this an enjoyable laptop, particularly as it can last through a day's work of light tasks. ⊠ **Henry Burrell**

£299 inc VAT

Buy from
■ tinyurl.com/jfgL79x

Specifications
15.6in (1366x768, 100dpi) TN LCD glossy; Windows 10 Home; 1.6GHz, up to 2.56GHz Burst Intel Pentium N3710, four cores four threads; Intel HD 405 GPU; 4GB RAM DDR3; 1TB HDD 5400rpm; 802.11b/g/n; Bluetooth 4.0; 1x USB-C 3.1 port; 1x USB 2.0 port; 1x USB 3.0 port; Ethernet; HDMI; VGA; stereo speakers; HD webcam; Digital array mic; 3.5mm headset jack; UK tiled keyboard; 36Wh 4-cell lithium-ion battery non-removable; 381x252x27.6mm; 2kg; 1-year RTB warranty

Build: ★★★☆☆
Features: ★★★★☆
Value: ★★★★☆
Performance: ★★★☆☆

★★★☆☆

LAPTOP
Asus VivoBook Max X541SA

The VivoBook Max X541SA is a low-cost 15.6in system that's designed for those who want to spend as little as possible while still getting something that looks and feels like a proper laptop.

Design
From arm's length, the silver model appears to be made from metal. The lid and keyboard surround have been designed to mimic brushed aluminium, and the lid has a silver-blue gradient. Unsurprisingly though, given its price, the X541SA is made from plastic. Like most budget laptops, the underside is also black, rather than matching the finish of the rest. (An all-white version is also available.) Similarly, the lid flexes under finger pressure. You will, however, have to accept a few build compromises like this if your budget only stretches to £300.

A perhaps more important area is the keyboard. There is some slight flexing, though not under the pressure of normal typing.

One crucial aspect to take on board is that the Asus is a laptop for home or work use, not one for taking on your travels. It weighs 2kg and is 27mm thick, which we'd consider too chunky to carry around all day.

Connectivity
Unlike slimmer laptops, the X541SA has an optical drive on its right side.

It has a DVD multi-writer. There's a decent spread of connections too: USB 2.0, USB 3.0 and USB-C sockets, VGA and HDMI video outputs and an Ethernet port. A full-size SD memory card slot also sits on underneath the front of the Asus. Almost no premium laptops offer VGA ports these days, but one may be essential if you have an old monitor you need to hook up.

Keyboard and trackpad
As a larger 15.6in laptop, the Asus has room for a numberpad alongside the keyboard. There's plenty of space to go around, and no keys have been made too small as a result. The feel is a little unusual though, particularly now we're accustomed to slim chiclet keyboards. There's a lot of travel to the keys, but they are also springy.

In a more expensive laptop this would be a major issue, but like the all-plastic build, a slightly patchy keyboard is to be expected at this price. There's also no backlight to help when working in a darker room, though at this price we'd have been surprised if Asus had included one.

The trackpad is solid, but again has some elements that seem rather basic. Positives include that it's smooth, is a good size and doesn't suffer from any annoying driver issues that make it appear to wilfully misbehave with Windows 10. On the downside, its clicker is stiff and a little harder to press than is necessary, and loud. This only becomes obvious when you try to double-click, though.

Display
Like almost every budget laptop, the Asus has a TN screen rather than the IPS kind more popular these days. These tend to have fast response times, but almost universally look worse than their IPS cousins because of the relatively narrow viewing angles.

This doesn't just affect looking at the screen from an extreme angle, as the character of the display alters from just a few degrees of tilt. Looking at the laptop dead on, the contrast appears different at the bottom of the screen than the top.

It's 15.6 inches across, which gives you plenty of space to work

——————

The VivoBook Max X541SA's lid and keyboard surround have been designed to mimic brushed aluminium, and the lid has a silver-blue gradient

on, but as the resolution is relatively low at 1366x768 there aren't enough pixels to make cramming in loads of windows a good idea.

Cementing its position as a home laptop rather than one to use on your travels, the maximum brightness is unremarkable at 210cd/m² and a glossy screen finish means reflections are an issue if you're not careful about how the laptop is angled.

Colour performance is limited too, although that's no surprise given it's a TN panel. The X541SA covers 59 percent of the sRGB colour standard, 41 percent of Adobe RGB and 42.2 percent of DCI P3. While not a bad result for this type of panel, it's not suitable for editing photos. In person, though, colour is one of the screen's stronger suits. It's perfectly good for general use, even if the punch of its tones is reduced by the poor 344:1 contrast.

Performance

One other big sub-£300 laptop sacrifice is performance. The Asus uses an Intel Pentium N3710 CPU rather than the Core i-series processors we'd recommend to anyone using Windows 10 every day.

For a little more context, all Core i-series CPUs can be considered 'premium' chipsets, even the Core i3. Intel's Pentium, Celeron and Atom models are used in lower-cost machines. For a laptop like the X541SA, the Pentium range is the best of the three. It uses more energy than an Atom, but tends to offer more power than either an Atom or Celeron chipset.

At maximum volume you will hear some distortion with certain content, but there's real mid-range bulk here and an approximation of bass

The Pentium N3710 is a quad-core CPU with a clock speed of 1.6GHz and a 2.56GHz burst mode. It offers acceptable performance with Windows 10, but we wouldn't say much more than that. Apps take a little while to load, and the system feels less responsive than a laptop with a Core i3. It's an important distinction as models like the HP 250 G5 offer Core i3 power for £350. That's more money, of course, but if you use your laptop for several hours a day, we'd argue the performance boost is worth paying the extra. Core i processors run Windows 10 as Microsoft intended, while Pentiums feel compromised.

Doing much more than basic tasks such as web browsing or writing documents makes the X541SA feel distinctly sluggish. And even the basics of Windows run slower than they would in a slightly more expensive machine.

Aside from the CPU, the X541SA has 4GB DDR3 RAM and a 1TB hard drive. There's plenty of storage, but this is a slow 5400rpm drive, which will contribute to the slightly slow feel of the operating system.

The Pentium N3710 also has a much worse GPU than the Core i3 family. It's the Intel HD 405, making all but the most basic of gaming inadvisable. As the laptop has a 1366x768-pixel screen we couldn't run our usual 1080p gaming tests, but even at 720p the results were terrible. With settings minimised, Thief ran at 5.9fps and Alien Isolation at 8.25fps. Neither was remotely playable, and those games slow down to 2.5fps (Thief) and 7.5fps (Alien) at native resolution with visual effects increased. If you want to play some basic titles, then the Asus should handle them just fine, but for more console-like games you'll need to look for ones at least a decade old.

It's also worth noting that this is a loud PC, with fans that seem to turn on regularly even when you're doing something undemanding such as watching a video. They are not high-pitch, but have a distinct almost husky tone that is noticeable in a quiet room.

Audio

The speakers are a pleasant surprise after all that. For a cheap laptop, they're rather good. They live behind the circular grilles above the keyboard and have a much fuller tone, and louder output, than we expected given the sacrifices elsewhere. At maximum volume you will hear some distortion with certain content, but there's real mid-range bulk here and an approximation of bass. We'd happily watch a film on this laptop.

Battery life

We wouldn't rely on the Asus for use away from the mains for extended periods though, as the battery life is not good enough. It lasted just three hours 57 minutes playing a 720p video on loop at standard 120cd/m² brightness (the sort of level you might use indoors).

Such pedestrian battery life is disappointing when the Pentium N3710 is still a low-power CPU with a 14nm architecture.

Verdict

The Asus VivoBook Max X541SA is a laptop that's designed for those who want a solid, cheap computer. It has some neat extras such as a large hard drive, a fake brushed metal finish and speakers that sound much better than most at the price. However, if you are looking for a computer that you'll use extensively most days we'd strongly advise getting one with an Intel Core i3 CPU rather than the Intel Pentium used here. While it's the 'next best' option, it is noticeably slower, regardless of what you're doing. If £300, or even £400, is your maximum budget you also have to accept that you won't get a great-looking screen. The VivoBook's dated display technology ensures image quality is, at best, passable. ⊠ **Andrew Williams**

Specifications
14.1in full-HD (1920x1080, 16:9) matte IPS display; Windows 10 Home 64-bit; 1.1- to 2.2GHz Intel Celeron N3450 (Apollo Lake) quad-core 64-bit processor; Intel 9th-gen Graphics 500; DirectX 12; 4GB DDR3L RAM; 64GB eMMC storage; 1x USB 3.0; 1x USB 2.0; 1x Micro-HDMI; DC charging port; microSD support (up to 128GB); dual-band 802.11a/b/g/n/ac Wi-Fi; OT; Bluetooth 4.0; 3.5mm headphone jack; 2Mp webcam; built-in dual-channel speaker; mic; 9000mAh lithium-polymer battery (up to 4 hours video playback); 329.2x220.5x9-20.5mm; 1.5kg

Build: ★★★½☆
Features: ★★★½☆
Value: ★★★★★
Performance: ★★★½☆

★★★★☆

LAPTOP
Chuwi LapBook 14.1

We've reviewed several Chuwi hybrid tablet-laptops in the past, but this is the first full laptop we've seen from the Chinese brand. Rather than a touchscreen tablet that docks into a keyboard, this is a proper laptop with a laptop processor – albeit a low-energy chip. The LapBook 14.1 is Chuwi's second notebook, almost identical to the larger LapBook 15.6 but with improved performance.

Highlights in the specification include a 14.1in full-HD IPS display and solid battery life that should get you through the most part of a working day. It's not a laptop built for ultimate performance, but you'd be hard-pushed to find more for your money. Let's take a closer look at the LapBook 14.1.

Price
Chuwi's Windows 10 line is not sold in the UK through the likes of PC World or Amazon, instead you must purchase it through a Chinese dealer such as GearBest (gearbest.com), which will import it to the UK for you. This isn't at all complicated, and free shipping to the UK is available, though you should note that there are some pitfalls.

First and foremost, technical support and aftercare can be an issue should something go wrong. Most people will find no issues and no cause to call for help, but should you find the need you may find getting what you're looking for – an in particular a refund or

replacement – more complicated. Secondly, because this item ships from China you will likely be asked to pay import duty. This is calculated at 20 percent of whatever value is on the shipping paperwork, plus an admin fee of around £11.

At the time of writing, the Chuwi LapBook 14.1 is available for £224. Even with import duty, it will still come in way under £300 and, as we'll discover below, that makes it a real bargain.

Design
We're not going to pretend this is something it isn't, but for the money it's very difficult to fault the design of the Chuwi LapBook 14.1. It's built entirely from plastic, but with none of the usual creaking and flexing. We think it actually looks rather nice for a budget laptop.

There are no cooling fans or heat vents, but the low-power processor inside means the LapBook really doesn't need them. Two speaker grilles are found on the base of the laptop, and while we'd obviously prefer them up top for clearer audio we do like the extra room this setup allows for a full-size keyboard. It's a US keyboard, with

no UK option available, but if you can live without a '£' key you'll find it just fine. The scissor-type flat tiles are of a reasonable size, quiet in use and with a nice spring to them. There's no separate numberpad, nor controls for the screen brightness, but everything else is present and correct. Our only real concern is the positioning of the power button at the top right – we kept accidentally hitting this when going for Delete.

The LapBook is white in the main, with a textured surface that stops it feeling overly cheap, while the screen surround and keyboard are black. Unlike most cheap laptops, the Chuwi LapBook has incredibly thin screen bezels – just 8mm to the left and right, but a little larger above and below where you get the integrated 2Mp webcam and Chuwi logo.

Whereas most cheap tech comes plastered with various legends and specifications, the LapBook is by contrast very clean and inoffensive, with just a small Chuwi LapBook logo in the bottom right corner of the lid, and a small Intel logo with a few specifications on the rear.

This is a highly portable, thin and light laptop, weighing in at just

The LapBook is white in the main, with a textured surface that stops it feeling overly cheap, while the screen surround and keyboard are black

1.5kg and with a tapering design that goes from 20.5mm at its highest point to just 9mm at the front. It has a 9000mAh battery inside that, in our experience, should last most of a working day (obviously depending on your usage). Unfortunately, when the battery does run dry this Chuwi LapBook requires a proprietary DC charger with a two-pin EU connector (you'll need a UK three-pin adaptor), unlike other models in the range that charge over Micro-USB or USB-C.

Speaking of which, you'll find a USB slot on either side of the machine, one USB 2.0 and the other USB 3.0. These ports are joined by a 3.5mm headphone jack, a microSD slot that can boost storage by up to 128GB and Micro-HDMI, which is useful for hooking up the LapBook to a second screen or projector. There's no ethernet port or SIM slot though, so connectivity is restricted to dual-band 802.11a/b/g/n/ac Wi-Fi or Bluetooth 4.0.

The highlight of the Chuwi LapBook's design is its 14.1in full-HD (1920x1080) 16:9 IPS display. This is a matte panel, which means no annoying reflections or glare, and is usefully bright, sharp and with strong viewing angles and realistic colours. It lies back sufficiently far for comfortable working on a lap, too.

The weakest component is the trackpad. It's a large, matte-touch trackpad centrally located below the keyboard. It supports gestures but unfortunately it's just too sensitive, and we found that in use we'd routinely click the bottom corner and open the Start menu. For occasional use it should do the job, but for anything more you will want a proper mouse.

Performance

The Chuwi LapBook 14.1 comes with the same 64GB storage and 4GB DDR3L RAM options as most cheap Windows 10 laptops and tablets, but the processor has been upgraded. Rather than the Intel Atom X5 Z8300 Cherry Trail chip we usually see, this laptop has been fitted with the Intel Celeron N3450, an Apollo Lake processor clocked at 1.1GHz that can Turbo Boost up to 2.2GHz when required. It is said to offer a 30 percent performance boost over the previous generation.

This is still not a fast laptop by any stretch of the mind, but it is quicker than many of its rivals as a result of the new processor, and also benefits from Intel Graphics 500. Our benchmark results show just how much of a difference this new combination can make when compared to a Z8300 laptop such as the similarly priced Jumper EZBook Air.

Whereas the EZBook scored 1052 points in the PCMark 8 Home test, the Chuwi scored 1411. It also beat it hands-down in Geekbench 4.0, with 3664 points against the Jumper's 2050.

Graphics were also slightly improved, with the LapBook turning in scores of 28fps and 13fps in GFXBench T-Rex and Manhattan where the Cherry Trail laptop managed 26fps and 13fps respectively. We also recorded 10fps in Manhattan 3.1 and 7fps in Car Chase for the LapBook.

It really isn't all about the benchmarks though, because this is not a laptop that has been designed to be a powerhouse.

Its intended usage ranges from writing emails and enjoying social media to browsing the web and some casual gaming at low settings. For that type of use, it is very responsive and feels incredibly nippy, but compare it against one of the best laptops you can buy and there's no competition.

One thing we were very pleasantly surprised by is how quick the Chuwi LapBook boots up and is ready to go. We have never seen a laptop – especially a budget laptop – so quick on its toes.

Using flash storage is often a good way to speed up a laptop, and the LapBook has 64GB as standard of which you'll find around 35GB is available. This isn't a true SSD but eMMC storage, which is basically like a microSD card. You can add a further 128GB of storage via a microSD card or plug in an external hard drive if required.

When compared to the Jumper EZBook Air this Chuwi has more than a faster processor and improved graphics on its side. There's also the larger screen, higher-rated 2Mp webcam, support for microSD, and more ports – the Jumper has a single USB-C port, which is out of action for peripherals as it charges.

In common with that laptop it runs a full version of Windows 10 Home 64-bit with zero bloatware. This has been activated, but out of the box a Chuwi user account has been set up – you may wish to factory reset it before making yourself at home.

Bear in mind before you buy the Chuwi LapBook that it is not intended to be user-upgradeable. So don't buy it assuming you're getting a cheap deal that you can improve with a few simple upgrades. Buy it for what it is now.

Verdict

Chuwi's LapBook is not the fastest laptop you can buy by any stretch of the mind, but it is both capable for most daily tasks and more up to the job than most cheap Windows 10 laptops. The full-HD screen and full-size keyboard are highlights, as is the incredibly quick startup, but you'll want a proper mouse to get around that awful trackpad. Recommended for those looking for a usable Windows 10 laptop at an attractive price. ⊠ **Marie Brewis**

Specifications
5.2in full-HD (1920x1080) SuperAMOLED screen, always-on display; Android 6.0.1 Marshmallow with TouchWiz; 1.9GHz Eynos octa-core processor; Mali-T830 GPU; 3GB RAM; 32GB storage; microSD up to 256GB; IP68; 802.11a/b/g/n/ac Wi-Fi; Bluetooth 4.2; NFC; GPS; GLONASS; 16Mp, f/1.9 rear camera, single-LED flash; 16Mp, f/1.9 front camera; 3000mAh non-removable battery, fast charging; USB-C; 146.1x71.4x7.9mm; 157g

Build: ★★★★⯪
Features: ★★★★⯪
Value: ★★★☆☆
Performance: ★★★★☆

★★★★☆
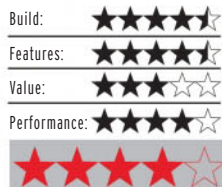
SMARTPHONE
Samsung Galaxy A5 (2017)

Samsung's A-series of mid-range Galaxy smartphones has been updated for 2017. This A5 is the middle model, with the smaller, cheaper and less powerful A3 (2017) below it and the larger A7 (2017) above. The new A5 shares many of the same specifications as the latest A7, and in our opinion offers much better value unless you particularly demand the larger screen. All three adopt the same design, one we've seen previously in the gorgeous Samsung Galaxy S7.

Price
Because this is a brand-new phone, chances are right now you'll pay close to its RRP to get it SIM-free – and clearly the improvements to the Galaxy A5 (2017) have come at a price, since its RRP has shot up from £319 to £399, taking it away from the affordable mid-ground and dangerously close to flagship territory.

At this price there is a difference of just £47 between this Galaxy A5 and the Galaxy S7 (you can now buy the year-old Galaxy S7 SIM-free from Amazon.co.uk for £446).

That RRP comes from MobileFun, though, which supplied our Galaxy A5 for review. You will find it a little cheaper if you shop around online through the likes of Carphone Warehouse, which at the time of writing lists the Galaxy A5 (2017) at £369. The extra £30 discount could be enough to sway you over the Galaxy S7, but it all depends on how tight is your budget.

As with all Samsung phones, we expect the price to rapidly drop – usually by as much as 20 percent within the first few months. At which point the Galaxy A5 (2017) would offer better value, though brand-new today it just doesn't represent a good deal when compared to the high-end Galaxy S7, which we still regard as the best Android phone on the market.

The alternative, of course, is to get the Galaxy A5 on a contract. While monthly prices for the Galaxy S7 (with no upfront charge) start at £30.99, you can get this Galaxy A5 from £27.50 per month. That seems to be a relatively small saving, but over the course of 24 months it works out just short of £85.

MobileFun supplied our Galaxy A5 2017 with a handful of cases to protect it from damage. It sells a wide range of Galaxy A5 (2017) cases and covers, chargers, car holders, screen protectors and other accessories. It particularly recommended to us the official Samsung S View Premium Cover Case (£34.99), which comes in black, blue, pink and gold to match the available colours of the Galaxy A5, the Olixar FlexiShield Samsung Galaxy A5 Gel Case (£4.99) and the Olixar Ultra-Thin Samsung Galaxy A5 (2017) Case (£5.99), covering a range of styles and budgets. The latter is not only cheap but as close as you'll get to invisible should you want to show off the Galaxy A5's gorgeous design.

Design
If you've ever played with a Galaxy S7, you will know roughly what the A5 (2017) looks and feels like. In our office at least, we found the tendency was to think of it as a smaller S7, which is crazy since it's actually larger – albeit only just.

The reason for this is the ever so slightly larger screen – 5.2in against the S7's 5.1in. The S7 is both shorter and narrower than the A5 (2017), measuring 142x70mm against its 146.1x71.4mm, although with matching 3000mAh batteries inside both are 7.9mm thick. That's not bad for a mid-range phone such as this.

The screen might be larger, but it has significantly fewer pixels. The S7 has a Quad-HD resolution of 2560x1440 pixels, turning in a screen density of 577ppi, while the full-HD resolution of this 1920x1080-pixel panel works out at just 424ppi. We say 'just', it's actually a very sharp screen (sharper than that of any iPhone, for example), simply inferior to that of the Galaxy S7.

We can't complain about the display, though, which uses our personal favourite SuperAMOLED tech. SuperAMOLED produces rich, vibrant, saturated colours with deep blacks and dazzling whites. Viewing angles are excellent, and the display is very bright and clear – a pleasure to use. Another plus: SuperAMOLED places less of a hit on battery life than many competing technologies.

New to the Galaxy A5 is Samsung's always-on display. We're still not convinced as to whether it is much more than a gimmick, but experts tell us that we each check our phones several hundred times a day. By displaying the information we need on the screen at all times we don't need to wake the screen to read it, which saves time and power. And although it is on at all times (unless you specifically turn it off in the settings), the feature uses very little battery life.

Everything we said about the improvements to the S7 design is also true here. The A5 of 2016 was

a fantastic-looking device, but this year's model is much more refined. The newly curved rear edges result in a glass-backed phone that make it less slippery in the hand and more comfortable to hold. It feels far less fragile – and that's not just down to the glass.

The addition of IP68 certification, which means it is resistant to dust and water and can survive a 1.5m dunk for up to 30 minutes, is very welcome. And pleasingly, as with the Galaxy S7, it has been achieved without fiddly port covers and flaps but the application of an anti-corrosive coating to the metalwork.

As USB-C becomes more mainstream – and will eventually become the standard for all Android phones – we're pleased to see Samsung has finally brought it to its smartphone line-up. USB-C is more convenient, a reversible port that Apple users have enjoyed for years, and potentially much faster than Micro-USB. USB-C will almost certainly be added in the next Galaxy S-series update, too.

The positioning of the speaker on the device's top right edge is a welcome move, since no matter how you hold it you'll struggle to muffle the sound. Pleasingly, following rumours Samsung would move to USB-C audio only, you also get a standard 3.5mm jack on the bottom of the phone.

The Galaxy A5 2017 is available in Black, Gold, Peach Cloud and a new Blue model replacing last year's White. We tried both the Black and Gold models, and though both are very good looking we very much prefer the black version. It will be worth your while trying them in store before you decide which is right for you.

Performance

The Galaxy A5 (2017) has had a decent upgrade on the inside, and is now significantly faster than last year's model. There's an octa-core Exynos processor clocked at 1.9GHz which builds in the Mali-T830 GPU. Samsung has also increased the RAM allocation from 2- to 3GB, and doubled the internal storage – now 32GB as standard.

TouchWiz, Samsung's own user interface that is applied over Android 6.0.1 Marshmallow, has been significantly slimmed down over recent years, and is now much

more user-friendly. There is still a lot of preinstalled software compared to some Android phones, with just 22.7GB of that 32GB available out of the box. Nevertheless, the interface feels smooth and fluid, and you can always add on more storage with up to 256GB possible via the microSD slot.

We ran the Galaxy A5 (2017) through our usual performance benchmarks and found decent performance that translates to a genuinely usable device in real-world use. Unfortunately, we have no Geekbench 4 scores with which to compare the Galaxy S7 and A5 (2016), since these were tested under Geekbench 3, but from the other results it's clear that the A5 (2017) has improved on all fronts. Gaming framerates are higher, as is general processing performance. It might be a mid-range phone, but it's capable of helping you fulfil all your daily tasks.

In Geekbench 4 we recorded a single-core score of 775 points, but with all its eight cores in action it gave a multi-core result of 4125 points. As a guide, 4000 points is the baseline set by an Intel Core i7-6600U processor, and higher scores are better. This score is right up there with many of today's flagships, though its AnTuTu 6 score of 60,437 is significantly lower.

Decent gaming framerates of 33-, 15-, 9- and 5fps respectively in GFXBench's T-Rex, Manhattan, Manhattan 3.1 and Car Chase components are partially thanks to a lower-resolution full-HD screen, since we run only GFXBench's on-screen tests, and yet they are still some way off those achieved by the Quad-HD-display S7. For casual gaming, though, you should have no problem with the A5 (2017).

Our final test is JetStream, a JavaScript benchmark, and here the Galaxy A5 turned in 25.959. That's a score very much in line with its mid-range rivals. You can compare the Galaxy A5 (2017)'s benchmark results with its predecessor and the Galaxy S7 in the chart above.

Inside the A5 (2017) is a 3000mAh battery, which matches the capacity of the S7 and is 100mAh higher in capacity than that of its predecessor. Because the phone doesn't use a Snapdragon processor it does not support Quick Charge, but just like Samsung's

GFXBench Manhattan

Samsung Galaxy A5 2017
Samsung Galaxy A5 2016
Samsung Galaxy S7

0 2 4 6 8 10 12 14 16 18 20 22 24 26

GFXBench T-Rex

Samsung Galaxy A5 2017
Samsung Galaxy A5 2016
Samsung Galaxy S7

0 5 10 15 20 25 30 35 40 45 50

JetStream

Samsung Galaxy A5 2017
Samsung Galaxy A5 2016
Samsung Galaxy S7

0 5 10 15 20 25 30 35 40 45 50 55 60
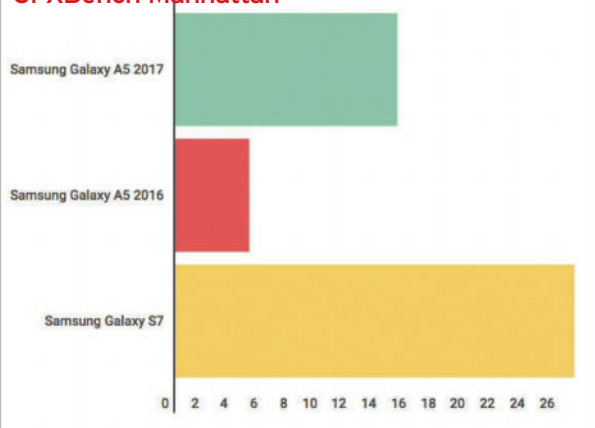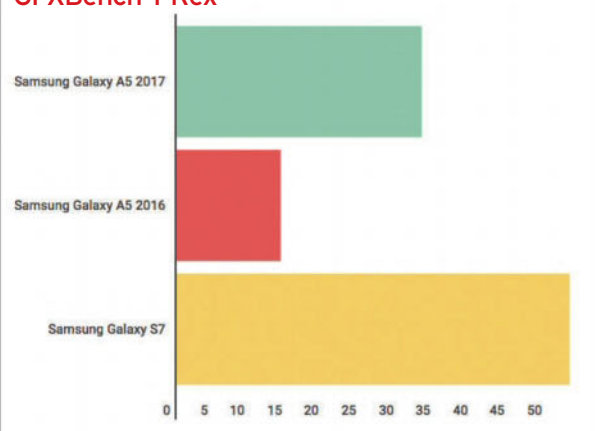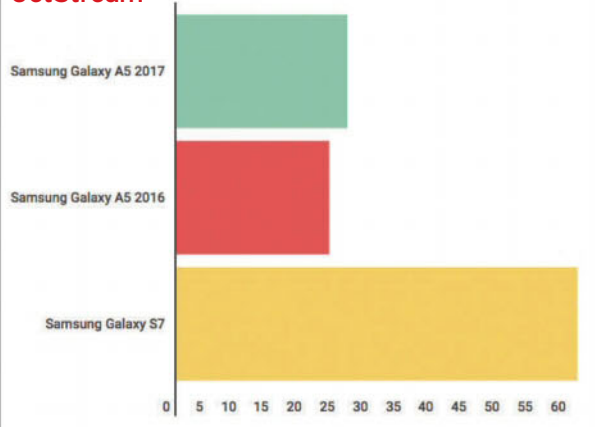
flagship there's support for the company's Adaptive Fast Charging. Unlike that phone there's no wireless charging. Battery life should easily stretch to a full day, though how much longer will really depend on how frequently you use the phone and for which type of tasks.

Connectivity

The version of the Galaxy A5 (2017) we review here is a single-SIM model, though apparently dual-SIM versions are or will be available in

Auto settings

HDR on
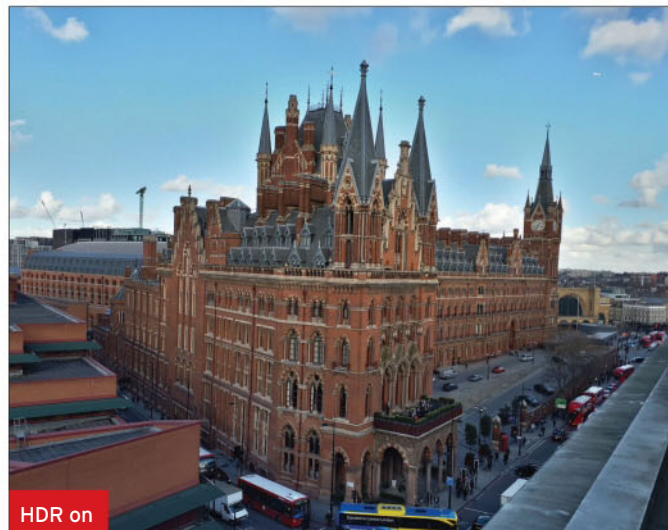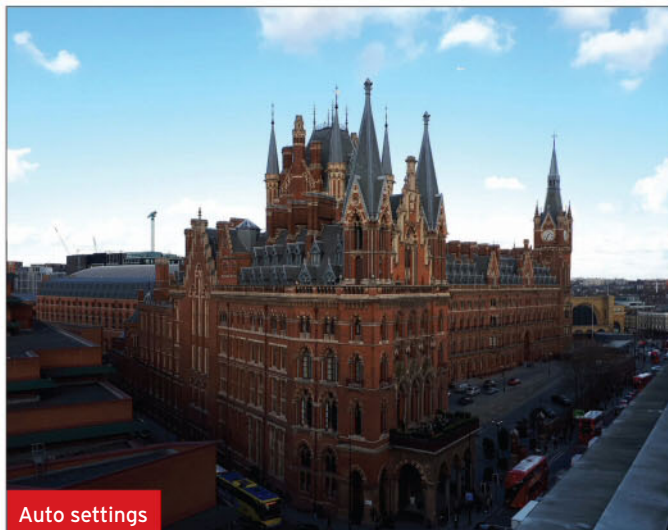
other territories. If you decide to buy one of these, then we advise you first check the specifications to ensure it will work on your network.

The Galaxy A5 (2017) comes with both a fingerprint scanner built into a physical home button and NFC, two of the key requirements for making mobile payments through Android Pay or Samsung Pay. Samsung Pay is not yet available in the UK, so you won't find the app preinstalled on this phone, though we suspect it might arrive alongside the Galaxy S8 in late March.

Both the Wi-Fi and Bluetooth have been upgraded over last year's model, now with support for the latest 802.11ac Wi-Fi and Bluetooth 4.2. You also get GPS with GLONASS and OTG. As with the Galaxy S7, there's no IR blaster, and this phone also lacks its heart-rate scanner.

Cameras

One of the key changes in the A5 (2017) over last year's A5 is its improved cameras. Previously fitted with a 13Mp camera at the rear and 5Mp at the front, both are now rated at 16Mp, suggesting Samsung is targeting the selfie-loving younger generation with this handset. As before, they have an aperture of f/1.9, and there's a single-LED flash at the rear while the display itself can act as a flash for the selfie camera. Video still maxes out at 1080p (full-HD), so don't buy this phone if you're hoping for 4K.

The quality of its still images is very good, though.

As you can see in some of our test shots above (with Auto and HDR modes engaged), sufficient detail is captured that you can make out the road names from shots captured from our seventh-floor roof terrace. There is some blurring toward the edges, but overall the camera does a great job and produces some excellent, lifelike colours.

The camera app is pretty decent, offering a range of real-time filters that include several beauty options. There are also Auto, Pro, Panorama, Hyperlapse, HDR, Night and Food presets, with a couple more available to download. Right now there's just Animated GIF and Sports shot, though we will hopefully see more added to the collection. As with Samsung's flagship you can open the Camera app with a double-press of the home button, and there is support for gestures and voice controls to trigger the shutter.

Software

Last year's Galaxy A5 came with Android Lollipop out of the box and, although Nougat is now rolling out to the S series, this A5 (2017) comes with Android 6.0 Marshmallow. Samsung applies its TouchWiz UI, plus some additional apps – most notably the Microsoft Office suite, S Health and the Galaxy Apps Store.

TouchWiz has been refined over the years, and is not the resource hog it once was. Some new design

changes include enhancements to the drop-down notification bar, with quick settings that are cleanly listed with none of the circular buttons of old. The Settings menu mirrors this with a very clean layout that is one long list rather than being separated into categories. It feels much more like vanilla Android than TouchWiz has previously, though it's still far from a carbon copy.

There are new wallpapers that react to movement by changing colour, and new features introduced in the Galaxy S7 such as the ability to take longer screenshots when you want to capture a web page or text conversation. Add to that one-handed operation and games modes, smart stay (stops the display timing out while you're looking at it) and a handful of gestures for quickly calling contacts, alerting you to missed notifications and more, and the Galaxy A5 (2017) has some very useful software indeed.

Verdict

The Galaxy A5 (2017) is a fantastic mid-range smartphone, with the looks of a flagship and some decent performance and all-round specs. Our only real concern is that Samsung is pricing itself out the market, with just a small difference in price separating this and the Galaxy S7 – we like the new A5, but we'd choose the higher-spec Galaxy S7 every time. ☒ **Marie Brewis**
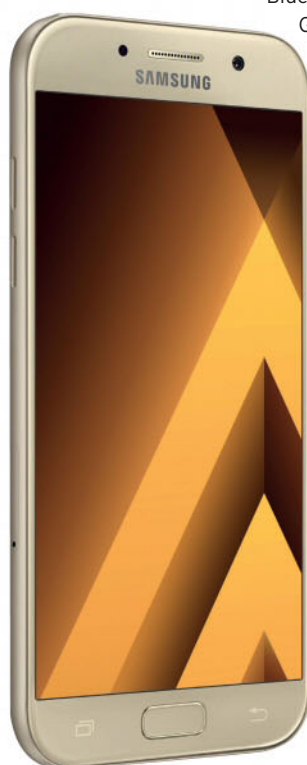
You can open the Camera app with a double-press of the home button, and there is support for gestures and voice controls to trigger the shutter

Specifications
5.96in (2560x1440, 494ppi) Quad HD display; Windows 10 Mobile; Qualcomm Snapdragon 820; 4GB RAM; 64GB storage; microSD card slot; Wi-Fi 11ac; Bluetooth 4.1; NFC; GPS; 16Mp rear camera; 8Mp front camera; B&O audio; USB Type-C;4150mAh non-removable battery; IP67; 162x84x7.8mm; 195g

Build: ★★★★☆
Features: ★★★½☆
Value: ★★★½☆
Performance: ★★★★☆

★★★½☆

SMARTPHONE

HP Elite x3

While having a very, very small market share, there are some excellent Windows 10 phones out there. The flagship Microsoft Lumia 950 and 950 XL were and are some of the best the platform had to offer, with solid performance, good looks and high-end specifications.

But that was November 2015. We've come a long way since then and unfortunately these phones can't match the best handsets out there any more. So does the HP Elite x3 manage to change that? It's the highest specified Windows phone ever made, but is it too geared towards the business user to appeal to the wider consumer?

Design

First things first. This phone is huge, and that's no exaggeration. It has a 5.96in screen, but the iPhone-esque wide bezels mean it is a big phone in the hand. It is a full centimetre taller than the Samsung Galaxy S7 edge, which has 5.5in screen. The Elite x3 is just about manageable in our small hands, but this is not a phone for one-handed operation however big your paws are.

HP is marketing the x3 firmly at the business user, and the design of it belies that. Next to the earpiece speaker there is a front-facing camera and an iris scanner like that of the Lumia 950s.

Glossy black bezels are only interrupted by a silver detail at the bottom front edge where you can see the Bang & Olufsen logo – there are front-facing speakers and mic beneath the dotted grate that oddly tries to look like a comet trail but ends up looking unfinished.

On the right edge there are the usual power/wake and volume buttons, a USB-C port on the bottom edge, incredibly fiddly dual-SIM slot on the left edge and a 3.5mm headphone jack on the top.

The neat rear of the phone has HP's logo, the camera bump with LED flash and a circular fingerprint scanner just below. HP has managed to keep the thickness down at just 7.8mm though, and the weight is under 200g which is good. This is still a hefty device though, measuring 161.8x83.5x7.8mm.

The Elite x3 also ships with a dock, which has a range of ports, so you can use it with a monitor like a desktop PC. Although the Elite x3 is unwieldy, the large size means space for things like a bigger battery (4150mAh) which is something that is often missing on a smartphone. After all, a dead handset is only really useful as a paperweight.

HP has also opted for a waterproof design with an IP67 rating meaning you can dunk it in up to 1m of water for up to 30 minutes.

A large part of the Elite x3's attraction is the dummy laptop which works with it. Because the phone supports Continuum, Windows' cool desktop conversion tech, this laptop can run entirely off the phone over USB-C. It's effectively a screen, keyboard and trackpad with nothing inside. It sort of reminds us of the Moto Atrix and its dummy laptop, which launched a few years ago.

Features

HP is wisely not denying the fact this phone was designed with the enterprise business user in mind. The lapdock functionality alongside Windows Continuum with

the included desk dock mean this phone can be used as a phone and a desktop. Its mammoth screen size means you could conceivably do away with a tablet too, and HP hopes you'll do just that. But what's the Elite x3 like to use?

Specifications wise, it has a Qualcomm Snapdragon 820 processor, which at the start of 2017 has only just been superseded by the 821 in phones like the OnePlus 3T. It zips along very quickly, with menus fast to load, apps quick to respond and the slick fluidity of Windows 10's tile-based operating system.

The near 6in display is capable of stunning reproductions given its Quad HD resolution of 2560x1440, and touch input is fast and responsive. 4GB RAM is more than enough for using the x3 as a smartphone – more on the performance with the lapdock and Continuum later.

There's a 16Mp rear-facing camera with autofocus capable of video at 1080p at 30fps, while the 8Mp front-facing camera is more than adequate for video calling.

The lapdock functionality alongside Windows Continuum with the included desk dock mean this phone can be used as a phone and a desktop

The dual front-facing speakers are very loud and good for those calls and for conference voice calls, but for music and video we found them tinny – a shame when the handset is stamped with the B&O branding.

With business in mind, the Elite x3 also has a dual Nano-SIM card slot. One of these slots can also be used for a microSD card if you prefer. In the dual-SIM setup, you can set either to roam or not roam, and would be useful if using a business number to roam abroad and avoid charges on your personal SIM. Also, obviously, it means you can receive calls to both your numbers from one device.

The lapdock is a dumb accessory, and does not come as standard

– it is an additional extra that retails at $599 in the US – undoubtedly a high price when it cannot be used as a laptop without the power of the x3 behind it. It can charge your x3 when connected though, and is itself charged over USB-C.

As you can see, the Elite x3 tries to do an awful lot. It cuts out your work phone and tries to convince you that you don't need a tablet with its 6in screen, all part of HP's vision of having created a 3-in-1 device. We will come to how it works as a desktop and laptop replacement further into this review, but as a smartphone, the x3 is highly accomplished.

Provided you get on with the OS, and don't mind having one of the largest handsets around, the performance for everyday tasks is easily as good as phones like the OnePlus 3 and HTC 10, though a shade below newer phones like the Samsung Galaxy S7. It's a shame, then, that it costs so much – £699 is far too expensive for the average consumer (the same price as the 128GB iPhone 7), particularly without the lapdock, and this is a result of HP's concentration on packing the device with business-centric specs and capabilities.

Software

Windows phones have always been derided for being sub standard compared to iPhones and high end Android devices but this is unfair. Flagship Windows devices have always been able to hold a candle to their high end rivals, but it is true

that the Windows Store has fewer apps than the Apple App Store or Google Play Store. However, that so-called 'app gap' is overplayed.

We used the HP Elite x3 as our main phone and had Facebook, Twitter, Spotify, WhatsApp, eBay, BBC iPlayer, Netflix and banking apps up and running in no time. There's a Slack app for work and of course unrivalled compatibility with Microsoft Office. Sure, you'll have the occasional tut when you can't get the latest game or trending photo app everyone is talking about, but there's no way we can say that Windows 10 for mobile is a totally compromised app platform. Also apps such as Sonos for home entertainment will simply never come to Windows phones.

Windows 10 is full of excellent design ideas. We still love the tile layout of the homescreen, though it won't be to everyone's tastes. It's highly customisable, and if you like little live changing windows into your photos, inbox and the news then you'll also love it in no time. Be aware though that if switching from Android or iOS, at first it's a bit confusing.

It also feels slightly on rails compared to Android and even the tightly controlled iOS, but in this instance that's okay. The Elite x3 is for getting serious work done, and Windows 10 is perfect for that. We didn't mind using Microsoft's Edge browser on mobile as it proved quite competent, but the one thing you'll have to get over is the lack of Google app support.

If your personal and work lives revolve around Google services, Windows 10 on mobile is a bit of a tough ask. Then again, if you're coming at cloud services fresh, then putting your eggs into the Microsoft basket will work very well, particularly if you're already a PC user (as opposed to Mac).

Lapdock and Continuum

So, the HP Elite x3 is a perfectly adequate, high-end Windows 10 phone. But as it's targeted at business users, we also got the swanky looking lapdock to check out too. HP positions the x3 as a 3-in-1 device: a personal phone, phablet device for work and laptop. The lapdock address the latter and it's a dumb clamshell design, meaning you need to connect the x3 to it. It then uses Windows Continuum to project the phone's Windows 10 operating system into a desktop experience.

The bottom line is: it works. It does do what it says it will do, which is allow you to browse the contents of your phone and use the apps on a laptop. However, there are a lot of performance issues with it that make it hard to recommend.

You can connect your x3 over the local Wi-Fi network to the lapdock, or by using the supplied USB-C cable. From there, the Start menu opens your phone's apps and you can navigate using either the touchpad of the lapdock or by using the x3's screen as a touchpad.

Despite the cleverness of the tech on show, our workflows and the technology simply aren't there

yet. We'd take a smartphone and separate laptop over this set up any day. The idea that Continuum will solve issues of workflow isn't true yet. The lapdock is an expensive way to project your phone for long document typing. For everything else like emailing, video viewing or gaming, the phone's 6in screen is more than enough.

Some third-party apps don't run full screen, and we sometimes lost a wired connection just by opening an app. Some apps don't work. In fact, you can only rely on Microsoft's Universal apps, the ones designed for Continuum, to work every time. It's a frustrating limitation of an excellent idea.

The same goes even if you don't fork out for the lapdock. If you have a monitor, keyboard and mouse, you can use the desk dock that comes with the x3 and hook them all up. The experience is much the same as on the lapdock – slower than a decent laptop and limited by the nature of the setup.

With the Elite x3, you also get access to HP Workspace, a version of Continuum designed for businesses to host corporate applications virtually. Again, it's a feature squarely marked 'business', but we found it frustrating. Even trying to boot up Word took forever,

and the resolution it produced on the lapdock was far from sharp. The regular version of Continuum worked a lot better.

The idea of the smartphone as portable mobile workstation is a good idea. However, it is yet to be perfected. If an entire company can run a superfast network, supply its workers with x3s and give each of them a permanent monitor set up to plug into, then maybe the idea of using the phone with the extra features would be efficient. For the rest of us, it's an expensive luxury that suffers from sluggish, buggy performance.

Verdict

The Elite x3 is an excellent phone, melding high-end specs with a solid design and good user experience. The Windows app store is still underrated, and the battery lasts for ages. However, at £699 without the lapdock, this is not a cheap device. We can recommend the HP as it is the best Windows 10 phone on the market, but the 3-in-1 device HP is marketing is best left to the whims of businesses and those to whom money is no object. If you can find a Lumia 950, you'll save yourself hundreds of pounds and get a similar Windows 10 mobile experience. ⊠ **Henry Burrell**

Windows 10 is full of excellent design ideas. We still love the tile layout of the home screen, though it won't be to everyone's tastes

Specifications
5.5in (1920x1080, 403ppi) Super AMOLED touchscreen; Android Marshmallow 6.0; 2GHz Qualcomm Snapdragon 625 octa-core processor; Adreno 506 graphics; 4GB RAM; 32GB internal storage, up to 128GB microSD; 13Mp main camera, with PDAF and single LED flash, support for 4K video at 30fps; 5Mp front camera; 802.11 b/g/n Wi-Fi; Bluetooth 4.1; 4G LTE; Dual Nano-SIM; GPS; NFC; 5100mAh non-removable battery; 76x153x8.5mm; 177g

Build: ★★★★☆
Features: ★★★★☆
Value: ★★★★½
Performance: ★★★★☆

★★★★☆

SMARTPHONE

Lenovo P2

If there's been one universal gripe of the smartphone era, it's complaints about the battery. Charging your device on a daily basis has become the norm, and almost all of us have a portable battery pack sitting around for when we can't get to a charger in time. That's where the Lenovo P2 comes in, offering solid specifications and performance, an attractive price, and what Lenovo claims is a whopping three-day battery life.

Price
The Lenovo P2 is currently available exclusively through Three, and you can buy it on Pay As You Go for just £199, which is great value given the phone's specifications and build quality, which we'll go into later. You can also grab it on a 24-month contract, starting at £18 per month with no upfront cost.

That puts the P2 in the same price band as the Honor 6X, currently available for £225, and the Moto G4, which you can grab for £159, and we compare the phones' respective performance in a little more detail below.

Design
For a £200 phone, the Lenovo P2 looks and feels a lot better than you might expect. It has a metal body that leaves it feeling much more expensive than it really is, and the Lenovo branding is kept to a subdued logo on the bottom of the phone's rear side. The UK is getting a graphite grey model with a black front, though other regions are

also getting it in champagne gold. The width of 8.5mm is impressively slight given the supercharged battery they've had to squeeze in, while the weight of 177g is typical for a phone with a metal body.

The 5.5in screen feels generous without making the phone uncomfortably large, and there are slim bezels at the side of the display. Otherwise, the front of the phone has a speaker and camera at the top, and a fingerprint sensor button at the bottom, while the rear has the main camera and flash, and that's about it. Elsewhere there are the usual power and volume buttons, microphone and speakers, 3.5mm headphone port, Dual-SIM and microSD slot and an extra button

to switch on a power saving mode – more on that later.

The overall impression is a phone that hides its price point well, and in terms of build it would be hard to argue that you aren't getting your money's worth, so we're pretty impressed.

Performance
The P2's headline feature is the massive 5100mAh battery, which is among the biggest we've seen in a smartphone yet. Lenovo boasts that it can manage a full three days of usage from a single charge, but we were sceptical – until we actually gave it a go. After 72 hours of standard usage (including checking emails, listening to music, Bluetooth, GPS-intensive apps such as Google Maps, and even a one-and-a-half hour video Skype call) the P2 was still ticking along with a few percent left in the tank. Even after just a week of using the phone, it was a huge relief to find ourselves no longer worrying about battery life or planning around the next charge.

It's equipped with fast charging via Micro-USB with a compatible charger, and you'll want it – all that extra battery capacity means extra charging time. Still, you can top it up with about 10 percent in 15 minutes, which should be enough to keep it running for eight or nine hours. If you want to keep it running for even longer, a flick of a

small switch on the left side of the case will activate 'Ultimate Power Saver', which in essence dumbs your phone down – you're left with the ability to send and receive calls and texts, and use simple apps such as the clock (for your all-important alarms), calculator and calendar, but that's it. It also tells you how long your battery will last while you stay in this mode – with 80 percent of battery left, it predicted another 81 hours of charge. It's worth noting that when we tested the phone's battery and kept it running for three days that was without using the power saver mode – so in theory you could keep it going for even longer.

Lenovo is actually so confident in the P2's battery that the phone can even double up as a power bank for your other devices. It comes with an included USB-to-Micro-USB adaptor, so that you can connect your phone directly into another phone, tablet, smartwatch or other gadget and share some of its battery power. In our testing, it didn't seem to charge other devices especially quickly, but it could be a great save if you find yourself in a pinch, and could save you from lugging a power bank around with you.

Getting beyond the battery, the rest of the P2's innards are pretty typical for the mid-range market. It's probably no surprise that it uses a relatively power-friendly 2GHz Snapdragon 625 processor – it's not going to come top in any performance charts, but it's plenty for most purposes, and together with the 4GB of RAM it means day-to-day usage feels fast and responsive. You also get Bluetooth 4.1, NFC, 4G and 802.11 b/g/n Wi-Fi – pretty much what you'd expect from a smartphone these days. As for storage, you get 32GB, but that's expandable with a microSD card – though that will take one of the two SIM card slots, so if you want to use it as a Dual-SIM phone, you'll have to make do with the internal storage.

In our benchmark tests, the P2 offers similar performance to the Honor 6X and the Moto G4, two of the other phones we recommend around this price, and does comparatively well on the graphics tests in particular. With roughly equivalent performance and pricing, the Lenovo's exceptional battery life makes a pretty compelling argument for picking it up.

The two cameras are also pretty typical for a mid-range Android device, with 13Mp for the rear camera and 5Mp for the front. Photos are crisp and bright, and look great on the bright AMOLED display, but don't expect anything exceptional – not that you should, given the price. There is also a 'quick snap' feature that lets you take a photo when the phone is asleep by double-tapping either volume button – great for photographing something in a rush, though don't expect pixel perfect photos from it.

Software

The P2 comes with Android 6.0 Marshmallow preinstalled, but we don't know if or when it might get an update to the more recent Nougat version. It runs a version of the operating system that's pretty close to stock, but with a few minor tweaks – mostly to allow you some extra customisation. There are some new power management tools to help keep the battery going for even longer, some minor changes to the app drawer and a few extra settings dotted around here and there. You can also map the Android navigation buttons to the fingerprint sensor (touch for back, press down the button for home, and long press to open your recent tasks), saving you some precious screen real estate.

It's mostly pretty minimal, so there's not too much running on top of the base Android OS, which helps keep things fast and battery-friendly. It does come preinstalled with a fair few apps you might not be interested in, like Three inTouch and Lenovo's SHAREit and SYNCit, along with the likes of Deezer and Amazon, but these are all easy to uninstall, so there's no need to keep them on the device if you don't want to.

Verdict

The Lenovo P2 is really being sold on the strength of its battery, and the great news is that it lives up to the company's hype, offering you days of usage and a power bank in a pinch. Throw in the premium design and build quality, and you have a phone that delivers tremendous value for money. It may not boast flagship performance, but by the time you hit your third day without charging, you're not likely to care that much. ⊠ **Dominic Preston**
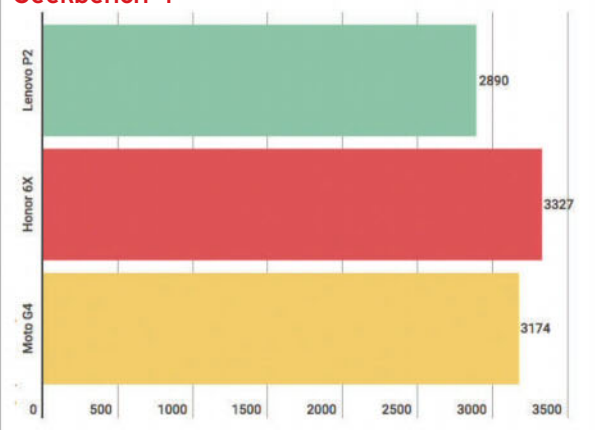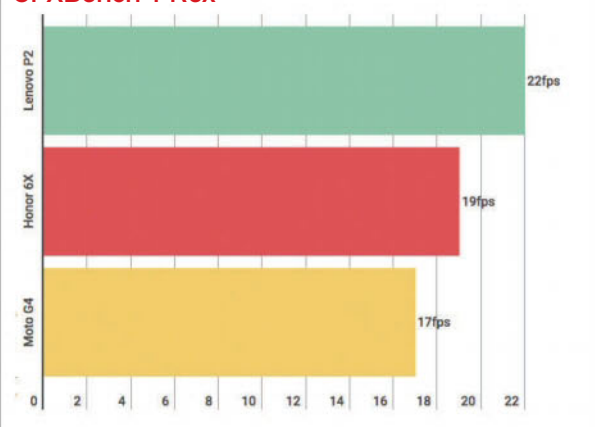
Geekbench 4

Lenovo P2	2890
Honor 6X	3327
Moto G4	3174

GFXBench Manhattan

Lenovo P2	6.1fps
Honor 6X	4.8fps
Moto G4	5fps

GFXBench T-Rex

Lenovo P2	22fps
Honor 6X	19fps
Moto G4	17fps

The P2's headline feature is the 5100mAh battery, which is among the biggest we've seen in a phone. Lenovo boasts it can manage a full three days

Specifications
5.5in full-HD (1920x1080) Sharp IGZO 2.5D display; Android 6.0 Marshmallow with Android 7.0 OTA upgrade available; 2.6GHz MediaTek Helio X27 deca-core processor; 875MHz Mali-T880 MP4 GPU; 4GB LPDDR3 RAM; 32GB storage; microSD support up to 256GB or dual-SIM dual-standby; 4G LTE-FDD 800/1800/2100/2600MHz; dual-band 802.11a/b/g/n Wi-Fi; Bluetooth 4.1; GPS; OTG; fingerprint scanner; 13Mp Samsung SK53L8 PDAF camera; 13Mp Samsung S5K3L8 selfie camera; 3.5mm headphone jack; USB-C; 3780mAh battery with fast charging; 154.6x76.8x8.2mm; 175g

Build: ★★★★☆
Features: ★★★★☆
Value: ★★★★½
Performance: ★★★★½

★★★★☆

SMARTPHONE

UMI Z

UMI is undergoing a rebranding exercise, and this Z is the last phone it will release before its name officially changes to UMIDIGI, short for UMI Digital. Somewhat confusingly an almost identical version of the UMI Z comes with a dual-camera at the rear and is known as the UMIDIGI Z Pro.

Price
The UMI Z is available in grey or champagne gold for just £192. It works with all three UK 4G bands, and runs stock Android 6.0 Marshmallow with an OTA upgrade promised to Nougat in the coming months, so there are no usability issues here. As we'll see below, it is a real bargain at this price, offering excellent value for money.

We would advise caution when buying from China, however, primarily because your consumer rights are not the same as in Europe, so should the product arrive faulty or not at all the process may not be as straightforward as you like. There's also the question of import duty, which is charged at 20 percent of the value on the shipping paperwork, plus an administration fee of around £11.

Design
Let's start with the screen, since it forms a large part of the face of the phone This is a 5.5in panel, which makes the UMI Z a 'phablet'. It's reasonably weighty at 175g, as you might expect, but with slim dimensions of 154.6x76.8x8.2mm it doesn't feel overly large in the hand. This is in part helped by the fact it has smooth, rounded edges that glide into the 2.5D curved screen glass, but also the incredibly thin bezels to the left and right edges of the display.

The display resolution of 1920x1080 pixels is what's known as full-HD, and you certainly wouldn't expect anything higher at this price. It's pleasingly sharp, and with good screen brightness, contrast and viewing angles this Sharp IGZO display shouldn't give you any headaches. The UMI Z supports MiraVision, which allows you to adjust the display to suit your tastes.

UMI claims it had in mind the Bauhaus principle when designing

the Z, which it says puts user experience above all else. It's crafted from a single block of space-grade aluminium-alloy, with two thin antenna strips integrated to the body top and bottom on the rear, and a stainless steel camera surround with sapphire glass lens protection.

It's certainly one of the best-looking UMI phones we've seen to date, and save for perhaps reducing the size of the CE logo on the back we find it difficult to pick holes in the Z's design. UMI has thought carefully about the positioning of everything from the power button, which falls neatly under the right thumb, to the selfie camera, which is slightly off-centre to match your stance when held in the right hand.

With its unibody build the UMI Z feels well put together, and with none of the usual creaking and flexing of plastic smartphones with removable rear panels it feels like a phone that will last. Of course, one of the downsides of the one-piece body is a non-removable battery, but UMI has cranked up the capacity to lessen this burden.

The rear camera protrudes slightly at the back, but to fit two 13Mp cameras and a large-capacity battery into a phone just 8.2mm thick is quite the achievement.

Two symmetrical rows of drilled holes sit either side of a forward-facing reversible USB-C port on the UMI Z's bottom. One houses a mic and the other a speaker, while you'll find the headphone jack up top. In its standard position at the top

left edge is a pin-operated hybrid SIM tray, which allows you to insert either two Nano-SIM cards or a single SIM and a microSD card of up to 256GB capacity.

If we had to pick one thing we didn't love it would be the home button, which you tap or hold rather than press. It doesn't feel natural to us. We're not especially keen on the removal of the navigation buttons at the bottom of the screen either, though these are accessible with a swipe up from the bottom of the screen. If you're happy not to use them you can tap the home button to go home, or long-press it to open the recents menu.

Performance
The UMI Z has two key selling points that differentiate it from other similarly-priced Chinese phones on the market. The first is the 13Mp selfie camera with soft LED flash, which we'll come on to later, and the second its Helio X27 processor. In time, many smartphones will adopt this chip, but for now the UMI Z is your only choice should you want to use it.

UMI claims it had in mind the Bauhaus principle when designing the Z, which it says puts user experience above all else

The Helio X27 is a deca-core chip, which always sounds impressive on paper, particularly when you're comparing it to the likes of the Snapdragon 820 and 821, which are quad-core chips. Equally important, of course, is the technology each of those cores use and at which speed they run. This 20nm processor builds in two Cortex-A72 cores running at 2.6GHz for performance, and two groups of four Cortex-A53s tuned for efficiency.

In raw processing performance we found the Helio X27 a close competitor to the Snapdragon 820, though with an inferior integrated GPU. To be fair to it, though, the Mali-T880 MP4 GPU inside the Helio X27 is said to show an 83 percent performance improvement over the Helio X20, MediaTek's first deca-core chip.

It's easy to think of the MediaTek Helio X-series chips as no-frills alternatives to Qualcomm's Snapdragon 820 series. They can't quite keep up in performance, but they offer more than most people will actually need and at a much cheaper price.

The UMI Z is fitted with 4GB of fast Samsung RAM, though it's still of the slower LPDDR3 variety than the LPDDR4 we see in many conventional flagships. It also has 32GB of storage as standard, and as we mentioned earlier you can boost this by up to 256GB simply by slotting in a microSD card.

We ran the UMI Z through our usual benchmarks and found some very decent scores, particularly on processing performance. In AnTuTu 6, for example, it scored a very high 110,374 points, while Geekbench 4.0 clocked it at 1,796 points single-core and 4,265 multi-core.

This is right up there with flagship phones running the Snapdragon 820/821, including the likes of the OnePlus 3T, Xiaomi Mi5s and even the Google Pixel.

It fell down in the graphics benchmarks, as expected, yet still turned in easily playable framerates in our tests. We recorded 27fps in GFXBench T-Rex, for example, as well as 18fps in Manhattan, 11fps in Manhattan 3.1 and 7fps in Car Chase.

In the JetStream JavaScript benchmark, the UMI Z turned in a respectable score of 56.02. You can compare its performance to some other flagship phones – many of which cost significantly more – in the chart, right.

What this means in the real world is that the UMI Z is capable of playing any mobile game you like, watching any film you want, or doing whatever other task you fancy having a go at. You don't need to worry about a lack of performance.

Battery performance is similarly good, with UMI quoting potential for 360 hours on standby, 60 hours of music playback or 14 hours of GPS navigation from the 3780mAh Sony-made cell. In the real world, of course, no one uses their phone for just one task, and usage can vary greatly day by day. We'd suggest that this is enough power to comfortably get all users through a full day, and lighter usage could result in two day's life.

The phone doesn't support wireless charging, but there is fast charging when paired with a compatible charger. It can fully charge in 100 minutes, but if you have less time to spare UMI says you'll get enough power for a full day's use from just 30 minutes. Again, that depends on your usage.

Connectivity

Very often we find with Chinese phones – especially those from Xiaomi and Meizu – that they do not support the 800MHz 4G LTE-FDD band that is used in the UK by all the major mobile operators. This is of particular issue to O2 customers – and those of companies which piggyback its network, such as Sky Mobile and Giffgaff – whereas other mobile networks do not rely on that single 4G frequency alone for LTE connectivity.

We're pleased to report, then, that the UMI Z works with all three 4G bands in use in the UK: 800-, 2100- and 2600MHz. This means you should get full network reception wherever you might have done on a previous phone or one sold specifically for UK use. Readers elsewhere should check the specifications to ensure the UMI Z will work correctly in their location.

The UMI Z can support two Nano-SIM cards, meaning you can carry a single phone and yet separate business and personal lines, or perhaps insert a local SIM when you go abroad. It works in dual-standby fashion, meaning both SIMs can make and receive calls and

Geekbench 4.0

UMI Z, Elephone S7, Xiaomi Mi Note 2, Xiaomi Mi5s (3GB), Xiaomi Redmi Pro, Google Pixel, OnePlus 3T, Moto Z, Sony Xperia XZ — axis 0 to 4500+

GFXBench Manhattan

UMI Z, Elephone S7, Xiaomi Mi5s (3GB), Xiaomi Redmi Pro, Google Pixel, OnePlus 3T, Moto Z, Sony Xperia XZ — axis 0 to 45

JetStream

UMI Z, Elephone S7, Xiaomi Mi Note 2, Xiaomi Mi5s (3GB), Xiaomi Redmi Pro, Google Pixel, OnePlus 3T, Moto Z, Sony Xperia XZ — axis 0 to 55
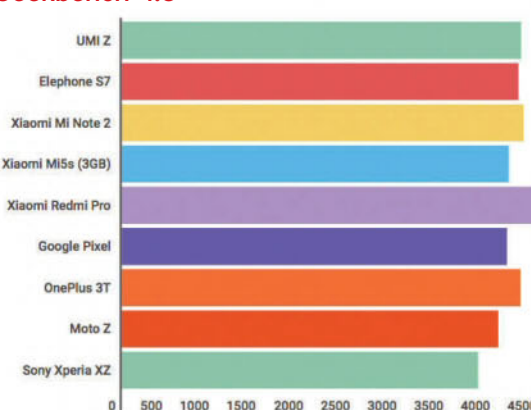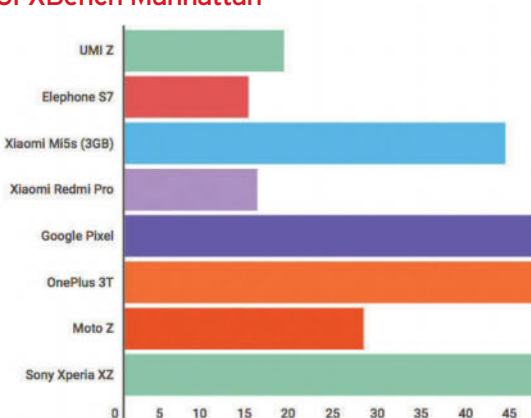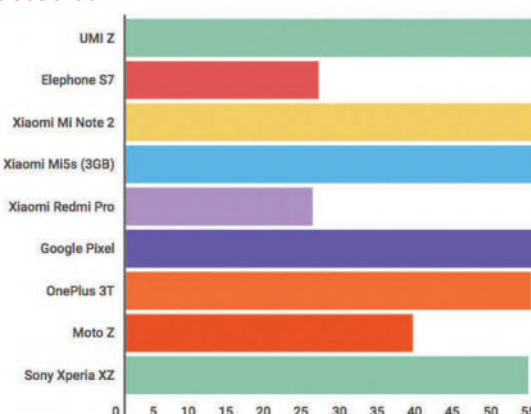
texts at all times, but only one SIM can be specified for data usage. If you have no use for this feature, then the second SIM slot also works as a microSD card slot.

Aside from NFC, which would be necessary if you wanted to make mobile payments and then verify them using the UMI Z's integrated fingerprint scanner, virtually everything you need connectivity-wise is here. There's dual-band 802.11a/b/g/n Wi-Fi, plus Bluetooth 4.1, GPS and OTG.

Auto settings

HDR on
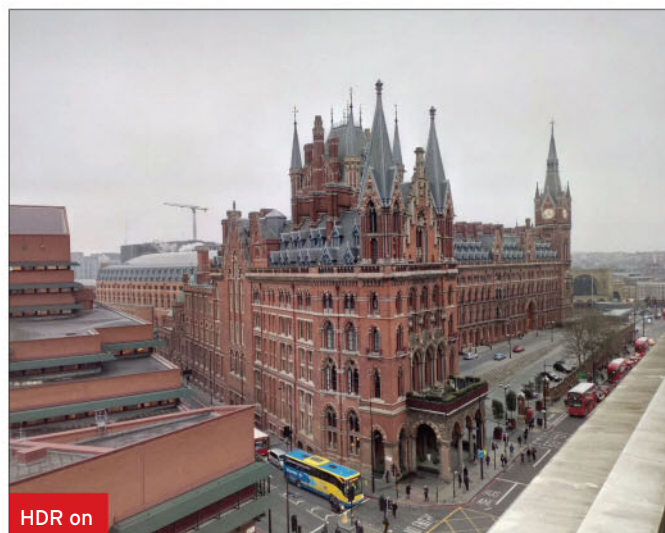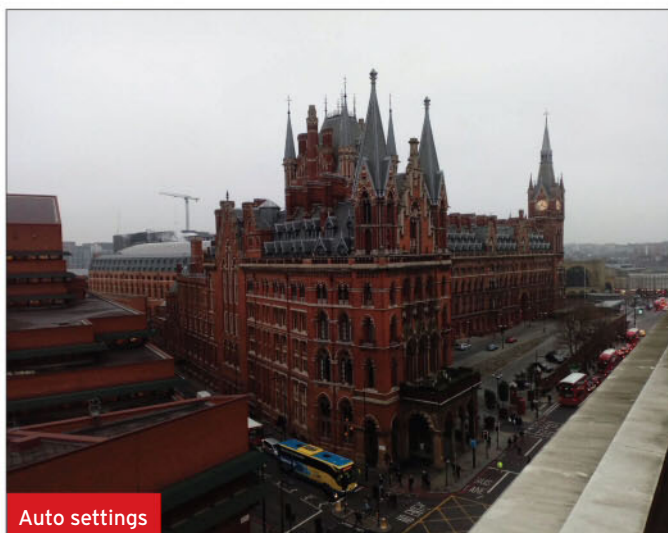
Cameras

The UMI Z is fitted with two 13Mp Samsung SK53L8 cameras – one at the front and one at the back. The UMIDIGI Z Pro comes with one at the front and two at the back.

The selfie camera is one of the best you'll find, and as well as the very high resolution it has 1.4µm pixels and a soft LED flash that can be turned on, off or to auto settings as required. Low-light is often a problem for self-portraits, so it's good to see UMI among those taking steps to fix it.

From the rear, the UMI Z at first looks as though it has two 13Mp cameras; in fact, to the right of the primary camera is a laser autofocus. This is part of a dual-focus system, with the UMI Z also adding phase-detection autofocus. In common with the iPhone 7 it has a quad-LED flash, which it says is 50 percent brighter than most dual-LED versions for low-light shots. The UMI Z can shoot high-quality photos or video at up to 4K quality.

The camera app is simple, with real-time filters available with a swipe from the left-hand side,

toggles for the flash and HDR mode along with a settings cog running across the top, and various modes at the bottom, including Videos, Face beauty, Photo and Panorama. Below this you can access a shortcut to the Gallery app or switch to the selfie camera, and above there is a digital zoom function.

We were reasonably impressed with our test photos, but spotted a lot of noise when viewed at full size. They were also easily blurred, with no image stabilisation seemingly in use. In Auto mode colours were vibrant and saturated, even in a gloomy London in February; HDR mode toned down this effect but left the images somewhat washed out.

Software

You won't find any bloatware, gestures or any other deviations from standard Android on this UMI Z: it is preinstalled with a stock version of Android 6.0 Marshmallow that includes a few Google apps but very little else. The notification bar and settings menus are exactly as you would expect to find them, and unlike Xiaomi and Meizu phones

there is an app tray (as opposed to placing all app shortcuts on the home screen). The only real difference is the camera app, but it's easy enough to use.

We like this approach since you don't get anything you don't want hogging storage space and slowing things down – it is Android as it was intended, which you get to customise as you so choose.

UMI has promised that Nougat will be released as an OTA upgrade in the coming months. It has advised that the software is ready to go, but it has chosen to wait until it can confirm it is as stable as the latest version of Marshmallow before upgrading users.

Verdict

The UMI Z is an excellent-value Android phone with a large battery, a decent screen, the most powerful MediaTek processor you can get and a very good selfie camera. Unfortunately, the primary camera doesn't quite live up, but it's otherwise difficult to fault. With full UK 4G connectivity it's a great buy. ⊠ **Marie Brewis**

Specifications
5.5in full-HD (1920x1080, 403ppi) full in-cell TDDI display; Flyme 5.5 (based on Android Marshmallow 6.0); 2.3GHz Helio X20 deca-core processor; ARM Mali-T880 GPU; 4GB LPDDR3 RAM; 32GB storage; mTouch fingerprint scanner; 12Mp, f/2.0 Sony IMX386 rear camera with six-element lens, dual-tone flash, PDAF, 1.25μm large pixels, 4K video at 30fps; 5Mp f/2.0 front camera with four-element lens; dual-SIM dual-standby (2x Nano-SIM); 802.11a/b/g/n/ac Wi-Fi; Bluetooth 4.1; GPS, A-GPS, GLONASS; 3.5mm headphone jack; USB-C; 3060mAh battery with mCharge; 153.6x75.2x7.25mm; 155g

Build: ★★★★☆
Features: ★★★★☆
Value: ★★★★☆
Performance: ★★★½☆

★★★½☆

SMARTPHONE
Meizu MX6

First impressions of the MX6 from Meizu are good. On paper it's got decent specifications, which include a deca-core processor, 4GB of RAM and 32GB of storage, and out the box it's a well-made and good-looking metal handset with a design somewhere between the latest iPhone and the HTC 10 – and, oddly enough, it's available in rose gold, grey, silver and gold.

Price

At £255 this is a mid-range smartphone, but the MX6 offers more for your money than phones you might find on the High Street. As you've probably guessed from the unfamiliar name this is a Chinese phone, but from a company well-known in its homeland.

In the past Meizu phones have reminded us of those of Xiaomi, of which it is a competitor, offering great value for money and coming preinstalled with a similarly customised Android interface that places everything on the Home screen, but with no Google apps built in. Flyme, the OS used by the MX6, is very different to Xiaomi's MIUI, but we'll get on to that later.

In common with those phones, the MX6 did not come preinstalled with Google services. However, upon turning it on for the first time we received a notification instructing us to install them. This might be disconcerting for new users, but installation proved a painless process and within a few moments we were able to log into our Google account and start downloading apps from the Google Play store.

The addition of Google services makes this Meizu phone much easier to use than the previously reviewed Meizu M3 Note – it's only a shame they weren't preinstalled before we took it out the box. Other than installing Google services, no tinkering is required for setting up this phone for UK use, which is reassuring for a Chinese phone.

Design

Our only issue with usability regards the 'mTouch' Home button on the front of the phone. It works exactly as you'd expect for a Home button with a fingerprint scanner built in, in that you press it to be returned

Home or to unlock the screen (though irritatingly for the latter you must either press it a second time or long-press to unlock it).

Our issue is with the lack of any buttons to the side of it and, unlike the recently reviewed Elephone S7 which has a similar setup, there's no option in the Settings menu to enable a navigation bar. To go back you tap the Home button, to lock the screen you long-press it, and to access the Recents menu you swipe up from the bottom of the screen (but not directly above the Home button). You can enable a Multi-window feature from the Recents menu, too, but not all apps are supported.

But while it's frustrating in use at first, this setup does enable a clean design with no button legends below the screen. And it's largely the same on the rear, with an inoffensive Meizu logo and a small (and very Apple-esque) scrawl at the bottom that says the phone was designed by Meizu and assembled in China. We're not entirely keen on the camera bump protruding from the rear, but it's something that is becoming increasingly common on Android phones and not so drastic that the phone will rock when used on a desk.

The overall design is very good, if similar to dozens of rival handsets, with a metal unibody and almost edge-to-edge 5.5in display. Although it's heavier than many phones of its size at 155g, it feels very small for a phablet, in part due to those slim bezels and in part to the 7.25mm ultra-thin frame and curved corners and edges – it's rounded on top with 2.5D curved glass, and on the rear. In fact, it's from the side that it arguably looks most like an iPhone.

The overall design is very good, if similar to dozens of rival handsets, with a metal unibody and almost edge-to-edge 5.5in display

GFXBench Manhattan

Meizu MX6
Xiaomi Redmi Note 4
Vernee Apollo Lite
Elephone S7

0 2 4 6 8 10 12 14 16 18

GFXBench T-Rex

Meizu MX6
Xiaomi Redmi Note 4
Vernee Apollo Lite
Elephone S7

0 5 10 15 20 25 30 35

JetStream

Meizu MX6
Xiaomi Redmi Note 4
Vernee Apollo Lite
Elephone S7

0 2 4 6 8 10 12 14 16 18 20 22 24
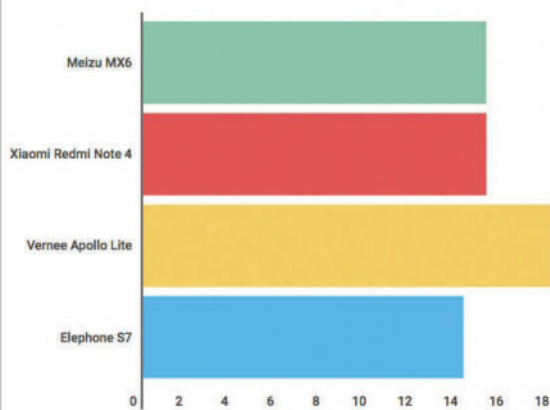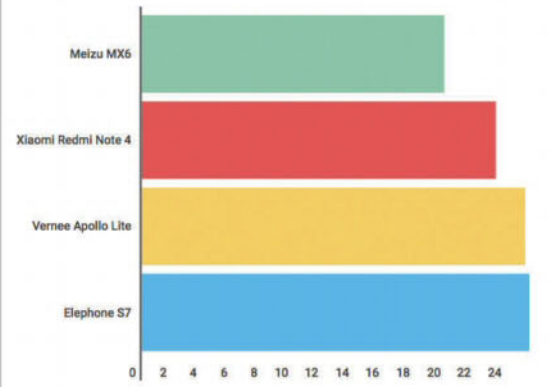
The MX6 looks like a smaller version of the flagship Meizu Pro 6. We haven't reviewed its predecessor, the MX5, but from what we understand the MX6 isn't a vast improvement over it. In place of an AMOLED panel with Gorilla Glass there's a TDDI in-cell display with no protection, rather than a 20.7Mp primary camera there's a 12Mp snapper, and the battery is 100mAh lower in capacity, yet the phone is wider and thicker.

We're not sure why Meizu has opted for a TDDI in-cell display

over AMOLED, nor why it hasn't fitted Gorilla Glass and left the screen glass vulnerable. AMOLED is our favourite type of screen tech, very thin and energy-efficient with excellent contrast and saturated colours. The TDDI panel here combines usually separate screen layers and has a two-layer touch control system. It is very responsive to touch, and still offers saturated colours, good contrast and brightness (particularly at the lower end of the scale, going right down to 1 nit for easier nighttime use), but it can appear cold.

The design is otherwise mostly standard, with a USB-C port and speaker grille at the bottom, a dual-SIM tray on the left edge and a volume rocker and a power button on the right. However, you'll note that in Flyme OS this volume rocker controls only the media volume (Silent mode is accessible from the pull-down notification bar, but to adjust the volume rather than mute the phone you need to enter the Settings menu), and that the headphone jack is unusually located at the bottom of the handset.

Performance
The MX6 is the first in Meizu's MX family to get the Helio X20 deca-core processor, which is similar to the Helio X25 but clocked slower at 2.3GHz. It combines four Cortex-A53 cores running at 1.4GHz with four running at 1.9GHz and two Cortex-A72 cores at 2.3GHz. The Mali-T880 GPU is integrated, and it's paired with 4GB of LPDDR3 RAM.

It's a very similar specification to that of the cheaper Elephone S7 (which happens to offer double the storage at 64GB plus the possibility of expansion through microSD). We've also seen this chip in the Xiaomi Redmi Note 4 – perhaps a closer competitor but with a larger battery – and Vernee Apollo Lite. All three of these smartphones come in significantly cheaper than the Meizu, but performance is reasonably similar. If anything, the MX6 performed less well in our benchmarks, which may be an effect of Flyme OS. You can see how the phones ranked in the chart above.

In real-world use the Meizu feels fast, and even the camera app launches quickly. Things could be sped up with the ability to wake and unlock the screen with

a single tap of the mTouch button, but we don't think you'll have any issues with navigating the handset once you're in. Games and video shouldn't present a problem either.

The Meizu MX6 comes with 32GB of storage built in which, compared to UK phones at this price point, is very generous. However, we're disappointed to find the dual-SIM slot doesn't allow you to substitute the second SIM for a microSD card. If you need more than 32GB of storage you'll need to rely on the cloud or a separate device.

The battery is a non-removable model that charges over USB-C. Using a compatible charger mCharge allows the battery to fill from zero to 100 percent in 75 minutes. Its 3060mAh capacity won't last you longer than a day, though, so be ready to charge it every night.

Connectivity
Before buying any Chinese phone you should ensure it will work on your network. The Meizu MX6, in common with Xiaomi phones, does not support the 800MHz 4G band in the UK. It does still work on the 2100MHz and 2600MHz UK 4G bands, but all the major mobile operators hold 800MHz frequency, which means your coverage might not be as wide as it was on a previous smartphone.

We used the MX6 on the Vodafone network, and didn't seem to receive 4G connectivity as commonly as previously, but that connectivity was never an issue – at least not in places we could previously get online.
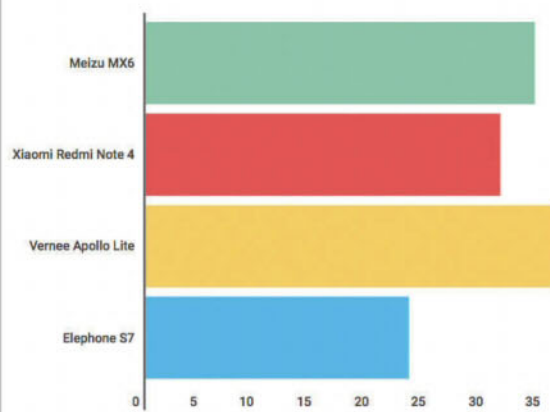
For O2 customers and those of any virtual mobile operators that piggyback its network (for example, GiffGaff and Sky Mobile), the lack of 800MHz (aka Band 20) will be frustrating because it's the only 4G frequency held by O2. If you use any of those networks you will not receive 4G at all on the MX6, though you will still be able to get online via 3G and dual-band 802.11a/b/g/n/ac Wi-Fi.

The MX6 allows you to add a second SIM (both are Nano-SIMs), which could potentially allow you to use separate contracts (from separate operators) for your calls and texts, and mobile data. Or you could insert a business SIM, allowing you to make and receive

Auto settings

HDR on
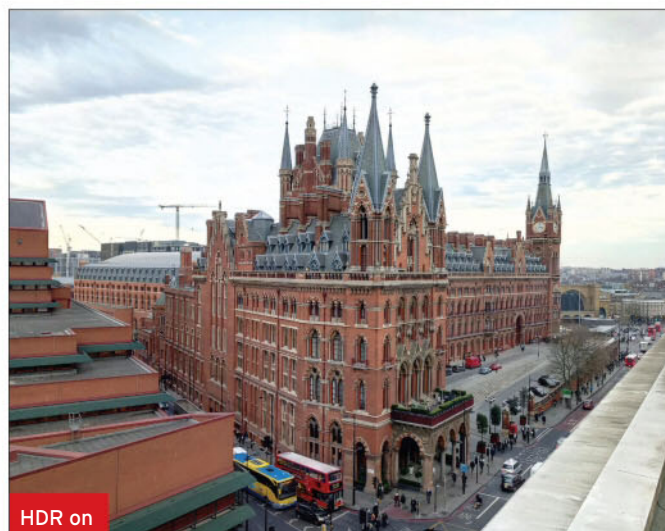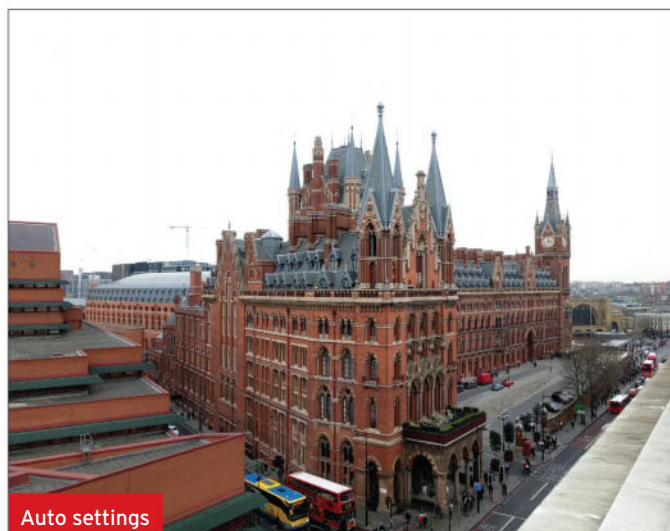
business calls without having to carry a second phone.

The dual-SIM setup is dual-standby, which means either SIM can send and receive calls and texts, although you can't make a call on both SIMs at once. You will need to select only one of the SIMs for mobile data, although you can switch which is used in the Settings menu. Meizu's MX6 also supports Bluetooth 4.1, GPS, A-GPS and GLONASS, though there is no NFC for making mobile payments.

Cameras

The MX6 is fitted with a Sony IMX386, a 12Mp, f/2.0 camera with a six-element lens, PDAF, 1.25µm large pixels and a dual-tone flash. It can record 4K video at 30fps.

The camera app supports many of the usual modes, real-time filters and a countdown timer, but HDR is hidden in the Settings menu and with no auto option. That's an improvement on the Elephone S7 mind, which has no HDR mode at all.

In our experience, though, you will want to leave HDR switched on in any case. In Auto mode the sky is completely blown out, whereas things look far more realistic with HDR switched on.

The results are average, and with a reasonable amount of noise visible, particularly in low light. Shot in good light the colours, contrast and white balance are accurate, though the

images aren't as sharp as we'd like. The Meizu MX6 also has a 5Mp, f/2.0 selfie camera with a four-element lens. You get all the same options as in the main camera app, but with the addition of the ability to flip the screen to get a mirror image.

Software

Meizu installs Flyme 5.5 on the MX6, which is a customised version of Android 6.0 Marshmallow. Upon turning it on for the first time you'll be prompted to download Google services, which gives you full access to Google Play and the Android apps with which you're familiar. We chose to download Google's apps for Maps, Drive, Calendar, Music and so on. You can happily use Meizu's alternatives, although you can't uninstall them if you don't want them.

The first most obvious difference between Flyme OS and Marshmallow is the removal of the app tray. Shortcuts for all your apps are found on the multiple home screens, which is a very iOS-esque setup that you'll either love or hate. We prefer to be able to hide away the apps we need but don't frequently use for a less cluttered interface, but here to do that you'll need to create folders.

The second most obvious difference is the removal of the navigation bar – another Apple-style move. Instead you use the mTouch button as both home

and back, and swipe up from the bottom of the screen to access recents. We don't like this setup, but if you're familiar with iOS you may see things differently. We have no doubt that given more time we would get used to the change.

You can also place anywhere on-screen a SmartTouch button, which in part replicates the mTouch button, but can also be used for screen hovering (which just seems to move half your apps off-screen), unfolding the notification bar, locking the screen and launching the tasking menu. On larger phones such a feature makes for easier one-handed use, though that shouldn't in itself be a great issue with the MX6.

The notification bar is also a little different. Pull this down to access customisable quick-access toggles for Wi-Fi, Bluetooth and so on, plus a screen brightness slider.

Extra software options include an extra-large mode, the ability to set the colour temperature of the screen, and an adjustable blue light filter to protect your eyes from glare. There is support for gestures, such as the ability to double-tap to wake the screen, as well as customisable gestures that you draw on-screen in standby to wake the phone and launch a specific app.

Verdict

The Meizu MX6 is a nicely designed phone, but compared to the Xiaomi Redmi Note 4 and Elephone S7 it is expensive and underpowered. The MX6 still has a great deal to offer at around £250, but we're not keen on Flyme OS or mTouch, and the MX6's camera isn't the best example we've seen. ⊠ **Marie Brewis**

The MX6 is fitted with a Sony IMX386, a 12Mp, f/2.0 camera with a six-element lens, PDAF, 1.25µm large pixels and a dual-tone flash

£240 inc VAT

Buy from
- tinyurl.com/h2mxp7e

Specifications

5.5in (2560x1440) 2.5D LTPS display; Android 6.0 Marshmallow; 2.5GHz MediaTek Helio X25 (MTK6797T) deca-core processor; 850MHz Mali-T880 MP4 GPU; 4GB LPDDR3 RAM; 64GB storage; microSD support up to 128GB; dual-SIM, dual-standby; 4G FDD-LTE Cat 6 800/1800/2100/2600MHz; dual-band 802.11a/b/g/n Wi-Fi; Bluetooth 4.0; GPS, A-GPS; OTG; fingerprint scanner; 21Mp, 1/2.4in Sony IMX230 rear camera; 8Mp selfie camera; 3.5mm headphone jack; USB-C; 3180mAh battery; comes with VR headset, USB-C cable and charger; 152x75.6x9.3mm; 188g

Build: ★★★★☆
Features: ★★★★½
Value: ★★★★½
Performance: ★★★★½

★★★★☆

SMARTPHONE
Vernee Apollo

We've been saying that virtual reality is the next big thing for over a year now, but 2017 really will be the year VR comes to phones. Samsung's upcoming Galaxy S8 and LG's G6 are among those expected to come with large, high-resolution screens and meaty processors and GPUs to enable the best mobile VR. Those are Snapdragon phones, so what of MediaTek?

The current best (available) MediaTek processor is the Helio X25, which is a deca-core chip that combines two clusters of four low-power, efficient Cortex-A53 cores with a high-performance Cortex-A72 duo, and integrates the 850MHz Mali-T880 MP4 GPU. Don't assume the Helio X25 is on par with – or with 10 cores even better than – the quad-core Snapdragon 820/821, which is paired with the Adreno 530 GPU and comes in many of today's flagships; in our benchmarks the Qualcomm chip outdoes it every time. We expect to see a similar situation with the upcoming Helio X30 and Snapdragon 835 – MediaTek X25 processors are ideal for the very best mid-range phones, but not really what we'd class as flagship-level.

The Vernee Apollo is not the first phone to feature the Helio X25 processor (you'll also find handsets from Xiaomi, Meizu, Elephone and LeEco), but it is the first to combine that processor with a 5.5in 2K screen (a high-resolution display is important for VR as the resolution is halved for each eye) and a VR headset in the box.

We say VR headset – it's really just a plastic, buttonless, NFC-less version of the Google Cardboard viewer with a rubber insert that is intended to seal around your face (it was too large to fit our face). It's not Daydream-ready (neither is the Apollo), and the viewer is not especially comfortable in use, though we understand its inclusion given the marketing.

The 2K screen makes the Vernee Apollo a better phone for VR than many others, especially MediaTek phones, though calling it the first MediaTek VR phone is possibly a bit of a stretch. No matter, the Apollo has lots more to offer under £250.

Price

The Apollo is available from a number of Chinese outlets, including Coolicool, TomTop and AliExpress, though the one we recommend is GearBest since you can ship the Apollo from its EU warehouse and therefore avoid any nasty surprises in the form of import duty.

Buying the Apollo from the EU warehouse (£240) is a little more expensive than buying it from China (£208), but if you opt for the latter choice you should bear in mind that import duty is calculated at 20 percent of whatever value is written on the shipping paperwork, plus there's an admin fee (in our experience this is £11 through DHL). Potentially, if you buy from China you could get an additional fee of up to £52, and in which case the £240 EU option will cost you less overall and come without the added hassle of paying fees.

The Vernee Apollo is sold on a SIM-free basis, which means you can use it with any UK-based mobile operator and on any tariff you like. It's a dual-SIM phone that can accept a Nano- or Micro-SIM, and supports all three UK 4G bands.

Design

The Apollo is a nicely designed phone with a 6000-series aluminium body and, as we've already mentioned, a 2K (or Quad-HD) screen. We tested the grey version, which from the rear has nice clean lines with simplistic antenna bands and a slightly protruding camera with a Smart Touch fingerprint scanner below and dual-LED flash to the side.

The sides are slightly curved and with chamfered edges top and bottom, making this 5.5in-screen phablet easier to hold and manageable in a single hand, especially given its weighty 188g body. This also makes it seem thinner than it is, since at 9.3mm it's pretty chunky for a flagship phone with only a 3180mAh battery inside.

At the front you find 2.5D curved glass, which would flow smoothly into the metal frame were it not for the black plastic bezel that is very obvious as you run a finger across the surface. We presume this will add strength to the edges of the screen as you routinely take it in and out the VR viewer, though it does nothing for the aesthetics.

The screen itself is decent, and with a 2560x1440-pixel resolution the sharpest of any Chinese phone we've reviewed. The resulting pixel density of 541ppi is very high, well above that of Retina quality, so you'll find no fuzzy text or graphics here. Of course, the primary reason for the high resolution is VR, since it is halved for each eye. Used with a VR viewer each eye will see a still-sharp 1080p resolution.

This is an LTPS display, which is easy on power consumption with decent brightness. Vernee quotes stats such as 500 nits brightness, 1500:1 contrast and 95 percent NTSC gamut. We found no reason to complain about the screen, which can be bright enough to use in direct sunlight and dim enough for night-time use. It's also protected with Gorilla Glass 3.

The Vernee Apollo has a USB-C port at the bottom, which can be used for charging, data transfer and audio. Pleasingly there's also a headphone jack at the top, so along with the built-in speaker you have plenty of audio options.

A volume rocker and power button are found on the right edge, but rather than a single pin-operated SIM tray on the left there are two. One accepts a single Nano-SIM and the other a Micro-SIM, or you can swap out the Nano-SIM for a microSD card up to 128GB in capacity.

Despite a lot of space above and below the screen, which makes the Apollo a rather tall 152mm, the navigation bar is displayed on-screen. You can fiddle around with its layout in the Settings menu.

There probably would have been space under the screen to fit the fingerprint scanner, but we like the rear positioning as it falls naturally under the forefinger as you use the phone, and can be used to both wake and unlock the screen at once. It's a decent scanner, recognising your fingerprint in 0.1s and allegedly becoming more accurate over time.

Performance

As we noted in the introduction to this review, the Vernee Apollo is one of few phones to run MediaTek's current best Helio X25 processor, a deca-core chip with eight Cortex-A53 cores and two Cortex-A72 cores, plus an integrated 850MHz Mali-T880 MP4 GPU. The Helio chip can run at

clock speeds of up to 2.5GHz, which is the main difference between it and the slightly slower-clocked Helio X20. Vernee pairs this processor with 4GB of RAM and a generous 64GB of storage.

On its site Vernee compares the core specification of the Apollo with the Xiaomi Mi5s Plus and OnePlus 3T. On paper it sounds impressive: a deca-core processor against their quad-core chips, a higher-resolution screen, a matching amount of memory and storage, and a higher megapixel rating on the primary camera. In fact the deca-core Helio X25 is not a match for the quad-core Snapdragon 821, and the 4GB of RAM is of the slower LPDDR3 rather than LPDDR4 variety (plus the OnePlus 3T has 6GB). Its higher-resolution screen is no doubt a good thing, but actually held it back in our graphics tests. And, as we well know, piling on the megapixels doesn't always make for a better camera. On the plus side, it is cheaper than those phones.

In real-world use the Apollo feels fast, with multitasking, gaming and multimedia no issue for it. In our synthetic benchmarks it couldn't compete with the OnePlus 3T, and is in fact a better match or Helio X20/X25 phones such as the Elephone S7, Xiaomi Redmi Note 4, Meizu MX6 and Vernee Apollo Lite.

The battery is on the small side for a 5.5in 2K-screen phablet, rated at just 3180mAh, so you'll need to charge it every day. It doesn't support wireless charging or, having a MediaTek chip, Qualcomm Quick Charge, but with a compatible adaptor Vcharge allows it to get a 50 percent charge in 30 minutes.

Connectivity

Usually with Chinese phones you must be careful to ensure they are supported on your home network. Fortunately the Apollo works with all UK 4G bands, so it's just as good on O2, GiffGaff or Sky Mobile as it is Vodafone, Three and EE. However, if you are buying outside the UK you should check the specifications and our guide on how to tell whether a phone is supported by your network.

The Apollo is a dual-SIM dual-standby phone, which means it can send and receive calls on two separate SIMs (although obviously not at exactly the same time). For data you must select one of the

Geekbench 4.0
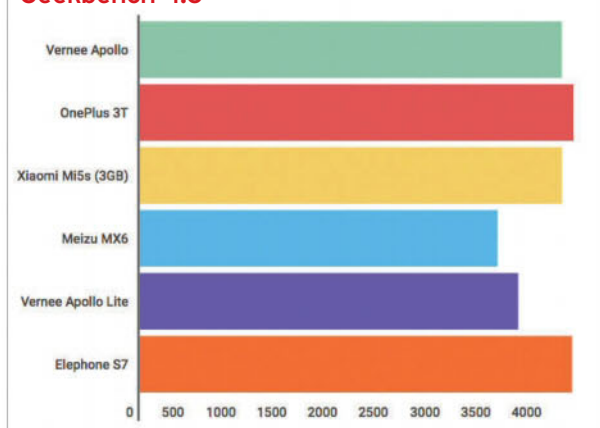
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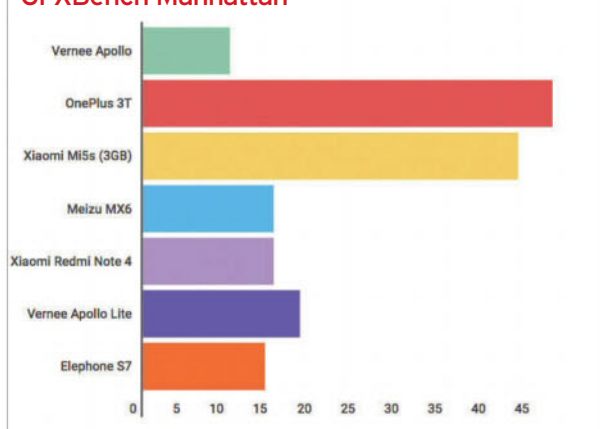
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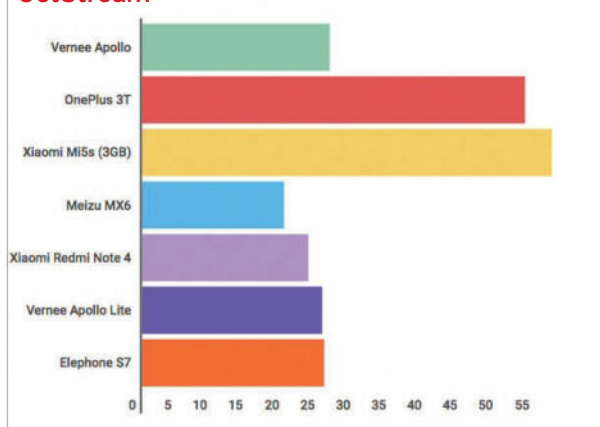
two SIMs, although you can change between them in the Settings.

The only thing that's really missing in terms of connectivity is NFC, which is necessary for making mobile payments and can be useful with some VR headsets. You do get dual-band 802.11n Wi-Fi, Bluetooth 4.0, GPS and A-GPS (GLONASS is not specified) and OTG.

Cameras

In a nice change from the countless Chinese phones with 13Mp cameras

Auto settings

that pass through *PC Advisor*'s doors, the Vernee Apollo is fitted with a 21Mp, 1/2.4in Sony IMX230. Specs include a dual-tone LED flash, 0.1s phase-detection autofocus, f/2.2 aperture and 4K video recording with videos saved in H.265 format.

We were impressed with the quality of our test photos, shot by default in a 21Mp widescreen format. Although viewed at full-size they show some softness at the extreme edges and are a bit grainy, overall they are amazingly sharp. And the HDR mode is the best we've seen on a phone at this price. It's incredible to think the two images were shot at the same time, the first in Auto and the second HDR.

The camera app itself offers a number of real-time filters, but shooting modes are limited to Auto, Panorama, HDR and a 40-shot burst mode. You can alter the ISO, white balance, exposure and image properties in the settings.

At the front is an 8Mp selfie camera, which includes the same real-time filters, HDR mode and a Beauty mode.

Software

The Apollo runs a vanilla version of Android Marshmallow, and the company confirms that it will be updated to Nougat, the latest version of the OS. There's a Turbo Download mode (which combines 4G and Wi-Fi for faster downloads), but very little in the way of preinstalled apps. There's a GoVR Player, for example, but no Google apps other than the Google Play store. This means you'll need to download the likes of Gmail, Maps and YouTube yourself if you wish to use them, and a benefit of this is storage isn't wasted if you don't. You can wake the screen with the fingerprint scanner and alter the layout of the navigation bar, but that's really it. And that's not a bad thing.

Verdict

The Vernee Apollo is a MediaTek flagship, which isn't what we expect from Qualcomm Snapdragon flagships, but a very decent phone nonetheless. It's pretty powerful, with a nice screen, a great camera and a relatively untouched Android OS. At less than £250, you can't argue with its value. ⊠ **Marie Brewis**

HDR on
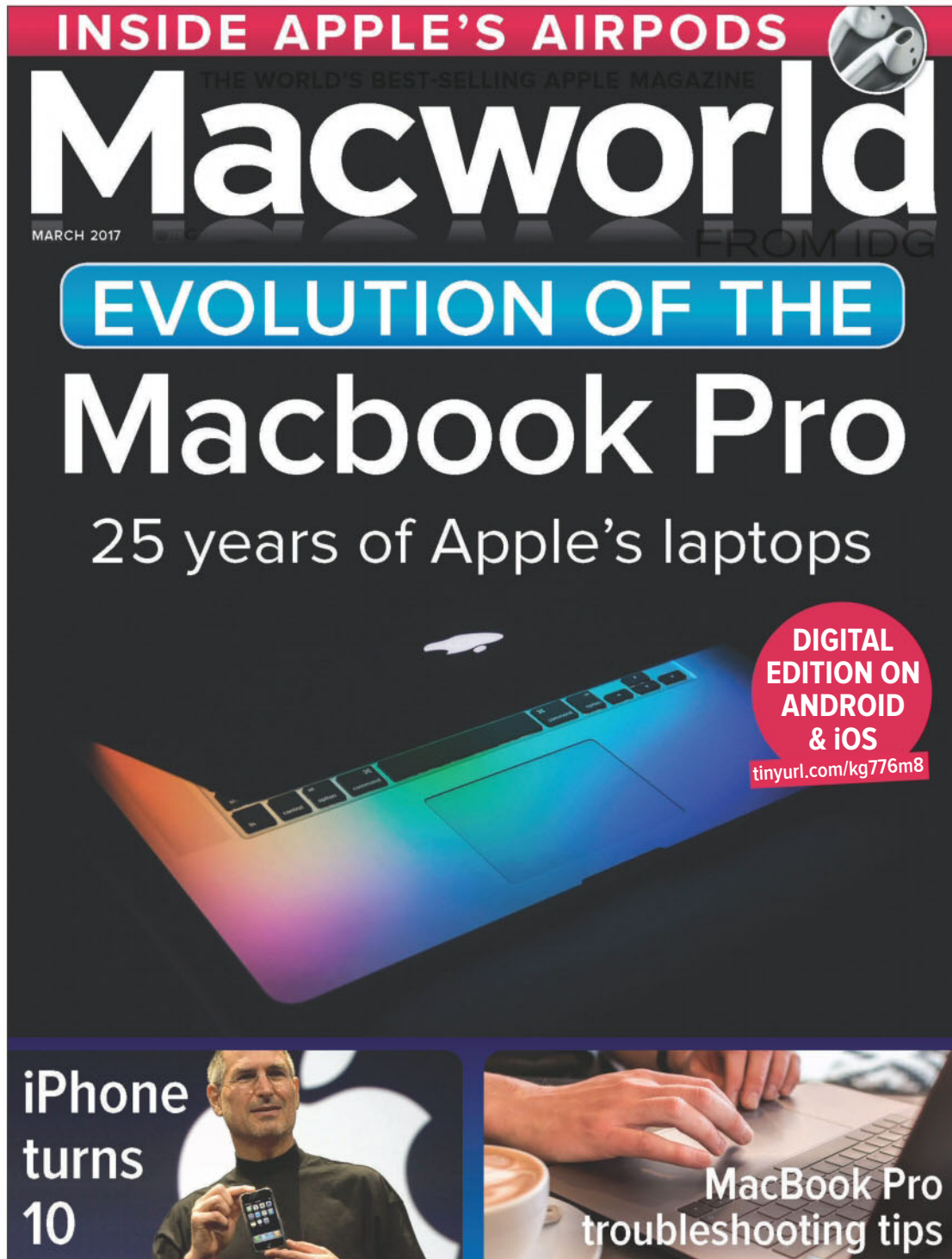
Specifications
Cloud SIM PAYG mobile hotspot, support for over 100 countries; also supports standard- and Micro-SIM to function as traditional Mi-Fi; GlocalMe U2 mobile app for Android and iOS; connects to up to five devices; LTE-FDD 1/2/3/4/5/7/8/17/20; LTE-TDD 39/40/41; WCDMA 1/2/4/5/8; CDMA/EVDO BC0/BC1; GSM 1900/1800/900/850MHz; downloads up to 150Mb/s; uploads up to 50Mb/s; 802.11b/g/n Wi-Fi; 3500mAh battery, lasts 12 hours; 5V/3A Micro-USB; 127x65.7x14.2mm; 151g

Build: ★★★★☆
Features: ★★★★☆
Value: ★★★★☆
Performance: ★★★★☆

★★★★☆
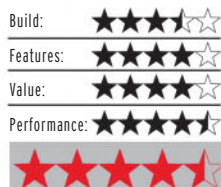
The GlocalMe U2 offers suggestions on how you can limit your data usage

MOBILE WI-FI ROUTER

GlocalMe U2

The GlocalMe U2 is an Indiegogo-funded project that offers a mobile Wi-Fi router unlike others on the market. It's best suited to frequent travellers who want to quickly and cheaply get online anywhere in the world, but it's a useful device for back home too, especially for business users who are tired of dealing with flaky internet connections while commuting and even in the various boardrooms they visit.

With embedded encryption the router also presents a safer method of getting online than connecting to potentially vulnerable public Wi-Fi hotspots. It's able to work as a standard Mi-Fi device, sharing the data connection of a mobile SIM (the network-unlocked U2 accepts both full-size and Micro-SIMs) with up to five devices, but what's more interesting about this is its cloud-SIM functionality. You don't need to insert a local SIM in this mobile router in order to get online in over 100 countries – you simply put some PAYG credit on it or buy a data pack and away you go.

GlocalMe works with multiple network operators, including AT&T, Sprint, Verizon, Orange, China Mobile, Vodafone, T-Mobile, O2, China Telecom and China Unicom, and supports a wide range of connectivity bands. Because it will automatically connect to the best network wherever you are, you'll often find – as we did – that getting online via the U2 is faster than with your current SIM.

Most data packages last 30 days, and the U2 itself can keep going for up to 12 hours on a single charge, which should easily power you through any working day. When the 3500mAh battery runs down charging is fast (around 3.5 hours) over a 3A Micro-USB connection.

Price

If you want to buy one in the UK you can still do so through the Indiegogo page, where your $129 purchase will also get you a bundled €20 top-up. This converts to around £104 in Sterling, plus shipping.

If you want to use the cloud SIM functionality, you have various options available to you for topping up. PAYG data is charged at €0.05 per MB, and can be used in any country you like. The minimum top-up is €20 at a time, which can be made via PayPal or Alipay.

Alternatively, you can buy a 30-day or annual data package that includes a set amount of data for a single country or a group of countries (for example, Europe). Prices differ between countries due to local pricing, for example 1GB in Vietnam will cost you €5 but €7 in the UK. You can see some of the pricing in the table opposite.

If you use a lot of data watching videos and downloading large apps and games, for example, the GlocalMe U2 isn't going to be a particularly cost-effective solution. In these scenarios you'll quickly gobble through any data you have purchased; but used merely for checking emails and getting online a gig or three of data can get you far.

There are a couple of unlimited data packages, but these are not truly 'unlimited', in fact restricted to 2GB per month at which point the speed drops to an all but unusable 128kb/s. (The U2 is otherwise very fast, capable of up to 150Mb/s downloads and 50Mb/s uploads.)

It's worth bearing in mind that if you frequently travel to different countries and are constantly switching SIMs to achieve a cheaper local rate, and perhaps don't even use all the credit you've purchased during your visit, this solution from GlocalMe will be both cheaper and easier to manage.

The accompanying GlocalMe U2 app gives some suggestions on how you can minimise data usage in order to keep down costs. For example, you can ensure Google Play doesn't download any app updates without your permission, or that apps aren't using data in the background. Pleasingly, we found these instructions were specific to the phone model on which the app was installed

The router supports a range of connectivity bands, although it still won't work with every network in the world. Supported bands include LTE-FDD 1/2/3/4/5/7/8/17/20, LTE-TDD 39/40/41, WCDMA 1/2/4/5/8, CDMA/EVDO BC0/BC1 and GSM 1900/1800/900/850MHz. For the UK at least, that means it supports all 4G networks (LTE-FDD 3, 7 and 20).

The company claims its device works in over 100 countries, but bearing in mind there are 196 countries in the world there will still be areas that are not covered. The current list of support countries is available on GlocalMe's Indiegogo page (tinyurl.com/z6d86x4).
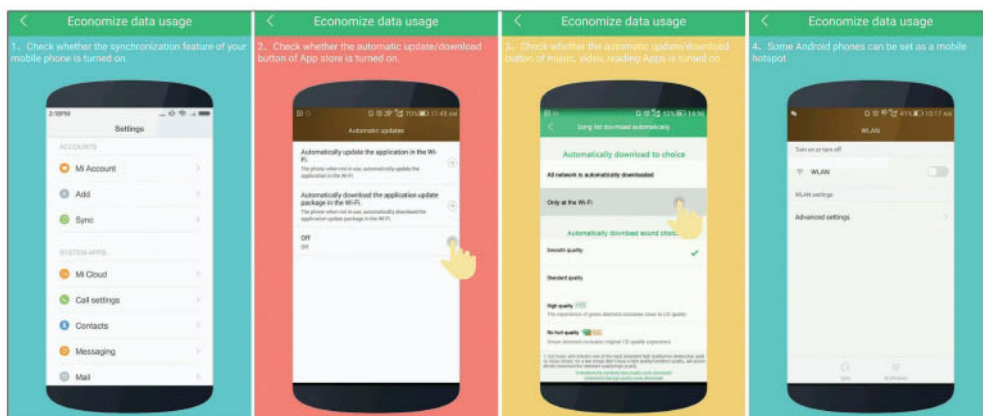
It's worth noting that the U2 is not the only cloud-SIM device offered by GlocalMe. There's also the G2, which is larger and heavier thanks to a built-in LCD screen and 6000mAh battery that allows the device to also be used as a power bank. By comparison, the U2 is controlled entirely by a mobile app. The G2 accepts only full-size SIMs, which isn't much use to us here in the UK without an adaptor, and supports fewer connectivity bands. It's also more expensive, currently priced at $149 at Amazon US.

Design

We have to say that as useful as we think the U2 is, we aren't too keen on its design. Yes it's reasonably slim and lightweight, at just 14.2mm thick and 151g in weight, and no taller or wider than the average smartphone, but it just doesn't look like a device that costs over £100.

Partly this is down to its plastic build (though this is probably a good thing in terms of reception, as metal can block cellular signals), but neither are we keen on the way the front panel comes off in order to access the SIM slots (none of which are Nano-SIM so you may need an adaptor) – we'd much prefer to see pin-operated SIM trays. To be fair there is no creaking or flexing as a result, which is something.

There's also a very ugly protruding corner at the top right, which has a hole through it for a lanyard. It reminds us of early mobile phones with their poking out antennae. The U2 will quite happily slip into a pocket, so there's no need to be attaching it to anything unless you're particularly prone to misplacing things. (If you are, then it's worth noting that you can deactivate the U2 from within the app, making it unusable should it fall into the wrong hands.)

Also making us feel as though this is something from the dark ages is the small reset button that sits just above the power button on the left edge. This surely could have been hidden away under the removable panel.

And then there's the lack of an LCD screen. We totally get GlocalMe removing it from the G2 in order to keep down the size and price, but actually we quite like the ability to see at a glance exactly what is going on. And when

AREA	300MB DATA PACKAGE	1GB DATA PACKAGE	3GB DATA PACKAGE	VALID PERIOD
United Kingdom	€4	€7	€19	30 days
Germany	€4	€7	€19	30 days
France	€5	€10	€24	30 days
Sweden	€5	€10	€24	30 days
Canada	€6	€12	€29	30 days
United States	€6	€12	€29	30 days
Japan	€4	€7	€19	30 days
Australia	€5	€10	€24	30 days
Singapore	€4	€7	€19	30 days
Vietnam	€3	€5	€12	30 days
United Arab Emirates	€10	€20	€48	30 days
South Africa	€6	€12	€29	30 days
Egypt	€4	€7	€19	30 days
Brazil	€8	€15	€36	30 days
South East Asia (7 countries)	N/A	€12	N/A	365 days
Europe (33 countries)	N/A	€16	N/A	30 days
Worldwide (100 countries)	N/A	€29.90	N/A	365 days

it comes to a device such as this we would like to be able to see how many devices are connected to it, how strong is the signal, and how much battery power remains. Two of these three things are available within the mobile app, but there's no scope for managing connected users unless you log into Device Management through a web browser (head to 192.168.43.1 and enter admin for both the username and password).

Instead, you get a row of four LEDs across the front plus three symbols for Wi-Fi, reception and battery. By default, the Wi-Fi symbol will be lit when the device is connected, and the LEDs below switched off. Pressing the power button on the side activates the battery symbol and LEDs below to show you the rough remaining capacity, while pressing it a second time activates the reception icon and the four LEDs instead show you how strong is the signal.

The colour of our review sample doesn't help things, a sickly gold colour that has been popularised by the iPhone and other recent

flagships, but we have to say it looks far more attractive in space grey. One thing we would like to see in a future version is the ability to add a microSD card and wirelessly share its contents between connected devices.

Setup

To set up the U2 you first need to download the GlocalMe app, though when we scanned the QR code in the Quick Setup guide to access the download page a 404 Error was returned. When we then browsed to the main site to manually search for the app we weren't able to scan the QR code because we were already using our phone. It's an awful lot easier to simply search Google Play or the App Store for the free GlocalMe app, which is exactly what we did in the end.

You'll need to register for a free account within the app, which is reasonably straightforward but for some reason it wanted to know our Passport or ID Card number. Not having this information to hand we decided to close the app and come back later, at which point it

Home download

Mi Mix with GlocalMe U2
Mi Mix with Vodafone UK SIM
Mi Mix with Wi-Fi

0 10 20 30 40 50 60 70

Office download

Mi Mix with GlocalMe U2
Mi Mix with Vodafone UK SIM
Mi Mix with Wi-Fi

0 5 10 15 20 25 30

Train download

Mi Mix with GlocalMe U2
Mi Mix with Vodafone UK SIM

0 5 10 15 20 25 30 35 40 45 50

Home upload

Mi Mix with GlocalMe U2
Mi Mix with Vodafone UK SIM
Mi Mix with Wi-Fi

0 1 2 3 4 5 6 7 8 9 10 11

Office upload

Mi Mix with GlocalMe U2
Mi Mix with Vodafone UK SIM
Mi Mix with Wi-Fi

0 5 10 15 20 25 30

Train upload

Mi Mix with GlocalMe U2
Mi Mix with Vodafone UK SIM

0 5 10 15 20 25 30 35

All figures in Mb/s

became apparent that it worked just fine without us entering this information. Now logged into the GlocalMe app you can activate the U2. You'll be instructed to scan the QR code on the back of the device, which was simple enough to do. We didn't need to purchase any data since this was a review sample, so instead powered on the device and connected to it as we would any other Wi-Fi router (the password is also printed on the rear of the device). Do note that it can take a couple of minutes to establish a connection, particularly when used in a new location.

You no longer need to use the mobile app unless you want to check how much data you have remaining, see your traffic and purchase history, top up or deactivate a lost device. It can also show you the exact battery capacity remaining in the My Device menu.

Made in China, some things have been lost in translation, but we still found the app pretty easy to use. The only thing that really confused us was the permanent link in the My Device menu to activate your device, even after the router had been activated. It isn't possible to connect more than one U2 to a single account, so we don't know why this was still visible.

We also found that the data packages weren't listed in any logical order, either by the amount of data, country or even alphabetically, so we'd advise using the search option

to quickly find the country you wish to purchase data for use in.

Performance

So the router's design didn't dazzle us and the app could use a little tweaking, but one thing we absolutely cannot criticise is the GlocalMe U2's performance. We often found ourselves able to get online in places we previously couldn't on our usual Vodafone network, and in every situation we also found it faster.

4G connectivity is supposed to produce Wi-Fi-like speeds, but it's very rare that you actually get to experience those (in our experience anyway). But given good signal the U2 really can be as fast as a Wi-Fi connection. We tested the GlocalMe using the

Speedtest app in three locations: at our home, where we struggle to get online at all via the Vodafone network; at a train station during our commute into London; and in our Euston Road office. As you can see in our charts, the U2's performance is extraordinarily good. Able to connect to the strongest network, it's like having SIM cards for every UK network installed in your phone – you'll always get the best performance.

Verdict

A fantastic device for getting on the fastest mobile network wherever you may be and on up to five devices. We don't love the design, but the GlocalMe U2 revolutionises the mobile hotspot with its cloud-SIM technology. ⊠ **Marie Brewis**

£139 inc VAT

Buy from
■ amazon.co.uk

Specifications
A4 colour inkjet printer with 9600x2400dpi resolution; 2400x4800dpi scanner/copier; 100-sheet A4; 20-sheet photo paper; CD/DVD/Blu-ray; USB; Wi-Fi; Apple AirPrint; 139x372x324mm; 6.5kg

Build: ★★★★☆
Features: ★★★★☆
Value: ★★★★☆
Performance: ★★★★☆

★★★★☆

COLOUR INKJET PRINTER

Canon Pixma TS8050

We've always been fans of Epson's 'small-in-one' printers, which provide very compact models for home users, and now Canon is getting in on the act with the latest addition to its Pixma range of photo printers. Like other models in the Pixma range, the compact TS8050 puts its focus on high-quality photo printing, with a print mechanism that uses six different ink cartridges. The standard cyan, magenta, yellow and black inks are complemented by a grey ink that helps to enhance contrast and subtle tonal graduations within photographs, while the sixth cartridge provides a special pigmented black ink that is used for printing text.

Price

That quality comes at a price though, and the TS8050 costs £179 when bought directly from Canon, although you can find cheaper if you shop around online. You can, for example, buy it for £139 from Amazon. That comes with only 'setup ink' though, and a bundle with full cartridges will cost £219, even from Amazon. See running costs below for more information.

Design

Canon says that the new TS8050 is 30 percent smaller than previous models in the range, and at 372x324x139mm deep it's certainly small enough to sit on a desk or a shelf in a home office. However, Canon manages to pack in plenty of useful features that help to justify the printer's relatively high cost. As well as the 9600x2400dpi printing, the TS8050 includes a 2400x4800dpi scanner and copier.

The main paper tray holds 100 sheets of A4 paper, but its focus on photo printing means there's a second tray that holds 20 sheets of photo paper, and a third tray for printing on CDs and other types of disc. As well as standard USB and Wi-Fi connections, the TS8050 also supports AirPrint for Apple's iOS devices, while Canon's Cloud Link feature let you print photos from social media such as Instagram.

Performance

The complexity of the six-ink printing process means that the TS8050 isn't the fastest printer around. Canon quotes speeds of 15 pages per minute (ppm) for text documents, 10ppm for colour graphics, and 21 seconds for a 150x100mm postcard print. We actually got closer to 12ppm for text and 7ppm for graphics, while our postcard prints took 30s. Even so, those speeds should still be perfectly adequate for most home users and, of course, the five inks used for photo printing ensured that our test prints were extremely good, with crisp, bold colours and subtle, attractive flesh-tones in portrait photography.

Oddly, though, text output using the standard quality setting was a little heavier than we'd expected, and lacked the near-laser-quality smoothness that you can now get from some inkjet printers. It'll be fine for most routine documents, but if you really need top-quality text then you might want to switch to the slightly slower Fine setting.

Running costs

We'd expected the six-ink mechanism to really push up the running costs for the TS8050, but we received a pleasant surprise here. If you shop around on Amazon you can find the pigmented black ink (300 pages) for around £11.20, which works out at 3.7p per page for text printing. That's quite steep, but if you opt for the high-yield XL cartridge – £12.53 and 500 pages – that comes down to a much more reasonable 2.5p per page.

A set of five standard colour cartridges comes to around £45, although Canon quotes a different number of pages for each individual colour cartridge, which makes the cost calculations rather complicated. After a bit of head-scratching and calculating with Excel, we estimate that colour printing with the standard cartridges works out at about 10.6p per page, which is on the higher end of average printing costs. But if you spend around £59.20 for a set of five XL cartridges then that price comes down to just 6p per page, which is very good for colour printing of this quality.

Verdict

The initial cost of the TS8050 is high, but its impressive photo printing will justify that price for people who are serious about photography. We'd avoid the standard size ink cartridges, as they're not great value, but if you buy the high-yield XL cartridges then this can provide top-quality photo-printing with very competitive running costs. ⊠ **Cliff Joseph**

> The compact Pixma TS8050 puts its focus on high-quality photo printing, with a print mechanism that uses six different ink cartridges

Specifications
36mm or 40mm models; compatible iOS and Android; 316L stainless steel; tracks steps, runs, swims, sleep and calories burned; sleep tracking; silent alar; digital display and analogue hands; incoming call and app notifications; 25-day battery life; Bluetooth LE; waterproof to 50m; 13mm thick; 39/49g

Build: ★★★★☆
Features: ★★★★☆
Value: ★★★★☆
Performance: ★★★★½

★★★★☆
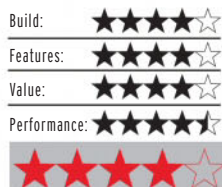
SMARTWATCH

Withings Steel HR

A lot of people will be waiting for the release of Android Wear 2.0, but sometimes a semi-smartwatch is a better choice. Withings is becoming a master of the hybrid wearable and its latest release is the stylish-looking Steel HR.

Design

Withings' £320 Activité set a high standard when it was released and the firm has done a great job of maintaining that level of build quality with its cheaper watches.

You won't be surprised to hear that the main body of the HR is made from steel. It also looks a lot like the original Steel, although the HR comes with a heart-rate monitor. It's available in two sizes: 36- and 40mm. Our review unit was the larger model, which has a wider bezel around the edge with engraved numbers.

The 40mm version is only available with a black watch face, so if you want white one you'll need to opt for the smaller option. Each model comes with a smooth silicone strap (18- and 20mm respectively), which uses a quick release mechanism. A leather strap priced £70 is also available from Withings, though it won't fit the 40mm model.

Aside from the heart-rate monitor there are two major differences between the Steel and the Steel HR. For starters, the activity tracking dial, which goes from 0- to 100 percent of your target, now goes full circle instead of 12- to 9 o'clock and sits centred. The other is the addition of a small digital screen, which provides information and notifications. This is slightly hidden when not in use on the black model, but stands out on the white watch face. A lone button on the side operates the display.

As with previous Withings watches, the Steel HR is waterproof up to a depth of 50m, though the firm points out that it can't be used for snorkelling or diving.

Features

Activity tracking
One of the Steel HR's main selling points is activity tracking. On top of walking, running and swimming, the watch tracks sports such as dancing, volleyball and table tennis.

You tell the Steel HR your daily exercise target (10,000 steps is the default setting) and the additional dial will let you know how you're doing. The accompanying Health Mate app (available for Android and iOS) is easy to use and delivers detailed information such as calories burned and distance travelled right to your phone. This data can then be shared with other fitness apps.

If you wear the Steel HR at night, it monitors your sleep patterns and can be set to wake you up with a silent alarm using a vibration motor.

Heart-rate monitor
The heart-rate monitor is located on the device's rear and uses green LEDs to measure your pulse . By default, it takes a reading every few minutes, but will start continuously monitoring your heart beat while you're exercising. During testing, we found it did a great job and this is a good choice for fitness fanatics.

You can also take a one-off scan by clicking the button on the side, though this didn't work as well in our tests and the results jumped around.

Digital screen
The HR's display is easy to use: push the button on the side repeatedly to cycle through the different modes. It provides information such as the date and battery percentage, but there are more useful items on offer. These include notifications for phone calls and texts, though you don't get a preview of what a message says even though a calendar reminder provides scrolling text.

Battery life
At the time of writing, we've been using the HR for almost two weeks and it still has 53 percent left in the tank, so is on track for the firm's claim of 25 days. At around the 25-day mark, the watch automatically turns on a power-saving mode, which Withings says will give you an extra 20 days' battery life.

We do, however, wish the watch came with a charging stand rather than the supplied cable, which doesn't always connect properly.

Verdict
If you're not fussed about a touchscreen smartwatch, the Steel HR is stylish, well-made and offers excellent battery life. Plus, we're glad to see the addition of the heart-rate monitor and the screen. Overall this is a great semi-smartwatch for the price. ⊠ **Chris Martin**

You tell the Steel HR your daily exercise target (10,000 steps is the default setting) and the additional dial will let you know how you're doing

£125 inc VAT

Buy from
■ rockjawaudio.com

Specifications
Balanced armature + 8mm dynamic (Multi driver); Pro MMCX detachable cables; 3x Interchangeable tuning filters; compatible with iOS/Android/Windows smartphones; 16 Ohm impedance; 103+/-3dB sensitivity; 20- to 20,000Hz frequency response; 1.25m cord; gold plated 3.5mm jack; mic with universal pause/play button

Build: ★★★★½
Features: ★★★★☆
Value: ★★★★½
Performance: ★★★★☆

★★★★½

IN-EAR HEADPHONES

RockJaw Resonate

If you're spending under £50 on a pair of in-ear headphones, you'd be hard pushed to find anything better than RockJaw's Alfa Genus V2. In fact, there isn't anything better. But what if your budget is over £100? Well that's where the firm's Resonate comes into play.

Price

Some may think £125 is a lot to spend on a pair of headphones, but in the grand scheme of things, it really isn't. In fact, you can easily spend more than double this, but as with a lot of things, it's a case of diminishing returns. And at £125 from RockJaw, the Resonate is actually very competitively priced.

Design

The Resonate is in a different league to the Alfa Genus, and you'd expect that at almost three times the price.

The buds are hewn from aluminium and have a reassuring weight and quality to them. The cables are detachable, so even if you do damage something, the fix is relatively simple and inexpensive.

Inside the buds are multiple drivers: a balanced armature and an 8mm dynamic driver to be precise. Put simply, this offers the best of both worlds: lots of detail, but also plenty of bass.

As with most of RockJaw's other earphones, the Resonate has removable 'tuning' filters. Gold is for 'reference class', which in essence is a flat EQ so you hear music the way the artist – or producer – intended. Blue is for treble, and accentuates high frequencies for those who

prefer their music to have extra detail, while Green – our favourite – is for bass and this increases the volume for lower frequencies.

Since the filters unscrew easily, it takes but a few seconds to swap them out if you want a different sound. The only issue is that the filters are tiny, and easily lost in the bottom of the soft carry pouch.

There's a remote control on the left-hand cable and this has a universal pause/play button (marked with a phone receiver since it can also answer calls) along with volume controls and a microphone for hands-free calling.

Audio

In the box, you'll find small, medium and large silicone tips, a pair of small double-flange silicone tips, plus medium and large memory foam tips. It can take a while to find the best fit, but you'll only get the best sound if you select

tips, which form a good seal in your ear. This is also necessary to prevent the buds from falling out when you're moving around.

Once you've done this, you'll be amazed as the sound quality. Even with the green 'bass' filters installed there's still a fantastic level of detail, regardless of the genre of music you listen to.

What's particularly noticeable compared to, say, the Alfa Genus V2 is the sheer separation of instruments. Listen to a classical piece and you'll feel like you're sat in the auditorium, able to pick out individual instruments, such is the Resonate's soundstage. They are, however, equally at home with pumping dance music, which is where those green filters really come into their own. Bass is bold and powerful without ever being sloppy or overpowering. Put on some jazz and you'll hear the micro-detail in vocals that – chances are – you've never heard before unless you're coming from even more expensive in-ear-monitors, which have even more drivers.

If there's a slight criticism it's that the highs can be a little harsh with the blue filters installed, but if that's the signature you prefer, it's not fatiguing. And if you don't like it, just swap the filters.

Verdict

Overall, the RockJaw Resonate is an excellent IEM, which serves up brilliant sound quality along with great build quality (including detachable cables) at an amazing price. ☒ **Jim Martin**

Specifications
15,000mAh power bank; parallel charge; 1x 5V/2.1A Micro-USB input; 1x 5V/2.1A USB-C input/5V/3.1A output; 1x Quick Charge 3.0 USB output; 1x 5V/2.4A Smart USB output; four-LED capacity indicators; Micro-USB and USB-C cables supplied; auto-on; no passthrough charging; no carry case; 158x78x20mm; 356g; 12-month warranty

Build:	★★★½☆
Features:	★★★★☆
Value:	★★★★½
Performance:	★★★★½

★★★★☆
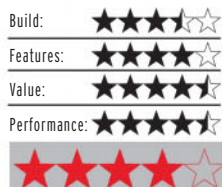
POWER BANK

Lumsing Glory P2 Plus

At a glance, the Lumsing Glory P2 Plus looks like your average high-capacity no-frills power bank, but it has several compelling attributes.

The first is price, and at £24 it offers good value for a 15,000mAh power bank, with several high-end features. Secondly, it has three outputs: one USB-C and two full-size USB, allowing you to charge a phone, a tablet and another device such as a smartwatch at once. We're pleased to see one of these full-size outputs supports Quick Charge 3.0 which, until Quick Charge 4.0 makes an appearance in the Snapdragon 835 mobile processor, is the current fastest charging standard for compatible tech.

The other USB output is a Smart connection, so-called because it is able to recognise your device type and adjust how much power it delivers accordingly, with a maximum 12W (2.4A), which is faster than many bundled phone chargers. It is true that your device will draw only the power it requires, therefore making the output less relevant for single-output power banks, but when you are potentially sharing the output between three devices optimising what is given to each can help all three to charge as fast as possible.

As more and more devices adopt USB-C for charging, we're beginning to see an increasing number of USB-C power banks flooding the market. Many of these are designed

(2.1A) from the mains, which means it powers your phone faster than it can charge its own battery. However, then we realised it supports parallel charge, which means that if you have two power sources you can refill this power bank using both its inputs at once. A desktop charger is ideal for such a job.

When refilled with a single power source, the P2 Plus will take up to nine hours to charge, but with two inputs in action charging time is reduced to just five hours.

That's a pretty cool feature we haven't seen before in a power bank, but unfortunately it isn't supplemented with passthrough charging capability. This is when you are able to simultaneously refill the power bank and charge a connected mobile device, freeing up power sockets, reducing cable clutter and allowing you to leave

efficiency is around 65- to 70 percent, meaning you should get around 10,000- to 10,500mAh from the P2 Plus. The highest energy-efficiency rating we've seen on a power bank is 90 percent.

So it has some nice features, but the Lumsing's design is fairly bland. It's a rectangular slab of matte black plastic, with a Lumsing logo on the top and four LEDs that light up (during operation or as you press the power button) to show how much capacity remains. With each LED representing 3750mAh, that's a fairly big jump between them. However, LCD screens with more accurate readouts remain pretty rare at this price point.

On one end you have the various inputs and outputs, each labelled accordingly, and on the other end (with the text facing the opposite way up) some key specifications.

The power bank itself is necessarily big and heavy, given its capacity, and measures a chunky 20mm thick, 78mm wide and 158mm high. It's a heavyweight at 356g, so it's not a power bank you'll particularly want to keep in a pocket. Nevertheless, given the functionality and pricing it offers a good deal.

Verdict
The design doesn't thrill us, and we'd like to see support for passthrough charging, but the Lumsing Glory P2 offers great value and some welcome features. Few power banks of this capacity will charge in just five hours. ⊠ **Marie Brewis**

When refilled with a single power source, it takes up to nine hours to charge, but with two inputs in action charging time is reduced to five hours

primarily for use with USB-C, and so they have just a single USB-C input. The Lumsing caters to all Android users, with both Micro-USB and USB-C inputs – and cables for each supplied in the box.

When we first examined the P2 Plus we were surprised to find that although this USB-C port can output 15.5W (3.1A), it can only draw 10.5W

both to charge overnight and wake up to find both batteries full.

With 15,000mAh of power inside you should find the Lumsing will charge an iPhone 7 five times, or a Galaxy S7 3.5 times. Why not more? Because all power banks lose capacity through heat generated and voltage conversion; the industry-standard

Specifications
10,000mAh power bank; 1x 5V/2.1A USB output; 1x 5V/2A Micro-USB input; IP67 dust- and water protection; passthrough charging; auto-on, auto-off; four-LED capacity indicator; LED flashlight; included in box: carry case, compass, carabiner clip, Velcro strap, Micro-USB cable; charges in five- to six hours over 5V/2A charger; 101x64x27mm; 200g; 24-month warranty

Build: ★★★★☆
Features: ★★★★☆
Value: ★★★★☆
Performance: ★★★★☆

★★★★☆

POWER BANK

DXPower Armor DX0001 10,000mAh

Choosing a power bank can be difficult, given the sheer number of options available, but if you require a rugged power bank your choices are more limited.

We like this 10,000mAh Armor power bank from DXPower, which costs £23. It's also available in a 6000mAh version for £15.

The Armor is rated IP67, which means it's shockproof, dustproof, and protected in 1m of water for up to 30 minutes. Note that in order for it to be waterproof the flap that covers the ports must be tightly closed, which means it is protected from the elements only while it's not in use. This won't be a difficult feat to achieve, though – you need to give it some muscle just to open the tight-fitting flap.

Protecting the ports from water with a plastic and rubber seal is the same approach as that used by the EasyAcc Rugged Power Bank, which is not only more expensive than this DXPower device but significantly larger and heavier. That's because it offers double the capacity at 20,000mAh, so more charges for your connected device.

We've seen several Amazon vendors listing what appears to be an identical power bank to this DXPower Armor – albeit in different colours – though they all publish a slightly different specification and price. One of those vendors mentions an efficiency rating of 88 percent, though we believe the

and green ABS and PC enclosure that features finger grips all the way around and is said to offer high temperature resistance. Though you'll need it only to keep together the bank and accessories, such as cables, a carry case is also provided in the box.

This is one of several nice touches: you also get a compass that clips on to a carabiner clip, which itself attaches to a Velcro strap. This fits through a circular protrusion at the top of the bank, though if we're honest we would prefer the design without this.

Given its tough casing we're surprised by how compact the Armor is for a 10,000mAh power bank. Weighing in at 200g and measuring 101x64x27mm, it's really not much larger than some non-rugged 10,000mAh banks we've seen. If you want a truly compact power bank, then a rugged model is not it, of course. You can switch down to the 6000mAh model, but you'll likely get only one full charge for your smartphone (two if it's an iPhone).

Despite having enough power to charge two phones, the Armor has just the one USB output. This is a fast-charging port, rated at 5V/2.1A (10.5W), though you can find faster ports that support Quick Charge. The Micro-USB

charge both devices, and won't need to keep an eye on when one is full to swap over to charging the other one.

Charging is automatic, so you simply plug in a phone or tablet and the Armor gets to work. There is a power button on the side of the case, but this is used purely to activate the built-in LEDs to see at-a-glance how much power remains or to turn on the LED flashlight. The latter may be handy if you're camping.

Once charging is complete, the Armor will automatically stop charging your phone or tablet, which means no unnecessary power is wasted and no damage can be caused to your device's battery by overcharging it. In that regard, the DXPower Armor battery builds in all the usual safeguards against overcharging, short-circuiting and so forth, though you still shouldn't leave it plugged in indefinitely.

Verdict

A good-looking, mid-capacity rugged power bank that will fit neatly into the pockets of campers, hikers and other outdoorsie-types. It's a shame that the DXPower Armor is waterproof only when it's not in use, but this is a criticism we could level at most – if not all – 'waterproof' power banks. ⊠ **Marie Brewis**

> ## You can connect a phone or tablet to its USB port and charge that device while the power bank itself is charging from a mains power outlet

Panasonic cells inside this bank are closer to the industry standard of around 65- to 70 percent.

This means from a 10,000mAh battery you would receive around 6500- to 7000mAh usable charge. And this falls in line with DXPower's claims that the Armor can offer 3.5 charges to an iPhone 7 (6860mAh), two charges to the Galaxy S7 (6000mAh) and one full charge to an iPad mini 4 (5124mAh).

The Armor has a cool-looking tough design, with a rugged black

input is similarly specified at 5V/2A (10W), and with a compatible charger this bank should be full in around five- to six hours.

A plus side when it comes to charging is the DXPower Armor's support for passthrough charging. This means you can connect a phone or tablet to its USB port and charge that device while the power bank itself is charging from a mains power outlet. The process will clearly take longer, but it means you need only one power outlet to

★★★★☆

GAME

Sniper Elite 4

The Sniper Elite franchise is famous for providing fans with a satisfying sniper-based shooter, and while the latest offering is similar to previous games in the series, it comes with a handful of improvements.

Plot

The action is set in the aftermath of the events of Sniper Elite III, with protagonist Karl Fairburne returning to do what he does best: kill Nazis. Not just any Nazis though; key members of the German military during World War 2. In Sniper Elite 4, he is sent to Italy to help the Resistance fight the Germans, plus complete his own missions, which range from destroying downed allied planes to searching for vaccines.

Beyond this though, there is very little to the plot and it seems that the story has been based around the objectives of each mission and not the other way around.

That's fine though, because Sniper Elite 4's developers have focused more on gameplay than plot, which we think was a smart decision. In terms of sniping fun this is one of the best games we've ever played, with no other providing more satisfaction as you ping helmets off the heads of your enemies from over 200m away. Those who want a Sniper sim aren't interested in deep, brooding storylines and emotional protagonists. They just want to shoot Nazis.

Gameplay

Sniper Elite 4 is similar to other games in the series, which is no bad thing, although it has received a number of much-need enhancements. The most noticeable change is that the sandbox environments are three times the size of those of its predecessor.

This extra space means there's an almost endless combination of ways to complete a mission. You might, for example, stumble upon a drainpipe that you can climb to access a makeshift sniper tower, giving you a great view of the area, so you can plan your move.

Tactics are crucial in Sniper Elite 4. It's not a run 'n' gun game, nor can you sit in a single spot and shoot your enemies. While that may initially be off-putting to some, the variety of ways you can tackle an objective means you can switch it up and creatively achieve your aims, helping to keep the game interesting.

Fans of the series will be glad to hear that Bullet Time makes an appearance. This provides slow-motion shots of a bullet as it leaves your gun and follows it along its trajectory until it reaches its target. However, as cool as it is following your bullet through foliage and other tiny gaps along its route, it's the X-ray view of the enemy's body as the bullet enters that provides the real satisfaction. No other game provides a mechanic as satisfying

as this, as you get to see all the damage you've done in real time.

While Sniper Elite 4 isn't open world in the same sense as Grand Theft Auto, missions and other objectives can be undertaken in any order. This can work to your advantage, especially if an objective is heavily guarded. In other games, you'd have to complete the mission, but here you can head to another objective, cause a huge deal of commotion and draw enemies away from your main target, making life a little bit easier.

The new game mechanics also allow players to shimmy, leap across ledges, hang from windows, and more. This allows access to better vantage points than was previously possible, and can come in handy when trying to make a quick escape. It also means that if you're spotted sniping from the first floor of an abandoned house, you can make a stealthy exit out of a rear window and hunt for your next vantage point without being seen.

It's not only the environment and mechanics that have had a facelift, as the non-player characters (NPCs) are more intelligent. Upon hearing gunshots, for example, enemies will try to triangulate where the noise was coming from, but it's once you've been spotted that the improvements become clear.

During one mission we found ourselves flanked by NPCs. We

thought we could take on a squad of troops and had a head-on firefight, taking cover to the side of a door frame in an abandoned house. Unfortunately, what we hadn't noticed was that at the same time, another team had approached from the rear, split into two smaller groups and hit us from the left and right at the same time. Unsurprisingly, the mission didn't end well, though we weren't upset. This added intelligence means you have to use your head and be aware of your surroundings because all it takes is one slip up before you are surrounded and killed.

Our one criticism of Sniper Elite 4 is that it doesn't reward you for completing all the side missions, beyond being able to get 100 percent in a level. With so many on offer, we feel that they should have some kind of impact on the story in a way that other open world games do. Let's say, for example, we had ignored a side mission to destroy an anti-aircraft battery, we should have had to face a harder challenge later in the game. Sadly, this isn't the case, and with no unlocks or other kind of motivation to complete these, we ignored them and focused instead the main

missions, which become increasingly difficult as the levels progress.

Verdict

Sniper Elite 4 is the best in the series, adding new mechanics that turn a good game into an amazing one. The open world layout and relaxed approach to objectives gives gamers the freedom to tackle each environment as they desire, and when combined with new climbing mechanics, opens the doors to impressive, long-distance shots. If you're looking for a solid sniper game, you'll struggle to find one better than this. ☒ Lewis Painter

THE BEST OF

CES 2017
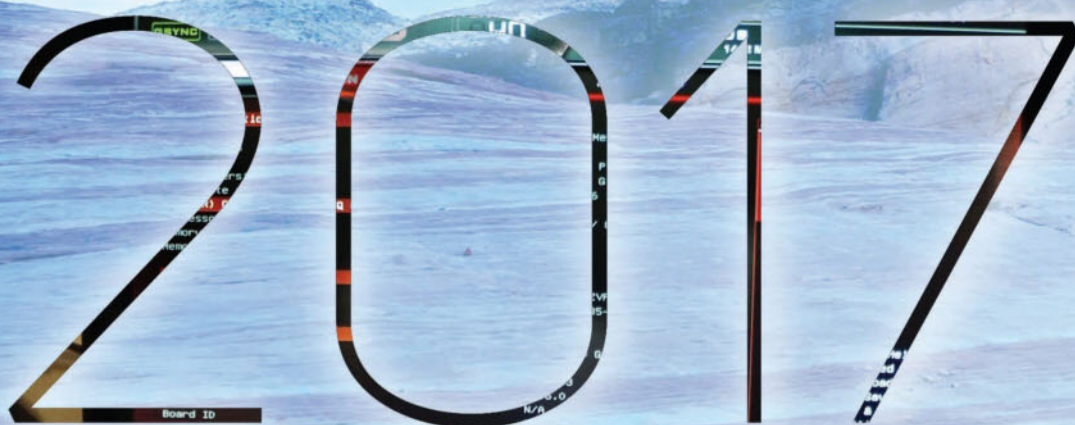
WILD, WEIRD, AND POWERFUL HARDWARE.
BY JON PHILLIPS

PROJECT VALERIE: RAZER'S TRI-SCREEN MEGA LAPTOP

Forget the smart hairbrush. Disregard the vaporous electric car. You can even walk past the latest TVs (though we have to concede, some are supercool). Like the last few Consumer Electronic Shows, CES 2017 has emerged as a fantastic pantheon of PC hardware – from the latest cutting-edge silicon, to wild laptops, to outrageous desktop machines and cases. Here, you can see the gear that *PC Advisor*'s CES foot soldiers found most intriguing.

Razer's laptop features three 17in 4K G-Sync displays, two of which automatically slide out from the main display with the help of robot arms. Project Valerie is still just a project – an R&D prototype that may never ship. And maybe you wouldn't actually want it. With about 370 square inches of display pixels to power, imagine the machine's brief battery life.

Also consider the price, which would likely hit at least $5,000 (£TBC). And what happens when you automatically extend those displays in a small, cramped space? Do they just snap off?

But, hey, whatever. It's prototypes like Project Valerie that make CES exciting. This is why we come.

PROJECT ARIANA: A 4K RAZER PROJECTOR THAT EXTENDS FROM MONITOR TO WALLS

Razer wasn't done after wowing us with Project Valerie. This is project Ariana, a 4K projector that extends the image on your display to your entire wall, creating a spectacular immersive effect. It could be available by the end of 2017 if Razer is convinced consumers are ready to buy in.

PROJECT MODENA IS THE SUM TOTAL OF DIGITAL STORM'S HARDCORE KNOWLEDGE

Digital Storm has a rich history in building luscious, water-cooled boutique PCs, and in its not-yet-for-retail Project Modena prototype, it pulls out all the stops. You can think of it as the living embodiment of all the company's PC knowledge (assuming, of course, you believe a PC can be 'alive'). The machine sports aggressive vents running on the front, top, and back of the case, allowing for a range of cooling approaches. And in this photo you can see the mobo-facing case panel, revealing interior lighting and the water-cooling apparatus, all tastefully executed. There's also a smaller case window on the other side for showing off your high-dollar SSD investment.

SNOWBLIND IS A CASE THAT PLAYS TRANSLUCENT VIDEOS ON ITS SIDE WINDOW

This is another CES oddity. iBuypower's Snowblind case option is a 19in transparent LCD that can show video on the side of your PC. Resolution is 1280x1024, and the display itself is protected by tempered glass. Note the CPU utilization widget on the right of the display – that's live, real-time-updating content. This is one of the coolest products we saw at CES 2017, and iBuypower says this case option will cost $250 (£TBC). You can watch a video of the case in action at tinyurl.com/hmz74bo.

ACER'S PREDATOR 21 X HAS A WILD CURVED DISPLAY

If you want to join Acer's extreme gaming laptop party, you'll need around £9,000. If this sounds like a lot, look what you get inside the Predator 21 X: Intel's Kaby Lake Core i7 7820HK; 64GB of 2.4GHz DDR4 RAM; two GeForce GTX 1080s running in SLI; and up to four SSDs running in RAID 0 (plus a hard drive if you want one). There's also a mechanical Cherry MX keyboard, Tobii eye-tracking, and tons of fans and heat pipes.

Obviously, the big allure of the Predator 21 X is the curved, 21in IPS display, the first of its kind in a laptop. It runs at 120Hz and supports Nvidia's G-Sync tech, and could make your gaming more immersive (or at least that's what Acer claims).

IN WIN D-FRAME 2.0 EKWB:
A TOUCH INDELICATE?

In Win makes hardcore cases for PC enthusiasts who just have to have something, well, showy. What makes the D-Frame 2.0 EKWB special is that it adds special mounting points for liquid-cooling. Our colleagues at PCWorld have created a video of the case at tinyurl.com/jrwf4Lh: pay special attention to the burbling reservoir at the front of the case.
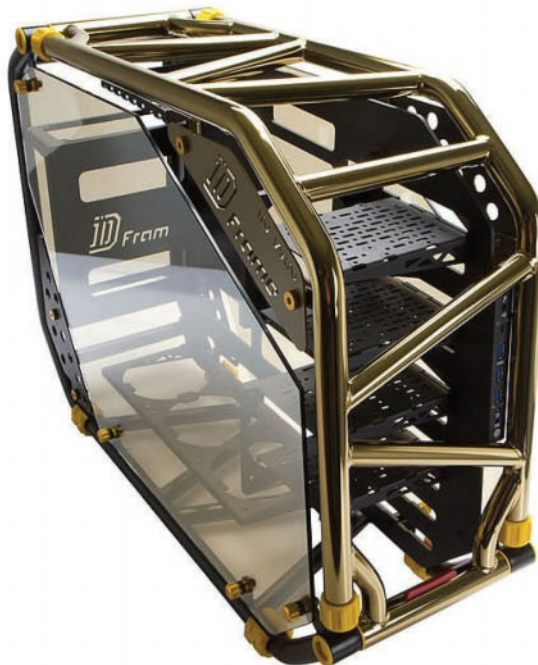
EVGA'S SC-15 IS A GAMING
LAPTOP THAT MAKES SENSE

You don't really need the 4K display in EVGA's SC-17 gaming laptop, so at this year's CES, the company released the SC-15, a 15in predecessor that boasts a 1080p, 120Hz G-Sync panel. It looks gorgeous, and is ably powered by Nvidia's mobile GTX 1060 chip. Other silicon includes a Kaby Lake Core i7-7700HQ processor, up to 16GB of DDR4, and a 256GB SSD paired with a 1TB hard drive. And, of course, there's an RGB backlit keyboard, too. It's a gaming machine.

EVGA DOES WATER-COOLING

Remember when EVGA was just a video card company? Well, besides getting into cases, power supplies, mice, motherboards, and full-fledged PCs, the company is now selling a trick water-cooling system that marries the simplicity of closed-loop water-cooling with the customisation of hard-line water-cooling.

The EVGA Quick Release cooler ecosystem starts with the main CPU cooler shown here, and then you customise to your heart's content with apparatus that suits your specific parts. From radiators to a GPU cooler to various extension cables they all use special quick-release fittings, so you can construct your setup, like building with an erector set.

AMD VEGA: THE FUTURE OF GAMING GRAPHICS?

AMD's more enthusiast-focused 14nm Radeon graphics architecture has been teased on the company's road map for a while, but AMD used this year's CES to release more technical details on these upcoming Vega GPUs.

In December, we saw an early Radeon Vega 10 card play the 2016 version of Doom at 4K resolution and settings cranked to Ultra. AMD's frame rates floated between 60- and 70fps, thus beating recorded frame rates for Nvidia's GTX 1080 at the same settings.

Intrigued? Well, we may not see shipping Vega hardware until this summer. Still, CES definitely whetted our appetite.

RYZEN RISING

Perhaps you haven't heard, but AMD's new Ryzen CPU (originally code-named Zen) looks to be competitive with Intel silicon. The processor is set for a Q1 2017 launch, and AMD and its partners used CES as a grand unveiling party for Ryzen hardware: from AM4 motherboards to CPU coolers to full-fledged PCs (like the Cybertron PC shown here).

INTEL KABY LAKE: NEW QUAD-CORE CPUS HIT 5GHZ

We first saw dual-core Kaby Lake notebook CPUs in August, but now it's time for quad-core processors – seven chips for laptops and 16 for desktops. They're all part of Intel's CES Kaby Lake series, and while performance increases in many scenarios aren't incredible relative to previous-generation silicon, the new architecture is still intriguing.

For starters, while cache size, the memory controller, and motherboard socket haven't changed since previous-generation Skylake chips, the Kaby Lake desktop CPUs seem ripe for overclocking (despite early reports). We've have seen the quad-core chip reach the vaunted 5GHz barrier without any problems. The Kaby Lake Z270 chipset is also "Optane-ready," suggesting motherboards will support Intel's superfast memory of the same name. Though we do have Optane caveats. See page 64.

NVIDIA G-SYNC HDR DISPLAYS DESCEND ON CES

While we've yet to see any displays that guarantee support for FreeSync 2 (AMD's HDR tech), we did see Nvidia's debut G-Sync HDR monitors and they look like the pinnacle of the desktop display market.

Keep your eyes peeled for the Acer Predator XB272-HDR and Asus ROG Swift PG27UQ. They're both G-Sync HDR 10 panels that shine at 1,000 nits of brightness, hit 144Hz, and deliver 384 backlight zones that can be individually controlled to help lush colours and deep blacks coexist side by side (that's basically the HDR promise). As if those HDR features weren't enough, they also rock 4K resolutions and blazing-fast 144Hz refresh speeds. No word on pricing, but expect to pay a lot for what will certainly be the finest desktop displays you can buy.

SPEAKING OF OPTANE...

Intel's Optane memory promises one thousand times the switching speed of an SSD, and to get PC nerds even more excited about the new format, Intel showed two images of its nonvolatile memory drives on the eve of CES. We have no idea how much the drives will cost or when they'll be available, but expect almost unusable small drive capacities of 16- and 32GB. At these sizes, they have little application save as hard drive cache.
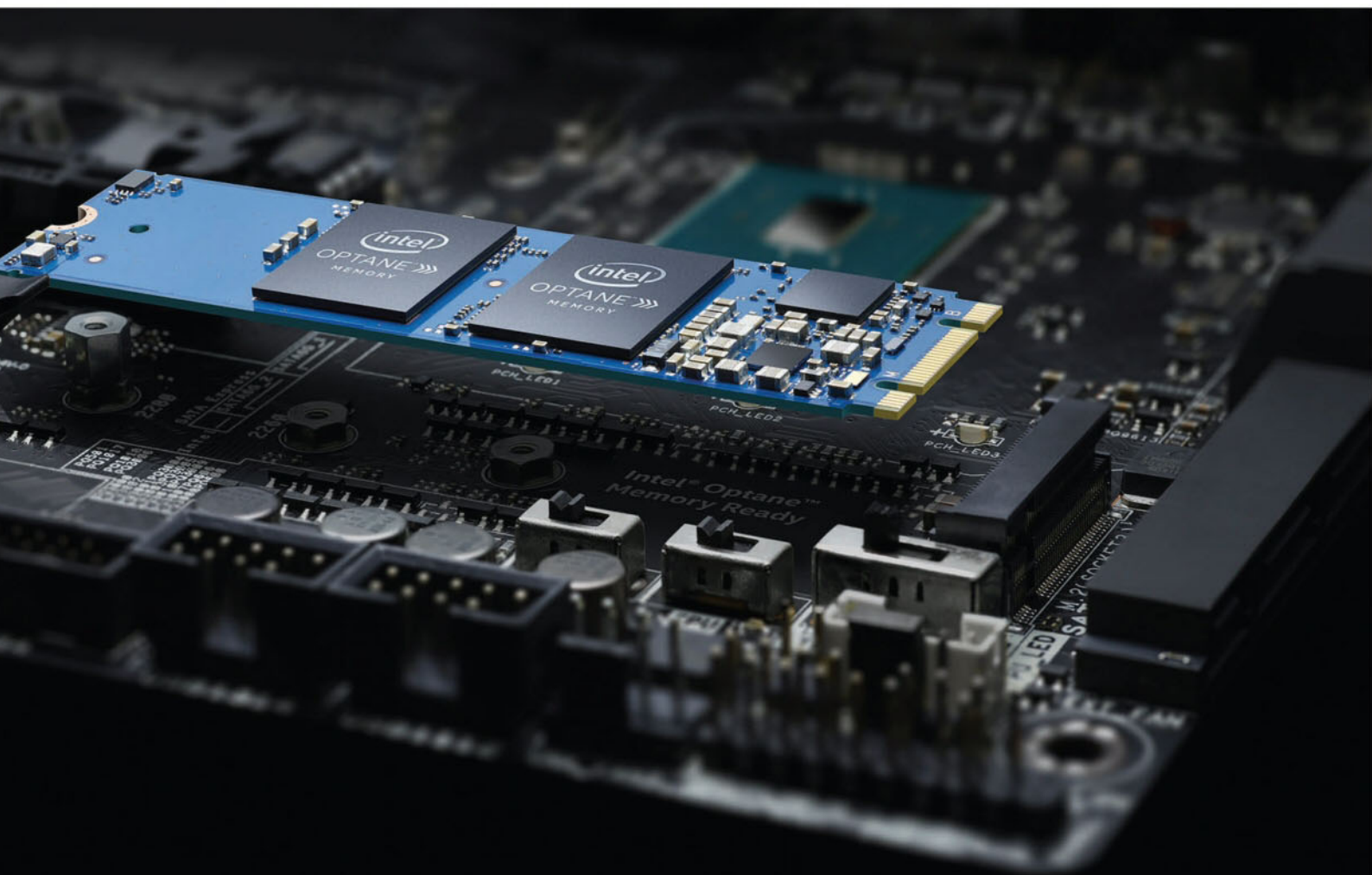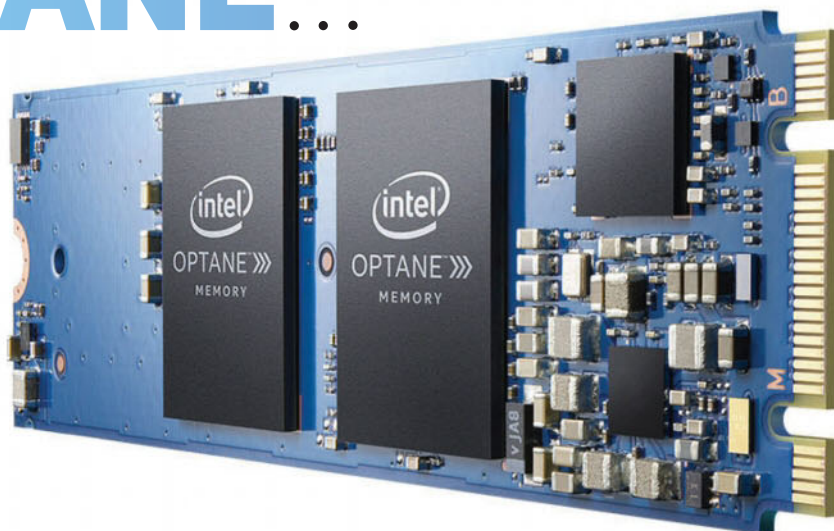
INTEL SHOWS OFF THE 10NM CANNON LAKE CPU

Okay, maybe "shows off" is an optimistic way to describe Intel's demonstration of its sometime-in-the-future 10nm process CPU. Brian Krzanich simply used the big stage of CES to show the processor playing back a video. We didn't actually see the chip, let alone touch the laptop that presumably contained the chip. But still, it's got a 10nm process. Intel has been stuck on a 14nm process for a few CPU generations, and AMD will finally be joining the 14nm club when it goes retail with Ryzen this year. So, yes, call us nerds, but even a 10nm tease is something to be excited about.

FreeSync 2 is
Brilliant Pixels
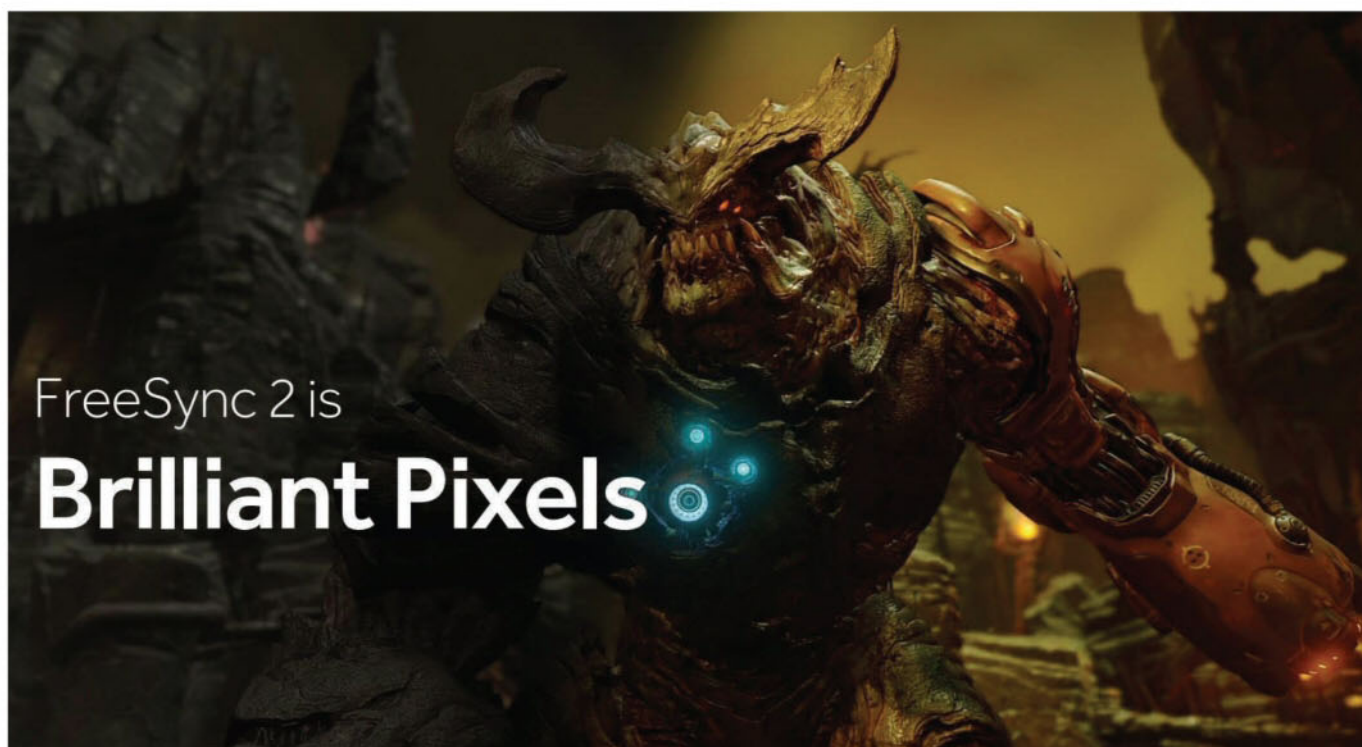
AMD FREESYNC 2
FOR HDR DISPLAY AWESOMENESS

AMD used CES to reveal details on the latest iteration of its FreeSync graphics technology. Where today's version simply smooths out gameplay and eliminates stutter and tearing, FreeSync 2 is focused squarely on HDR displays – those High Dynamic Range monitors that make supported content look lush with saturated colours, deep blacks, and stunning contrast. We have all the technical details on FreeSync 2, but just know that you'll need a display that meets FreeSync 2 certification (these monitors should hit retail in Q1 of this year). We also learned that any GPU that currently supports the technology can be upgraded to FreeSync 2 via a driver update. Both versions will be supported going forward, with FreeSync 2 monitors expected to be just a small percentage of the total number of FreeSync displays shipped.

THE **LINKSYS WRT32X** IS A HARDCORE GAMING ROUTER

Every modern Wi-Fi router has some type of quality-of-service (QoS) feature that assigns different priorities to different types of Internet traffic. But Linksys says the WRT32X – a 802.11n/802.11ac MU-MIMO router – is highly optimised to recognise lag-sensitive traffic like games. The secret ingredient is Rivet Networks' Killer Prioritization Engine.

The firm told us the technology uses heuristic logic to determine which network traffic is gaming traffic, and then assigns that data the highest priority. As the company's marketing officer, Bob Grim, said, "A Microsoft Windows update packet shouldn't be treated as just as important as a gaming packet. We'll never queue a gaming packet, for example, because it's latency dependent."

Of course, it doesn't hurt that the WRT32X looks fantastic. Even router companies want in on CES's PC-enthusiast action.

LENOVO LAUNCHES **LEGION,** ITS GAMING LAPTOP BRAND

Yes, Lenovo – the enterprise laptop company – makes good gaming machines, and now it's putting these laptops under their own unique brand name, Legion. Above, you can see the RGB backlighting underneath the Legion Y720's keyboard.

The Y720 includes a Kaby Lake Core i7, 16GB of DDR4 memory, and can be outfitted with a 512GB SSD and 6GB Nvidia GTX 1060, making the machine capable of powering a VR headset. There's also a 4K screen option, and even the baseline display is IPS, addressing a complaint we had with Lenovo's Y50 gaming machine from 2015.
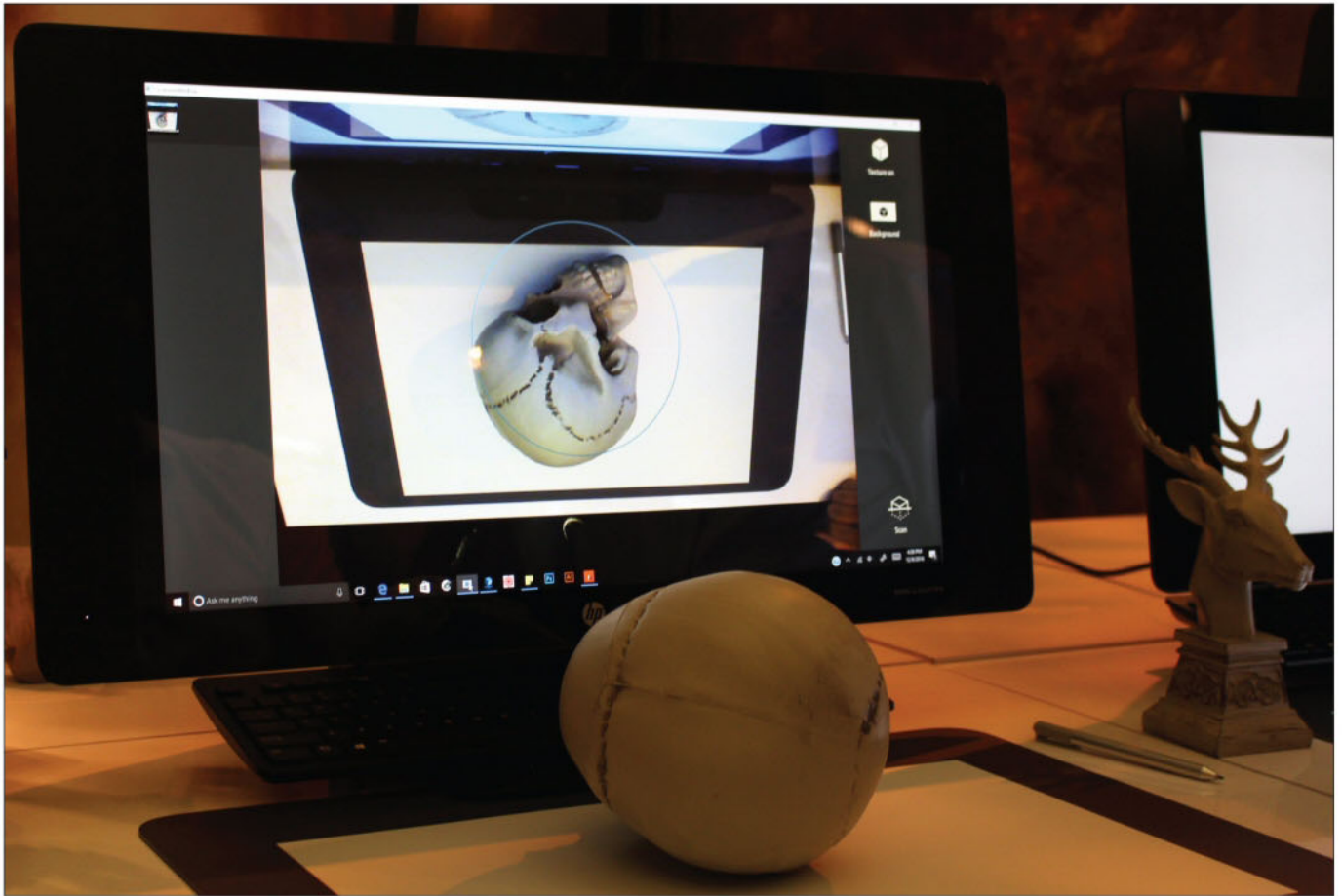
HP UPGRADES ITS SPROUT CREATIVITY PC FOR A VR AND AR WORLD

Hardcore PC hardware isn't just about gaming, so HP used CES 2017 to reveal its upgraded Sprout Pro workstation. And thanks to the Windows 10 Creators Update, the firm's Sprout platform should be more friendly to 3D content creation than ever before.

The machine uses a Full-HD DLP projector and what HP calls a Touch Mat to quickly turn any small object – like the skull model shown here – into a 3D wire frame. The benefits for VR and AR content creation should be obvious.

The upgraded Sprout Pro has a 2.9GHz Kaby Lake Core i7-7700T and Nvidia's GeForce GTX 960M with 2GB of GDDR5 memory. The main display is 23.8 inches with a 1920x1080 resolution and 10-point touch. Pricing is unknown, but the original Sprout costs £2,266.

KINGSTON'S 2TB DATATRAVELER NEEDS NO EXPLANATION

Two terabytes. In a flash drive. That you can put in your pocket. Okay, you'll need a very large pocket, because as Kingston's image illustrates, the drive itself dwarves its USB 3.1 connector. We have no idea how much the DataTraveler Ultimate Generation Terabyte will cost, but we do know that it will come in 1TB and 2TB configurations, and that Kingston's current 1TB DataTraveler HyperX Predator costs £420. So, maybe the new 2TB version will cost twice that?

PHANTEKS'S ENTHOO ELITE CASE IS SO BIG, WE COULDN'T FIT IT IN THE FRAME

With enough interior room for not one but two PC builds, the Enthoo Elite is a case of absurd proportions. At 30 inches tall and two feet wide, the enclosure can accommodate one E-ATX system plus a mini-ITX system. The case is rife with interesting detailed design to make system building easier.

THERMALTAKE'S CORE P1 TG
WANTS ON YOUR WALL

Why would you want to mount a PC on your wall? We can't tell you. But ThermalTake thinks there's a wall PC market, and thus we have the Core P1 TG, an open-air case that supports Mini ITX motherboards, and can be mounted on your wall. A flexible PCIe riser cable lets you mount your video card perpendicular to the motherboard, and a piece of tempered glass prevents flying objects from disturbing your water-cooling apparatus.

HWBOT'S EXTREME
OVERCLOCKING CHALLENGE

Think those new Kaby Lake desktop CPUs resist overclocking? No. Think again. Industry sources tell us the chip is happy to reach 5GHz with water-cooling, and at the warm-up for HWbot's extreme overclocking event, we saw 7GHz. Granted, the overclocking superstars at this CES event were using liquid nitrogen to cool down the silicon and ratchet up the clocks. But one still has to marvel at just how far these PCs can be pushed. ⊠
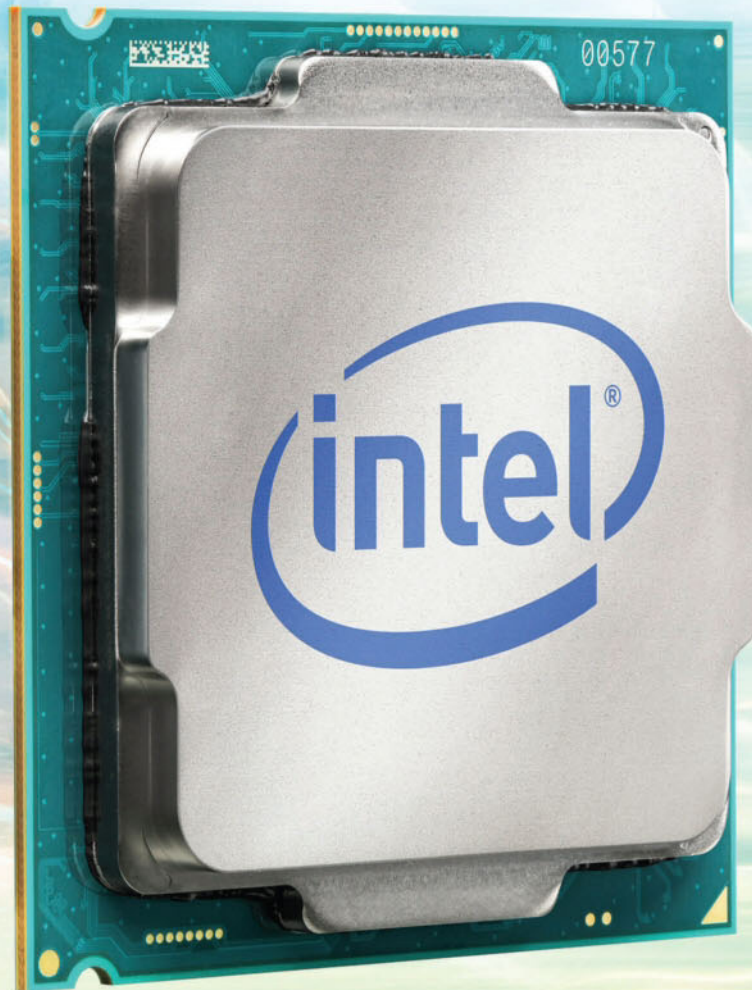
Intel's 7th-generation Kaby Lake CPU

One big change makes up for smaller ones, reveals Gordon Mah Ung

Intel's recent rollout of the seventh-generation Kaby Lake CPU for desktops has met with a muted response from leaked reviews that dismiss the new chip as one huge Core i-Yawn. Kaby Lake seems to offer barely any movement forward, and when it's overclocked, it apparently gets to nuclear-fusion levels of heat output. It is, however, too early to write off Kaby Lake. There's a lot more to it that you still need to know.

What Kaby Lake brings to the desktop

Kaby Lake launched in August 2016 with dual-core versions for laptops that offered reasonable performance upticks. The highlight is its video engine, which can handle 10-bit content without breaking a sweat. Play a 10-bit colour depth file on a Skylake laptop with integrated graphics, and you drop frames and destroy battery
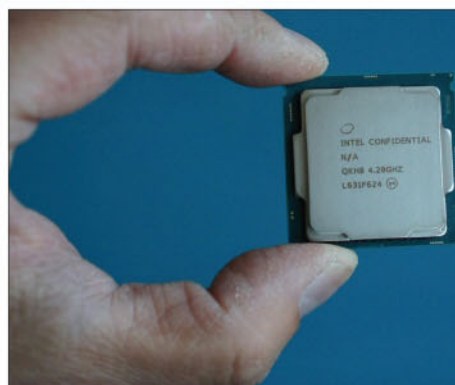
Kaby Lake is the first K chip in several generations that seems able to hit 5GHz

life. The same video on Kaby Lake hums along with far less impact. You can see this demonstrated at (tinyurl.com/z4tr9bL). The updated graphics core with the latest content protection can now stream 4K from services such as Netflix.

On the desktop side, however, power users don't care about integrated graphics,

focusing more on the lacklustre x86 performance. To be fair, Intel set the expectation in August that Kaby Lake was basically Skylake on an improved process that squeezes out more megahertz.

For example, the top-end Core i7-7700K has a base clock speed of 4.2GHz and a Turbo Boost clock speed of 4.5GHz, versus

System Agent w/Display, Memory Control, I/O Control

CPU Core

CPU Core

Shared Cache

CPU Core

CPU Core

Memory and I/O Interface

Graphics Core + New Media Capabilities
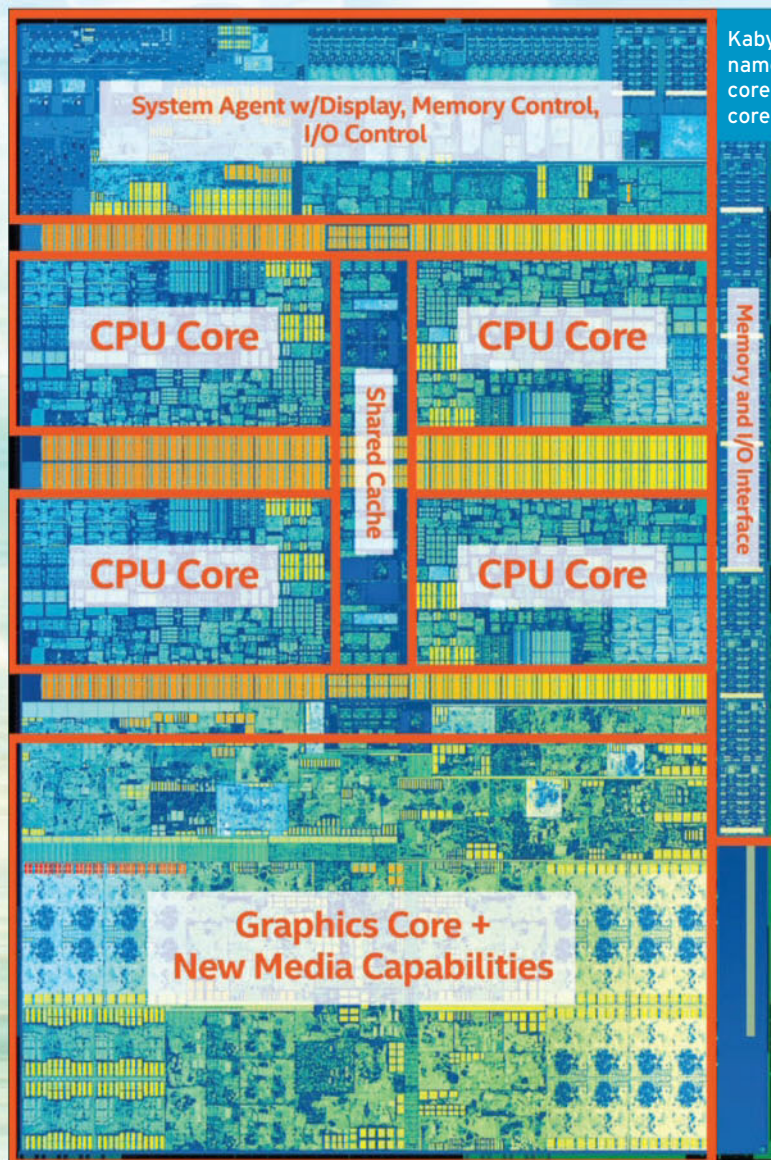
Kaby Lake gets the seventh-generation name because of the improved graphics core and video engine, while the x86 cores are essentially unchanged

a Skylake Core i7-6700K's base clock of 4GHz and Turbo Boost of 4.2GHz.

The cache size, the core count, the memory controller and even the same LGA1151 socket are unchanged from the previous chip.

This is the real launch

Intel fleshes out the Kaby Lake line-up with a total of 42 CPUs: 17 ultra low-power chips for laptops, two quad-core Xeons, seven quad-core laptop CPUs, and 16 desktop CPUs.

Of particular interest in that desktop line-up to do-it-yourselfers are the three unlocked K chips. The first two were expected: a quad-core with 4.2GHz Core i7-7700K with Hyper-Threading and a quad-core 3.8GHz Core i5-7600K without Hyper-Threading. The third is a surprise: the dual-core 4.2GHz Core i3-7350K. The CPU has Hyper-Threading but since it is a Core i3, does not have Turbo Boost enabled.

This isn't Intel's first 'budget' overclocking chips, though. The company introduced the dual-core Pentium G3258 Anniversary Edition in 2014 and as early as 2010, Intel sold the dual-core Core i5-655K.

The new Z270 is 'Optane-Ready'

With Kaby Lake for desktops, Intel is introducing new 200-series chipsets to replace the 100-series chipsets that were introduced with Skylake. Like Kaby Lake, it is an incremental update that disappoints a bit.

We expected the 200-series chipsets to feature native support for USB 3.1 10Gb/s or maybe even Thunderbolt 3, but no. Instead, motherboard makers will have to add additional chips for those functions.

From what we can tell, there are three key changes to Z270. The first is an upgrade from the 20 lanes of PCIe Gen 3 in the Z170 to 24 lanes in the new performance Z270 chipset. The move will let motherboard makers integrate high-bandwidth connections such as M.2 or U.2 without having to share bandwidth between devices. Intel says it has also improved overclocking capability.

The last upgrade is official 'Optane-ready' support. What that means isn't exactly clear, but we do know Intel's Optane (a nonvolatile memory that promises much higher performance than SSDs) will go into an M.2 slot on the board, where it can be

SEVENTH-GENERATION INTEL CORE PROCESSOR QUICK SUMMARY CHART

	CORES/ THREADS	BASE FREQ.	SCT	UNLOCK	INTEL GRAPHICS	DYNAMIC FREQ.	INTEL SMART CACHE	DDR4±/ DDR3L	TDP	INTEL VPRO
S-Series										
i7-7700K	4/8	4.2	4.5	✓	HD 630	1150	8M	2400/1600	91W	
i5-7600K	4/4	3.8	4.2	✓	HD 630	1150	6M	2400/1600	91W	
i7-7700t	4/8	3.6	4.2		HD 630	1150	8M	2400/1600	65W	✓
i5-7600	4/4	3.5	4.1		HD 630	1150	6M	2400/1600	65W	✓
i5-7500	4/4	3.4	3.8		HD 630	1100	6M	2400/1600	65W	✓
i7-7700T	4/8	2.9	3.8		HD 630	1150	8M	2400/1600	35W	✓
i5-7600T	4/4	2.8	3.7		HD 630	1100	6M	2400/1600	35W	✓
i5-7500T	4/4	2.7	3.3		HD 630	1100	6M	2400/1600	35W	✓
i5-7400	4/4	3.0	3.5		HD 630	1000	6M	2400/1600	65W	
i5-7400T	4/4	2.4	3.0		HD 630	1000	6M	2400/1600	35W	
i3-7350K	2/4	4.2	N/A	✓	HD 630	1150	4M	2400/1600	60W	
i3-7320	2/4	4.1	N/A		HD 630	1150	4M	2400/1600	51W	
i3-7300	2/4	4.0	N/A		HD 630	1150	4M	2400/1600	51W	
i3-7100	2/4	3.9	N/A		HD 630	1100	3M	2400/1600	51W	
i3-7300T	2/4	3.5	N/A		HD 630	1100	3M	2400/1600	35W	
i3-7100T	2/4	3.4	N/A		HD 630	1100	3M	2400/1600	35W	

Intel's 'S-series' compromises its desktop line-up of new Kaby Lake-based Core CPUs

used as a traditional storage device or as a way to accelerate system performance, much like what's done today with Intel's Smart Response Technology, which uses a solid-state drive (SSD) to cache performance from a traditional hard drive.

That doesn't mean Optane won't work in other systems using older chipsets, but Intel is likely to support it only for 'system acceleration' on Z270 initially.

If none of these sound like much of an upgrade to your existing Z170 motherboard, the good news is you don't have to buy a Z270 mother-board. Kaby Lake drops into most LGA1151 Z170 motherboards and works just fine, as long as you're using an updated BIOS that supports the new CPU.

How we tested

For our performance testing, we focused on how Kaby Lake does against the CPU it replaces: we dropped the Core i7-7700K into the same Asus Z170 Deluxe motherboard that the Skylake chip was first tested with. The CPU was cooled with a Corsair H80i closed liquid cooler and outfitted with 16GB of Corsair DDR4/2133 RAM, a reference GeForce GTX 980 card, and a 256GB HyperX SSD. The operating system was Windows 10 running the TH2 build.

Cinebench R15
multi-core performance

Our first test is Maxon's Cinebench R15. It's a benchmark based on Maxon's professional Cinema4D rendering engine and is a pure CPU test. We recorded scores from many of Intel's high-end quad-core mainstream chips and from chips with more cores, for context.

Among the quad-cores, the Core i7-7700K was the winner by the expected amount. The Kaby Lake CPU is roughly 4- to 5 percent higher in clock speed and roughly 4- to 5 percent faster in Cinebench. When you look back to the Core i7-2600K though, it's a huge 42 percent difference in performance. Stock clock performance between the Kaby Lake, Skylake and Devil's Canyon though, isn't exactly going to set the world on fire.

Cinebench R15
single-core performance

One error with focusing exclusively on multi-core performance is reality doesn't match that. The vast majority of applications are lucky to exploit more than a single thread, instead favouring higher clock speeds and more efficient CPU cores. Once we set Cinebench R15 to run in single-threaded

GETTING READY FOR INTEL'S REVOLUTIONARY MEMORY
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Intel® Optane™ Memory

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Snappy PC experience with short boot times and fast application launches

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Pair Intel® Optane™ memory with an HDD for SSD-like speed and HDD capacity

Intel® Optane™ Memory Ready

For partners and customers to promote desktop motherboards and systems equipped with M.2 connector that supports addition of Intel Optane memory purchased aftermarket

INTEL® Z270 CHIPSET BLOCK DIAGRAM

From left to right: an 8-core Core i7-5960X, the new Core i7-7700K, the ancient Core i7-2600K, and a Core i7-4790K

Cinebench R15 Multi-Threaded Performance

CPU	Score
Core i7-6950X (10-core)	1,792
Core i7-5960X (8-core)	1,315
Core i7-4960X (6-core)	1,070
Core i7-7700K @ 5GHz (4-core)	1,067
Core i7-7700K (4-core)	951
Core i7-6700K (4-core)	925
Core i7-4790K (4-core)	875
Core i7-5775C (4-core)	687
Core i7-2600K (4-Core)	615

LONGER BARS INDICATE BETTER PERFORMANCE

Cinebench R15 puts the new Core i7-7700K at the top of the heap for mainstream quad-core chips

POV Ray 3.7a Multi-Threaded Performance (sec)

CPU	Score
Core i7-6700K (4-core)	132
Core i7-7700K (4-core)	126
Core i7-4960X (6-core)	122
Core i7-5960X (8-core)	96
Core i7-6950X (10-core)	74

SHORTER BARS INDICATE BETTER PERFORMANCE
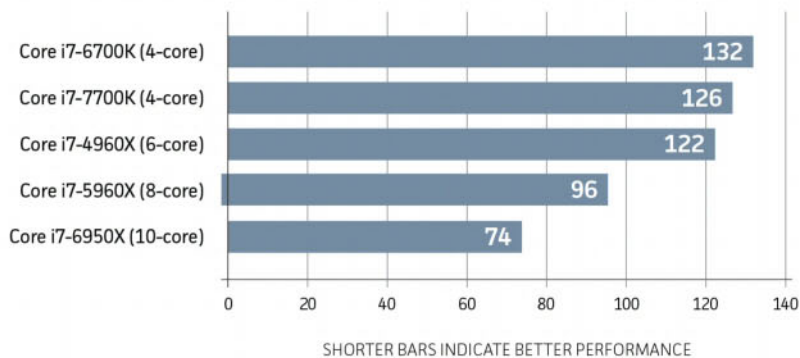
POV Ray mostly matches our results from Cinebench R15. The Kaby Lake chip eases out in front of the Skylake chip, but it's not a game changer

POV Ray 3.7a Single-Threaded Performance (sec)

CPU	Score
Core i7-4960K (6-core)	841
Core i7-5960X (8-core)	795
Core i7-6950X (10-core)	745
Core i7-6700K (4-core)	595
Core i7-7700K (4-core)	571

SHORTER BARS INDICATE BETTER PERFORMANCE
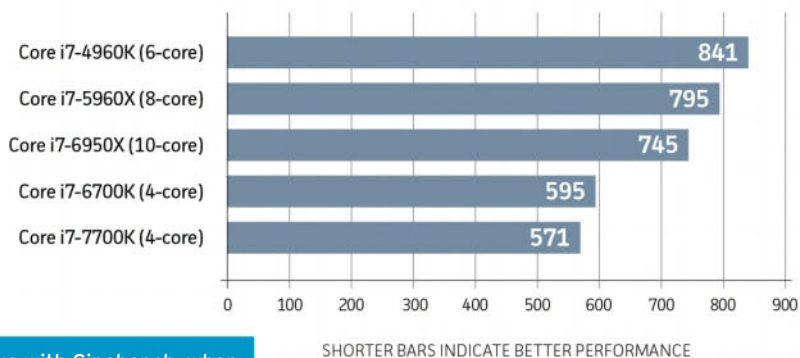
Just like with Cinebench, when you run on a single core, the higher frequency chips win

mode, the quad-cores with their higher clock speeds jump to the front of the line, with the Core i7-7700K now leading the pack. For most people, those who don't do 3D rendering or other heavily multi-threaded tasks, a quad-core with higher clock speeds is the right choice.

There isn't a lot of daylight between the Core i7-7700K and the Core i7-6700K. Note, too, that our 10-core Broadwell-E Core i7-6950X was performed without Turbo Boost Max. Turbo Boost Max lets the CPU greatly increase the clock speed on a single core, bringing performance a lot closer to the quad-cores.

POV Ray performance

Another CPU-heavy test we use is POV Ray. It's a ray-tracing program that traces its roots back to the Amiga. Our benchmark set is a little smaller but no surprise, the Kaby Lake, with its 4- to 5 percent clock speed advantage, finishes the test about 4- to 5 percent faster, putting the Core i7-7700K just barely behind a six-core Ivy Bridge-E Core i7-4960X.

As with Cinebench R15, we also run the test using a single-threaded workload. With lighter loads the CPUs can run at higher clock speeds and no surprise, the pair of quad-cores take the lead. Again, we saw maybe a 5 percent advantage for the Core i7-7700K over the Core i7-6700K.

Blender performance

Our final rendering test uses Blender 2.77a and Mike Pan's BMW work file to measure how fast the various CPUs can render a single frame using the free and popular Blender app. The Core i7-7700K again pulls ahead of the Core i7-6700K by a small percentage, well within what we expected for its clock-speed advantage. And yes, that six-core Ivy Bridge-E Core i7-4960X is really starting to look mouldy here. One thing we'd like to point out about Blender is that it doesn't show the scaling with thread count as much as Cinebench R15. While the 10-core Core i7-6950X is the winner here, it's not as impressive as we would have expected for a £1,600 CPU.

HandBrake 10.2 performance

Turning to video encoding, we used the popular and free HandBrake 10.2 encode to convert a 30GB MKV file using the Android tablet preset. The Core i7-7700K again comes in slightly ahead of the Core i7-6700K. There's also a pretty healthy distance between the Kaby Lake chip and the still-excellent Devil's Canyon chip. The older Ivy Bridge-E Core i7-4960X disappoints yet again, especially considering that it has six cores yet is basically tied with the quad-core Kaby Lake chip.

WinRAR Performance

You should have the idea by now that the 4- to 5 percent clock increase from Skylake to Kaby Lake pretty much yields a 4- to 5 percent increase in performance across the board, so our last CPU-only test is WinRAR. Unlike the other tests, where we ran the exact same app our machines, these results include both 5.21 and 5.31 results (for the Core i7-5775C and Core i7-4790K). The only difference between 5.21 and 5.31 appears to be bug fixes that don't impact the built-in benchmark. Unlike Cinebench, POV Ray, or Blender, WinRAR is a little more sensitive to memory bandwidth.

Both the Skylake and Kaby Lake CPUs are pretty much dead even here. We also see the Devil's Canyon chip is more than 15 percent slower than the Skylake and Kaby Lake chips. The surprise, for the quad-core CPUs, is the Core i7-5775C Broadwell CPU. Despite its lower clock speed of 3.3- to 3.7GHz, it's leading the pack of quad-core chips.

That isn't some magic of the Broadwell micro-architecture, though. It's likely due to the large amount of embedded DRAM cache Intel put into the CPU.

3DMark performance

Gaming in this day and age is still 90 percent about the GPU, which is why we ran 3DMark Fire Strike. All of the machines used reference GeForce GTX 980 cards and the same driver. As you can see, it's mostly a tie. The 10-core Broadwell-E gets a small advantage because 3DMark factors the physics performance into the overall score, but this is mostly a tie.

Because this is a CPU review, we also decided to break out the physics performance, which favours core count over clock speed. No surprise, the 10-core comes out on top. If you're looking at these two charts and trying to decide how they should influence your buying or building decision, we'd say the graphics score is far more important so long as you have a decently powered quad-core chip.

Tomb Raider performance

We also fired up the slightly older Tomb Raid and ran the built-in benchmark at 1080p resolution at the Normal quality setting. We chose Normal rather than Ultra to try to make this more about the CPU than the GPU.

The Core i7-7700K again leads the pack for quad-cores but it's really no big deal.

The IPCs have it

CPU nerds like to talk about IPC, or instructions per cycle of a CPU. It's one way to gauge efficiency at a given clock speed. We took the performance of each CPU running the Cinebench R15 test in single-threaded mode with Turbo Boost switched off on all of the CPUs. As we said with the Skylake Core i7-6700K review, it's a pretty sobering wake-up call to see just how slowly IPC is inching along in modern CPUs.

The good news for modern processors is IPC isn't the only place you can pick up performance. Clock speed, core count, and ability to hold Turbo Boost speeds longer have all added up to better performance. Here's that reminder seen in the first chart we ran from Cinebench R15, when each CPU is allowed to run unfettered rather than locked down to a fixed frequency.

Blender 2.77a BMW (sec)

	Value
Core i7-6700K(4-Core)	247
Core i7-4960X (6-Core)	245
Core i7-7700K (4-Core)	240
Core i7-5960X (8-Core)	206
Core i7-6950X (10-Core)	195

SHORTER BARS INDICATE BETTER PERFORMANCE

Blender 2.77a is a free render application popular with indie filmmakers

HandBrake 10.2 Encode Performance

	Value
Core i7-5775C (4-Core)	2,963
Core i7-4790K (4-Core)	2,241
Core i7-6700K (4-Core)	1,993
Core i7-7700K (4-Core)	1,914
Core i7-4960X (6-Core)	1,874
Core i7-5960X (8-Core)	1,560
Core i7-6950X (10-Core)	1,327

SHORTER BARS INDICATE BETTER PERFORMANCE
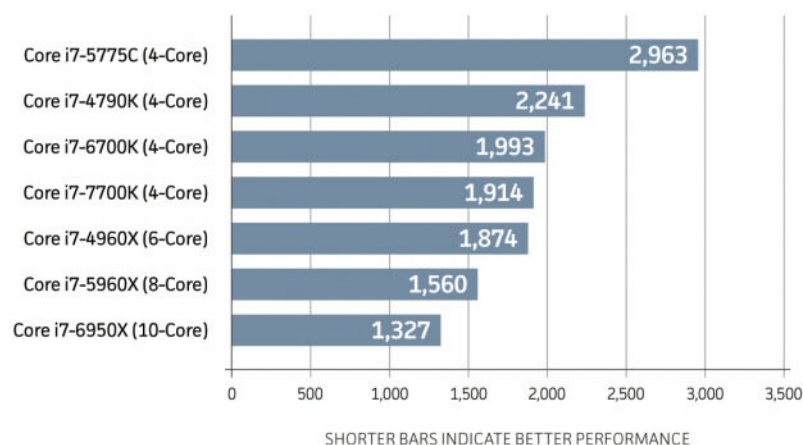
WinRar 5.x Multi-Threaded Performance

	Value
Core i7-6950X (10-Core)	32,864
Core i7-5960X (8-Core)	22,600
Core i7-4960X (6-Core)	18,276
Core i7-5775C (4-Core)	12,540
Core i7-6700K (4-Core)	11,168
Core i7-7700K (4-Core)	11,158
Core i7-4790K (4-Core)	9,333

LONGER BARS INDICATE BETTER PERFORMANCE

3DMark Fire Strike Overall

CPU	Score
Core i7-6950X (10-Core)	12,224
Core i7-7700K (4-Core)	11,724
Core i7-6700K (4-Core)	11,711
Core i7-5960X (8-Core)	11,695
Core i7-4960X (6-Core)	11,539

LONGER BARS INDICATE BETTER PERFORMANCE
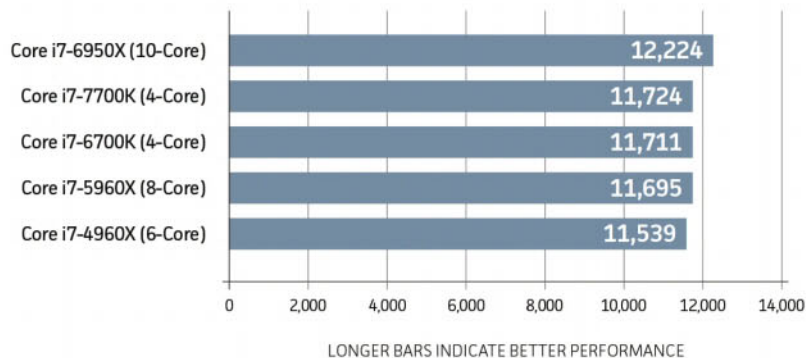
The CPU still plays very little role in most graphics chores

3DMark Fire Strike Physics

CPU	Score
Core i7-6950X (10-Core)	21,073
Core i7-5960X (8-Core)	16,167
Core i7-4960X (6-Core)	15,020
Core i7-7700K (4-Core)	13,819
Core i7-6700K (4-Core)	13,596

LONGER BARS INDICATE BETTER PERFORMANCE
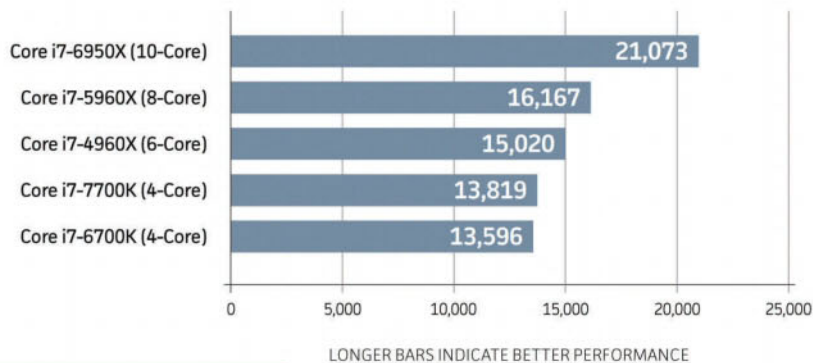
When it comes to physics there is an advantage, but most gaming is still primarily a graphics task

Tomb Raider Normal 19x10 (fps)

CPU	fps
Core i7-5960X (8-Core)	320
Core i7-6950X (10-Core)	318
Core i7-7700K (4-Core)	314
Core i7-4790K (4-Core)	310
Core i7-4960X (6-Core)	310
Core i7-6700K (4-Core)	302
Core i7-5775C (4-Core)	301
Core i7-2600K (4-Core)	274

LONGER BARS INDICATE BETTER PERFORMANCE
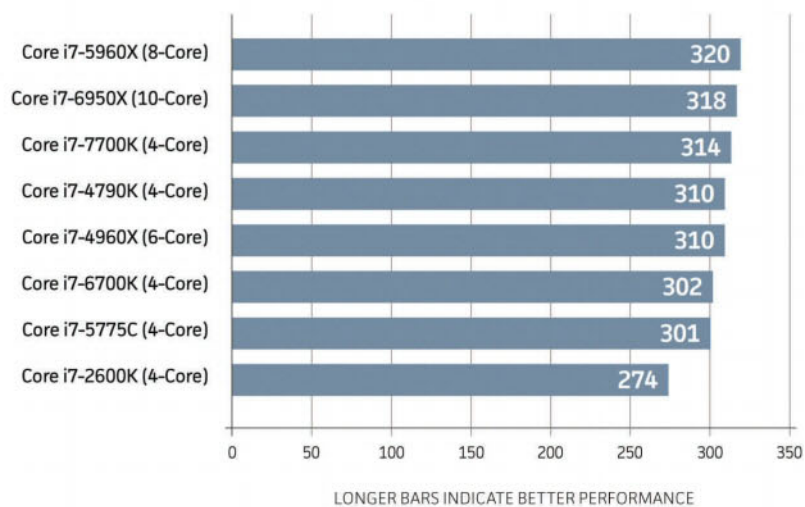
In an actual game, most of your dividends still come from the graphics chip once you have a decently powered quad-core chip
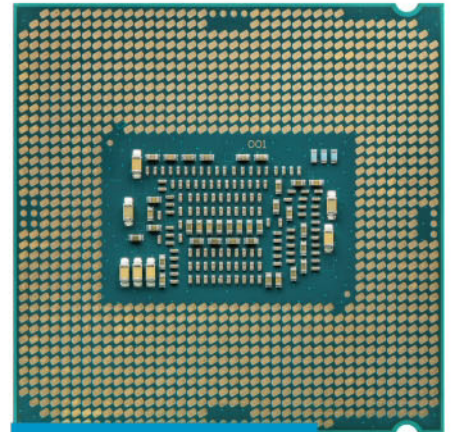
The rear of a Kaby lake CPU

Overclocking performance

Many of the early unsanctioned reviews of Kaby Lake gave it a black mark for generating excessive heat when overclocked.

We have always been reluctant to offer judgment about the overall overclocking performance of an entire CPU series when working with a sample of one. Combine that with new motherboards, new BIOSs and the dizzying amount of mistakes a reviewer can make, and you can see why we think it's unfair to decide on an entire line based on one CPU and early motherboards.

Still, in an attempt to get a feel for how Kaby Lake will overclock for most, we spoke to two PC OEMs and a motherboard maker who have been trying to overclock the CPU for far longer and with far more samples.

The Kaby Lake results they've seen were quite good. Many of their chips hit 5GHz

Asus said its new Z270 motherboards should be able to overclock Intel's new with an 80 percent success rate

or got very close. Motherboard maker Asus, in fact, will feature overclocking profiles that should make overclocking a lot simpler.

"Through rigorous testing, Asus engineers have fine-tuned a profile that allows Kaby Lake CPUs to overclock to 5GHz with an 80 percent success rate," the company said. This is actually a great sign for practical overclockers because 5GHz overclocks haven't been seen since the days of the Core i5-2500K and Core i7-2600K. Both of which could seemingly run at 4.5GHz on air or 5GHz with liquid cooling.

You can't say the same about the CPUs that followed Sandy Bridge. Ivy Bridge and Haswell both hit walls at 4.5GHz for most people. Devil's Canyon was supposed to break the 4.5GHz barrier but all we got were chips that could get closer to 4.5GHz but not surpass it. Broadwell didn't count (it didn't ship in great volume), and Skylake also hit that same invisible barrier at 4.5GHz.

With its massaged 14nm process, Kaby Lake finally seems to break that magical barrier. To prove it, we had two system builders send two production PCs that could break the 4.5GHz barrier. Both did. The first system, for example, was able to withstand almost four hours of continuous HandBrake encodes with all cores locked at 5GHz without issue. The second machine could hit 5GHz in a small-form-factor box.

Running at 5GHz, the Kaby Lake will match a six-core Ivy Bridge-E in performance. In single-threaded applications at 5GHz, the results are even more impressive.

Does this mean your chip will hit 5GHz? No. Remember, it's always been a lottery system with overclocking results, but the word from experienced boutique PC builders and Asus is far more promising than it's been in a long time.

As much as everyone wants to be a hater, it's looking very much like Kaby Lake, for those who want to go there, can break 4.5GHz at last.

Umm, how much again?

So we have an official, sanctioned view of just how a desktop Kaby Lake performs. Now, what everyone wants to know is how much. There is, again, more disappointment.

The initial prices the press was given for Kaby Lake CPUs would have made the Core

Cinebench R15 Single-threaded Performance Locked at 2.5Ghz

Core i7-7700K Kaby Lake	107
Core i7-6700K Skylake	106
Core i7-5775C Broadwell	105
Core i7-4790K Haswell	101
Core i7-2600K Sandy Bridge	89

LONGER BARS INDICATE BETTER PERFORMANCE
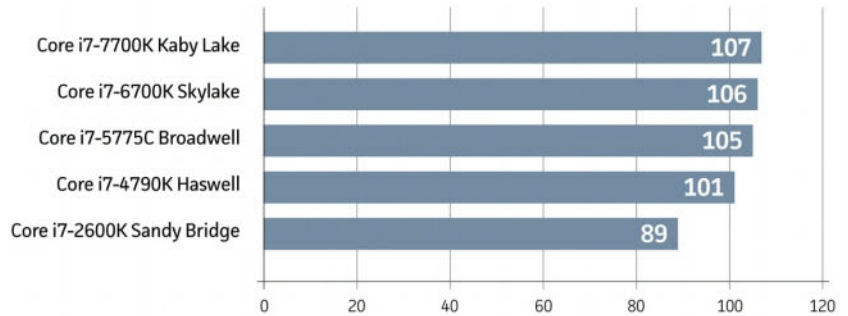
With all five CPUs locked at 2.5GHz, you can see that the efficiency of each has only slowly increased

Cinebench R15 Multi-threaded Performance

Core i7-6950X (10-core)	1,792
Core i7-5960X (8-core)	1,315
Core i7-4960 (6-core)	1,070
Core i7-7700 (4-core)	951
Core i7-6700K (4-core)	925
Core i7-4790 K (4-Core)	875
Core i7-5775C (4-core)	687
Core i7-2600K (4-core)	615

LONGER BARS INDICATE BETTER PERFORMANCE

Clock speeds, core count, and process keeps performance moving along

price of the chip in a chart and was prepared to write that the CPU price war had already begun with AMD over its upcoming Ryzen.

Alas, it was all wrong. Intel updated its price sheets, increasing the cost to £339. That's the same price as the Haswell, Devil's Canyon, and Skylake Core i7 processors launched at.

In defence of Intel, every new chip in the price list went up by around £30 to £60.

Excel formula error and not a reason that's spelled Ryzen. Clearly, though, the price war with AMD isn't kicking off with Kaby Lake.

Conclusion

So let's sum it up. In laptops, the performance bump is very decent, with perhaps 20 percent or more going from just Broadwell to Kaby Lake.

Desktops aren't constrained by thermals and battery life the way laptops are, so the performance difference between the generations is far less. The one really big difference between previous chips is the greatly improved video engine. To performance-oriented desktop users, though, integrated graphics – outside of NUC-style mini-PCs – is unimportant.

The price, though equal to Skylake, is a little disappointing for those who expected it to be cheaper, but it's not like you're

Running at 5GHz, the Kaby Lake will match a six-core Ivy Bridge-E in performance. In single-threaded applications at 5GHz, the results are even more impressive

i7-7700K, at around £300, the cheapest Core i7 'K' CPU the company has ever produced. It was low enough that we mapped out the

Even laptop CPUs, where Intel essentially has no competition from AMD today, increased. So maybe this was truly just an across-the-

Cinebench R15 Single-threaded performance

CPU	Score
Core i7-7700K @ 5GHz (4-core)	214
Core i7-7700K (4-core)	188
Core i7-6700K (4-core)	182
Core i7-4790K (4-core)	173
Core i7-5775C (4-core)	153
Core i7-6950X (10-core)	147
Core i7-2600K (4-core)	131
Core i7-4960X (6-core)	130
Core i7-5960X (8-core)	118

LONGER BARS INDICATE BETTER PERFORMANCE

A Kaby Lake running at 5GHz in single-threaded tasks will be tough to beat

Volume Pricing on Intel Performance Mainstream Quad-Core CPUs

CPU	Price
Core i7-875K	$353
Core i7-2600K	$317
Core i7-2700K	$332
Core i7-3770K	$332
Core i7-4770K	$339
Core i7-4790K	$339
Core i7-5776C	$366
Core i7-6700K	$339
Core i7-7700K	$305

The initial price of the Core i7-7700K we were given would have been the cheapest Core i7 'K' CPU in history. Unfortunately, that turned out to be wrong

Kaby Lake is a drop-in replacement for Skylake. I'm just not sure anyone should or would do that

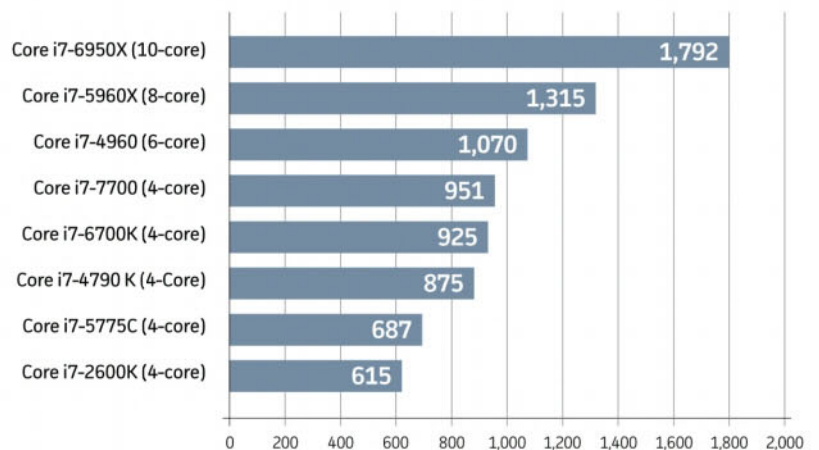paying more for less performance. Instead, you're paying the same price to get a little better performance. Kaby Lake is better and faster, but despite the greater overclocking potential, you can see why, for most DIYers, it's a little bit of a yawn. Still, some builders should consider it, and we break down the decision tree CPU by CPU right here.

If we had a Core i7-6700K system: We wouldn't upgrade to Kaby Lake, and we don't think Intel expects you to unless you want to help prop up its bottom line. There's just absolutely nothing compelling that would warrant it on a discrete graphics system right now. If Intel's Optane emerges as a game changer, then you'd consider a move.

If we were going to build a new Core i7-6700K system: We wouldn't. Instead, we'd build one using the new Core 7-7700K. Even

if you don't intend to overclock it at first, the stock clock is already higher, and prices will be the same once initial demand settles down. The simple answer is Kaby Lake is better, so there's no reason to buy Skylake.

If we had a Core i7-4770K or Core i7-4790K system: We probably wouldn't upgrade. The Core i7-4770K is still a powerful and useful CPU. The only reason would be the need for more M.2 or U.2 storage options, or if you want to be ready for Optane.

If we had a Core i7-4960X or Core i7-3960X system: Even a once mighty six-core CPU can now be matched by Intel's new Core i7-7700K in some workloads. However, if you were the kind of person who bought a six-core Sandy Bridge-E or Ivy Bridge-E, you care about core count for a reason. It makes far more sense to buy into Intel's Broadwell-E platform to run a six-core or eight-core CPU. Or just wait to see if AMD's Ryzen can give you the core counts and performance you need.
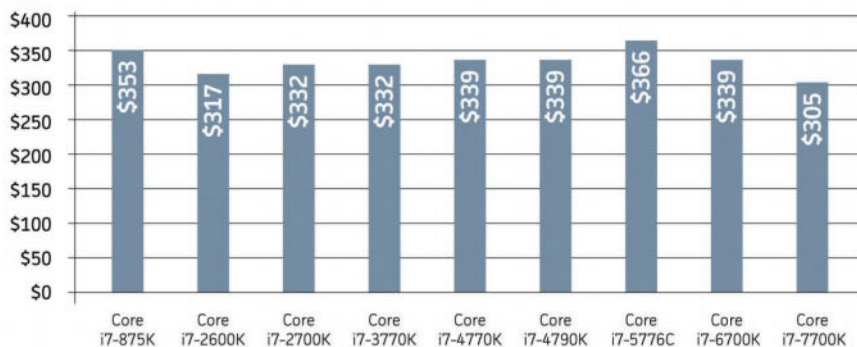
If we had a Core i7-3770K or Core i7-2600K: Look, there's nothing wrong with the classic Core i7-3770K or Core i7-2600K in actual CPU performance. The problem is your chipset. The Z77 chipset only has two SATA 6Gb/s ports, and good luck trying to run a modern M.2 NVMe drive in them. These platforms are about as creaky as a Austin Maestro with 275,000 miles on the milometer and a leaky gearbox. It's basically time to upgrade, and Kaby Lake would be fine for both.

If we had a Core i5: You can get by with a quad-core without Hyper-Threading, but anecdotal reports say the days of a quad-core only CPU are drawing to a close. And if you have to upgrade your Sandy Bridge or Ivy Bridge Core i5 chip (or even Haswell or Skylake), it probably makes sense to upgrade all the way to a new Kaby Lake CPU.

If we had an AMD FX-9590: Well yes, an upgrade to Kaby Lake for your AMD 'eight-core' would be very nice. But let's face it, there's a reason you're rolling one of AMD's top CPUs – you're an AMD fan. Just wait to see if AMD's Ryzen materializes and offers the price-to-performance ratio people are hoping for, so you can continue to fly the white, black and green flag. If Ryzen does falter out of the gate (unlikely), then, yes, a shiny Kaby Lake might be in your future. ⊠

RADEON VEGA REVEALED
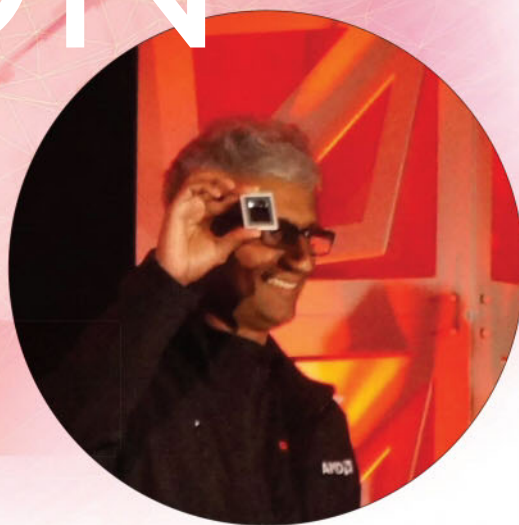
5 things you need to know about AMD's cutting-edge graphics cards

AMD's latest cards bring graphics and memory closer together, reveals Brad Chacos

W ait for Vega." For the past six months that's been the message from the Radeon faithful, as Nvidia's beastly GeForce GTX 1070 and GTX 1080 stomped above AMD's Radeon RX 400-series graphics cards.

While Nvidia's powerful new 16nm Pascal GPU architecture scales all the way from the lowly £150 GTX 1050 to the mighty £1,300 GTX Titan X, AMD's 14nm Polaris graphics are designed for more mainstream video cards, and the flagship Radeon RX 480 is no match for Nvidia's higher-end brawlers. Thus 'Wait for Vega' has become the rallying cry for AMD supporters with a thirst for face-melting gameplay – Vega being the code name of the new enthusiast-class 14nm Radeon graphics architecture teased on AMD road maps for early 2017.

Unfortunately, the wait will continue, as the new architecture won't appear in shipping cards until sometime later in the first half of 2017. But at CES, Vega is becoming more than a mere codename: AMD is finally revealing some technical teases for

Radeon's performance-focused response to Nvidia's titans, including how the new GPU intertwines graphics performance and memory architectures in radical new ways.

Before we dive in too deeply, here's a high-level overview of the Vega technical architecture preview. All those words will become meaningful in time. Let's start with what you want to hear about first.

1. Speed demon

In a preview shown to journalists and analysts in December, AMD played 2016's sublime Doom on an early Radeon Vega 10 graphics card with everything cranked to Ultra at 4K resolution. The game scales like a champ, but that's hell on any graphics card: even the GTX 1080 can't hit a 60 frames per second (fps) average at those

A technical preview of AMD's Radeon Vega graphics architecture

High-Bandwidth
Cache Controller

AMD | RADEON

settings, per Techspot tinyurl.com/gvt9kxe. Radeon Vega, meanwhile, floated between 60- and 70fps. Sure, it was running Vulkan – a graphics API that favours Radeon cards in Doom – rather than DirectX 11. But, hot damn, the demo was impressive.

A couple of other sightings in recent months confirm Vega's speed. At the New Horizon livestream that introduced AMD's Ryzen CPU to the world, the company showed Star Wars: Battlefront running on a PC that pairs Ryzen with Vega. The duo maxed out the 4K monitor's 60Hz speed with everything cranked to Ultra. The GTX 1080, on the other hand, hits just shy of 50fps, Techspot's testing shows (tinyurl.com/hbf6fad).

Meanwhile, a since-deleted leak in the Ashes of the Singularity database in early December showed a GPU with the Device ID '687F:C1' surpassing many GTX 1080s in benchmark results. Here's the twist: the Device ID shown in the frame rate overlay during AMD's recent Vega preview with Doom confirmed that Vega 10 is indeed 687F:C1. These numbers come with all sorts of caveats: Vega 10 isn't in its final form yet, we don't know whether the graphics card AMD teased is Vega's beefiest incarnation, all three of those benchmarked games heavily favour Radeon, and so on.

But all that said, Vega certainly looks competitive on the graphics performance front, partly because AMD designed Vega to work smarter, not just harder. "Moving the right data at the right time and working on it the right way," was a major goal for the team, according to Mike Mantor, an AMD corporate fellow focused on graphics and parallel compute architecture – and a large part of that stems from tying graphics processing more closely with Vega's radical memory design.

2. All about memory

When it comes to onboard memory, Vega is downright revolutionary – just like its

predecessor. AMD's current high-end graphics cards, the Radeon Fury series, brought cutting-edge high-bandwidth memory to the world. Vega carries on the torch with improved next-gen HBM2, bolstered by a new 'high-bandwidth cache controller' introduced by AMD.

Technical limitations limited the first generation of HBM to a mere 4GB of capacity, which in turn limited the Fury series to 4GB of onboard RAM. Thankfully, HBM's raw speed hid that flaw in the

vast majority of games, but now HBM2 tosses those shackles aside. AMD hasn't officially confirmed Vega's capacity, but the overlay during the Doom demo revealed that particular graphics card packed 8GB of RAM. And that super-fast RAM is getting even faster, with AMD's Joe Macri stating that HBM2 offers twice the bandwidth per pin of HBM1.

But as it turns out, HBM was just the beginning. "It's an evolutionary technology we can take through time, make it bigger, faster, make all these key improvements," said Macri, a driving force behind HBM's creation. Vega builds on HBM's shoulders with the introduction of a new high-bandwidth cache and high-bandwidth cache controller, which combine to form what Radeon boss Raja Koduri calls "the world's most scalable GPU memory architecture".

AMD crafted Vega's high-bandwidth memory architecture to help propel memory design forward in a world where sheer graphics performance keeps improving by leaps and bounds, but memory capacities and capabilities have remained relatively

High-Bandwidth
Cache Controller

512 TB
virtual address space

AMD | RADEON

THE WITCHER WILD HUNT
(Ultra 4K)

Fallout 4
(Ultra 4K)

Total Allocations   Accessed
See endnotes for details

AMD | RADEON

static. The HB cache replaces the graphics card's traditional frame buffer, while the HB cache controller provides fine-grained control over data and supports a whopping 512TB – not gigabytes, terabytes – of virtual address space. Vega's HBM design can expand graphics memory beyond onboard RAM to a more heterogeneous memory system capable of managing several memory sources at once.

That's likely to make its biggest impact in professional applications, such as the new Radeon Instinct line-up or the cutting-edge Radeon Pro SSG card that graft high-capacity NAND memory directly to its graphics processor. "This will allow us to connect terabytes of memory to the GPU," David Watters, AMD's head of Industry Alliances, told our colleagues at PCWorld when the Radeon Pro SSG was revealed, and this new cache and controller architecture designed for HBM's high speeds should supercharge those capabilities even more.

To drive the potential benefits home, AMD revealed a photorealistic recreation of Macri's home living room. The 600GB scene normally takes hours to render, but the combination of Vega's prowess and the new HBM2 architecture pumps it out in mere minutes. AMD even allowed journalists to move the camera around the room in real-time, albeit somewhat sluggishly. It was an eye-opening demo.

Koduri stressed that games can also benefit from the high-bandwidth cache controller's fine-grained, dynamic data management, citing Witcher 3 and Fallout 4, each of which actually use less than half the memory allocated by the games when they're running at 4K resolution. "And those are well-optimised games," he said. Memory demands are only getting greedier in high-profile games, and doubly so at bleeding-edge resolutions. Here's hoping that the HB cache's finer controls paired with HBM's sheer speed alleviates that somewhat.

AMD also says that future generations of games could take advantage of high-bandwidth memory design to upload large data sets directly to the graphics processor, rather than handling it with a more hands-on approach as done today.

3. Efficient pipeline management

The way graphics cards render games isn't very efficient. Case in point: the scene (shown top right) from Deus Ex: Mankind Divided. It packs in a whopping 220 million polygons, according to Koduri, but only two million or so are actually visible to the player. Enter Vega's new programmable geometry pipeline.

Vega's Primitive Shaders

Rendering a scene is a multi-step process, with graphics cards processing vertex shaders before passing the information on to the geometry engine for additional work.

the peak throughput of its predecessors, and includes a new 'Intelligent Workgroup Distributor' to improve task load balancing from the very beginning of the pipeline.

The scene from Deus Ex: Mankind Divided. It packs in a whopping 220 million polygons, according to Koduri, but only two million or so are actually visible to the player

Vega speeds things up with the help of primitive shaders that identify the polygons that aren't visible to players so the geometry engine doesn't waste time on them. Vega also blazes through information at over twice

These tweaks drive home how AMD's infiltration in consoles can benefit PC gamers, too. The inspiration for the load balancing tweaks comes from console developers used to working "closer to the
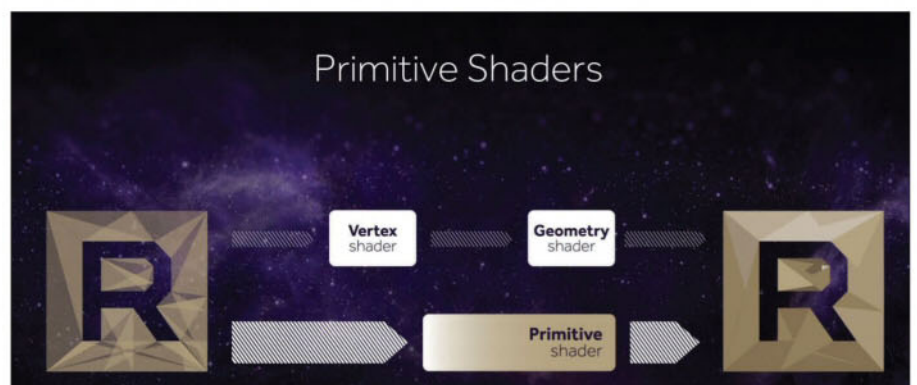
metal" than PC developers, who highlighted it as a potential area for improvement for AMD, Raja Koduri explained.

4. Right task, right time

AMD designed Vega to "smartly schedule past the work that doesn't have to be done," according to Mike Mantor. The final tidbits made public by the company drive that home. Vega continues AMD's multi-year push to reduce memory bandwidth consumption. Its next-gen pixel engine includes a 'draw stream binning rasterizer' that improves performance and saves power by teaming with the high-bandwidth cache controller to more efficiently process a scene. After the geometry engine performs its (already reduced amount of) work, Vega identifies overlapping pixels that won't be seen by the user and thus don't need to be rendered. The GPU then discards those pixels rather than wasting time rendering them. The draw stream binning rasterizer's design "lets us visit a pixel to be rendered only once," reveals Mantor.

The revamped Vega architecture also now feeds render back-ends from the pixel engine into the larger, shared L2 cache, rather than pumping them directly into the memory controller. AMD says that should
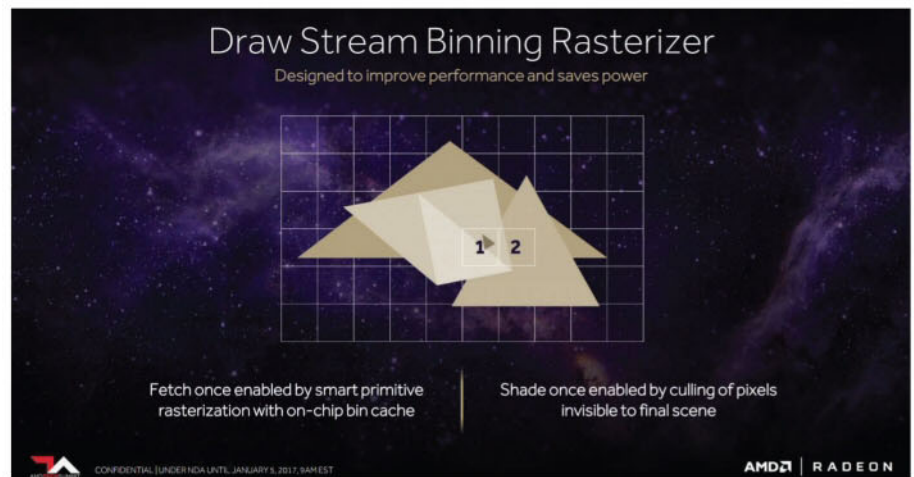
help improve performance in GPU compute applications that rely on deferred shading.

5. Next-gen compute engine

Finally, AMD teased Vega's 'next-gen compute engine', which is capable of 512 8-bit operations per clock, 256 16-bit operations per clock, or 128 32-bit operations per clock. The 8- and 16-bit ops mostly matter for machine learning, computer vision, and other GPU compute tasks, though Koduri says the 16-bit ops can come in handy for certain gaming tasks

that require less stringent accuracy as well. (The AMD-powered PlayStation 4 Pro also supports 256 16-bit operations per clock.)

Coincidentally enough, the Vega NCU can perform two 16-bit ops simultaneously, doubled up and scheduled together. This wasn't possible in previous AMD GPUs, Koduri says. Vega's next-gen compute unit has been optimised for the GPU's higher clock speeds and higher instructions-per-cycle, though AMD declined to disclose the core clock speeds for Vega just yet.

Waiting for Vega

The wait for Vega continues, but now we have some idea of the ace hidden up the Radeon Technologies Group's sleeve. These technical teases provide just enough of a glimpse to whet the whistle of graphics enthusiasts while revealing tantalisingly little in the way of hard news relating to consumer-focused Vega graphics cards. (AMD doesn't want to show its hand to Nvidia too much, after all.) It's clear that AMD's attempting some nifty new tricks to improve the efficiency and potential of Vega both in games and professional uses. Details are sure to drip-drop out over the coming months.

Fingers crossed that Vega comes sooner rather than later, however. AMD teased its 14nm Polaris GPU architecture at CES 2016 but failed to actually launch the Radeon RX 480 until the very end of June. Vega has been slapped with a release window sometime in the first half of 2017, so if AMD waits until E3 to launch this new generation of enthusiast-class graphics cards, Nvidia's beastly GTX 1080 will have already been on the streets for a full year.

Vega looks incredibly intriguing, but even the most diehard Radeon loyalists can only wait for so long to build a new rig, especially with AMD's much-hyped Ryzen processors launching now. ⊠
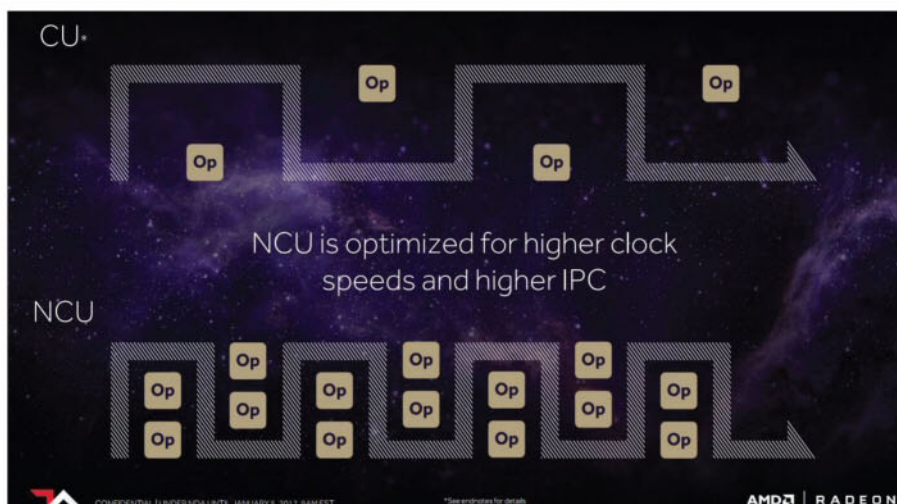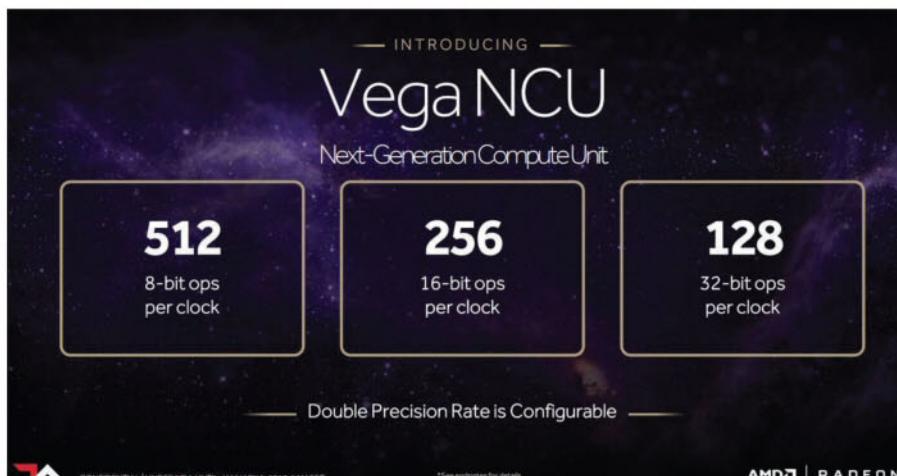
Vega's New Compute Unit can perform two 16-bit ops at once

Why you should use a VPN

Ian Paul explains how to protect your online privacy as the government steps up its online surveillance

One of the most important skills any computer user should have is the ability to use a virtual private network (VPN) to protect their privacy. A VPN is typically a paid service that keeps your web browsing secure and private over public Wi-Fi hotspots. VPNs can also get past regional restrictions for video- and music-streaming sites and help you evade government censorship restrictions, though that last one is especially tricky.

The best way to think of a VPN is as a secure tunnel between your PC and destinations you visit on the internet. Your PC connects to a VPN server, which can be located in the United Kingdom or

COFFEE SHOP

OUR LAPTOP

OUR LAPTOP

PUBLIC Wi-Fi

TUNNEL ENDPOINT

WEBSITE

SECURE TUNNEL
UNENCRYPTED
WIRELESS

A VPN is like a secure tunnel for web traffic

a foreign country like the United States, France, Sweden or Thailand. Your web traffic then passes back and forth through that server. The end result is that as far as most websites are concerned, you're browsing from that server's geographical location, not your computer's location.

We'll get to the implications of a VPN's location in a moment, but first, let's get back to our secure tunnel example. Once you're

This is why many regionally restricted websites and online services such as BBC's iPlayer or Sling TV can be fooled by a VPN. We say 'most' services because some, most notably Netflix, are fighting against VPN use to prevent people from getting access to, say, the American version of Netflix when they're really in Australia.

For the most part, however, if you're visiting Belgium and connect to a US VPN

unrestricted web. A VPN would have limited use. If you're trying to evade government restrictions and access sites such as Facebook and Twitter, a VPN might be useful. Even then, you'd have to be somewhat dependent on the government's willingness to look the other way.

Anything more serious than that, such as mission-critical anonymity, is far more difficult to achieve, even with a VPN. Privacy against passive surveillance? No problem. Protection against an active and hostile government? Probably not.

The problem with anonymity is there are so many issues to consider – most of which are beyond the scope of this article. Has the government surreptitiously installed malware on your PC in order to monitor your activity, for example? Does the VPN you want to use have any issues with data leakage or weak encryption that could expose your web browsing? How much information does your VPN provider log about your activity, and would that information be accessible to the government? Are you using an anonymous identity online on a PC that you never use in conjunction with your actual identity?

Anonymity online is a very difficult goal to achieve. If, however, you are trying to remain private from prying eyes or evade NSA-style bulk data collection as a matter of principle, a reputable VPN will probably be good enough. Beyond surveillance, a VPN also won't do much to keep advertisers from tracking you online. Remember that the website you visit is aware of what you do on its site and that applies equally to advertisers serving ads on that site.

To prevent online tracking by advertisers and websites you'll still need browser add-ons such as Ghostery, Privacy Badger, and HTTPS Everywhere.

You get the benefits of spoofing your location. If you're in London, for example, and the VPN server is in the US, it will look to most sites that you're browsing from there, not the UK

connected to the VPN and are 'inside the tunnel', it becomes very difficult for anyone else to spy on your web-browsing activity. The only people who will know what you're up to are you, the VPN provider (usually an HTTPS connection can mitigate this), and the website you're visiting.

When you're on public Wi-Fi at an airport or café, that means hackers will have a harder time stealing your login credentials or redirecting your PC to a phony banking site. Your internet service provider (ISP), or anyone else trying to spy on you, will also have a near impossible time figuring out which websites you're visiting.

On top of all that, you get the benefits of spoofing your location. If you're in London, for example, and the VPN server is in the US, it will look to most websites that you're browsing from there, not the UK.

server, you should get access to most American sites and services just as if you were sitting at a Starbucks in Chicago.

What a VPN can't do

While VPNs are an important tool, they are far from foolproof. Let's say you live in an oppressive country and want to evade censorship in order to access the

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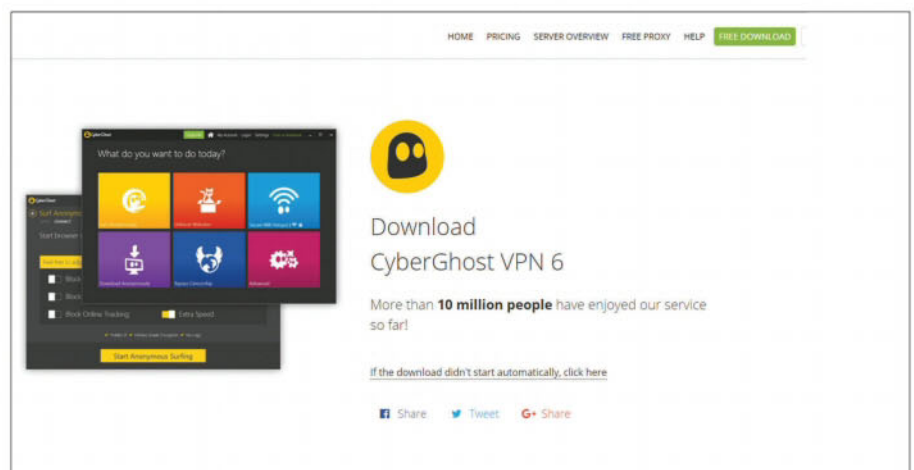
How to choose a VPN provider

There was a time when using a VPN required users to know about the built-in VPN client for Windows or universal open-source solutions such as OpenVPN. Nowadays, however, nearly every VPN provider has their own one-click client that gets you up and running in seconds. There are usually mobile apps as well to keep your Android or iOS device secure over public Wi-Fi.

Of course that brings up another problem. Since there are so many services to choose from, how can you tell which ones are worth using, and what are the criteria to judge them by?

First, let's get the big question out of the way. The bad news for anyone used to free services is that it pays to pay when it comes to a VPN. There are tons of free options from reputable companies, but these are usually a poor substitute for the paid options. Free services usually allow a limited amount of bandwidth usage per month or offer a slower service. Tunnel Bear, for example, offers just 500MB of free bandwidth per month, while CyberGhost offers a free service that is significantly slower than its paid service.

Then there are the free VPNs that use an ad-supported model, which in our experience aren't worth using at all. Plus, free VPNs are usually anything but; in lieu of payment they may be harvesting your data (in anonymised form, of course) and selling it as 'marketing insights' to advertisers. The good news is VPNs aren't expensive. You can usually pay as little as £4 per month for VPN coverage.

We won't get into specific VPN service recommendations in this article: for that, see tinyurl.com/j3k977m. Instead, here are some issues to consider when shopping around for a VPN provider.

First, what kind of logging does your VPN provider do? In other words, what information do they keep about your VPN sessions and how long is it kept? Are they recording the IP addresses you use, the websites you visit, the amount of bandwidth used, or any other key details?

All VPNs have to do some kind of logging, but there are VPNs that collect as little data as possible and others that aren't so minimalist. On top of that, some services discard their logs in a matter of hours or days, while other companies hold onto them for months at a time. How much privacy you expect from your VPN-based browsing will greatly influence how long you can stand having your provider maintain your activity logs – and what those logs contain.

Secondly, what are the acceptable terms of use for your VPN provider? Thanks to the popularity of VPNs with torrent users, permissible activity on specific VPNs can vary. Some companies disallow torrents completely, some are totally fine with them, while others won't stop torrents but officially disallow them. We aren't here to advise pirates, but anyone looking to use a VPN should understand what is and is not okay to do on their provider's network.

Finally, does the VPN provider offer their own application that you can download and install? Unless you're a power user who wants to mess with OpenVPN, a customised VPN program is really the way to go. It's simple to use and doesn't require any great technical knowledge or the need to adjust any significant settings.

Using a VPN

You've done your due diligence, checked out your VPN's logging policies, and found a service with a great price and a customised
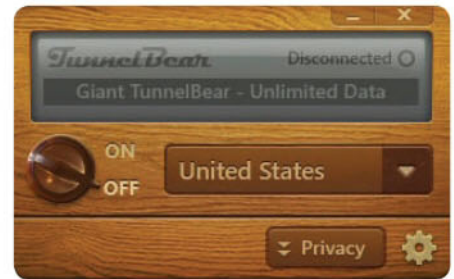
TunnelBear is one of our favourite VPNs, but there are many good choices

UK, the US and Germany are at the top. Once that's done, hit the Connect button and wait for the confirmation message.

HMA Pro's interface is slightly more complicated, but it's easy to understand. To select your desired virtual location, click the Location Mode tab, then the location name, and choose your preferred location from the list. Once that's done, click the slider button

> **Free VPNs are usually anything but; in lieu of payment they may be harvesting your data (in anonymised form, of course) and selling it as 'marketing insights' to advertisers**

application. Now, for the easy part: connecting to the VPN. Here's a look at a few examples of VPN desktop applications.

TunnelBear, for example, has a very simple interface – if a little skeuomorphic. All you need to do is select the country you want to be virtually present in, click the dial to the On position, and wait for a connection-confirmation message.

SaferVPN works similarly. From the left-hand side you select the country you'd like to use – the more common choices such as the

that says Disconnected. Once it flips to Connected, you're ready to roll.

There are numerous VPN services out there, and they all have different interfaces; but they are all similar enough that if you can successfully use one, you'll be able to use the others.

That's all there is to using a VPN. The hard part is figuring out which service to use. Once that's done, connecting to a VPN for added privacy or to stream your favourite TV shows while abroad is just a click away. ⊠

With SaferVPN, choose the country you wish to have a virtual presence in
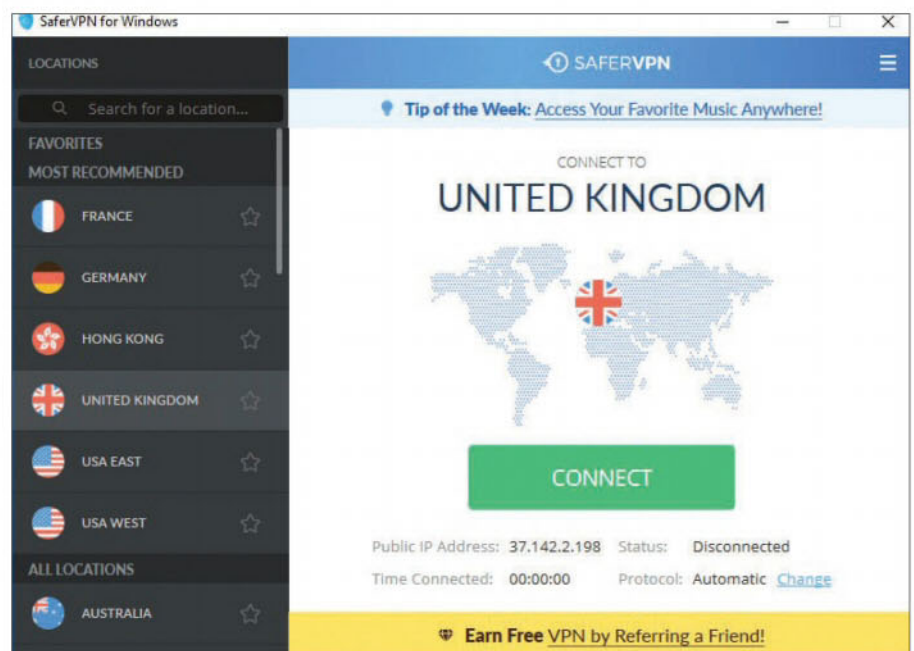
Why PC game downloads are so big

Your hard drives and data caps are begging for mercy. There could be an answer, writes Hayden Dingman

I t's always fun looking back at old PC ads, right? Back when 48KB of RAM was a huge deal, or when a 450MHz processor was the norm, or when 10MB of storage space was more than anyone expected to fill in a lifetime. Nowadays, we have multiple terabytes of storage capacity, and it just keeps filling up. It's all video games.

One of 2016's large-scale PC gaming trends – emphasis on large – was the rapid inflation of download sizes and drive footprints. It's becoming a problem, and one that's fast putting PC gaming out of reach for some people.

Let's dig into why before examining some potential solutions.
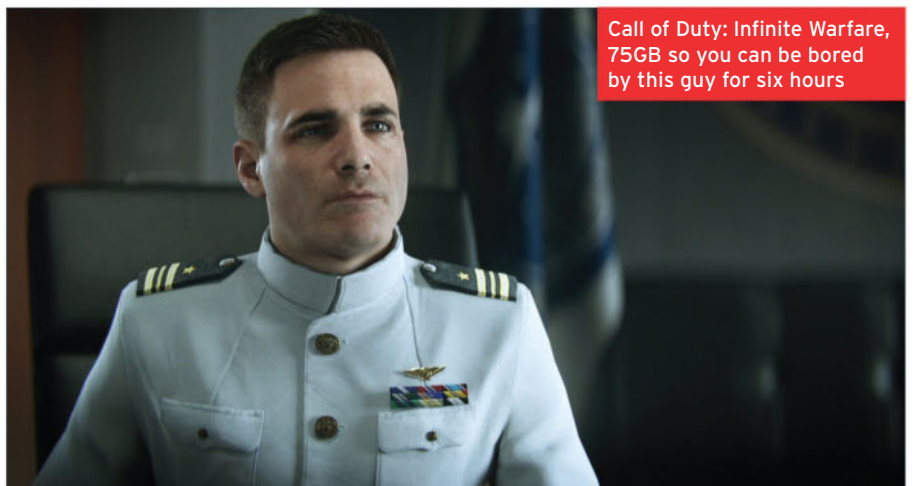
Call of Duty: Infinite Warfare, 75GB so you can be bored by this guy for six hours

Breaking the 50GB barrier

We love our all-digital future. We really do. Moving to Steam and away from traditional retail channels has enabled a much more diverse games industry – releases as small and meditative as Sorcery! or as gun-happy as the Doom reboot. It's allowed for the revival of long-dead genres such as the isometric CRPG, leaving us with Wasteland 2 and Divinity: Original Sin and Pillars of Eternity. It's given us back the B-games, the middle of the market we thought died with THQ – games such as Shadow Warrior 2 and Obduction, too big to feel 'indie' in the traditional sense but still comparatively small when put up against games from Ubisoft and EA.

And if we contrast the size of our Steam library with our not-so-huge flat, we're pretty grateful that our games don't take up physical space nowadays. We would be drowning in jewel cases.

Last year gave way to some truly massive releases, though – and again, we're talking massive in terms of hard drive footprint, not marketing pounds or shelf presence or whatever. The largest we've seen: the double-packed Call of Duty: Infinite Warfare and Modern Warfare Remastered.

Want to take a guess at how much space the pair requires? Brace yourself and brace your hard drive, because it's 120GB. Yes, over 100GB of space to install the pair, with Infinite Warfare taking up 75GB of that all by itself. Just to break that down into more concrete terms: if the PC version of Infinite Warfare were released during the Xbox 360 era, it would've required

approximately 10 DVDs to hold all that data. Even with Blu-ray, you'd need two dual-layer discs for Infinite Warfare alone.

There's a reason games take up this much space, and we have only ourselves to blame for demanding ever-increasing fidelity. High-resolution textures and uncompressed audio are storage hogs.

But it still stings a bit, when a few years ago the biggest games topped out at around 30GB – and even that was a rarity. When Titanfall hit 50GB back in 2014, it literally made headlines. Respawn had to come out and explain why it was that large. (All that uncompressed audio.) These days it's commonplace and also baffling.

Solid-state drives are getting cheaper, but that space still comes at a premium. Most people we know are running – at most

– a 500GB SSD. Factor in your operating system install and a few programs and you've only got enough room for four or five of these massive games.

More important, and more pressing, is the fact that it's simply not feasible for many people to download 50GB of data a couple times a month. We're blessed with an excellent internet connection here in London, but you may not be so fortunate if you live in rural parts of the country. A 50GB-plus game install could tie up your bandwidth all day, or maybe multiple days.

Even if you only install a single game each month, you're talking maybe 60- to 70GB for the game itself, then another few gigabytes for those day one patches and probably some multiplayer matches. There's nearly a tenth of your monthly 1TB usage, gone.

Doom

The original Titanfall made headlines in 2014 for its 50GB install

Pretty standard, right? So why not in games?

But why?

What irks us is that for many people, these supersized installs are unnecessary. Sure, there are cases where performance might be better with uncompressed audio or textures (that was Titanfall's argument), but by and large it's for enthusiasts with high-end hardware. If you're running a game on a single GeForce GTX 1060, do you really need assets designed for 4K? Probably not. If you're playing in English, do you need to install uncompressed audio for a dozen other languages? Nein. And if you only ever plan to play single player, do you need all of the multiplayer stuff, too? Though it's largely completed on the PC, the weird transition period between physical and digital media has left us with some troublesome baggage – namely, that we still package games as if they were being pressed to disc, and everything needs to be included in the box.

A better model is readily apparent. Software already uses it, and has for years. When you go to install Microsoft's Visual Studio, for instance, you're given a long list of files you may or may not need. Mark the ones you want, ignore the rest, and save yourself some drive space.

Oh, we're just starting to see this modular approach taken in video games. Shadow of Mordor, for instance, allowed players to install the oversized 'HD Content' pack if they had enough VRAM to make higher-resolution textures viable. Fallout 4 is doing the same, with its recently announced 58GB high-resolution texture pack being offer as an optional add-on.

Call of Duty – of all things – has decoupled its single- and multiplayer portions ever since Modern Warfare II. If you own any of the games in Steam you'll notice, for example, separate entries for Call of Duty: Black Ops II; Call of Duty: Black Ops II – Multiplayer; and Call of Duty: Black Ops II – Zombies.

That method was unwieldy and left this writer's Steam library a mess, but it's even cleaner now. Call of Duty: Black Ops III and Infinite Warfare listed their single- and multiplayer modules as DLC, so you can uninstall it the same as any other add-on.

We're not saying these are the only – or even the best – solutions. But we offer them up to hopefully get us talking about this issue before it gets worse.

The games industry needs to ease the burden of these gargantuan installations. Let the people who want (and can handle) 80GB downloads continue as normal, but the flexibility of the PC as a platform should mean there's a way for people who don't need the whole package to pick and choose, be it by accepting downgraded assets or by installing only one mode at a time, or whatever else developers can think up. ⊠

Shadows of Mordor: HD Content Steam
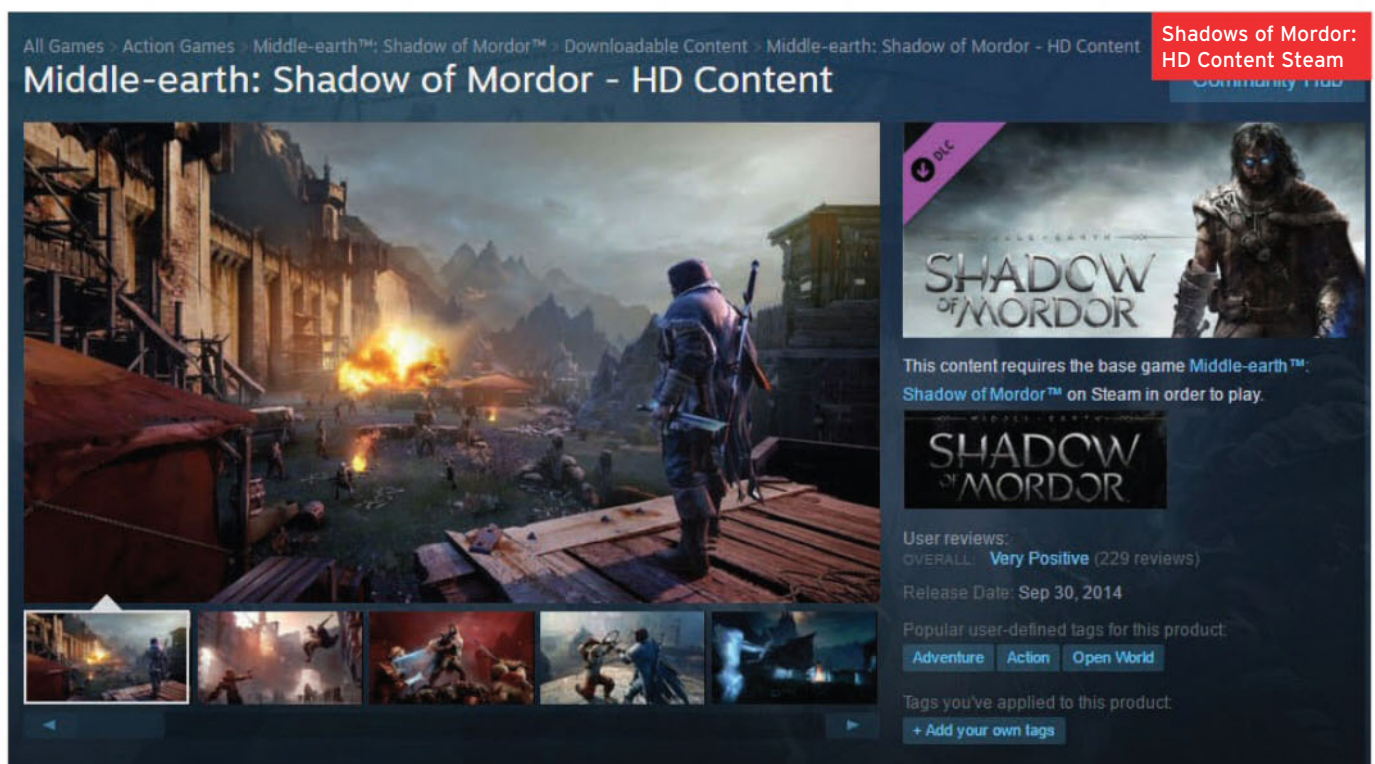
Install an SSD to boost your PC's performance

Chris Martin reveals how to install an SSD as your Windows boot drive and maximise a PC's potential

When installed on a solid-state drive, Windows not only boots and shuts down quicker but applications load faster and the computer feels more responsive. Plus, since prices have fallen considerably in recent years, an SSD is much more affordable.

If you're still not convinced it's worth the hassle, we took an Alienware X51 PC that's a few years old and well used and ran various tests before and after installing a 128GB Integral V Series SSD, which costs just £39.99 from Amazon. As you can see in our table, you can expect your PC to boot up significantly quicker, in our case more than twice as fast. You'll also programs and games load quick (look at the difference starting Overwatch), files move faster and generally more responsive performance.

Before you begin

Almost every PC case has internal bays for adding extra hard disks, which are 3.5in wide. SSDs tend to be 2.5in wide though, so you may need a mounting bracket to fit one in your computer. SSDs have Serial ATA (SATA) data connectors, of which there are three versions (1, 2 or 3), that can transfer data at 1.5-, 3- or 6Gb/s, respectively.

It doesn't matter if your computer doesn't support SATA 3. SSDs are backwards compatible, and sequential transfer speed isn't the only reason for their improved performance. More important is their much-reduced latency over conventional hard disks, as it takes far less time to access data from an SSD's NAND flash memory than for a hard disk's mechanical arm to move into position. There are a few disadvantages to be aware of, though. SSDs cost more per

	NO SSD	SSD INSTALLED
PCMark 8 Home	3575	3693
AJA read/write (MB/s)	58/51	208/242
Boot time (seconds)	41	16
Load Overwatch (seconds)	65	10

GB of storage than conventional hard disks. Plus, their capacities top out at around 512GB, which is well short of the current 4TB maximum for hard disks. It makes sense to keep Windows and your apps on the SSD, which will benefit from the improved loading times, and large media collections on a separate hard disk. We'll also explain how to configure the BIOS and Windows.

For the rest of this tutorial, we're using a desktop PC with an Asus P8P67 Pro motherboard and a Fractal Design Define R3 case, which has internal space for SSDs, but our advice applies to any desktop computer. You can install a fresh copy of Windows or transfer your current operating system. There are plenty of programs for doing this job, such as Acronis True Image HD.

How to install an SSD in your PC

START Unscrew and remove the sides of your computer's case. Some have latches holding the sides in place, which must be pushed open. Make sure you have clear access to the motherboard's SATA ports and hard disk bays.

2 Place the SSD into its mounting bracket or a removable bay, line it up with the holes underneath, then screw it in. You can buy a 3.5- to 2.5in adaptor bracket for a few pounds or simply use a single hole in a 3.5in bay in your PC.

3 Connect the L-shaped end of a SATA cable to the SSD, and the other end to a spare SATA port (SATA 6Gb/s ports are blue). Connect a SATA power cable to the SSD. For a fresh Windows installation, disconnect any other hard disks inside your PC.

4 Insert a USB drive or DVD with Windows 10 and turn on the PC. Press F12 to see the boot menu and select the USB or DVD. Follow the instructions to install the operating system on the SSD. Once the installation is complete, you can put other hard drives back in the PC.

Obviously, all your old files and Windows installation will still be on your old disk. You can copy your documents, videos, music and pictures across to their respective folders on the SSD, but it's best to leave most of your files on the hard disk to avoid using up the limited space on your SSD.

There are numerous ways to tell your new Windows installation that your documents and other files are on a different hard disk. With Microsoft's OS, the most elegant method is to use its libraries feature. Create a folder on your hard disk: for example, e:/docs. Right-click the folder in Explorer, scroll down to the Include in library option, then choose the Documents library from the list. Next, copy any documents from the My Documents folder to the new one. You can do the same for movies, music and pictures, keeping your files close at hand without them residing on the SSD.

When it comes to software, it makes sense to install those programs you use most often on the SSD, so that they benefit from its speed. When space becomes too tight, or you don't need the extra speed, install new applications on your old hard disk by specifying where to store the files during the installation process. If you leave the settings at their defaults, programs will always be installed to the same drive as Windows. ⊠

Uninstall Windows 10's built-in apps

Martyn Casserly shows how to clear away the clutter on your PC by getting rid of unwanted apps

Windows 10 has some pretty useful features out of the box, a number of which are delivered through dedicated apps that are preinstalled when you buy a new machine. If you don't use them though then all they're doing is taking up space on your hard drive, not to mention cluttering your desktop. We show you how to clear them out in this quick tutorial.

Uninstall bloatware

Here's the deal: Windows 10 PCs and laptops often arrive with a shed-load all bloatware that manufacturers preinstall, such as trial software, antivirus and unwanted games. This uses up precious disk space and can even slow down your brand new machine. Fortunately, Microsoft has got a neat solution for getting rid of it.

The Refresh Windows Tool is a free app that you can download directly from Microsoft (tinyurl.com/jz52gsv). When you run it the tool installs a clean and unencumbered version of Windows 10 onto your machine, removing any apps that are not core to the system. This means it will also delete apps you've downloaded yourself, so ensure you not only backup your data but that you've also got the original disks or files for any application you want to keep.

It's kind of a nuclear option in some ways, although the app can leave all of your personal data alone if you choose that option when you initially launch it. Windows does slow down over time, so using the refresh tool every couple of years is an easy way to keep your system up to snuff, plus the tool is an excellent idea if you've just bought or been given a second-hand PC.
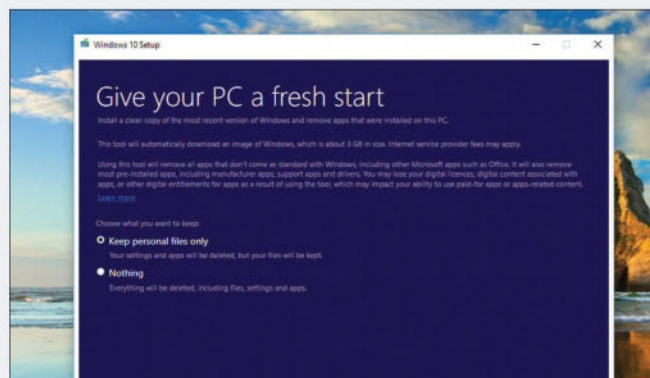
If you simply want to remove a few programs manually, they can be deleted in the same way as any program. To do this, go to the Start Menu and scroll through the application list until you find one you want to remove. Right-click on its name and then select the Uninstall option.

Remove built-in apps

The approach above won't remove any of the apps that are actually part of Windows 10, and you won't see an option to uninstall the app when you right-click on it. For such apps it's going to take a little more work. It's not difficult, but it will involve using the command line, which while intimidating at first is actually quite straightforward.
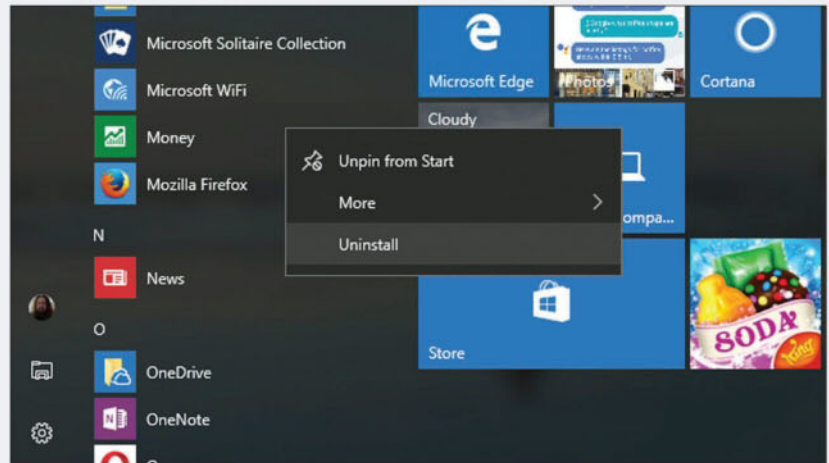
Open the Start Menu again and type **Powershell** into the search box. It should appear as Windows PowerShell at the top of the list of results. Right-click on it and select the Run as Administrator option. Obviously, you'll either need to logged in as an Administrator account for this to work. (The default user account you created when you first got your computer should be an admin account.)
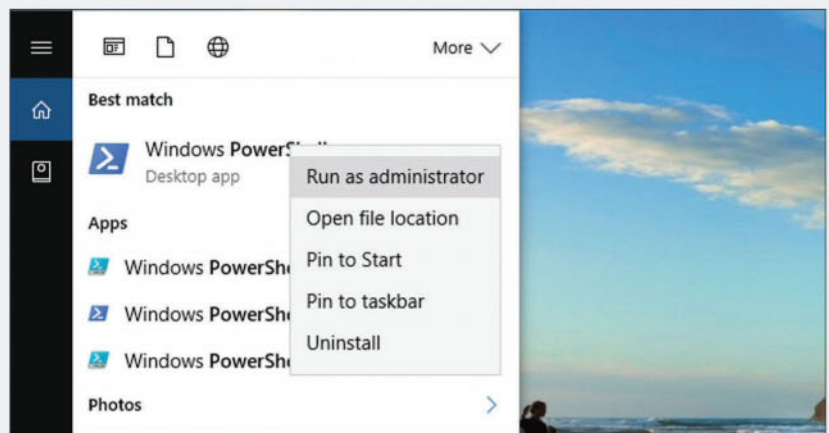
With the PowerShell window open you can now type in commands to remove the apps in question. The command you need to use follows this format:

> Get-AppxPackage *name of app* | Remove-AppxPackage

So, for example, if you wish to remove the Office Hub app you'd type the following command and press Enter:

> Get-AppxPackage *officehub* | Remove-AppxPackage

Here's a list the built-in apps and the names you need to use to delete them:

3D Builder: 3dbuilder
Alarms & Clock: alarms
Calculator: calculator
Calendar & Mail: communicationsapps
Camera: camera
Films & TV: zunevideo
Get Office: officehub
Get Skype: skypeapp
Get Started: getstarted
Groove Music: zunemusic
Maps: maps
Messaging: messaging
Microsoft Solitaire Collection: solitaire

Money: bingfinance
News: bingnews
Onenote: onenote
Photos: photos
Sports: bingsports
Voice recorder: soundrecorder
Weather: bingweather
Xbox: xbox

There are a few apps that can't be deleted, though. These are Cortana, Microsoft Edge, Contact Support, Windows Feedback and, while you can remove the Windows Store, it's not a great idea since you might want it in the future.

So there you go, a simple way to clean up your system and declutter your app tray. Now you can either keep it sparse or replace the removed items with ones you might prefer. ⊠

Retrieve trashed Windows documents

Losing an Office document can be stressful, but there are steps you can take. Jim Martin reports

It's an awful feeling when you realise that you've deleted or failed to save the changes in a Word, Excel or PowerPoint document. You might have been the victim of a Windows crash or even a power cut, but hours of hard work may not be lost as there are several ways you can try to recover Office documents. Here we'll explain where to look for temporary files, backups and old versions of your files as well as software which can attempt to recover a deleted file.

Top tip: If you've accidentally deleted something in a document (or the whole thing) but Word, Excel or PowerPoint is still open, press Ctrl-Z to undo the mistake. This works in most situations, including in web browsers. If that doesn't work, it may still be possible to get your document back. It depends on how your computer (and Office) is configured, which version of Office you're running and how the file was lost, deleted or corrupted. There are no guarantees, but try the following.

Look for the AutoRecover or backup version

By default, Office saves a copy of your file from time to time in case of a power cut or other failure. In theory, when you next launch Word, Excel or other Office program, it should present a list of files you can continue to work on, but sometimes you'll see nothing at all. If this happens, here's how to find the AutoRecover files.

Word 2002/2003
• In the Tools menu, click Options
• Go to the File Locations tab and double-click AutoRecover files
• Copy or write down the file path, the click Cancel, and then Close
• Using Windows Explorer navigate to the AutoRecover file location
• Search for files with names ending in .asd

Word 2007
• Click the Office button (top left) and choose Word Options
• In the Navigation Pane, click Save
• In the AutoRecover file location box, note the path, and then click Cancel.
• Using Windows Explorer navigate to the AutoRecover file location
• Search for files with names ending in .asd
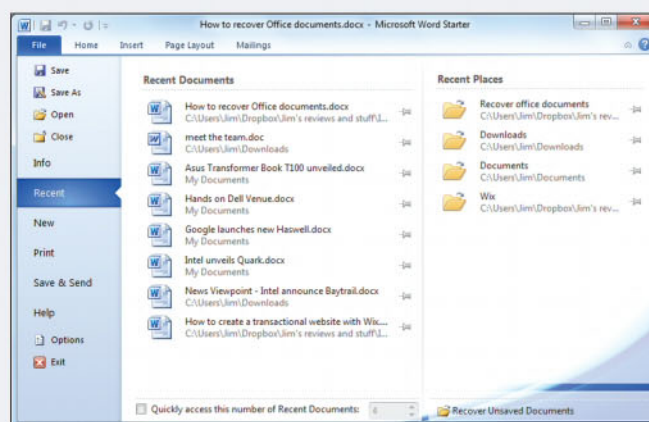
Word 2010
• Go to the File menu and choose Recent
• Click on Recover Unsaved Documents (at the bottom)

This takes you to the folder in which Office automatically saves your work, even if you never hit 'Save' and gave it a filename.

Similarly, in Office 2013 or later, a panel listing recovered documents will appear when you next open a document:

Manual search

If this all fails, then you can put in some detective work. You can use Windows Search (or the Start menu search box in Windows Vista, 7 or 10) to search for the file name (assuming you saved it at least once).

You need only remember one word from the filename, or if not, search for all Word documents. To do that type ***.doc** or type ***.docx** to find all Word files. (The '*' is called a wildcard and means Windows will return any file with a .doc or .docx extension.) If you know you used a different file type, such as RTF, then search for ***.rtf** instead. (Excel files are .xls or .xlsx, while PowerPoint documents have .ppt or .pptx extensions.)

If that fails, try searching instead for Word backup files using the *.wbk or *.asd wildcards. If that turns nothing up, try ***.tmp** or **~*.***. You can find more detailed information on Microsoft's troubleshooting page (tinyurl.com/jscn7wu).
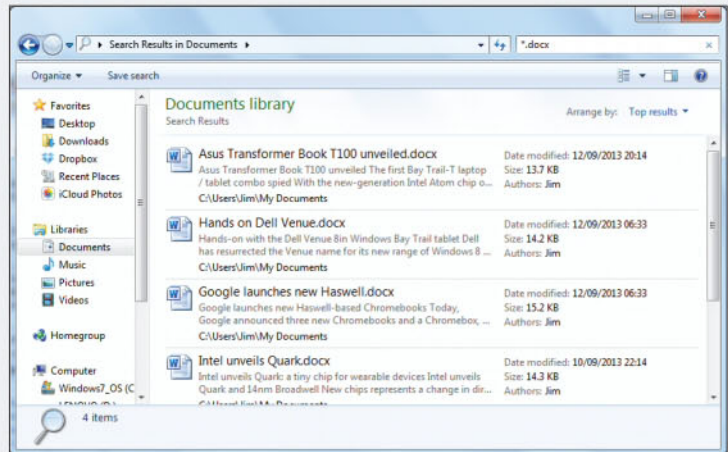
Undelete them

It's easy to inadvertently delete a document, but the chances of getting it back are high if you act quickly. First, look in the Windows Recycle Bin. Your document is likely to be in this temporary folder unless you're in the habit of pressing Shift-Delete, in which case it bypasses the Recycle Bin and gets 'properly' deleted. However, it doesn't get erased from your hard drive: Windows merely 'forgets' where the file is and that disk space can then be overwritten.

It's at this point you should try an file recovery utility. There are many free options, but a popular one is Recuva (tinyurl.com/

kw6g2u8), which comes in both installable and 'portable' versions. This is important as you don't want to download or install a utility on the computer on which your deleted file resides as the new program might overwrite it.

Instead, install the portable version of Recuva onto a handy USB flash drive (using a different computer to download it) and then run it on the computer where your file has been deleted. As long as it hasn't been overwritten you should be able to recover the document, although it may be missing its file name.

Find a copy of the document

There might be an older copy of your file, which might save you some work as you'll only have to update it if any changes were made between the copy and the version that's lost.

But unless you (or someone) ticked the option, Office doesn't automatically create copies of your documents. But if enabled, there should be a second version of your file called 'Backup of xxxx' where xxxx is the original filename.

options, find the Save section and look for an 'Always create a backup copy' setting. Not all versions of Office have this, but you will find options there to save AutoRecover data – set the time between auto-saves to a few minutes, and that way you'll only ever lose a small amount of work.

Some cloud storage services, including Dropbox, automatically create copies (versions) of your files each time you edit them, so it's well worth checking for this if your file was ever saved to the cloud.

Another glimmer of hope of finding your file comes in the form of Windows Shadow Copy. This isn't available in all editions of Windows, but you can check if yours has it and whether or not it's enabled. To see if there's an older version of your file, launch Windows Explorer and right-click on the file that contained your document. Click Properties and then look for a Previous Versions tab. If there is one, click on it and you should see a list of dates. Double-click on a date you think the file should have existed and look for the file. ⊠

For future reference, and not that you really want to hear it now, but to force Office to make copies you need to go into the
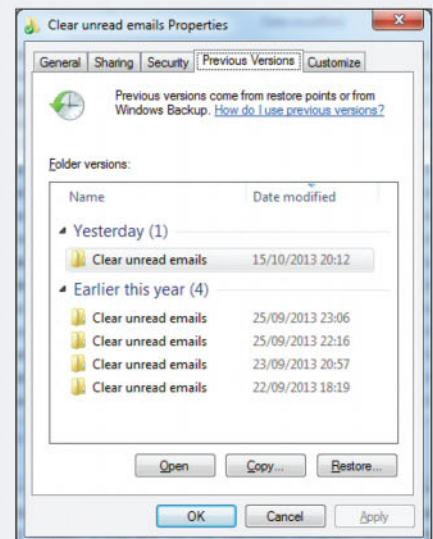
Turn a Windows laptop into a Wi-Fi hotspot

Martyn Casserly explains how you can connect to the internet via your Windows PC's Wi-Fi network

Being connected to the internet is pretty much a requirement for all our mobile devices these days. But whether you're at home or away, it's not always possible to get the best signal for every bit of your kit. One easy solution is to turn your laptop into a Wi-Fi hotspot. In big houses and offices, where the Wi-Fi may have dead zones, a hotspot can give access to devices that wouldn't normally be able to connect.

Your hotspot can also come in handy when you're out and about. If you've paid to connect to a public Wi-Fi, you can use your laptop to connect other devices or a friend's computers and make the most of it. A new feature in the Windows 10 Anniversary update called Mobile Hotspot makes it easy to set up a network that uses your laptop's Wi-Fi connection, allowing up to eight devices access to the web. It works with either Wi-Fi or an ethernet connection.

Turn your laptop or PC into a Wi-Fi Hotspot

To create a hotspot on your Windows 10 PC make sure you've already installed the Anniversary update.

If Windows is set to automatically install updates, which we'd recommend, then the chances are that this has already happened. The way to check which version of Windows you're currently running is to open up the Start Menu, select Settings > System, then scroll down the left-hand column until you find About. Click on this and in the main pane look halfway down for the Version number. Window 10 Anniversary is 1607, so if you have that (or higher) then you're good to go.

If you're not on the Anniversary update you can manually update your version of Windows by going back to the Settings menu and selecting Update & Security. Here you'll see the option Check for updates. Click that and Windows will look for the most recent release.
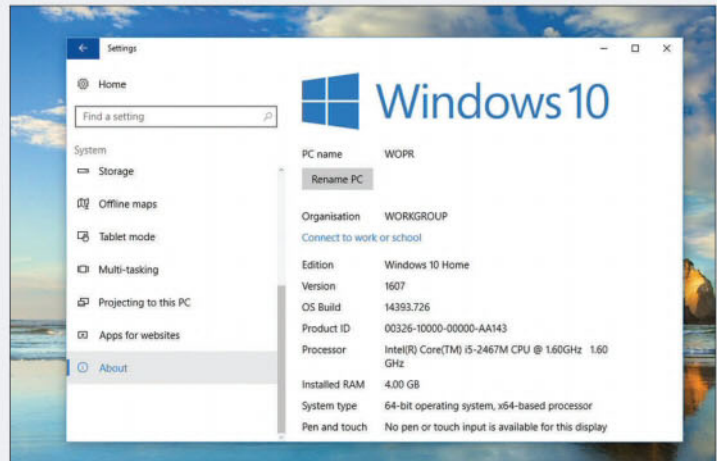
Set up a Wi-Fi hotspot in Windows 10

Creating a Wi-Fi hotspot is simple thanks to the new Mobile Hotspot feature. First of all go to the Start Menu and select Settings > Network & Internet > Mobile hotspot.

In the main pane there is a drop-down menu entitled 'Share my Internet connection' from which will most likely display Wi-Fi if you're using a laptop, or possibly Wired for those of you who have the PC connected directly to the router via an ethernet cable. If you're using a desktop and don't have the Mobile Hotspot option showing, this most likely means that your machine doesn't have a Wi-Fi adaptor, so the Mobile hotspot feature is disabled.

Select the connection you want to use for your hotspot, then click the Edit button to add a new network name and password. This won't alter the logon details the PC uses, instead it creates a new virtual connection from your computer that other devices will need to log onto the hotspot.

With that done, the final step is to turn on the Share my Internet connection with other devices that you'll find at the top of the Mobile hotspot settings.

Now you can use your phone, tablet, or any other internet enabled device to connect to the network on your PC. Just open the Wi-Fi settings on your device, look for the name of the network you created, enter the password, and you should find yourself online.

We have seen people experience problems with the Mobile hotspot setting, where their computers report they can't turn on Wi-Fi when users toggle the Share my internet connection with other devices option. The solutions for this error seem to vary across different systems, with some people finding turning off Bluetooth clears the problem. If you do encounter this issue, then we suggest searching online for both the error and your computer model to find the answer as quickly as possible.
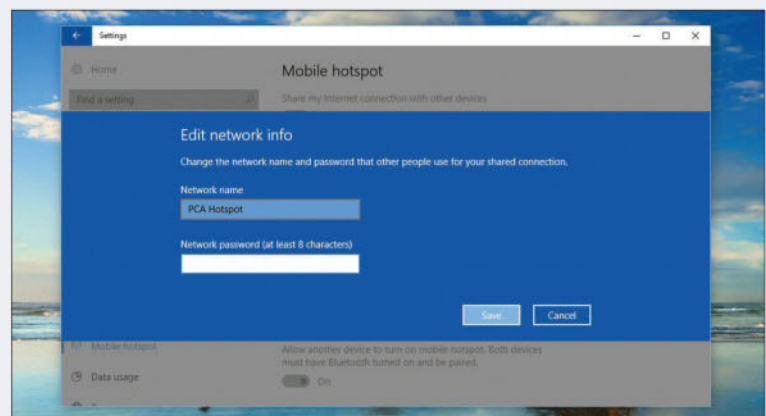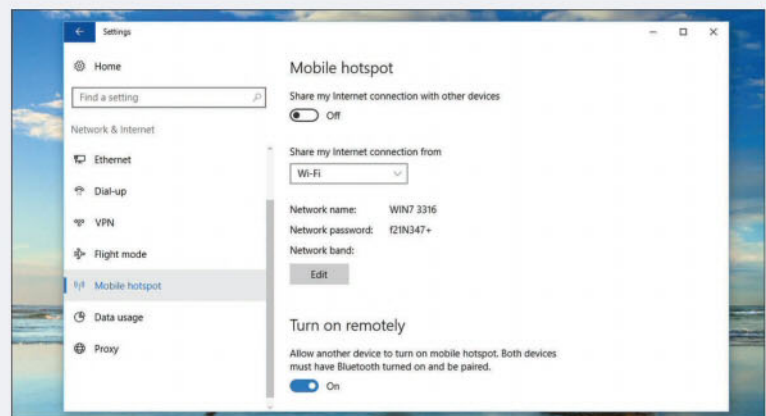
Set up a Wi-Fi hotspot in Windows 7 or 8

Under Windows 7, it was easy to share your internet connection as part of an ad hoc network. Though that functionality is still there in Windows 8, it's much more difficult to configure. Instead, you can use a piece of software that can set up a hotspot.

To begin with, your laptop will need to be online. It could be connected up by Ethernet cable to a modem or via Wi-Fi. We've tried a couple of software solutions, but the easiest is Virtual Router Manager (tinyurl.com/q3vLv89). The program works on Windows Vista, 7 and 8, and unlike other, similar tools, it doesn't install any extra toolbars are adware when used.

Once installed, you can enter a new Network Name (SSID) and password for the hotspot. Select your Wireless Network Connection from the Shared Connection menu. Finally, click Start Virtual Router. The hotspot's name should now appear in the network settings of any of your Wi-Fi enabled devices and you should be able to connect using the password you entered. ⊠

Check whether your PC's hard drive is dying

A failing hard disk could be a disaster. Martyn Casserly shows how to tell when this will happen

It's a heart-stopping moment when your PC has a hard disk crash. In an instant all those photos, videos, music, files, and pretty much everything else can disappear in an instant. So how can you protect yourself from this worst case scenario? We've put together a guide to the signs you can watch out for, and the steps you can take.

Before we look at ways to sniff out any trouble with your hard drive, the first thing you need to do is back up your data. If you already have a regular backup routine then that's excellent, but if it's been a while then we suggest you do it right now.

It's almost impossible to predict exactly when a hard disk will fail, but there are some common signals that could suggest your storage is on its way out.

Reduced performance
If you notice your system beginning to slow down, then it could be an early warning. The ponderous behaviour will often occur when you're accessing the disk, such as launching programs or saving documents, but it can also be general sluggishness.

Odd noises
When you've had a computer for a while, you get to know the sounds it makes. These days there aren't very many, but new ones such as clicking or grinding or even 'beeping' should be taken very seriously. If you hear these noises when using the machine, then there's a good chance that something is very wrong with your hard drive and continuing to use it will only hasten its demise.

File corruption
Another telltale error you might see is that of an increasing amount of corrupted files or 'blue screens of death'. So if you find you're saving documents or similar items but when you go to load them again they're corrupt, a failing disk could well be to blame.

Use the Check Disk feature in Windows
Windows has long had a built-in disk analysing feature called Check Disk (or chkdsk). This looks for errors, corruption, and bad sectors on a drive that could be causing problems. It won't tell you that a disk needs replacing, but if you run it regularly then you'll see whether the amount of faults are rising. It's also just a useful tool to keep your drive in a healthy state.

To run Check Disk you need to open File Explorer, select This PC, then right-click on the drive you want to test. A pop-up menu will appear at the bottom of which is Properties.
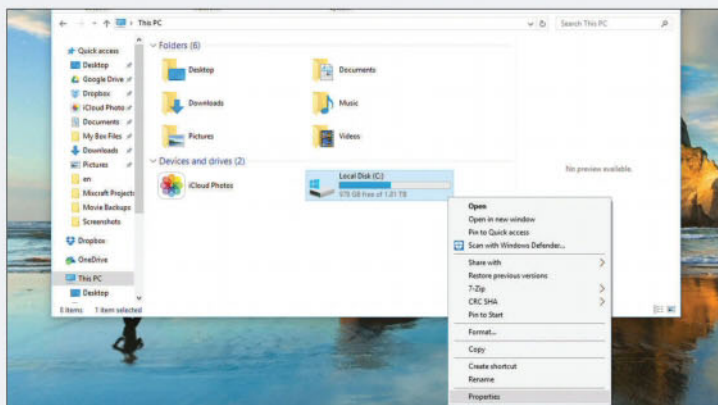
Click this, then choose the Tools tab at the top of the new window that appears. Here you'll see an area entitled Error Checking. Click the Check option and Windows will examine the drive. This might take a long while, so be sure to run this when you don't need to use the PC.
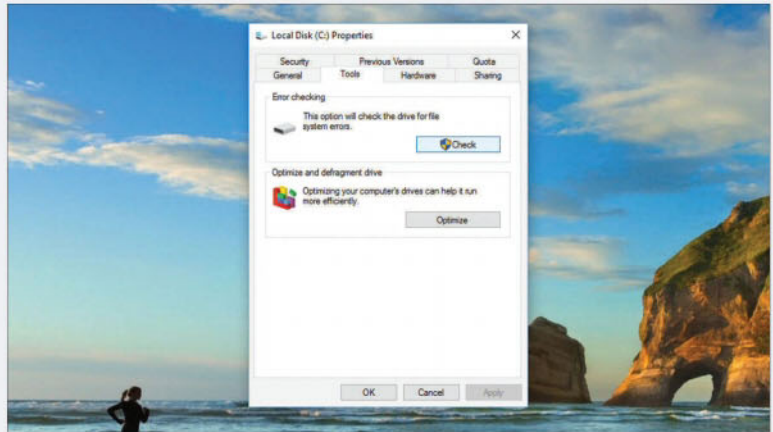
Check your hard drive with free diagnostic software

One of the best free third-party options for monitoring your drive is DiskCheckup by PassMark software (tinyurl.com/q33a98j). This utilises the SMART features that are present on most disk drives and allows it to detect when issues might be arising. SMART (Self-Monitoring Analysis and Reporting Technology) looks at various attributes on a disk to see if performance is degrading, and programs such as DiskCheckup let the user see reports based on that information.

It's not a catch-all, as SMART can't say whether a disk is dying or just naturally deteriorating, but it does give users a comprehensive look at the current state of a drive and suggests when it should be replaced.

DiskCheckup is compatible with Windows 7, 8 and 10, plus the personal use version is completely free.

It's also worth noting that many hard disk manufacturers have their own diagnostic software available for free on their websites. If you know what make your drive is then downloading the respective program would be a sensible move.
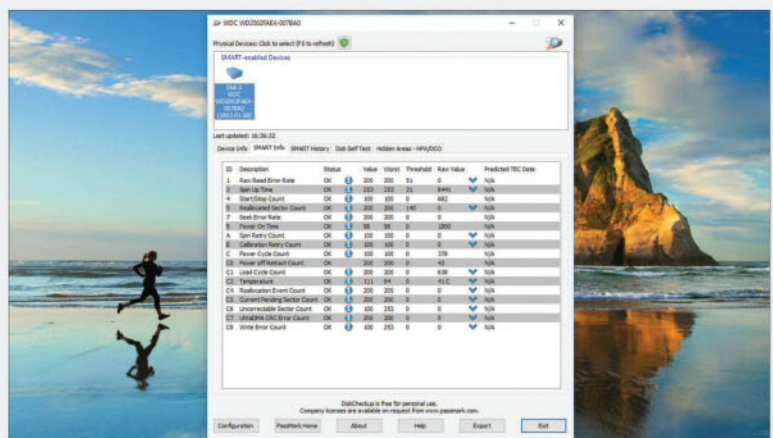
Paid-for hard drive diagnostic software

If you're willing to spend a bit of money on your diagnostic software then the first place to go is the Gibson Research Corporation's website (tinyurl.com/yc5dLz4). When you first arrive you might find yourself rather questionable of the aesthetics – the site looks like something out of Geocities in the 1990s – but don't let this put you off. This is the home of SpinRite, a legendary disk monitoring and data recovery app that plenty of users swear by.

The software, now in its sixth generation, has five levels of operation ranging from a simple scan to restoring sectors, and has been known to often get supposedly dead drives running again. It's not cheap, but then quality software rarely is. At the moment you can buy SpinRite V6 for around £70 at tinyurl.com/y9adc76. ⊠

Free up disk space on a Windows computer

If you need to retrieve some space on your Windows PC's hard drive, Jim Martin reveals how

Disk Clean-up

Windows has several built-in tools which will automatically find and delete unnecessary files to free up disk space.

The first to try is Disk Clean-up. Simply search for it in the Start menu (if you have Windows 8, search on the Start screen). This will scan your PC an highlight space used by temporary files, downloaded updates, cached files and files in the Recycle Bin. You can tick the boxes to delete some or all of the files.

You have to click the Clean up system files button to do a deeper scan (you have to select the particular drive - usually C: - to check for system files). This will let you delete old versions of Windows which could be using up scores of gigabytes.
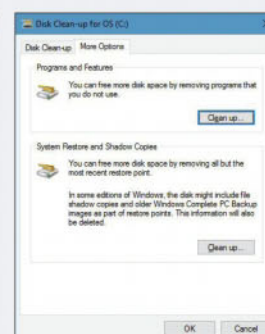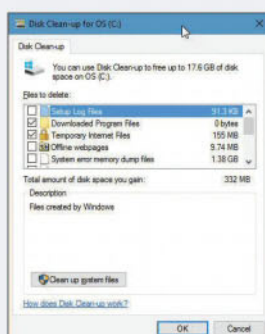
Uninstall games and apps

A relatively quick and easy way to free up space is to uninstall programs you don't need or use. From the Start menu search for Control Panel and then look for 'Uninstall a program'. Click on this and you'll see a list of everything installed and you can rearrange the list by clicking on 'Size' to order it so the programs taking up the most space are at the top. Typically these will be games, but some applications can also use multiple gigabytes. You have to remove them one by one, and it can take a while, but it can free up an awful lot of disk space.

There are certain uninstaller programs you can download which can remove multiple programs in one go (see our round-up at tinyurl.com/haoudm3).

You can even uninstall some of Windows 10's built-in apps to free up yet more space.

Restore points

Windows creates restore points automatically, so you can roll back to a previous state if something goes wrong after you install a new driver or program. This uses up disk space, but you can adjust how much space System Restore uses. To do this, search the Start menu for System Restore, then click on it when it appears. It will bring up the System Properties windows on the System Protection tab. Click the Configure... button to see and change how much space this tool uses. It's unwise to disable system protection as you'll have no restore points should anything go wrong.
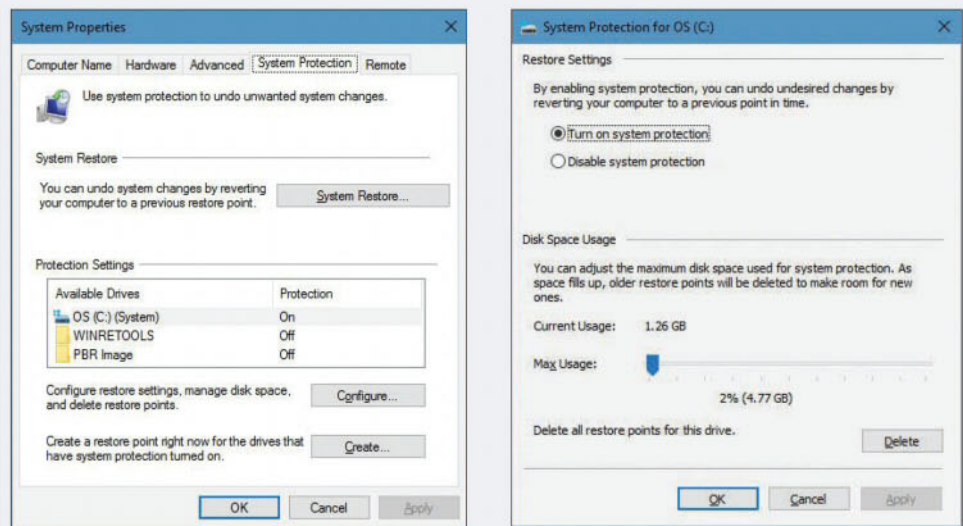
Delete driver downloads, duplicate files, and more

Beyond Windows' own tools, you can download a plethora of utilities which can do a more thorough search, finding and deleting even more unnecessary files. Ccleaner (tinyurl.com/hnmonqg) is a good place to start, as it's free, but there are also others which can find duplicate files (such as photos and downloads) and remove the surplus copies. One is Auslogics Duplicate File Finder (tinyurl.com/jon3av9), but there are many others.
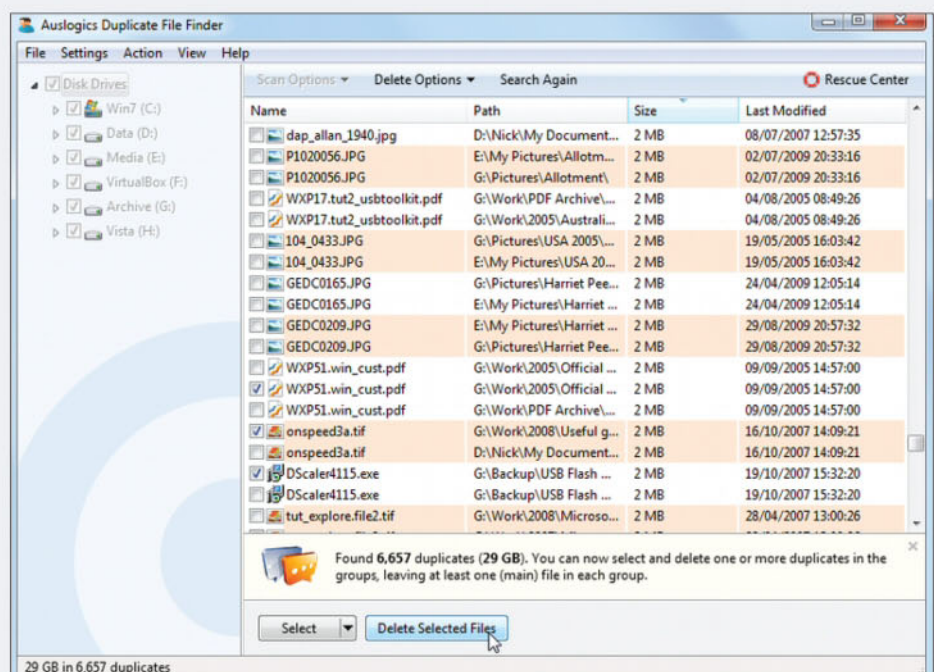
Find large files on your hard drive

If you've followed the advice above, but don't know where else to look, you can find the biggest individual files on your hard drive by opening File Explorer (Windows Explorer in previous versions) and typing 'size:gigantic' into the search bar.

This will bring up a list of any find over 128MB in size, which you can then look through to find large files such as downloads, outdated drivers, backups and ISO images. However, always be careful and make sure you know exactly what it is your deleting, as some files could stop certain programs from running if removed.
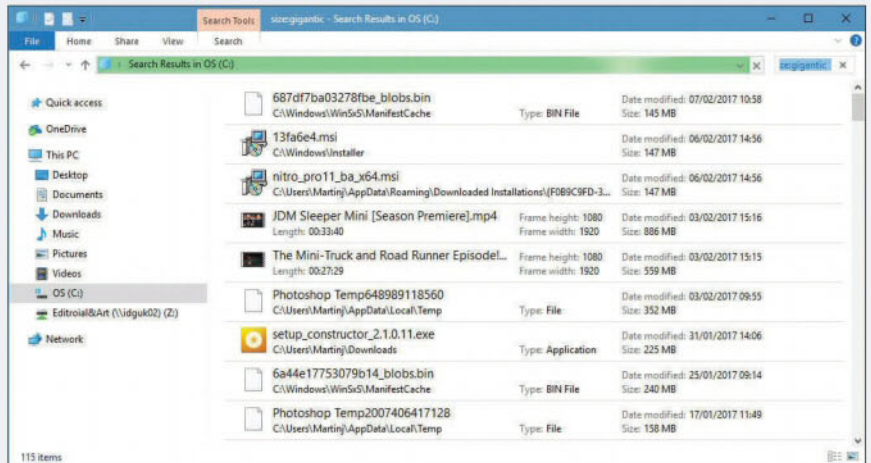
Of course, sometimes it's not large individual files that take up room, but rather folders full of lots of small files. In this case, the best option is to download a small third-party program that scans your computer to inform you which files and folders are the biggest offenders.

Our favourite application for this task is the free SpaceSniffer (tinyurl.com/m6Le4p). It doesn't require installation, so just run the program and it will scan your chosen HDD, and then visually display your disk information using rectangular boxes; the bigger the box, the bigger the file or folder. You can also customise the view to show more detail, or double-click each box to expand it and find out which files or folders within that box are taking up the most space.

Once you've ascertained which files and folders are taking up excess space on your disk, you can delete the ones you no longer need using File Explorer.
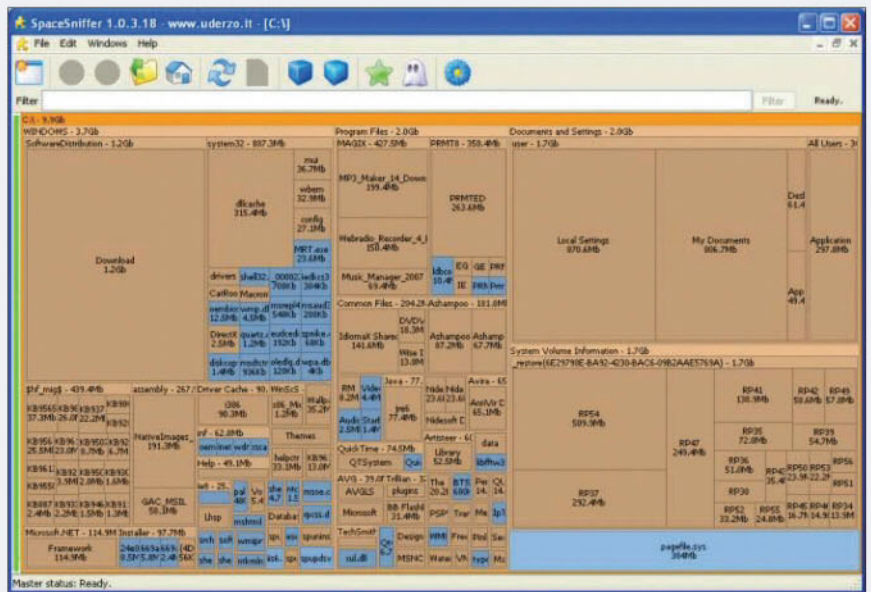
Delete backups

Another way to reclaim disk space is to check for backups. If you use backup software, use the software (or check in the folder where it stores files) to delete old versions you no longer need.

The same goes for iPhone and iPad backups. These can create enormous files, which can hog hundreds of gigabytes. Open iTunes, click the tiny drop-down menu at the top left, choose Preferences, then click on Devices. You will see a list of backups, although not how much space they're occupying. Aim to keep only the most recent one for each device, but if you find even these are taking up too much space, delete them and make a fresh backup from your device.

Another place to check is your Videos folder, and any on-demand video software such as BBC iPlayer. Delete downloaded videos you don't need, and copy personal videos to an external hard drive. ⊠
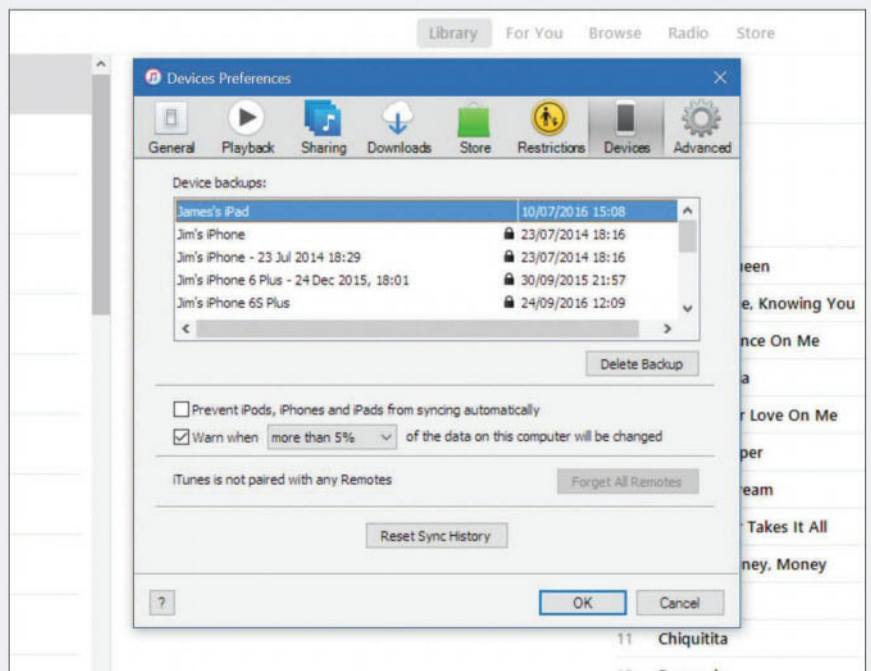
Use a Samsung phone in any country

Samsung phone won't work in a different country? Marie Brewis shows how to remove its region lock

Samsung phones running Android 4.3 or later, including the Galaxy S7 and S7 edge, feature a region lock that the phone maker applies with the intent of halting grey market imports. This is separate from carrier- or SIM locking, and means that when you first take it out the box you can use your handset only with a SIM card sold in approved markets. So what happens when you need to use your phone abroad, and how do you remove Samsung's region lock?

We should point out that this is nothing new, and has been going on since July 2013. However, readers are still having issues with the firm's region lock, particularly with its dual-SIM phones. To our knowledge Samsung does not region-lock its dual-SIM phones, but even if it did you could use the advice below to remove the lock.

First off, the region lock isn't as scary as it sounds. European Samsung smartphones are region-locked, but only to the UK and countries within Europe (Austria, Belgium, Bulgaria, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Liechtenstein, Lithuania, Luxembourg, Malta, Netherlands, Norway, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland and Croatia), plus a few non-EU countries (Albania, Andorra, Bosnia and Herzegovina, Former Yugoslav Republic of Macedonia, Monaco, Montenegro, San Marino, Serbia and Vatican City).

If you're going anywhere else, say the US, and you need to use your Samsung phone with a local SIM, you can deactivate the region lock by first placing (or receiving) a five-minute call within one of the approved countries.

The US version, incidentally, is region-locked to the North, South and Central Americas and the Caribbean. To use it outside those areas you can remove the region locking by first placing (again, or receiving) a five-minute call within one of those territories.

Should you have any problems removing the region lock Samsung can do it for you through one of its support centres. In the UK you can discover your closest support centre by visiting tinyurl.com/h7uddkj. ⊠
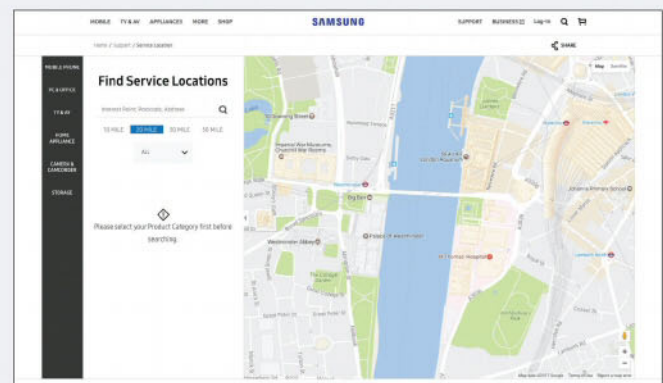
Use Cortana on an Android device

Microsoft has released Cortana for Android users. Martyn Casserly explains how to use it

Microsoft has made its Cortana voice assistant available on Android phones. It arrives at a time when the voice control battleground features some serious players. Amazon has Alexa, Apple has Siri, and 'OK Google' has long been Android users' weapon of choice.

To find the Cortana app, go to the Google Play Store and search for the name, then hit the install button. When you first launch it you'll be asked to grant the app access to your location and your files. Both of these are necessary for the app to be able to be able to work fully, so agree to the requests. You'll also be asked to agree to access to a long list of things, including your calendar, search history, and voice interface. This is due to Cortana being a voice assistant rather than a standard app, so when you tell it to do something it needs to be able to do it without popping up a permission box. Tap agree, then log into your Microsoft account. If you don't have one tap the 'Create one!' option.

Now Cortana will begin a setup process that asks you to enter the name you want the app to call you and the colour of the background. Once these are decided, you can run through a quick tutorial with the app that suggests different things it can do. If at any point you are unsure about commands available, you can tap the microphone in the bottom right corner and ask "What can I do?" Cortana will then tell you about the various options.
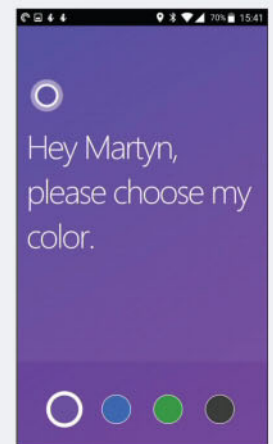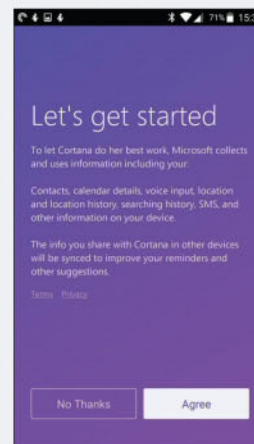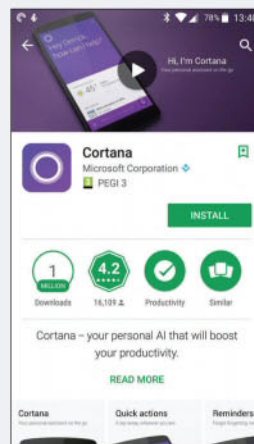
Features

You can do a number of different things with Cortana, just as you can with the Google Assistant. Tapping the square of nine dots in the bottom left corner opens up a list of functions you can try out. Swiping the menu to the left reveals several more options that are also available.
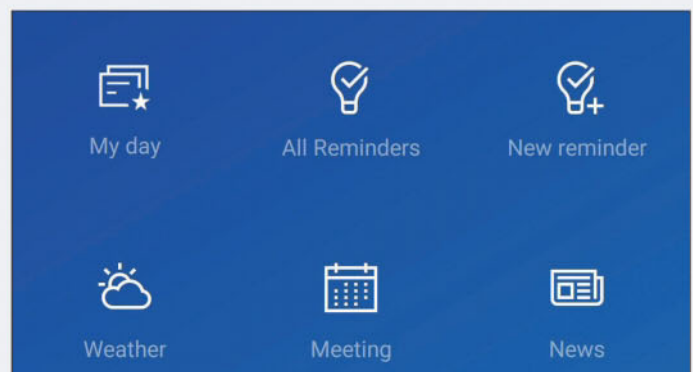
My Day

The first option is My Day. This provides information that the app thinks will be relevant to you each morning. It includes appointments, news headlines, weather, places to eat nearby, and other ephemera. As you use the Cortana more frequently My Day is designed to learn your likes and dislikes so that this features becomes more useful.
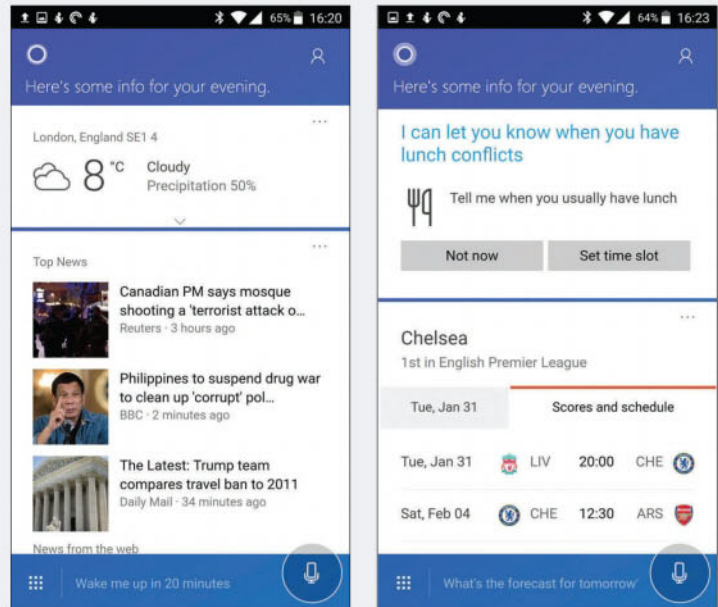
Reminders

As you would expect from a digital assistant, Cortana makes it easy to set up reminders. It does this in two different ways. When you select the New Reminder option you'll be given the option of either entering the time when something is happening, or to be reminded of a task when you either arrive at or depart from a specific location.

So if you know you have to pick up milk on the way home you can enter that the reminder needs to warn you when you leave the office. Clever and useful.
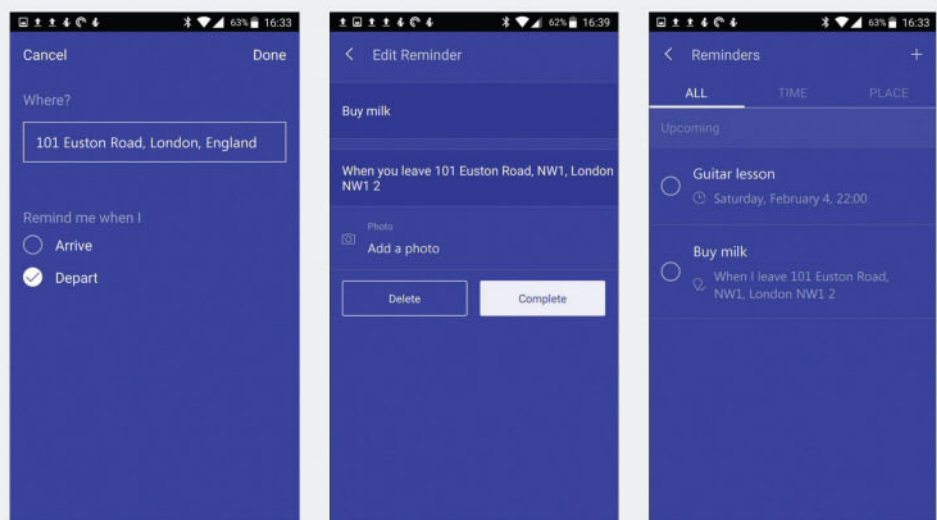
Meetings

Organisation is at the heart of any digital assistant, so to complement the reminders there are also Meetings. When you first tap on this icon you'll be asked to give permission to access your calender. Once you agree to this the Meetings section essentially turns into the agenda style version of your calendar. Tapping on any of the scheduled appointments will open them up in Google Calendar or whatever app you normally use. You can also link different calendars to the app – say a Microsoft Exchange account – by tapping the Connect Calendar option and then selecting the app you want to attach.
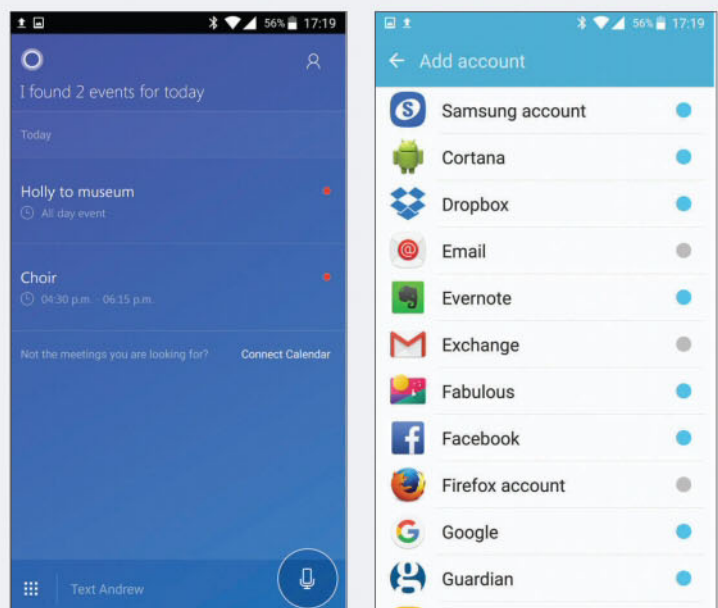
Extra features

There are also options for Weather, News, Alarms, and you can even ask Cortana to tell you a joke or sing you a song. She's got a good voice, too.
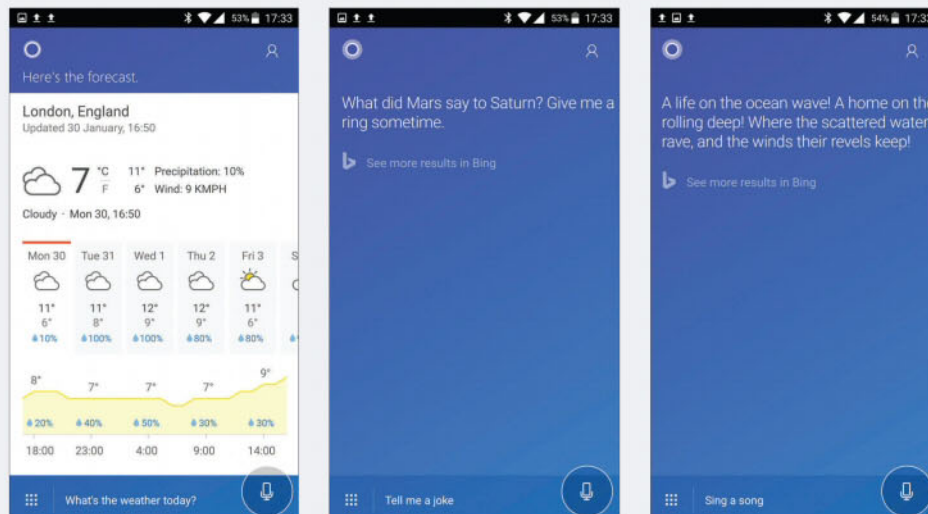
Change settings

In the top right-hand corner of every screen you'll see the icon of shoulders and head. Tap this to open up the settings menu. Here you'll see a couple of sections: Notebook and Settings.

Notebook

Notebook is where you can control the information that Cortana learns about you and the kind of recommendations you'll receive. Tapping on it brings up a list of areas that include Events, Navigation, News, and a number of others. Each section has settings within it, so if you tap on Eat and Drink you can then tell Cortana whether you like to eat out often, how far you're willing to travel, and the preferred price ranges of restaurants.
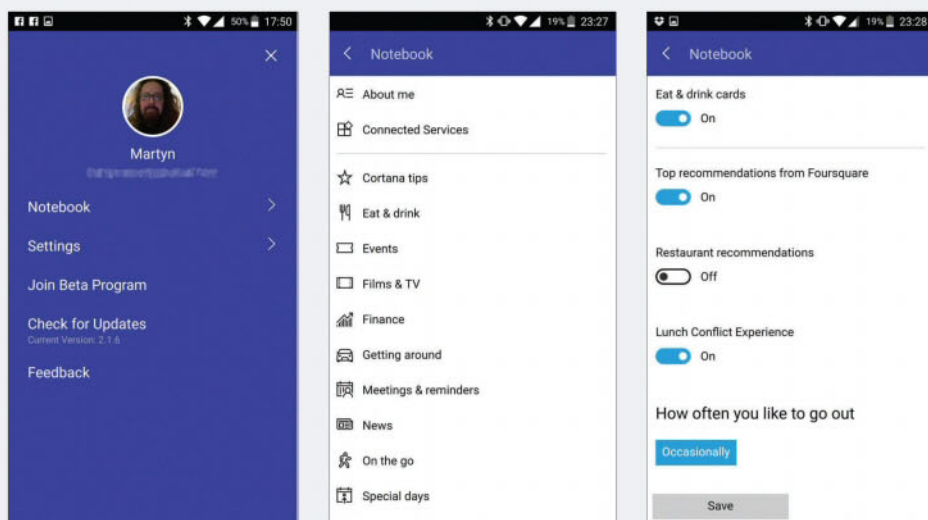
Settings

Here you'll find the settings that pertain more to the look and feel of Cortana. You can create a shortcut on the home screen for the voice interface, turn on the 'Hey Cortana' feature so that when you're in the app you can say that phrase and immediately issue requests without having to press a button, plus you can sync notifications to Cortana on your computer.

So that's it. A whistle-stop guide to Cortana. Microsoft has built a very interesting app with personality and useful, granular controls. Whether it can knock Google's own offering off the throne is something that remains to be seen, but it's a good start. ⊠
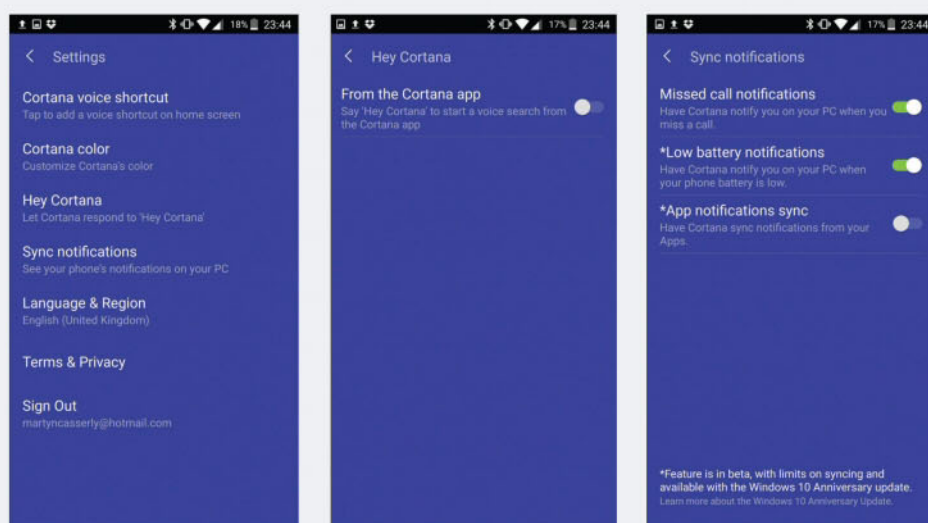
Secure a phone's lock pattern or passcode

Marie Brewis explains how to prevent people hacking into your smartphone

If you don't want to be fraped by your friends or risk losing sensitive data to those with malicious intentions, or maybe you've just got something on there to hide, creating a phone lock is a great idea. These days you can even lock down individual apps for convenience or a layer of extra security.

Unfortunately, hacking a phone lock is simple, and with only a small amount of effort. We only have to look over your shoulder, inspect the smudge left behind by your fingertip from repeated unlocking, watch the way your fingers move as you unlock the phone or sneakily place a camera close by and we're in. Or we could just guess, because chances are your passcode is 1234, 0000, 1379, 9999 or perhaps your birthday or that of your child's, or your lock pattern resembles a C, an X or maybe it's a square.

Researchers at Lancaster University, the University of Bath and China's Northwest University have discovered just how easy it is to hack these lock patterns, and the team successfully cracked 95 percent of 120 lock patterns within five attempts. They used smartphone cameras and a computer vision algorithm to work out the patterns, and found that even the most complex of designs were easy to hack, even when the screen was out of view.

Fortunately, it's easy enough to protect your phone lock pattern or passcode being hacked simply by covering over your screen and ensuring no-one is watching (cameras included) – exactly as you would at a cash machine. Then do your utmost to ensure that phone never leaves your side.

Should your phone get into the wrong hands, you can still remotely secure it from hackers. Using Android's Device Manager or Find My iPhone you can lock and even erase its contents, but you'll need to set it up in advance.

Some phones support a self-destruct feature that will wipe the contents when a passcode is incorrectly entered a number of times. Be absolutely sure you want to do this before activating it, because if one of your mates is on a wind-up and attempting to break into your phone then you could lose everything. Be sure to back up your iPhone or back up your Android phone first.

As a word of warning, using the phone's built-in fingerprint- or iris scanner (assuming there is one) won't stop hackers getting in. Upon the phone failing to recognise the fingerprint or eye scan, it will still ask for that fail-safe passcode, meaning your phone's security is only ever as strong as your passcode. ⊠

Recover accidentally deleted files

Free file recovery software can get back deleted photos, documents, and more, reveals Mike Bedford

Deleting files by accident is extremely easy to do. It's a sickening feeling when you realise what you've done. Fortunately, you might be able to get them back without spending any money. Even though Windows may not be able to see a file that you deleted accidentally or was the victim of a disk failure, it's quite possible that the data could still be there. There are many free applications that will attempt to recover deleted files, but you need to be careful before installing and using them (we'll explain why below).

In this tutorial we're using Disk Digger (diskdigger.org), but most file recovery utilities work the same way, and we'll recommend some alternatives if this doesn't work for you.

Look in the Recycle Bin
The first thing you should do is check the Recycle Bin if you've just deleted something you didn't mean to. When you select a file and press the Delete key (or right-click and choose the Delete

If you've inadvertently deleted a file it may be in the NAS drive's own recycle bin

option from the menu), Windows makes no attempt to delete it at all. Instead, it moves it to a special folder called the Recycle Bin, which has its own icon on the desktop. Restoring a file from the Recycle Bin is a simple matter of double-clicking on the desktop icon to display the contents and then right-clicking on the file and selecting Restore from the menu.

If the Recycle bin icon is not there, search in the Start menu for 'Show or Hide' and you should see a shortcut to the settings where you can tick the box next to the Recycle Bin and make it appear.

Don't rely on the Recycle Bin as a safety net, though: it has a size limit and once you exceed that, older files will be deleted permanently and automatically. The default size is more than adequate for most people, so there's a good chance that any files you want to restore will still be present in the Recycle Bin. To check the capacity or alter it, right click on the Recycle Bin and choose Properties. There are occasions when you've emptied the Recycle Bin too hastily, or perhaps you're overly fond of the Shift-Delete shortcut, which bypasses the Recycle Bin and actually deletes the data. (We're still tying to wean ourselves off this unhelpful habit.)

If your files were on an SD card or USB flash drive, there is no Recycle Bin function, so delete really is delete in this case.

But before resorting to file recovery software, it is still worth checking other avenues. Have you shared the file or document via email? Have you saved or synchronised it with a cloud storage service? Or have you been sensible and made a backup of the files on another hard drive? No? Well fear not, because there are plenty of applications including Disk Digger and PC Inspector File Recovery (pcinspector.de), which might be able to bring them back. There are lots of others, too:

Recuva (tinyurl.com/kw6g2u8)

Paragon Rescue Kit 14 Free (tinyurl.com/jk6p5jp)

CGSecurity PhotoRec (tinyurl.com/zdbpjx5)

Minitool Partition Wizard Free Edition 9.1 (tinyurl.com/huf952f)

Undelete programs

They work by looking on the disk to see if the data is still there, even after a 'permanent' deletion. All that Windows really does when it deletes a file (permanently) is scrubs out the information about where it was stored on the disk. It's a bit like crossing out the address on an envelope: the contents are still in it, but a postman wouldn't know where to deliver it.

However, it pays to understand the limitations of this method. First of all, as well as removing the 'pointer' to the file, Windows also marks the areas of the disk occupied by the file as available for reuse, Windows will eventually overwrite them with new files and, once that's happened, your data is gone for good.

So the sooner you realise you've accidentally deleted a file, the better your chances of recovering it. When you notice your loss, don't save anything to the disk and don't even download or install a file recovery utility if the file was on your PC or laptop's hard drive as it might overwrite the very files you're trying to recover.

Some recovery software can run directly from a USB flash drive, but you must download it using a different computer. Even browsing the internet to find an undelete utility causes files to be written to your disk so use a different PC to download the utility.

Undelete utilities only work reliably with sequential files. If your disk is reasonably full, Windows often has to split the file across spare blocks around the disk and in this case, a deleted file is very difficult to recover. Plus, different types of drive use different file systems and any undelete utility will work only with particular types of file system. Hard disks in Windows PCs use the NTFS file system but USB flash drives and memory cards usually use some variant of FAT (FAT16, FAT32 or exFAT) and you should select software with the necessary support for all your media.

NAS drives

Another drawback with most undelete utilities is that they won't work with networked storage, in other words NAS drives. The disk(s) in a NAS drive are under the control of the drive's own operating system (usually a Linux variant), so software running under Windows isn't typically able to attempt a recovery. If you've accidentally deleted a file it might just be in the NAS drive's own recycle bin (if enabled) in which case you might be able to recover it, so first check the documentation. If the file is properly deleted, though, there are only two options.

So long as you don't mind getting to grips with the insides of the NAS drive and your PC, it might be possible to remove the disk(s) from the NAS and attach them directly to your PC. Now it becomes possible to use a Windows undelete utility but with two provisos.

First, your NAS drive might use a different file system from the drive in your PC so you'll have to check the NAS drive's documentation to select suitable software. Secondly, if your NAS drive uses a RAID array, your file might be distributed between more than one physical disk.

Some recovery software is able to handle RAID arrays but, again, you need to bear this in mind in making your selection.

If you don't fancy dismantling your NAS drive and selecting suitable software, the other option is to send your array off to a professional data recovery company.

How to recover corrupt files

Another way files can be lost is if they become corrupted. This could happen, for example, if a power failure occurred while a file was being written, leaving the disk directory in an unpredictable state. As with accidentally deleted files, the data could all be there but Windows wouldn't know where to find it. Often this sort of problem will manifest itself by Windows reporting some sort of error when you try to open a file or, conceivably, files could just have disappeared, even though you're pretty sure you hadn't deleted them.

Software utilities are available to identify and correct this sort of error and you'll find that some undelete products also offer the ability to recover from logical errors in the file system. While some pure undeletion utilities are free, you'll often have to pay for those more fully featured products.

Some let you try before you buy, though. With RecoverMyFiles (recovermyfiles.com), for example, you can download the software in evaluation mode and run it to see what files it can recover from your disk. If you like what you see, you pay a fee to allow those files to be permanently recovered.

An exception to the rule that you get only what you pay is TestDisk which is free and open source and has earned a good reputation. It's available for Windows, Linux and macOS. Whatever software you use, though, as with pure undeletion packages, don't install it to the offending disk as doing so could render your lost data permanently unrecoverable.

Also bear in mind that packages will differ in their ability to recover lost data. It would be a good idea, therefore, to try out several (so long as they have an evaluation mode which will show what they're able to recover without actually writing to your disk) and choose whichever has the best success.

Alternatively, if you don't find any software that meets your needs, the option of using a data recovery service is always available, but it isn't necessarily a cheap option.

Recover files from a broken hard drive

Having dispelled the myth that deleted and corrupted files are lost forever, we now come to the problem that all PC users dread – a hard disk failure. This could manifest in several ways but generally Windows won't start, even in Safe Mode, and turning on your PC might be accompanied by unhealthy clicking noises. What you stand to lose, therefore, isn't just a few of your treasured files but the entire contents of the disk.

It's commonly suggested that hard disks can be repaired by putting them in the freezer. While this has been known to work, bringing the drive back to life for just long enough to extract the most important files, it's effective only for certain very specific types of fault. Often it won't work and attempting it might just prove to be the last straw for your ailing disk. Our recommendation, therefore, is that you don't attempt this nor any other DIY repair.

Instead, as soon as you suspect a hardware failure, turn off your PC immediately and make contact with a data recovery company such as Kroll OnTrack (krollontrack.co.uk). These companies have vast stocks of parts that they are able to swap in their clean room to restore a disk to a working state. Once this has been achieved they'll copy all the data they can recover to encrypted removable media such as a USB drive. This will work for failures of most parts of the disk including the electronic circuit boards, the motor and the read/write head, but there's a limit to what can be achieved.

As the part on which the data is stored, if the platter is scratched or shattered it's normally game over, though, fortunately, this is rare. As always, it pays to shop around before deciding which firm to use and it's also a good idea to choose a company that will diagnose the problem for free. As guidance, if you were to go to Kroll OnTrack, you'd pay a fixed fee of £599 as a consumer whereas charges for businesses depend on exactly what's involved.

How to use Disk Digger

START Download Disk Digger (diskdigger.org). You don't need to install it – just extract the contents of the .zip archive and run the .exe file. Remember that if you've already accidentally deleted some files, you shouldn't download DiskDigger to the disk containing your lost files as it could overwrite your files and make it impossible to recover them. Ideally, download it before you actually need it.
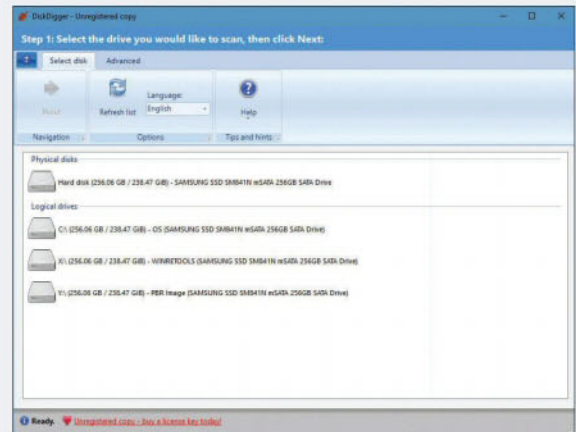
2 Start DiskDigger. The opening screen shows all the disks, so select the one containing your deleted files and click on 'Next' three times. The disk will now be scanned and any deleted files will be listed – this could take some time. If your missing files are listed, continue to the next step. If not you could try altering some of the options in the earlier screens.
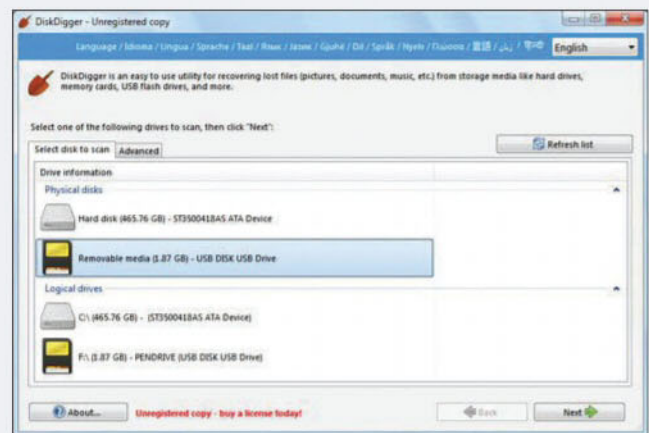
3 DiskDigger won't be able to show correct filenames so, to help identify lost files, a preview option is provided. Select a file in the list at the left and choose either the 'Preview' (for photos) or the 'First few bytes' tag. Also useful for photographs is the 'Thumbnail' option in the 'View' menu which will show small images in the list.
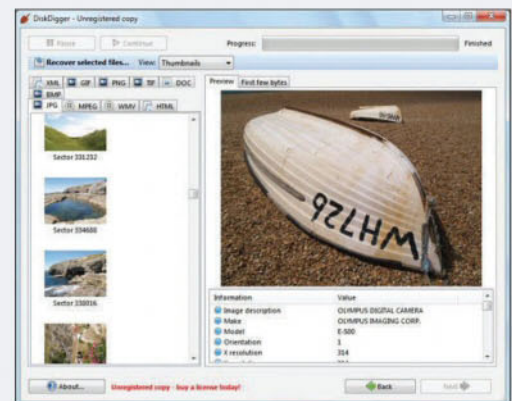
4 When you've identified your lost file(s) select them in the list at the left and click on 'Recover selected files...'. Next, select the device and folder where you want your files to be restored to (this must not be on the same physical drive as the lost file) and click on OK. The missing file(s) will be saved with automatically generated filenames, so you'll need to rename them to their original names or something meaningful. ⊠
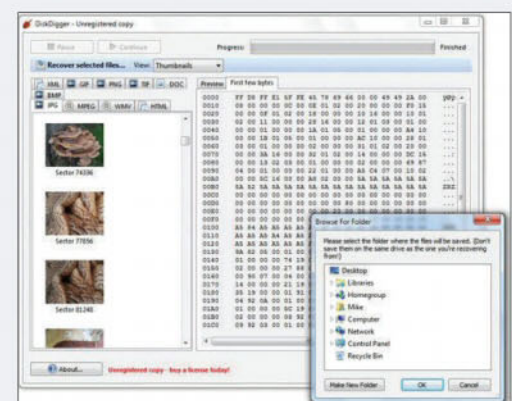
Master your computer's keyboard shortcuts

Ian Paul shows how to incorporate keyboard shortcuts into your workflow and boost your productivity

Using keyboard shortcuts may seem complicated since you have to remember a bunch of key combinations. However, when it comes to efficiency you just can't beat them. It's much faster (and eventually easier) to keep your hands on the keyboard while navigating around your PC.

Still, it can be hard to know where to get started with keyboard shortcuts. To give shortcut newbies a possible usage template, we've broken down how we use keyboard shortcuts on a typical working day.

Firing up programs

We use the mouse or Cortana voice commands to open up programs, but you can use keyboard shortcuts as well. If you have anything pinned to your taskbar you can open each item using the Windows key plus a number shortcut. In the screenshot of our desktop (top right), we have the Control Panel, File Explorer, and Chrome pinned to my taskbar. To start the day by opening Chrome, we use Win-3 (Chrome is the third program pinned to the taskbar). To open File Explorer, we use Win-2.

Navigating the browser
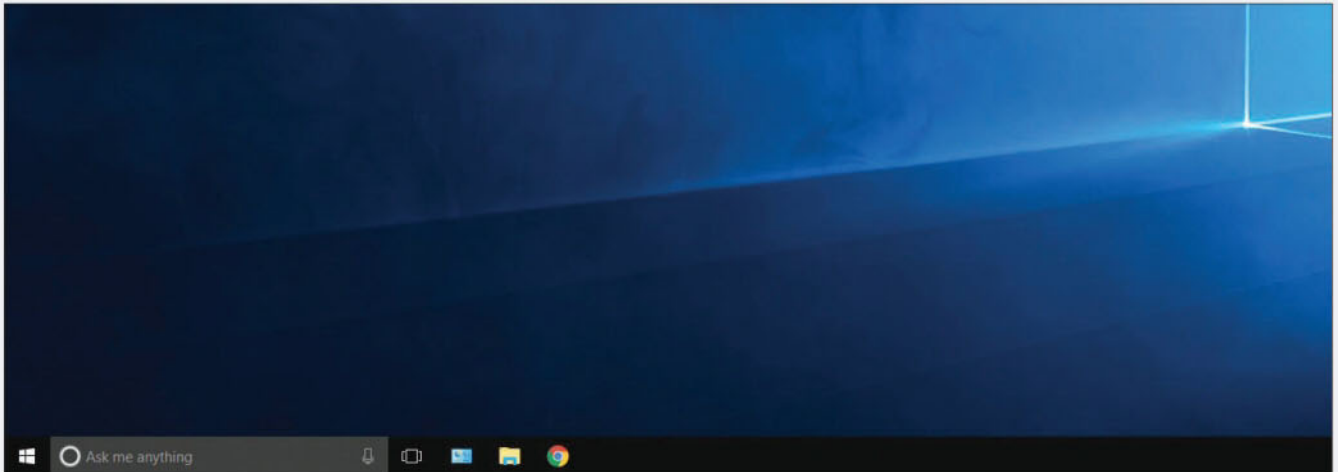
Another method is to just hit the Windows key to open the Start menu (on Windows 7 and 10), and then scroll through the Start menu to find the right program. That is not very efficient, though. Another option in Windows 10 is to hit Win-C to call up Cortana and search for each program.

Navigating the browser

Now that the applications are open – in our case Chrome, OneNote, Outlook 2016, Slack and Sublime Text 2 – it's time to get to work. After checking in with the news team in Slack, we switch to the browser using Alt-Tab and get to work on our research for whatever the news topic is.

When in the browser, we use a combination of standard Chrome browser shortcuts, as well as the specialised navigation features of Vimium (a must-have extension). To begin, we need to open a new tab to carry out a Google search, so we hit T and then type our query into the address bar.

If it turns out that our query didn't get us what we wanted, we hit Ctrl-L to highlight the contents of the address bar (the Google search URL in this case), and then type in whatever our new inquiry is.

If this result gets us what we want we hit Shift-F, which is a Vimium command that says we want to open a link on the current page in a new tab. Vimium then labels every possible link on the Google results page with a keyboard shortcut. That can get a little messy, but you get used to it. In this case, we hit the L key and we're off.

On the new website, we start navigating the web page using the J and K keys to scroll up and down the page as we read. Once we reach the bottom, we realise we want to double-check some information at the top so we hit GG to jump back up. Oh, but what was that thing we wanted from the bottom again? We hit the G key to jump right back to the bottom.

Our research is now finished and stored in OneNote via a quick succession of Alt-Tab shortcuts to switch between OneNote and Chrome. Now it's time to go back to the Google search tab, so we hit Shift-J to move to the next tab to the left in Chrome. We find another page we want to check out in the search results. This time, however, we land on a page where, for whatever reason, Vimium just isn't working

that well – these pages are rare but it happens sometimes. We can navigate up and down the page, but can't jump back with a Shift-J. No problem, Chrome has a built-in keyboard navigation shortcut. Google occupies the second tab in our window, so we hit Ctrl-2 and we're back where we started. We go through a few more pages, close a bunch of tabs using Vimium's close tab command (a simple x), and then it's time to get to work writing the news story. At this point, we hit Alt-Tab again to jump into Sublime Text. We might hit the Windows key, plus the right arrow to snap Sublime to the right-hand side of the screen, and then use the mouse to select OneNote as the program to occupy the left of the screen.

Once the research is complete, we give up on shortcuts of any kind and use the traditional keyboard and mouse setup. Keyboard diehards could take their love of efficiency to an extreme by customising Sublime to work like Vim (tinyurl.com/j33vbmu): a keyboard-controlled text editor that inspired Vimium. ⊠

A Google results page with Vimium activated
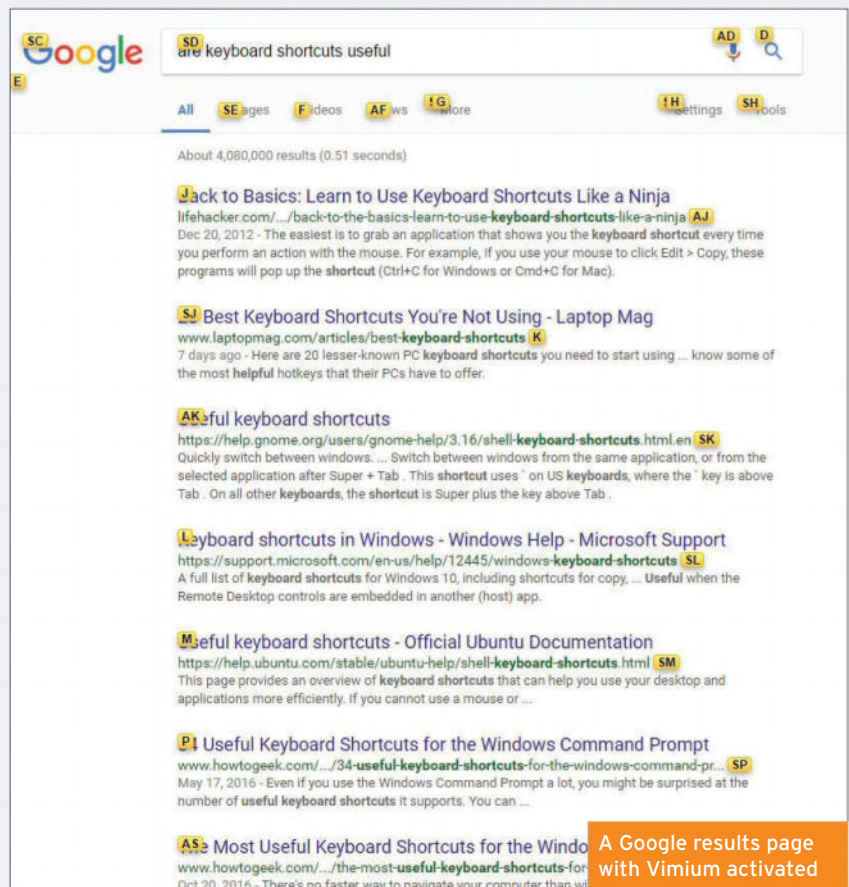
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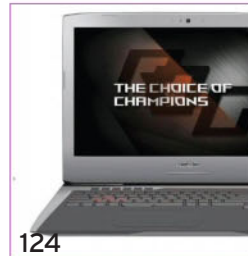
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Star ratings are awarded at the time of the original review and given in relation to the market competition at that time.

Best laptops	1 Dell XPS 13 9360	2 Lenovo Yoga 710 (11in)	3 Asus ZenBook UX310UA	4 Dell Latitude 13 7370	5 HP Envy 13
Price	£999 inc VAT	£549 inc VAT	£699 inc VAT	£1,079 inc VAT	£799 inc VAT
Website	Dell.co.uk	Lenovo.com/uk	Asus.com/uk	Dell.co.uk	Hp.com/uk
Build rating	★★★★★	★★★★½	★★★½☆	★★★★½	★★★☆☆
Features rating	★★★★½	★★★★☆	★★★★½	★★★★☆	★★★★★
Value rating	★★★★½	★★★★½	★★★★★	★★★☆☆	★★★★☆
Performance rating	★★★★½	★★★☆☆	★★★★☆	★★★★☆	★★★★★
Overall rating	★★★★½	★★★★½	★★★★½	★★★★½	★★★★☆
Processor	2.7GHz Intel Core i7-7500U	Intel Core M3-6Y30	2.3GHz Intel Core i5-6200U	Intel Core m5-6Y57	2.5GHz Intel Core i7
RAM	16GB DDR3	8GB LPDDR3	8GB DDR4	8GB	8GB DDR3
Storage	512GB SSD	128GB SSD	128GB SSD, 500GB HDD	256GB SSD	256GB SSD
Screen size	13.3in IPS	11.6in TN glossy	13.3in LCD	13.3in InfinityEdge	13.3in matt
Screen resolution	3200x1800	1920x1080	3200x1800	1920x1080	1920x1080
Graphics	Intel HD Graphics 620	Intel HD 515	Intel HD 520	Intel HD 515	Intel HD 520
Video memory	N/A	N/A	N/A	N/A	N/A
Wireless	802.11ac	802.11ac	802.11a/b/g/n/ac	802.11ac	802.11a/b/g/n/ac
Ethernet	Gigabit	Gigabit	Gigabit	Gigabit	Gigabit
Bluetooth	✓	✓	✗	✓	✓
USB	2x USB 3.0	1x USB 3.0	1x USB 3.0, 1x USB 2.0	1x USB 3.0, 2x USB-C	3x USB 3.0
FireWire	✗	✗	✗	✗	✗
Thunderbolt	✓	✗	✗	✓	✗
DisplayPort	✗	✗	✗	✗	✓
HDMI	✓	✓	✓	✓	✓
DVI	✗	✗	✗	✗	✗
VGA	✗	✗	✗	✗	✗
eSATA	✗	✗	✗	✗	✗
Media card slot	✓	✓	✓	✓	✓
Audio	Headphone jack, mic	Headphone jack, mic	Headphone jack, mic	Headphone jack, mic	Headphone jack, mic
Optical drive	N/A	N/A	N/A	N/A	N/A
Extras	720p webcam	HD webcam	0.9Mp webcam	HD webcam	HD webcam
Operating system	Windows 10 Home	Windows 10 Home	Windows 10 Home	Windows 10 Professional	Windows 10 Home
Bundled software	None	None	None	None	None
Gaming scores	Not tested	Not tested	Not tested	Not tested	Not tested
Battery	60Wh	40Wh lithium-ion	48Wh lithium-ion	34Wh	45Wh lithium-ion
Battery life	12 hours 30 mins	9 hrs 45 mins	8 hrs 10 mins	8 hrs 23 mins	1 hr 24 mins
PCMark 8 score	2499	4712	2097	2942	2657
Dimensions	304x200x15mm	281x195x14.9mm	323x223x19mm	304.8x210.5x14.mm	326x226x13mm
Weight	1.3kg	1.04kg	1.45kg	1.12kg	1.3kg
Warranty	1 year	1 year	1 year	1 year	1-year collect-and-return
FULL REVIEW	TINYURL.COM/ZCTTZLO	TINYURL.COM/ZSVR34C	TINYURL.COM/ZYLAEF8	TINYURL.COM/HDHYG2P	TINYURL.COM/HDAQHQX

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Best laptops	Acer S 13 S5-371	Microsoft Surface Book	Apple MacBook (2016)	HP Spectre 13	Apple MacBook Pro (2016)
		7	**8**	**9**	**10**
Price	£549 inc VAT	£1,299 inc VAT	£1,049 inc VAT	£1,299 inc VAT	£1,4949 inc VAT
Website	Acer.com/uk	Microsoft.com/en-gb	Apple.com/uk	Hp.com/uk	Apple.com/uk
Build rating	★★★★☆	★★★★½	★★★★☆	★★★★½	★★★★☆
Features rating	★★★★½	★★★★½	★★★★☆	★★★☆☆	★★★★☆
Value rating	★★★★★	★★★★☆	★★★★☆	★★★☆☆	★★★★☆
Performance rating	★★★★☆	★★★★½	★★★★☆	★★★★☆	★★★★☆
Overall rating	★★★★½	★★★★½	★★★★☆	★★★★☆	★★★★☆
Processor	2.3GHz Intel Core i3-6100U	Intel Core i5	1.1GHz Intel Core m3	2.5GHz Intel Core i7-6500U	2GHz Intel Core i5
RAM	8GB LPDDR3	8GB	8GB LPDDR3	8GB DDR3	8GB LPDDR3
Storage	128GB SSD	128GB SSD	256GB SSD	512GB SSD	256GB SSD
Screen size	13.3in IPS	13.5in PixelSense	12in IPS	13.3in IPS	13.3in IPS
Screen resolution	1920x1080	3000x2000	2304x1440	1920x1080	1680x1050
Graphics	Intel HD Graphics 520	Intel HD Graphics 520	Intel HD Graphics 515	Intel HD 520	Intel Iris Graphics 540
Video memory	N/A	N/A	N/A	N/A	N/A
Wireless	802.11a/b/g/n/ac	802.11a/b/g/n/ac	802.11ac	802.11ac	802.11a/b/g/n/ac
Ethernet	✗	✗	✗	✗	Gigabit
Bluetooth	✓	✓	✓	✓	✓
USB	2x USB 3.0	2x USB 3.0	1x USB-C	1x USB-C	1x USB-C
FireWire	✗	✗	✗	✗	✗
Thunderbolt	✗	✗	✗	✓	✗
DisplayPort	✗	✓	✗	✗	✗
HDMI	✓	✗	✗	✗	✗
DVI	✗	✗	✗	✗	✗
VGA	✗	✗	✗	✗	✗
eSATA	✗	✗	✗	✗	✗
Media card slot	✓	✓	✗	✗	✗
Audio	Headphone jack, mic	Headphone jack, mic	Headphone jack, mic	Headphone jack, mic	Headphone jack, mic
Optical drive	N/A	N/A	N/A	N/A	N/A
Extras	HD Webcam	Surface Pen	480p FaceTime	Webcam	720p webcam
Operating system	Windows 10	Windows 10 Professional	macOS Sierra	Windows 10	macOS Sierra
Bundled software	None	None	None	None	None
Gaming scores	27.6/12.3fps Alien Isolation	Not tested	Not tested	Not tested	Not tested
Battery	4030mAh lithium-ion	Not stated	41.4Wh lithium-polymer	38Wh lithium-polymer	54.5Wh lithium-polymer
Battery life	10 hours	12 hours	8 hrs 23 mins	8 hrs 55 mins	10 hrs
PCMark 8 score	2040	Not tested	Not tested	2735	Not tested
Dimensions	327x287x15mm	312.3x232.11x3mm	280.5x196.5x35mm	325x229x10.4mm	304x212x14mm
Weight	1.33kg	1.52kg	920g	1.1kg	1.37kg
Warranty	1 year	1 year	1 year	1 year	1 year
FULL REVIEW	TINYURL.COM/ZAU8QLM	TINYURL.COM/ZZF4ZQ2	TINYURL.COM/HSSXYUJ	TINYURL.COM/HSXM7SH	TINYURL.COM/ZTX4LC3

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Best budget laptops	**1** HP 250 G4	**2** Dell Inspiron 11 3000	**3** Asus X555LA	**4** Chuwi LapBook 14.1	**5** HP Stream 11
Price	£299 inc VAT	£179 inc VAT	£349 inc VAT	£224 inc VAT	£179 inc VAT
Website	Hp.com/uk	Dell.co.uk	Asus.com/uk	En.chuwi.com	Hp.com/uk
Build rating	★★★★☆	★★★★☆	★★★½☆	★★★½☆	★★★½☆
Features rating	★★★★☆	★★★★☆	★★★½☆	★★★½☆	★★★½☆
Value rating	★★★★☆	★★★★★	★★★★☆	★★★★★	★★★½☆
Performance rating	★★★★☆	★★☆☆☆	★★★½☆	★★★½☆	★★★★½
Overall rating	★★★★★	★★★★☆	★★★★☆	★★★★☆	★★★★☆
Processor	2.1GHz Intel Core i5-5005U	1.6-2.1GHz Intel Celeron N3050	2GHz Intel Core i3-5005U	Intel Celeron N3450	2.16GHz Intel Celeron
RAM	8GB	2GB	4GB DDR3	4GB DDR3L	2GB DDR3
Storage	1TB HDD	32GB SSD	1TB HDD	64GB eMMc drive	32GB eMMc drive
Screen size	15.6in matt	11.6in matt	15.6in glossy	14.1in matt	11.6in matt
Screen resolution	1366x768	1366x768	1366x768	1920x1080	1366x768
Graphics	Intel HD GPU	Intel HD	Intel HD Graphics 5500	Intel Graphics 5000	Intel HD Graphics
Video memory	N/A	N/A	N/A	N/A	N/A
Wireless	802.11b/g/n	802.11a/b/g/n	802.11b/g/n	802.11b/g/n/ac	802.11b/g/n
Ethernet	Gigabit	✗	Gigabit	✗	✗
Bluetooth	✓	✓	✓	✓	✓
USB	1x USB 3.0, 2x USB 2.0	1x USB 3.0, 1x USB 2.0	1x USB 3.0, 2x USB 2.0	1x USB 3.0, 1x USB 2.0	1x USB 3.0, 1x USB 2.0
FireWire	✗	✗	✗	✗	✗
Thunderbolt	✗	✗	✗	✗	✗
DisplayPort	✗	✗	✗	✗	✗
HDMI	✓	✓	✓	✓	✓
DVI	✗	✗	✗	✗	✗
VGA	✓	✗	✓	✗	✗
eSATA	✗	✗	✗	✗	✗
Media card slot	✓	✓	✗	✓	✓
Audio	Headphone minijack	Headphone minijack	Headphone minijack	Headphone minijack	Headphone minijack
Optical drive	DVD±RW	✗	DVD±RW	✗	✗
Extras	Webcam	Webcam	Kensington lock slot, webcam	Webcam	Kensington lock slot, webcam
Operating system	Windows 10	Windows 8	Windows 8.1	Windows 10 Home	Windows 8.1
Bundled software	None	None	None	None	None
Battery	31Wh Lithium-ion	32Wh Lithium-polymer	37Wh Lithium-ion	9000mAh Lithium-polymer	37Wh Lithium-polymer
Battery life	5 hrs 5 mins	8 hrs 15 mins	5 hrs 17 mins	4 hrs	8 hrs 45 mins
PCMark 8 Home score	2171	Not tested	1985	3664	Not tested
Batman (Low/High)	Not tested	Not tested	30fps/Not tested	Not tested	Not tested
Dimensions	384x254x24mm	292x196x19.9mm	381x257x26.3mm	329.2x220.5x20.5mm	300x205x20mm
Weight	2.1kg	1.39kg	2.1kg	1.5kg	1.25kg
Warranty	1 year	1 year	1 year	1 year	1 year
FULL REVIEW	TINYURL.COM/Z5XNZOR	TINYURL.COM/Z3AUEFY	TINYURL.COM/OMYZQJ3	TINYURL.COM/ZKWN33K	TINYURL.COM/GNRP9BC

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Best budget laptops	**6** Asus X553SA	**7** Chuwi HiBook Pro	**8** Asus VivoBook Max X541SA	**9** Lenovo Yoga 300	**10** Chuwi Hi10 Pro
Price	£279 inc VAT	£172 inc VAT	£299 inc VAT	£299 inc VAT	£128 inc VAT
Website	Asus.com/uk	En.chuwi.com	Asus.com/uk	Lenovo.com/uk	En.chuwi.com
Build rating	★★★½☆	★★★★☆	★★★☆☆	★★★★☆	★★★★☆
Features rating	★★★★½	★★★½☆	★★★½☆	★★★★☆	★★★½☆
Value rating	★★★½☆	★★★★½	★★★★☆	★★½☆☆	★★★★½
Performance rating	★★☆☆☆	★★★½☆	★★★½☆	★★½☆☆	★★★½☆
Overall rating	★★★★½	★★★★☆	★★★☆☆	★★★☆☆	★★★★☆
Processor	2.1GHz Intel Core Celeron	1.84GHz Intel Atom X5	1.6GHz Intel Pentium N3710	2.16GHz Intel Pentium N3700	1.44GHz Intel Atom X5
RAM	8GB DDR3	4GB DDR3	4GB DDR3	4GB DDR	4GB
Storage	500GB	64GB	1TB	500GB	64GB
Screen size	15.6in glossy	10.1in matt IPS	15.6in IPS	11.6in IPS	10.1in full-HD
Screen resolution	1366x768	2560x1600	1366x768	1366x768	1920x1200
Graphics	Intel HD	Intel HD Graphics	Intel HD 405	Intel HD Graphics	Intel HD Graphics
Video memory	N/A	N/A	N/A	N/A	N/A
Wireless	802.11a/b/g/n/ac	802.11b/g/n	802.11b/g/n	802.11ac	802.11b/g/n
Ethernet	Gigabit	Gigabit	Gigabit	Gigabit	Gigabit
Bluetooth	✓	✓	✓	✓	✓
USB	1x USB 3.0, 1x USB 2.0	1x USB-C	1x USB-C, 1x USB 2.0, 1x USB 3.0	1x USB 3.0, 2x USB 2.0	1x USB-C, 1x Micro-USB
FireWire	✗	✗	✗	✗	✗
Thunderbolt	✗	✗	✗	✗	✗
DisplayPort	✗	✗	✗	✗	✗
HDMI	✓	✓	✓	✓	✓
DVI	✗	✗	✗	✗	✗
VGA	✗	✗	✗	✗	✗
eSATA	✗	✗	✗	✗	✗
Media card slot	✓	✓	✓	✓	✓
Audio	Headphone jack, mic	Headphone jack, mic	Headphone minijack	Headphone jack, mic	Headphone minijack
Optical drive	Super-Multi DVD	✗	✗	N/A	✗
Extras	VGA webcam	720p webcam	HD webcam	None	2Mp/2Mp front and rear cameras
Operating system	Windows 10 Home	Windows 10 Home	Windows 10 Home	Windows 10 Home	Windows 10/Android 5.1
Bundled software	None	None	None	None	None
Battery	48Wh lithium-ion	8000mAh	36Wh lithium-ion	48Wh lithium-ion	6500mAh
Battery life	4 hrs 35 mins	Not tested	3 hrs 57 mins	6 hrs 34 mins	8 hrs
PCMark 8 Home score	Not tested	940	Not tested	1457	1041
Batman (Low/High)	Not tested	Not tested	Not tested	Not tested	Not tested
Dimensions	380x258x25.3mm	262x167.5x8.5mm	381x252x27.6mm	299x209x22mm	261.8x167.3x8.5mm (battery)
Weight	2.2kg	550g	2kg	1.39kg	562g (battery); 545g (keyboard)
Warranty	1 year	1 year	1 year	1 year	1 year
FULL REVIEW	TINYURL.COM/ZLN2DVF	TINYURL.COM/JVYEQYV	TINYURL.COM/H3HC4Q8	TINYURL.COM/HRXVJXT	TINYURL.COM/J7F5URW

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Best Chromebooks	1 Dell Chromebook 11 (3120)	2 Asus Chromebook Flip C100PA	3 Acer Chromebook 14	4 Chromebook Pixel (2015)
Price	£202 inc VAT	£249 inc VAT	£199 inc VAT	£799 inc VAT
Website	Dell.co.uk	UK.asus.com	Acer.co.uk	Google.co.uk
Build rating	★★★★½	★★★★½	★★★½	★★★★½
Features rating	★★★★☆	★★★★☆	★★★☆☆	★★★½
Value rating	★★★★☆	★★★★☆	★★★½	★★★★½
Performance rating	★★★★☆	★★★★☆	★★★½	★★★☆☆
Overall rating	★★★★☆	★★★★☆	★★★½	★★★★½
Processor	2.16GHz Intel Celeron N2840	1.86GHz Rockchip RK3288C	1.6GHz Intel Celeron N3060	Intel Core i7
RAM	4GB DDR3	4GB DDR3	2GB	8GB DDR3
Storage	16GB SSD	16GB SSD	16GB eMMC	32GB SSD
Screen size	11.6in HD	10.1in	14in LCD	12.85in IPS
Screen resolution	1366x768	1280x800	1366x768	2560x1700
Graphics	Intel HD graphics	Rockchip Mali T764	Intel HD graphics	Intel HD 5500
Video memory	N/A	N/A	N/A	N/A
Wireless	802.11a/b/g/n	802.11a/b/g/n/ac	802.11a/b/g/n/ac	802.11a/b/g/n/ac
Ethernet	Gigabit	Gigabit	Gigabit	Gigabit
Bluetooth	✓	✓	✓	✓
USB	1x USB 3.0, 1x USB 2.0	2x USB 2.0	2x USB 3.0	2x USB 3.0
FireWire	✗	✗	✗	✗
Thunderbolt	✗	✗	✗	✗
DisplayPort	✗	✗	✗	✗
HDMI	✓	✓	✓	✓
DVI	✗	✗	✗	✗
VGA	✗	✗	✗	✗
eSATA	✗	✗	✗	✗
Media card slot	✓	✓	✓	✓
Audio	Headphone minijack	Headphone minijack	Headphone minijack	Headphone minijack
Optical drive	N/A	N/A	N/A	N/A
Extras	Webcam	Webcam	HD webcam	Webcam
Operating system	Google Chrome OS	Google Chrome OS	Google Chrome OS	Google Chrome OS
Bundled software	None	None	None	None
Battery life	9 hrs 46 mins	9 hrs 33 mins	11 hrs 13mins	9 hrs
SunSpider score	697ms	803ms	638ms	Not tested
Dimensions	297x217.7x120.1mm	262.8x182.4x15.6mm	340x236x17mm	297.7x224.55x5.3mm
Weight	1.25kg	890g	1.6kg	1.5kg
Warranty	1 year	1 year	1 year	1 year
FULL REVIEW	TINYURL.COM/ZQFP4MF	TINYURL.COM/J9CU5YH	TINYURL.COM/HH8OOT4	TINYURL.COM/HQDFR8H

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Best Chromebooks	5 Acer Chromebook R11	6 HP Chromebook 11	7 Asus C300M
Price	£229 inc VAT	£229 inc VAT	£250 inc VAT
Website	Acer.co.uk	Hp.com/uk	UK.asus.com
Build rating	★★★½☆	★★★☆☆	★★★½☆
Features rating	★★★½☆	★★★☆☆	★★★★☆
Value rating	★★★½☆	★★★½☆	★★★★☆
Performance rating	★★★½☆	★★☆☆☆	★★★½☆
Overall rating	★★★½☆	★★★☆☆	★★★★☆
Processor	1.6GHz Intel Celeron N3050	1.7GHz Exynos 5250	Intel Celeron N2830
RAM	2GB DDR3	2GB DDR3	2GB DDR3
Storage	16GB SSD	16GB	16GB SSD
Screen size	11in IPS	11.6in IPS	13.3in
Screen resolution	1366x768	1366x768	1366x768
Graphics	Intel HD graphics	Intel HD graphics	Intel HD graphics
Video memory	N/A	N/A	N/A
Wireless	802.11a/b/g/n/ac	802.11a/b/g/n	802.11a/b/g/n
Ethernet	Gigabit	None	Gigabit
Bluetooth	✓	✓	✓
USB	4x USB 3.0, 1x USB 2.0	2x USB 2.0	1x USB 3.0, 1x USB 2.0
FireWire	✗	✗	✗
Thunderbolt	✗	✗	✗
DisplayPort	✗	✗	✗
HDMI	✓	✗	✓
DVI	✗	✗	✗
VGA	✗	✗	✗
eSATA	✗	✗	✗
Media card slot	✓	✗	✓
Audio	Headphone minijack	Headphone minijack	Headphone minijack
Optical drive	N/A	N/A	N/A
Extras	Webcam	Webcam	720p webcam
Operating system	Google Chrome OS	Google Chrome OS	Google Chrome OS
Bundled software	None	None	None
Battery life	9 hrs 30 mins	5 hrs	9 hrs 28 mins
SunSpider score	Not tested	Not tested	Not tested
Dimensions	19.2x294x204mm	297x195x17.4mm	339x230x20.3mm
Weight	1.25kg	1.03kg	1.4kg
Warranty	1 year	1 year	1 year
FULL REVIEW	TINYURL.COM/GOVMT3X	TINYURL.COM/HB3JEBG	TINYURL.COM/HW86CWG

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Best gaming laptops	**1** Asus RoG G752VM	**2** Alienware 17	**3** MSI GL62-6QC 065UK	**4** Asus RoG GL552VW-DM201T	**5** Dell Inspiron 15 7559
Price	£1,599 inc VAT	£1,350 inc VAT	£599 inc VAT	£899 inc VAT	£999 inc VAT
Website	Asus.com/uk	Alienware.co.uk	Asus.com/uk	Asus.com/uk	Dell.co.uk
Build rating	★★★★★	★★★★½	★★★★☆	★★★½☆	★★★★☆
Features rating	★★★★★	★★★★★	★★★★☆	★★★½☆	★★★★☆
Value rating	★★★★☆	★★★½☆	★★★½☆	★★★☆☆	★★★★☆
Performance rating	★★★★★	★★★★★	★★★½☆	★★★★☆	★★★★☆
Overall rating	★★★★½	★★★★½	★★★½☆	★★★½☆	★★★★☆
Processor	2.6GHz Intel Core i7-6700HQ	4.1GHz Intel Core i7-6820	2.3GHz Intel Core i5-6300HQ	2.6GHz Intel Core i7-6700HQ	2.6GHz Intel Core i7-6700HQ
RAM	16GB DDR4-2400	8GB DDR5, 16GB DDR4	8GB DDR3L	8GB DDR3	16GB DDR3L RAM
Storage	256GB SSD, 1TB HDD	512GB SSD, 1TB HDD	1TB HDD	1TB HDD	128GB SSD, 1TB HDD
Screen size	17.3in IPS	17.3in IPS	15.6in IPS	15.6in IPS	13.6in IPS
Screen resolution	1920x1080	1920x1080	1920x1080	1920x1080	3840x2160
Graphics	Nvidia GeForce GTX 1060	Nvidia GeForce GTX 980M	Nvidia GeForce 940MX	Nvidia GeForce GTX 960M	nVidia GeForce GTX 960M
Video memory	Not specified	Not specified	Not specified	Not specified	N/A
Wireless	802.11ac	802.11ac	802.11ac	802.11ac	802.11ac 1x1 MIMO
Ethernet	Gigabit	Gigabit	Gigabit	Gigabit	Gigabit
Bluetooth	✓	✓	✓	✓	✓
USB	4x USB 3.0, 1x USB-C	3x USB 3.0, 1x USB-C	2x USB 3.0, 1x USB-C	2x USB 3.0, 1x USB 3.0	3x USB 3.0
FireWire	✗	✗	✗	✗	✗
Thunderbolt	✗	✓	✗	✗	✗
DisplayPort	✓	✗	✓	✗	✗
HDMI	✓	✓	✓	✓	✓
DVI	✗	✗	✗	✗	✗
VGA	✗	✗	✗	✗	✗
eSATA	✗	✗	✗	✗	✗
Media card slot	✓	✓	✓	✓	✓
Audio	Headphone jack, mic	Headphone jack, mic	Headphone jack, mic	Headphone jack, mic	Headphone jack, mic
Optical drive	✓	None	✓	None	N/A
Extras	1.2Mp webcam	2Mp webcam	HD webcam	HD webcam	0.9Mp webcam
Operating system	Windows 10	Windows 10 Home	Windows 10	Windows 10	Windows 10 Home
Bundled software	None	None	None	None	None
Gaming scores	Not tested	Not tested	Not tested	Not tested	34/27fps in Tomb Raider
Battery	67Wh lithium-ion	31Wh lithium-polymer	41Wh lithium-ion	48Wh lithium-polymer	74Wh lithium-ion
Battery life	4 hrs	3 hrs 59 mins	3rs 55 mins	4 hrs 50 mins	5 hrs 27 mins
PCMark 8 score	Not tested	3400	Not tested	3102	Not tested
Dimensions	428x334x43mm	430x292x34.4mm	383x260x27mm	384x257x34.5mm	383x265x26.1mm
Weight	4.1kg	3.8kg	2.3kg	2.6kg	2.8kg
Warranty	1 year	1 year	1 year	1 year	1 year
FULL REVIEW	TINYURL.COM/H23QHCQ	TINYURL.COM/JYK953S	TINYURL.COM/JAXBRDB	TINYURL.COM/HQKNNRJ	TINYURL.COM/ZZV3JQZ

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Best gaming PCs	1 Wired2Fire Diablo Fury	2 Yoyotech Warbird RS10 V2	3 Chillblast Fusion Tracer RX 480	4 Overclockers UK Kinetic HR	5 Mesh Storm PCA
Price	£914 inc VAT	£824 inc VAT	£749 inc VAT	£660 inc VAT	£699 inc VAT
Website	Wired2fire.co.uk	Yoyotech.co.uk	Chillblast.com	Overclockers.co.uk	Meshcomputers.com
Build rating	★★★★★	★★★★½	★★★★☆	★★★★☆	★★★★☆
Features rating	★★★★☆	★★★★☆	★★★★☆	★★★★☆	★★★☆☆
Value rating	★★★★★	★★★★★	★★★★☆	★★★★★	★★★★½
Performance rating	★★★★☆	★★★★☆	★★★★½	★★★½☆	★★★★☆
Overall rating	★★★★½	★★★★½	★★★★☆	★★★★☆	★★★★☆
Processor	3.5GHz Intel Core i5-6600K (OC 4.4GHz)	3.5GHz Intel i5-6600K (OC 4.6GHz)	2.8- to 3.4GHz Intel Core i5-6420P	3.7GHz Intel Core i3-6100	3.2GHz Intel Core i5-6500 (3.6GHz Turbo)
CPU cooler	ID Cooling SE-214X	Coolermaster Hyper 212 EVO	Intel Stock Cooler	Stock cooler	BeQuiet Pure Rock Slim Compact
Memory	16GB DDR4	8GB DDR4	8GB DDR	8GB DDR4	8GB DDR4
Storage	250GB SSD	1TB HDD	1TB HDD, 250GB SSD	1TB SSHD	1TB HDD
Power supply	500W FSP	500W Evga 80Plus	500W PSU	500W Kolink	500W Aerocool Quiet
Motherboard	Asus Z170-P	MSI Z170-A Pro	Gigabyte GA-H110M-S2H	Asus H110M-K mATX	Asus B150M Pro Gaming
Operating system	Windows 10 Home (64-bit)	Windows 10 (64-bit)	Windows 10 Home	Windows 10 (64-bit)	Windows 10 Home (64-bit)
Screen	None supplied	None supplied	None supplied	None supplied	None supplied
Graphics	Nvidia GeForce GTX 1060	Nvidia GeForce GTX 1060	AMD Radeon RX 480	Sapphire Nitro+ OC RX470	GeForce GTX 1060
Sound	Onboard	Onboard	Onboard	Onboard	Onboard
Connectivity	Gigabit ethernet	Gigabit ethernet	Gigabit ethernet	Gigabit ethernet	Gigabit ethernet
Ports	4x USB 3.0, 2x USB 2.0, 1x USB Type-C, 2x DVI, HDMI, DisplayPort, eSATA	5x USB 3.0, 3x USB 2.0, 2x DisplayPort, 2x HDMI, DVI	3x USB 3.0, 6x USB 2.0, 2x PS/2, DisplayPort, DVI, HDMI	3x USB 3.0, 5x USB 2.0. VGA: 2x HDMI, 2x DisplayPort, DVI. Motherboard: DVI-D, VGA	5x USB 3.0, 5x USB 2.0, line in, line out, PS/2, 10/100/1000 (LAN)
Optical drive	None	None	None	None	None
Case	NZXT Source 340	Aerocool Aero-500	CiT F3 Black and Red	Kolink Victory Micro-ATX Gaming Dase	CiT Storm Black ATX
Keyboard & mouse	None supplied	None supplied	None supplied	None supplied	✓
PCMark 8 2.0 Home score	5200	4686	3984	4048	4158
Alien Isolation score (4K)	17.02/49.28fps	48.7/59.1fps	45.1/52.7fps	42.6/50.8fps	46.5/56.9fps
Thief (4K High)	32.4/38.9fps	31.7/38.2fps	32.3/40.1fps	30.7/37.4fps	24.9/35.7fps
Thief (1080p Ultra)	72.1/89.1fps	48.3/81.7fps	48.8/70.3fps	32.4/65.3fps	32.6/67.8fps
VRMark Orange	7063	6993	6934	5812	6356
Power Consumption	46.5/263	52.6/249W	53/297W	37/308W	38/215W
Warranty	2 years C&R, 1 year return to labour	3 years RTB (1 year parts & labour, 2 years labour)	3 years C&R, 5 years labour only, lifetime phone	2 years parts & labour C&R, 1 year RTB labour only	Lifetime labour, 2-year parts, 1 year free C&R
FULL REVIEW	TINYURL.COM/JSJLOPV	TINYURL.COM/ZZLFK56	TINYURL.COM/GRASZCO	TINYURL.COM/ZR2EGFB	TINYURL.COM/ZUYDBHD

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Best smartphones	1 Samsung Galaxy S7 edge	2 Samsung Galaxy S7	3 LG G5	4 Apple iPhone 7	5 OnePlus 3T
Price	£639 inc VAT	£569 inc VAT	£529 inc VAT	£599 inc VAT	£399 inc VAT
Website	Samsung.com/uk	Samsung.com/uk	LG.com/uk	Apple.com/uk	Oneplus.net
Build rating	★★★★½	★★★★½	★★★★☆	★★★★½	★★★★½
Features rating	★★★★½	★★★★½	★★★★½	★★★★☆	★★★★½
Value rating	★★★★☆	★★★★½	★★★★½	★★★½☆	★★★★½
Performance rating	★★★★★	★★★★★	★★★★½	★★★★½	★★★★½
Overall rating	★★★★½	★★★★½	★★★★½	★★★★☆	★★★★½
OS (out of box)	Android 6.0 Marshmallow	Android 6.0 Marshmallow	Android 6.0 Marshmallow	iOS 10	Android 6.0.1 Marshmallow
Processor	Qualcomm Snapdragon 820	Qualcomm Snapdragon 820	Qualcomm Snapdragon 820	A10 Fusion	Qualcomm Snapdragon 821
RAM	4GB	4GB	4GB	2GB	6GB
Storage	32GB	32GB	32GB	32/128/256GB	64/128GB
MicroSD support	✓	✓	✓	✗	✗
Graphics	Adreno 530	Adreno 530	Adreno 530	Not stated	Adreno 530
Screen size	5.5in	5.1in	5.3in	4.7in	5.5in
Screen resolution	2560x1440	2560x1440	2560x1440	1334x720	1920x1080
Pixel density	534ppi	577ppi	554ppi	326ppi	401ppi
Screen technology	IPS	IPS	IPS	IPS	AMOLED
Front camera	5Mp	5Mp	8Mp	7Mp	16Mp
Rear camera	16Mp, LED flash	12Mp, LED flash	8/16Mp, LED flash	12Mp, LED flash	16Mp, LED flash
Video recording	4K	4K	4K	4K	4K
Cellular connectivity	4G	4G	4G	4G	4G
SIM type	Nano-SIM	Nano-SIM	Nano-SIM	Nano-SIM	Nano-SIM
Dual-SIM as standard	✗	✗	✗	✗	✗
Wi-Fi	802.11a/b/g/n/ac, dual-band	802.11a/b/g/n/ac, dual-band	802.11a/b/g/n/ac, dual-band	802.11a/b/g/n/ac, dual-band	802.11a/b/g/n/ac, dual-band
Bluetooth	Bluetooth 4.2	Bluetooth 4.2	Bluetooth 4.2	Bluetooth 4.2	Bluetooth 4.2
GPS	GPS, Glonass	A-GPS, Glonass	A-GPS	A-GPS, Glonass	A-GPS, Glonass
NFC	✓	✓	✓	✓	✓
USB OTG	✓	✓	✓	✓	✓
Extra features	Fingerprint scanner	Fingerprint scanner	Fingerprint scanner	Fingerprint scanner	Fingerprint scanner
Geekbench 4.0 (multi)	6469 (Geekbench 3.0)	6466 (Geekbench 3.0)	5404 (Geekbench 3.0)	6088	4257
JetStream	66.1	61	53.5	160.2	53.6
GFXBench: T-Rex	53fps	53fps	53fps	60fps	60fps
GFXBench: Manhattan	27fps	27fps	29fps	60fps	47fps
Battery	3600mAh, non-removable	3000mAh, non-removable	2800mAh, removable	Lithium-ion	3400mAh, non-removable
Dimensions	151x73x7.8mm	142x70x7.9mm	149x74x7.7mm	138.3x67.1x7.1mm	152.7x74.7x7.4mm
Weight	157g	152g	159g	138g	158g
Warranty	1 year	1 year	1 year	1 year	1 year
FULL REVIEW	TINYURL.COM/ZDKDRE4	TINYURL.COM/J5CQ9OU	TINYURL.COM/JES3ZUD	TINYURL.COM/JKDLR6H	TINYURL.COM/GM92C55

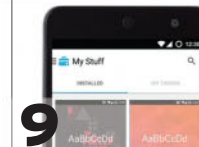## HEAD TO TINYURL.COM/PNWWW6X FOR OUR BUYING ADVICE

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Best smartphones	**6** Xiaomi Mi 5s	**7** Google Pixel	**8** Apple iPhone 7 Plus	**9** Huawei Mate 9	**10** Google Nexus 6P
Price	**£282 inc VAT**	**£599 inc VAT**	**£719 inc VAT**	**£599 inc VAT**	**£449 inc VAT**
Website	Xiaomi-mi.co.uk	Google.co.uk	Apple.com/uk	Consumer.huawei.com/uk	Google.co.uk
Build rating	★★★★½	★★★★½	★★★★½	★★★★★	★★★★½
Features rating	★★★★½	★★★★☆	★★★★½	★★★★½	★★★★½
Value rating	★★★★★	★★★½☆	★★★½☆	★★★★☆	★★★★½
Performance rating	★★★★½	★★★★½	★★★★½	★★★★★	★★★★☆
Overall rating	★★★★½	★★★★☆	★★★★☆	★★★★½	★★★★½
OS (out of box)	Android 6.0 Marshmallow	Android 7.1 Nougat	iOS 10	Android 7.0 Nougat	Android 6.0 Marshmallow
Processor	Qualcomm Snapdragon 821	Qualcomm Snapdragon 821	Apple A10 Fusion	Kirin 960	Qualcomm Snapdragon 810
RAM	3/4GB	4GB	3GB	4GB	3GB
Storage	64/128GB	32/128GB	32/128/256GB	64GB	32/64/128GB
MicroSD support	✗	✗	✗	✓	✗
Graphics	Adreno 530	Adreno 530	PowerVR Series7XT Plus	Mali G71	Adreno 430
Screen size	5.15in	5in	5.5in	5.9in	5.7in
Screen resolution	1920x1080	1920x1080	1920x1080	1920x1080	2560x1440
Pixel density	428ppi	441ppi	401ppi	373ppi	518ppi
Screen technology	IPS	AMOLED	IPS	IPS	AMOLED
Front camera	4Mp	8Mp	7Mp	8Mp	8Mp
Rear camera	12Mp, LED flash	12.3Mp, LED flash	12Mp, LED flash	20Mp, LED flash	12.3Mp, LED flash
Video recording	4K	4K	4K	4K	4K
Cellular connectivity	4G	4G	4G	4G	4G
SIM type	Nano-SIM	Nano-SIM	Nano-SIM	Nano-SIM	Nano-SIM
Dual-SIM as standard	✗	✗	✗	✗	✗
Wi-Fi	802.11a/b/g/n/ac	802.11a/b/g/n/ac, dual-band	802.11a/b/g/n/ac, dual-band	802.11a/b/g/n/ac, dual-band	802.11a/b/g/n/ac, dual-band
Bluetooth	Bluetooth 4.2	Bluetooth 4.2	Bluetooth 4.2	Bluetooth 4.2	Bluetooth 4.2
GPS	A-GPS, Glonass	A-GPS, Glonass	A-GPS	A-GPS	A-GPS, Glonass
NFC	✓	✓	✓	✓	✓
USB OTG	✓	✓	✓	✓	✓
Extra features	Fingerprint scanner	Fingerprint scanner	Fingerprint scanner	Fingerprint scanner	Fingerprint scanner
Geekbench 4.0 (multi)	4157	4116	6106	5986	3939 (Geekbench 3.0)
JetStream	57.4	54.9	168.7	68.5	Not tested
GFXBench: T-Rex	59fps	58fps	58fps	60fps	34fps
GFXBench: Manhattan	43fps	47fps	44fps	34fps	14fps
Battery	3200mAh, non-removable	2770mAh, non-removable	2900mAh, non-removable	4000mAh, non-removable	3450mAh, non-removable
Dimensions	145.6x70.3x8.3mm	143.8x69.5x8.5mm	158.2x77.9x7.3mm	156.9x78.9x7.9mm	159.3x77.8x7.3mm
Weight	145g	143g	188g	190g	178g
Warranty	1 year	1 year	1 year	1 year	1 year
FULL REVIEW	TINYURL.COM/H6X5M3Z	TINYURL.COM/J4V6WVC	TINYURL.COM/ZSKOF5P	TINYURL.COM/J6N8TW2	TINYURL.COM/NABSV4E

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Best budget smartphones	**1** Motorola Moto G (3rd gen)	**2** Vodafone Smart Ultra 6	**3** Vodafone Smart Prime 7	**4** Vodafone Smart Prime 6	**5** Xiaomi Redmi 3S
Price	£149 inc VAT	£125 inc VAT	£75 inc VAT	£79 inc VAT	£121 inc VAT
Website	Motorola.co.uk	Vodafone.co.uk	Vodafone.co.uk	Vodafone.co.uk	Xiaomi-mi.co.uk
Build rating	★★★★☆	★★★★½	★★★★½	★★★★½	★★★★☆
Features rating	★★★★½	★★★★½	★★★★☆	★★★★☆	★★★★☆
Value rating	★★★★☆	★★★★★	★★★★½	★★★★☆	★★★★☆
Performance rating	★★★★½	★★★★½	★★★½☆	★★★★★	★★★★☆
Overall rating	★★★★½	★★★★½	★★★★☆	★★★★½	★★★★☆
OS (out of box)	Android 5.1.1 Lollipop	Android 5.0.2 Lollipop	Android 6.0 Marshmallow	Android 5.0.2 Lollipop	MIUI 7.5
Processor	1.4GHz Snapdragon 410	2.5GHz Snapdragon 615	1.2GHz Snapdragon 210	1.2GHz Snapdragon 410	1.4GHz Snapdragon 4130
RAM	2GB	2GB	1GB	1GB	2GB
Storage	16GB	16GB	8GB	8GB	16GB
MicroSD support	Up to 32GB	Up to 128GB	Up to 128GB	Up to 64GB	Up to 128GB
Graphics	Adreno 406	Adreno 405	Adreno 304	Adreno 306	Adreno 505
Screen size	5in	5.5in	5in	5in	5in
Screen resolution	1280x720	1920x1080	1280x720	1280x720	1280x720
Pixel density	294ppi	401ppi	294ppi	294ppi	294ppi
Screen technology	IPS	IPS	IPS	IPS	IPS
Front camera	5Mp	5Mp	5Mp	2Mp	5Mp
Rear camera	13Mp	13Mp	8Mp	8Mp	13Mp
Video recording	720p	1080p	720p	1080p	1080p
Cellular connectivity	4G	4G*	4G*	4G*	4G
SIM type	Micro-SIM	Nano-SIM	Micro-SIM	Micro-SIM	1x Micro-SIM, 1x Nano-SIM
Dual-SIM as standard	✗	✗	✗	✗	✓
Wi-Fi	802.11b/g/n	802.11b/g/n	802.11b/g/n	802.11b/g/n	802.11b/g/n
Bluetooth	Bluetooth 4.0	Bluetooth 4.0	Bluetooth 4.1	Bluetooth 4.0	Bluetooth 4.1
GPS	GPS, A-GPS, GLONASS	GPS, A-GPS	A-GPS	A-GPS	GPS, A-GPS
NFC	✗	✓	✓	✗	✗
USB OTG	✗	✗	✗	✓	✗
Extra features	FM radio, accelerometer	FM radio	FM radio	FM radio	Rear-mounted fingerprint scanner
Geekbench 3.0 (single)	Not tested	649	Not tested	464	Not tested
Geekbench 3.0 (multi)	1628	2469	1098	1401	2848
SunSpider	1344ms	1545ms	Not tested	1301ms	Not tested
GFXBench: T-Rex	10fps	14fps	10fps	9.4fps	24fps
GFXBench: Manhattan	4fps	5.7fps	4fps	3.8fps	13fps
Battery	2470mAh, non-removable	3000mAh, non-removable	2540mAh, non-removable	Not specified	4100mAh, non-removable
Dimensions	142.1x72.4x11.6mm	154x77x9mm	144x72x8mm	141.65x71.89x9mm	139.3x69.6x8.5mm
Weight	155g	159g	128g	155g	144g
Warranty	1 year	1 year	1 year	1 year	1 year
FULL REVIEW	TINYURL.COM/HTEFW7H	TINYURL.COM/Q7Q9NXR	TINYURL.COM/ZTLQLUZ	TINYURL.COM/Q5DSNHE	TINYURL.COM/J8HXZ49

* Locked to Vodafone. All other models here are unlocked

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Best budget smartphones	**6** Vodafone Smart Ultra 7	**7** Motorola Moto E 4G 2015	**8** Cubot P12	**9** Wileyfox Swift	**10** Xiaomi Redmi Note 3
Price	£135 inc VAT	£109 inc VAT	£74 inc VAT	£129 inc VAT	£118 inc VAT
Website	Vodafone.co.uk	Motorola.co.uk	Cubot.net	Wileyfox.com	Xiaomi-mi.com
Build rating	★★★☆☆	★★★★☆	★★★★½	★★★★☆	★★★★½
Features rating	★★★☆☆	★★★★☆	★★★★☆	★★★★☆	★★★★☆
Value rating	★★★☆☆	★★★★☆	★★★★★	★★★★½	★★★★½
Performance rating	★★★½☆	★★★★★	★★★½☆	★★★½☆	★★★★½
Overall rating	★★★☆☆	★★★★☆	★★★★☆	★★★★☆	★★★★½
OS (out of box)	Android 6.0.1 Marshmallow	Android 5.0 Lollipop	Android 5.1 Lollipop	Cyanogen OS	Android 5.0 Lollipop
Processor	1.8GHz Mediatek MT6755M	1.2GHz Snapdragon 410	1.3GHz MediaTek MT6580	1.2GHz Snapdragon 410	2GHz MediaTek MT6795
RAM	2GB	1GB	1GB	2GB	2GB
Storage	16GB	8GB	16GB	16GB	16GB
MicroSD support	Up to 256GB	Up to 32GB	Up to 32GB	Up to 32GB	No
Graphics	Mali-T860MP2	Adreno 306	Mali 400mp	Adreno 306	Not specified
Screen size	5.5in	4.5in	5in	5in	5.5in
Screen resolution	1920x1080	960x540	1280x720	1280x720	1920x1080
Pixel density	401ppi	245ppi	294ppi	294ppi	403ppi
Screen technology	IPS	IPS	IPS	IPS	Full HD
Front camera	5Mp	0.3Mp	5Mp	5Mp	5Mp
Rear camera	13Mp	5Mp	8Mp, LED flash	13Mp, LED flash	13Mp, LED flash
Video recording	1080p	720p	1080p	1080p	Not specified
Cellular connectivity	4G*	4G	3G	4G	4G
SIM type	Micro-SIM	Micro-SIM	Micro-SIM	Micro-SIM	Micro-SIM
Dual-SIM as standard	✗	✗	✓	✗	✓
Wi-Fi	802.11b/g/n	802.11b/g/n	802.11b/g/n	802.11b/g/n	802.11ac
Bluetooth	Bluetooth 4.1	Bluetooth 4.0	✗	Bluetooth 4.0	Bluetooth 4.0
GPS	GPS, A-GPS	GPS, A-GPS, Glonass	GPS, A-GPS	A-GPS	GPS, A-GPS, Glonass
NFC	✗	✗	✗	✗	✓
USB OTG	✗	✗	✓	✓	✗
Extra features	FM radio, accelerometer	Double-twist launches camera, lockscreen alerts	Gesture controls	3D G-Sensor	Fingerprint scanner
Geekbench 3.0 (single)	Not tested	464	Not tested	Not tested	Not tested
Geekbench 3.0 (multi)	3002	1463	1401	1456	4597
SunSpider	Not tested	1301ms	1726ms	1760ms	907ms
GFXBench: T-Rex	13fps	13fps	13fps	10fps	122fps
GFXBench: Manhattan	5.3fps	6fps	6fps	4fps	8fps
Battery	2960mAh, non-removable	2390mAh, non-removable	2200mmAh, removable	2500mAh, removable	4000mAh, non-removable
Dimensions	152.2x78.1x8.7mm	66.8x5.2-12.3x129.9mm	141x71x9.4mm	141x71x9.4mm	150x76x8.65mm
Weight	150g	145g	71.5x8.1x143.9mm	135g	164g
Warranty	1 year	1 year	1 year	1 year	1 year
FULL REVIEW	TINYURL.COM/ZL3X7QG	TINYURL.COM/Q7Q9NXR	TINYURL.COM/JVEOZSF	TINYURL.COM/PO9KG38	TINYURL.COM/JQNP2RB

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Best phablets	Xiaomi Mi Mix	Samsung Galaxy S7 edge	OnePlus 3T	Google Nexus 6P	Huawei Mate 9
Price	£639 inc VAT	£639 inc VAT	£399 inc VAT	£449 inc VAT	£599 inc VAT
Website	Xiaomi-mi.co.uk	Samsung.com/uk	Oneplus.net	Google.co.uk	Consumer.huawei.com/uk
Build rating	★★★★½	★★★★½	★★★★½	★★★★½	★★★★★
Features rating	★★★★½	★★★★½	★★★★½	★★★★½	★★★★½
Value rating	★★★★½	★★★★☆	★★★★½	★★★★½	★★★★☆
Performance rating	★★★★½	★★★★★	★★★★½	★★★★☆	★★★★★
Overall rating	★★★★½	★★★★½	★★★★½	★★★★½	★★★★½
OS (out of box)	Android 6.0 Marshmallow	Android 6.0 Marshmallow	Android 6.0.1 Marshmallow	Android 6.0 Marshmallow	Android 7.0 Nougat
Processor	Qualcomm Snapdragon 821	Qualcomm Snapdragon 820	Qualcomm Snapdragon 821	Qualcomm Snapdragon 810	Kirin 960
RAM	4/6GB	4GB	6GB	3GB	4GB
Storage	128/256GB	32GB	64/128GB	32/64/128GB	64GB
MicroSD support	✗	✓	✗	✗	✓
Graphics	Adreno 530	Adreno 530	Adreno 530	Adreno 430	Mali G71
Screen size	6.4in	5.5in	5.5in	5.7in	5.9in
Screen resolution	2040x1080	2560x1440	1920x1080	2560x1440	1920x1080
Pixel density	326ppi	534ppi	401ppi	518ppi	373ppi
Screen technology	IPS	IPS	AMOLED	Quad HD capacitive	IPS
Front camera	5Mp	5Mp	16Mp	8Mp	8Mp
Rear camera	16Mp, LED flash	16Mp, LED flash	16Mp, LED flash	12.3Mp, LED flash	20Mp, LED flash
Video recording	2160p	4K	4K	4K	4K
Cellular connectivity	4G	4G	4G	4G	4G
SIM type	Nano-SIM	Nano-SIM	Nano-SIM	Nano-SIM	Nano-SIM
Dual-SIM as standard	✗	✗	✗	✗	✗
Wi-Fi	802.11a/b/g/n/ac, dual-band	802.11a/b/g/n/ac, dual-band	802.11a/b/g/n/ac, dual-band	802.11a/b/g/n/ac, dual-band	802.11a/b/g/n/ac, dual-band
Bluetooth	Bluetooth 4.2	Bluetooth 4.2	Bluetooth 4.2	Bluetooth 4.2	Bluetooth 4.2
GPS	GPS, Glonass	GPS, Glonass	A-GPS, Glonass	A-GPS, Glonass	A-GPS
NFC	✓	✓	✓	✓	✓
USB OTG	✓	✓	✓	✓	✓
Extra features	Fingerprint scanner	Fingerprint scanner	Fingerprint scanner	Fingerprint scanner	Fingerprint scanner
Geekbench 4.0 (single)	Not tested	Not tested	Not tested	Not tested	Not tested
Geekbench 4.0 (multi)	4301	6469 (Geekbench 3.0)	4257	3939 (Geekbench 3.0)	5986
SunSpider	Note tested	53fps	Not tested	636ms	Not tested
GFXBench: T-Rex	60fps	27fps	60fps	34fps	60fps
GFXBench: Manhattan	46fps	27fps	47fps	14fps	34fps
Battery	4400mAh, non-removable	3600mAh, non-removable	3400mAh, non-removable	3450mAh, non-removable	4000mAh, non-removable
Dimensions	158.8x81.9x7.9mm	151x73x7.8mm	152.7x74.7x7.4mm	159.3x77.8x7.3mm	156.9x78.9x7.9mm
Weight	209g	157g	158g	178g	190g
Warranty	1 year	1 year	1 year	1 year	1 year
FULL REVIEW	TINYURL.COM/ZC5LMDC	TINYURL.COM/ZDKDRE4	TINYURL.COM/GM92C55	TINYURL.COM/NABSV4E	TINYURL.COM/J6N8TW2

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Best phablets	6 Apple iPhone 7 Plus	7 Xiaomi Mi Note 2	8 Samsung Galaxy Note5	9 Apple iPhone 6s Plus	10 Google Pixel XL
Price	£719 inc VAT	£472 inc VAT	£499 inc VAT	£619 inc VAT	£719 inc VAT
Website	Apple.com/uk	Xiaomi-mi.co.uk	Samsung.com/uk	Apple.com/uk	Google.co.uk
Build rating	★★★★½	★★★★½	★★★★½	★★★★½	★★★★½
Features rating	★★★★½	★★★★☆	★★★★☆	★★★★½	★★★★☆
Value rating	★★★½☆	★★★★½	★★★★☆	★★★★☆	★★★★☆
Performance rating	★★★★½	★★★★½	★★★★½	★★★★½	★★★★☆
Overall rating	★★★★☆	★★★★½	★★★★½	★★★★½	★★★★☆
OS (out of box)	iOS 10	Android 7.1 Nougat	Android 5.1.1 Lollipop	iOS 9	Android 7.1 Nougat
Processor	Apple A10 Fusion	Qualcomm Snapdragon 821	2.1GHz Exynos 7420	A9	Qualcomm Snapdragon 821
RAM	3GB	4/6GB	4GB	2GB	4GB
Storage	32/128/256GB	64/128GB	32/64GB	16/64/128GB	32/128GB
MicroSD support	✗	✗	✗	✗	✗
Graphics	PowerVR Series7XT Plus	Adreno 530	Mali-T760MP8	M9	Adreno 530
Screen size	5.5in	5.7in	5.7in	5.5in	5.5in
Screen resolution	1920x1080	1920x1080	1280x720	1920x1080	2560x1440
Pixel density	401ppi	386ppi	518ppi	401ppi	534ppi
Screen technology	IPS	AMOLED	Super AMOLED	IPS	IPS
Front camera	7Mp	8Mp	5Mp	5Mp	8Mp
Rear camera	12Mp, LED flash	22.5Mp, LED flash	16Mp, LED flash	12Mp, LED flash	12.3Mp, LED flash
Video recording	4K	2160p	4K	4K	2160p
Cellular connectivity	4G	4G	4G	4G	4G
SIM type	Nano-SIM	Nano-SIM	Nano-SIM	Nano-SIM	Nano-SIM
Dual-SIM as standard	✗	✗	✗	✗	✗
Wi-Fi	802.11a/b/g/n/ac, dual-band	802.11a/b/g/n/ac, dual-band	802.11a/b/g/n/ac, dual-band	802.11a/b/g/n/ac, dual-band	802.11a/b/g/n/ac, dual-band
Bluetooth	Bluetooth 4.2	Bluetooth 4.2	Bluetooth 4.2	Bluetooth 4.2	Bluetooth 4.2
GPS	A-GPS	GPS, Glonass	A-GPS, Glonass	A-GPS, Glonass	GPS, Glonass
NFC	✓	✓	✓	✓	✓
USB OTG	✓	✓	✓	✓	✓
Extra features	Fingerprint scanner	Fingerprint scanner	Heart-rate sensor, fingerprint scanner	Fingerprint scanner	Fingerprint scanner
Geekbench 4.0 (single)	Not tested	1663	1497 (Geekbench 3.0)	2527 (Geekbench 3.0)	1581
Geekbench 4.0 (multi)	6106	4137	Not tested	4407 (Geekbench 3.0)	4067
SunSpider	Not tested	Not tested	718ms	210ms	Not tested
GFXBench: T-Rex	58fps	Not tested	37fps	59fps	55fps
GFXBench: Manhattan	44fps	31fps	15fps	38fps	30fps
Battery	2900mAh, non-removable	4070mAh, non-removable	2300mAh, non-removable	Lithium-ion	3450mAh, non-removable
Dimensions	158.2x77.9x7.3mm	156.2x77.3x7.6mm	153.2x76.1x7.6mm	158.2x77.9x7.3mm	154.7x75.7x8.5mm
Weight	188g	166g	171g	192g	168g
Warranty	1 year	1 year	1 year	1 year	1 year
FULL REVIEW	TINYURL.COM/ZSKOF5P	TINYURL.COM/GSOBSEE	TINYURL.COM/OCQAJPL	TINYURL.COM/OYRA5MX	TINYURL.COM/HBXFGXX

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Best tablets	**1** Apple iPad Air 2	**2** Samsung Galaxy Tab S2 8	**3** 9.7in Apple iPad Pro	**4** Apple iPad mini 4	**5** Sony Xperia Z3 Tablet Compact
Price	£399 inc VAT	£319 inc VAT	£499 inc VAT	£319 inc VAT	£299 inc VAT
Website	Apple.com/uk	Samsung.com/uk	Apple.com/uk	Apple.com/uk	Sony.co.uk
Build rating	★★★★★	★★★★½	★★★★½	★★★★½	★★★★☆
Features rating	★★★★½	★★★★☆	★★★★½	★★★★☆	★★★★½
Performance rating	★★★★½	★★★★½	★★★★½	★★★★☆	★★★★½
Value rating	★★★★☆	★★★★☆	★★★½☆	★★★½☆	★★★★☆
Overall rating	★★★★½	★★★★☆	★★★★½	★★★★☆	★★★★½
OS (out of box)	iOS 10	Android 5.0 Lollipop	iOS 10	iOS 10	Android 4.4 KitKat
Processor	Apple A8X, Apple M8	1.9GHz Exynos 5433	Apple A9X, Apple M9	Apple A8, Apple M8	2.5GHz Snapdragon 801
RAM	2GB	3GB	3GB	2GB	3GB
Storage	16/64/128GB	32GB/64GB	32GB/128GB/256GB	16GB/64/128GB	16GB/32GB
MicroSD support	✘	Up to 128GB	✘	✘	Up to 128GB
Graphics	Apple A8X	Not specified	Apple A9X	Apple A8	Adreno 330
Screen size	9.7in	8in	9.7in	7.9in	8in
Screen resolution	2048x1536	2048x1536	2048x1536	2048x1536	1920x1200
Pixel density	264ppi	320ppi	264ppi	326ppi	283ppi
Screen technology	IPS	Super AMOLED	IPS	IPS	IPS
Front camera	1.2Mp	2.1Mp	8Mp	1.2Mp	2.2Mp
Rear camera	8Mp	8Mp	12Mp, LED flash	8Mp	8.1Mp
Video recording	1080p	QHD	1080p	1080p	1080p
Cellular connectivity	4G version available	4G version available	4G version available	4G version available	4G version available
Wi-Fi	802.11a/b/g/n/ac, dual-band	802.11a/b/g/n/ac	802.11a/b/g/n/ac, dual-band	802.11a/b/g/n/ac, dual-band	802.11a/b/g/n/ac, dual-band
Bluetooth	Bluetooth 4.0	Bluetooth 4.1	Bluetooth 4.2	Bluetooth 4.2	Bluetooth 4.0
GPS	A-GPS, Glonass	A-GPS, Glonass	GPS in cellular model only	A-GPS, Glonass	A-GPS, Glonass
NFC	✘	✘	✘	✘	✓
USB OTG	✘	✓	✘	✘	✓
Fingerprint scanner	✓	✘	✓	✓	✘
Waterproof	✘	✘	✘	✘	✓
Extra features	None	None	Stereo speakers	None	PS4 Remote Play, stereo speakers
Geekbench 3.0 (single)	1816	Not tested	Not tested	1719	Not tested
Geekbench 3.0 (multi)	4523	4305	5257	3101	2708
JetStream	Not tested	Not tested	142	Not tested	1017ms
GFXBench: T-Rex	48fps	26fps	60fps	52fps	28fps
GFXBench: Manhattan	Not tested	11fps	34fps	25fps	11fps
Battery	7340mAh, non-removable	4000mAh, non-removable, Qi	7306mAh, non-removable	5124mAh, non-removable	4500mAh, non-removable
Dimensions	240x169.5x6.1mm	198.6x134.8x5.6mm	170x240x6.1mm	203.2x134.8x6.1mm	213x124x6.4mm
Weight	437g	265g	437g	304g	270g
Warranty	1 year	1 year	1 year	1 year	1 year
FULL REVIEW	TINYURL.COM/PLQXWSZ	TINYURL.COM/P37QFDW	TINYURL.COM/HFY7T4Z	TINYURL.COM/PBMONMA	TINYURL.COM/NJ6VHEO

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Best tablets	**6** Google Pixel C	**7** Huawei MediaPad M3	**8** Amazon Fire	**9** Sony Xperia Z4 Tablet	**10** Xiaomi Mi Pad 2
Price	£399 inc VAT	£299 inc VAT	£49 inc VAT	£499 inc VAT	£144 inc VAT
Website	Google.co.uk	Consumer.huawei.com/uk	Amazon.co.uk	Sony.co.uk	Mi.com/en
Build rating	★★★★½	★★★★½	★★★★½	★★★★½	★★★★½
Features rating	★★★★½	★★★½☆	★★★★½	★★★★½	★★★★☆
Performance rating	★★★★½	★★★½☆	★★★★☆	★★★★½	★★★★½
Value rating	★★★★½	★★★★☆	★★★☆☆	★★★½☆	★★★★★
Overall rating	★★★★½	★★★★☆	★★★★☆	★★★★½	★★★★½
OS (out of box)	Android 6.0 Marshmallow	Android 6.0 Marshmallow	FireOS 5	Android 5.0 Lollipop	Android 5.1 Lollipop
Processor	Nvidia Tegra X1	Hisilicon Kirin 950	1.3GHz quad-core	Snapdragon 810	Intel Atom X5-Z8500
RAM	3GB	3GB	1GB	3GB	2GB
Storage	32GB/64GB	32GB/64GB	8GB	32GB	16GB/64GB
MicroSD support	✗	Up to 256GB	Up to 128GB	Up to 128GB	✗
Graphics	Nvidia Tegra X1	Mali-T880 MP4	Mali 450	Adreno 430	Intel HD Graphics
Screen size	10.2in	8.4in	7in	10.1in	7.9in
Screen resolution	2560x1800	2560x1600	1024x600	2560x1600	2048x1536
Pixel density	308ppi	359ppi	171ppi	299ppi	326ppi
Screen technology	IPS	IPS	IPS	IPS	IPS
Front camera	2Mp	8Mp	VGA	5.1Mp	5Mp
Rear camera	8Mp	8Mp	2Mp	8.1Mp	8Mp
Video recording	1080p	1080p	Not specified	1080p	Not specified
Cellular connectivity	✗	✗	✗	4G version available	✗
Wi-Fi	802.11a/b/g/n/ac, dual-band	802.11a/b/g/n/ac	802.11a/b/g/n	802.11a/b/g/n/ac, dual-band	802.11a/b/g/n/ac, dual-band
Bluetooth	Bluetooth 4.1	Bluetooth 4.1	Bluetooth 4.0	Bluetooth 4.1	Bluetooth 4.1
GPS	✗	✗	✗	A-GPS, Glonass	✗
NFC	✗	✗	✗	✓	✗
USB OTG	✗	✗	✗	✓	✗
Fingerprint scanner	✗	✓	✗	✗	✗
Waterproof	✗	✗	✗	✗	✗
Extra features	None	None	None	None	None
Geekbench 3.0 (single)	Not tested	Not tested	Not tested	Not tested	Not tested
Geekbench 3.0 (multi)	4048	5060 (Geekbench 4.0)	Not tested	4573	3280
JetStream	Not tested	Not tested	Not tested	580ms (SunSpider)	454
GFXBench: T-Rex	48fps	Not tested	Not tested	37fps	30fps
GFXBench: Manhattan	28fps	Not tested	Not tested	16fps	13fps
Battery	9000mAh, non-removable	5100mAh, non-removable	Not specified	6000mAh, non-removable	6190mAh, non-removable
Dimensions	242x179x7mm	215.5x124.2x7.3mm	191x115x10.6mm	254x167x6.1mm	200x133x7mm
Weight	517g	517g	313g	393g	322g
Warranty	1 year	1 year	1-year return-to-base	1 year	1 year
FULL REVIEW	TINYURL.COM/ZA79M7Z	TINYURL.COM/ZA79M7Z	TINYURL.COM/J3LJP7T	TINYURL.COM/JG34GZP	TINYURL.COM/H7DYTTL

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Best smartwatches

	1 Huawei Watch	2 Apple Watch Series 2	3 Motorola Moto 360 2	4 Samsung Gear S2	5 Fossil Q Founder
Price	£289 inc VAT	£369 inc VAT	£229 inc VAT	£199 inc VAT	£259 inc VAT
Website	Consumer.huawei.com/en	Apple.com/uk	Motorola.co.uk	Samsung.com/uk	Fossil.com/uk
Overall rating	★★★★☆	★★★★☆	★★★★☆	★★★★☆	★★★★☆
Operating system	Android Wear	iOS 10	Android Wear	Tizen-based OS	Android Wear
Compatibility	Android	iOS	Android, iOS	Android, iOS	Android, iOS
Display	1.4in 400x400 AMOLED	38mm, 340x272; 42mm, 390x312, AMOLED	1.37in 360x325 LCD	1.2in 360x360 AMOLED	1.5in, 360x326 LCD
Processor	Snapdragon 400	S2	Snapdragon 400	1GHz Exynos 3250	Intel Atom Z34XX
RAM	512MB	Not stated	512MB	512MB	1GB
Storage	4GB	4GB	4GB	4GB	4GB
Waterproof	✓	✓	✓	✓	✓
Battery	300mAh	273mAh	300mAh	250mAh	400mAh
Dimensions	42x11.3mm	38.6/42.5x33.3/36.4mm	42x11.4mm	42.3x49.8x11.4mm	47x13mm
Weight	40g	28.2g/34.2g	53.6g	47g	156g
Warranty	1 year	1 year	1 year	1 year	1 year
FULL REVIEW	TINYURL.COM/PXV9PVX	TINYURL.COM/HAT545L	TINYURL.COM/GUJR9XX	TINYURL.COM/P4UKB74	TINYURL.COM/Z3X6D6F

Best smartwatches

	6 Samsung Gear S3 Frontier	7 LG G Watch R	8 Asus ZenWatch 2	9 Motorola Moto 360	10 LG Watch Urbane
Price	£349 inc VAT	£195 inc VAT	£149 inc VAT	£199 inc VAT	£259 inc VAT
Website	Samsung.com/uk	Lg.com/uk	Uk.sasus.com	Motorola.co.uk	Lg.com/uk
Overall rating	★★★½☆	★★★★½	★★★★☆	★★★★½	★★★★☆
Operating system	Tizen-based OS	Android Wear	Android Wear	Android Wear	Android Wear
Compatibility	Android, iOS	Android	Android, iOS	Android	Android
Display	1.3in 360x360 Super AMOLED	1.3in 320x320 P-OLED	1.63in 320x320 LCD	1.56in 290x320 LCD	1.3in 320x320 P-OLED
Processor	1GHz Dual-core	1.2GHz Snapdragon 400	1.2GHz Snapdragon 400	TI OMAP 3	1.2GHz Snapdragon 400
RAM	768MB	512MB	512MB	512MB	512MB
Storage	4GB	4GB	4GB	4GB	4GB
Waterproof	✓	✓	✓	✓	✓
Battery	380mAh	410mAh	300mAh	320mAh	410mAh
Dimensions	46x49x12.97mm	46.4x53.6x9.7mm	40.7x49.6x10.9mm	46x11.5mm	46x52x10.9mm
Weight	62g (without strap)	62g	50g	49g (leather band model)	67g
Warranty	1 year	1 year	1 year	1 year	1 year
FULL REVIEW	TINYURL.COM/GSSNXZM	TINYURL.COM/QATY8FT	TINYURL.COM/ZVRZLNJ	TINYURL.COM/O9C69K6	TINYURL.COM/Q3VK7ES

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Best activity trackers	1 Fitbit Charge 2	2 Apple Watch Series 2	3 Fitbit Charge HR	4 Fitbit Alta	5 Withings Steel HR
Price	£129 inc VAT	£369 inc VAT	£119 inc VAT	£99 inc VAT	£179 inc VAT
Website	Fitbit.com/uk	Apple.com/uk	Fitbit.com/uk	Fitbit.com/uk	Withings.com/uk
Overall rating	★★★★½	★★★★☆	★★★★½	★★★★☆	★★★★☆
Compatibility	iOS, Android, Windows	iOS	iOS, Android, Windows	iOS, Android, Windows	iOS, Android
Display	OLED	AMOLED	OLED	OLED	OLED
Pedometer	✓	✓	✓	✓	✓
Heart-rate monitor	✓	✓	✓	✗	✓
Sleep tracking	✓	✗	✓	✓	✓
Alarm	✓	✓	✓	✓	✓
Third-party app synching	✓	✓	✓	✓	✗
Call notifications	✓	✓	✓	✓	✓
Waterproof	✓	✓	✓	✓	✓
Battery life	5 days	18 hours	5+ days	5 days	25 days
Weight	35g	28.2g/34.2g	26g	32g	39/49g
FULL REVIEW	TINYURL.COM/Z3NN8RL	TINYURL.COM/HAT545L	TINYURL.COM/PCKV4SU	TINYURL.COM/ZO8TN2L	TINYURL.COM/HXHTT3O

Best activity trackers	6 Xiaomi Mi Band 2	7 Fitbit Surge	8 Misfit Ray	9 MyZone MZ-3	10 Fitbit One
Price	£33 inc VAT	£199 inc VAT	£79 inc VAT	£129 inc VAT	£79 inc VAT
Website	Mi.com/en	Fitbit.com/uk	Misfit.com	Myzone.org	Fitbit.com/uk
Overall rating	★★★★½	★★★★½	★★★★½	★★★½☆	★★★★½
Compatibility	iOS, Android	iOS, Android, Windows	iOS, Android	iOS, Android, Windows	iOS, Android
Display	OLED	Touchscreen	✗	✗	OLED
Pedometer	✓	✓	✓	✗	✓
Heart-rate monitor	✓	✓	✗	✓	✗
Sleep tracking	✓	✓	✓	✗	✓
Alarm	✓	✓	✓	✗	✓
Third-party app synching	✓	✓	✓	✗	✓
Call notifications	✓	✓	✓	✗	✗
Waterproof	✓	✓	✓	✓	✗
Battery life	20-day	5 days	6 months	7 months	10-14 days
Weight	7g (tracker only)	51g	8g	Not stated	8g
FULL REVIEW	TINYURL.COM/ZAF6OAW	TINYURL.COM/O83DR47	TINYURL.COM/JG3XVT9	TINYURL.COM/HK5JOXX	TINYURL.COM/PT2TC6F

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Best printers	1 Canon Pixma MG7550	2 Samsung Xpress M2835DW	3 Brother HL-L9200CDWT	4 HP LaserJet Pro M277dw	5 HP OfficeJet 7510
Price	£130 inc VAT	£143 inc VAT	£548 inc VAT	£258 inc VAT	£129 inc VAT
Website	Canon.co.uk	Samsung.com/uk	Brother.co.uk	Hp.com/uk	Hp.com/uk
Overall rating	★★★★½	★★★★½	★★★★½	★★★★☆	★★★★☆
Technology	Colour inkjet	Mono laser	Colour laser	Colour laser	Colour inkjet
Max print resolution	9600x2400dpi	4800x600dpi	2400x600dpi	300dpi	1200x600dpi
Actual print speed	B=14.3ppm	B=22.7ppm	B=30ppm C=30ppm	B=15ppm C=13ppm	B=12.5ppm C=7.5ppm
Scan/fax facilities	2400x4800dpi scanner	None	None	1200x1200dpi scanner, 300x300dpi fax	1200x1200dpi scanner, 300x300dpi fax
Supported interfaces	USB 2.0, ethernet, 802.11b/g/n	USB 2.0, ethernet, 802.11b/g/n	USB 2.0, ethernet, 802.11b/g/n	USB 2.0, ethernet, 802.11b/g/n	USB 2.0, ethernet, 802.11b/g/n
Cost per page	B=2.4p C=8.1p	B=1.5p	B=1p C=5.9p	B=2.2p C=9p	B=1.7p C=3.3p
Media card/auto duplex	✗✓	✗✓	✗✓	✗✓	✗✓
Input capacity	125 sheets	250 sheets	750 sheets + 50 sheet	150 sheets + 50 sheet	250 sheets + 75 sheet
Dimensions	435x370x148mm	368x335x202mm	410x495x445mm	420x417x322mm	613x725x287mm
Weight	7.9kg	7.4kg	28.3kg	16.3kg	13kg
Warranty	1 year	1 year	1 year	1 year	1 year
FULL REVIEW	TINYURL.COM/PZ3SVH7	TINYURL.COM/QECOF7V	TINYURL.COM/PT52MH6	TINYURL.COM/GPXACL7	TINYURL.COM/HDXF85Y

Best printers	6 Epson EcoTank ET-2500	7 Epson Expression XP-640	8 HP LaserJet Pro MFP M130nw	9 Ricoh SP 150SUw	10 Canon Pixma MG3650
Price	£229 inc VAT	£119 inc VAT	£150 inc VAT	£129 inc VAT	£61 inc VAT
Website	Epson.co.uk	Epson.co.uk	Hp.com/uk	Ricoh.co.uk	Canon.co.uk
Overall rating	★★★★☆	★★★★☆	★★★★☆	★★★★☆	★★★½☆
Technology	Colour inkjet	Colour inkjet	Mono laser	Mono laser	Colour inkjet
Max print resolution	5760x1440dpi	5760x1440dpi	600x600dpi	1200x600dpi	4800x1200dpi
Actual print speed	B=7.5ppm C=4ppm	B=12ppm C=8ppm	B=22ppm	B=20ppm	B=9ppm C=5ppm
Scan/fax facilities	2400x4800dpi scanner	2400x1200dpi scanner	600dpi scanner	1200dpi scanner	2400x1200dpi scanner
Supported interfaces	USB 2.0, ethernet, 802.11b/g/n	USB 2.0, 802.11b/g/n, AirPrint	USB 2.0, ethernet, 802.11b/g/n	USB 2.0, 802.11b/g/n	USB 2.0, 802.11b/g/n, AirPrint
Cost per page	B=0.2p C=0.4p	B=3.4p C=9.7p	B=3.5p	B=6p	B=2.8p C=4.5p
Media card/auto duplex	✗✗	✗✓	✗✓	✗✗	✗✓
Input capacity	100 sheets	100 sheets + 20 sheets	150 sheets + 100 sheets	50 sheets	100 sheets
Dimensions	169x489x300mm	130x385x335mm	230x383x260mm	350x275x137mm	152x449x304mm
Weight	4.6kg	6.7kg	7.6kg	7.5kg	5.4kg
Warranty	1 year	1 year	1 year	1 year	1 year
FULL REVIEW	TINYURL.COM/ZWCECPA	TINYURL.COM/GSOR6KU	TINYURL.COM/ZEMNEJ9	TINYURL.COM/GVQ5XCT	TINYURL.COM/J8CNOV2

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Best wireless routers	1	2	3	4	5
	Apple AirPort Extreme	TP-Link Archer VR900	BT Smart Hub	Netgear Nighthawk R7000	TP-Link VR2600
Price	£169 inc VAT	£139 inc VAT	£129 inc VAT	£150 inc VAT	£174 inc VAT
Website	Apple.com/uk	Tp-link.com	Bt.com	Netgear.co.uk	Tp-link.com
Overall rating	★★★★☆	★★★★½	★★★★★	★★★★½	★★★★½
Standards supported	802.11a/b/g/n/ac	802.11a/b/g/n/ac	802.11a/b/g/n/ac	802.11a/b/g/n/ac	802.11a/b/g/n/ac
Frequency modes	2.4GHz/5GHz (concurrent)	2.4GHz/5GHz (concurrent)	2.4GHz/5GHz (concurrent)	2.4GHz/5GHz (concurrent)	2.4GHz/5GHz (concurrent)
Antennas	6x internal	3x external	7x internal	3x external	4x external
Built-in modem	✗	✓	✓	✗	✓
Manufacturer's rating	1300/450Mb/s	1300/600Mb/s	Not specified	1300/600Mb/s	1733/800Mb/s
WPS	✗	✓	✓	✓	✓
Ports	Gigabit WAN, 3x gigabit LAN, USB	Gigabit WAN, 1x USB 3.0, 1x USB 2.0	Gigabit LAN, 1x USB 3.0	Gigabit WAN, 1x USB 3.0, 1x USB 2.0	2x USB 3.0, 4 x RJ11
Average power use	8W	N/S	N/S	9W	N/S
Max speed (11n/11ac)	171/572Mb/s	146/622Mb/s	85/239.5Mb/s	171/592Mb/s	Not tested
Dimensions, weight	98x168x98mm, 945g	245x181x90mm, 720g	240x155x65mm	285x186x45mm, 750g	263.8x197.8x37.3mm
Warranty	1 year	Not specified	Not specified	Not specified	Not specified
FULL REVIEW	TINYURL.COM/MFDLLSC	TINYURL.COM/OF8KYPC	TINYURL.COM/ZL9TV96	TINYURL.COM/Q2NRQ8Q	TINYURL.COM/Z6E2DMG

Best powerline adaptors	1	2	3	4	5
	TP-Link AV2000	TrendNet Powerline 500 AV2	TP-Link AV1200	Solwise SmartLink 1200AV2	Devolo dLan 1200+
Price	£99 inc VAT	£41 inc VAT	£88 inc VAT	£43 inc VAT	£119 inc VAT
Website	Uk.tp-link.com	Trendnet.com	Uk.tp-link.com	Solwise.com	Devolo.com/uk
Overall rating	★★★★½	★★★★½	★★★★☆	★★★★½	★★★★½
No of adaptors in kit	2	2	2	1 (2 required)	2
Max throughput	2000Mb/s	600Mb/s	1200Mb/s	1200Mb/s	1200Mb/s
Near test result	432Mb/s	146Mb/s	500Mb/s	410Mb/s	357Mb/s
Far test result	117Mb/s	71Mb/s	200Mb/s	107Mb/s	126Mb/s
Ethernet ports	2x gigabit	1x gigabit	1x gigabit	2x gigabit	1x gigabit
Passthrough socket	Yes	No	Yes	Yes	Yes
Wireless hotspot	No	No	No	No	No
Encryption	128-bit	128-bit	128-bit	128-bit	128-bit
Dimensions	131x72x42mm	55x87x58mm	230x190x100mm	62x122x41mm	130x66x42mm
Weight	Not specified	90g	898g	Not specified	Not specified
Warranty	1 year	3 years	1 year	2 years	3 years
FULL REVIEW	TINYURL.COM/H9W89QM	TINYURL.COM/QYEPJQ7	TINYURL.COM/NVONCWT	TINYURL.COM/NZ4EJW8	TINYURL.COM/Q4EOO4M

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Best NAS drives

	1 Synology 216+II	2 Asustor AS1004T	3 Qnap TS-251A	4 WD My Cloud Mirror 4TB	5 Synology DS115j
Price	£239 inc VAT (diskless)	£239 inc VAT (diskless)	£249 inc VAT (diskless)	£239 inc VAT (diskless)	£83 inc VAT (diskless)
Website	Synology.com	Asustor.com	Qnap.com	Wdc.com	Synology.com
Overall rating	★★★★½	★★★★½	★★★★½	★★★★☆	★★★★☆
Drive bays	2	4	2	2	1
Processor	1.6GHz Intel Celeron N3060	1GHz Marvell ARMADA-385	1.6GHz Intel Celeron N3060	1.3GHz Marvell ARMADA-385	800MHz Marvell Armada 370
Memory	1GB DDR3	512MB	2GB DDR3	512MB	256MB DDR3
Remote access	✓	✓	✓	✓	✓
eSATA	✓	✗	✗	✗	✗
USB port	2x USB 3.0, USB 2.0	2x USB 3.0	3x USB 3.0, HDMI, USB 3.0 micro B	1x USB 3.0	2x USB 2.0
Raid options	0/1/JBOD/Basic/Synology Hybrid	0/1/5/6/10/JBOD	0/1/JBOD	0/1/JBOD	None
Software	DSM 6.1	Control Center	QTS 4.2	My Cloud	DSM 5.1
Dimensions	108x165x233.2mm	218x2165x164mm	102x169x219mm	139.9x170.6x49mm	71x161x224mm
Weight	1.25kg	1.5kg	1.28kg	1.6kg	700g
Warranty	2 years	3 years	2 years	2 years	1 year
FULL REVIEW	TINYURL.COM/JRWSCE3	TINYURL.COM/GLCBLG6	TINYURL.COM/JK6KQLN	TINYURL.COM/J76VSHR	TINYURL.COM/MNEYVNK

Best portable hard drives

	1 Adata SE730	2 Samsung Portable SSD T3	3 Transcend ESD400	4 SanDisk Extreme 500 Portable SSD	5 Western Digital My Passport
Price	£106 inc VAT	£606 inc VAT	£420 inc VAT	£70 inc VAT	£159 inc VAT
Website	Adata.com	Samsung.com/uk	Transcend-info.com	Sandisk.co.uk	Wdc.com
Overall rating	★★★★½	★★★★½	★★★★☆	★★★★☆	★★★★☆
Price per GB (at capacity tested)	46p	32p	39p	31p	4p
Capacity tested	250GB	2TB	256GB	240GB	4TB
Capacity range	250GB	250GB, 500GB, 1TB, 2TB	128GB, 256GB, 512GB, 1TB	120GB, 240GB, 480GB	1TB, 2TB, 3TB, 4TB
Storage	MLC NAND Flash	NAND Flash	NAND Flash	NAND Flash SSD	HDD
Sequential performance	380.8/278.5MB/s	406.9/211.2MB/s	410.8/163.8MB/s	398.3/203.4MB/s	119.3/112.8/s
4K performance	19.8/38.9MB/s	21.9/2.3MB/s	16.1/2.7MB/s	19.8/3.7MB/s	0.5/1.6MB/s
Other interfaces	USB 3.1 Gen 2 Type-C	USB 3.1 Gen 2 Type-C	USB 3.0	USB 3.0	USB 3.0
Encryption	None	256-bit AES	None	128-bit AES	256-bit AES
Software	None	T3 Security Enabler	Transcend Elite Data Management	SanDisk SecureAccess	WD Backup, WD Utilities
Dimensions	44x73x12mm	58x74x10mm	92x62x10.5mm	75.7x75.7x10.7mm	81.5x110x16.3mm
Weight	33g	51g	56g	79g	245g
Warranty	3 years	3 years	3 years	3 years	2 years
FULL REVIEW	TINYURL.COM/OABWL4B	TINYURL.COM/M72D3EP	TINYURL.COM/J43SQM5	TINYURL.COM/HNKNV3M	TINYURL.COM/GP6JNCM

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Best SSDs	1 Samsung 850 Evo (500GB)	2 Toshiba Q300 (480GB)	3 Samsung 960 Pro (512GB)	4 Samsung 960 Evo (1TB)	5 Samsung 850 Pro (1TB)
Price	£109 inc VAT	£79 inc VAT	£311 inc VAT	£404 inc VAT	£365 inc VAT
Website	Samsung.com/uk	Toshiba.co.uk	Samsung.com/uk	Samsung.com/uk	Samsung.com/uk
Overall rating	★★★★½	★★★★½	★★★★½	★★★★½	★★★★½
Price per GB	23p	18p	65p	43p	36.5p
4K performance	36.3/106.2MB/s	29.8/65.1MB/s	41.5/165.9MB/s	32.8/50.2MB/s	36/89MB/s
Sequential performance	525.4/512.1MB/s	529.3/511.5MB/s	2048.8/1822.7MB/s	1717.8/1729.8MB/s	508/482MB/s
Memory cache	512MB DDR3 SDRAM	Unknown	512MB DDR3	1GB	1GB LPDDR2
Controller	Samsung MGX	Toshiba TC58NC1000	Samsung Polaris	Samsung Polaris	Samsung MCX
Encryption	AES 256-bit	None	AES 256-bit	AES 256-bit	AES 256-bit
Flash	Samsung 3D V-NAND	TLC NAND	Samsung V-NAND	Samsung V-NAND	Samsung 40nm V-NAND MLC
Connection	SATA III 6GB/s	SATA III 6GB/s	NVMe 1.2	NVMe 1.2	SATA III 6GB/s
Power consumption	4.7W active/0.5W idle	3.6W active/0.3W idle	5.1W active/0.4W idle	5.7W active/0.4W idle	5.8W active/0.6W idle
Warranty	5 years	3 years	5 years	3 years	10 years
Dimensions	69.85x100x6.8mm	69.85x100x7mm	22.15x80.15x2.38mm	22.15x80.15x2.38mm	69.85x100x6.8mm
FULL REVIEW	TINYURL.COM/JB2VWLF	TINYURL.COM/ZZBWFJZ	TINYURL.COM/JOQMWUE	TINYURL.COM/HBSLQJD	TINYURL.COM/OVHDALD

Smart thermostats	1 Heat Genius	2 Honeywell EvoHome	3 Nest Learning Thermostat	4 Hive Active Heating 2	5 Tado
Price (from)	£249 inc VAT	£249 inc VAT	£199 inc VAT	£179 inc VAT	£199 inc VAT
Website	Heatgenius.co.uk	Honeywelluk.com	Nest.com	Hivehome.com	Tado.com/gb
Overall rating	★★★★☆	★★★★☆	★★★★☆	★★★★☆	★★★★☆
Zones controlled	6	12	1	1	1
Hot water control	✓	✓	✗	✓	✓
Underfloor heating	✗	✓	✗	✗	✗
Warranty	2 years	18 months	2 years	1 year	1 year
Verdict	Heat Genius is very good at a very useful thing. It is easy to use and efficient. How long it takes to pay for itself will depend on your circumstances, and it may be that a full system is too much of a long-term investment for you. If you are looking to install in your a zoned smart heating system, we are happy to recommend Heat Genius.	EvoHome is the best smart heating system we've tested. It isn't perfect though, and it's also very expensive, or can be. But if you value convenience and comfort above saving money, it's the one to buy.	If you need only a single thermostat and don't need control over hot water, the Nest is a good choice. The Nest Protect smoke and carbon monoxide alarm also works with the thermostat, but it's not cheap. There's also the Nest Cam, but the tie-in with the thermostat is minimal.	The Hive Active Heating system is a great upgrade for anyone that wants or needs the ability to be able to control their heating remotely. It's by no means the most advanced smart thermostat, but it will do the job at a good price for a lot of people.	Tado is the best smart thermostat if you like the idea of presence detection as it simply follows you and your smartphone via GPS, and turns the heating up or down as you get further away or nearer home. There's also hot water control, but the thermostat itself isn't the best looking.
FULL REVIEW	TINYURL.COM/Q2TUKL9	TINYURL.COM/Q3CXA4Z	TINYURL.COM/N9MWV4G	TINYURL.COM/PDLCSAS	TINYURL.COM/O4K3A2A

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Best graphics cards	1 Asus ROG Strix GTX 1080	2 MSI GTX 1070 Gaming X 8G	3 Zotac GeForce GTX 1050 Ti	4 Nvidia GTX 1080 Founders Ed	5 Nvidia GTX 1060 Founders Ed
Price	£659 inc VAT	£419 inc VAT	£149 inc VAT	£619 inc VAT	£275 inc VAT
Website	Asus.com/uk	Uk.msi.com	Zotac.com	Nvidia.co.uk	Nvidia.co.uk
Overall rating	★★★★½	★★★★½	★★★★½	★★★★☆	★★★★☆
Graphics processor	Nvidia GeForce GTX 1080	Nvidia GeForce GTX 1070	Nvidia GeForce GTX 1050 Ti	Nvidia GeForce GTX 1080	Nvidia GeForce GTX 1060
Installed RAM	8GB	8GB	4GB DDR5	8GB	6GB
Memory interface	256-bit	256-bit	128-bit	256-bit	192-bit
Core clock/boost	1759/1898MHz	1607/1797MHz	1392/506MHz	1607/1733MHz	1506/1708MHz
Memory clock	10,010MHz	4006MHz	7GHz	10,000MHz	4006MHz
Stream processors	2560	1920	768	2560	1280
Texture units	160	120	48	160	80
Power connectors	1x 8-pin, 1x 6-pin	1x 8-pin, 1x 6-pin		1x 8-pin	2x 6-pin
DirectX	12	12	12	12	12
Digital interface	DVI, 2x HDMI, 2x DisplayPort	DVI, HDMI, 3x DisplayPort	DVI-D, HDMI, DisplayPort	DVI, HDMI, 3x DisplayPort	DVI, HDMI 2.0, 3x DisplayPort 1.4
Warranty	3 years	3 years	3 years	3 years	3 years
FULL REVIEW	TINYURL.COM/HL4SOJ2	TINYURL.COM/J6HWN55	TINYURL.COM/J6HWN55	TINYURL.COM/ZEQXYQU	TINYURL.COM/HH6TYT8

Best graphics cards	6 XFX Radeon RX 480	7 Palit GeForce GTX 1050	8 XFX AMD Radeon RX460	9 Sapphire Radeon R7 250X	10 Asus GeForce GTX 980 Ti
Price	£249 inc VAT	£107 inc VAT	£129 inc VAT	£65 inc VAT	£639 inc VAT
Website	Novatech.co.uk	Palit.com	Xfxforce.com	Sapphiretech.com	Asus.com/uk
Overall rating	★★★★☆	★★★★☆	★★★★☆	★★★★½	★★★★★
Graphics processor	AMD Radeon RX480	Nvidia GeForce GTX 1050	AMD Radeon RX 460	AMD Radeon R7 250X	nVidia GeForce GTX 980 Ti
Installed RAM	8GB	2GB GDDR5	4GB GDDR5	1GB GDDR5	12GB
Memory interface	256-bit	128-bit	128-bit	128-bit	384-bit
Core clock/boost	1120/1288MHz	1345/1455MHz	1220MHz	950MHz	1216/1317MHz
Memory clock	7000MHz	7GHz	7GHz	1125/4500MHz	7200MHz
Stream processors	2304	640	896	640	2816
Texture units	144	40	56	40	172
Power connectors	1x 6-pin	None	1x 6-pin	1x 6-pin	2x 8-pin
DirectX	12	12	12	12	12
Digital interface	3x DP 1.4, HDMI	DVI-D, HDMI, DisplayPort	DVI-D, HDMI, DisplayPort	1x DVI, HDMI, DisplayPort	DVI, HDMI 2.0, 3x DisplayPort 1.2
Warranty	2 years	2 years	3 years	2 years	3 years
FULL REVIEW	TINYURL.COM/HSVQWBQ	TINYURL.COM/JSJK88H	TINYURL.COM/JKSP5OE	TINYURL.COM/OLJ83SQ	TINYURL.COM/NDZZQKJ

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Best 4K flat-panel TVs	1 Panasonic TX-50CX802B	2 Samsung UE48JU7000	3 Sony KD-55X8505C	4 Philips 40PUT6400	5 Finlux 55UX3EC320S
Price	£1,299 inc VAT	£1,200 inc VAT	£1,200 inc VAT	£449 inc VAT	£799 inc VAT
Website	Panasonic.co.uk	Samsung.com/uk	Sony.co.uk	Philips.co.uk	Finlux.co.uk
Overall rating	★★★★½	★★★★½	★★★★☆	★★★★☆	★★★½☆
Screen size	50in	48in	55in	40in	55in
Panel type	LCD (LED)	LCD (LED)	LCD (LED)	LCD (LED)	LCD (LED)
Native resolution	3840x2160	3840x2160	3840x2160	3840x2160	3840x2160
3D enabled	✓	✓	✓	✗	✗
Apps	BBC iPlayer, ITV Player, All 4, Demand 5, Netflix, YouTube, Amazon	BBC iPlayer, ITV Player, All 4, Netflix, Amazon, YouTube and apps store	YouView with BBC iPlayer, ITV Player, All 4 and Demand 5; Netflix, YouTube, Amazon	BBC iPlayer, Netflix, YouTube, Spotify Connect, Daily Motion, Philips App Store, Google Play	BBC iPlayer, Netflix, YouTube, Twitter, Facebook, Viewster, Flickr
Networking	Ethernet, Wi-Fi, Wi-Fi Direct	Ethernet, Wi-Fi, Wi-Fi Direct	Ethernet, Wi-Fi, Wi-Fi Direct	Ethernet, Wi-Fi, Wi-Fi Direct	Ethernet, Wi-Fi
Inputs	3x HDMI, 3x USB	4x HDMI, 3x USB	4x HDMI, 3x USB	4x HDMI, 3x USB	4x HDMI, 3x USB
Dimensions	112.1x4.6x65.2cm	108.7x6.7x63cm	123.6x6x72.2cm	90.4x8.3x52.6m	123.3x10.6x71.3cm
Weight	18kg	11.1kg	19.9kg	7.8kg	17.2kg
Warranty	1 year	1 year	1 year	1 year	1 year
FULL REVIEW	TINYURL.COM/ZLFQ3JV	TINYURL.COM/Q2W3VZY	TINYURL.COM/ZGSP9FM	TINYURL.COM/JQVWCFU	TINYURL.COM/P934VXT

Best 4K flat-panel displays	1 BenQ BL3201PT	2 Philips BDM4065UC	3 BenQ RL2460HT	4 AOC G2460VQ6	5 ViewSonic VX2457-mhd
Price	£699 inc VAT	£600 inc VAT	£168 inc VAT	£122 inc VAT	£139 inc VAT
Website	Benq.co.uk	Philips.co.uk	Benq.co.uk	Aoc-europe.coom	Viewsoniceurope.com/uk
Overall rating	★★★★☆	★★★★☆	★★★★½	★★★★☆	★★★★☆
Screen size	32in	40in	24in	24in	23.6in
Panel type	IPS	VA	TN matt	TN matt	TN matt
Native resolution	3840x2160	3840x2160	1920x1080	1920x1080	1920x1080
Pixel density	157ppi	110ppi	92ppi	92ppi	93ppi
Brightness	350cd/m²	120cd/m²	250cd/m²	250cd/m²	300cd/m²
Static contrast ratio	1000:1	5000:1	1000:1	1000:1	1000:1
Response time	4ms	8.5ms	1ms	1ms	2ms
Ports	DVI-DL, HDMI, DP, mDP	HDMI, DP, mDP, VGA	2x HDMI, DVI, VGA, Aux in/out, HDMI out	DP, HDMI, VGA, Aux in/out	DP, HDMI, VGA, Aux in/out
Dimensions	490.2x740.3x213.4mm	904x512x88mm	579x213x502mm	565.4x219.3x411.6mm	558.7x229.6x422.4mm
Weight	12.5kg	8.5kg	5.2kg	4.27kg	4.08kg
Warranty	3 years	2 years	3 years	3 years	2 years
FULL REVIEW	TINYURL.COM/NPA62QL	TINYURL.COM/Q2W3VZY	TINYURL.COM/ZA48HDY	TINYURL.COM/HOGLYL3	TINYURL.COM/HBVD2GD

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Best e-book readers

	1 Amazon Kindle Voyage	2 Amazon Kindle Oasis	3 Amazon Kindle (8th gen)	4 Amazon Kindle Paperwhite	5 Amazon Kindle (7th gen)
Price	£169 inc VAT	£269 inc VAT	£59 inc VAT	£109 inc VAT	£59 inc VAT
Website	Amazon.co.uk	Amazon.co.uk	Amazon.co.uk	Amazon.co.uk	Amazon.co.uk
Overall rating	★★★★☆	★★★★☆	★★★½☆	★★★★☆	★★★½☆
Screen size	6in touchscreen	6in touchscreen	6in touchscreen	6in touchscreen	6in touchscreen
Screen technology	E Ink	E Ink	E Ink	E Ink	E Ink
Screen resolution	1440x1080	1440x1080	600x800	768x1024	600x800
Built-in light	✓	✓	✗	✓	✗
Storage	4GB	4GB	4GB	2GB	4GB
Book store	Amazon Kindle	Amazon Kindle	Amazon Kindle	Amazon Kindle	Amazon Kindle
Cellular connectivity	Optional extra	Optional extra	✗	Optional extra	✗
Battery life	Six weeks	Eight weeks	Four weeks	Eight weeks	Four weeks
Dimensions	162x115x7.6mm	143x122x8.5mm	160x115x9.1mm	117x169x9.1mm	169x119x10.2mm
Weight	180g	131g	161g	206g	191g
Warranty	1 year	1 year	1 year	1 year	1 year
FULL REVIEW	TINYURL.COM/NXAAU3Q	TINYURL.COM/Z924POY	TINYURL.COM/HJONZA4	TINYURL.COM/PREZPRK	TINYURL.COM/NSFORJE

Best media streamers

	1 Roku Streaming Stick	2 Roku 3	3 Google Chromecast 2	4 Amazon Fire TV Stick	5 Google Chromecast Ultra
Price	£49 inc VAT	£99 inc VAT	£30 inc VAT	£35 inc VAT	£69 inc VAT
Website	Roku.com	Roku.com	Play.google.com	Apple.com/uk	Play.google.com
Overall rating	★★★★½	★★★★☆	★★★★☆	★★★★☆	★★★★½
Type	Dongle	Set-top box	Dongle	Dongle	Dongle
Ports	HDMI, Micro-USB	HDMI, USB, ethernet	HDMI, Micro-USB	HDMI, Micro-USB	HDMI, Micro-USB
Processor	600MHz single-core	900MHz single-core	13.GHz dual-core	Dual-core	Not specified
RAM	512MB	512MB	512MB	1GB	Not specified
Graphics	Not specified	Not specified	Not specified	Not specified	Not specified
Storage	None	512MB, plus microSD slot	None	8GB (not user-accessible)	None
Voice search	✗	✓	✗	✗	No
Remote control	✓	✓	✗	✓	No
Dimensions	78.7x27.9x12.7mm	89x89x25mm	52x52x13.5mm	84.9x25x11.5mm	58.2x13.7x58.2mm
Weight	18g	170g	39g	25g	Device 47g; adaptor 101g
Warranty	1 year	1 year	1 year	1 year	1 year
FULL REVIEW	TINYURL.COM/OAP9QF9	TINYURL.COM/PT7MGUL	TINYURL.COM/Q4B6B29	TINYURL.COM/NAQRNOC	TINYURL.COM/ZZJD5KQ

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Best games consoles

	1 Sony PlayStation 4 Pro	2 Microsoft Xbox One S	3 Sony PlayStation 4 Slim	4 Sony PlayStation 4	5 Microsoft Xbox One
Price	£349 inc VAT	£349 inc VAT	£259 inc VAT	£259 inc VAT	£349 inc VAT
Website	Playstation.com	Xbox.com	Playstation.com	Playstation.com	Xbox.com
Overall rating	★★★★½	★★★★☆	★★★★☆	★★★★☆	★★★★☆
Processor	Octa-core AMD x86-64	1.75GHz octa-core AMD x86	Octa-core AMD x86	Octa-core AMD x86	1.75GHz octa-core AMD x86
Graphics	4.2TFlops AMD Radeon GPU	AMD Radeon GPU at 914MHz	1.84TFlops AMD Radeon GPU	1.84TFlops AMD Radeon GPU	1.31TFlops AMD Radeon GPU
RAM	8GB GDDR5	8GB DDR3	8GB GDDR5	8GB GDDR5	8GB DDR3
Storage	1TB	500GB, 1TB or 2TB	500GB	500GB	500GB
Optical drive	Blu-ray, DVD, game discs	4K Blu-ray, DVD, game discs	Blu-ray, DVD, game discs	Blu-ray, DVD, game discs	Blu-ray, DVD, game discs
Ports	3x USB 3.1, AUX, HDMI	3x USB 3.0, HDMI 2.0, Kinect port	2x USB 3.0, AUX, HDMI	2x USB 3.0, AUX, HDMI	USB 3.0, HDMI
Connectivity	Ethernet, 802.11b/g/n/ac, Bluetooth	Ethernet, 802.11b/g/n/ac	Ethernet, 802.11b/g/n, Bluetooth	Ethernet, 802.11b/g/n, Bluetooth	Ethernet, 802.11b/g/n
Other	1 controller	1 controller, 4K, Kinect option	1 controller	1 controller	1 controller, 4K, Kinect option
Dimensions	327x295x55mm	3294x226x64mm	275x53x305mm	275x53x305mm	333x274x79mm
Weight	3.3kg	2.9kg	2.8kg	2.8kg	3.2kg
Warranty	1 year	1 year	1 year	1 year	1 year
FULL REVIEW	TINYURL.COM/HCNB3XP	TINYURL.COM/HWO8PJU	TINYURL.COM/HUL2J8Q	TINYURL.COM/NBFLQK2	TINYURL.COM/M6J4KHS

Best budget portable speakers

	1 Denon Envaya Mini	2 Sumvision Psyc Monic	3 Lava BrightSounds 2	4 UE Roll	5 Marsboy 5W Orb
Price	£99 inc VAT	£37 inc VAT	£39 inc VAT	£99 inc VAT	£38 inc VAT
Website	Denon.com	Sumvision.com	Lavaaccessories.co.uk	Ultimateears.com	Amazon.co.uk
Overall rating	★★★★½	★★★★½	★★★★½	★★★★½	★★★★☆
Speaker(s)	Not specified	Not specified	Not specified	Not specified	Not specified
Bluetooth	Bluetooth 4.0	Bluetooth 4.0	Bluetooth	Bluetooth	Bluetooth 4.1 + EDR
Handsfree calls	✓	✗	✓	✗	✗
NFC	✓	✗	✗	✓	✗
Frequency response	Not specified	90Hz to 20KHz	Not specified	108Hz to 20kHz	80Hz to 18kHz
Impedence	Not specified	Not specified	Not specified	Not specified	4 ohms
Extra features	IPX4 splashproof	None	IPX4 water resistance	IPX7 splashproof	MicroSD slot
Claimed battery life	10 hours	7 hours	36 hours	9 hours	12 hours
Dimensions	209x54x51mm	200x60x60mm	190x95x103mm	134x39x40mm	150x148x138mm
Weight	558g	Not stated	624g	330g	454g
Warranty	1 year	1 year	1 year	2 years	1 year
FULL REVIEW	TINYURL.COM/QDRNP3P	TINYURL.COM/JC8CZM2	TINYURL.COM/ZZ7HUDG	TINYURL.COM/O7T7ZUU	TINYURL.COM/JJLOPCD

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Best headphones	**1** B&W P9 Signature	**2** Bose QuietComfort 35	**3** Denon AH-D600	**4** Sharkk Bravo	**5** Denon AH-MM400
Price	£699 inc VAT	£289 inc VAT	£229 inc VAT	£249 inc VAT	£196 inc VAT
Website	Bowers-wilkins.co.uk	Bose.co.uk	Denon.co.uk	Sharkk.com	Denon.co.uk
Overall rating	★★★★½	★★★★½	★★★★½	★★★★☆	★★★★☆
Type	Circumaural over-ear	Circumaural over-ear	Circumaural over-ear	Circumaural over-ear	Circumaural over-ear
Frequency response	Not stated	Not stated	5Hz to 45kHz	6Hz to 45kHz	10Hz to 40kHz
Nominal impedance	Not stated	Not stated	25 ohms	32 ohms	32 ohms
Sensitivity	Not stated	Not stated	108dB	118dB	96dB
In-line remote	✗	✗	✓	✗	✓
Mic	✓	✓	✓	✗	✓
Extra tips	N/A	N/A	N/A	N/A	N/A
Carry case	✓	✓	✓	✓	✓
Cable length	Not stated	1.2m	3m	1.35m	Not stated
Weight	413g	310g	250g	294g	310g
Warranty	1 year	1 year	1 year	1 year	1 year
FULL REVIEW	TINYURL.COM/HDR2UUG	TINYURL.COM/JZWSSSQ	TINYURL.COM/NBCFJW6	TINYURL.COM/Z5BGX9X	TINYURL.COM/J7G56N9

Best headphones	**6** Final Audio Design Sonorous III	**7** Audio-Technica ATH-WS99	**8** Bose QuietComfort 20	**9** Bowers & Wilkins P5	**10** Kef M100
Price	£299 inc VAT	£79 inc VAT	£259 inc VAT	£249 inc VAT	£119 inc VAT
Website	Final-audio-design.com	Eu.audio-technica.com/en	Bose.co.uk	Bowers-wilkins.co.uk	Kef.com
Overall rating	★★★★½	★★★★☆	★★★★½	★★★★½	★★★★½
Type	Circumaural over-ear	Over-ear	In-ear	On-ear, foldable	In-ear
Frequency response	Not stated	8Hz to 25kHz	20-21kHz	10Hz to 20kHz	20Hz to 20kHz
Nominal impedance	25 ohms	37 ohms	32 ohms	22 ohms	50 ohms
Sensitivity	105dB	120dB	105dB	108dB	-25dB
In-line remote	✗	✓	✓	✗	✓
Mic	✗	✓	✓	✓	✓
Extra tips	N/A	N/A	✓	N/A	✓
Carry case	✗	✗	✓	✗	✓
Cable length	1.5m	0.8m	1.3m	1.2m	1.3m
Weight	410g	250g	44g	195g	18g
Warranty	1 year	1 year	1 year	1 year	1 year
FULL REVIEW	TINYURL.COM/JQW529E	TINYURL.COM/QDRCCAT	TINYURL.COM/OEAGFOF	TINYURL.COM/NNRV6UT	TINYURL.COM/Z384BD2

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PC ADVISOR TEST CENTRE

Best power banks

	1 Zendure A2 (2nd gen)	2 Anker PowerCore 10000	3 Omnicharge13	4 RavPower PowerStation	5 CHJDG UltraCompact
Price	£25 inc VAT	£20 inc VAT	£103 inc VAT	£99 inc VAT	£19 inc VAT
Website	Zendure.com	Anker.com	Omnicharge.co	Ravpower.com	Chargedpower.com
Overall rating	★★★★½	★★★★½	★★★★½	★★★★½	★★★★☆
Capacity	6700mAh	10,000mAh	13,600mAh	20,100mAh	10,000mAh
Input	1x 7.5W Micro-USB	1x 10W Micro-USB	DC 4.5-36V, 1W-34W	19V/1.6A DC	1x 5W Micro-USB
Outputs	1x 10.5W USB	1x QC 3.0 USB	2x 4.8A USB ports, plug socket	5V USB-C, 3A output	1x 10.5W USB
Auto-on/-off	✓	✓/✗	✗	✗/✗	✓/✗
Passthrough charging	✓	✗	✓	✗	✓
Status indicator	4 LEDs	4 LEDs	OLED display	5 LEDs	4 LEDs
LED flashlight	✗	✗	✗	✓	No
Carry case	✓	✗	✗	✓	No
Dimensions	93x48x23mm	92x60x22mm	135x85x23.5mm	69x69x146mm	93x19x63mm
Weight	137g	188g	365g	207g	181g
Warranty	1 year	1 year	1 year	18 months	1 year
FULL REVIEW	TINYURL.COM/NGCNO5F	TINYURL.COM/ZSREH65	TINYURL.COM/JL97MK5	TINYURL.COM/H48JZWL	TINYURL.COM/JMOUUUO

Best desktop chargers

		1 Tronsmart Titan	2 Tronsmart U5PTA	3 CHOEtech 6-port Charger	4 Aukey USB Charging Station	5 iClever USB Travel Charger
Price		£25 inc VAT	£22 inc VAT	£25 inc VAT	£17 inc VAT	£20 inc VAT
Website		Tronsmart.com	Tronsmart.com	Choetech.com	Hisgadget.com	Hisgadget.com
Overall rating		★★★★½	★★★★½	★★★★½	★★★★☆	★★★★☆
Max output		90W	54W	60W	54W	50W
Outputs:	USB 1	QC 2.0	QC 3.0	QC 2.0	QC 2.0	12W USB
	USB 2	QC 2.0	12W	QC 2.0	12W	12W USB
	USB 3	QC 2.0	12W	12W	12W	12W USB
	USB 4	QC 2.0	12W	12W	12W	12W USB
	USB 5	QC 2.0	12W	12W	12W	12W USB
	USB 6	N/A	N/A	12W	N/A	12W USB
Colours available		Black	Black	Black	Black	Black
Dimensions		160x81x28mm	165x156x56mm	71.5x29x88.4mm	94x60x25mm	100x69x27mm
Weight		292g	390g	158g	149g	180g
Warranty		1 year	18 months	1 year	1 year	1 year
FULL REVIEW		TINYURL.COM/GMVDCHM	TINYURL.COM/QG4X5D9	TINYURL.COM/QG4X5D9	TINYURL.COM/P2CZMCU	TINYURL.COM/MPA4DWC

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7 security threats to technology that scare experts

MARK
HACHMAN

What happens if a hacker turns off your heating, then demands £1,000 to turn it back on? Or even holds a town's power for ransom? Those kinds of attacks to personal, corporate and infrastructure technology were among the top concerns for security experts from the SANS Institute. Here are the seven biggest threats, according to SANS, and what, if anything, you can do about them.

1. Ransomware

Ransomware surfaced more than 20 years ago, but has since evolved into a frightening form of malware: crypto-ransomware, which encrypts your files and demands payment to unlock them. It's an ideal way for hackers to attack: ransomware spreads like a virus, locks up your data independently, and forces you to contact the criminals for payment and recovery.

What you can do: Practice 'network hygiene:' patching your system, using antimalware, and setting permissions and network-access controls to limit exposure.

2. The Internet of Things

The next stage of the evolution in consumer products is connectedness: everything from baby cameras to toothbrushes are using wireless protocols to connect to each other and the internet. That, in turn, has left them vulnerable to hacks. Worse still, IoT devices are now attack platforms, as the Mirai worm demonstrated.

What you can do: Change the default passwords. You can also insulate connected devices by disabling remote access, using a separate dedicated home LAN for IoT devices, as well as a dedicated cloud account for controlling them.

3. The intersection of ransomware and IoT

Last year, an Austrian hotel was hacked, disrupting its keycard system. Such attacks could eventually migrate to your home, holding your smart thermostat hostage until you pay up.

What you can do: This sort of attack is more theoretical than anything else, but it's something to think about as you start fitting out your home.

4. Attacks against the industrial IoT

In 2015 and again in 2016, unknown hackers took down power stations in the Ukraine, leveraging the growing trend of automated, distributed systems against the power company. Fortunately, first responders were able to manually flip the breakers and restore power, but there's no guarantee that will always be the case.

What you can do: As consumers, not much. Infrastructure organisations are going to have to decide whether to operate with intelligent systems or shut them down. Scaling up with increased automation can lower your bills, but the penalty may be increased vulnerability to attacks.

5. Weak random number generations

Truly random numbers are the basis of good encryption, but 'random' number generators aren't truly random, which makes the encryption they're based upon easier to crack. This gives an edge to criminals, who may exploit this and unlock 'secure' encrypted connections.

What you can do: This is a problem for device manufacturers to solve. Keep in mind that your 'secure' network may be weaker than you think.

6. Over-reliance on web services

More and more, apps and software are talking to and incorporating third-party services, such as Docker or Azure. There is, however, no real certainty that those apps are connecting to the expected entity, or whether an attacker is stepping in, stealing data, and returning false information.

What you can do: Again, this is a problem for developers, but mobile apps are becoming increasingly vulnerable, so even if an app isn't trying to steal your data, the 'service' that it thinks it's connecting to may be.

7. SoQL attacks against NoSQL databases

This is another developer problem, but it could affect data collected about you. For years, SQL injections, where executable code was forced inside of a SQL database entry field, were one of the scourges of the internet. Now, as developers move away from SQL to NoSQL databases like MongoDB, they're finding that those databases aren't as secure as they should be. ⊠

> **Ransomware surfaced more than 20 years ago, but has since evolved into a frightening form of malware**

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