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WINDOWS 95: THE INSIDE STORY

HOW THE WORLD-CHANGING OS CAME TO BE

YOUR WINDOWS 11 UPGRADE

18 THINGS IT DOES BETTER THAN WINDOWS 10

Asus ROG Zephyrus G14. Page 58

Gaming & creative laptops

Dream Machines

New RTX 5080 & 5090 systems from Asus, HP, Lenovo & more! *Tested & rated!*

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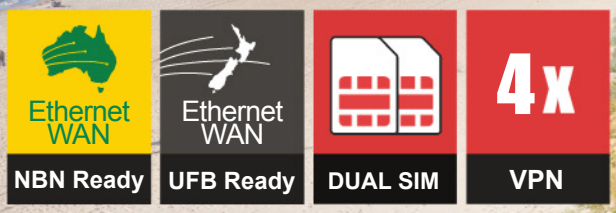


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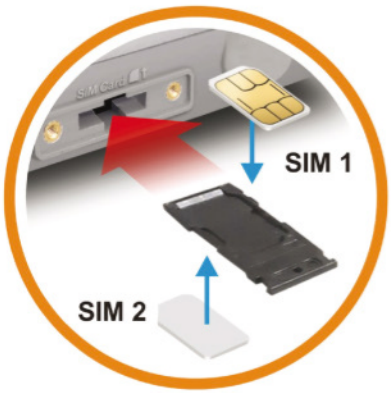
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- 5G Max. Data Rate NR NSA: 3.4Gbps (DL) / 550Mbps (UL)**
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New PC trends

The crystal ball clears.

Every year the show known as Computex is the focus of the entire PC industry. It's where every company you know has a glorious big stand showing off its new gear, with most of it is being unveiled for the first time. It's where AMD's Lisa Su and Nvidia's Jensen Huang – along with many of the power-players in the scene – get up on stage and engage maximum hype mode as they lay out their company's new products, tech and direction. It's also where an almost uncountable number of smaller companies fight for your attention amidst the noise and chaos, hoping journos will notice and create some publicity, and where retail buyers might just like what they see and place orders.

We were there, we rode the waves of excitement and explored every part of the mammoth event across several Taipei locations. We came home sick, too, or at least Lindsay did. He swears it was the coughing children surrounding him on the flight home.

But our discoveries need to be shared with you, and so after a weekend of semi-recovery, our man Lindsay took to the keyboard, surrounding himself with pages of notes, spec sheets and a brain overflowing with new and exciting gear and tech info, to tell you how it all went.

Personally, I'm always keen to see what the new trends are, both of the PR-shaped kind, and the happy little discoveries and things we notice that veer off the PR script. That's what we've got for you in the mighty annual Computex feature story, which begins over on page 38. It's a glorious ten pages packed with everything that got our attention while roaming the halls in Taipei, and our takes on what it all means for the PC, and you.

AI was predictably the big trend this year, with a myriad of new products, tech and systems all gunning to capitalise in the AI boom. We hear so much about the ever-amazing abilities of AI, but little of the hardware that powers it, so it was nice to take it all in and engage in fascinating conversations with the people behind the scenes.

Over the coming months we'll be getting the gear we liked the best from the show into the Labs for testing. So, once again, the big info drop has happened and the year ahead looks a little clearer. Enjoy! ■

MEET THE TEAM Along with Australia's best tech journos, our core crew work hard to make *APC* a great read every month.



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ASHAMPOO ACTION CLICK

CUSTOM MACROS, SHORTCUTS, AND WORKFLOWS.

Ashampoo Action Click is a software solution designed to automate and optimise recurring tasks on a PC. Featuring a fully customisable toolbar, it allows users to create macros, commands, and actions for launching programs, opening websites, or executing processes with a single click.

Beyond simple shortcuts, it supports complex workflows involving CMD commands, simulated keystrokes, and delayed execution. The software includes predefined categories and commands for easy setup, enabling users to organise functions into groups for specific applications, thus maintaining a clear and structured workflow. Action Click enhances accessibility for less experienced users by simplifying essential tasks and reducing manual clicks and repetitive actions.

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Gaming Hub
Quick access to your favourite games in one place

*Source : IDC Worldwide Quarterly Gaming Tracker. Based on value (amount) from 2023-2024.Q3, gaming segment 144Hz and above.

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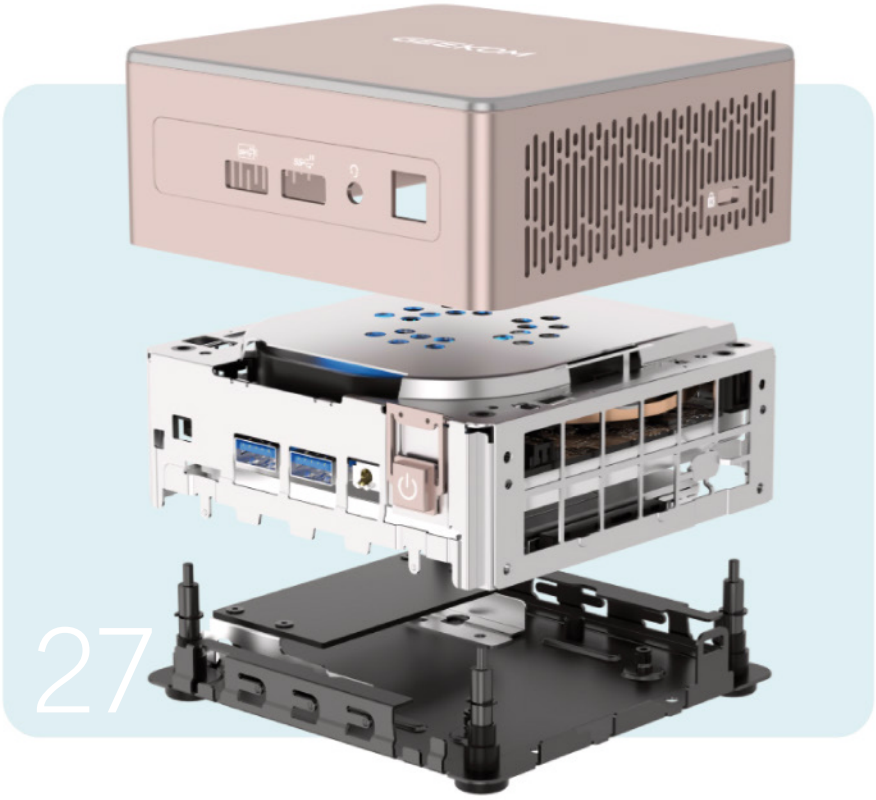


64 **The inside story of Windows 95**
On its 30th anniversary, we retrace the development and inside stories of the operating system that changed the world.



"May 2nd is World Tuna Day. The first Saturday in May is World Naked Gardening Day, so it would be best to check the weather forecast. And who could miss May 15th's International Kangaroo Care Awareness Day?"

Jon Honeyball - **One more thing page 15**



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TECHNOTES

Everything you need to know from the month in tech

CAMM2 modules revealed

BUT DO NOT EXPECT THEM ON THE MARKET SOON.

Multiple manufacturers of enthusiast-grade DRAM modules demonstrated compression-attached memory (CAMM2) modules at Computex 2025, indicating their interest in this form factor. However, none of the manufacturers are confident of exactly when these DDR5 modules will hit the market, as they are unsure when motherboard makers will release suitable platforms.

CAMM and LPCAMM2 memory modules have an indisputable advantage over regular DIMMs and SODIMMs in terms of capacity density and interface width (128-bit) over regular DIMMs. CAMM2 also promises to improve signal integrity by reducing electrical path lengths, enabling higher data transfer rates and better power efficiency. However, memory modules can increase performance potential on modern platforms by adding clock driver chips to their products even without adopting an all-new form-factor.



Some Asus routers compromised by botnet attack

THE BACKDOOR EVADES DETECTION AND SURVIVES FIRMWARE UPDATES.

Thousands of Asus routers have been compromised due to a newly discovered botnet called 'AyySSHush.' The stealth attack was detected in March 2025 and reportedly exploits authentication and makes use of the router features to maintain long-term access. Notably, the backdoor does not make use of any malware, and the unauthorised access cannot be removed using firmware updates.

To ensure routers are fully secured, users are advised to take additional manual steps, including checking for active SSH access on TCP port 53282, reviewing the authorized_ keys file for unfamiliar entries, and blocking the known malicious IP addresses. If a device is suspected to be compromised, it is best to perform a full factory reset and then reconfigure the router from the beginning.

Microsoft 'ending USB-C port confusion'

All USB-C ports need to support data, charging, & display functionality.

Microsoft promises it is "ending USB-C port confusion" with its updated Windows 11 Windows Hardware Compatibility Program (WHCP) initiative. Going forward, it pledges to ensure all USB data, charging, and display functionality "just works" on all your USB-C ports. Moreover, an additional rule means USB 40Gbps ports will be fully compatible with both USB4 and Thunderbolt 3 peripherals. The Microsoft blog indicates that these rules should already be in place with certified Windows 11 laptops and tablets that come with Windows 11 24H2 installed.

It isn't the USB-C port that's the problem, says the Microsoft exec, it is "the inconsistent implementations of USB-C port capabilities across the PC ecosystem." Or in other words, not all USB-C ports are created equal.

To fix this inconsistency, the WHCP will now mandate that every USB-C port on new Windows laptops and tablets needs to support data, charging, and display functionality. This should mean no more guessing about which ports support what, and might also mean end users are happier as they can connect a charger or second display to either side of a laptop (if there are USB-C ports both side).

Microsoft put the chart below together to show the capabilities of WHCP-compliant laptops. Yes, they all support the three core functions, but their levels of support will still vary. In addition to the familiar data speed differences, USB 3.X ports won't provide as much accessory power, or support as many displays, as USB4.

On the topic of USB4, you can also see in the table that "On a WHCP-certified USB 40Gbps system, you can also plug in any USB4 or Thunderbolt 3 device and trust it will work every time on every port."

Not mentioned yet, or hinted at in the table, Microsoft is also requiring USB-IF certified silicon in the PC. Moreover, a new Microsoft driver stack requirement means PCs are validated using Microsoft's built-in USB controller drivers. This should ensure security and feature updates arrive via Windows Update.

To wrap up its post, Microsoft explains that the Hardware Lab Kit (HLK) is behind these improvements. The process is ongoing, with WHCP updating with every Windows release, delivering fixes and enhancements.

USB-C capabilities on WHCP-compliant laptops and tablets

Windows 11 USB-C WHCP Requirements	USB 3			USB4	
	5Gbps	10Gbps	20Gbps	40Gbps	80Gbps
Max Data Speed	5Gbps	10Gbps	20Gbps	40Gbps	80Gbps
Accessory Power	≥4.5W		≥7.5W	≥15W (7.5W for tablets)	
PC Charging Support	Yes				
Display Support	Minimum 1 Display			Mininum Dual 4k at 60Hz	
PCI Express (PCIe) Support	No			Yes	
Thunderbolt™ 3 Compatibility	No			Yes	

Microsoft

Gabe Newell's brain-computer interface startup to reveal first chips

SYSTEM CONNECTS TO MULTIPLE PARTS OF THE BRAIN SIMULTANEOUSLY.

Starfish Neuroscience, a startup co-founded by Valve CEO Gabe Newell, has published an article revealing the first details of its brain-computer interface (BCI) chip (**tinyurl.com/APC547starfish**). The firm proposes a "new class of minimally-invasive, distributed neural interfaces that enable simultaneous access to multiple brain regions." Moreover, a Starfish BCI could be the first fully wireless, battery-free implant available, if all goes to plan. According to its blog, the startup's first chips are expected to arrive "in late 2025."

Newell's fascination with BCIs began over 10 years ago, and that Valve once considered adding earlobe monitors to its VR headset products. As recently as 2019, Valve also publicly explored BCIs for gaming. Later the same year, Newell incorporated Starfish Neuroscience, and we are now seeing the first fruits as it emerges from stealth mode.

Starfish says its BCI has the opportunity to do well thanks to two key features, its minimal size and the eschewing of built-in battery power. In regular use, the Starfish processor will consume just 1.1mW, it says. That contrasts with the Neuralink N1, which uses around 6mW.





Windows 11 gets quantum-hardened cryptography

PREPARING FOR FUTURE QUANTUM COMPUTER ATTACKS.

Microsoft is preparing Windows 11 against the next major cybersecurity threat: quantum computers. In a blog post, Microsoft announced that Windows 11 Canary build 27852 and higher now support post-quantum cryptography, through PQC algorithms, allegedly securing them against quantum computers' unmatched crypto hacking power (against traditional crypto algorithms).

Specifically, Microsoft has upgraded SymCrypt (Microsoft's cryptographic library) to support ML-KEM, and ML-DSA (on top of PQC) through its Cryptography API: Next Generation libraries and certificate and cryptographic messaging functions. ML-KEM is aimed at helping secure keys against the "harvest now, decrypt later" threat. That's a threat where attackers focus on collecting targeted data today, then store it and wait for quantum computers to become fast enough to break the encryption on the targeted data in the future.



'Majority of gamers are still playing at 1080p'

AMD CHIEF CLAIMS THERE'S STILL A PLACE FOR 8GB GPUS.

Frank Azor, AMD's Chief Architect of Gaming Solutions and Gaming Marketing, shared a post on X in response to a gaming account questioning why AMD is still offering GPUs with 8GB of VRAM in 2025.

"Majority of gamers are still playing at 1080p and have no use for more than 8GB of memory," Azor wrote. "Most played games [worldwide] are mostly esports games. We wouldn't build it if there wasn't a market for it."

Available data backs up that claim, according to the Steam Hardware Survey, over half of gamers (55.27%) are playing on 1080p monitors. One of the top five GPUs among Steam users in 2025 is still somehow the GTX 1650, which only has 4GB of VRAM. The number one GPU as of April is the RTX 4060 laptop version with 8GB of VRAM.



Unreal Engine 5.6 promises 60 FPS Ray Tracing

BETTER OPTIMISATION CAN LEAD TO MORE FPS.

Epic Games just released Unreal Engine 5.6 (UE 5.6), the latest version of its powerful engine designed for game developers and other professionals. According to the company, one of the main targets of this update is to allow current-gen consoles, high-end PCs, and powerful mobile devices to hit 60 fps while using hardware ray tracing.

Epic Games achieved this by offloading some tasks from the CPU to the GPU, which allows its Lumen Global Illumination system to achieve higher performance.

Aside from this, it also released an experimental module called Fast Geometry Streaming Plugin. This feature aims to improve open-world loading speeds even as developers add more static objects while still maintaining constant frame rates.

Starfish Neuroscience , Microsoft, Epic Games



Apple CEO Tim Cook "chose poorly", according to the judgment.

Trouble in Store for Apple

Barry Collins investigates the problems facing Apple after its stinging court defeat to Epic Games.

If you head to YouTube, you'll find a five-minute video of Steve Jobs on stage at WWDC in 1997. In it, he answers a pointed question from a snotty developer who tells Jobs it's "clear that on several accounts you've discussed, you don't know what you're talking about".

The developer is upset that Jobs has seemingly chosen Java over OpenDoc. Jobs takes a long pause, a slug of water and then justifies his decision to the developer, implying it's a fool's errand to pick a technology and then work out how to make it work for the consumer. "As we have tried to come up with a strategy and a vision for Apple, it started with what incredible benefits we can give to the customer."

Somewhere along the line, it appears Apple lost sight of that strategy. What "incredible benefits" do customers get from forcing Spotify to hide links to cheaper subscriptions in its iOS app? Or preventing Kindle app owners from buying books directly in-app? It's much easier to see the incredible benefit Apple can give to itself, as it insists on taking a cut on every purchase, whether the app developer is using Apple's payment system or not.

It's a decision that has infuriated a federal judge in California, too. "Apple's continued attempts to interfere with competition will not be tolerated," ruled district judge Yvonne Gonzalez Rogers in an excoriating judgment against the company in late April. One in which she accused the company and its officers of contempt – both civil and criminal. The judgment brought an immediate end to Apple's practice of charging a 27% commission on off-app purchases and preventing developers from linking to their own payment systems.

Apple is, of course, appealing, but for now let's examine who the big winners and losers are from the court's extraordinary judgment.

"Apple imposed a 27% commission on off-app purchases, something the court has now ruled was a 'gross miscalculation'"

An Epic victory

The judgment against Apple is the latest salvo in the long-running case brought by Epic Games. Back in 2020, Epic Games provoked Apple into ejecting its *Fortnite* app from the App Store after inviting gamers to buy in-game credits using Epic's own payment system rather than Apple's, a contravention of the App Store rules.

Epic took Apple to court in the Northern District of California, claiming the company was a monopolist and anti-competitive. A case it largely lost. However, it did prevail on one issue: it won the right to steer consumers towards alternate payment systems outside of the app. Apple responded by imposing a 27% commission on those off-app purchases, something the court has now ruled was a "gross miscalculation" and a means to "maintain its anticompetitive revenue stream".

Epic took immediate delight in the ruling from the district court. "We will return *Fortnite* to the US iOS App Store next week," CEO Tim Sweeney posted on X, and a couple of days later was lauding Spotify for amending its iOS app in the US with links to purchase subscriptions directly from Spotify. "Congratulations to Spotify on being the first major iOS app to exercise its court-mandated right to do digital commerce with customers free of Apple obstruction, interference, and the Apple Tax!"

Spotify itself put out a statement, praising the court's ruling for making it "clear that Apple deliberately abused its market power to intentionally harm others and benefit only itself".

Industry analysts agree that the victors from all this are the major players such as Epic and Spotify: for the time being at least, they're free from the Apple levy. For apps where "you're paying a monthly subscription for a service like a Spotify, or you're doing something like an Amazon where you're just buying stuff that's available elsewhere, they're the big, big winners because they're high-volume players," said Ben Wood, chief analyst at CCS Insight.

Do consumers win, too? That really is a "time will tell" situation. Ultimately, consumers only win if the purchases they make are cheaper because Apple is no longer taking a commission. If the app developers just pocket what they would

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have paid in commission for themselves, the consumer is no better off.

In its statement, Spotify said that the ruling means consumers "can finally see how much something costs in our app, including pricing details on subscriptions and information about promotions that will save money", adding that it might also open new opportunities. "These changes should soon allow publishers to sell their audiobooks through Spotify's platform seamlessly."

We don't yet know if Epic's customers will benefit. *Fortnite* has yet to return to the App Store at the time of writing, although when the *Fortnite* app flouted the rules back in 2020, Epic made a point of offering discounts of 20% to gamers who used its own payment system.

Trouble for Apple

On the other side of the fence, Apple is facing problems on multiple fronts. First, if the ruling is upheld and Apple can no longer take a cut on off-app purchases, it's going to take a financial hit.

Apple's earnings reports aren't granular enough for us to work out precisely how much it stands to lose, but there are clues in the motion to stay that Apple lodged in early May, trying to get the judgment put on hold until a full appeal can be heard. "The district court acknowledged that compliance will cost Apple 'hundreds of millions to billions' of dollars annually, which Apple can never recoup," the company's motion stated.

Lest anyone consider launching a crowdfunder to ensure Apple survives the financial turmoil, even a low billions annual hit won't put a serious dent in the company's profits. It made almost $94 billion in net income in 2024.

If Apple does manage to overturn the court's decision, the fact that Spotify and others have rushed in to amend their apps will make it harder for Apple to turn back the clock. "The precedent has been set," said Ben Wood, referring to apps offering off-app payments, in the US at least. "Reversing it would be quite an undertaking as well, and would generate a lot of bad will."

> "Documents reveal that Apple knew exactly what it was doing and at every turn chose the most an ti-competitive option"

Perhaps more worrying for Apple is the threat of contempt proceedings against its senior executives. The judgment was scathing about the conduct of Tim Cook and other senior Apple executives, accusing them of deliberately trying to circumvent the court's will. "Apple sought to maintain a revenue stream worth billions in direct defiance of this court's Injunction," the verdict read.

"In stark contrast to Apple's initial in-court testimony, contemporaneous business documents (see "A rare glimpse inside Apple", below) reveal that Apple knew exactly what it was doing and at every turn chose the most anti-competitive option," it continued. "To hide the truth, vice-president of finance, Alex Roman, outright lied under oath. Internally, [App Store chief] Philip Schiller had advocated that Apple comply with the injunction, but Tim Cook ignored Schiller and instead allowed chief financial officer Luca Maestri and his finance team to convince him otherwise. Cook chose poorly."

Judgments don't come much more damning, or more personal, than that. The district court has referred the matter to the attorney for the Northern District of California to determine whether there's a case for criminal contempt proceedings. That could potentially lead to imprisonment for executives found guilty.

All of this hangs on the verdict not being overturned. As Ben Wood states, at least one party is keen to see an appeal fail. "You've got to admire the tenacity of Epic [Games]," he said. "They've been relentless in pursuing this, and it's meant they've got knocked out of the [App] Store, they've lost revenue, it's no doubt cost them a small fortune in legal fees, but they just have not let it go.

"From their side of things, they'll be very keen to make sure that this ruling now sticks." ■

A RARE GLIMPSE INSIDE APPLE

The court ruling from the Northern District of California gave us a rare insight into the inner workings of the normally highly secretive Apple. In particular, it exposed divisions among the ranks of senior executives over whether or not to apply a commission on off-app purchases.

The court documents reveal how the executive committee was split in a meeting held on 20 June 2023. "Those advocating for a commission included [chief financial officer] Mr Maestri and [vice president of finance] Mr Roman," the court judgment states. "In an email, [App Store chief] Mr Schiller relayed that, with respect to the proposal for 'a 27% commission for 24 hours', 'I have already explained my many issues with the commission concept,' and that 'clearly I am not on team commission/fee'."



ABOVE Phil Schiller's advice was not taken by fellow executives.

The court judgment also reveals that, "unlike Mr Maestri and Mr Roman, Mr Schiller sat through the entire underlying trial and actually read the entire 180-page decision. That Messrs Maestri and Roman did neither, does not shield Apple of its knowledge (actual and constructive) of the Court's findings."

Details of a further meeting on 5 July 2023 reveal that Tim Cook had to settle the dispute. "One purpose of this meeting was to settle on the commission rate that Apple would charge and its associated tracking window," the judgment reads.

"Apple settled on a 27% commission for linked-out purchases, a decision ultimately made by Messrs Cook, Maestri, and Schiller. As Mr Schiller was not advocating for a commission, and Mr Maestri was fully advocating for the lucrative approach, Mr Cook was the tie-breaker.

"Commissions would be collected on a seven-day window, even if those subsequent purchases on a developer's website were made on a device other than the user's iPhone. Thus, in response to the injunction, Apple chose to impose a new commission representing the most anti-competitive option considered."



System News

With floating infinity fans and scented thermal paste, Mark Williams wants to enter the Battlematrix!

Computex has wrapped for another year, giving us a swathe of new products and technologies to look forward to incorporating into our computers over the next year. Dive into Lindsay's mega-report starting on page 38. For me, many of the things that caught my eye fell into two primary categories: cases and graphics cards. Outside of those some neat products that also caught our attention were: ID Coolings scented thermal paste, to keep your rig smelling fresh or fruity; Pulsar's Noctua-themed mouse with inbuilt Noctua fan to keep sweaty palms dry, and Team Group's T-Create SSDs that feature a self-destruct button to either erase all data on the drive or physically damage it, preventing data recovery. Sorry, no Mission Impossible explosions here.

Cases

The Phanteks Evolv X2 is a fish tank-style case with an array of nine-hundred ARGB LEDs in a thick band around the base where the PSU shroud is. These lights are programmable to let you display moving text or animations.

Lian Li's Lancool 4 featured glass front panels, but with fans mounted in the glass. The fans appear to just float in mid-air! The Lancool 217 Infinity takes this one step further and adds an infinity mirror behind the glass with RGB lighting for a trippy look.

Corsair had an innovative design with what you might call a triple chamber case. The Corsair Air 5400 is a traditional dual chamber fish tank design, but the front panel fans are designed to have a radiator seated behind them with a huge air guide behind that to channel air from the front panel directly out the side of the case, completely bypassing the interior. Expect that to perform great in thermal tests.

Silverstone went all in on a retro themed case called the FLP02. The beige throwback looks like it's from the early 1990s, but with an updated modern interior for today's needs. The ultimate sleeper case, it sacrifices ventilation to maintain the retro look but can fit water coolers and large modern graphics cards inside. It features a turbo button and segmented display on the front panel, lock and key for the power rocker switch and 5.25in faux floppy disk bay fasciae to complete the look.

Graphics cards

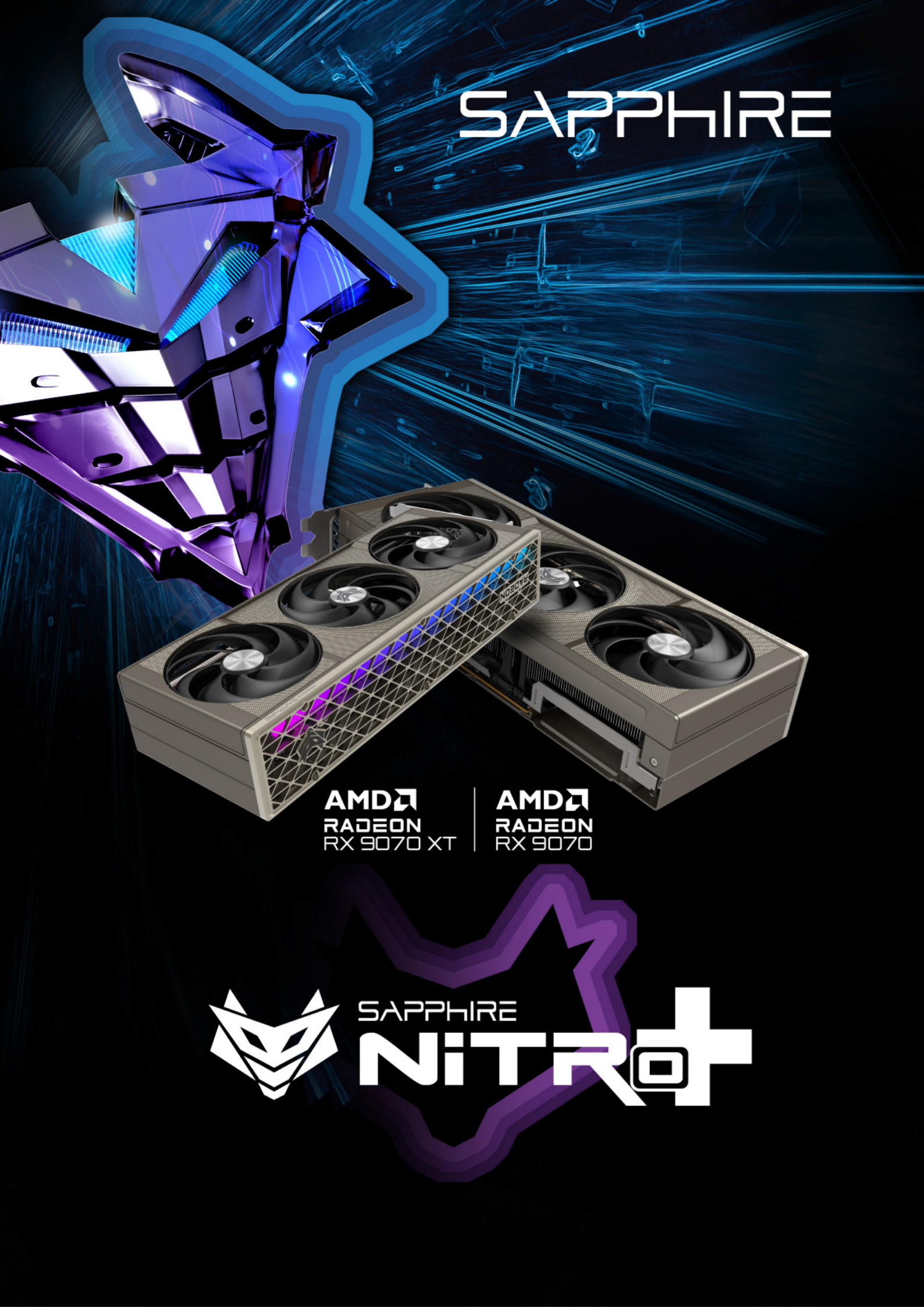
Intel had its new Arc Pro B60 and B50 cards with 24GB of VRAM for the workstation crowd. A good sign that Arc isn't dead just yet. They even had a dual B60 GPU design from Maxsun with 48GB of total VRAM on board. As even 48GB isn't enough for modern AI models to run locally, Intel came up with some software that allows multiple Arc GPUs to combine their VRAM capacities into one big logical pool for programs to use. The software to make this happen has possibly the best product name of the whole show, Project Battlematrix!

Nvidia's Jenson Huang only spent a few minutes announcing the new RTX 5060. For good reason, it's 8GB VRAM buffer makes this a very entry level card for modern title demands.

AMD was in attendance too and released its anticipated 60 series contender in the RX 9060 XT. With 8GB and 16GB versions the 16GB model is set to be a tantalising choice as it's expected to be priced around an RTX 5060 Ti 8GB but with a bit more performance and double the VRAM.

Lastly AMD showed off FSR "Redstone", its initiative to get FSR caught up to DLSS's feature set. Including neural radiance caching, ray regeneration and ML based frame generation. ■

Mark Williams is an IT professional with a strong interest in voiding warranties.


SAPPHIRE
AMD
RADEON
RX 9070 XT
AMD
RADEON
RX 9070
SAPPHIRE
NITRO+



The handheld future is heating up, but to whom does it belong?

Big chunky living room devices don't factor heavily into gaming's future, writes Shaun Prescott.

Nintendo's Switch 2 launched last month, and only a few days later Microsoft announced the ROG Xbox Ally, a handheld PC that's basically Asus' ROG Ally, but with an Xbox user interface. Meanwhile, Valve has started to open the floodgates for non-Valve companies to ship handheld devices with SteamOS installed, meaning we could be on the verge of a tsunami of Steam Deck-style consoles.

It's a great time to love portable (or in-bed) gaming, but the focus on this form factor reflects a broader shift in the industry, where the old model of major publishers doling out a half-dozen blockbuster games every year has become commercially unviable (or so publishers claim). Instead, games like *Clair Obscur*, *Baldur's Gate 3*, *Balatro* and *Vampire Survivors* emerge from the AA and indie spaces to become phenomenons the likes of which an Electronic Arts or Ubisoft don't seem as capable of creating anymore. There's a sense that the future of gaming no longer lies in the medium's ability to wow with ever-increasing graphical fidelity: it's now the realm of cool ideas. The likes of *Gears of War* or *God of War* would sink like a stone if they were to debut in this climate.

In other words, a "hardcore gamer" is no longer someone with an RTX 5090, or a PS5 Pro: it is someone who spends a lot of time playing videogames whether they're something that can fit on a 1980s floppy disc (*Animal Well*) or a sprawling, uncompromisingly complex CRPG (*Baldur's Gate 3*) that would have terrified the suits during the 2000s. Crucially, both play extremely well on handheld devices, even though neither were targeted to run on them.

This current climate would have felt unthinkable 14 years ago when the PlayStation Vita was released. Yes, Sony's last proper handheld had some unfixable design problems – no trigger buttons chief among them – but it was the software line-up that probably killed it. Blockbuster console games like *Uncharted*, *FIFA*, *Wipeout*, *Killzone* and *Call of Duty* don't translate particularly well to handheld in a native context, and all the games that did feel right at home – *Hot Shots Golf*, *Lumines* – were sold at blockbuster prices. The tail end of the Vita's lifespan saw some brilliant indies join the fold, but by then it was too late.

When the Nintendo Switch launched six years later, handheld gaming was considered solely the province of smartphones. But the Japanese company's hybrid approach, coupled with the fact that its first-party tentpole titles never demand home console level horsepower, ensured its success, as did its openness to indies. Nintendo blew a hole in the wall, and now Valve and Microsoft are eagerly stepping through it. The future of mainstream gaming is handheld, or else, the flexibility inherent in the handheld form factor. And it can be that way, because the graphical arms race is finally over. It's finished.

During this year's Summer Games Fest, the amount of talking heads drawing attention to flashy new graphics tech was at an all time low. Sure, games are still chasing fleeting trends that will likely have lapsed by the time they're ready to ship, but no one talks about pixels anymore. Welcome to the handheld future: who's going to win it? ■

"There's a sense that the future of gaming no longer lies in the medium's ability to wow with ever-increasing graphical fidelity: it's now the realm of cool ideas."

Shaun Prescott is an Australian editor for PC Gamer and GamesRadar, and writes for APC, TechRadar and more.



Every day is special

Finding the genuinely useful amid the internet haze.

You know that sinking feeling you get when you land on a website and you're instantly sucked in? Down the dark rabbit hole you go, either in amazement at wonderful things or in mild horror at what is being presented. Today I fell upon the website called National Day Calendar (nationaldaycalendar.com).

This site details all of the National Day of Something that seems to be happening all of the time. It's a very well presented website without a hint of parody. You can search by all sorts of useful parameters, but my own rabbit hole was its International Day page.

Did you know that January 4th is World Hypnotism Day? Click on the page and you're taken to a fact-filled page all about the day, and I now feel strangely compelled to tell you to visit **worldhypnotismday.com**.

But it isn't just days: there are whole weeks too. The last full week in January is Global Crayola Creativity Week. Who knew? I must, however, call into question January 8th, which is Earth's Rotation Day. I hadn't appreciated that Mother Earth's ego was so fragile that she needed recognition to summon up the energy to keep rotating, but will confess I found this a very educational rabbit hole.

To escape the clutches of January I'm sorry to report that we must pass over January 21st, which is of course International Sweatpants Day. Truly our cup filleth over.

But wait, there is more. May 2nd is World Tuna Day. The first Saturday in May is World Naked Gardening Day, so it would be best to check the weather forecast. And who could miss May 15th's International Kangaroo Care Awareness Day? I will make sure I warm my teapot specially for May 21st International Tea Day, which is officially approved by the United Nations.

Of course, it's easy to be flippant about these things, as you may have noticed, but the sobering reality is that, amongst the fun, there are innumerable serious issues that need to be discussed, and maybe having an International Day marking it is what's needed to get the mainstream media to discuss these things. I can't see my mates in the pub reminding me on May 22nd that "Oi, Jon, it's World Goth Day today, and here's how we're celebrating it". But May 30th is World Multiple Sclerosis day and that is worth a few moments of thought. As is September 21 for World Alzheimers Day, because my late Dad had that. And August 18th for World Never Give Up Day.

As all this illustrates, balancing the good from the trash is hard, and if anything the National Day Calendar is merely a microcosm of the world wide web where it's becoming increasingly difficult to separate the useful from the noise. The background level of nonsense has now increased to the point where it's drowned social media in almost every form.

At the top of the site, we're invited to "Register a National Day". So, how about International Politicians Telling the Truth Day? Actually, let's make that a whole week. Or even a month. I'd vote for International Fix Your Bugs Day too. ■

"May 2nd is World Tuna Day. The first Saturday in May is World Naked Gardening Day, so it would be best to check the weather forecast. And who could miss May 15th's International Kangaroo Care Awareness Day?"

Jon Honeyball has, for the past 61 years, aimed to make every day special.

GADGETS

Nice things to have



Neat wireless earbuds that boast Denon quality, AirPod Pro-like features and a great price.

The free Denon Headphones app makes adjusting the sound settings super easy.

Denon AH-C840NCW

Available in black or white, these true wireless earbuds from hi-fi makers Denon promise to be a great alternative to Apple's own AirPods Pro. Costing just $335, they're packed with features, including 12mm FreeEdge drivers, active noise cancelling (ANC) and twin mics for crystal clear calls, plus up to 35 hours of playback between recharges using a combination of both the earbuds and the charging case with ANC off.

Not only that, but the AH-C840NCW are also waterproof to IPX4 and offer multi-point connectivity so you can easily switch between your PC or Mac, phone, tablet and watch and the case can be wirelessly charged as well.

The earbuds come with three pairs of silicone eartips in different sizes to suit your ears (while offering increased sound isolation). Plus, they can also be teamed with the free Denon app so you can tweak their sound.

$335 | denon.com



The Denon AH-C840NCW true wireless earbuds feature both Blueooth LE and Bluetooth Auracast connectivity.

EIZO FlexScan FLT monitor

Described as the world's most energy-efficient monitor, the EIZO FlexScan FLT has just been given a coveted Class A ranking European Energy Label, the first display of its type to do so. The FLT is also made from 95% recycled plastic and sips just 6W of power when in use. Even its packaging materials are eco-friendly. The display itself features a 23.8-inch 1920x1080 IPS screen with three USB-C ports (one for power) and a swivelling desk-mounted arm.

$TBA | From eizovisualsolutions.com



Not only does it look good, EIZO's FlexScan FLT display is good for the planet too.



Insta360 X5

Whether you're enjoying a summer garden party or heading out on your latest adventure, this action cam can help you capture the moment. Featuring 1/1.28in image sensors and a Triple AI (artificial intelligence) chip system, the X5 enables you to record 360° videos in glorious 8K (30fps) resolution. Plus, it's tough enough to be used almost anywhere – from the top of a mountain to beneath the waves, thanks to a robust camera housing that can be immersed in up to 15m of water. And if the worst should happen and you damage its F2.0/6mm lens, you can replace it with another one.

$899 | insta360.com



Nanoleaf Pegboard Desk Dock

Nanoleaf, maker of colourful smart lighting, is now branching out into desk accessories as its latest product shows. Handy for stowing peripherals such as headphones and games controllers, the Pegboard Desk Dock boasts both flexible hanging space for your accessories (with four pegboard hooks) on one side, and a full-face smart light on the other – complete with a suite of jazzy lighting effects to brighten up your day. The Pegboard can even charge your accessories while they 'rest' via its built-in USB-C and USB-A ports.

$TBA | nanoleaf.me



Aqara Climate Sensor W100

Whether you're feeling hot or cold, this Cimate Sensor can keep you in the know – thanks to its info-packed 3.4-inch LD display. Designed to work with HomeKit (via Matter and Thread smart home protocols), the Climate Sensor can display both temperature and humidity when using Thread, with additional info available if you prefer to use Zigbee instead. Powered by replaceable CR2450 batteries (which last for up to 28 months), the Climate Sensor plays nicely with other smart home gear too, making it great for automations.

$TBA | aqara.com

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GO BIG ON AI WITH A NUC

Small in stature while packing a big punch, AI-accelerated NUCs ensure artificial intelligence is always by your side.

As artificial intelligence becomes part of our everyday lives for both work and play, it's critical that your PC can unlock its full potential.

AI isn't out to replace you, instead it's there to work by your side and help you be your best. That's why Microsoft has dubbed its powerful AI tools 'Copilot', guiding you along the way rather than taking over.

The new generation 'AI PCs' are designed to make the most of artificial intelligence to boost your productivity, creativity, gaming, entertainment, security and more. The key is a built-in Neural Processing Unit (NPU), which is optimised to accelerate the algorithms which underpin artificial intelligence and machine learning.

Back in the early days of personal computing, GPUs were created to accelerate graphics and ease the load on the CPU. Likewise, today the NPU handles all the AI heavy lifting to boost overall performance and improve power efficiency.

Just as GPUs took gaming to the next level, NPUs are unlocking the full potential of AI.

GO SMALL, THINK BIG

Of course, personal computers aren't just getting smarter, they're also getting smaller. A NUC, or Next Unit of Computing, is a palm-sized device which packs all the power and features of a desktop PC, but is small enough to tuck out of the way. You can even mount one on the back of your monitor.



A convenient hinged case allows quick and easy memory and storage upgrades.



Asus offers a range of brilliant NUC devices to cater to your needs and budget.

The whisper-quiet design makes a NUC well-suited to not just your desk but also the lounge room, bedroom or any other location where you don't want to see or hear a traditional desktop PC.

Developed through a partnership between Asus and Intel, the Asus NUC delivers uncompromised performance in the smallest form factors.

Despite their tiny footprint, powerful NUCs like the Asus NUC 14 Pro AI still run a full version of Windows. It's the world's first compact "Copilot+ PC", powered by the Intel Core Ultra processor, to ensure it can make the most of the high-end Copilot AI features built into Microsoft's Windows 11 and Office 365.

The Asus NUC 14 Pro AI tips the scales at only 500 grams, with a footprint the size of a CD case. Even so, it still packs all the great features you'd expect from a fully-fledged desktop PC.

Inside you'll find an Intel Core Ultra processor (Series 2, formerly "Lunar Lake") with Intel® Arc Graphics, Intel® AI Boost, accompanied by a superfast solid state drive and built-in high-speed LPDDR5x, which is 1.5x the bandwidth of conventional DDR5-5600 memory. This allows it to pump out up to 48 TOPs AI performance on its NPU alone, while remaining highly energy efficient. When it comes to connectivity you've got the latest Wi-Fi 7, Gigabit Ethernet and Bluetooth 5.4, along with HDMI 2.1, Thunderbolt 4 and USB 3.2 GEN2.



It's the world's first compact Copilot+ PC, powered by the Intel Core Ultra processor, **to ensure it can make the most of the high-end Copilot AI features** built into Microsoft's Windows 11 and Office 365.

While the built-in NPU isn't the most standout feature, the impressive thermal solution on the Asus NUC 15 Pro and Pro Plus allows the processor power to be vastly unlocked. This pushes their performance, especially under complex applications involving parallel-processing of mixed load to the next level. Selected SKUs are also equipped with the benefit of Intel vPro Enterprise technology, underpinning advanced security features as well as automated systems and maintenance.

BOOST PRODUCTIVITY

Whether you're working for a corporate giant, hustling on the side or studying in pursuit of your dreams, AI delivers a serious productivity boost.

For starters, an AI-capable Asus NUC helps bring Microsoft's Copilot assistant to life. Copilot is built directly into Microsoft's Windows 11 and Office 365 productivity suite, so it's always at your beck and call.

Copilot's intuitive support for natural language means you can simply ask it for what you need, safe in the knowledge that answers are drawn from your own trusted data, rather than the supposed wisdom of the internet.

Within Outlook, Copilot can prioritise important emails, summarise long threads and help you write the perfect reply. In Word, it can analyse documents in search of insight, as well as drafting content such as reports, summaries and blog posts.

Collaboration tools like Microsoft Teams and Zoom also take advantage of AI to enhance meetings and online classes. AI can even take notes, generate summaries and produce subtitles.



Your Asus NUC boasts a plethora of connectivity options featuring the latest standards.

UNLEASH CREATIVITY

As small but powerful AI-capable PCs, the Asus NUC is perfect for unlocking your creativity. When you're working on the perfect meeting presentation, school assignment, side hustle or pet project, AI can take things to the next level. Whether you're working with images, graphics, audio or video, you'll find AI features built into a wide range of today's best creativity tools from the likes of Adobe and Avid.

Copilot+ PC experiences from Microsoft includes a collective of useful features exclusive to Copilot+ PCs that exiles your creativity. You can easily restyle your existing work, generate the rough skeleton drawing with a text prompt, or upscale low resolution images, easily bring your big ideas to life. AI can be your handy campaign every stage of the way during the journey to your next masterpiece.

ENHANCED SECURITY

An AI-capable Asus NUC is equipped to protect against modern security threats, working hand-in-hand with the latest security tools to keep you safe.

CrowdStrike leverages AI and the Intel Core Ultra processor's NPU to accelerate the detection and investigation of cyber threats, as well as address CPU, memory and network challenges. Meanwhile, ESET runs key cybersecurity workloads on the NPU in AI PCs with Intel Core Ultra processors and Intel vPro, to help stop advanced threats.

Whether you're getting creative or getting down to business, an Asus NUC mini PC ensures that AI is always working hard by your side.

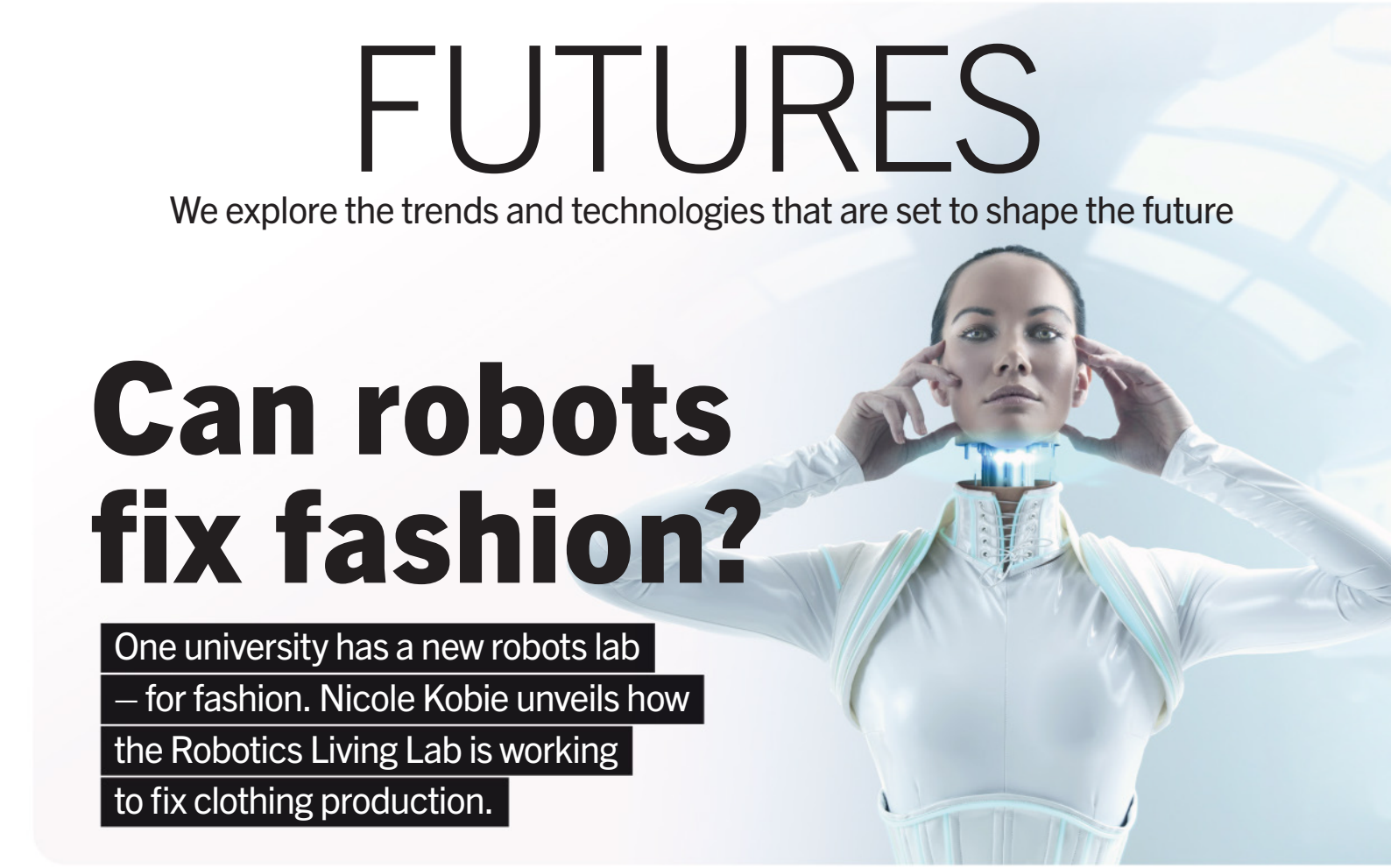
RATED AI PERFORMANCE

		NUC 14 Pro AI	NUC 15 Pro Plus	NUC 15 Pro
AI TOPs	Whole System	Up to 120	Up to 99	Core Ultra: Up to 99
	GPU (High Throughput)	Up to 67	Up to 77	Core Ultra: Up to 77
	NPU (Energy Efficient)	Up to 48	13	Core Ultra: 13
Processor Power	cTDP	30W	Ultra 9: 65W Others: 40W	Core Ultra: 40W Core: 25W

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FUTURES

We explore the trends and technologies that are set to shape the future



Can robots fix fashion?

One university has a new robots lab – for fashion. Nicole Kobie unveils how the Robotics Living Lab is working to fix clothing production.

The Robotics Living Lab at Manchester Metropolitan University is trying to solve long-running robotics challenges. Nothing too special in that statement, but rather than sit in the computing or engineering department, this robot factory is part of the Manchester Fashion Institute.

Why? Robotics are central to manufacturing in most industries, but clothing production has challenges not seen in car factories or chip fabs – after all, fabric is soft, making it difficult to manipulate by machine hands. If there was some way to solve this then we could reduce the fashion industry's reliance on so-called sweat shops and allow it to finally catch up with the rest of the world.

As it stands, fashion has a monstrous impact on people and the environment. Offshoring to regions where people are paid less for their work raises ethical quandaries, exacerbated by poor treatment of workers – exemplified by the worst but by no means only example of the fire at Rana Plaza garment factory in Bangladesh that killed 1,134 people.

There's also the environmental impact of fashion, with the rise of plastic-filled fabrics that are difficult, if not impossible, to recycle. This leads to clothing being dumped in developing countries.

Can robots help solve such challenges? Could our metallic friends help to fix fashion?

What's here, and what we're waiting on

Some technology is on the horizon or here already. CNC-style laser cutting machines have been slicing patterns out of fabric for decades, and have recently added robotic assistance; existing machines knit at a pace unachievable by even the best wool warrior, for instance. Robots also help with tasks such as packaging, testing fabrics and manipulating delicate materials.

For example, Robotextile created a system using Kuka industrial robots with custom grippers to gently pick up thin layers of material and place it carefully to be sewn. Levi's used a robot-driven laser to "distress" jeans, slashing the time required from half an hour manually to 90 seconds.

But sewing can be a tougher challenge. Startup company Sewbo attempted to address the problem by temporarily stiffening fabrics using water-soluble plastics for easier manipulation, but the system remains in development. SoftWear Automation's Sewbots manage pliable fabrics using AI-guided robots; while trials have been run, the system remains in development. Vienna's Silana makes the SiBot, to automate the entire sewing process, but the website still promises that a demo is coming soon.

In short, more work is needed. So the opening earlier this year of the Robotics Living Lab (RoLL) at the Manchester Fashion Institute is helping bring high tech to high fashion at just the right moment.

Building robots for fashion

Susan Postlethwaite had robotics in mind when she applied to work at Manchester Metropolitan University's Fashion Institute more than three years ago.

"I can remember describing a lab space in my interview," she told *APC*. "One of the visual triggers was an image that I



ABOVE Robotextile uses robots to pick up layers of material ready to be sewn.

had seen in a student's work at the RCA [Royal College of Arts] that involved a person sitting in an exoskeleton working on a car dashboard. All their tools were next to them suspended from the ceiling. This image really encouraged me to start considering why tools for the fashion industry hadn't really changed in 150 years."

A year into her work at the institute, Postlethwaite was awarded $8 million in funding from the Arts and Humanities Research Council to create the Robotics Living Lab.

"We were able to commission bespoke robot cells, buy collaborative small-scale robots, lots of gripper 'tool end effectors', and fit out the lab space with high-specification fashion-related technologies including a state-of-the-art sewing machine, knit and embroidery machines and 3D printers," she said. "We were set up to work with micro and SME businesses to collaborate on the kinds of tooling they could envisage for their workspaces, studios and micro factories."

Such equipment has a purpose: to improve the manufacturing of clothing with sustainability in mind. The best way to achieve that, RoLL research suggests, is reshoring or near-shoring, ending the practice of making clothing using "cheap labour" overseas before shipping finished garments across the world. That said, it's worth noting that machine labour hasn't exactly ended offshoring in other industries, so there's more to solving these challenges than robots.

Local production also enables circular economies. For example, clothing maker Rapanui uses robotics to take apart old clothing for recycling into new items, rewarding customers with discounts for returning worn out T-shirts.

That makes less economic sense if old shirts have to be shipped half-way around the world to be recycled and remade. Postlethwaite says: "If we can reshore then circular economic models become much more feasible."

Beyond labour ethics and sustainability, there are other reasons this could benefit the fashion industry. "The new geopolitical landscape suggests very strongly that we need to produce more locally, and there is a new focus on robotics and manufacturing," she added.



TOP The lab hopes to design robotics that can cut and sew fabrics.
ABOVE Tool end effectors attach to a robot's wrist for specific tasks.

How robots make clothes now

Cars, chips, mobile phones and many of the other goods we make using robotics are helpfully solid objects. As anyone who has tried sewing can attest, fabric is irritatingly flexible, with stretch and give that makes for a difficult task.

Teaching that to a robot is hard enough, but even more so given every fabric is different. "The deformable materials problem is very complex in terms of robotics, especially in a fashion context where you are dealing with floppy textiles," said Postlethwaite. "Currently robots are very good at pick and place tasks but not textile handling."

That's why startups such as Sewbo attempted to dodge the challenge by turning fabric stiff, making it easier to manage. "At RoLL we aim to develop a stitch tool but know that this will be a big challenge," she said.

For help, RoLL is turning to external industry partners in Germany to develop what's known as a stitch end effector tool, which is a gadget that attaches to a robot's wrist for specific tasks – essentially, it's a robotic sewing hand for, as Postlethwaite calls it, "the business end of a collaborative robot arm".

Lots of tasks adjacent to sewing have already been automated, even if sewing itself is proving a challenge. For example, pressing and 3D knit and weave are both highly automated, but Postlethwaite notes that the latter requires a lot of skill to set up.

"We know there are volume manufacturers internationally who have largely deskilled the workforce by automating so many tasks," said Postlethwaite. "This is the reason at RoLL we think collaborative robotics are the way forward."

And for all we know, exciting things may be happening behind closed doors. There's a limit to how much is shared about the state of robotics innovation in the industry because of non-disclosure agreements and other IP protection. "I think we can speculate that there is a lot of development currently happening behind the scenes," she said.

RoLL robots

RoLL has already produced plenty of its own tools to help the clothing production industry.

"We have developed several bespoke collaborative robot cells at the lab that include a vacuum table, magnetic tabletop and the ability to suspend collaborative robots from multiple angles – horizontal, top to bottom and side mounted – to deliver different capabilities," Postlethwaite said.

To develop such technologies, RoLL worked with small-scale companies. With POMO Robotics, the lab spent 18



LEFT Susan Postlethwaite is pioneering the use of robots in fashion.

months developing a rotary cutting tool end effector for collaborative robots. It's been through three design stages with tweaks made for operability, ease of use, and health and safety, with the lab saying it's at a technology readiness level of six or seven out of nine.

The lab also worked with Innovo Robotics. "Innovo produced for RoLL a fully enclosed demonstrator cell so that we can showcase to visitors what we are doing without the need for health and safety training," she said. "Innovo cobots are reconfigurable, which makes them very versatile in terms of reach and we are using these a lot currently."

But the longer-term aim is to create end effectors for robots that can be used in fashion production. One is already built, but still undergoing fine-tuning. RoLL started with a cutting tool to help small businesses. "We know from our research that cutting out manually created a serious bottleneck in the production process, so this is the first tool we have developed," Postlethwaite said.

"We would like to make this tool open source with a Creative Commons licence so that we can share with other labs, enabling them to develop on from where we are, with attribution as to the originators of course."

Next up is a stitching tool and a universal former, for making different sizes. "We have been influenced by the tooling development in the automotive and aerospace industries to think about smaller-scale tooling than the huge industrial robots employed there, but with similar capabilities," Postlethwaite explained. "The cobot technology will come into its own where a skilled human operator will be able to place textile to be stitched by a robot."

Indeed, in her view, robots will always remain just one part of clothing production, with human expertise remaining essential to keep in the loop. "Manual handling of textiles is an important aspect to making and a sensory experience so it's important to keep these skills," she said. "At RoLL we talk about taking the tool to the textile rather than the more conventional way of taking the textile to the machine."

What's holding it all back?

Robotics and fashion can feel worlds apart, and that's part of the problem – there aren't enough people with expertise in both clothing production and robotics. "The fashion industry is currently facing a severe skills shortage," said Postlethwaite.

And that means training is, as ever, crucial to these nascent technologies.

What's more, as we shift from existing practice to these new ideas, we need to be wary of energy use, the environmental impact of creating and decommissioning robotics, and much more besides. After all, if we trade landfills full of cheap T-shirts for those full of electronics, we haven't improved anything.

"We will need to be aware of zero carbon legislation on the horizon and the development of robotics in the build, in use and the decommissioning phase," Postlethwaite said. "We will also need to do further research around the rare minerals and metals used in the construction of robotics and consider the ethics of where they are found, what alternatives are currently being developed, where they are mined and by whom."

Otherwise, we're trading one problem for another when it comes to sustainability and ethics in fashion.

Beyond that, Postlethwaite hopes to get the fashion moving forward using new technology. "Fashion should be recognised as a cornerstone of creative industries straddling both design and manufacture," she argued, referencing the idea of creativity pairing with technology.

If we can get it right, robotics could help reshore textiles production locally, offering better-quality clothing at a lower cost that's made sustainably with ethics in mind, all while staying globally competitive. Robot-made clothing won't end fast fashion, but it could give us tools to address such challenges in the industry. ■

Not all down to robots

While this article focuses on the role robots will hopefully play when it comes to fixing fashion, it's not the only role tech is playing. For example, there's research into new materials that will biodegrade more quickly, while a handful of companies are using blockchain to add transparency to supply chains. These are all reasons to be optimistic in the future.

But for now, there are things we can all do. If your favourite online retailer offers AR or VR options for trying on clothes, give it a try. Use apps such as Depop and Vinted to buy and sell "preloved" clothing. Digitising your existing wardrobe (try apps such as Whering) may also make you realise you already own clothing similar to what you were considering buying.

Fundamentally, we can't ignore the fact that our consumption habits are part of the problem. Cheap, fast fashion shouldn't be the norm. Well-made pieces with high-quality materials are now more accessible and affordable thanks to technology, and changing how we buy clothing today will still have a big impact while we await robots that can cut and sew.

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REVIEWS

Expert reviews and recommendations to help you buy with confidence



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APC is Australia's oldest consumer technology magazine – having been consistently in print for over forty years, since our first issue way back in May 1980 – and we take that heritage and responsibility very seriously. While our focus is obviously on the personal computer the very definition of the PC has changed and shifted markedly since the early 1980s.

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PRICE $669 **WEB** geekom.au

Geekom A5 2025 edition

A small and budget-friendly PC that handles everyday tasks with ease.



There are a lot of mini computers available these days, from powerful gaming capable PCs, to modest little machines. The Geekom A5 is an existing model, now updated for 2025, and aimed at anyone after an affordable tiny desktop. But how does it hold up in the real world?

While the 2025 A5 is also available with a more powerful Ryzen 7 5825U, our review unit rocks the 2023 Zen 3 Ryzen 5 7430U inside the compact 0.6-litre shell. While not the latest generation anymore, it's a solid low-to-mid-range chip with a 15W TDP, a 4.3GHz boost clock, and includes capable Radeon Vega 7 graphics clocked at 1800MHz. In the A5, it's paired with 16GB of DDR4-3200 RAM and a 512GB PCIe Gen3 NVMe SSD. Handily, the RAM sits in two easily accessible slots for upgrades up to 64GB (and it's easily accessible after via the bottom cover), and there's a spare 2.5in SATA bay for extra storage.

Ports are plentiful enough to keep most folks happy, with 2x USB-C 3.2 10Gbps (with DisplayPort), 3x USB-A 10Gbps (two on the front, one on the back), 1x USB 2.0 Type-A, 2x HDMI 2.0b, an SD card reader on the side, plus a 3.5mm headphone/mic jack.

Wireless duties are handled by Wi-Fi 6 (2.4 / 5GHz) and Bluetooth 5.2, and impressively, it also has a 2.5GbE LAN port. The A5 can drive an 8K display, or more usefully, four monitors via the HDMI ports, and DisplayPort out via the two USB-C connections. It's also VESA mountable.

If you were hoping for flashy AI tricks (or maybe to avoid them), look elsewhere – the A5 just delivers solid Windows 11 Pro performance without any CoPilot+ shenanigans to worry about.

Cooling is provided by Geekom's IceBlast 2.0 system that features dual copper heat pipes and a dedicated CPU plate. The setup keeps that CPU humming at near full tilt, with little to no throttling under most loads. It's audible when put to work, but for normal office apps or web browsing, the A5 is whisper-quiet.

In a head-to-head comparison with the NiPoGi E3B mini PC (also equipped with the Ryzen 5 7430U) the Geekom A5 superior cooling results in noticeably better results in most tests. While it's a lower-end machine, performance overall is perfectly good for everyday web browsing or office tasks, and the Vega 7 graphics can help accelerate certain workloads.

Changing the cooling to Performance mode in BIOS gives around an 8% improvement to multi-threaded scores (but doesn't impact single core loads much) and only makes the A5 slightly noisier. If you need more grunt, the Ryzen 7 5825U has two extra cores and can be 10% or so faster in multi-threaded workloads and gives about 20% extra graphics performance.

At the time of writing, our reviewed machine had a discounted street price of $439, but the RRP is $669. If you want to grab the Ryzen 7 model, expect to pay at least $499. While not an overtly powerful machine, when discounted the 2025 A5 offers a hard-to-beat mix of mini-PC price and punch. ■

BENCHMARK RESULTS	Geekom A5 2025	NiPoGi E3B mini PC
CPU	Ryzen 5 7430U	Ryzen 5 7430U
GPU	Radeon RX Vega 7	Radeon RX Vega 7
PCMark 10 - Overall	5,687	5,368
Cinebench R24 - CPU (multi-threaded)	433	429
Cinebench R24 - CPU (single-threaded)	81	81
Geekbench 6 - Multi-core	6,472	7,187
Geekbench 6 - Single-core	1,945	1,899
Geekbench 6 - GPU	14,503	12,065
Fire Strike	3,541	3,021
3DMark Time Spy	1,372	1,261
Wild Life	7,633	4,928
CrystalDiskMark Read (MB/s)	3,529	4,382
CrystalDiskMark Write (MB/s)	3,096	3,785

SPECS W11 Pro; AMD Ryzen 5 7430U, Radeon Vega 7 iGPU; 16GB DDR4-3200 RAM; 512GB M.2 SSD; 2x USB-C 10Gbps, 3x USB-A 10Gbps, 1x USB-A 2.0, 2 x HDMI 2.0b; 2.5G LAN, Wi-Fi 6, Bluetooth 5.2; 117 x 112 x 49 mm, 652 grams; 3-year warranty.

VERDICT

★★★★☆

The Geekom A5 2025 edition punches above its weight, but it's the best value when picked up on special.

Lindsay Handmer

PRICE $1,699 **WEB** microsoft.com

Microsoft Surface Laptop 13in

Microsoft's latest and smallest Surface is an affordability winner in a gorgeous shell.

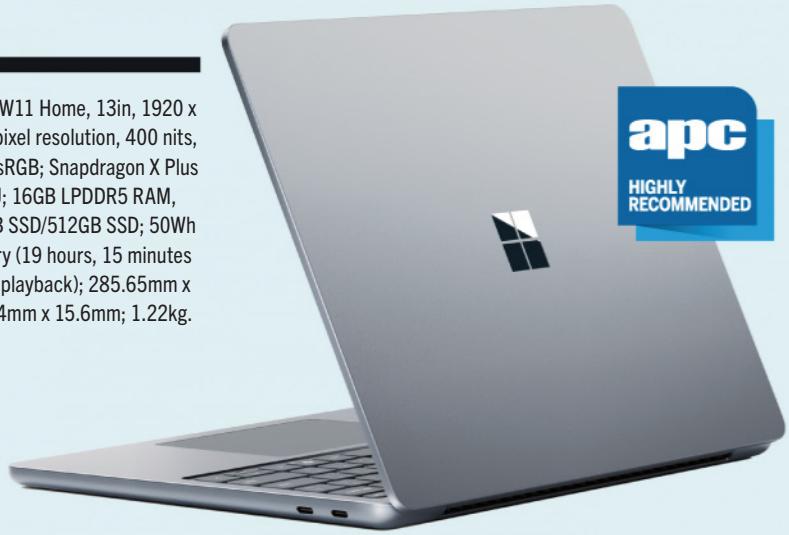
The Microsoft Surface Laptop 13in is intended to be an accessible refresh of Microsoft's laptop range. The efficient Snapdragon chip inside allows for a long-lasting battery, while also powering a handful of useful AI tasks.

The Microsoft Surface Laptop 13in is a new 7th generation member of the Windows-maker's laptop line, and is cheaper than the earlier released Surface Laptop 13.8 and Surface Laptop 15. Its 13in screen size naturally makes it a smaller device, with 15.6mm thickness and 1.22kg weight, making it the thinnest option.

The Snapdragon X Plus (8 core) is the lowest spec processor seen in the Surface Laptop range, and it comes paired with the same Qualcomm's Adreno GPU and 45 TOPS Hexagon NPU used in the the 13.8in and 15in models). 256GB and 512GB storage options are available, though you can swap the SSD for a larger one if you choose. Unfortunately, the 16GB RAM can't be upgraded at all.

The laptop has dual USB-C 3.2 ports (one on each side) with DisplayPort 1.4a capability that are capable of driving two 4K/60Hz monitors. Both can charge at up to 60W, though the included charger is only 45W. There's also a USB-A 3.1 port on the left, beside a 3.5mm jack. These ports are slightly underwhelming compared to the laptop's siblings, which sport USB-C 4 and USB-A 3.2 connections. There's no Surface Connect port this time around, as Microsoft is phasing it out in favour of USB-C.

SPECS W11 Home, 13in, 1920 x 1280 pixel resolution, 400 nits, 100% sRGB; Snapdragon X Plus CPU; 16GB LPDDR5 RAM, 256GB SSD/512GB SSD; 50Wh battery (19 hours, 15 minutes video playback); 285.65mm x 214.14mm x 15.6mm; 1.22kg.



The 13in touchscreen, which features an IPS 1920 x 1280 resolution (60Hz, 1000:1 contrast ratio) and a 3:2 aspect ratio, has a maximum brightness of 400 nits and is a little difficult to view in light-filled environments. It's not as flashy as the larger and more detailed displays found in the 13.8 and 15, both of which offer 120Hz refresh rates, but it's not bad for a cheaper laptop.

I never noticed any sluggishness in use – though bear in mind I used this laptop primarily as a work laptop for typing out articles and quickly whipping up Canva images. The laptop outpaced the Acer Swift 14 AI with the more expensive Intel Core Ultra 7 258V processor in the multi-core Cinebench test, and was only slightly behind the Swift in Geekbench. The Snapdragon X isn't particularly good at graphics processing, so it lagged far behind on the 3DMark test. Additionally, as the system is Arm-based, and while support has improved, we have observed some applications that still aren't fully compatible.

The keyboard is very satisfying and perfect for typing out long documents but I found the physical trackpad feels a bit too stiff. Windows Hello's facial and fingerprint recognition worked perfectly and the speakers were fine for casual use. We were impressed with the battery life, and the laptop managed 19 hours and 15 minutes of video playback.

It's awesome to see Microsoft's vision come to life. Recall has seen genuine privacy improvements that I'm a fan of, and the new AI-powered system search, which uses large language processing to aid with search beyond file names, is a breeze to use. ■

BENCHMARK RESULTS

	Microsoft Surface Laptop 13in	Acer Swift 14 AI	HP OmniBook Ultra Flip 14
CPU	Snapdragon X Plus (8 Core)	Intel Ultra 7 258V	Intel Ultra 7 258V
GPU	Qualcomm Adreno GPU	Intel Arc 140V	Intel Arc 140V
Battery Capacity	39W	65 Wh	65 Wh
RRP	$1,699 ($1,899 for tested 512GB model)	$2,399	$3699
PCMark 10	N/A (not ARM supported)	7,193	7,490
Cinebench R24 - CPU (multi-threaded)	642	600	599
Cinebench R24 - CPU (single-threaded)	97	121	120
Geekbench 6 - Multi-core (score)	10,456	11,133	11,192
Geekbench 6 - Single-core (score)	2,214	2,731	2,696
Geekbench 6 - GPU (score)	9,308	29,188	29,537
3DMark Time Spy (score)	923	4,267	4,366
3DMark Night Raid (score)	16,421	36,517	35,257
Battery life - 1080p video playback (h:min)	19:15	21:43	12:37
CrystalDiskMark Read (MB/s)	3,837	5,150	7,084
CrystalDiskMark Write (MB/s)	3,474.46	4,662	5,208

VERDICT

★★★★☆

Aside from a firm touchpad, the Microsoft Surface Laptop 13 is a more affordable win for users that showcases how good Snapdragon-based laptops can be.

Zachariah Kelly



PRICE $2,799 **WEB** acer.com

Acer Swift 16 AI

The latest Intel CPU in an impressive 16in OLED laptop, with a couple of minor quirks.

Aimed at those who want a premium slim but powerful Windows machine, the Acer Swift 16 AI has a compelling spec. It uses Intel's new Core Ultra 7 258V CPU, backed up by 32GB LPDDR5x RAM, a 1TB SSD, and a pretty impressive 16in 3K OLED display – all in a thin laptop that weighs just 1.46kg.

The Swift's OLED display is the standout feature, thanks to a 2880 x 1800 resolution that results in a 16:10 ratio and loads of desktop real estate, plus a 100% DCI-P3 colour accuracy and the ability to fold through 180-degrees and lay flat. Our test model didn't have the optional touchscreen, and Acer doesn't give a brightness for the panel, but the matte screen handled reflections well.

When it comes to performance, the Ultra 7 258V really shows its chops in single-core workloads, and gives great performance in everyday tasks like web browsing and office apps. In more demanding multi-threaded applications like video rendering, it still does pretty well, but falls well behind competitors like AMD's powerhouse Ryzen 9 HX 370.

Thanks to the Arc graphics built into the Ultra 7 258V, the Swift handles graphics accelerated workloads well, and can even handle some casual gaming at low settings. The Swift is near silent for typical use, but under heavy loads the fan does spool up to a mild but noticeable hum.

The 258V gives the efficiency that previous Intel mobile CPUs lacked, and in our testing, the Swift managed 19 hours, 24 minutes of video playback at 50% brightness. For office work and lighter tasks it happily lasts 10+ hours unplugged, but that drops to about 5 hours under sustained workloads like video editing.

Connectivity options are above average for a slim device, with two USB-C ports supporting USB4 40Gbps (and Thunderbolt 4), as well as DisplayPort out and USB charging – though annoyingly these are both on the same side of the laptop. It also has two USB-A ports, one HDMI 2.1 connector and a headphone/microphone combo jack. You also get the latest Wi-Fi 7 and Bluetooth 5.4.

The webcam supports Windows Hello facial recognition but we found it was often slow, and instead favoured the fingerprint reader built into the power button. The webcam has a physical privacy slider and the quality is fine for video meetings, but the speakers are disappointing even by laptop standards.

The keyboard squeezes in a mini numpad, and while we like it in theory, it offsets typing and makes it feel a little awkward. The keyboard also has a noticeable amount of bounce, and while backlit, there is a bit of light bleed from under the keys. The trackpad is big and responsive, but there's no haptic feedback. The build quality is great and it has a stiff, robust feeling chassis, but the diamond-cut edges feel a little too sharp to be as comfortable as we'd like.

While the overall experience is pretty good, the Swift 16 AI has a few niggles that make it a little less appealing than the competition. ■

BENCHMARK RESULTS	Acer Swift 16 AI	Lenovo Yoga Slim 7i Aura
CPU	Intel Ultra 7 258V	Intel Ultra 7 258V
GPU	Intel Arc 140V	Intel Arc 140V
Battery Capacity	70 Wh	70 Wh
RRP	$2,799	$2,799
Cinebench R24 - CPU (multi-threaded)	535	606
Cinebench R24 - CPU (single-threaded)	121	121
Geekbench 6 - Multi-core	11,033	11,113
Geekbench 6 - Single-core	2,755	2,721
Geekbench 6 - GPU	26,536	28,889
CrossMark	1,911	1,796
3DMark Time Spy	4,351	4,379
3DMark Night Raid	31,373	35,878
Battery life - 1080p video playback (h:min)	19:24	20:03
CrystalDiskMark Read (MB/s)	6,387	6,034
CrystalDiskMark Write (MB/s)	5,726	4,215

SPECS W11 Home; Ultra 7 258V; 32GB LPDDR5x RAM; 1TB SSD; 16in OLED display, 2880 x 1800 pixel resolution, 100% DCI-P3 colour, 120Hz; 70Wh battery 19h, 24m video playback; 35.6 x 24.9 x 1.6cm; 1.46kg.

VERDICT

★★★★☆

The Acer Swift 16 AI is a reasonably powerful laptop with a great display, but is let down slightly by some of the design decisions.
Lindsay Handmer

PRICE $2,799 **WEB** www.asus.com/au

Asus ProArt Display OLED PA32UCDM

Has Asus made the ultimate monitor. Again?

Not content with recently releasing some of the very best gaming monitors we've ever seen, Asus has now launched the ProArt Display OLED PA32UCDM which strives rule them all. Has it succeeded and will it be worth the inevitably high price?

The 31.5-inch PA32UCDM feels special as soon as you open the box. The one-piece metal stand, stem and matching backing would fit inside the chicest of chic offices and studios. It's aimed squarely at graphics professionals including television editors, filmmakers, video editors, professional colourists, game developers, 3D and VFX artists, designers and photographers – those who need ultimate control over colour accuracy, brightness and pixel response. Its list of features tells the tale.

The PA32UCDM has a pin-sharp 4K, 3,840 x 2,160 resolution. The QD-OLED panel ensures that colours are vibrant, contrast sublime and true-black performance is perfect. It has a 0.1ms (GTG) pixel response time which marries with a rapid 240Hz refresh rate to ensure fast-moving objects are rendered without blur.

It has an eye-melting, 1,000-nit peak brightness that works with multiple HDR10 'curves' (including PQ Hard Clip, Optimised and Basic) which, among other things, help tailor maximum luminance. This further-enhances contrast and ensures that both colourful and monochromatic transitions are rendered smoothly. In practice, we sometimes found it hard to stop details getting lost in blown-out highlights, but there are so many settings to adjust, that you're able to tailor the picture perfectly for every task. There's also an HDR Preview mode which quickly shows what pre-rendered footage (and images from directly connected cameras) will look like before processing. The semi-gloss, coating does wonders at eliminating annoying reflections, too.



"It has an eye-melting, 1,000-nit peak brightness that works with multiple HDR10 'curves' (including PQ Hard Clip, Optimised and Basic) which, among other things, help tailor maximum luminance."

The list of technical specifications continues: it has a true, 10-bit colour depth, covers 99 per cent of the tricky DCI-P3 colour space and supports the even-trickier BT.2020 UHD TV-related colour-and-framerate requirements. It also supports hybrid log-gamma (HLG) dynamic-range and will support Dolby Vision later this year (via an update). Every monitor is calibrated in the factory to an industry-leading colour-accuracy standard of $\Delta E < 1$. Its ProArt Calibration software works with PCs, Macs and hardware calibration devices (the latter can save profiles directly to the monitor). Other built-in, professional calibration tools include Calman and Light Illusion ColourSpace CMS.

Most features can be easily adjusted using Asus' DisplayWidget Center app which is intuitive and well featured. An online 'Color Center' tool helps sysadmins manage the colour accuracy of multiple displays. The PA32UCDM also has dual Thunderbolt 4 ports (one with 96-Watt power delivery for laptop charging and daisy-chaining displays) and an HDMI 2.1 port. A fast, USB 3.2 Gen 2 hub has both Type-A and Type-C ports. Asus bundles all the high-quality cables you need to make the most of this.

Ultimately, it performs as well as it sounds. The only issue is the speakers which are somewhat muddy, have minimal bass and suffer top-end distortion, despite getting loud.

Its $2,800 price tag makes it an expensive option for demanding consumers, but we expect professional studios to buy crates of them. ■

SPECS 31.5-inch, semi-gloss, 3,840 x 2,160, HDR10, 240Hz, QD-OLED. 0.1ms GTG response time. 1,000-nit brightness. 1,500,000:1 contrast. 1x HDMI 2.1, 2x Thunderbolt 4, 1x USB-C 3.2 Gen 2, 1x USB-A 3.2 Gen 2. Tilt +20° -5°, Pivot +90° -90°, Height +130mm. 2x 3-Watt speakers. 717 x 603 x 228mm, 9KG.

VERDICT

★★★★★

A brilliant, does-it-all monitor for professionals who won't wince at the price.

Nick Ross

PRICE $466.40 **WEB** www.dell.com

Dell Pro 14 Plus Portable Monitor P1425

Easy to use, but not strong on configuration choices.

There's no shortage of portable monitors available if you fancy a little dual screen action on the go. Dell's latest effort, the Dell Pro 14 Plus Portable Monitor P1425 as tested is built around a 14 inch WUXGA (1920x1200) IPS LCD display with dual USB-C ports – one for video delivery and one capable of USB-PD passthrough power if needed.

Dell produces its Pro Plus external monitor line all the way up to 55-inch models, though predictably portability and cost become more interesting challenges at that size. 14 inches is something of a sweet spot here, as it'll likely compliment the size of displays from most of the laptops it's going to be plugged into.

The integrated stand for the P1425 extends out the back of the monitor and offers excellent stability on a variety of surfaces, making it suitable for everything from tiny hotel room desks to even bed-based working. While it's built with horizontal support in mind, it does support automatic switching to vertical modes with the stand tilting backwards at a slight angle when you do so. Outside of the monitor itself, you also get a single USB-C cable with a sideways mounted plug to hide behind the display and a simple carrying pouch for portability.

Build quality is decent while keeping the entire unit light enough to quickly slip into a bag and carry it with you as needed. While the casing has a plastic feel to it, the basic silver framing still gives it a nicely professional look, though whether that will last over time is debateable.

> "Dell produces its Pro Plus external monitor line all the way up to 55-inch models, though predictably portability and cost become more interesting challenges at that size."



USB-C is your sole connection method – you'll have to look elsewhere for HDMI connectivity if that's your preference – but that does mean that setup is no more complicated than hooking up both ends of a USB-C cable to a suitable laptop or desktop system. Direct connection worked nicely in my tests, though it was fiddlier if I was using an external hub or dock, with some failures to find a suitable USB-C signal encountered.

The best feature of the P1425 is its rated contrast ratio of 1500:1, delivering a crisp, bright picture for productivity work. Visibility is good at most tilt angles too, which is vital for a monitor likely to sit at the side of your primary screen.

With a standard 60Hz refresh rate and response time of 7ms it's certainly not built for gaming, though if you're feeling masochistic there's nothing stopping you. That's not the P1425's biggest issue, however. Along with a rotation lock button, the only physical controls are for brightness. You're not just stuck with Dell's choices as long as you're also happy to install its Windows-based Peripheral Manager Software (sorry Mac/Linux fans, not you!) which affords you a lot more calibration choices. It's functional enough software, but the P1425 would be far better served with a standard inbuilt OSD that you could use on any system without needing the additional software install each time.

While the Dell Pro 14 Plus Portable Monitor P1425 fulfills its basic remit of being a portable screen, that's about all it does, and at around $466 it's also not exceptionally price competitive if you do just want a basic extension laptop monitor. Shop around – or wait for the inevitable Dell sale, because there's nearly always one of those. ■

SPECS 14-inch, 1,920 x 1,200 16:10, 6Hz, IPS, 7ms response time, 400-nit brightness, 1,500:1 contrast; Ports: 2xUSB-C ports (DisplayPort 1.2, power pass through 65W); Tilt 10° to 90°, 90 degree rotation; Dimensions: 223.54mm x 315.15mm x 4.60mm(thick) - 14.65mm (depth with stand), 570g.

VERDICT



A decent tool for on the go use, but with nothing that stands out.

Alex Kidman

PRICE $99.95 **WEB** www.dlink.com.au

D-Link DWR-933M 4G+ Cat6 Wi-Fi 6 Mobile Hotspot

Simple and very affordable, but absolutely a niche device in 2025.

At just $99.95, the D-Link DWR-933M is a budget range mobile hotspot device with a strong pitch towards consumer users, as distinct from business-grade 5G capable mobile hotspot devices.

Setup feels suitably old school, like a classic feature phone, with a pop-off rear cover that reveals the battery; remove that and you're faced with a flat Nano SIM card tray and simple metal shutter to hold it in place. Getting it to hold in place is a tad fiddly, but not something you'd really need to do all that often.

The DWR-933M comes pre-setup with default login codes printed on the main board underneath the battery, but one of the big benefits of a mobile hotspot over a smartphone one is configuration, which you can do via D-Link's Mobile Connect app for IOS or Android, or just via IP address from any browser. This isn't a fully-fledged router so more advanced features like QoS aren't present, but you can select Wi-Fi channels, use MAC filtering to block devices or use WPS for simpler quick connections.

The DWR-933M supports up to 64 client devices, though you'd realistically be seriously stretching the capabilities of any 4G connection, even a pristine one, running that many. By default it assigns half of that pool to its broader 2.4GHz network while the other half sits with its 5GHz network, with support for differentiated network names if that suits your uses.

Not that $99.95 buys you peak speeds; far from it. The DWR-933M is a Cat6 capable 4G LTE device instead. 4G still has its place, as well as wider coverage across Australia, with the promise of up to 300Mbps download rates. Will you see those speeds?

Probably not, because network conditions always play their role. Testing in Sydney on the Telstra network, our test coverage on a single device averaged more around the 30-5Mpbs range typically, quite a bit lower than the claimed rate. 4G data rates can vary a lot over time and location, however, and the same data rates were achieved for the same Nano SIM sitting in a Galaxy S25 Ultra – or in other words, the data rates I got weren't exactly the DWR-933M's fault.



> "Testing in Sydney on the Telstra network, our test coverage on a single device averaged more around the 30-5Mpbs range typically, quite a bit lower than the claimed rate."

Range may also be a smaller issue if you needed to share across a small house, because it's not like the DWR-933M features anything in the way of external antennas, though I could get coverage for a couple of rooms with minimal issues. 4G won't supplant a decent quality fixed NBN connection, but then this maybe isn't the point.

D-Link rates the DWR-933M's 3000mAh battery as being good for up to 12 hours, though that's more likely with just a single device connected; with a trio running I was able to hit around 3 hours of moderate usage, so it might be wise to also pair it to a mobile battery pack if you needed to run a lot of devices for extended periods.

If you only need a hotspot every now and again, stick to your smartphone and its hotspot pairing, but if you're after something a little more flexible – or you're just tired of sending your phone flat by using it as a hotspot – then the DWR-933M is a decent, if not exactly high-end device. ■

SPECS 4G LTE (6-300Mbps); Wi-Fi: Wi-Fi 6 (802.11ax), Maximum 64 clients; Battery: 3000mAh; Dimensions: 108 x 63 x 16 mm.

VERDICT



A wonderful pick-up-and-use option – and the inclusion of multitouch gesture controls really sets it apart from the crowd.

Alex Kidman



PRICE $1,299 **WEB** www.dell.com

Dell S3225QC QD-OLED

Dell's first non-gaming QD-OLED screen is a winner... But where are all the ports?

The Dell S3225QC is potentially the best all-rounder model on the Australian market. Large with an epic row of in-built speakers, fitted with a gorgeous 4K QD-OLED panel operating at 120Hz, and capped off at a reasonably generous price of $1,289, the S3225QC is billed at being your monitor for work, school or play, all in one device.

But that sales pitch is knee-capped by one big problem – the audio and video ports. Most monitors typically come with a healthy assortment of input ports – a healthy mix of HDMI and Display Ports typically – but the S3225QC only has an HDMI 2.1 port and a USB-C port (utilising the DisplayPort alternate mode) for projecting the screen of your laptop or PC.

At first glance you might not consider it a problem – two inputs are perfectly fine for a stationary workstation and a portable laptop. However, for devices that might only work with an HDMI port, such as a Google TV Streamer, you'll likely be forced into an awkward dance between your computer's ports to use your tech. But believe me when I say that this is the only thing holding the monitor back, and it can be easily overcome by conversion cables or splitters (just not as neatly as having the separate port to begin with).

The S3225QC makes no compromises in any other department. It features the best in-built monitor sound that I've ever experienced, along with a to be expected epic QD-OLED panel. These two features combine to offer epic headphone-less gameplay and an awesome experience for anyone who likes to stream TV shows and movies at their desk. The 120Hz refresh rate is just enough for high framerate-craving gamers, and it's perfectly fine for most users looking for epic 4K visuals.

It's also a perfect monitor for productivity. There's no haziness or blur to speak of when using apps like Google Docs or Sheets, and I found the monitor's in-built settings quite easy to navigate when I wanted to adjust something quickly.

As for the additional ports, the monitor is fitted with two extra USB-C connections. One is located under the monitor, and pops up and down so that you can tuck it out of the way when not in use. The other is located behind the monitor, nested in the typical port location.

The USB-C port with DisplayPort alternate mode can also deliver up to 90W, allowing you to charge your laptop while projecting. Meanwhile, the other two USB-C ports offer up to 15W power delivery and can be used to connect peripherals and data storage devices to your computer, letting the S3225QC act as a USB hub.

The Dell S3225QC has taken the lead as my favourite OLED monitor on the market, but while I could happily live with it and its lack of ports, I'm not confident in calling it the perfect monitor for everyone – despite its attempt at being an all-rounder. ■

SPECS 32-inch, matte, 3,440 x 1,440, VESA DisplayHDR TrueBlack 400, 120Hz, OLED. 0.03ms response time. 250-nit brightness, 1000-nit HDR. 1,500,000:1 contrast. 1x HDMI 2.1, 1x USB-C 5Gbps upstream (with Display Port alternate mode), 2x USB-C 5Gbps downstream. Tilt, Swivel and Height adjustment: Yes. 718.78 x 457.65 x 70.35mm, 10KG.

VERDICT

★★★★☆

Potentially the best all-rounder monitor with one severe drawback.

Zachariah Kelly



PRICE $579 **WEB** asus.com

Asus ROG Ryujin III 360 ARGB Extreme AIO

A next-level cooling solution for people who refuse to compromise on performance or style.

The ROG Ryujin III 360 ARGB Extreme doesn't just show up – it arrives in style, flaunting a 360 mm radiator, magnetic ARGB fans, black or white trim, and a 3.5-inch IPS display built right into the CPU block.

What's the downside? The rather eye-watering $699 RRP of course, and street prices of at least $579. That's a lot, especially when a less blingy but still very competent 360mm AIO cooler can be had for less than half the price. So it's fair to say that those interested in the ROG Ryujin III are not too worried about the cost, and think it's worth paying for premium style. With that in mind, how does it stack up?

For a start, it's not just a showpony, and underneath the bling is some premium engineering and a real focus on performance. The Ryujin III brings a copper CPU plate, a high-flow, low-noise Asetek 8th Gen V2 pump, an embedded VRM fan, thicker radiator fans and every Aura Sync LED customisation you could ask for via Armoury Crate. The trio of 120 mm magnetic ARGB fans are rated for 89.73 CFM at 2800 RPM with 5.15mmH_2O of pressure.

When eyeing up its glory on the testbench, one of the APC team suggested it's like showing up to a black-tie event in a bespoke tux with neon trim. In other words, you'll certainly stand out!

Installation is mostly painless, and the pre-installed Intel and AMD brackets cut mounting time, plus the block has CPU paste already applied. The magnetic daisy-chain fan connectors are both incredibly satisfying to clip together, and simplify cabling tremendously and give a very neat look. Overall, build quality is impeccable and the 400mm long sleeved tubing is supple and easy to route.

Connected up to our testbench with an Intel Core i9 14900K installed, the ROG Ryujin III kept temps below 42°C when gaming, and we saw a peak of 83°C during a stress test. When pushing further with an overclock, we saw up to 89°C. This is as good as, or better than, most similar AIO coolers, but it's not an earth-shattering difference. The VRM fan in the CPU block keeps air flowing over your motherboard components and VRM heatsinks and does noticeably reduce temps compared to when it's disabled. At full tilt, the pump and fans are not exactly quiet, but for typical gaming level workloads (and mounted in a case), you likely won't notice the sound at all.

So what about aesthetics? The 3.5-inch LCD has a 640x480 resolution and a 60Hz refresh rate, and can show real-time stats like temps, clock frequencies and water flow, animations or a custom logo. It's inset into the cooling block a little, so it is easy to make it look a little more restrained, or, if you prefer, go all out with a vibrant animation.

It's worth noting that the Ryujin III isn't the flashiest Asus AIO cooler, and the ROG Ryuo IV SLC 360 knocks it up a notch with a 6.67in 2K curved display on the water block. ■

SPECS 360mm aluminium radiator; 3x 120 mm Magnetic ARGB fans, 0-2800 RPM, 89.73 CFM; Asetek 8th Gen V2 pump; embedded VRM fan; 3.5in 480p IPS display; 400mm sleeved rubber tubing; Intel LGA 1851/1700/1200/115x & AMD AM5/AM4 compatibility; 399.5 × 120 × 30 mm; 6-year warranty.

VERDICT



It's an expensive cooler, no doubt, but for enthusiasts chasing peak performance and standout style, it's worth every cent.
Lindsay Handmer



PRICE $99 **WEB** asus.com

Asus A31

apc EDITOR'S CHOICE

A great versatile case for a system builder.

The Asus A31 is a brilliant entry-level case – one of the most attractive and easy to pull apart models I've come across. Available in black and white, it follows what appears to be a standard design for a Mid Tower box – rectangular with an underslung compartment for the PSU and an SSD rack (2 x 2.5in / 3.5in) – but there are aspects to the A31 that make it an attractive case for system builders and a decent budget option alike.

The model I received for review is the A31 Plus – which comes with three intake fans on the side and one exhaust on the back – though the Plus hasn't been priced for Australia yet and no retailers have stock, but the standard A31 is the same beast, minus the fans. When you're shopping for cooling, you'll have an easy time picking out a solution, with 120mm clearance for a radiator on the back and up to 360mm on the top.

The top has support for up to three 120mm fans and the rear a 140mm (though these are sized for smaller fans as well). On the right side there's vents for up to three 120mm fans, with this unique side-cooling layout used as there's a glass pane on the front. If you so wish, there's even room for three 120mm fans across the bottom. At most, you can have 10 fans strapped in, along with a 380mm graphics card and a 165mm CPU air cooler. A 34mm gap between the right-side panel and the motherboard wall allows for plenty of cabling to reside.

Below the pane on the front are your I/O buttons and ports, including the standard power button, combined headphone/mic 3.5mm jack, two USB 3.2 ports and a Type-C 3.2 connector. There's also a reset button using a USB-C cutout.

The case is sized for ATX boards, but it'll also fit Micro-ATX, Mini-ITX and Asus' 'BTF' boards, the company's standard for motherboards with connectors on the backside (removing ugly cabling from the front).

The computer's panels are easily removed, but the front glass panel may catch you out. This requires a screwdriver to remove screws in the top and bottom of the pane's left side. After this, the pane slides out to the left. The left and right side panels slide off after releasing finger-tight screws on the back, with both glass panes having metal bordering to hold without marking the glass.

One last unique thing about the case is its eight degree angled bottom. The floor of the case is angled in a way to supposedly encourage enhanced airflow, sitting at a slant with a grated sheet, allowing you to view your PSU and cabling underneath. I'm not sure how much this would actually improve airflow, but it does widen the viewing angle of the case and adds to the aesthetic appeal. Filter sheets are magnetised to the top and bottom and lift away easily for cleaning.

The Asus A31 is built to be a minimalist and problem-free case, designed to cut down on cable clutter while also offering a unique internal viewing angle. I'd recommend it to anyone looking to add some flair to their custom-built computer, though note you'd need to factor in purchasing fans, as none come included as standard. ■

SPECS Motherboard support: ITX, Micro-ATX, ATX, E-ATX; max fan support: Top: 3 x 120 mm; Rear: 1 x 140 mm; Left side: 3 x 120 mm; Bottom: 3 x 120mm; dimensions: 238 x 511 x 435 mm; graphics card clearance: 380mm; warranty: 2 years.

VERDICT

★★★★★

An awesome budget PC case with tonnes of fan space and a gorgeous double-pane glass design.

Zachariah Kelly

PRICE $1,999 **WEB** amazon.com.au

Moto Razr 60 Ultra

A stunning screen, great cameras, superb battery life and a powerful chipset make this the best flip phone yet – but it comes at a price.

Folding phones are no longer the hot new thing, but Motorola's Razr mobiles keep getting better. The Razr 60 Ultra is the best take we've seen on the flip format, although the cost pits it against formidable non-folding competition.

At least Motorola is providing a generous specification in return for your cash. The Razr 60 Ultra comes with 512GB of storage, the latest processor, a big 4,700mAh battery and fast charging. You also have a great range of new Pantone-branded finish options to choose from, namely Cabaret, Mountain Trail, Rio Red and Scarab – translating to a rich pinky purple, earth tones, maroon and opal green, respectively.

Aside from the new colours, Motorola deviates little from the established Razr design; the most visible change is the addition of the quick-access AI key on the left side. However, the hinge is now reinforced with titanium, making it feel snappier and more substantial. The crease in the middle of the display also seems shallower than ever – it's visible if you look for it, but not a distraction.

In all, the Razr 60 Ultra is a charming little thing. Despite the thin construction it feels sturdy, with a reassuring IP48 rating for protection against rain and accidental drops in the bath, although you'll still need to protect it from crumbs and dust.



apc HIGHLY RECOMMENDED

Bright spots

The Razr 60 Ultra's main display is a 7in fold-out AMOLED panel. It looks great, with impeccable detail, wide viewing angles and bright colours. And I do mean bright: it peaks at a blazing 1,112cd/m2 with SDR content but goes to a wear-sunglasses-to-protect-your-eyes 1,835cd/m2 when viewing HDR films. It's a delight to use this phone in any conditions, and few rivals are capable of getting close to this level of luminance.

> "It's a delight to use this phone in any conditions, and few rivals are capable of getting close to this level of luminance"

Colour coverage is superb – well beyond 100% of the DCI-P3 gamut – and if the colours are too much then you can always switch to Natural mode.

As usual with flip handsets, the tall 22:9 aspect ratio might take some getting used to; it doesn't interfere with how I generally use a phone, but watching videos is odd as 16:9 media displays with gaps at the sides.

The outside display is a 4in OLED panel, which is also bright and detailed. As before, there are tons of personalisation options, and a selection of "flex modes" for when the phone's propped up on a desk.

Canny cameras

The Razr Ultra 2025 offers main and ultrawide 50MP cameras. I was happy

SPECS 8-core 4.32GHz/3.53GHz Qualcomm Snapdragon 8 Elite SoC; 16GB RAM; Adreno 830 graphics; Hexagon NPU; 6.9in foldable 120Hz AMOLED screen, 1,224 x 2,992 resolution; 4in AMOLED 165Hz cover screen, 1,272 x 1,080 resolution; 512GB storage; IP48; dual 50MP/50MP rear cameras; 50MP selfie camera; 5G, Wi-Fi 7, Bluetooth 4, USB-C 2 connector, 4,700mAh battery, Android 15 (3yr OS updates), open, 74 x 7.2x 172mm (WDH); closed, 74 x 15.7 x 88mm (WDH), 199g.

with the images from both, which came out with plenty of detail and natural-looking colours – more so than last year's Razr 50 Ultra, which boosted the saturation too much for my liking.

Although there's no optical telephoto lens, the Razr 60 Ultra does a good job of digitally zooming in to 2x and even 4x magnification. You can even get away with pushing right up to the maximum 30x zoom, with captured images looking reasonably clear. I love the macro mode. Often, these are a waste of space, but the Razr 60 Ultra let me get close up to nature subjects and capture a huge amount of detail.

Its weakest suit is low-light photography: in dark environments, the phone had a tough time finding focus, and images came out visibly underexposed. I also question the point of the 50MP selfie camera embedded into the main display; this produces soft shots and is superfluous – you can just use the main rear camera, with the outer display as your viewfinder.

Content creators will enjoy the number of camera modes available, including additions such as Group Shot, which takes a burst of images and blends the best faces for idealised results. I also enjoyed using Pro mode to tweak the camera settings to my liking, but this is only for photos and not video.

On that note, video can be recorded at 4K 60fps or 8K 30fps – giving you an option to shoot at an ultra-high resolution, then crop in and reframe your footage before exporting it at 4K. With a wide field of view and good stabilisation, this phone is a great choice if you're looking for a pocket vlogging companion.

Full speed ahead

The Razr 60 Ultra is armed with a top-performing Snapdragon 8 Elite chipset and 16GB of RAM, making it the most powerful foldable phone around. I found apps and games ran perfectly, whether on the main or outer screen; an adaptive 165Hz refresh rate gives animations an extra fluid look.

Motorola's custom software runs on top of Android 15, but adds several major features, such as allowing you to run two apps simultaneously on the main display. I've always appreciated the way that Razr phones let you run any app on the outer screen too – it's ideal for one-handed use, with my sole grumble being that the camera lens sometimes gets in the way.

Meanwhile, the Smart Connect feature lets you connect wirelessly to other devices and share resources. It's genuinely useful, allowing you to access apps and files stored elsewhere, and I was even able to cast a virtual version of the phone onto my Windows 11 laptop.



> "I haven't yet been persuaded to switch to a flip-phone, but the Razr 60 Ultra very nearly made me want to make the move"

Motorola's own-brand AI features include Catch Me Up (this uses AI to summarise your recent notifications), Pay Attention (a voice recorder that can transcribe and summarise recordings) and Remember This, which saves screenshots, photos and more for future reference. There are also powerful (albeit now commonplace) visual tools, which let you generate images from a text prompt, and turn quick sketches into detailed images.

Google Photos takes care of removing unwanted image elements and reimagining scenes, and the Google Gemini and Perplexity assistants are both built in, although they're free for a miserly three months.

The only disappointment is that Motorola offers a lowly three years of software support; that's less than half what you're promised with a similarly priced phone from Google or Samsung.

Snap decision

It's hard to believe that there's a 4,700mAh battery inside such a small phone – but there is, and paired with the power-efficient chipset it provides excellent longevity. Out of the box, with default settings, the Razr 60 Ultra lasted an excellent 15hrs 42mins of use on a single charge, and switching to the power-saving "Efficiency First" mode saw that shoot up to 18hrs 57mins.

The battery easily got me through an entire day, even a busy one. And when the time does come for a refill, the Razr 60 Ultra supports reasonably fast 45W wired charging; this took it to 40% capacity in 15 minutes and 72% after 30 minutes. Wireless top-ups are speedy, too, with support for 30W Qi charging.

I haven't yet been persuaded to switch to a flip phone, but the Razr 60 Ultra almost made me want to make the move. It's powerful, practical and compact, and it will run all day with ease. I also love the camera setup, which is superb for creators, and the new AI features.

What I'm torn about is the cost: at this price the Razr 60 Ultra is competing with mighty market leaders such as the Google Pixel 9 Pro and the Samsung Galaxy S25 Ultra. But if you like the flip format, this is easily its best implementation yet. ■

VERDICT

★★★★☆

A wonderful pick-up-and-use option – and the inclusion of multitouch gesture controls really sets it apart from the crowd.

John Velasco


GIGABYTE
T-FORCE
USB
ADATA
SEAGATE
WISE-Edge
400
NVIDIA

COMPUTEX SPECIAL 2025

COMPUTEX 2025 SHOWCASE

LINDSAY HANDMER investigates the latest and greatest at the world's biggest PC show.

After a big return in 2024, Computex came back even harder in 2025, with more visitors and even more energy. The Nangang halls were packed, and many brands spilled out into nearby hotels and even restaurants just to find space to show off their latest gear. The show even got a visit from Taiwan President Lai Ching-te. But to be fair, the crowds and security were even bigger when Nvidia's Jensen Huang swept through, leaving his signature on products like a rockstar.

If there's one non-AI trend that defined Computex 2025, it's LCDs crammed into everything. Mostly coolers, but also PSUs, GPUs, cases, and even RAM. Laptops also stood out, with a wave of clean designs and powerful, ultra-lightweight models dipping under the 1KG mark.

Of course, AI was everywhere. It was part of almost every showcase and sometimes awkwardly shoehorned into things that had little to do with actual LLM-style transformer models. Still, we saw some genuinely useful advancements too, with Nvidia devoting most of its packed keynote to the idea of the AI factory future.

While RGB was still going strong, we also noticed a shift toward cleaner, more understated aesthetics, with more white LEDs and gear that skipped lighting entirely. Some big brands also branched out – Acer had a range of electric scooters and bikes on display.

And Computex got back to its grittier roots a bit, with G.Skill hosting the grand finale of its 2025 OC World Cup right on the show floor.

Read on for our full report on the latest from the big brands.

MSI BRINGS A BIT OF EVERYTHING

At Computex this year, MSI focused on, well, everything, with new announcements for handheld gaming devices, artistic laptop collaborations, high-refresh rate monitors, mini motherboards, and more.

GAMING GALORE: LAPTOPS, DESKTOPS, DISPLAYS AND THE CLAW

Grabbing attention was the Prestige 13 AI+ Ukiyo-e Edition – a laptop that features Japanese lacquerware craftsmanship with hand-applied art on its lid. Oh, and it also weighs just 990g, packs an Intel Lunar Lake CPU, a 2.8K OLED display, up to 32GB RAM, and a 1TB SSD.

MSI also had an intriguing but as-yet not launched Panther Lake business laptop on display, with a fold-back 2-in-1 screen and a neat integrated stylus holder underneath.

The MSI gaming laptop lineup on display included the mighty Titan 18 HX Dragon Edition (though to be fair it officially launched at CES) with an 18-inch Mini LED 120Hz display and an RTX 5090 GPU in a Norse-themed chassis. We also got a peek at the new Stealth A16 AI+ and Prestige 16 AI+ Mercedes-AMG models and while they aren't our usual style, we were suitably impressed by the bespoke finishes.

Despite the mouthful of a name, the Claw 8 AI+ Polar Tempest Edition looked great in a glittering white finish, and more importantly, uses the new Core Ultra 7 258V processor and it doubles storage to 2TB. MSI also gave AMD some love with the Claw A8, which has a Ryzen Z2 Extreme CPU that includes some pretty powerful RDNA graphics.

While MSI had many displays on, well, display, the MPG 271QR QD-OLED X50 stood out with real-time person detection via an AI Care Sensor. It adjusts brightness and panel usage based on user presence, for maximum OLED burn-in prevention. Oh, and it has a 1440p resolution and a mighty 500Hz refresh rate.

COOLERS AND MOTHERBOARDS FOR SHOWY BUILDS

Then came motherboards. So many motherboards. But we were especially fond of MSI's new mini-ITX boards: the MPG X870I Edge TI WIFI and MPG B850I Edge TI WIFI. They both look great for compact builds, and support all the good stuff: next-gen AMD processors, DDR5 memory, PCIe 5.0, and Wi-Fi 7.

MSI's latest liquid coolers included the MEG Coreliquid E13 Series, which feature integrated displays for real-time monitoring or, more likely, for playing fun custom animations. If you're after a more streamlined aesthetic, the MPG Coreliquid P13 Series blends in, except for, you guessed it, an LCD display.



MSI showed off some impressive gaming OLEDs with 500Hz refresh rates.



We loved the retro aesthetics of the MSI RTX 5070 Cyclone Visual.



MSI had some great looking white mini ITX motherboards on display.



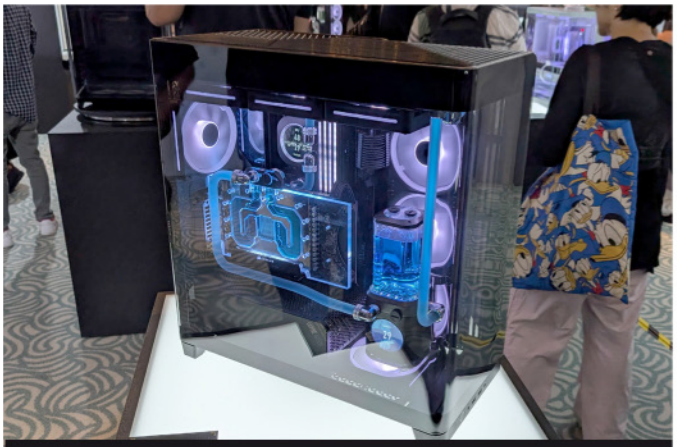
MSI was showing off new components in this sleek white build.

THINGS YOU PROBABLY FORGOT MSI MAKES

Oh right, MSI makes SSDs! And the latest models (like the Spatium M571 PCIe 5.0 M.2) are built with Phison's E28 controller and TSMC's 6nm process. This offers much reduced power use and, as a result, runs cooler, which is especially handy for laptops and handheld devices.

And who can forget, MSI also does networking. The new Roamii lineup includes the BE Pro with tri-band Wi-Fi 7 and 10GbE ports. Then there's the Roamii BE Max for ultra-fast 21Gbps speeds, and the Roamii BE Lite with 5Gbps. Stay tuned for our tests.

MSI's brand new PSUs (wait, MSI builds PSUs now?) were also on display. We favoured the mainstream MPG and enthusiast MEG series, both well thought out with ATX 3.1 and PCIe 5.1 support, fully modular cables, and 80 PLUS Platinum or Gold ratings.



The Corsair Frame 4500X case uses a compelling wrap-around glass design.



The Corsair Platform:6 standing desk offers customisability like no other.

CORSAIR DOUBLES DOWN ON DIY

This year Corsair went for a more personal showcase off the main show floor, demoing a mix of sleek hardware, upgraded cooling and DIY focused gear. Not to mention a flex before Computex even started: announcing a record-breaking 12,832 MT/s Vengeance DDR5 overclock.

PC CASES JUST THE WAY YOU ALWAYS WANTED

Corsair's new case lineup kept us entertained for most of the morning. The Air 5400 plays with airflow by splitting the case into three chambers – one each for the CPU, GPU, and PSU. Then there's the Frame 5000D, which supports reverse-connection motherboards and uses Corsair's FRAME Modular Case System, meaning you can shift fan brackets and motherboard trays around like Meccano for grownups.

Even cooler (but not literally): Corsair showed off the Xeneon Edge, a Frame 5000D compatible 14.5in touchscreen LCD panel that acts as a secondary display for system stats, media, or overlays, and can be connected via iCUE. In other words, a nerdy yet elegant way to get the benefit of an extra screen without eating up desk space.

But our favourite Corsair case this year? It was without a doubt the Frame 4500X. It's a curved-glass, dual-360-radiator, fully modular monster of a case. Everything from PSU shrouds to fan mounts is swappable or removable, which gives pretty great control over airflow, layout, and aesthetics.

CORSAIR'S DESK GAME IS STRONG

After escaping the thrall of the cases, we were immediately entranced by the Platform:6 motorised standing desk. Corsair says it's designed for streamers, creators, and power users, but really it's for anyone who wants a super cool desk.



Corsair showed off the new modular Stream Deck with huge display.

It brought out our DIY cravings more than usual thanks to a big range of modular add-ons from monitor arms, shelves and pegboards.

Also earning our praise: Corsair continues to lean into maker culture with designs for official 3D-printable accessories. Stuff like cup holders, headset stands, cable management and mounting brackets, or all sorts of options the community shares. It's a small thing, but it shows they know who their users are.

AIO COOLING THAT DOESN'T COMPROMISE LOOKS

Corsair showed off the Nautilus RS LCD AIO – a sleek liquid cooler with (yep...) a customisable display right on the pump block. And to be fair, we don't hate this focus on performance cooling that also enhances your build's aesthetic, but have yet to get solid pricing to see how much extra it costs.

POWER, BUT NEATER

Power supplies can be same old same old, but Corsair's new HXi and RMx Shift series are actually trying to do something a bit new and different. Features like side-mounted connectors make cable routing easier, especially with reverse-connection boards. The HXi models go all the way up to 1500W and support iCUE Link, while the RMx Shift lineup is more about efficiency and noise control. Both ranges include native 12V-2x6 support, so you're set for those future high-end GPUs you can't actually afford.

PERIPHERALS MADE FOR POWER USERS

Corsair's new peripherals followed the same focus: customisation is king. The new MAKR 75 is a barebones mechanical keyboard kit with a 75% layout, gasket mounting, and 8000 Hz polling – aka a playground for keeb builders. Meanwhile, the Scimitar Elite Wireless SE mouse caters to MMO fans (or maybe those who love Excel macros), with 16 programmable buttons and Stream Deck software integration.

The Corsair-owned Elgato also introduced some cool new Stream Deck options. There's a scissor-switch model for faster tactile input, a software-only Virtual Deck, and a whole line of modular units (6, 15, or 32-key) that connect over USB-C. Corsair noticed modders pulling Stream Decks apart and building them into things, so releasing a barebone unit is a great way to support the DIY community.



The Corsair Xeneon Edge is a modular touchscreen for your case.

SYNOLOGY KEEPS IT PRACTICAL, POWERFUL, AND JUST A LITTLE BIT AI

Synology took a pretty grounded approach at Computex this year, focusing on storage, backup, and surveillance solutions for both home users and enterprise customers. From simplified private cloud to all-flash performance monsters, it was all about control, privacy, and smart management, with the barest hint of AI.

BEESTATION PLUS: CLOUD CONVENIENCE WITHOUT THE CLOUD

For home users, the new BeeStation Plus is Synology's answer to the chaos of scattered photo backups and cloud subscription fees. Designed with families in mind, it offers automatic photo sync from smartphones, backups and even supports local media streaming through Plex. In other words, a quiet competitor to services like iCloud or Google Photos, with a clear emphasis on privacy and control.

Beyond media, the BeeStation Plus also steps into smart home territory. When paired with Synology's upcoming CC400W AI camera, it becomes a pretty decent looking local surveillance hub, storing footage without the need for third-party platforms.

PLUS SERIES NAS: MORE POWER FOR SMALL OFFICES AND HOME LABS

Synology's new Plus Series NAS lineup brings six refreshed models, built for Pro home users and small businesses that need a bit more horsepower. Models like the DS225+, DS425+, and DS725+ offer faster than average processors and room for more RAM. The DS725+ in particular stands out with an AMD Ryzen R1600 chip and support for up to 32GB of ECC DDR4. While we reserve judgement until we can get hands-on, the new NAS models look like a good fit for demanding tasks, like sharing large video files or VM hosting.

One interesting twist is Synology's new drive compatibility policy. To get access to full system features, you now need to use Synology-branded or certified drives. The goal is to improve reliability, but we worry it may limit flexibility for users who want to save some money with specific third-party storage options.

PAS7700: ALL-FLASH SPEED FOR ENTERPRISE WORKLOADS

At the high end, Synology introduced the PAS7700 – a huge all-flash array that delivers up to 2 million IOPS with sub-millisecond latency. It's built for critical enterprise environments rather than everyday users, with active-active failover and support for immutable snapshots. Security is handled through AMD Infinity Guard, and the system does seem to be a good fit for Synology's 3-2-1-1 backup strategy. Synology also unveiled the ActiveProtect DP7200 – a business backup appliance designed with built-in immutability and network isolation to protect against ransomware attacks.



Synology wowed with the all-flash PAS7700 enterprise storage array.



The BeeStation Plus is a very sleek home NAS from Synology.



Synology launched a range of new NAS.



Synology showed off the detection chops of its new AI-powered surveillance system.

SURVEILLANCE GOES SMARTER WITH AI AND C2

C2 Surveillance is a system that removes the need for on-site NVRs, and of course, slips in some AI integration. It's built for multi-location setups and supports fast deployment, centralised control, and integration with Windows Active Directory. Synology was keen to make the point that it continues recording during outages, providing more resilience than typical cloud solutions.

The platform works with Synology's own AI-equipped cameras, including the BC500, TC500, and the upcoming BC800Z. They had a live demo of the key features, like facial recognition, license plate detection and wide-angle monitoring. Notably, for those preferring a local setup, the cameras also integrate just fine with the existing Synology Surveillance Station, so offer some appeal to home users.



Intel teased us before giving us the insight into Panther Lake.



The new Intel Core Ultra 300 series arrives later this year.

INTEL SKIPS THE FANFARE BUT BRINGS THE FUTURE

Despite it being Intel's 40th anniversary at Computex, things were unusually quiet from the chipmaker at Computex 2025. No keynote. No press conference. But tucked into a few low-key demos were some meaningful updates on what's coming next for CPUs, GPUs, and AI acceleration.

The giant picture of a Panther in the Intel booth was a dead giveaway, and Intel announced that the next-gen Panther Lake CPU family will launch in the second half of 2025. These chips are named the Core Ultra 300 series and are the first to be built on Intel's advanced 18A process. They pair new Cougar Cove performance cores with Darkmont efficiency cores, plus integrated Xe3 graphics.

Intel ran a few demos to show off Panther Lake's AI chops. One showed AI-assisted video editing in DaVinci Resolve, and with a 50 TOPs NPU and 120 TOPS from the iGPU, can reportedly give about 50% better performance in these sorts of workloads compared to the current Lunar Lake CPUs. Which, by all accounts, is impressive, and we are excited by Intel's CPUs again – for laptops at least anyway.

ARC PRO: GPUS AIMED AT PRO WORKLOADS

On the GPU side, Intel expanded its professional Arc lineup with the Arc Pro B60 and B50. Built on the Xe2 architecture, both cards are made for AI inference and workstation tasks. The B60 comes with 24GB of memory while the B50 offers 16GB. Both include Intel's Xe Matrix Extensions (XMX) for AI workloads and advanced ray tracing units for rendering and simulation.

AMD'S QUIET CONFIDENCE SHOWS IN GPUS, CPUS, AND AI SMARTS

AMD didn't do anything too flashy this year, but showed off new gear for gaming, AI, and high-end compute.

First up was the Radeon RX 9060 XT, a mid-range RDNA 4 graphics card aimed at 1440p gamers. With 32 compute units and up to 16GB of GDDR6 memory, it looks set to give solid mid-range performance at higher resolutions. FSR 4 is built in, now with extra machine learning smarts, and early demos seem to show decent frame rates. We don't yet have Australian pricing, but it starts at US$299 and will hopefully give another bang-for-buck option for gamers by the end of June.

AMD didn't forget about AI, and introduced the Radeon AI PRO R9700, a workstation GPU with 128 AI accelerators, 32GB of GDDR6 memory, and 1,531 TOPS of performance. It's built to handle local AI workloads, from development to deployment, without relying on cloud infrastructure.

THREADRIPPER RETURNS

On the CPU side, AMD revealed the Ryzen Threadripper 9000 Series, codenamed "Shimada Peak." Built on Zen 5 and TSMC's 4 nm process, the flagship 9995WX features 96 cores, 192 threads, and a boost clock up to 5.4 GHz. With support for 128 PCIe 5.0 lanes and 8-channel DDR5-6400 ECC memory, it's aimed at pros in VFX, simulation, and AI. The chips launch globally in July and will slot into the existing sTR5 socket.

We also saw new Ryzen AI PRO 300 and AI Max+ CPUs in laptops like Asus's ExpertBook P3, not to mention the AMD Ryzen Z2 Extreme chip in various new handheld gaming devices on show, like the MSI Claw.



AMD showed off some of its partners Ryzen-powered gaming handhelds.



AMD had some powerful Radeon gaming machines on display.

NVIDIA'S AI EMPIRE EXPANDS, WITH JUST ENOUGH GPU LOVE TO KEEP GAMERS CALM

Nvidia was, unsurprisingly, all-in on AI at Computex 2025. From data centres to desktop systems and even robot gyms, Team Green made sure to remind everyone that it's not just about gaming anymore. That said, Jensen Huang did toss in a cheeky "we haven't forgotten about GeForce" during his keynote, as a nod to the company's history.

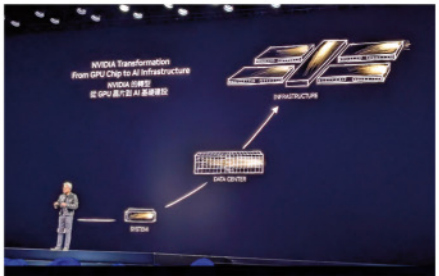
RTX 5060 LANDS WITH DLSS 4, BUT LEAVES 40-SERIES BEHIND

The big gaming reveal was the GeForce RTX 5060, a new mid-range GPU built on the Blackwell architecture. It features 8GB of ultra-fast GDDR7 memory and promises about 18 percent better performance over the RTX 4060. It is designed for 1080p and 1440p gaming, with the usual suite of next-gen ray tracing and AI-enhanced rendering.

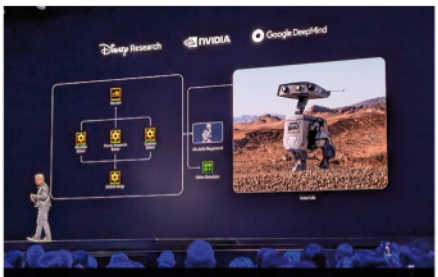
Of course, DLSS 4.0 was front and center. Nvidia touted major gains in frame generation and latency reduction, now supported in over 125 titles. But not everyone's thrilled. DLSS 4 is exclusive to RTX 50-series cards, and unlike earlier versions, it does not run at all on older GPUs. It is a smart move for performance, but it does leave plenty of RTX 40-series owners feeling a bit sidelined. Strategic? Definitely. Friendly? Not exactly.



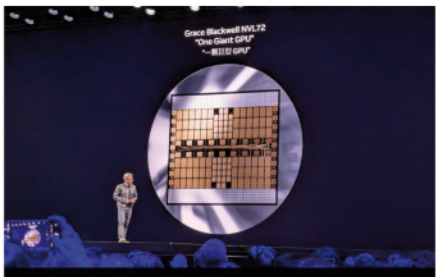
Love it or hate it, the GeForce RTX 5060 stirred up trouble at Computex.



Nvidia is shifting to a new paradigm, with AI factories where the output is tokens.



Nvidia showed off some impressive AI based robotics training systems.



Nvidia's new GB10 chip puts advanced AI hardware on your desktop.

FROM AI FACTORIES TO ROBOT GYMS, NVIDIA WANTS TO DO IT ALL

Outside of gaming, Nvidia went big on AI infrastructure. The company introduced its "AI factories," next-generation data centers powered by Blackwell GPUs and NVLink Fusion, designed to train and deploy massive AI models. On the robotics front, the Isaac platform received an upgrade with GR00T N1.5 and a new simulator, GR00T-Dreams, built for training humanoid robots in virtual environments.

For more desktop level AI, Nvidia announced the DGX Spark – a compact AI supercomputer with 1,000 TOPS of performance that gives researchers and developers serious local AI horsepower without the need for a server room. Whether you like AI or not, the DGX Spark is a seriously cool bit of kit.

SAPPHIRE SERVES UP CABLE-FREE GPUS OVER BRUNCH

Sapphire took us away from the showroom floor this year, and set up in a nearby restaurant. What better way to discuss custom GPUs, AI-focused mini PCs, and the new PhantomLink power system, than over a plate (or two) of pancakes.

Our favourite new bit of Sapphire tech by far is PhantomLink – a cable-free GPU power solution that pulls power directly from a special motherboard slot instead of using the traditional power connectors and cables. It delivers up to 600W and works with compatible boards like the Sapphire Nitro+ X870EA Wi-Fi, and is still interoperable with traditional 12V-2x6 plugs. And we have to say, we really do love the look of monster GPUs without the cables hanging out the top.

The flagship RX 9070 XT Nitro+ PhantomLink was on display, but Sapphire also showed off its RX 9060 XT cards, available with 8GB or 16GB of memory and by all accounts, solid RDNA 4 performance.

We also found the new Edge AI 370 mini PC rather appealing. It's compact but has a powerful Ryzen AI 9 HX 370 CPU, supports up to 96GB of DDR5 memory, has 50 TOPS of AI performance, and if you are into that kind of self-abuse, it offers full Copilot+ support.



Sapphire showed off its RX 9070 XT Nitro+ with PhantomLink.



We loved the versatile ROG Falcata split keyboard.



Asus has the latest Wi-Fi 7 ROG Rapture gaming router on display, with a mind boggling 19Gbps of wireless bandwidth.

ASUS PACKS IN POWER, PERIPHERALS, AND A 3D CPU COOLER

Asus had so much to show off at Computex that it filled out two huge areas on the showroom floor. AI-powered laptops, esports-grade peripherals, next-gen handhelds, enterprise PCs, hidden-cable motherboards, and yes, even a CPU cooler with a curved LCD screen.

ROG DELIVERS ESPORTS SPEED AND REFINED HANDHELDS

The latest ROG gaming gear was a big drawcard for the crowds this year. We especially loved the very unique Falcata 75 percent split gaming keyboard that can be positioned in all sorts of interesting ways, is wireless, and uses hot-swappable magnetic switches. The Harpe II Ace mouse (co-designed with gamer Valorant pro Demon1) felt impressively rigid, considering the ultra-lightweight 48g weight.

Asus also impressed us with the Strix Ace XG248 esports monitor that, just to be the fastest, uses a 610MHz refresh rate. The ROG Ally X was on show, and really felt like a well refined handheld thanks to some new tweaks like a much larger 80Wh battery, better grips and improved cooling.

COOLERS WITH CURVES, AND AI RIGS BUILT FOR DEVELOPERS

Asus also had our favourite of the near endless CPU coolers with screens: the ROG Ryuo IV SLC 360 ARGB AIO unit. Cooling functionality and daisy-chainable ARGB fans aside, the standout feature is a 6.67-inch curved 2K AMOLED display that when viewed from the right angle, gives a 3D effect that actually works pretty well.

On the AI development side, Asus had the Ascent GX10 (using Nvidia's GB10 Grace Blackwell Superchip) that provides developers 1,000 AI TOPS and 128GB of unified memory in a desktop form factor.

GIGABYTE GOES BIG, SLIM, AND A LITTLE BIT ROUND

Gigabyte came to Computex 2025 with so much to demo it needed to book out a function room in a nearby hotel, in addition to its spaceship-shaped stand on the showroom floor. And yes, Gigabyte did launch some new AIO water coolers with inbuilt LCDs, but one minor point of difference – the screens were round, rather than square.

FROM TINY GPUS TO EXTERNAL 5090S

Gigabyte had its take on the mid-range Radeon RX 9060 XT on hand – designed for high-refresh gaming at better than 1080p resolutions. But our surprise favourite was a little RTX 5060 OC Low Profile GPU. This half-height triple-fan card looks perfect for building a slim casual gaming rig or maybe a stealthy but powerful HTPC.

Of course, Gigabyte also had their share of heavy-duty AI hardware featuring the latest from Nvidia. The Aorus RTX 5090 AI Box is especially interesting, and is a water-cooled external GPU that connects to your PC via Thunderbolt 5. It is built to handle gaming or AI workloads, and the claim is it's as little as 14% slower than the same GPU in a desktop machine.

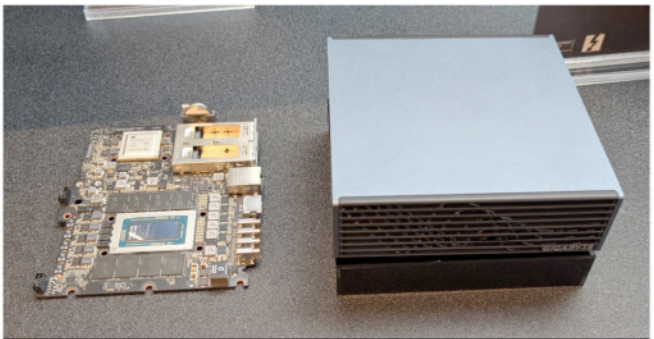
Then there is the AI TOP Atom – personal desktop AI dev rig running Nvidia's Grace Blackwell chip, with 1,000 TOPS of performance and 128GB of memory.

ACTUAL SMARTER LAPTOPS

Gigabyte had loads of new gaming laptop models to show off (like the Gaming A16 and A18) but were more interested in talking about the built-in AI tools. We look forward to trying them out, as options like the GiMATE Coder for beginner-friendly programming and automatic sound adjustment when the laptop is on soft surfaces actually seem pretty useful.



This little half height Gigabyte RTX 5060 is tiny compared to the mighty RTX 5090.



Gigabyte showed off its AI TOP Atom box based on the Nvidia DGX Spark.

KINGSTON AT COMPUTEX: FAST DRIVES AND THE FUTURE OF RAM

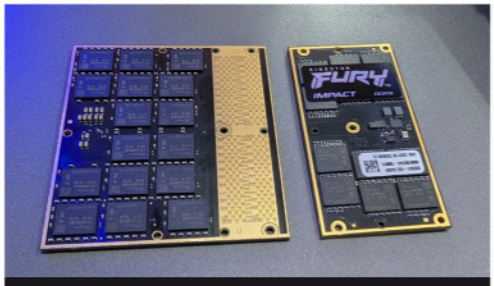
Kingston was spread out over multiple hotel rooms this year, showing off high speed storage and RAM, plus a robot and a rocket to showcase industrial uses of their enterprise products.

Kingston launched its new Fury Renegade G5 PCIe 5.0 SSD that can hit read speeds up to 14,800 MB/s (plus the similar DC3000ME PCIe 5.0 U.2 SSD aimed at enterprise use), as well as new DDR5 CUDIMM modules rated at 8,800 MT/s. They also debuted Fury Impact DDR5 CAMM2 modules, offering up to 128GB for laptops and mobile workstations. And while CAMM2 still isn't mainstream, this was our first time seeing the 128GB high-capacity modules in the flesh.

Kingston introduced the Data Traveler Exodia S USB drive, which isn't super fast but is available up to 512GB, and refreshed its Canvas Plus SD and microSD cards. While not setting any performance records, it was nice to see some products that aim to be a bit more affordable.



The new Kingston Fury Renegade G5 PCIe 5.0 SSD offers read speeds up to 14 800 MB/s.



Kingston showed off Fury Impact DDR5 CAMM2 modules in sizes up to 128GB.

MICRON SHOWS OFF NEXT-GEN SPEED AND TECHNOLOGY

This year, Micron gave us a one-on-one showcase of next-gen SSDs, rugged portable storage, and compact memory modules. Micron stands out as one of the few full-stack memory producers, designing and manufacturing DRAM, NAND, and storage from the wafer up.

The new Crucial T710 was our favourite – a PCIe Gen5 NVMe SSD built with Micron's 276-layer TLC NAND and the SM2508 controller. It promises impressive read speeds up to 14.9 GB/s and write speeds up to 13.8 GB/s, with capacities reaching 4TB. We also had a play with the new Crucial X10 portable SSD – rated for 2.1 GB/s over USB 3.2 Gen 2×2 and available up to an impressive 8TB size.

While not yet available for consumers, Micron also had LPCAMM2 memory modules showcasing what might be next for compact laptops, plus a very cool PCIe 6.0 SSD prototype capable of 30.25 GB/s throughput.



The Crucial T710 (PCIe Gen5 NVMe SSD) offers 14.9 GB/s reads and 13.8 GB/s writes.



The Crucial X10 is a tough, high speed portable SSD.

ADATA SHOWCASES SPEED, SCREENS AND SERIOUS STORAGE

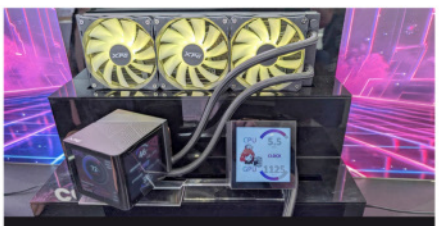
Adata had a big stand this year, focused on AI-ready storage, high-speed memory, and small but mighty gaming gear.

From its gaming brand XPG, the standout to us was the Mars 980 M.2 SSD with a Silicon Motion SM2508 controller. It reportedly hits read speeds up to 14,000 MB per second and writes up to 13,000 MB per second. You can cool it with air, liquid, or leave it bare if feeling adventurous.

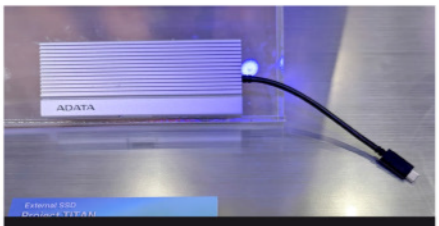
We have a certain fondness for fast portable storage, like Adata's Project Titan – a Thunderbolt 5 external SSD with 6,000 MB/s speeds and DisplayPort out.

ADATA also launched Trusta Gen5 SSDs and DDR5 LPCAMM2 memory, though you shouldn't expect it in your next laptop or system any time soon, as it's aiming squarely at AI PCs and next-gen enterprise storage.

The XPG cooling lineup includes Levante View AIOs with the obligatory LCD screens, plus decent looking air coolers like the Maestro Plus. It had been a long day, but sadly we couldn't grab a nap in the comfy looking Nexus Plus gaming chair.



Of course, Adata also had a cooler with a LCD screen.



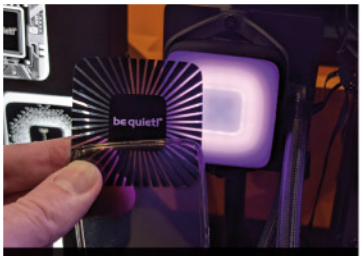
Adata showed off Project Titan: a Thunderbolt 5 external SSD.



More than just coolers, be quiet! had an (un) surprisingly quiet mechanical keyboard.

BE QUIET! SHOWS OFF SLEEK NEW COOLERS, PSUS AND GAMING GEAR

be quiet! made some serious noise at Computex 2025, though quietly of course. The German company rolled out new coolers, refined power supplies, and made its first move into the peripherals space with gaming mice and mechanical keyboards.



To keep the Pure Loop 3 LX cooler affordable, be quiet! offers a customisable backlit panel.

REFINED PSUS AND COOLER UPGRADES

The updated Pure Power 13 M series looks like everything one could want in a non-ostentatious PSU, with full ATX 3.1 compliance, native PCIe 5.1 support, and wattages from 550W to 1000W. These modular power supplies use a semi-passive 120 mm fan for near-silent operation, deliver 80 Plus Gold efficiency, and come with a 10-year warranty.

Cooling gets a level up too. The new Pure Loop 3 all-in-one coolers focus on quiet performance with Pure Wings 3 fans and wide socket support for Intel and AMD. The higher-end Pure Loop 3 LX adds ARGB lighting, a 6-pole motor pump, and Light Wings LX fans, with radiators available up to 420 mm. And amazingly, no integrated LCD – though the be quiet! boffins do say they plan to launch one in the future, once they can do it without it impacting the price too much.

NEW PERIPHERALS MAKE CONFIDENT DEBUT

At just 55 grams, the Dark Perk Ergo and Sym mice feel great in hand, and both have features like 32,000 DPI sensors, 8,000 Hz polling, and tactile optical switches. On the keyboard side, the Dark Mount and Light Mount offer silent mechanical switches (well, perhaps low noise rather than silent), per-key RGB and aluminium frames that leave them impressively solid.

THERMALTAKE'S COMPUTEX LINEUP COVERS GAMERS, MODDERS, AND SIM RACERS

Thermaltake turned heads at Computex with a huge range of sim setups, not to mention new PC cases, cooling systems, power supplies and modded cases.

CASES AND COOLERS WITH STYLE AND SCREENS



Yep, more screens: this time on the Thermaltake MINECUBE 360 Ultra ARGB AIO.

Thermaltake added the TR200 and TR300 cases to its compact lineup, building on the TR100 with roomier GPU support and better airflow. The Tower 600 brought an octagonal prism layout that fits long 420 mm AIOs and long graphics cards. More eye-catching were the TR100 and View 270 models in soft pastels and wood-accented finishes – a welcome change compared to the usual black, white, or bold primary colours. The TR100 even has a travel case to make your gaming PC more portable, because yes, LANning is still a thing.

Despite not being officially associated with *Minecraft*, the Minecube 360 Ultra AIO stole the spotlight with a cube-shaped pump block and four 3.95-inch LCDs that can show stats, GIFs or whatever weird meme you like. Paired with Swafan EX12 ARGB fans, it's both loud and proud, and we want one in our next build. We also liked that the new TS120 and TS140 EX RGB fans include temp sensors and magnetic cable connectors.

FROM WATTS TO WHEELS

Power users will be pleased to see the Toughpower i2000W Platinum, with four PCIe Gen 5 connectors and live monitoring. For fans of small-form-factor machines, the Toughpower SFX Titanium delivers 1200W in a somewhat space-saving design.

Thermaltake also leaned hard into showing off sim racing with options on display like the GR700 Cockpit, GM9 6DOF Motion Platform, and the slightly more affordable G6 Racing Wheel Bundle. We only got to try a short stint in a racing sim, but now have to add it to our ever-growing list of needs.



Thermaltake showed off some impressive custom racing simulators.

APC's Computex 2025 trip was co-sponsored by MSI Components, Corsair and Synology.

msi CORSAIR Synology

NEEDS Windows 10 or 11, macOS or Linux **WEB** www.gimp.org

GIMP 3.0

Image editor

GIMP – or the GNU Image Manipulation Program, to give it its full name – is commonly regarded as the closest free alternative to Adobe Photoshop. It's packed with expert tools for editing photos, which can make it seem daunting at first, but it provides lots of online tutorials (www.gimp.org/tutorials/) to help you get started.

Incredibly, it's been seven years since the last major GIMP release (2.10), but version 3.0 is finally here, following extensive beta testing. One of the biggest changes is to the program's interface. While the layout remains familiar to long-time users, the design has been streamlined and is now optimised for high-resolution displays.

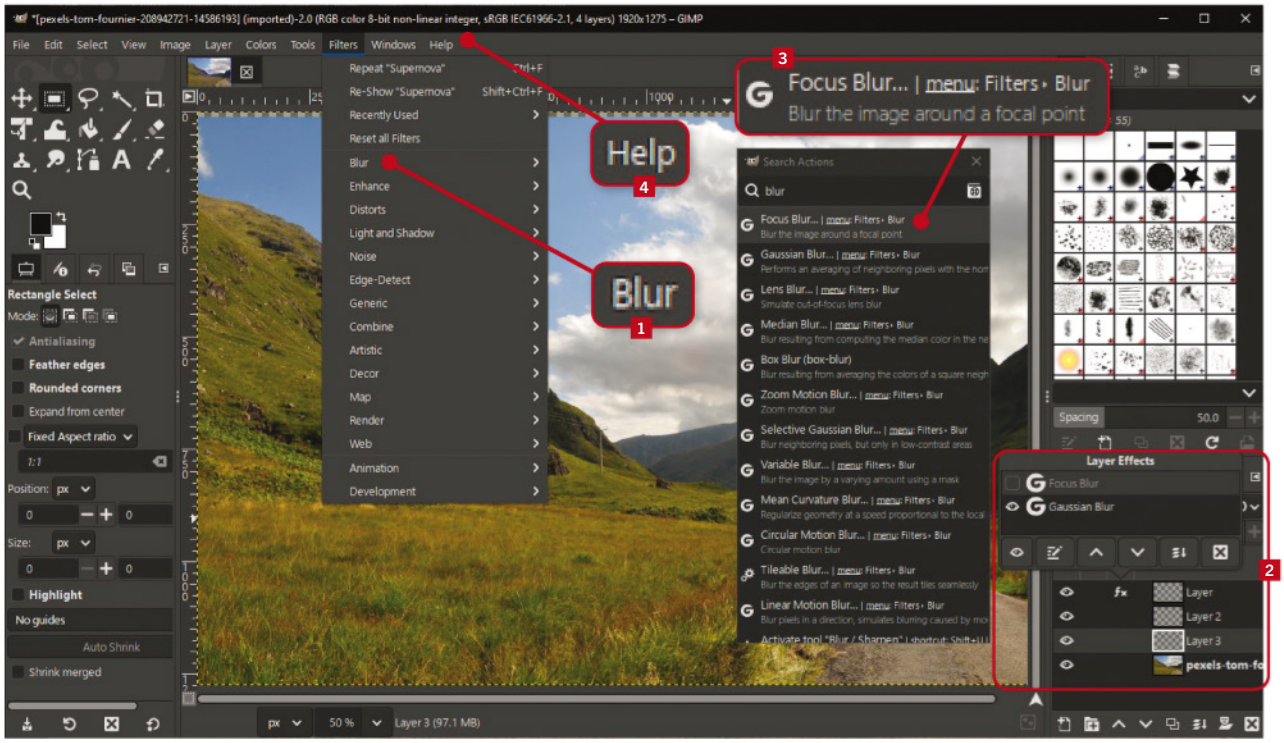
This is a critical improvement, because older versions of GIMP often struggled with scaling issues on larger, high-DPI screens. The updated interface also displays better when using GIMP on Windows tablets.

The program now greets you with a Welcome screen, which makes its learning curve a little less steep. Click the Personalise tab to adjust the colour scheme, font and icon size of the GIMP interface, and the Create tab to open a new image or reopen one you've been working on.

GIMP 3.0 introduces non-destructive editing when applying filters to image layers. In GIMP 2.10, filters were automatically merged with the current layer, which prevented you from making further edits without repeatedly undoing your changes. You can now select, deselect and delete filters individually to save you reverting your work.

Other improvements include support for more image formats, such as JPEG XL and QOI, and better handling of text, so you can quickly distinguish between different fonts and their bold and italic variants.

GIMP has also updated its search tool, which opens when you press the forward-slash key (/). When you search for a particular feature, it now tells you precisely which menu and sub-menu you'll find it in.



1 GIMP offers a huge selection of filters and effects for enhancing your images. These include removing red-eye, turning photos into artwork and various styles of blur. Each filter has its own settings for adjusting its strength and radius.

2 The new non-destructive layer effects in GIMP 3.0 allow you to experiment with filters without them being automatically merged with the current layer. Click the 'fx' icon next to a layer to view, deselect and delete the effects you've applied.

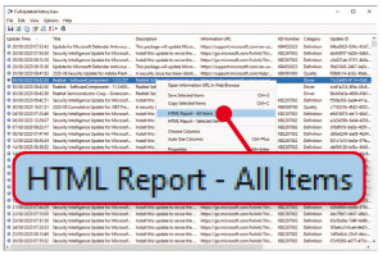
3 To find a specific option in GIMP, press the forward-slash key to open the search tool. Type the name of an action to view matching results, including details of the menus they're located in and their keyboard shortcuts where available.

4 With so many advanced tools, GIMP can seem confusing at first, but it includes lots of help to get you started. Click the Help menu and choose User Manual for a complete guide to the program or choose 'Tip of the Day' for helpful hints.

UPDATE VIEWER

FullUpdatesHistoryView 1.0

WEB tinyurl.com/APC547updates **NEEDS** Windows 10 or 11



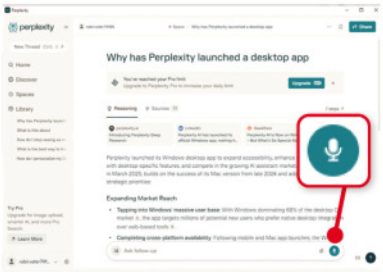
Aside from big feature updates – such as the beleaguered 24H2 – most Windows updates are installed automatically and silently. That's both convenient and safe, but it's still useful to know which updates you've received. FullUpdatesHistoryView is a tiny (223KB) new tool from the prolific developer NirSoft, which reveals your update history in Windows 10 (22H2 and later) and 11. Simply launch the tool and it will detect and list every Windows update that's ever been installed on your PC, using info from the Windows database. You can see the time of each update, as well as its title, description and KB (Knowledge Base) number, and its category – such as security, driver or virus-definitions update. Export the list by right- clicking and choosing 'HTML Report – All Items' (see screenshot). It triggers a SmartScreen warning but it's completely safe to use, so click 'More info' then 'Run anyway'.

"Simply launch the tool and it will detect and list every Windows update that's ever been installed on your PC, using info from the Windows database."

AI SEARCH TOOL

Perplexity 1.1.2

WEB www.perplexity.ai/platforms **NEEDS** Windows 10 or 11

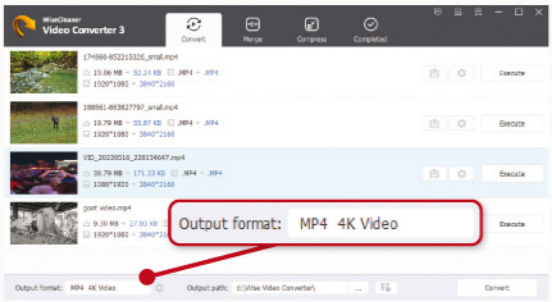


In past issues we have recommended Perplexity as a faster and more focused alternative to ChatGPT and Google. The AI-powered search engine has now launched its own Windows program (as opposed to Microsoft Store app), so you can use it directly on your desktop without opening your browser. Simply type a query and Perplexity will deliver a speedy response using information from trusted online sources.

As with other AI tools, you can speak to it by clicking the Dictate button in the message box (see screenshot), and attach text files to ask Perplexity questions about their content. It also has a Reasoning option for advanced problem solving, and Deep Research for in-depth reports on complex topics. On the downside, Perplexity's Discovery feed is biased towards US news, and its free plan has a few daily limits.

Should I pay for?

Choose the right version of software



Wise Video Converter Pro

WEB tinyurl.com/APC547wise **PRICE** $23.22 per year
FREE TRIAL N/A **NEEDS** Windows 10 or 11

Wise makes an impressive range of free and freemium programs. Wise Video Converter is one of the latter and offers some useful tools in its simple interface.

Add some videos to convert, either by dragging them to the main window or by clicking the 'Add video' button in the bottom toolbar. Click the cog next to 'Output format' (see screenshot) to specify which video or audio format to convert the files into, as well as your preferred resolution – for example, 4K Video in MP4 format.

You can also select the device you intend to watch the videos on to set the ideal format and resolution. Options include Apple iPhone and iPad, Samsung and 'Snoy' [we assume Sony], but curiously not Android.

Wise Video Converter lets you enhance videos before you convert them, such as by tweaking the brightness and contrast, applying effects – including blur and sepia – and even adjusting their volume. You can also add a basic watermark.

Click 'Convert' to process all the videos, or Execute to convert them individually. There are also options to merge and compress clips, but annoyingly you have to import them again rather than use videos you've already added.

Strangely, the only advantage of upgrading to the Pro version is that you can convert videos longer than 30 minutes. Aside from that, all options are the same.

OUR VERDICT: DON'T PAY FOR IT

The Pro version doesn't offer you much extra over the free version. We prefer Any Video Converter (**tinyurl.com/APC547anyvid**), which is also freemium, but offers many more features in both its free and paid-for editions. ■

"Wise Video Converter lets you enhance videos before you convert them, such as by tweaking the brightness and contrast, applying effects – including blur and sepia – and even adjusting their volume."

6 apps for Stargazing and astrophotography

Eyes on the skies for the astral prize.







Night Sky

Free (IAPs) | nightsky.com
iOS only

Unless you're an expert stargazer, you might not be able to name all the stars, planets satellites and constellations in the night sky. That's where the aptly named Night Sky app comes in. Point your iPhone at the heavens and the app overlays a beautiful star map on top of your screen, labelling everything with beautiful icons and illustrations. You can tap an object to learn more, zoom into deep space to explore the abyss, tag your favourite celestial bodies, and more.

The Moon: Calendar Moon Phases

Free (IAPs) | gv-apps.com
iOS and Android

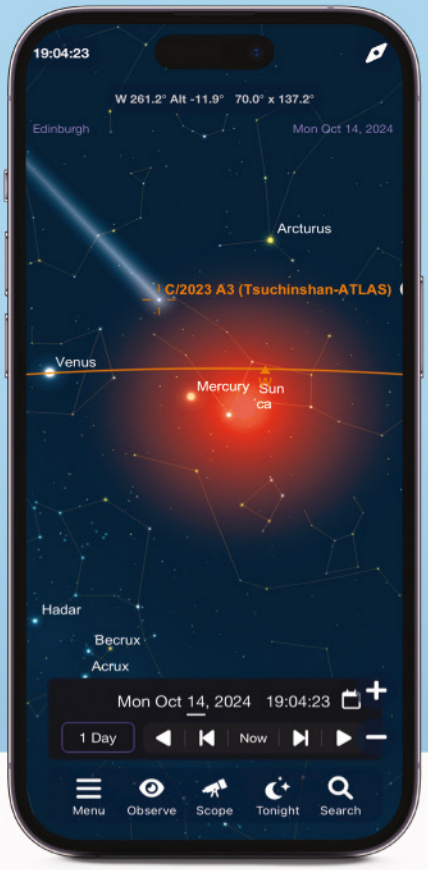
Tracking the phases of the moon can be both a great pastime and an essential component to astral photography. This app makes tracking easy. It provides a wide range of helpful stats and info, from moonrise and moonset times to the level of illumination, the distance from Earth, the moon's position in the sky, and more. It comes with a lunar calendar so you know how the moon will appear in the sky tonight – perfect for planning photos.

PhotoPills

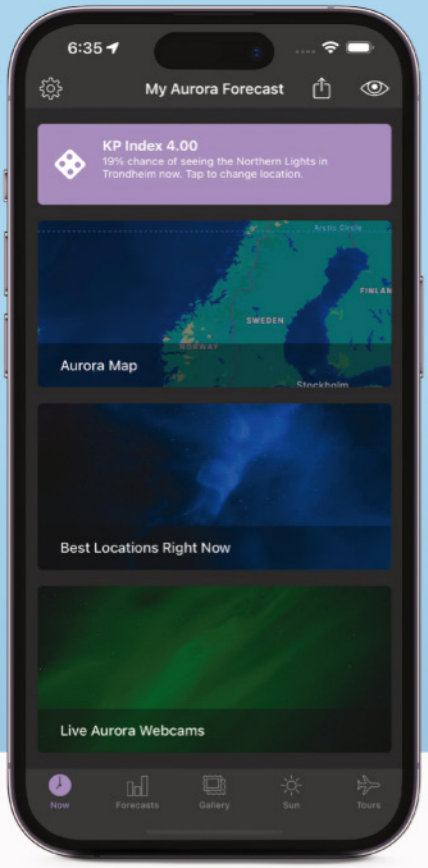
$16.99 | photopills.com
iOS and Android

Taking beautiful night-time photos takes careful planning – after all, you don't want to miss your next opportunity to capture the Milky Way. The PhotoPills app makes preparation a breeze, as it comes with maps showing where and when various astral phenomena will be visible. But it doesn't just show you when to head out with your camera – it assists with settings too, suggesting optimal exposure, field of view, and more to ensure your pictures are perfect.

Few of us spend our evenings with our eyes glued to the sky, but there's so much beauty up there that can be missed if we don't pay attention. Now that the weather is warmer, staying up late to watch the stars or indulge in a touch of astrophotography can feel like very tempting pastimes. Without the right apps, though, enjoying them fully can be tricky. We've picked six apps to meet your space-loving needs – install them on your phone and head out into the night to explore the celestial wonder.
Alex Blake







SkySafari 7 Pro

$19.99 | skysafariastronomy.com
iOS only

SkySafari is the perfect app if you're curious about the universe and want to learn about it. It has the largest database of any astronomy app, so you can look up pretty much anything that's been discovered to gain insights and see the object's current position in the sky. It boasts an augmented reality mode, connects to digital telescopes, alerts you to upcoming celestial events, and allows you to stargaze with other observers and app users around the world.

NASA

Free | nasa.gov/nasa-app
iOS and Android

If you love all things NASA, the agency's iOS app should be next on your download list. It's a hub for following everything that's keeping NASA busy, and it serves up all of the organisation's on-demand videos and live footage so you can get up close from the comfort of your home. You can browse over 21,000 space images, read up on the latest news, listen to podcasts, and enjoy interactive augmented reality experiences that take you into the heart of NASA's spacefaring activities.

My Aurora Forecast & Alerts

Free | jrustonapps.com
iOS and Android

There's no doubt that the aurora borealis is one of the most spectacular sightings in the night sky. Instead of puzzling over when it might be visible, use this app. With its detailed forecasts, simple-to-use maps and notifications alerting you to a likely appearance, it's a key helper for lovers of the phenomenon. Load it up on your phone and you'll be able to focus on the marvel of the Northern Lights instead of trying to work out when they'll appear.

DEVELOPER Canonical **WEB** https://ubuntu.com **LICENCE** Mainly GPL

Ubuntu 25.04

Huffing and puffing, Nate Drake takes a look at the interim 25.04 release and wonders how things could get much better.

SPECS
CPU: 2GHz
Mem: 4GB
HDD: 25GB
Builds: ARMhf, PPC64el, RISC-V, s390x, x86_64



The Evince document viewer has been replaced by Papers. The latest version has new features like digital signature verification.

The name Ubuntu is derived from a Bantu word that roughly translates as 'humanity towards others'. Since October 2004, this community spirit has been reflected by regular releases of this Debian-based OS.

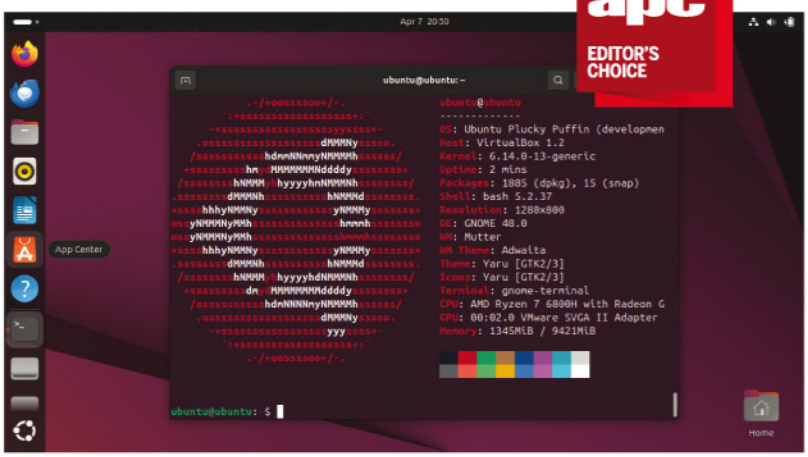
Over the years, Ubuntu has undergone many iterations. Initially, its flagship edition deployed the Gnome 2 desktop environment. This all changed with the advent of Ubuntu 11.04 Natty Narwhal in 2011, which heralded Canonical's own Unity desktop environment, which provided a more modern and touch-friendly interface.

In 2017, Canonical abandoned Unity in favour of Gnome. Ubuntu's release cycle now roughly follows that of new versions of the desktop environment, with new versions being released approximately every six months.

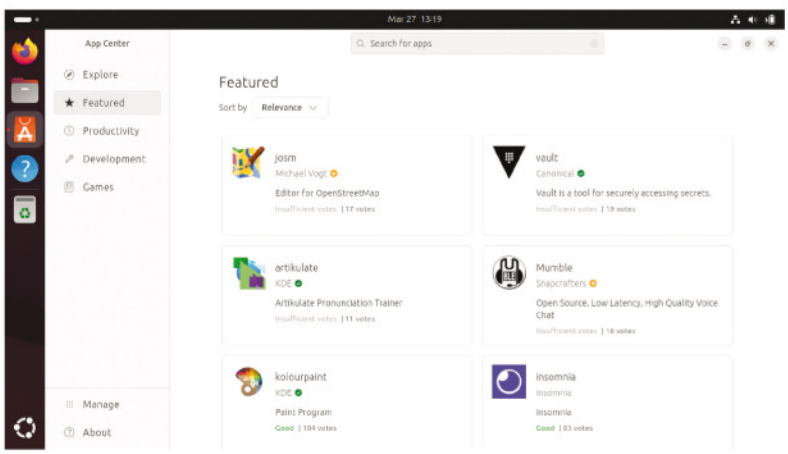
At the time of writing, Ubuntu 25.04 has yet to be released, so our review focuses on the beta. This means that the listed features or screenshots may differ from the final release. As always, do your own research before installing.

One of the first things we noticed when downloading the latest build of Ubuntu 25.04 is that it's around 1GB (at 6.3GB) larger than version 24.10 (5.3GB).

Upon booting the live image in our virtual machine, we saw that the setup contained no surprises for those already familiar with the OS. The assistant prompts you to choose a language



Ubuntu 25.04 uses kernel v6.14. It has new features such as drastically improved performance for emulating Windows programs.



Our build didn't include Top Charts in App Center to list popular programs, but it may be in the final release.

and offers accessibility options. The keyboard layout screen seems to be different from before, given that there's a Detect button. Pressing this prompts you to type specific keys – such as * – to determine the layout. There's also a handy text field where users can type using their chosen configuration.

As with previous versions, you can also choose between an interactive guided installation or automatic setup using a YAML file. Setup also still offers the choice between a small default collection of apps, or extended installation that includes extra software like office tools.

After choosing the first option in each case, we were prompted to choose a partition. Disk encryption using LUKS with LVM is supported. You can also opt to encrypt with a passphrase using ZFS or use hardware-backed encryption, though these are classified as experimental.

Once the install was underway, we were treated to a series of colourful splash screens explaining all that's great about Ubuntu. This included the claim that it's the choice of 66% of developers. This is based on a 2020 survey by Hacker Earth, and reflects the preferences of "experienced developers".

The installer also contained helpful links to Ubuntu's official documentation, as well as Ubuntu Discourse, which serves as a combination of a mailing list and forum for users. This is one area in which the OS shines. Ubuntu's online documentation and discussions are the most prolific we've ever seen for a Linux distro, with the possible exception of Red Hat.

Setup completed in around six minutes, which is

on a par with previous iterations of Ubuntu.

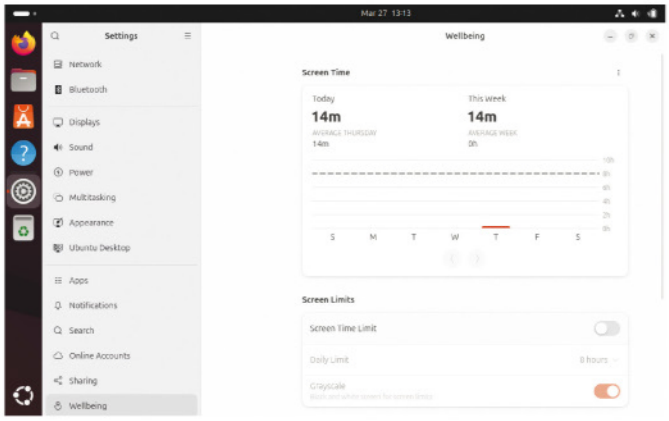
Once we restarted our virtual machine, we were invited to visit the aforementioned Ubuntu Discourse to view the release notes. Though we ask you to bear in mind our prior warning that details for the stable release of Ubuntu 25.04 may differ from our daily build, we did uncover some useful titbits of information.

These included the fact that this release (code name Plucky Puffin) will be supported for nine months until January 2026.

It was here that we discovered the Ubuntu installer now has additional encryption options beyond those that we chose. There's now better support for installing Ubuntu alongside existing encrypted Windows BitLocker partitions. The installer can also now replace an existing Ubuntu installation altogether.

After returning to the welcome window, you are asked whether you wish to share system data with Canonical to help improve Ubuntu. There's also a prompt to open the App Center.

After launching System Monitor, we found that Ubuntu is still very forgiving on system resources. With no other programs running, the OS consumed 1.3GB of our virtual RAM and only 4% of CPU resources. As we chose the Default selection of apps earlier, the install footprint also weighed in at a very reasonable 10.6GB.



Gnome 48's new Wellbeing settings enable users to set screen time limits. There are also options to configure break notifications.

According to the release notes, Ubuntu 25.04 comes with Gnome 48. Thanks to the efforts of Canonical developers, the desktop environment now supports triple buffering, which helps with rendering on lower-end GPUs, such as Intel integrated graphics.

Other changes to Gnome are more overt. Version 48 now includes a dedicated Wellbeing section. Android users will find the options familiar, given that you can set limits on screen time, such as eight hours a day. There's also a dedicated Break Reminders section, where you can have the OS prompt you to look away from the screen and/or move around at regular intervals.

While browsing through the Gnome settings, we also reviewed the Appearance section, where we discovered there are no fewer than 10 alternative Puffin-themed wallpapers. From here, you can still adjust accent colours, as in the previous version of Gnome.

We next decided to take the Welcome Assistant's advice to launch the App Center. We'd previously read on Ubuntu Discourse that the developers planned to introduce Top Charts support here to list apps based on popularity. This didn't seem to be present in our daily build, though we live in hopes it will be included in the final release. Nevertheless, we took the opportunity to search for and install the Thunderbird mail client in under one minute.

The release notes state that if you're upgrading to Ubuntu 25.04, instead of doing a clean install as we did, updates will refresh seeded Snaps to the appropriate Snaps channels, regardless of what was tracked before.

One exception to this is the document viewer, which has now been upgraded from Evince to Papers. The latest version includes some nifty new features, including the ability to verify digital signatures. The App Center also now offers the latest stable release of GIMP (3.0.0).

Ubuntu now deploys the new Linux 6.14 kernel. This news is probably most exciting to those who like to run Windows games on Linux, given that it includes an overhauled NTSYNC driver, which emulates Windows NT synchronisation primitives.

This can hugely improve performance for those running Windows titles via compatibility layers like those in Wine or Steam Play. ■

UBUNTU FLAVOURS

One of Ubuntu's strengths is that official versions are available using multiple desktop environments. Although the flagship edition deploys Gnome 48, Kubuntu uses Plasma 6.3.

As the OS doesn't include snapd, if users opt for a minimal install, by default the OS doesn't include the Snap version of Firefox. However, users can still install a web browser via the command line from Ubuntu repositories. Kubuntu also uses Calamares instead of the customer installer found in the flagship edition.

Xubuntu 25.04 is due to ship with the version 4.20 of the Xfce desktop. This means the OS will ship with tentative experimental support for Wayland, though it still has X11 functionality. It will also support the Labwc and Wayfire compositors and work better with HiDPI displays. Developer notes on GitHub also state that there will be a friendly GUI for backing up data. This has been tentatively set as deja-dup, though this may change for the final release.

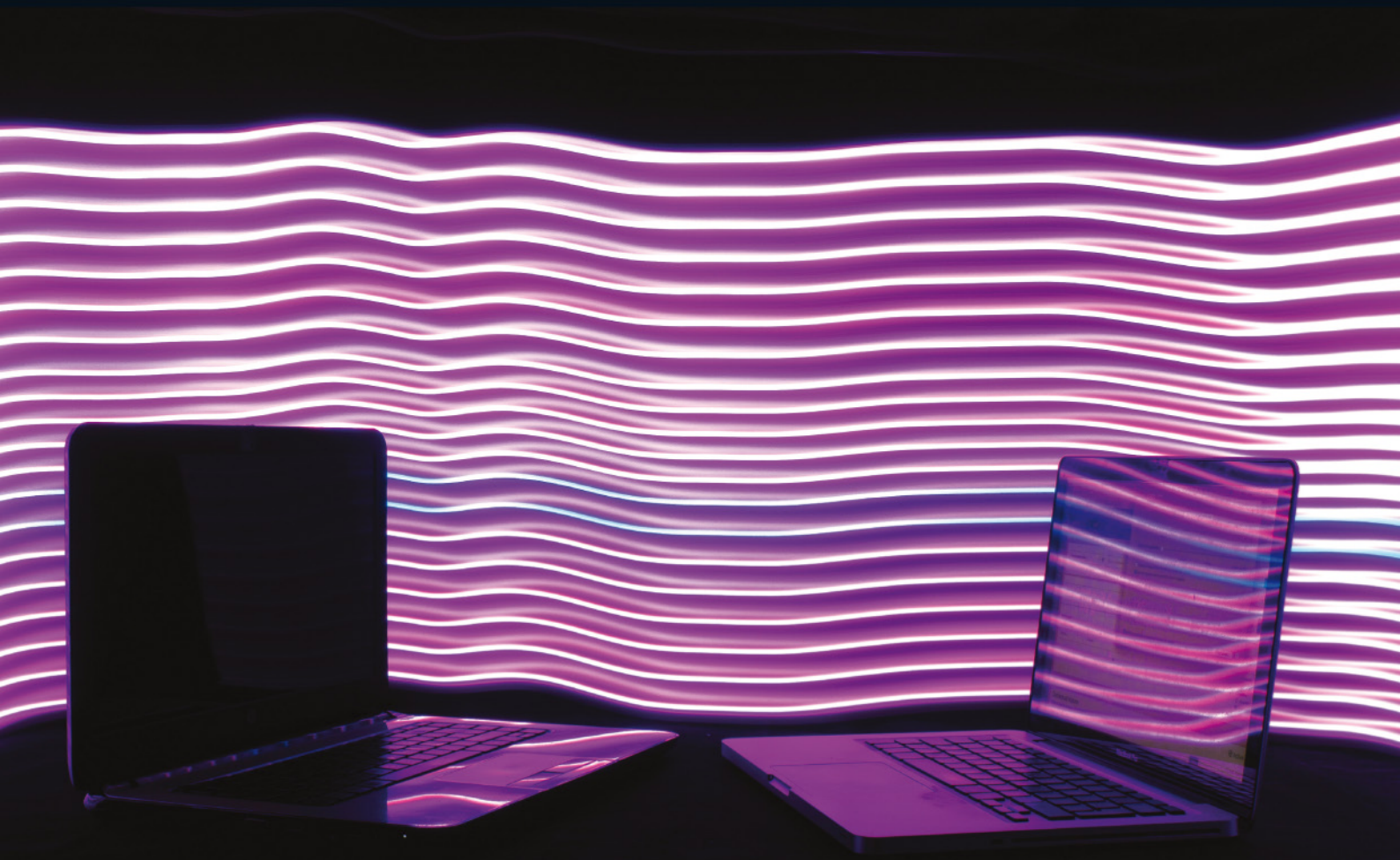
Lubuntu 25.04 deploys the LXQt 2.1 desktop. As the beta was available at the time of writing, we confirmed that it has performance improvements, including two-minute minimal installs. If you opt for a Normal or Full installation, you can also install Snap packages during setup. Pre-installed Snaps can also be upgraded via delta downloads, which is more efficient than downloading the entire new package each time. There's no support for Wayland, though the developers hope to include this before the release of Ubuntu 26.04 LTS.

VERDICT

★★★★★

Ubuntu 25.04 comes with an overhauled setup and features. The upgraded kernel is more efficient and there's extensive online documentation.

Nate Drake



GAMING & CREATIVE LAPTOPS

With Nvidia's RTX 50–series now coming to laptops en masse, we put seven top contenders through their paces.

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We've already had a trickle of laptops based on Nvidia's new RTX 50 series of mobile graphics. Now that trickle is a flood. Our aim here is to round up a collection of the best gaming laptops that have landed so far, to help you decide which is best for you and also to show the state of the market.

Our benchmarks inevitably focus on games, but one of the reasons we're keen to cover these laptops in depth is that they lead a convincing double life as creative laptops. It's ludicrously easy to switch between Nvidia's Game Ready drivers and its Studio drivers, with the latter guaranteed to work with creative apps from Adobe, Blackmagic, 3ds and many more.

There's another side to these laptops, too: they're a brilliant choice for running local AI apps. That could be image creation and editing, but we're very much at the beginning of LLMs (and small language models) on our systems.

So even if you're not in the market for a gaming laptop, we hope that you find this round-up interesting.

CONTRIBUTORS Jason England, Andrew E Freedman, Brandon Hill, Madeline Ricchiuto, Rami Tabari, Alex Wawro



		RECOMMENDED	RECOMMENDED			RECOMMENDED	
	Asus ROG Strix Scar 16 (2025)	Asus ROG Strix Scar 18 (2025)	Asus ROG Zephyrus G14 (2025)	Gigabyte Aorus Master 16 (2025)	HP Omen Max 16 (2025)	Lenovo Legion Pro 7i Gen 10	MSI Raider 18 HX
Overall rating	★★★★☆	★★★★☆	★★★★★	★★★★☆	★★★☆☆	★★★★★	★★★★☆
Purchase information							
Price [1]	$6,599	$6,999	$5,899	$5,599	$6,997	$5,699	$8,599
Dimensions (WDH)	354 x 268 x 22.8-30.8mm	399 x 298 x 23.5-32mm	311 x 220 x 15.9-18.3mm	357 x 254 x 23-29.9mm	357 x 269 x 22.9-24.8mm	364 x 276 x 21.9-26.6mm	404 x 308 x 24-32.1mm
Weight	2.8kg	3.3kg	1.6kg	2.5kg	2.7kg	2.7kg	3.6kg
Warranty [2]	2yr RTB	2yr RTB	2yr RTB	2yr RTB	1yr RTB	1yr C&R	2yr RTB
Core components							
Processor	Intel Core Ultra 9 275HX	Intel Core Ultra 9 275HX	AMD Ryzen AI 9 HX 370	Intel Core Ultra 9 275HX	Intel Core Ultra 9 275HX	Intel Core Ultra 9 275HX	Intel Core Ultra 9 285HX
Cores	24 (8 P-cores, 16 E-cores)	24 (8 P-cores, 16 E-cores)	12	24 (8 P-cores, 16 E-cores)	24 (8 P-cores, 16 E-cores)	24 (8 P-cores, 16 E-cores)	24 (8 P-cores, 16 E-cores)
Graphics	16GB Nvidia GeForce RTX 5080	24GB Nvidia GeForce RTX 5090	16GB Nvidia GeForce RTX 5080	16GB Nvidia GeForce RTX 5080	24GB Nvidia GeForce RTX 5090	16GB Nvidia GeForce RTX 5080	16GB Nvidia GeForce RTX 5080
Boost wattage	175W	175W	110W	175W	Not stated	175W	175W
RAM	32GB DDR5-5600	64GB DDR5-5600 (tested with 32GB)	32GB LPDDR5X-8000	32GB DDR5-5600	64GB DDR5-5600 (tested with 32GB)	32GB DDR5-6400	32GB DDR5-6400
Storage	1TB	2 x 1TB (RAID0)	2TB	1 x 2TB	2TB	1TB	2 x 2TB
Display							
Size	16in	18in	14in	16in	16in	16in	18in
Technology	Mini-LED	Mini-LED	OLED	OLED	OLED	OLED	Mini-LED
Resolution	2,560 x 1,600	2,560 x 1,600	2,880 x 1,800	2,560 x 1,600	2,560 x 1,600	2,560 x 1,600	3,840 x 2,400
Frequency	240Hz	240Hz	120Hz	240Hz	240Hz	240Hz	120Hz
Battery & charger							
Battery capacity	90Wh	90Wh	73Wh	99Wh	83Wh	99Wh	99.9Wh
Charger wattage	380W	380W	200W	330W	330W	400W	400W
USB-C charging?	✓ (120W)	✓ (120W)	✗	✓ (PD 3.0)	✓ (wattage not stated)	✓ (140W)	✗
Ports & connectivity							
Wireless standard	Wi-Fi 7	Wi-Fi 7	Wi-Fi 7	Wi-Fi 7	Wi-Fi 7	Wi-Fi 7	Wi-Fi 7
Bluetooth	Bluetooth 5.4	Bluetooth 5.4	Bluetooth 5.4	Bluetooth 5.4	Bluetooth 5.4	Bluetooth 5.4	Bluetooth 5.4
HDMI	HDMI 2.1	HDMI 2.1	HDMI 2.1	HDMI 2.1	HDMI 2.1	HDMI 2.1	HDMI 2.1
USB-C	2 x Thunderbolt 5	2 x Thunderbolt 5	1 x USB 4, 1 x USB 3.2 Gen 1	1 x Thunderbolt 5, 1 x Thunderbolt 4	2 x Thunderbolt 4	1 x Thunderbolt 4, 1 x USB 3.2 Gen 2	2 x Thunderbolt 5
USB-A	3 x USB 3.2 Gen 2	3 x USB 3.2 Gen 2	2 x USB 3.2 Gen 2	2 x USB 3.2 Gen 2	2 x USB 3.2 Gen 2	1 x USB 3.2 Gen 2, 2 x USB 3.2 Gen 1	3 x USB 3.2 Gen 2
LAN	2.5GbE	2.5GbE	✗	1GbE	2.5GbE	2.5GbE	2.5GbE
SD card reader	✗	✗	✓	✓ (microSD)	✗	✗	✓ (SD Express)
3.5mm audio jack	✓	✓	✓	✓	✓	✓	✓
Webcam	1080p IR	1080p IR	1080p IR	1080p IR	1080p IR	5MP IR	1080p IR
Other features							
RGB	Aura Sync Light Bar, Aura Sync logo, AniMe Vision	Aura Sync Light Bar, Aura Sync logo, AniMe Vision	Slash Lighting	Front light bar, rear strip	Front light bar	✗	Front light bar
Supplied OS	Windows 11 Home	Windows 11 Home	Windows 11 Home	Windows 11 Home	Windows 11 Home	Windows 11 Home	Windows 11 Home

1 Price is correct at time of going to press.

Asus ROG Strix Scar 16 (2025)

With flashy lights and strong performance, the ROG Strix Scar 16 is only let down by its relatively high cost.

★★★★☆

PRICE $6,599
from rog.asus.com



Asus' ROG Strix Scar 16 makes quite a visual statement. For a start, the large ROG logo on the lid is actually a multicolour LED. Even that is made to look bashful compared to the array of 810 white LEDs that dance around when the laptop is in standby mode and flash "STRIX" when you turn it on. You can change these patterns to premade animations or import your own.

Want more? There's an RGB light ring around the entire perimeter of the enclosure, and per-key backlighting on the keyboard – all of which can be configured with the supplied Armoury Crate tool.

Despite the showy exterior, the construction feels basic in places. It's solid, but the keyboard deck and chassis bottom are constructed of plastic (this helps to prevent overheating and cuts down on weight), while the bezels at the top and bottom of the screen are sizeable.

Still, there's a good set of ports around the edges. Asus incorporates three USB-A ports and twin Thunderbolt 5 connectors, along with an HDMI 2.1 port and a 3.5mm headphone jack. There's also a 2.5GbE port, plus Wi-Fi 7.

The screen is a 16in, 2,560 x 1,600 number, with a refresh rate of 240Hz. The standout feature is mini-LED backlighting, which puts this laptop far above its peers in brightness: I measured 457cd/m² with SDR content, while peak levels exceeded 1,200cd/m² when viewing HDR content. Colours are rich and vibrant, with the panel covering 81% of the DCI-P3 colour space and 115% of the sRGB space.

Inside, the expected Core Ultra 9 275HX processor – featuring eight performance cores and 16 efficiency cores – is matched here with a GeForce RTX 5080 GPU and 32GB of DDR5-5600 memory.

This version is plenty for most gamers, though. I tried out various titles but spent most of my time running and gunning in *Indiana Jones and the Great Circle*. It's a visual masterpiece and the Strix Scar 16 has the hardware to do it justice: with the resolution set to 1440p and the detail setting cranked to "Ultra," the game ran smoothly at between 70fps and 100fps, with high-quality textures and realistic reflections.

Aside from big screens, larger gaming laptops usually benefit from spacious keyboards. Asus has fitted the ROG Strix Scar 16 with a pleasing full-size keyboard, offering 2mm of key travel. Five keys at the top of the keyboard deck default to controlling the volume, microphone and power mode, although you can reprogram these using Armoury Crate.

Below, you'll find a large glass trackpad, which is smooth and has a satisfying click. It also supports Asus' quirky NumberPad feature, which turns the touchpad into a touch-sensitive numeric keypad when you hit the Num Lock key. It's not ideal for lengthy data-entry tasks, but it works well for shorter jobs and means the main keyboard doesn't get shunted to the side.

Audio from the ROG Strix Scar 16's four built-in speakers is strong, with plenty of volume and adequate bass. They certainly helped bring *Indiana Jones and the Great Circle* alive, from the whip cracks to Indy's feverish punches and the grunts he makes when he jumps from ledges. The speakers do, however, have to compete with audible fan noise when you're gaming; I still preferred to use a headset.

ABOVE **Light appeal: the eye-catching ROG Strix Scar 16 is a strong performer.**

"While the ROG Strix Scar 16 comes with a decent amount of memory and storage, it's delightfully easy to upgrade"

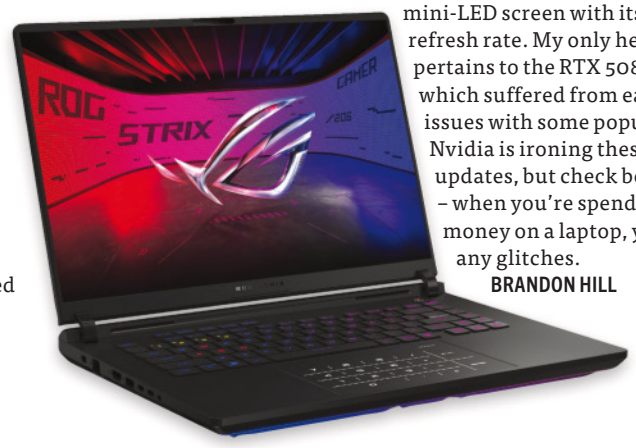
While the ROG Strix Scar 16 comes with a decent amount of memory and storage, it's delightfully easy to upgrade. You don't need a screwdriver at all: flip the laptop over and you'll see a small latch at the front of the chassis with an arrow on it. Push this forward and you can slide the whole bottom casing off, exposing the interior and granting direct access to the system's twin SODIMM sockets – our review unit had both occupied with 16GB DDR5-5600 modules – and two M.2 slots. One of these was taken by a 1TB Western Digital PCIe 4 SSD, but the board also supports PCIe 5 drives if you want to add the fastest available storage.

As for battery life, you're never going to get hours and hours of gaming from a laptop like this, but in our desktop endurance benchmark – which browses the web, streams videos and runs light OpenGL tests – it lasted 6hrs 30mins. That's respectable for a gaming laptop.

In all the ROG Strix Scar 16 is a strong choice, with an eye-catching design, plenty of connectivity and a fast SSD that can be extended or replaced with an even faster one. Games look great on the large mini-LED screen with its excellent refresh rate. My only hesitation pertains to the RTX 5080 graphics, which suffered from early driver issues with some popular games. Nvidia is ironing these out with updates, but check before you buy – when you're spending this sort of money on a laptop, you don't want any glitches.

BRANDON HILL

BELOW **The mini-LED panel's backlighting puts this laptop above its peers in brightness.**



Asus ROG Strix Scar 18 (2025)

The most powerful gaming laptop around – a fact that's amply reflected in its bulk and that whopping price.

★★★★☆

PRICE $6,999
from asus.com



If you thought the ROG Strix Scar 16 was a beast, you'll baulk at this huge gaming laptop. It has an 18in display that looks more like a desktop monitor than a laptop screen, and it weighs a hefty 3.3kg.

While the ROG Strix Scar 18 isn't the most portable gaming system around, it is one of the best. That's thanks to a combination of top-tier components and a screen that's not only huge but gorgeous.

When I say top-tier components, I mean the aspirational combination of an Intel Core Ultra 9 275HX CPU and Nvidia RTX 5090 GPU. It's a power pairing made in gaming heaven, enabling the latest AAA titles to run smoothly with incredible visuals. In fact, Asus squeezes notably more performance out of the duo than other laptops in this class: in the *Cyberpunk 2077* benchmark, the Strix Scar 18 proved around 14% faster than the HP Omen Max 16, even though both machines have the same CPU and GPU combination.

That's before we talk about Nvidia's DLSS 4 technology, which uses AI to boost frame rates with little impact on the overall experience. Turning it on, I saw frame rates in *Cyberpunk 2077* leap to an insane average of 232fps at the maximum quality settings and 1080p.

Rounding it all off is the stunning display, with a sharp resolution and a 16:10 aspect ratio – great for games and productivity alike. It supports a 240Hz refresh rate for impeccably smooth motion, allowing you to get the full benefit of those high frame rates. The use of mini-LED backlighting means you don't quite get the perfect contrast of an OLED panel, but the Strix Scar 18 makes up for that with superb brightness. And if you choose to turn this immensely capable laptop to creative projects, Pantone validation means you can have total confidence in its accurate, professional-grade colour reproduction.

In short, whether you're racing at 200mph through the vivid streets of Mexico in *Forza Horizon 5*, exploring the neon-lit ghettos of *Cyberpunk 2077* or colour-grading HDR video footage, everything is presented with real pizzazz; it's a screen that you can't look away from.

Considering the size of the Strix Scar 18, the design is impressively ergonomic. In past years, Asus' Strix Scar laptops have tended to be big hunks of plastic. There's still some plastic, primarily to keep the weight down, but this time around the shell has gone through considerable refinement. If you want to show off by playing with the "AniMe" LED display on the lid, or the underbody RGB glow, be my guest, but for a more modest look you can switch those off and enjoy an unfussy, utilitarian design. And I don't only mean the aesthetic: as with the 16in model, I love the way you can quickly unlatch and slide off the bottom panel to replace or upgrade the RAM and SSD.

The keyboard and touchpad have been updated, too. On past models they both felt spongy, with an uncomfortable amount of flex on the deck. Here the touchpad feels smooth and solid, while each key has plenty of tactile depth. Asus takes advantage of the scale of the chassis to build in a full numeric keypad, too.

Last but not least, a new vapour chamber across the back and vents helps this laptop to keep its cool under load. To be sure, things get loud when you push it hard, but you don't have to worry about thermal throttling.

ABOVE **A stunning screen and stellar performance make this a desirable laptop.**

Not everything about the Asus ROG Strix Scar 18 is a hit. In our battery tests it managed just over 90 minutes of gaming on a full charge; that's not a huge shock, especially considering the size of the display, but it's a limitation. I was also disappointed by the grainy quality of the 1080p webcam. It's good that it works with Windows Hello (previous models didn't), but I still expect better from a laptop costing this much.

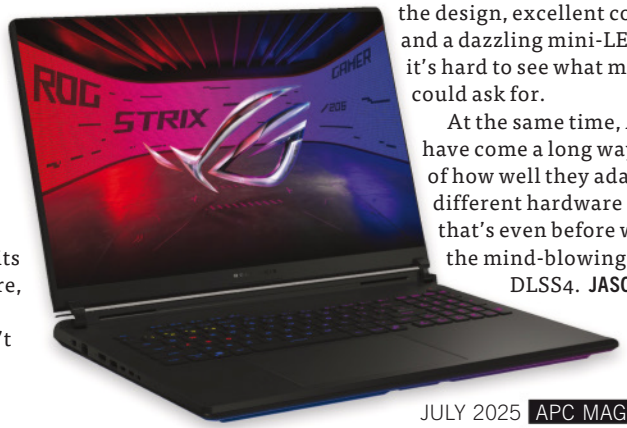
In fact, that's my major gripe with this laptop. Gaming laptops are always expensive, but $6,999 is a huge ask. It's a step up over last year's model, even though that also used the most premium components available at the time of its release. There's no obvious reason for the hike, and it makes it harder to recommend the Strix Scar 18 to anyone who hasn't recently won the lottery.

"With uncompromising internal hardware, excellent connectivity and a dazzling mini-LED display, it's hard to see what more you could ask for"

In many ways, this is still one of the best gaming laptops you can buy. With uncompromising internal hardware, a premium makeover of the design, excellent connectivity and a dazzling mini-LED display, it's hard to see what more you could ask for.

At the same time, AAA games have come a long way in terms of how well they adapt to different hardware specs – and that's even before we consider the mind-blowing impact of DLSS4. **JASON ENGLAND**

BELOW **A huge, uncompromising laptop with a huge, uncompromising price.**



Asus ROG Zephyrus G14 (2025)

Superb performance combines with a svelte design and mesmerising OLED to deliver big.

★★★★★

PRICE $5,899
from asus.com



So there I was at the airport, my flight delayed by three hours. Normally in such a situation I'd bemoan my fate on social media, but with the Asus ROG Zephyrus G14 in my carry-on I had no complaints. I happily whiled away the time, engrossed in high-end gaming; when at last it was time to board, I was actually disappointed that I had to fold down the lid.

That's the beauty of a 14in gaming laptop. While I see the appeal of 16in and 18in screens, the smaller format is more practical wherever you may be. The ROG Zephyrus G14 looks beautiful, too, combining a clean, Apple-style aesthetic with a touch of excitement courtesy of a diagonal slash of subtle lighting on the back. I never felt less than proud to whip it out, whether I was in a business meeting, down the local pub or sitting in the departures lounge of Lisbon airport.

The CNC-milled aluminium construction also means it feels reassuringly durable, and Asus' glass-topped trackpad and chiclet keyboard continue to be the best in the business for gaming systems.

As with the Razer Blade 16, the slim chassis lends itself to a Ryzen AI 9 HX 370 CPU, here partnered by Nvidia's RTX 5080 GPU and 32GB of RAM. Windows 11 has never felt so snappy, but as the CPU only contains eight cores to the 24 inside the Ultra 9 275HX it props up the table in Geekbench 6 multicore. Still, a score of 15,280 shows it will have no trouble multitasking. I could play multiple 4K video streams at once, with Adobe Photoshop and *Cyberpunk 2077* sitting open in the background. No matter how intense your workload is, the ROG Zephyrus G14 can take it.

The G14 can only deliver 110W to the GeForce RTX 5080 GPU compared to 175W from its rivals, and that shows in the performance tables on p63, but there's still plenty of gaming power here. Running *Cyberpunk 2077* in 1080p with ray-tracing and no DLSS, the ROG Zephyrus G14 averaged 50fps – but you can go much higher thanks to Nvidia's Multi Frame generation. I saw *Cyberpunk 2077* race up to an absurd 147fps at maximum quality settings, without any noticeable impact on latency.

All this high-end silicon makes the Zephyrus G14 a mightily impressive portable workstation, too. With its grown-up design, it works equally well as a creator machine as it does a gaming laptop, and it features all the connectivity most professionals need. There are two USB-C ports, one of which supports USB 4 (40Gbits/sec) and another USB 3.2 Gen 2 (10Gbits/sec). Two USB-A 3.2 Gen ports are also present, along with a microSD card slot and an HDMI 2.1 output. Not that there's any need for designers to hook up an expensive external display: the screen is Pantone validated.

In fact, the screen is an all-round winner. It's an OLED panel with a 3K resolution and 16:10 aspect ratio, which is ideal for productivity. The 120Hz refresh rate isn't up there with the fastest panels, but it's still smooth.

I must give a shout out to the speakers, too. The dual side woofers offer far more bass than I've come to expect from previous Zephyrus models, and they're more than loud enough to enjoy over the sound of the fans. That's an achievement, as those fans aren't quiet when you're driving the system hard, but they do their job of keeping the system cool enough to minimise thermal throttling.

While my impressions of the ROG Zephyrus G14 are almost entirely positive, the usual caveat applies – a seemingly unavoidable one, given how power-hungry gaming laptops are. Asus has managed to lengthen the gaming battery life by around three-quarters of an hour compared to last year's Zephyrus G14 model, but it still conked out after 1hr 45mins.

ABOVE **The stylish and powerful Zephyrus G14 is equally as adept in creative tasks as it is in gaming.**

For desktop tasks, it fares better. You should squeeze up to six hours out of it on one charge, so you can be reasonably productive as long as you're not expecting to work through a long-haul flight.

Overall, it's hard to criticise the Asus ROG Zephyrus G14. Its killer combination of CPU and GPU, plus Nvidia's latest DLSS technology, unlocks incredible performance. Games shine on its crisp OLED display, while its tasteful looks and relatively portable design make it an appealing choice for professional tasks, too.

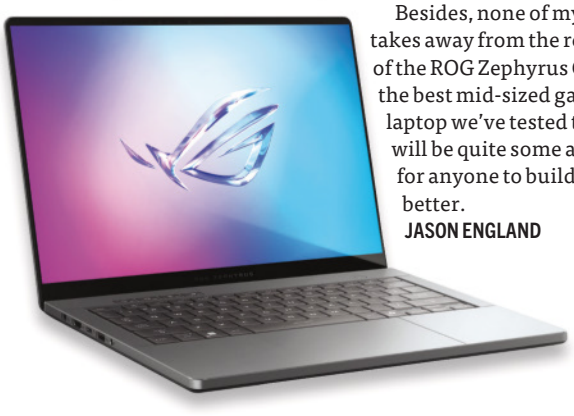
"It's the best mid-sized gaming laptop we've tested this year, and it will be quite some achievement for anyone to build something better"

Battery life is always going to be limited on a laptop like this, and it's not exactly a budget machine – you're undoubtedly paying a premium for the design and branding, over and above the manufacturing cost. However, you can save $1,000 by choosing the RTX 5070 Ti version, which still includes the 32GB of RAM included in my test system.

Besides, none of my criticisms takes away from the real appeal of the ROG Zephyrus G14: it's the best mid-sized gaming laptop we've tested this year, and it will be quite some achievement for anyone to build something better.

JASON ENGLAND

BELOW **The stunning 3K OLED screen is ideal for productivity.**



Gigabyte Aorus Master 16 (2025)

A strong performer, but it doesn't feel as premium as its rivals – a fact reflected by its asking price.

★★★★☆

PRICE $5,599
from gigabyte.com



No laptop costing almost $5,600 can be considered cheap, but the Aorus Master 16 is the only gaming laptop here to duck under that mark. But it does feel cheaper than its rivals. Though many gaming laptops use plastic to prevent overheating and reduce weight, Gigabyte's implementation of the material isn't perfect.

For instance, the lid features a lenticular material that reveals a ribbed pattern around the RGB-lit Aorus falcon logo. But the material feels like something I'd expect from a Happy Meal toy. At least on the lid, Gigabyte should have gone with premium aluminium. Then there's the Aorus logo displayed garishly across the touchpad, spilling onto the palm rest. Mix that with the RGB keyboard (including a handful of transparent keys), and there's no mistake that this laptop is meant for gamers. There's plenty of RGB, including a light bar underneath the palm rest and a second on the rear of the laptop. There's also a small RGB projection of the Aorus wordmark from the rear of the laptop.

The left side includes a Thunderbolt 5 port, USB-A 3.2 Gen 2 port, HDMI 2.1 and an Ethernet jack. On the right, there's another USB-A port, Thunderbolt 4, a headphone jack and a microSD card slot. I would have liked to see a full-size SD card slot on a laptop this size. My other slight complaint is that the power cable was bothersome as it juts out of the side about halfway along the left-hand side.

Although Gigabyte sells the Aorus Master 16 with an RTX 5090, the $5,599 price here buys you a 5080 to accompany Intel's popular Core Ultra 9 275HX. It can supply up to 175W of power to the GPU, and with the large chassis offering plenty of room for cooling we expected the Aorus Master to vie with the best RTX 5080 laptops. Which it did, even beating the RTX 5090 systems in *Borderlands 3* and *Shadow of the Tomb Raider*.

Nor will you have complaints outside of gaming, helped along by 32GB of RAM in our test system. It was actually the slowest of the Core 9 Ultra systems in Geekbench 6, but in practice this is an incredibly responsive PC. And it redeemed itself in our video-encoding test, taking third place with 2mins 17secs.

Like the HP and Lenovo, the Aorus includes a 16in OLED panel with a 240Hz refresh rate. While it only covers 81% of the DCI-P3 space, when I explored a forest at sunrise in *Alan Wake 2* the green foliage was vibrant and the entire scene lightly coloured by an appropriate orange tint. It's a brighter panel than the HP's but only just, with a 378cd/m² peak.

Gigabyte's keyboard features poppy scissor switches that provide a comfortable bounce while writing and gaming. I wish the keycaps were larger, and there's clearly room for them, as Gigabyte has speaker grille patterns on each side of the keyboard. But not actual speaker grilles, with the audio here another sign of weakness: they're passable for listening to music, but far better tuned for gaming. The 1080p webcam is fine, if too cool for my liking.

The touchpad is a generous size, with a mechanical click that works well. It's smooth and proved a fine partner for Windows gestures.

Removing the bottom cover requires dispatching 12 screws. There are three sizes here, so be sure to keep track of which ones go where. You're rewarded by a second empty M.2 slot, with the first occupied by a 2TB SSD. This was surprisingly slow in our real-world 25GB file-transfer test, at 665MB/sec compared to the 1,500MB/sec we've become used to, but this didn't affect its day-to-day speed.

ABOVE **The Aorus Master 16 is the cheapest laptop in this group test.**

You'll also discover a 99.2Wh battery, again typical for a gaming laptop, and it didn't tear up any records in our battery life tests: 5hrs 2mins under light use and 1hr 40mins in PCMark's gaming test.

Gigabyte is mercifully light on the amount of software it includes on the Aorus Master. It boils down to two apps: Gigabyte Speed and GiMate. Gigabyte Speed tries to prioritise gaming traffic on your network, but GiMate is a system monitor that, Gigabyte claims, has AI capabilities.

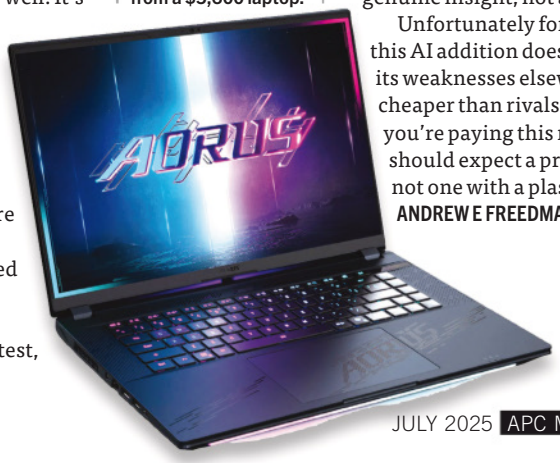
"It's cheaper than rivals, but when you're paying this much you should expect a premium device, not one with a plasticky build"

These aren't obvious. Its primary use is for changing performance modes, checking CPU and GPU speeds and adjusting system settings, much like previous iterations. There's an AI agent, and if you tell it you want to play a game it will switch to Game Mode. Or you can write "I'm going to a meeting" and it will downclock in "Online Meeting Mode." But in the time it takes to chat with the LLM, you could switch these manually with two clicks; I want something that will give me genuine insight, not act as a shortcut.

Unfortunately for Gigabyte, then, this AI addition doesn't make up for its weaknesses elsewhere. Yes, it's cheaper than rivals, but when you're paying this much you should expect a premium device, not one with a plasticky build.

ANDREW E FREEDMAN

BELOW **Sadly, the build quality is not what you'd expect from a $5,600 laptop.**



HP Omen Max 16 (2025)

Promises so much with its cutting-edge components and gorgeous OLED display, but ultimately disappoints.

★★★☆☆

PRICE $6,997 **from** hp.com



Not much makes me happier than a powerful gaming laptop, and the HP Omen Max 16 is one of the most powerful around. With an Intel Core Ultra 9 275HX CPU and top-of-the-line Nvidia GeForce RTX 5090 graphics, it's an unbeatable specification – and the OLED screen is a treat for the eyes, too.

The design is chunky – that's inevitable for a 16in gaming laptop – but its 2.7kg weight is on the heavy side even compared to its competitors this month. The overall shape is clean and simple, but is decorated with several attention-seeking design features: aside from the lightbar and RGB keys, there's a glossy black Omen logo on the lid, and another "O16" logo below the keyboard, along with text in an alien alphabet that I'm not going to try to decipher.

The bezels on the display are pleasingly thin, with the webcam on top and a much appreciated privacy shutter. HP scatters plenty of connections around the sides, with twin Thunderbolt 4 ports, two USB-A 10Gbits/sec ports, HDMI 2.1, Ethernet and a headphone/microphone jack – plus Wi-Fi 7.

But the big attraction is the screen. The OLED panel stunned me with its fever dream of colours, while a native resolution of 2,560 x 1,600 and 240Hz refresh rate means that games will look both sharp and smooth.

My only caveat is that for the best experience you'll want to play in a dark room, as the panel isn't bright enough to overcome glossy glare. I noticed this not only when gaming, but when watching the trailer for the upcoming *Lilo & Stitch* film; bright ocean scenes looked so incredible I felt I could literally dive in, but when the action moved to Lilo's dark room I was distracted by reflections.

I was a little disappointed by the audio, too, with the bottom-firing speakers producing mediocre sound. This isn't just about immersion; it can actually affect gameplay. In *Marvel Rivals*, there's a cacophony of noises and warnings you must pay attention to, but on these speakers I sometimes struggled to make out the dialogue. HP seems to anticipate that you'll be using this laptop with a headset: it includes a licence for DTS Sound Unbound, but only for headphones.

On the plus side, the keyboard is a pleasure to use. I like a bit of kick and bounce in my keyboard, and the HP Omen Max 16 has a great feel. The size of the keys gives my fingers enough room to breathe, too. I don't like the almost non-existent spacing between them, but there's enough texture on the keytops to guide your fingers to the right place, and space on the deck for your palms to rest comfortably.

With all that out of the way, it's time to talk about the gaming performance. And I'm torn. While the Omen Max 16 has enough power to tear through any game you care to try, its benchmark scores didn't always match up to the competition. Arguably these raw results don't matter as much any more, as the GPU supports DLSS 4 and that can double or triple a game's native frame rate. In compatible games, a difference of 5-15fps between this and competing laptops is almost academic.

The HP Omen Max 16 also throws some heavy punches in desktop performance, thanks to its 24-core CPU and 32GB of RAM. Skipping back and forth between a few dozen Chrome tabs and a handful of YouTube videos while *Marvel Rivals* downloaded in the background felt like a breeze. That's borne out by a terrific performance in the Geekbench 6 benchmark.

While this isn't marketed as a Copilot+ PC, the CPU and GPU together are also more than powerful enough to run AI-powered features such as Recall, Windows Studio Effects and Live Captions.

ABOVE **A top-of-the-range CPU and GPU didn't result in chart-topping results.**

There aren't any obvious HP-branded AI features on the Omen Max 16, apart from AI Noise Removal in the myHP audio settings, but you do get the Omen Gaming Hub. This is where you can tune your performance and monitor system vitals. Head to the myHP tool for additional display, audio and battery life settings.

With so much high-end hardware, the HP Omen Max 16 doesn't run for long on battery power. In the PCMark 10 gaming test, it lasted for 1hr 26mins away from the mains: that's not bad enough to ruin the deal, but once again rival machines do better.

"The Omen Max 16 throws some heavy punches in desktop performance, thanks to its 24-core CPU and 32GB of RAM"

I've been using an older HP Omen laptop as my gaming PC for quite a while now, so I had high hopes for the HP Omen Max 16. And if I'm honest, I was disappointed: for this price I was expecting best-in-class gaming performance and battery life, and the Omen Max 16 delivers neither. The sound is a letdown too, if you want to enjoy your games out loud. There are excellent 16in alternatives on test this month, such as the Lenovo Legion Pro 7i Gen 10 opposite.

Even so, if you like HP's Omen laptops then there's enough performance here to make almost anyone happy – and you simply can't beat the sumptuous 16in OLED display. As long as you're not planning to play in direct sunlight, this laptop delivers one of the best all round visual experiences I've seen. **RAMI TABARI**

BELOW **The display is also superb, as long as you're in a darkened room.**



Lenovo Legion Pro 7i Gen 10

A beast that delivers a new level of performance to take advantage of the bright 240Hz OLED panel.

★★★★★

PRICE $5,699 from lenovo.com



Lenovo's latest 16in gaming laptop justifies its high price with a one-two punch of killer performance and a superb display. Frankly it's one of the most attractive machines I've ever reviewed.

That has much do with its OLED display. I've always loved the bright whites, inky blacks and sharp contrast of OLED panels, and it makes everything you do on this laptop look amazing, especially gaming in HDR and Dolby Vision. Every time I opened the lid, I was struck by how rich and colourful the screen looked.

I was even more impressed at the panel's technical performance. This thing is bright, more than 100cd/m² brighter than the HP opposite, with an SDR peak of 464cd/m² that climbs all the way up to 1,000cd/m² when viewing HDR content – and at the same time, it manages to cover over 100% of the DCI-P3 gamut (139% volume). Its accuracy is excellent, too, with an average Delta E of 0.29. You don't need this level of quality to enjoy games, but these are all pluses if you need a laptop for more creative tasks.

The screen is far from the only outstanding thing about the Legion. With its Intel Core Ultra 9 275HX CPU and Nvidia GeForce RTX 5080 GPU, it's capable of running the latest games at more than 60 frames per second even at the screen's native 2,560 x 1,600 resolution.

That's thanks to the latest generation of Nvidia's DLSS upscaling tech, which can smooth performance by inserting AI-generated frames between "real" frames. I admit that I was initially sceptical of this feature, but having tried it in several titles I can confirm that it works very well, enabling beautifully fluid gaming with no noticeable graphical issues or input latency.

Even without DLSS, the Lenovo Legion Pro 7i is no slouch. Our benchmarks were all carried out at 1080p with no upscaling, and they show the Legion Pro 7i holding its own comfortably against competing systems. While it doesn't quite match the HP Omen Max 16 or the Asus ROG Strix Scar 16, that's to be expected since those systems come with a more powerful RTX 5090 GPU.

As with all the laptops here other than the Zephyrus G14, the Legion Pro 7i is a hefty beast, weighing 2.7kg. It doesn't look bulky, though: every time I picked up this machine I was surprised by its weight, relative to its sleek and elegant chassis.

Other design plus points include the easy-open lip on the top lid, the intuitive function keys – I love the way you can hit the Fn key and see all the relevant key combos light up on the keyboard – the reassuring 1.8mm of key travel and the side-mounted shutter switch that disables the webcam when you want privacy. Gaming laptops often try too hard to be edgy and not hard enough to be ergonomic or practical, but the Legion Pro 7i can't be accused of that.

Around the edges you'll also find all the ports you need for serious PC gaming. The right-hand side offers a pair of USB-A ports, a headphone jack and an Ethernet socket for wired networking; on the left you get one regular USB-C port, one Thunderbolt 4 port, another USB-A port, HDMI 2.1 and a barrel-type power socket – although you can also charge the laptop via the USB-C port if you prefer. Some of these ports are set further forward than usual, but I didn't have any problems with this in general use.

As impressive as the Lenovo Legion Pro 7i is, there are some caveats you should be aware of before buying one. As always with gaming laptops, you pay a premium for the portable design without benefitting from a laptop that you'll want to carry around with you. And if you do, it won't last long away from the mains: it lasted a shade over an hour and a half of simulated gaming in the PCMark 10 battery benchmark test, and in *Cyberpunk 2077* I got barely more than an hour of game time before the laptop was down to 10% battery and alerting me to plug it in.

ABOVE **The Legion Pro 7i is a stunning laptop with a screen that will blow you away.**

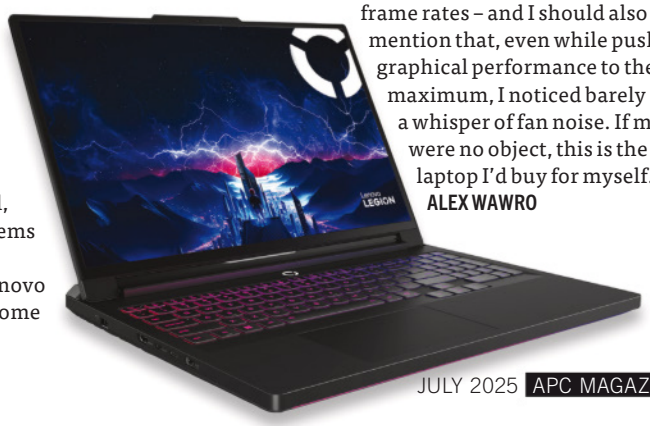
"The elegant design makes it easy on the eyes and a joy to use. Games look gorgeous on the bright OLED screen"

At least you can improve matters by fine-tuning the performance settings using the Lenovo Vantage app. Unlike the bloatware provided by some laptop vendors, this offers detailed and actually useful power controls, including an overclocking button that's enabled when the laptop is plugged in via its primary charger.

Overall, the Legion Pro 7i is the standout 16in gaming laptop in this group. Inescapably, the format comes with compromises on price, weight and battery life, but the elegant design is easy on the eye and a joy to use. Games look gorgeous on the bright OLED screen, with beautifully smooth frame rates – and I should also mention that, even while pushing graphical performance to the maximum, I noticed barely a whisper of fan noise. If money were no object, this is the gaming laptop I'd buy for myself.

ALEX WAWRO

BELOW **There's plenty of connectivity on offer, including a Thunderbolt 4 port.**



MSI Raider 18

A punchy display and audio combo ensure this laptop feels premium, but MSI asks too much for 5080 graphics.

★★★★☆

PRICE $8,599 **from** au.msi.com



Powerful gaming laptops command premium prices, and the MSI Raider is no different.

It feature a generous 4TB of storage spread across a pair of 2TB drives, and the result is excellent speed: 2,252MB/sec in our real-world file-copy tests. Of the other systems here, only the Lenovo Legion Pro 7i breached 2,000MB/sec.

And this laptop is all about speed, with the Raider hitting a maximum operating power of 260W thanks to MSI's OverBoost Ultra technology. This led to atrocious battery life in our light-use test, 2hrs 33mins, but it lasted for a more respectable 1hr 46mins when we switched to gaming.

More importantly to most, it easily hit over 100fps at 1080p in most games, although more difficult titles such as *Black Myth: Wukong* and *Cyberpunk 2077* proved a challenge. This is where DLSS 4 and frame generation come in. With DLSS 4 enabled at the 18in panel's 2400p resolution and High settings, I was easily able to keep a stable 47fps in *Monster Hunter Wilds*. That jumped up to 70fps with frame generation enabled. I saw similar improvements in *Avowed*, going from 77fps at 2400p on High settings with only DLSS 4 to 115fps with frame generation also toggled on. Without either, the game was hitting 46fps.

Lastly, I used the Raider to take on my *Final Fantasy XIV: Dawntrail* dailies (recurring activities that give rewards), and averaged 80fps with the laptop at 2400p and High (Desktop) settings without any supersampling. Dropping the graphics down to High (Laptop) saw those frame rates capped at 110fps, generally staying in the ballpark of 95fps during gameplay.

Curiously the Raider was one of the slower systems in the single-core Geekbench 6 test, but then topped the charts for both the multicore section and the HandBrake encoding test. But with a 24-core Intel Core Ultra 9 285HX and 64GB of RAM inside, this laptop should never feel slow.

During my hands-on testing, nothing I threw at the Raider made the fans kick on. Except for Cinebench R23: MSI claims this laptop can break the 40,000 mark, but in our tests it peaked at 39,414. Which is still pretty darn impressive.

Then again, it should be at this size. MSI describes the Raider as "large and in charge", but even that undersells this 3.6kg behemoth that measures 404mm wide and 32.1mm thick at its chunkiest point. I don't own a backpack that's large enough to contain it. In return MSI gives you every possible port: two Thunderbolt 5, three USB-A 3.2 Gen 2, 2.5Gbits/sec Ethernet, a full-size SD Express card slot and an HDMI 2.1 port.

My favourite detail of this chassis is the alternating red and black vent covers along the rear and sides of the chassis, which add contrast to the hefty design. MSI takes a minimalist approach to RGB lighting, with a thin strip below the keyboard deck and a backlit MSI logo on the cover panel.

The keyboard deck is similarly sparse, with a few vents for the onboard audio and additional thermal control, which leaves most of the width for a full-size keyboard, number pad and a large touchpad. Naturally, per-key RGB lighting is here, while the board is designed by SteelSeries. It has a solid amount of bounce with nicely spaced keys to avoid mistypes. The keys are quiet but have a good amount of key travel.

Then we come to the 18in, 3,840 x 2,400, 120Hz matte mini-LED panel. In *Avowed*, the corals along a beach stopped me in my tracks thanks to their crisp detail against the stormy grey skies and weather-beaten wood of a wrecked ship in the background. This feeling was backed up in our tests, with an average Delta E of 0.25 and covering 83% of the DCI-P3 gamut (although others here go higher still). It hit a peak brightness of 668cd/m² in SDR content, upping to 793cd/m² with HDR active.

ABOVE **The Raider 18 is a huge, powerful and ridiculously expensive laptop.**

"This is the only laptop on test that does full justice to the phrase 'desktop replacement'. It offers superb all-round and gaming performance"

The audio setup is similarly impressive, with two woofers and four tweeters bringing sheer volume and high fidelity. Normally gaming laptops struggle with gentle ballads, but I found no such problems here. I was less impressed by the 1080p IR webcam, with its washed-out colours.

Software-wise, there's little to shout about: the MSI Center app controls your power settings and includes an "AI Engine" to help, but you're better off spending time with Intel's AI Playground and ChatRTX.

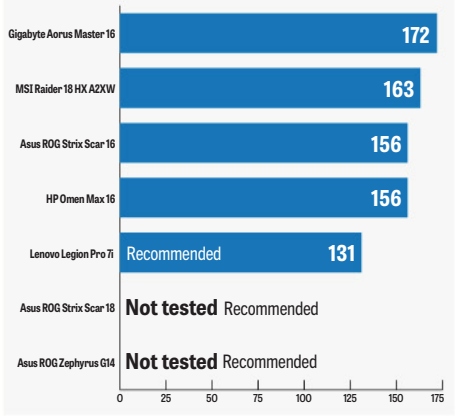
So to the big question: is the Raider 18 worth the high price? Not for everyone: there are so many excellent gaming/creative laptops here that cost more than $2,000 less. Yet this is the only laptop on test this month that does full justice to the phrase "desktop replacement". It offers superb all-round and gaming performance, a bright, giant mini-LED display, a comfortable keyboard and powerful audio.

MADELINE RICCHIUTO

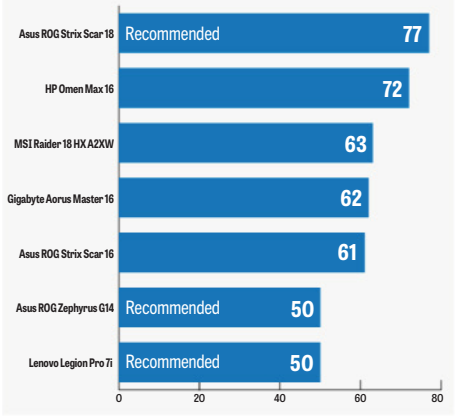
BELOW **The enormous mini-LED display has a desktop-like resolution of 3,840 x 2,400.**



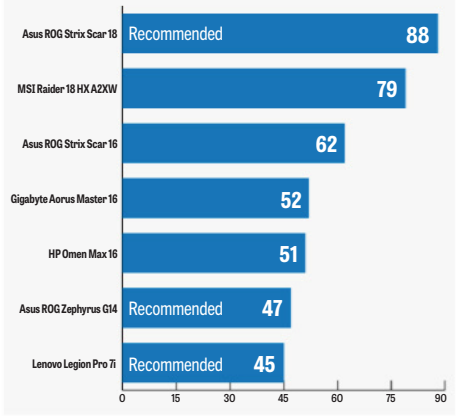
Borderlands 3 (1080p Ultra)



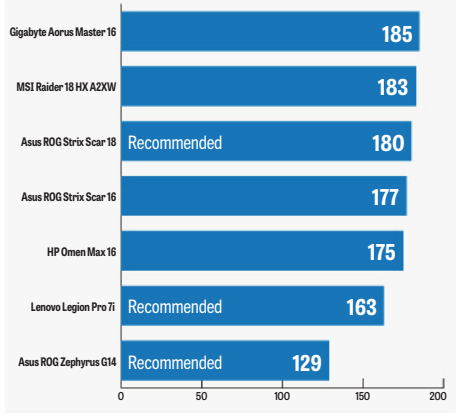
Cyberpunk 2077 (1080p RT Ultra DLSS off)



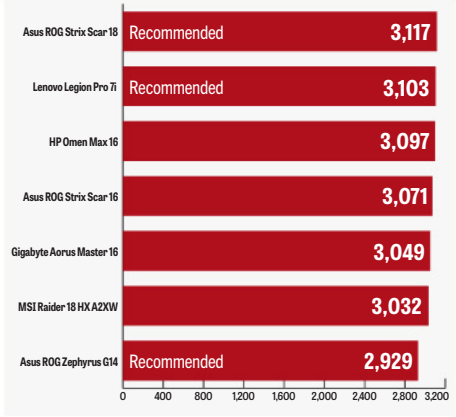
Black Myth: Wukong (1080p Cinematic DLSS off)



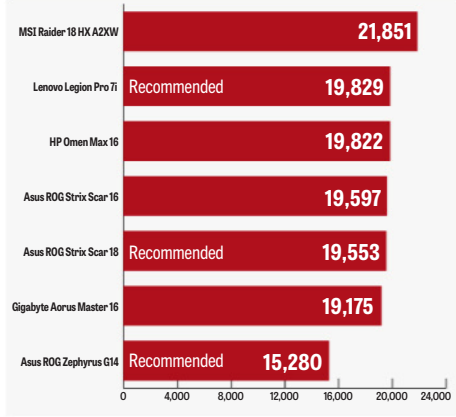
Shadow of the Tomb Raider (1080p Highest DLSS off)



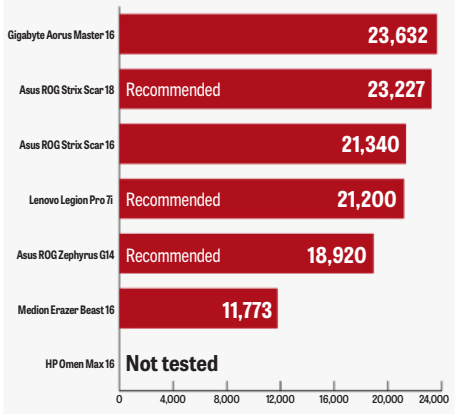
Geekbench 6 single-core



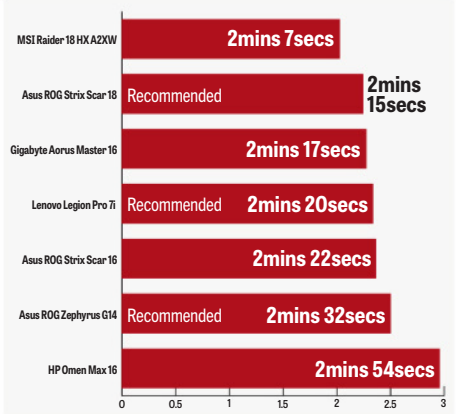
Geekbench 6 multicore



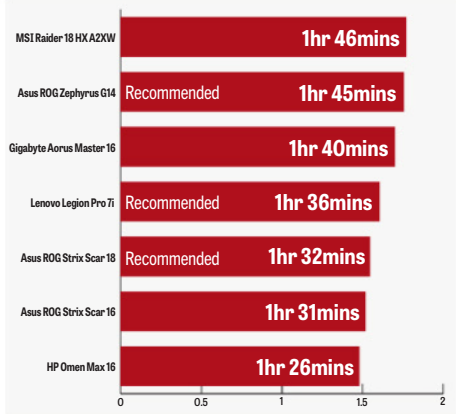
Geekbench AI (ONNX GPU quantized)



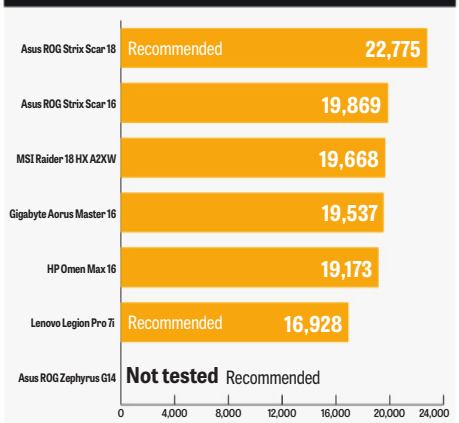
HandBrake



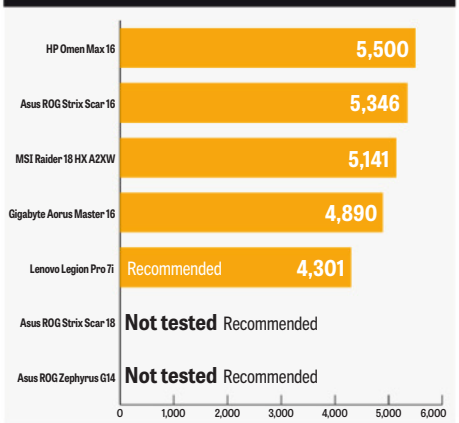
Battery life (PCMark gaming)



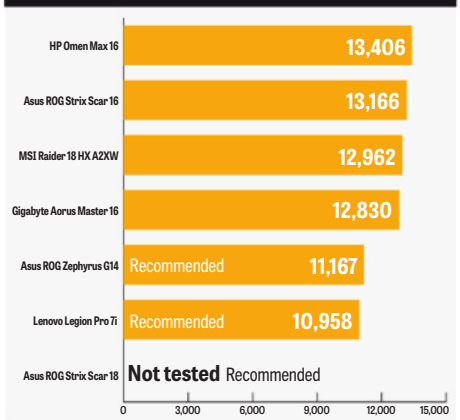
3DMark Time Spy



3DMark Speed Way



3DMark Port Royal





30th ANNIVERSARY

The inside story of Windows 95

On its 30th anniversary, we retrace the development and inside stories of the operating system that changed the world.

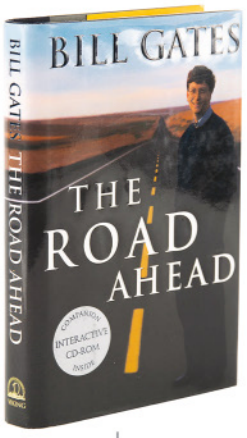
Contributors: Simon Bisson, Barry Collins, Lee Grant, Jon Honeyball

The Rolling Stones' "Start Me Up" blared across Microsoft's Redmond campus on the day Windows 95 was unveiled to the world. This was the big one. A landmark release on Microsoft's journey away from its DOS roots and into the 32-bit era. "Start me up and I'll never stop," shouted Mick Jagger, and so far that promise has held. Well, apart from the occasional blue screen of death.

It had been a long road to launch, twisting and turning away from its original vision with such vigour that even Mick must have looked on with admiration. But now it was here, bringing us the roots of the Windows user experience we still use 30 years later. Millions of copies were sold over the next few days, many to people who didn't even own PCs, with queues that reached around a thousand blocks. It even had a Special Edition release.

Windows 95 changed everything, not least the people who worked on its development, and the people whose careers depended on the PC. Here we look back on their stories, revealing insider tales of how Windows 95 was brought to market and the impact it had on the wider IT profession.

Crying out for change



RIGHT Bill Gates laid out his vision for computing in his 1995 book *The Road Ahead.*

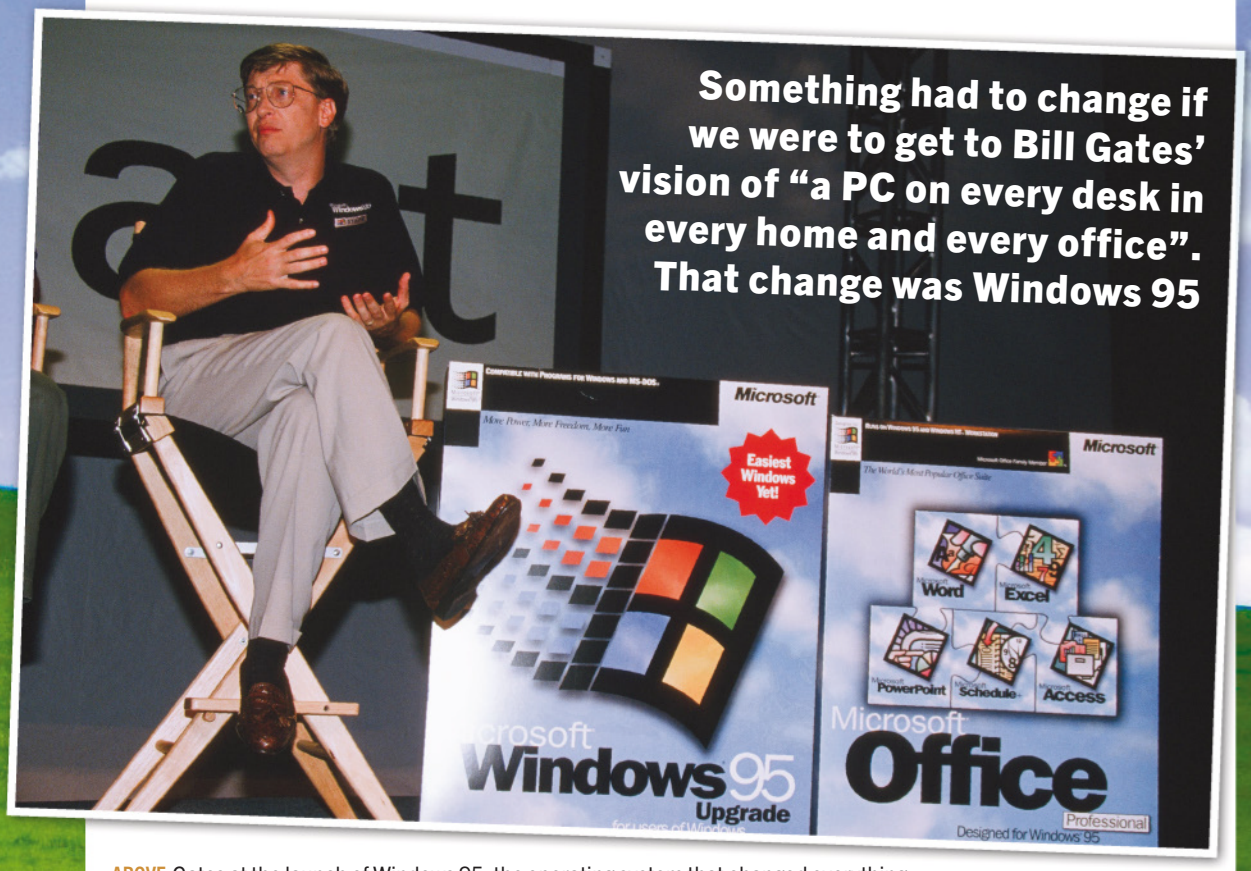
The PC hardware of the early 1990s was nothing like the embarrassment of riches we enjoy today, where even sub-$2,000 systems are over-specified for most people's needs. The 80286 processor's limitations meant that memory was segmented, and we were still hamstrung by the old DOS 640KB limit. Third-party tools gave us access to more memory, but they had to be configured for each application, along with setting interrupts for ISA cards for sound and networking. Even for mice. Launcher applications used batch files to configure DOS and Windows for each PC setup.

Something had to change if we were to get to Bill Gates' vision of "a PC on every desk in every home and every office". That change was Windows 95.

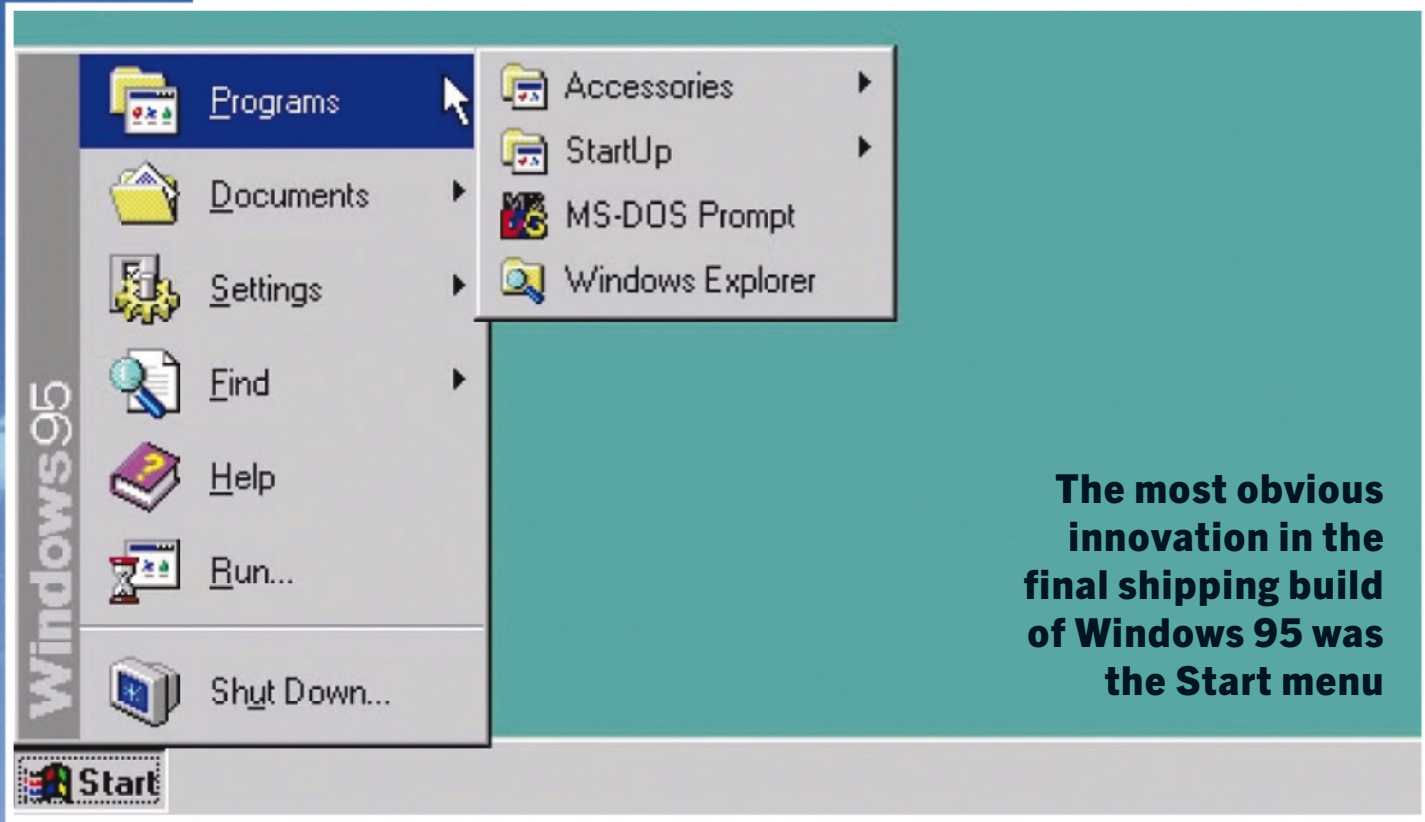
At the time Brad Silverberg was Microsoft's senior vice-president of what was the company's Personal Systems Division, running the project that would deliver Windows 95. Compared to today's Microsoft his team was tiny, but it delivered one of the company's most influential products. Silverberg has retired now, like many of his team, but when we recently spoke to him about Windows 95, he described the project as one with "lots of great memories".

Windows 3.1 had only just shipped when Microsoft began work on its successor. With Windows NT targeting the business market, the future was expected to be one with two different Windows releases: a consumer version carrying on the DOS heritage and a business OS building on NT. Codenamed Chicago and Cairo, the two new operating systems had a big vision of a connected home and work, one that was eventually captured in Bill Gates' 1995 book *The Road Ahead*.

The intention was to deliver an operating system



ABOVE Gates at the launch of Windows 95, the operating system that changed everything.



The most obvious innovation in the final shipping build of Windows 95 was the Start menu

that was ready for the next generation of Intel processors, the fifth-generation Pentium. This would require a jump from 16-bit to 32-bit architectures, while still supporting existing 16-bit software.

It would also be a network-ready OS, with support for the rapidly growing TCP/IP networking standard alongside Microsoft's own workgroup software. Other innovations included DirectX, which Silverberg described as bringing "the most demanding and best games to the PC". *Doom* 95 would go on to become the first published DirectX game. Can it run *Doom*? Yes, it can. Although, somewhat ironically given its name, not until August 1996.

Start of something big

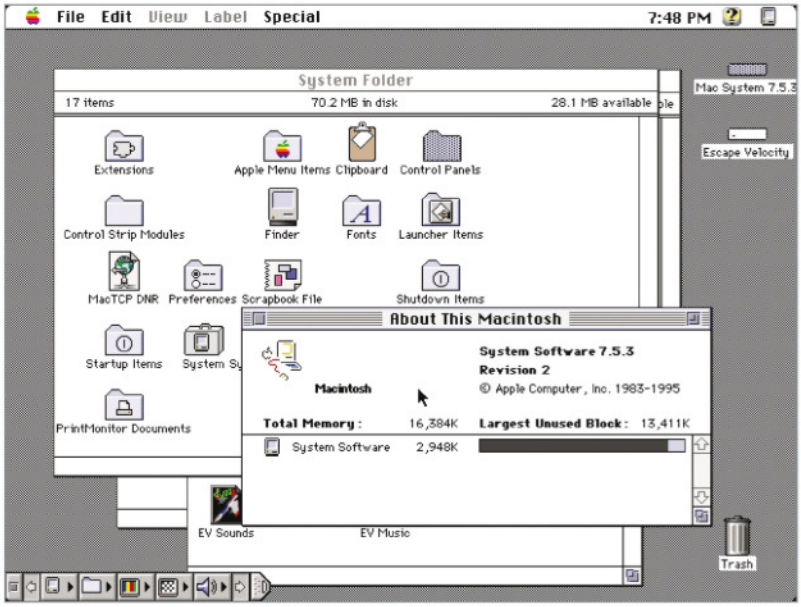
The most obvious innovation in the final shipping build of Windows 95 was the Start menu. Now a key element of the Windows user experience, Start was intended to avoid the Windows 3.1 problem of a crowded Program Manager, where it could be hard to find the applications and tools you wanted to use. With Windows 95's Start menu you could scroll through an alphabetical menu of applications, allowing you to quickly find what you wanted.

Early internal builds had both prototype Start menus alongside the then familiar Program Manager. Instead of one button, there were three, for system, search and help options. Those early builds were also only part of the way through the 16- to 32-bit transition, and many features were yet to be implemented. Looking back at those early builds it's possible to see that the evolution to Windows 95 was one that built on earlier Windows releases much more than the final release version showed.

By 1994 we started to see Microsoft dropping the Chicago codename in favour of Windows 95, and its final user interface starting to take shape. Delivering a fresh user experience was a key requirement for the new operating system. Windows 3.1 was tired, and it didn't compare well with Apple's Macintosh System 7. Microsoft set up a UI design team for Chicago late in 1992, early in Windows 95's development. It mixed designers, testers and programmers, with a development team dedicated to building out their designs.

The project had two conflicting design goals. It had to be easy for new users, but it also needed to support those who were already familiar with Windows. With these broad requirements, the team dropped Microsoft's traditional specification-driven process and opted for an iterative design approach, going from paper prototypes to code that was used in usability tests, both internal and with real-world users.

The system tray was an early part of the design, with user tests showing confusion with the early version of File



RIGHT Apple's Macintosh System 7 was far superior to Windows 3.1.

Explorer, the File Cabinet and the folder-based Program folder. The team went back to the drawing board and looked at how people really used Windows 3.1, which showed serious flaws with the way Windows worked. That entailed a complete rethink, one part of which was a separate shell for beginners. That idea didn't pan out, but quickly became the foundation of the Start menu, intended to be a home base for users of all skill levels.

Users also found it hard to manage windows, losing track of them quickly and wasting time clicking to find what they were doing. The early Taskbar quickly gained what the team called "plates" that showed open windows, adding the option to click to bring them to the front or even hide them. New file dialogs made it easier to open and save files, a design that's still with us in Windows 11. Other tools made it easier to work with that perennial problem, the printer.

One of the tools used to help manage the design process, detailed in a paper by team member Kent Sullivan, was a bug-tracking database that helped the team identify different classes of issue and helped them focus on solving specific problems. It's a technique still used inside Microsoft today.

Win32 for the masses

Operating systems are more than a UI. At the core is their kernel, which manages low-level functionality. On top of that are the APIs and SDKs that let Microsoft, and developers, build applications. Windows 95 was one of those points in Windows' history where everything changed, with the transition to a new generation of silicon, and the programming interfaces needed to work with it – interfaces we're still using today.

The legacy of Windows 95 lives on in the shape of the Win32 APIs it inherited from Windows NT. Although much evolved since Windows 95, they're still the foundation of much of Windows development. Not all of Windows 95 was 32-bit, though, with some elements built as 16-bit applications. It also offered a feature that allowed older 16-bit applications to run alongside 32-bit code, ensuring backwards compatibility with older Windows releases.

That compatibility came at a cost: an engineer was sent to a large computer shop in Seattle and bought a copy of every PC program on their shelves. All the engineers on the project were assigned two applications and had to make sure they worked with every build, filing bug reports. After Windows 95 shipped they were allowed to keep their adopted application, which left some engineers with quite unusual boxes in their offices.

The project did much to overturn the image Microsoft had at the time of delivering buggy, unstable code. Veteran Microsoft developer Raymond Chen tells the story of a Windows 95 developer who went to an Apple event wearing a project T-shirt and had a conversation with an Apple engineer who'd been looking at the beta code. "I have to commend you guys on Windows 95 so far," the engineer said. "It sucks less."

There was a lot of focus on the little things, such as Brian Eno's startup sound. In later interviews he compared it to a tiny jewel, and

The team went back to the drawing board and looked at how people really used Windows 3.1, which showed serious flaws with the way Windows worked

Windows 95's border issues



Former Microsoft vice president Laura Butler tells *APC* how a pixel almost broke Windows 95.

Few people realise just how many problems were caused by making the border around windows in Windows 95 one pixel bigger on each side to create a bevel effect.

We had system metrics, a way for apps to get and use the values of things such as colours, border sizes and so on at runtime. We had functions that would compute how big your window should be given a certain display area, if you wanted a title bar and menu bar and so on. We had functions to convert screen coordinates to window frame and window client coordinates. But did developers use them properly? Of course not!

Every which way developers could get it wrong, they did. We're talking developers at big famous software companies. They hard-coded "1" values for border size. They did crazy magical calculations, ending up with windows that were too big or too small and extended off screen. They had off-by-one errors with painting, and off-by-one errors with mouse interactions. They had divide-by-zero errors.

Apps crashed in every which way an app could crash. Even some services with invisible windows had problems. Best of all, app-crash-handling code often crashed too because it had never been tested before. Pizza Hut and Starbucks made a lot of money in 1994 and 1995 because of that blasted bevel.



LEFT Millions of copies of Windows 95 were snapped up by eager users.

noted that after composing it, a traditional three-minute track seemed like an ocean of time.

Clinging on to DOS

As much as Windows 95 tried to show that it was a system in its own right, like earlier Windows versions DOS was still there. As it boots, however, the underlying MS-DOS 7 system becomes less important, with Windows functions replacing most of its capabilities, relegating it to another compatibility layer, this time for DOS drivers. This approach caused Microsoft legal issues down the line, as it locked out third-party DOS systems which had been able to work with Windows 3.1.

Microsoft had shipped a 32-bit operating system in the shape of Windows NT, but that was a green-field site, with no real ambitions for backwards compatibility. Windows 95 was different, as it would allow your DOS programs and your Windows 3.1 applications to run alongside newer 32-bit Windows 95 applications. Windows was intended to be backwards compatible, and that would require plenty of work. It would also require a lot of hacks and shims to work around the inevitable issues.

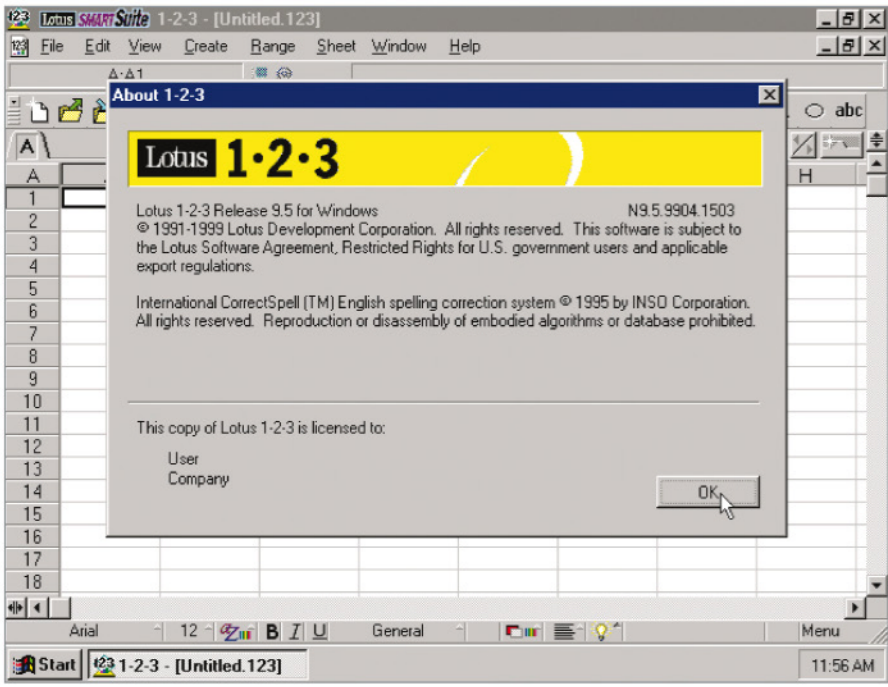
Windows NT had introduced a set of 32-bit APIs, in the shape of Win32. It's been a surprisingly long-lived set of technologies that have evolved with Windows editions, into the .NET world and outliving technologies that were expected to replace it, such as WinRT and the Universal Windows Platform. The early Win32 spun off a mostly forgotten extension to Windows 3.1, called Win32s. This allowed 32-bit applications to run in the 16-bit Windows environment, with a subset of the Win32 APIs (hence the "s" in its name).

Win32s introduced the concept of "thunking" to run inside the constraints of Windows 3.1, especially in its shared address space. This is a risky technique, as it makes it hard to manage memory and protect the operating system kernel. Badly written applications would crash Windows.

In Windows 95, 16-bit applications used the same technique, thunking into the larger 32-bit memory space. This had the side effect of making code safer, as it was much harder for memory allocations to collide. There also needed to be a lot of hand-coded shims that took the idiosyncrasies of



BELOW Gates' plans for an object file system in Win95 failed to materialise.



ABOVE Windows 95 was designed to be backwards compatible, so that classic DOS programs such as Lotus 1-2-3 still worked.

The time zone snafu that sunk Poland

Speaking on the Dave's Garage YouTube channel, Microsoft veteran Raymond Chen recalled an awkward problem with the Windows 95 clock.



Image: Microsoft/Raymond Chen

Windows 95 introduced the time zone map. Instead of selecting your time zone from a drop-down menu or some such, you clicked on a map to identify your current location. "Everybody thought that was a lot of fun," said Chen. "Until geopolitics entered the picture."

Microsoft used official UN-recognised maps to determine boundaries, Chen said, but not every country recognises those maps and there were all sorts of border disputes around the world. "A small European country would contact us and say 'our country's kinda small, can you give us one of our neighbour's pixels to make it easier to click on, because our citizens are having difficulty clicking on that thing because we have to hit a really tiny target," Chen recalled. Of course, that would prompt the shrunken country to get in touch, saying "hey, why did you give our pixels to our neighbour? If you look at the map, that pixel belongs to us!"

Microsoft eventually decided to ditch drawing borders between countries. But that introduced a very unfortunate bug that basically eradicated Poland. Microsoft had ditched a colour-coding scheme to highlight countries in a particular time zone, fading out any country not in that zone. But when Poland's time zone was changed in the 1990s, the colour coding wasn't updated properly, meaning on the world map "there was ocean where Poland was meant to be".

"I forget exactly when we finally fixed it," said Chen. "But there was a period of time where if you went to the time zone map, instead of Poland you saw what we called the Great Polish Sea."

One of Brad Silverberg's goals was to make it "easy for users to add new devices to their PCs"

DOS and early Windows code and handled OS calls, redirecting them to new features and functions. The resulting legacy of backwards compatibility has remained to this day, with Windows still shimming old code – and with classic DOS programs such as Lotus 1-2-3 still running.

Bringing Win32 to consumer Windows was a big move. Not only did it set the wheels in motion for the Windows XP-era merger with Windows NT, it began to reduce the risk of memory being used by more than one program, introducing protected memory allocations that could be any size. No longer was memory allocated in 64KB segments, and an error in one program was unlikely to affect other code – unless it was running in one of the shared memory spaces that were still needed for compatibility.

Having a common API for Windows 95 and Windows NT meant that programs written for one should run on the other, though there were issues with Windows 95 thunking back down into 16-bit sections of the kernel that hadn't been rewritten as 32-bit code. A complete rewrite would have to wait until Windows XP, as it was considered too big a task to complete in one go.

As much as we like to think of Windows 95 as an elegant new operating system, it was really a loosely connected set of features that happened to work, with much more of Windows 3.1 and DOS under the hood than we remember. One example of just how loosely connected Windows 95 was? Its installer, which was built around three different operating systems: first a version of DOS, then a minimal version of Windows 3.1, and finally Windows 95 itself. This actually made sense, as it addressed the various installation scenarios: installing on a fresh system, or upgrading from Windows 3.1 or an earlier Windows 95 release.

Another change was support for what came to be known as "plug and play" hardware, where the PC BIOS set up resources at boot, managing address, interrupts and direct memory access. One of Brad Silverberg's goals was to make it "easy for users to add new devices to their PCs".

As part of Windows 95's development, Microsoft delivered a set of standards that were intended to allow new hardware to work without tedious manual configuration, though in the early days incompatible older hardware led to conflicts and the nickname "plug and pray" when things inevitably failed to work. It would take time for the hardware industry to deliver on this promise, but once it did, we quickly forgot how awkward working with hardware used to be.

The big omission

Not everything that was planned for Microsoft's mid-90s operating systems made it out the lab. The most obvious was the most ambitious, the object file system.



LEFT "Plug and play" support made it easier to connect hardware.

How we tested Windows 95



Jon Honeyball fondly recalls testing early builds of Windows 95.

Back in the 1990s, testing operating systems when they were in beta release was fun. The fun wasn't the crashes, the reinstalls or the piles of 3.5in floppy disks you had to pump into your computer. It was seeing the rapid rate of change on every new build. We were watching evolution in action.

In the mid-1990s, Windows NT was carving out its high-end powerhouse niche. But the requirements were still too high for many mainstream customers, who wanted to move on from the relatively lightweight Windows 3.x. Hence Windows 95 was born, as a stepping stone that would eventually lead to the merging into Windows XP of both the NT and 9X worlds.

Beta testing for Windows 95 was on a CompuServe group, and even the most senior members of the team were present, keeping a watchful eye over the bug reports. I made friends with them, and regularly chatted to Brad Silverberg, the head of the Windows 95 team. My most memorable bug was finding that the Windows Calculator app couldn't do sums properly: 2.11-2.01 = 0.00 was a particular clanger.

But back then life was simpler, the beta testing groups were smaller, and it felt worthwhile to make the effort. After all, only a few years previously we were still using Windows 2.x, and that was extremely primitive by comparison with 95.

Today, it's almost stagnation, beta testing isn't really serious any more, and there's no sense of being in a team. So I remember Windows 95 very fondly indeed. Not so much for the product itself – I was a fervent Windows NT flag waver. But for what it meant at a critical time in the evolution of the PC. Maybe I could find such fun in the open-source Linux world today, but I highly doubt it. Nobody seems to be doing radical OS and user experience work any more. Except for Apple's Vision Pro, of course.



RIGHT The Preview Program made the beta version of the OS available to all.



ABOVE Punters queued for hours to get hold of Windows 95.

There was no practical means of delivering downloadable software in those days, so the Preview Program came as a stack of floppy disks

Bill Gates' big vision for the Cairo and Chicago projects was the object file system. Fascinated by the then new concept of object-oriented computing, he envisioned treating files as objects, making them easier both to search and to use in your applications. Aspects of the object file system appeared in Office's OLE tools, but the system was never to ship. Prototypes proved too unwieldy and too slow, and used too much memory and disk space, even for the new hardware Microsoft was expecting to arrive alongside Chicago.

The object file system never appeared in any public builds of Chicago and ended up as part of the business-focused Cairo concept (which would end up being cancelled, and shipping as parts of the Windows NT 4.0 release).

Object file systems have remained an unattainable part of the Windows vision, reappearing as WinFS as part of the abortive Longhorn project. Microsoft's ambition of delivering an object file system never went away, despite high-profile failures, and they're still being experimented with: the semantic search that underlies the Recall tool designed for Copilot+ PCs owes much to the metadata models in the object file system and WinFS, though now built by AI rather than humans.

Testing times

Once Microsoft had nailed down what was going to ship with Windows 95, it made the surprising decision to offer users a public beta release, called the Windows 95 Preview Program. There was no practical means of delivering downloadable software in those days, so this came as a stack of floppy disks that could be used to install a clean version or upgrade from an existing Windows 3.1 install. This was a paid program, with a subscription costing $19.95. The preview version was designed to time out in November 1995, by when the final version would be widely available.

It wasn't anything like today's Windows Insider program. For one thing there was no online bug reporting, though you could report issues through the included trial of the Microsoft Network (more on which below). Looking back, the Preview Program wasn't really what we now think of as a beta. The code was almost finished and relatively bug free. It was more of a marketing tool, to get people excited about what was a very big change, and to get them ready to move away from the still quite capable Windows 3.1. It certainly worked, with the launch resulting in queues at computer stores around the world.

There was still one big thing missing in that first launch: the internet. Yes, Windows 95 had support for workgroup office networking out of the box, and you could bundle together a mix of free software and shareware to put your PC online, but Microsoft wanted you in its own walled garden. It had seen how successful AOL and CompuServe were, offering subscriptions to their online services, full of content. That's why it had been working on a project codenamed Blackbird, an online service of its own. Like AOL, the new Microsoft Network was a subscription service – but it was one that turned out to be very short lived, as an explosion of ISPs changed the way we went online.

Put that in your 3D pipes

Writing on Microsoft's The Old New Thing blog, company veteran Raymond Chen recalls a screensaver complaint.



Although not built specifically for Windows 95, the 3D pipes screensaver will be fondly remembered by users of the operating system. Well, not so fondly by some, it seems.

"A customer complained that they were losing productivity because employees were spending too much time running the 3D Pipes screensaver and waiting for teapots to appear," wrote Chen. "They requested an option to increase the likelihood of a teapot, so the employees would be placated more quickly and get back to their work."

Teapots were an Easter Egg in the screensaver, appearing in the join of pipes in tribute to the Utah teapot, a standard reference object in the computer graphics industry.

"I can't find any evidence that this feature request was accepted," wrote Chen. And, "despite rumours to the contrary, the rate of teapot appearance does not improve the longer you leave the screensaver running". Get back to work, slackers.

Microsoft was going to have to quickly launch add-ons, in the shape of "Plus!" packs, that brought its own browser and dial-up tools to Windows 95. The combined browser and dialler in Plus were called the Internet Jumpstart Kit, with a browser based on Spyglass Mosaic, Internet Explorer 1.0. It would be the only Microsoft browser that wasn't bundled with an operating system release, as Internet Explorer 2 came as part of the OSR 1 refresh. The initial deal with Spyglass resulted in legal action; Microsoft avoided paying royalties for the use of the browser by making it a "free" component, though it ended up paying more than $8 million in a settlement.

The first releases of Internet Explorer were basic, just enough to make sure that Microsoft had skin in the game. But it was the later release of Internet Explorer 3 that made the difference, giving Windows 95 the online market share Microsoft craved.

Hacked together miracle

Looking back at Windows 95, it's clear how hacky its development really was. Beneath that shiny, customisable user experience, the transition to 32-bit operation was not a smooth one, nor was the introduction of a whole new way to work with PC hardware. Windows 95 had to do a lot of heavy lifting with very few resources.

There's one other aspect of the project that made it influential, one that we tend not to think about 30 years on. It's the part Brad Silverberg is perhaps most proud of. "It was built as a worldwide product from the start and dramatically expanded the universe of people who used PCs," he said.

He passed on a quote he found on LinkedIn from someone who was a child in India in the 1990s (and who went on to work for Microsoft). "Windows 95 was my first introduction to the magic of PC computing. I loved everything about it. As a kid in India it really helped bring the internet to me."

It wasn't only kids who were getting their first taste of computing via Windows 95, but elders, too. "It meant my mom could finally be able to use a PC – to play bridge online, read the news, stay in touch with family and friends," said Silverberg.

That universal appeal made it an operating system like no other before it, and its influence is still felt today, from the way software manages hardware, to how we build and use software, to the magazine you're holding in your hands. That's quite the legacy, and one its relatively small team of developers and designers can still be proud of.

And that launch Special Edition we mentioned at the top? It was the same version that we all used, but with different printing on the box. ■

Windows 95: The repairer's perspective



Lee Grant reflects on a back-breaking era for PC repairers.

Windows 95 was peak "beige box" era in PC land. Our repair shop floor was stacked with a myriad of bland towers which, because of their thick steel chassis, weighed the same as a small family hatchback. One frequent visitor to our shop had casters and required two people to lift it. Laptops weren't much better but were rarely seen.

Building Windows 95 desktops presented physical complexities: 40-pin IDE drives used 40mm wide cables and, although they could be rolled, they remained unwieldy. If a customer wanted twin opticals, dual hard disks, a ZIP and floppy, it wasn't the work of a moment to connect everything together. Plus, that rat's nest of data and power lines provided airflow problems in an era before case manufacturers considered cable management.

And that was just the start. Even a fundamental task such as installing a CPU required the correct alignment of jumpers to ensure the front side bus was up to speed. Getting drivers into a Win95 machine wasn't simple as floppy disks were usually corrupt and USB support was flakey. Many manufacturers didn't have websites, so driver repositories such as driver-downloads.com were vital in preventing most 95 users from staring at a 640 x 480, 256-colour output.

Windows 95 had two neat tricks to aid repair. Step-by-step confirmation could be invoked via F8 during boot. From this, each line of MSDOS.SYS and AUTOEXEC.BAT could be loaded or ignored to help find faults. Mashing F5 during the boot sequence would also start the machine in Safe Mode, a much simpler method than exists today.

Some Windows 95 fixes were beautifully simplistic. To repair a machine that wouldn't boot, I inserted an MS-DOS system disk to start the machine and typed SYS C:. This DOS command copied IO.SYS, MSDOS.SYS and COMMAND.COM from the floppy to the C: root, allowing the machine to start.

Windows 95 lacked the polished user-friendliness of its successors, but it didn't give a stuff about what you did to it. I remember using Windows 95 for the first time and enjoying the improvement over Windows 3.1. Later, I thought the same when Windows 98 arrived to take Microsoft's vision further. The one thing I missed was the eight orange words on shutdown: "It's now safe to turn off your computer."



LEFT Windows 95 helped to open up computing for the masses.

WINDOWS 11

The 18 things it does much better than Windows 10

With support for Windows 10 ending soon, it's time you became a Windows 11 expert. Daniel Booth reveals the best new features you must use.

If you listened carefully during March you might just have heard the sighs of relief coming from Microsoft's Seattle headquarters. Windows 11's global market share jumped from 38.13 to 42.69 per cent (tinyurl.com/APC547winshare), while Windows 10 fell from 58.7 to 54.2 per cent. It was one of Windows 11's best ever months. At that rate it'll overtake Windows 10 by the time you read this. It's already more popular in some countries, including Australia (tinyurl.com/PC547winau).

There will still be hundreds of millions of computers running Windows 10 when Microsoft axes support in October. That'll prove to be a major headache for the company. But there's significant momentum behind Windows 11 now, and it's well deserved. Despite an underwhelming launch in 2021 and several flawed updates since, it has grown into a brilliant operating system.

In this feature we've picked the 18 most impressive things it does better than Windows 10. We've focused on tasks you can actually do, rather than system improvements under the bonnet (you can take it as a given that it's faster, smoother and more secure). These are features you'll use often, not background processes you'll barely notice.

We've left out Copilot tips. While its new tools show promise (see page 8), we're still not convinced it's anything more than a glorified Clippy. And too many Copilot features require an expensive Copilot+ computer see (tinyurl.com/APC547copilot).

You don't need one of those to use the many excellent new features in Snipping Tool, File Explorer, Narrator and more – but you will benefit from having the 24H2 update, which isn't the buggy mess it was a few months ago.

Follow our advice and you'll soon be mastering every aspect of Windows 11.

WHAT YOU CAN DO

- Turn on advanced settings to squeeze maximum speed out of your computer
- Master all of File Explorer's new tools, including tabs and unzipping new formats
- Add captions to any video playing live, whether from your PC or online
- Listen to more human-sounding voices in Narrator
- Record specific areas of your screen using Snipping Tool
- Use new AI tools to erase unwanted images in the Paint app
- Set the 'Volume mixer' to play app audio through different device

MAKE YOUR PC RUN FASTER

1 Turn on Best Performance in power settings

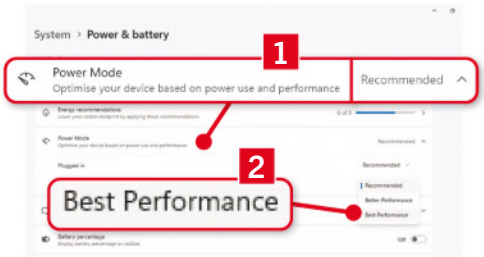
If you need to squeeze extra speed out of your Windows 10 computer, you can turn on High Performance in Control Panel's Power Options. This provides a small boost, but holds back a bit of power to save energy.

Windows 11's Best Performance mode is more aggressive, prioritising speed over power efficiency. This pushes your processor and graphics closer to the max, making games load faster and photo or video edits finish sooner – sometimes cutting seconds off certain tasks.

It's been part of Windows 11 since launch, but the 22H2 update (released September 2022) made it more effective when working with newer processors and graphics cards.

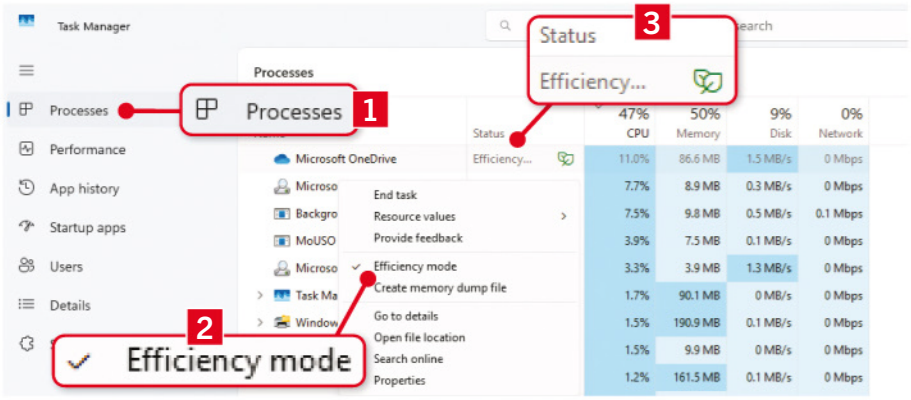
To turn it on, open Settings (press Windows key+I), then click System followed by 'Power & battery'. Now click the Power Mode dropdown menu and change Recommended (1 in our screenshot below) to 'Best Performance' 2.

You can do this for either or both of the 'Plugged in' and 'On battery' options. The former is for when your computer is plugged in and you want maximum speed (there's no downside to this because power consumption isn't a concern when plugged in). The latter is when your computer isn't plugged in, so needs to be used more carefully because it drains your battery much faster.



Choose 'Best Performance' in the Power Mode dropdown menu to squeeze out every bit of PC speed.

Running your computer at full pelt has trade-offs. Your laptop will use more electricity when plugged in, nudging up your bill slightly if used a lot. If not plugged in, it'll drain the battery faster. Your computer will also give off more heat, and become noisier as the fans kick in to keep it cool. But it's an essential mode for short tasks when speed is the priority, such as exporting 4K video or working on huge spreadsheets.



To make your PC run faster, switch resource-hungry apps and processes to Efficiency Mode in Task Manager, and confirm the change in the Status column.

2 Make your apps run more efficiently

Another way to make your computer run faster is to reduce how much power your processor devotes to programs or Windows processes you're not currently using. Windows 11 22H2 made this easier by introducing an Efficiency Mode.

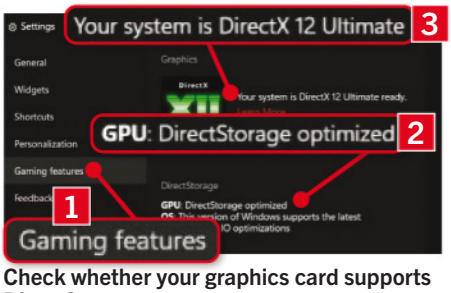
Search for and open Task Manager (or press Ctrl+Shift+Esc), then click the Processes tab (1 in our screenshot above). Now click the CPU tab and the column will show which apps and processes are using the most processor resources – from most to least. If an app you don't need to use is devouring a lot of processor power, right-click it and select 'Efficiency mode' 2. This will be confirmed in the Status column 3.

However, if the column is updating too quickly to click the correct app, click Details on the left, then right-click the app and turn on the mode there.

This mode is particularly useful for apps or processes that you need to access regularly but not continuously – say once or twice a day. Think of apps like Dropbox or OneDrive that sync in the background, and email tools like Outlook and Thunderbird that check for new emails.

Note however that Windows greys out the Efficiency Mode option for apps and processes it deems to be critical, or for those that have their own power-saving settings like Chrome. Also, the mode stays enabled only for your current session, so you'll need to set it again when you next reboot.

The closest Windows 10 gets to this is Control Panel's Power Options, but these apply only across your whole computer, not specific programs.



Check whether your graphics card supports DirectStorage.

3 Make games load faster

DirectStorage is a Windows tool that makes games load faster, by speeding up how quickly data can move between NVMe SSDs and Direct X12 graphics cards. This is reasonably fast in Windows 10, but it's supersonic in 11 because it can work with newer SSDs.

It's turned on by default, so you should check whether your computer has the correct SSD and graphics card to take advantage. Press Windows key+G to open Windows Game Bar, then click the Settings cog icon at the top. Now click 'Gaming features' on the left (1 in our screenshot above) and check whether it shows 'DirectStorage optimized/supported' to the right of GPU 2. Also check whether your computer supports Direct X12 Ultimate 3, which is the latest version. If so, DirectStorage will work even faster.

For extra confirmation, check your SSD is NVMe by opening Task Manager, then clicking Performance and looking under the Disc heading just to the right. If it says 'SSD (NVMe)' then you're in luck.

DirectStorage is still an emerging and complex technology so only a handful of games support it at the moment, including *Forspoken*, *Ratchet & Clank: Rift Apart*, *Forza Motorsport* and *Horizon Forbidden West*. Many more are likely to adopt it in future though.

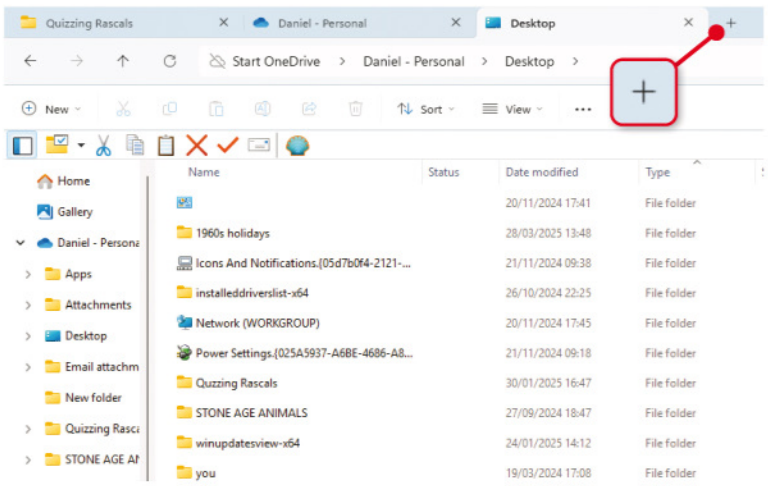
HACK FILE EXPLORER TO MAKE IT BETTER

4 Open folders in tabs

None of Windows' key tools has improved as much as File Explorer. The best feature – unique to Windows 11 – is tabbed browsing, which lets you open multiple folders in a single window, just as you would with browser tabs.

Open File Explorer and click the plus (+) button next to the current tab (see screenshot right). You can also press Ctrl+T, while Ctrl+Tab switches between tabs. To move a file between folders, drag it to the appropriate tab at the top.

If you want to use Explorer tabs in Windows 10, you'll need to install a separate program such as Files (files.community) or QTTabBar (sourceforge.net/projects/qttabbar), both of which are free. Without them, you'd have to open a separate window for each folder, cluttering your screen.



Click the plus (+) button in File Explorer to open a new tab.

5 Extract RAR, 7z and TAR files

Another improvement that cuts the need for third-party software is File Explorer's support for file-compression formats RAR, 7z and TAR, which Microsoft added as part of last autumn's 24H2 update. Previously – and still on Windows 10 – you'd have to install programs such as WinRAR (www.win-rar.com) and 7-Zip (www.7-zip.org).

Right-click a file in File Explorer then select 'Compress to' (1 in our screenshot below left) to see a choice of formats 2. Clicking 'Additional options' 3 brings up advanced settings, the most useful of which is a 'Compression level' slider that lets you balance speed of compression with file size. Move it to the left for faster compression but larger files, and to the right for slower compression but smaller files.

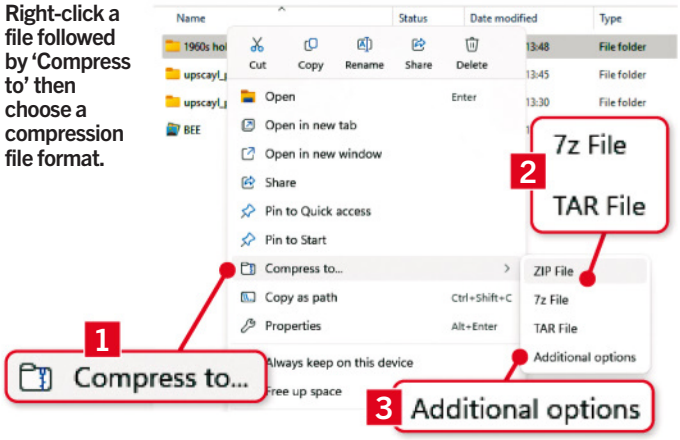
Unzipping files in Windows 11 will soon be faster too, following a recent speed tweak in Preview Build 27818 for Windows Insiders on the Canary Channel. Microsoft said that in particular "unzipping a large number of small files" will be a lot quicker (see tinyurl.com/APC547unzip).

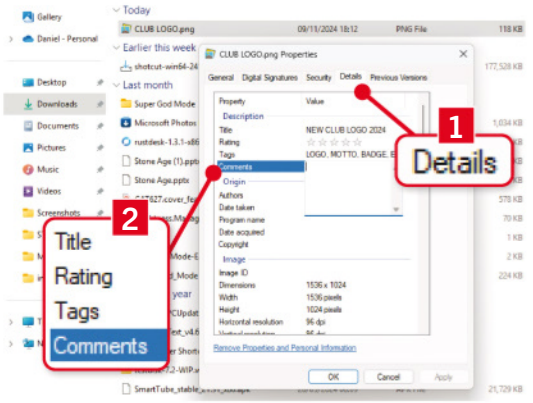
6 Edit metadata in PNG files

Also new in 24H2 is the ability to edit the metadata of PNG files – an image format used for graphics, logos, charts and illustrations. Right-click a PNG file then select Properties followed by the Details tab (1 in our screenshot below).

Now click the space to the right of each heading, such as Title, Rating, Tags and Comments 2 and add the relevant data. Click OK to save. You can use this new metadata to search for PNGs on your PC. For example, you could tag a PNG of a chart with '2025 Expenses' and search for that to find it easily. To edit PNG files in Windows 10, use third-party software, such as ExifTool (https://exiftool.org).

Right-click a file followed by 'Compress to' then choose a compression file format.





Edit PNG metadata in Windows 11, including Title, Rating, Tags and Comments.

MASTER NEW ACCESSIBILITY TOOLS

7 Control your computer using Voice Access

Windows 10's Speech Recognition isn't bad, but it's hardly the comprehensive voice-controlled system many people need.

Windows 11's Voice Access takes it to a different level with more advanced spoken commands and improved features.

To use it, press Windows key+Ctrl+S. You can also open Settings then click Accessibility followed by Speech under the Interaction heading, then move the 'Voice access' slider at the top. In Settings you can also decide whether to make 'Voice access' start before or after you sign into your PC. You'll find a full list of commands at tinyurl.com/APC547say, or by asking "What can I say?".

When it starts you need to say 'voice access wake up' or press the microphone button at the top left (1 in our screenshot above right). If it's working you'll see 'Listening' at the top left 2, which then



Control your computer with spoken commands by turning on 'Voice access'.

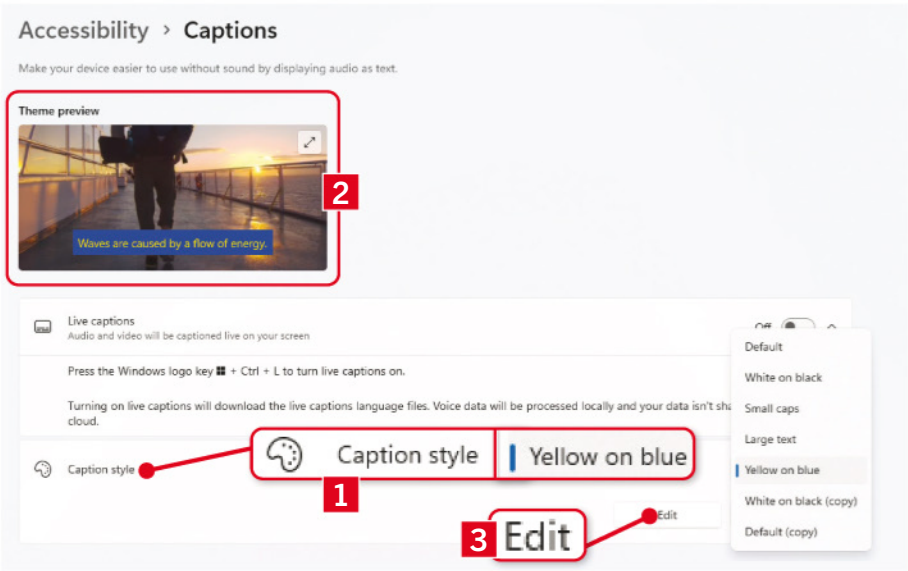
changes to whatever it has heard you say. Microsoft added more "natural sounding" commands in the 24H2 update (for example, "open my music" rather than simply "open music"). It also improved automatic punctuation, which you can turn on by clicking the top-right cog icon and selecting 'Manage options' 3.

Also new in 24H2 are voice shortcuts, letting you create your own commands for tasks you perform often. Microsoft provides full instructions at tinyurl.com/APC547talk.

8 Add live captions to any video

Windows 10 doesn't have system-wide captions. Instead you have to rely on settings within specific software. The 22H2 update for Windows 11 brought captions to any video you're playing, whether downloaded to your desktop or online (on YouTube, for example). It works in real time, so will provide captions for live broadcasts (perfect for sports and news). It also captions anything captured by your microphone, so works during online video chats.

Turn on captions by pressing Windows key+Ctrl+L, or by opening Settings then clicking Accessibility followed by Captions and turning on the slider. You'll need to click 'Yes, continue' at the top to confirm, then select 'English (United Kingdom)'.



You can change the caption style so it uses different fonts, colours and sizes.

The default caption style is white words on a black background written in the Segoe UI font. You can change this to yellow on blue in the Captions section of Settings by clicking the dropdown menu to the right of 'Caption style' (1 in our screenshot above). You can also make the text larger, though only in white on black. You can see what each change looks like by clicking the 'Theme preview' box above 2. If none of Microsoft's options suit you, click Edit 3 and use the colour, opacity, size, font and effects menus to create your own style.

Once that's done, give the caption style a name. It will be added to the 'Caption style' menu on the previous page, ready for you to select. When a video is playing click the top-right cog, then Position to move the captions above your screen, below it, or within a moveable floating box.

9 Listen to more human-sounding screen readers

Ryan and Sonia are waiting to be downloaded in Windows 11. They're two 'Natural' voices Microsoft added to Narrator in 2023, and while still artificial they sound much more realistic than their robotic predecessors in Windows 10. They both have English accents, but you can choose Natural US voices if you prefer.

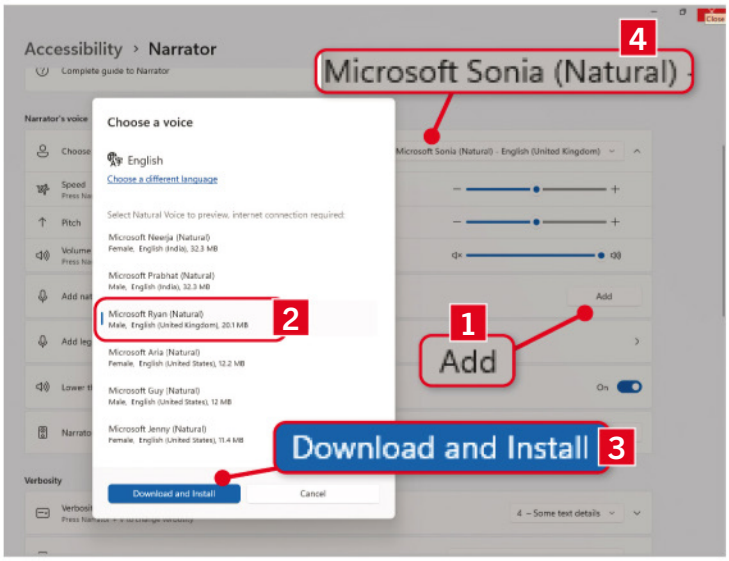
Open Settings then click Accessibility followed by Narrator on the right, in the Vision section. Click the 'Add' button to the right of 'Add natural voices' (1 in our screenshot below left), then select a voice to hear it 2. If you like it, click 'Download and Install' 3. It will appear as an option in the 'Choose a voice' dropdown menu 4.

Also, last year, Microsoft added more keyboard shortcuts, including Narrator key+Ctrl+X to copy the last phrase spoken, letting you paste it as normal using Ctrl+V. Press Narrator key+Shift+B and Narrator will announce if your laptop is plugged in for charging, followed by battery status, network name and network status. Incidentally, the Narrator key is either Caps Lock or Insert.

Microsoft also added new shortcuts to Scan Mode, which lets you skip through content using arrow keys and specific shortcuts: press L to go to lists on the page, and N to bypass a block of links. These are helpful when you're trying to get to the main content on a web page. You can turn on Scan Mode by pressing the Narrator key+spacebar.

Visit tinyurl.com/APC547scan to compare all shortcuts and touchscreen gestures between Windows 10 and 11.

Choose more human-sounding Narrator voices in Windows 11.



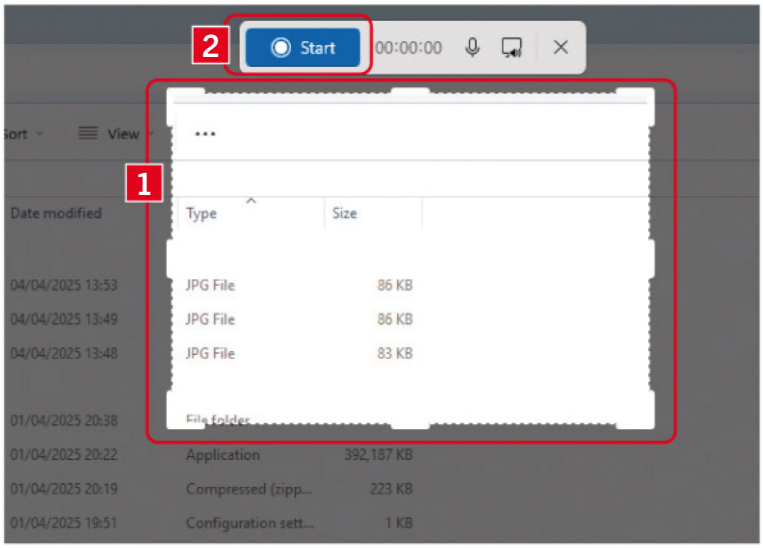
MASTER NEW & IMPROVED APPS

10 Record parts of your screen with Snipping Tool

Microsoft has revamped Snipping Tool in Windows 11 as a screen-recording app, with the extra benefit of capturing just areas of your screen rather than the whole thing. Screen-recording in Windows 10 remains limited to full-screen captures in Game Bar (press Windows key+G), and it doesn't work on your desktop or in File Explorer.

Open Snipping Tool in Windows 11 by pressing Windows key+Shift+S. Now click the Record icon and move the plus-sign cursor to mark the area you want to record (1 in our screenshot). Press the blue Start button 2 then the red 'Stop recording' button to finish. It'll be saved as an MP4.

Click the 'Microphone' icon to record your voice as you capture your screen. To turn on the mic by default for every screen recording, search for and open the Snipping Tool, then click the top-right menu (three horizontal dots) followed by Settings. Scroll down and turn on 'Include microphone input by default when a screen recording starts'.



Select the area to record, then press the blue Start button.

Here, you'll also find settings for automatically saving your screen recordings and changing where they are saved. Look out soon for the 'trim' feature – see box opposite for more about that and what else is coming.

11 Add coloured borders to your screenshots

The latest version of Sticky Notes, released last summer, lets you paste screenshots straight into a note. By default it adds a light-blue border to the screenshot, but you can change this if it's not what you want.



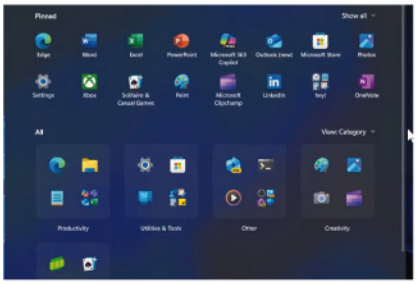
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WHAT'S COMING SOON TO WINDOWS 11

Taskbar icons will automatically get smaller to keep more apps visible and clickable without you having to open another menu: tinyurl.com/APC547menu.

Larger Start menu with everything on a single scrollable page (see screenshot below). The 'All apps' list is below Recommendations, which you can disable: tinyurl.com/APC547start.



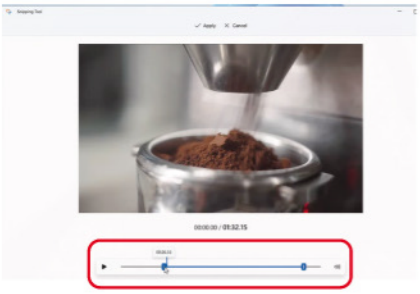
A new 'drag tray' will appear at the top of your screen when you drag a file from File Explorer or your desktop, letting you drop it into one of the programs shown: tinyurl.com/APC547drag.

Narrator is getting a 'Speech recap' tool that shows a history of things it has said recently, triggered by the keyboard shortcut Narrator key+Alt+X: /tinyurl.com/APC547narrator.

The 'Windows share' window will let you crop, rotate and compress images, as well as apply filters, before you share them: tinyurl.com/APC547share.

A new 'Frequently Asked Questions' (FAQ) section in Settings will show "answers to common questions about your PC and Windows 11". It'll be on the System, About page: tinyurl.com/APC547share.

Snipping Tool is getting a 'trim' feature for adjusting the start and end times of your recordings to remove any "unnecessary video snippets" (see screenshot below): tinyurl.com/APC547snip.



Launch the Sticky Notes app then click 'Screenshot' (1 in our screenshot below) and the page you're currently on will appear in the app. Now click the three dots 2 and pick one of the colours that appears 3. You can keep clicking until you've found a colour you like. Above the screenshot you'll see details of where it comes from. If it's from a browser, you'll see its icon – Chrome in our example 4; if it's from Windows you'll see the relevant icon – as in the Settings cog here 5. There are also options for copying the note and deleting it.

This new-look Sticky Notes is actually part of OneNote. To open it for the first time, search for and open OneNote (or install it from the Microsoft Store if you need to) then sign into your Microsoft account. Now click Sticky Notes at the top right of OneNote's toolbar. You only need to do this once because afterwards it'll be available from the Start menu and Taskbar (where you can pin it as usual).

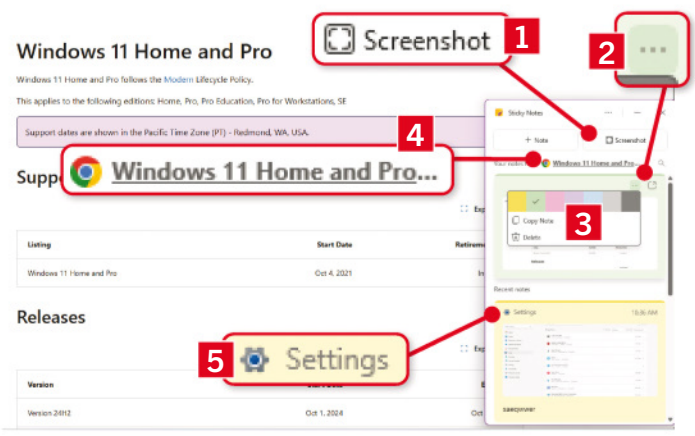
12 Use AI to erase elements from Paint app

Microsoft's big AI bet is Copilot, but more useful are the new tools in its revamped Paint app. The first to arrive was 'Generative erase', now available to everyone, which removes unwanted images by guessing what should be behind an object based on the background.

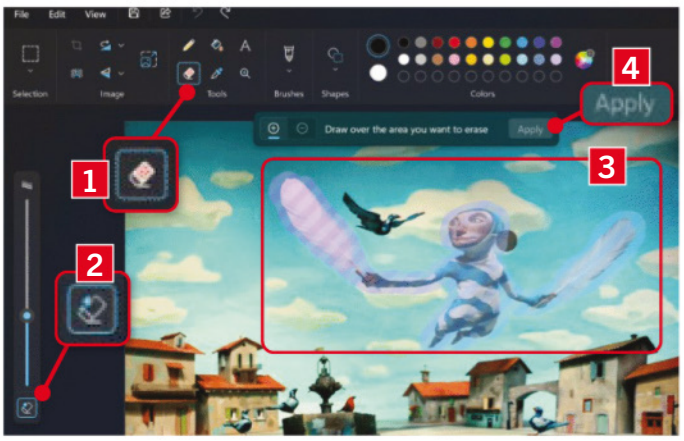
Add an image to Paint, then click the Eraser icon at the top (1 in our screenshot below right), followed by the 'Generative erase' icon below the vertical slider on the left 2. Use your mouse to move the brush over what you want to remove 3. When you've selected what needs removing, click Apply 4 and you'll see a box appear over that area. After a few seconds it will show you the resulting effect.

Microsoft is also working on 'Generative fill', which lets you edit images with typed commands. It's currently available only on Copilot+ computers running a Snapdragon processor, but will hopefully come to more machines soon (see box above for more Windows 11 features in the pipeline).

Don't forget that 'Generative erase' also works in the Photos app, both in Windows 11 and 10. Open a photo, then click Edit top left, followed by the Background icon. Now choose Blur, Remove or Replace.



Add coloured borders to screenshots in the latest version of Sticky Notes.



Use Paint's 'Generative Erase' to remove unwanted background items.

IMPROVE YOUR AUDIO & VIDEO

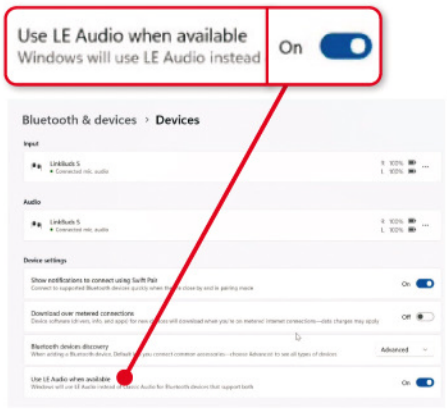
13 Improve Bluetooth audio quality

Bluetooth 5.2, released in early 2020, contains LE Audio technology, which improves sound quality when streaming to earbuds and hearing aids. It uses less power too, making those devices last longer between charges.

Windows 11 added support for Bluetooth LE Audio in 2023, and enhanced this in last year's 24H2 update to include compatible hearing aids. But your computer needs a Bluetooth 5.2 (or later) adapter that supports LE Audio. These are usually provided by the manufacturer of your Bluetooth processor (such as Intel, Qualcomm or Broadcom).

To check you have LE Audio, open Settings, then click 'Bluetooth & devices' on the left. Now click 'Devices' on the right, then scroll down to the 'Device settings' section. Here, look for the setting 'Use LE Audio when available' and turn it on.

If it's not there, your computer isn't compatible. You should then search for Bluetooth 5.2 updates on your manufacturer's website (one of the three above) and try to install it.

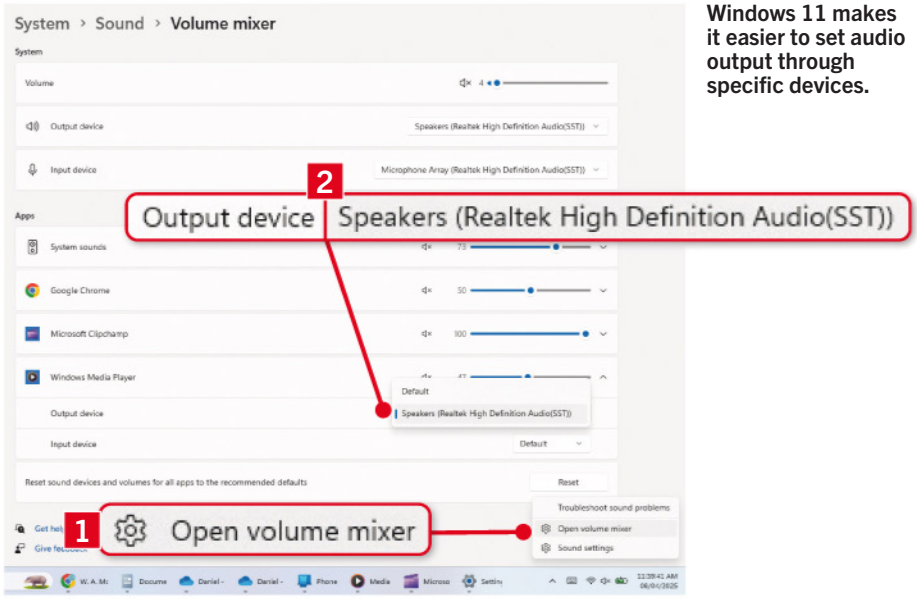


Turn on 'Use LE Audio when available' in the Devices section of Windows Settings.

14 Set audio to play through specific devices

This feature isn't entirely new in Windows 11, but it's so much easier to apply that it feels that way. Like Windows 10 it lets you choose which device each app's audio plays through. For example, you could have your music app running through your Bluetooth earbuds while keeping video calls on your desktop speakers. But changing these settings is so much easier in Windows 11.

Right-click the volume icon in the taskbar, then click 'Open volume mixer' (1 in our screenshot above). This takes you straight to the 'Volume mixer' deep in Windows settings, where you'll see which apps are playing audio. Click the dropdown arrow next to one then pick the input and output device you want 2.



Windows 11 makes it easier to set audio output through specific devices.

Also, get into the habit of clicking the volume icon in the taskbar followed by the 'Select a sound output' icon at the right (or press Windows key+Ctrl+V). This takes you to a small menu where you can quickly switch output devices.

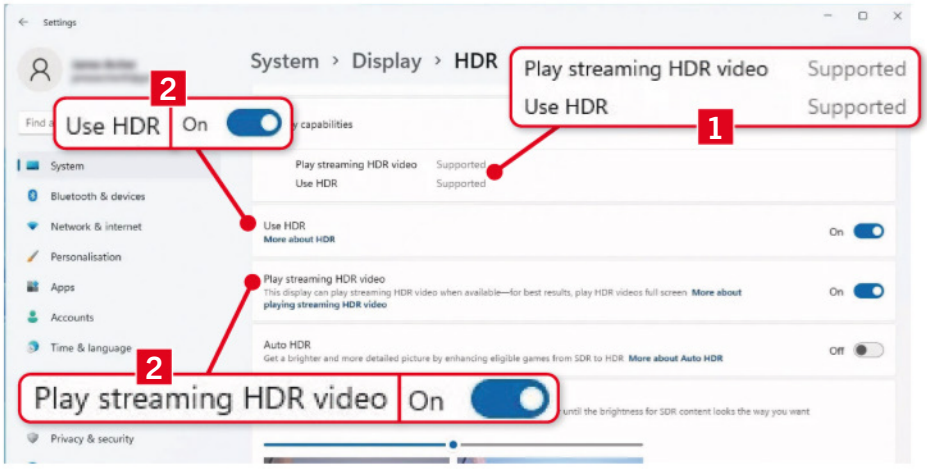
15 Turn on Auto HDR for sharper games

Windows 10 supports High Dynamic Range (HDR), which enhances image quality in games by letting screens show a wider range of brightness and contrast levels. However, it's a system-wide setting that tries to make all games HDR. This is fine for content that supports HDR, but it makes anything in standard resolution (SDR) look washed out.

Windows 11 fixes this with an 'Auto HDR' setting that leaves HDR games as they are, but transforms SDR games to match some of the amazing visuals without diluting the overall effect.

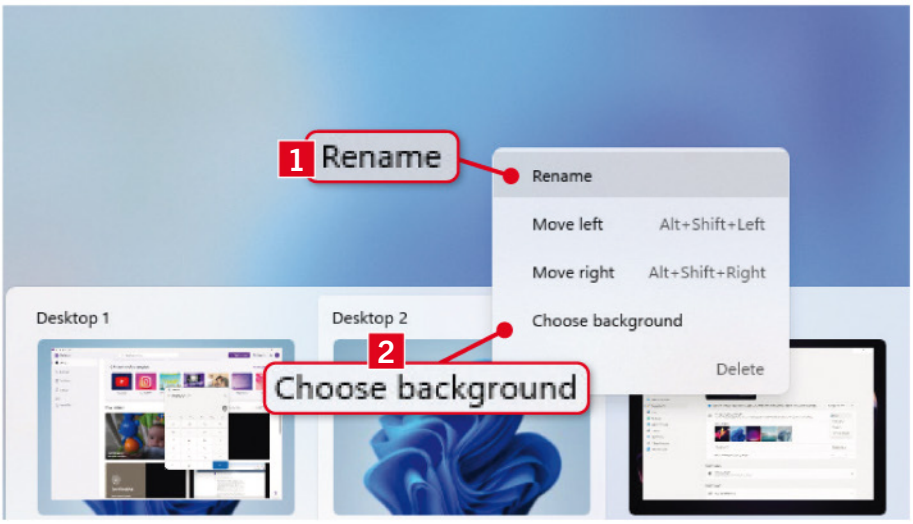
Open Settings, then click System on the left followed by Display on the right. Check whether your monitor supports both HDR options (1 in our screenshot below), and if so turn on both settings 2. HDR is becoming more common in monitors, with some decent models available now for under $200.

Another useful setting in Game Bar changes the intensity of the HDR effects, making images brighter or darker. Press Windows key+G then the top-right settings cog followed by 'Gaming features'. Now move the 'Adjust HDR Intensity' slider while playing a game to suit your taste, then click Done to lock that setting in.

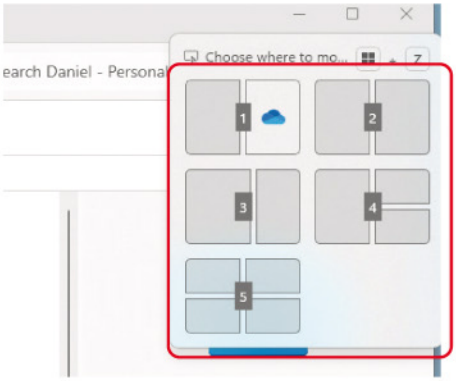


Turn on these HDR settings to improve image quality in games and videos.

ENHANCE YOUR DESKTOP AND WIDGETS



Windows 11's multiple desktops let you rename them and change their backgrounds.



Press a number in Snap Layouts to choose a particular grid.

16 Set up Snap Layouts

Snap Layouts are much more flexible than the options in Windows 10 – which comprise drag-to-edge snapping, as well as 'Cascade windows', 'Show windows stacked' and 'Show windows side by side' when you right-click the taskbar.

First, open Settings, then click System followed by Multi-tasking and turn on 'Snap windows'. Now hover over a window's 'Maximise' icon (or press Windows key+Z) and your 'snap layout' grid will appear top right. Microsoft has regularly added new options to Snap Layouts since its launch, including numbers on the layouts when you press Windows key+Z. Press a number key to move to that layout, then another number to fill a specific zone within it.

17 Rename multiple desktops & set different backgrounds

Where Windows 10 had virtual desktops, Windows 11 has multiple desktops. They're essentially the same thing, but more customisable. Press Windows key+Tab to open Task View, then 'New desktop' to create one.

New features in Windows 11 include right-clicking to rename them (1 in our screenshot above right), and to choose specific backgrounds for each 2. For the latter, make sure you choose Picture in the 'Personalise your background' dropdown menu. Combine these options to create distinct desktops that are easy to spot and open.

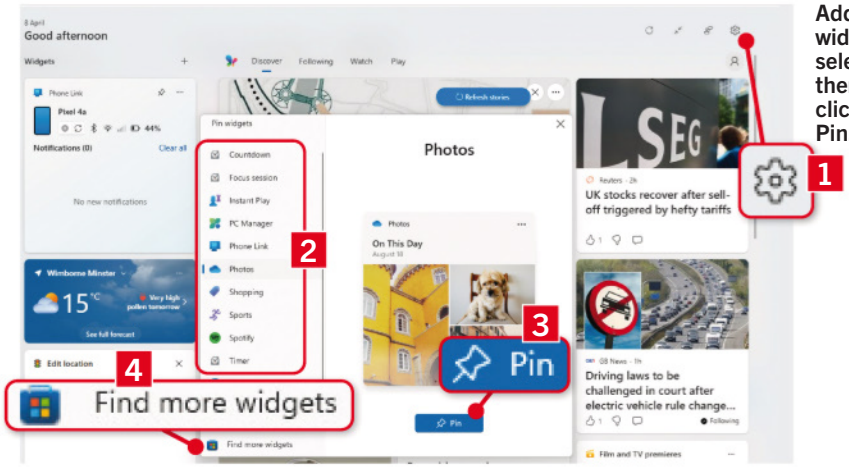
18 Add new widgets and set your location

Nothing has surprised us more in Windows 11 than how useful widgets are. In Windows 10 (and earlier versions) they just seemed like desktop clutter.

Open them by pressing Windows key+W. Two of the most helpful – weather and traffic – need to know your location to give you localised information. Open Windows Settings, then click 'Privacy & security' followed by Location on the right. Turn on the sliders next to 'Location services', 'Let apps access your location' and Weather.

If you need to change your traffic location, click the three dots top right followed by 'Customise widget'. Now click 'Specify default location' then type and select the place you want.

Add new widgets by clicking the top-right cog (1 in our screenshot below) followed by 'Discover new widgets'. Click one you want 2 then click 'Pin' 3, or search for new ones in the Microsoft Store 4. ■



Add new widgets by selecting them, then clicking Pin.

Has Microsoft fixed all the 24H2 bugs?

We recently recommended avoiding the 24H2 update because it had more bugs than a Peruvian rainforest. But Microsoft has released key updates since, fixing problems with audio, Bluetooth, webcams, File Explorer and several other functions. Some glitches remain, but they affect more niche software, such as sound-boosting program Dirac Audio and gaming tool Easy Anti-Cheat (see more at tinyurl.com/APC547cheat). For most users 24H2 is now fit for purpose. And in any case, if your computer is likely to struggle, Microsoft might place a 'safeguard hold' on it, preventing it from upgrading to 24H2.

How AI taught itself to reason

AI researcher and author Sebastian Raschka explains how large language models learned to "think through" their answers.



If you work in artificial intelligence or machine learning, you're probably familiar with vague and hotly debated definitions. The term "reasoning models" is no exception. Eventually, someone will define it formally in a paper, only for it to be redefined in the next, and so on.

I define "reasoning" as the process of answering questions that require complex, multi-step generation with intermediate steps. For example, factual question-answering such as "What is the capital of France?" doesn't involve reasoning. In contrast, a question like "If a train is moving at 60mph and travels for three hours, how far does it go?" requires simple reasoning. After all, it requires recognising the relationship between distance, speed and time before arriving at the answer. A regular large language model (LLM) may only provide a short answer, whereas reasoning models typically include intermediate steps that reveal part of the thought process.

Most modern LLMs are capable of basic reasoning and can answer questions like the one above. So, today, when we refer to reasoning models, we typically mean LLMs that excel at more complex reasoning tasks, such as solving puzzles, riddles and mathematical proofs. Additionally, most LLMs branded as reasoning models now include a "thought" or "thinking" process as part of their response. Whether and how an LLM actually "thinks" is a separate discussion.

Intermediate steps in reasoning models can appear in two ways. First, they may be explicitly included in the response – the answer literally includes the thinking. Other reasoning LLMs, such as OpenAI's o1, run multiple iterations with intermediate steps that are not always shown to the user.

When should we use reasoning models?

Now that we have defined reasoning models, we can move on to the more interesting part: how to build and improve LLMs for reasoning tasks. But before diving into the technical details, it is important to consider when reasoning models are actually needed.

Reasoning models are designed to be good at complex tasks such as solving puzzles, advanced math problems and challenging coding tasks. However, they are not necessary for simpler tasks such as summarisation, translation or knowledge-based question answering. In fact, using reasoning models for everything can be inefficient and expensive. For instance, reasoning models are typically more expensive to use, more verbose and sometimes more prone to errors due to "overthinking". The simple rule applies: use the right tool (or type of LLM) for the task.

Reasoning models are typically more expensive to use, more verbose and sometimes more prone to errors

The four ways to build reasoning models

There are four main techniques currently used to enhance the reasoning capabilities of LLMs and to build specialised reasoning models such as DeepSeek-R1, OpenAI's o1 and o3, and others. The exact workings of o1 and o3 remain unknown outside of OpenAI. However, they are rumoured to leverage a combination of both inference and training techniques.

1 Inference-time scaling

One way to improve an LLM's reasoning capabilities (or any capability in general) is inference-time scaling. This term has multiple meanings, but in this context, it refers to increasing computational resources during inference to improve output quality.

A rough analogy is how humans tend to generate better responses when given more time to think through complex problems. Similarly, we can apply techniques that encourage the LLM to "think" more while generating an answer.

One straightforward approach to inference-time scaling is clever prompt engineering. A classic example is chain-of-thought prompting, where phrases like "think step-by-step" are included in the input prompt. This encourages the model to generate intermediate reasoning steps rather than jumping directly to the final answer, which can often lead to more accurate results on more complex problems.

It doesn't make sense to employ this strategy for simpler knowledge-based questions, such as "What is the capital of France?", which is a good rule of thumb to find out whether a reasoning model makes sense on your given input query.

The chain-of-thought approach can be seen as inference-time scaling, because it makes inference more expensive through generating more output tokens.

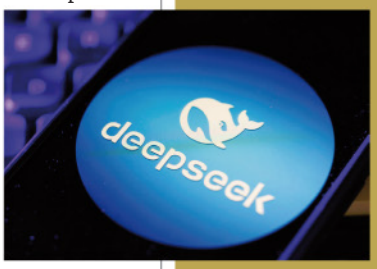
Another approach to inference-time scaling is the use of voting and search strategies. One simple example is majority voting, where we have the LLM generate multiple answers and we select the correct answer by majority vote. Similarly, we can use beam search (used to find the most likely sequence of words) and other search algorithms to generate better responses.

The DeepSeek R1 technical report states that its models do not use inference-time scaling. However, this technique is often implemented at the



BELOW Most LLMs include a thought process to answer questions that need simple reasoning.

application layer on top of the LLM, so it is possible that DeepSeek applies it within its app. I suspect that OpenAI's o1 and o3 models use inference-time scaling, which would explain why they are relatively expensive compared to models such as GPT-4o. In addition to inference-time scaling, o1 and o3 were likely trained using reinforcement learning pipelines similar to those used for DeepSeek R1. More on these below.



2 Pure reinforcement learning

One of my personal highlights from the DeepSeek R1 paper is the discovery that reasoning emerges as a behaviour from pure reinforcement learning (RL). As outlined earlier, DeepSeek developed three types of R1 models. The first, DeepSeek-R1-Zero, was built on top of the DeepSeek-V3 base model, a standard pre-trained LLM the company released in December 2024. Unlike typical reinforcement learning pipelines, where supervised fine-tuning (SFT) is applied beforehand, DeepSeek-R1-Zero was trained exclusively with reinforcement learning, without an initial SFT stage.

Still, this reinforcement learning process is similar to the commonly used reinforcement learning from human feedback (RLHF) approach, which is typically applied to preference-tune LLMs. However, the key difference in DeepSeek-R1-Zero is that they skipped the supervised fine-tuning stage for instruction tuning. This is why they refer to it as "pure" RL.

Instead of using a reward model trained on human preferences, DeepSeek employed two types of rewards: an accuracy reward and a format reward.

- The accuracy reward uses the LeetCode compiler to verify coding answers and a deterministic system to evaluate mathematical responses.

- The format reward relies on an LLM judge to ensure responses follow the expected format, such as placing reasoning steps inside <think> tags.

Surprisingly, this approach was enough for the LLM to develop basic reasoning skills. The researchers observed an "aha!" moment, where the model began generating reasoning traces as part of its responses despite not being explicitly trained to do so. While solving an equation, for example, the model would respond with "Let's reevaluate this step-by-step to identify if the correct sum can be…", effectively showing its working like school children are taught to do in exams.

While R1-Zero is not a top-performing reasoning model, it does demonstrate reasoning capabilities by generating intermediate "thinking" steps. This confirms that it is possible to develop a reasoning model using pure RL, and the DeepSeek team was the first to demonstrate (or at least publish) this approach.

3 Supervised fine-tuning and reinforcement learning (SFT + RL)

Next, let's look at the development of DeepSeek-R1, DeepSeek's flagship reasoning model, which serves as a blueprint for building reasoning models. This model improves upon DeepSeek-R1-Zero by incorporating additional supervised fine-tuning and reinforcement learning to improve its reasoning performance.

It is actually common to include an SFT stage before RL, as seen in the standard RLHF pipeline. OpenAI's o1 was likely developed using a similar approach.

The DeepSeek team used DeepSeek-R1-Zero to generate what it calls "cold-start" SFT data. The term "cold start" refers to the fact that this data was produced by DeepSeek-R1-Zero, which itself had not been trained on any SFT data.

Using this cold-start SFT data, DeepSeek then trained the model via instruction fine-tuning, followed by another RL stage. This RL stage retained the same accuracy and format rewards used in DeepSeek-R1-Zero's RL process. However, it added a consistency reward to prevent language mixing, which occurs when the model switches between multiple languages within a response.

The RL stage was followed by another round of SFT data collection. In this phase, the most recent model checkpoint was used to generate 600,000 chain-of-thought SFT examples, while an additional 200,000 knowledge-based SFT examples were created using the DeepSeek-V3 base model.

These 800,000 SFT samples were then used for instruction fine-tuning the DeepSeek-V3 base before following up with a final round of RL. In this stage, they again used rule-based methods for accuracy rewards for maths and coding questions, with human preference labels used for other question types. All in all, this is very similar to regular RLHF except that the SFT data contains (more) chain-of-thought examples. And the RL has verifiable rewards in addition to human preference-based rewards.

DeepSeek-R1 has a noticeable performance boost over DeepSeek-R1-Zero thanks to the additional SFT and RL stages.

4 Pure supervised fine-tuning (SFT) and distillation

So far, we have covered three key approaches to building and improving reasoning models:

1 Inference-time scaling, a technique that improves reasoning capabilities without training or otherwise modifying the underlying model.
2 Pure reinforcement learning as in DeepSeek-R1-Zero, which showed that reasoning can emerge as a learned

How disruptive is DeepSeek?

The DeepSeek-R1 models are an awesome achievement. As a research engineer, I particularly appreciate the detailed technical report, which provides insights into their methodology that I can learn from.

One of the most fascinating takeaways is how reasoning emerged as a behaviour from pure reinforcement learning. And it's impressive that DeepSeek has open-sourced its models under a permissive open-source MIT licence, which has even fewer restrictions than Meta's Llama models.

Is DeepSeek-R1 better than OpenAI's o1? I'd say it's roughly in the same ballpark. However, what stands out is that DeepSeek-R1 is more efficient at inference time. This suggests that DeepSeek likely invested more heavily in the training process, while OpenAI may have relied more on inference-time scaling for o1.

Another point of discussion has been the cost of developing DeepSeek-R1. Some have mentioned a ~$6m training cost, but they likely conflated DeepSeek-V3 (the base model released in December last year) and DeepSeek-R1. The $6m estimate is based on an assumed $2 per GPU hour and the number of GPU hours required for the final training run of DeepSeek-V3, which was originally discussed back in December 2024.

However, the DeepSeek team has never disclosed the exact GPU hours or development cost for R1, so any cost estimates remain pure speculation. Either way, ultimately DeepSeek-R1 is a major milestone in open-weight reasoning models, and its efficiency at inference time makes it an interesting alternative to o1.

It's possible to develop a reasoning model using pure RL, and DeepSeek was the first to demonstrate this

behaviour without supervised fine-tuning.

3 Supervised fine-tuning plus reinforcement learning, which led to DeepSeek-R1, DeepSeek's flagship reasoning model.

So what's left? Surprisingly, DeepSeek also released smaller models trained via a process it calls distillation. However, in the context of LLMs, distillation does not necessarily follow the classical knowledge distillation approach used in deep learning. Traditionally, in knowledge distillation, a smaller student model is trained on both the logits (the raw scores that come out of a machine learning model) of a larger teacher model and a target dataset.

Instead, here distillation refers to instruction fine-tuning smaller LLMs, such as Llama 8B, on an SFT dataset generated by larger LLMs. Specifically, these larger LLMs are DeepSeek-V3 and an intermediate checkpoint of DeepSeek-R1. In fact, the SFT data used for this distillation process is the same dataset that was used to train DeepSeek-R1, as described earlier.

Why did DeepSeek develop these distilled models? In my opinion, there are two key reasons:

1 Smaller models are more efficient. This means they're cheaper to run, but they also can run on lower-end hardware, which makes these especially interesting for many researchers and tinkerers like me.

2 A case study in pure supervised fine-tuning. These distilled models serve as an interesting benchmark, showing how far pure SFT can take a model without reinforcement learning.

Smaller models are more efficient. They're cheaper to run, but they also can run on lower-end hardware



From published performance data, we can see the distilled models are noticeably weaker than DeepSeek-R1, but they are surprisingly strong relative to DeepSeek-R1-Zero, despite being orders of magnitude smaller. It's also interesting to note how well these models perform compared to o1-mini.

There's one more interesting comparison worth mentioning. The DeepSeek team tested whether the emergent reasoning behaviour seen in DeepSeek-R1-Zero could also appear in smaller models. The results suggest that distillation is far more effective than pure reinforcement learning for smaller models. This aligns with the idea that reinforcement learning alone may not be sufficient to induce strong reasoning abilities in models of this scale, whereas supervised fine-tuning on high-quality reasoning data can be a more effective strategy when working with small models.

What we've learned

Overall, we explored four different strategies for building and improving reasoning models:

1 Inference-time scaling requires no additional training but increases inference costs, making large-scale deployment more expensive as the number of users or query volume grows. Still, it remains a no-brainer for improving the performance of already strong models. I strongly suspect that o1 leverages inference-time scaling, which helps explain why it is more expensive on a per-token basis compared to DeepSeek-R1.

2 Pure RL is interesting for research purposes because it provides insights into reasoning as an emergent behaviour. However, in practical model development, RL + SFT is the preferred approach as it leads to stronger reasoning models. I strongly suspect that o1 was trained using RL + SFT as well. More precisely, I believe o1 starts from a weaker, smaller base model than DeepSeek-R1 but compensates with RL + SFT and inference-time scaling.

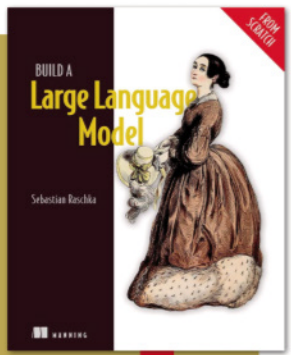
3 As mentioned above, RL + SFT is the key approach for building high-performance reasoning models. DeepSeek-R1 is a nice blueprint showing how this can be done.

4 Distillation is an attractive approach, especially for creating smaller, more efficient models. However, the limitation is that distillation doesn't drive innovation or produce the next generation of reasoning models. For instance, distillation always depends on an existing stronger model to generate the supervised fine-tuning data.

One interesting aspect I expect to see next is to combine RL + SFT (approach 3) with inference-time scaling (approach 1). This is likely what OpenAI o1 is doing, except it's probably based on a weaker base model than DeepSeek-R1, which explains why DeepSeek-R1 performs so well while remaining relatively cheap at inference time. ■

About the author

This article is an excerpt from *Ahead of AI*, an online magazine focused on AI and LLM research. Sebastian Raschka is also the author of the bestselling *Build a Large Language Model From Scratch*, available from Amazon (tinyurl.com/APC547LLM).



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$297, lenovo.com/au

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$479, canon.com

Brother MFC-J4540DW
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There are cheaper Wi-Fi 6E meshes, but the XE200 wins for its superb download speeds, excellent coverage and the fact that older clients reap benefits of 6E, not just new ones. And a two-pack should be enough for most premises.
$1,299 (2-pack), tp-ink.com



TP-Link Deco X20
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Asus ZenWiFi AX
The interface and design certainly aren't the prettiest (the charcoal version is straight out of the 1980s), but if you're after strong performance, great features and plenty of expansion potential, the ZenWiFi AX is a compelling prospect.
$939 (2-pack), asus.com/au

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A particularly strong choice as a media server, the updated Nimbustor 4 is both flexible and quick. Asustor's Nimbustor 4 AS5404T is a four-drive NAS enclosure aimed at demanding home users or small offices.
$879, asustor.com



Synology DiskStation DS925+
Casual NAS users will find better value elsewhere. However, access to the vast, polished and professional Synology ecosystem will more-than justify the high price to buyers who make use of it.
$1,099, synology.com

Qnap TS-264
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$729, qnap.com

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Free, avast.com

NordVPN
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$59 per year, nordvpn.com

THE ALTERNATIVES

PROTONVPN
ProtonVPN provided one of the best free offerings of all the VPNs in our group test, including unlimited data, but upgrade to benefit from even faster speeds and many more options.
Free, protonvpn.com

SURFSHARK
A strong rival to NordVPN, especially if you're willing to commit to its two-year contract. It's fast, cheap and a fine choice for people who like to switch to US streaming services.
$79.61 for one year, surfshark.com

Bitwarden
Bitwarden has a huge advantage: it's free. It isn't as slick as some paid-for rivals, but it can sync passwords across all devices for no extra charge. **Free, bitwarden.com**

THE ALTERNATIVES

DASHLANE
A manager that's ideal for beginners, and it even builds in an unlimited (if basic) VPN service. Note you may prefer to buy the Family plan ($60 per year) as this extends the service to six people.
$55.99 per year (Premium), dashlane.com

1PASSWORD
1Password is targeted at users who are looking for the last word in security. It even offers a Travel Mode that may ease your mind if surrendering your phone to customs officials. **$54.99 per year (individual), 1password.com**

Market Watch

A sampling of PC systems available this month.



D&D COMPUTERS SYS319

$1,950

tinyurl.com/APC547DD

Coming in as the cheapest of this roundup, this system puts much of its priority onto the CPU with the strong i7 14700F serving up twenty cores for your general computing needs. With only Intel's OEM heatsink to cool it, under sustained loads it'll get rather toasty and downclock, losing some performance.

The paired RTX 4060 Ti will get you by at 1080P. The memory at 16GB is ok but the slow 4800MHz speeds will also prevent the CPU from achieving its best.

While this is $200 less than the Umart system, this doesn't come with a Windows 11 license, so keep that in mind.

If productivity is your main focus and gaming is secondary, this system could be a good choice.

CPU Intel Core i7 14700F; **COOLER** OEM; **MOTHERBOARD** Intel B760 chipset-based; **GRAPHICS** NVidia RTX 4060Ti 8GB; **MEMORY** 16GB 4800MHz DDR5; **STORAGE** 1TB M.2 PCIe NVMe SSD; **POWER SUPPLY** Premium ATX PSU with 120mm Fan; **CASE** MSI MAG Forge M100R.



UMART G5

$2,149

tinyurl.com/APC547umart

At about the same price as the D&D system (once Win11 is factored in), this system strikes a more balanced approach for typical gaming scenarios. The i5 14400F is a perfectly adequate match for the paired RTX 5060 Ti. While this card is one generation newer, it's quite a bit faster at around 33% on average. So this will be the more capable gaming system overall.

Having double the system RAM and VRAM is also appreciated and will give this system a leg up as time goes on.

A well-balanced system with enough to not leave you wanting more.

CPU Intel Core i5-14400F; **COOLER** Thermaltake ARGB 120mm air cooler; **MOTHERBOARD** Intel B760M-based; **GRAPHICS** GeForce RTX 5060 Ti 16GB; **MEMORY** 32GB RGB DDR5; **STORAGE** 1TB NVMe SSD; **POWER SUPPLY** MSI MAG 650W; **CASE** Thermaltake Divider 170.



PC CASE GEAR NITRO 9070 XT

$3,799

tinyurl.com/APC547pccg

Sporting the greatest hits from AMD in the 9800X3D and RX 9070 XT, it doesn't get a whole lot better than this, lest you throw down double the amount in cash. This top-of-the-line gaming CPU is cooled by a little over the top 360mm AIO, though one can't deny it looks great and will be whisper quiet under full load.

A top end Sapphire Nitro+ graphics card is rather opulent, and combined with the ROG Strix motherboard gives this system a sense of grandeur.

A 2TB SSD, 32GB of RAM and 850W PSU are all what you'd expect at this price bracket, nothing overly fancy or extra there. Several high-end parts in this system, certainly one for the gamers that know what they want.

CPU AMD Ryzen 7 9800X3D; **COOLER** Thermalright Frozen Infinity 360mm AIO; **MOTHERBOARD** Asus ROG Strix B850-F Gaming WiFi; **GRAPHICS** Sapphire Radeon RX 9070 XT Nitro+ Gaming OC 16GB; **MEMORY** Team T-Force Delta RGB 32GB 6000MHz CL38 DDR5; **STORAGE** Lexar NQ790 NVMe Gen4 SSD 2TB; **POWER SUPPLY** Kolink Regulator 850W; **CASE** Kolink Unity Arena ARGB.



AFTERSHOCK PC SAMURAI PLUS

$3,800

tinyurl.com/APC547aft

Matching the PC Case Gear rig's price, this makes some significant trades to do it in style. The RTX 5070 Ti is equal with the RX 9070 XT so theoretically can keep up with the other system, however what will hold it back is the slower CPU. Certainly, no slouch the Ryzen 7 7700 doesn't have that much sought after V-Cache for peak gaming results.

Along with this the system also has half the SSD capacity at 1TB, and a last generation B650 motherboard.

These compromises offset the cost of the stunning printed Japanese Samuri iconography on the front and side of the case. If you're into Japan or Samurais in general, this is a great desktop art piece to get.

CPU AMD Ryzen 7 7700; **COOLER** Aftershock M 42 Frost Air Cooler White; **MOTHERBOARD** Gigabyte B650 Eagle AX DDR5; **GRAPHICS** Zotac RTX 5070Ti Solid OC 16GB; **MEMORY** 32GB Lexar Thor 6000MHz; **STORAGE** 1TB Lexar NQ790 M.2 NVME SSD; **POWER SUPPLY** Antec GSK 850W; **CASE** Bolt+ White.

YOUR NEXT PC

BLUEPRINTS

Build the best PC for your budget



KEY

Budget build

Pick these parts if you want to build a new, well-rounded PC for a good price.

Mid-range build

For productivity power and running every new game at 1080p 60fps. This recommended build will see you through.

Advanced build

You're looking for the best PC on the market and superior components. But you still want to spend smart.

BUDGET BUILD

Enjoy 1080p gaming and most tasks without breaking the bank.



TOTAL
$1,691

MOTHERBOARD		**B660M-HDV** Asrock $139 This is as cheap as we want to go while still offering room for expansion and upgrades down the line.
PROCESSOR		**Core i5 13400F** Intel $225 With ten cores, six of them the Performance kind, this Raptor Lake Core i5 is fantastic value and a great all-rounder.
GRAPHICS CARD		**Radeon RX 7600** AMD $459 AMD delivers what we need for 1080p gaming at a solid price. AMD claims it'll do over 350fps in *Rocket League*, which is a lot.
COOLER		**Laminar RM1 (included with CPU)** Intel Free There's room for an upgrade here, but on a budget the included CPU cooler will work just fine.
MEMORY		**T-Force Vulkan Z 16GB** Teamgroup $59 8 GB of RAM is simply not enough these days, but 16 GB of speedy DDR4 is much more like it.
POWER SUPPLY		**RM650 80 Plus** Corsair $149 A great power supply is a must, and Corsair builds some reliable workhorses. This one's a good balance of price and power.
SSD		**NM790 1TB** Lexar $119 It's time to ditch SATA and go for an NVMe drive, even for a budget PC. You'll appreciate the extra speed and fast boot times.
CASE		**NX200M** Antec $65 This Antec will let your components breathe and has space for further expansion and cooling.
DISPLAY		**Mobiuz EX241** BenQ $270 This BenQ is proof you can buy an excellent 24in 1080p 220Hz gaming monitor for not a huge sum of cash nowadays.
KEYBOARD		**C3 Pro Wired** Keychron $59 It's actually mind blowing what you can pick up for this little cash: a USB mechanical board that looks lovely.
MOUSE		**G305 Lightspeed** Logitech $69 Even on a budget you can still grab a fantastic, ultra-rapid wireless squeaker like this one here.
HEADSET		**HS55 Stereo** Corsair $59 Corsair's budget wired cans are comfy and have a surprisingly excellent microphone for the money.
MOUSE PAD		**MM100** Corsair $19 A simple black rectangle that can make a world of difference over no-name models, and it's almost as cheap, too.

MID-RANGE BUILD

Our recommended build for solid productivity and playing the latest games.



TOTAL
$3,073

MOTHERBOARD		**TUF Gaming B650-E** Asus $299 A reliable motherboard with plenty of frills, including Wi-Fi 6E, 2.5Gb Ethernet, PCIe 5.0 for the SSD and USB-C on the back.
PROCESSOR		**Ryzen 7 7700X** AMD $529 For the longevity offered by the AM5 socket, we're going for AMD's excellent eight-core Ryzen 7.
GRAPHICS CARD	NEW ENTRY 	**RTX 5060 Ti 16GB** NVIDIA $800 Nvidia's RTX 50-series cards have been hard to find for good prices, but this one's widely available, punchy and affordable.
COOLER		**Peerless Assassin 120 SE** Thermaltake $55 It's a big beast, but it brings cooling performance to the table that's undeniably impressive.
MEMORY		**Delta RGB 16GB 5600MHz** Team T-Force $89 It even has fancy RGB lighting, and this Patriot RAM certainly has the speed you need for less.
POWER SUPPLY		**Pure Power 12 M 750W** Be Quiet! $179 This larger Be Quiet! PSU offers a stable platform with PCIe 5.0 connectivity. At 750W, there's room for a GPU upgrade too.
SSD		**NM790 1TB** Lexar $119 The Lexar proves you can, sometimes, have it all: blazing speeds, cool operation and a great price.
CASE		**H7** Nzxt $179 It's very clever of Nzxt to design such an easy PC case to build into, and make it look so gorgeous too.
DISPLAY		**MPG 275CQRXF** MSI $479 The price of this MSI, considering the 1440p resolution, curve and 240Hz refresh rate, is quite something.
KEYBOARD		**K855 Wireless TKL** Logitech $119 You could spend more for a full-size keyboard, but this mechanical Logitech will certainly suffice for most people.
MOUSE		**DeathAdder V2** Razer $59 This Razer mouse is a superb companion for competitive gaming without breaking the bank.
HEADSET		**Cloud Alpha** HyperX $140 We're still not over the awesome audio quality and excellent comfort of the HyperX Cloud Alpha.
MOUSE PAD		**G440** Logitech $27 This low-friction hard-top mouse pad with minimal branding offers the smoothest of glides for a reasonable price.

ADVANCED BUILD

Go above and beyond with a PC powerful enough to tackle anything.



TOTAL
$8,797

MOTHERBOARD



NEW ENTRY

MAG X870E Tomahawk

MSU $569

With support for four M.2 drives, huge amounts of DDR5, Wi-Fi 7 and more, this mega mobo is specced to the hilt.

PROCESSOR



Ryzen 7 9800X3D

AMD $889

The top-tier Zen 5 X3D models will have more cores, but for gaming and most uses this is the bee's knees.

GRAPHICS CARD

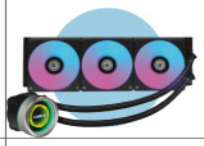


GeForce RTX 5080

Nvidia $2,500

The RTX 5090 is ridiculously expensive, so we're recommending the RTX 5080 instead, but if you can afford a 5090 go for it.

COOLER



Galahad II Trinity 360

Lian Li $249

Lian Li's Galahad is all about pure liquid cooling performance and it delivers this flawlessly.

MEMORY



Trident Z5 RGB (2x16GB) 6000MHz

G.Skill $159

This is a new memory standard for a new era of memory speed. DDR5 is blisteringly and fantastically quick.

POWER SUPPLY



Prime PX-1300

Seasonic $499

This PC is a thirsty beast, so you'd better give it a serious power supply – and this one's similarly monstrous.

BOOT DRIVE



NM790 4 TB

Lexar $368

With 4TB of storage, it's going to take one seriously big Steam library to get anywhere close to filling this drive up.

MOUSE PAD



Firefly V2 Pro

Razer $169

Do you need an RGB mouse mat? If it makes you feel any better it's excellent for flick shots.

CASE



5000D

Corsair $189

We swear this stylish mid-tower is bigger on the inside. It's the PC equivalent of the TARDIS.

DISPLAY



ROG Swift OLED PG32UCDM

Asus $2,229

You could be much more sensible on your screen than this. For this build, however, we only want the best.

KEYBOARD



ROG Strix Scope II 96 Wireless

Asus $299

We're keyboard snobs, and we can say with confidence that this full-sized Asus board is about as good as it gets.

MOUSE



DeathAdder V3 Pro

Razer $179

This is the best gaming mouse in our opinion, made better by an incredibly lightweight frame.

HEADSET



Maxwell

Audeze $499

Planar magnetic drivers make this headset pure heaven for audio fans. And everyone else, to be honest.

Make Windows better

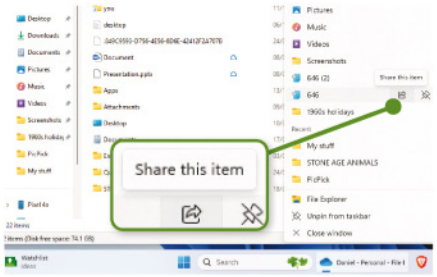
Expert tips for a better experience.

WINDOWS 11

Share files from an app's jump list

Microsoft's Windows 11 KB5053598 update, released on 11 March, adds the option to share files when you right-click an app's icon on the taskbar. First, pin an app to the taskbar by right-clicking it and selecting 'Pin to taskbar'. Next, right-click the icon to bring up the app's jump list, then hover over the file you want to share and click the 'Share this item' icon (see screenshot below).

Now choose how you want to share it – by email, Phone Link, Nearby Sharing, WhatsApp, OneDrive and so on. It only works with apps that have the option to share files, such as File Explorer, Microsoft Word and Snipping Tool.

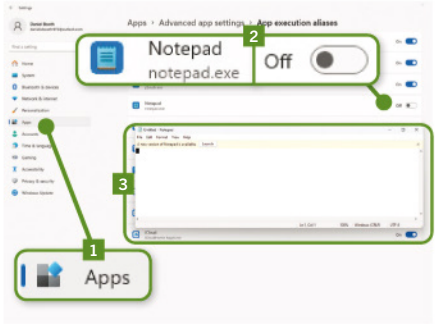


WINDOWS 11

Go back to the old Notepad

Microsoft 365 subscribers can now use the AI-powered Rewrite feature in Notepad (see **tinyurl.com/APC547rewrite**). It's the latest change to Notepad, following design tweaks to match Windows 11's style.

If you don't like these changes you can revert to the old Notepad. First, press Windows key+I to open Settings, then click Apps on the left (1 in our screenshot below). Now click 'Advanced app settings' followed by 'App execution aliases'. Scroll down to Notepad then turn off the slider 2. Now press Windows key+R,



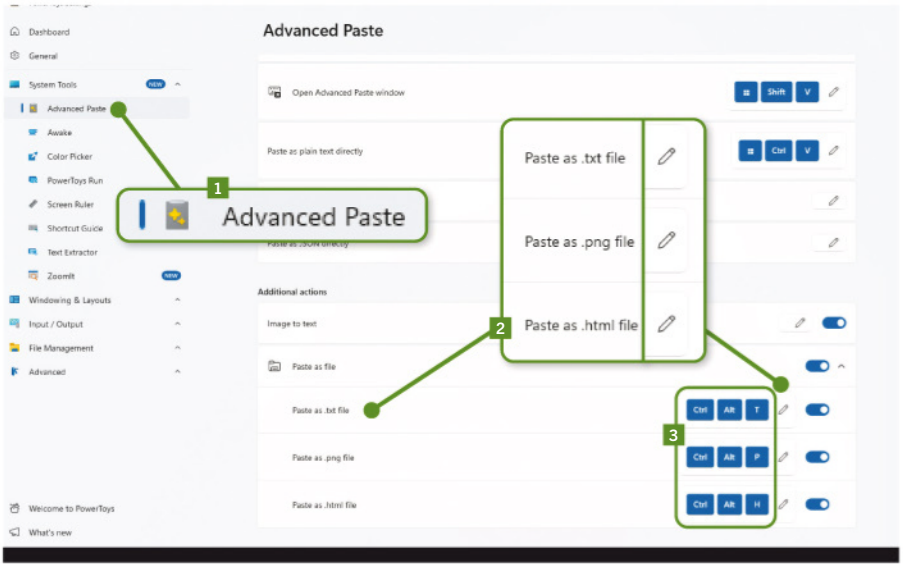
Windows 10 & 11

Set keyboard shortcuts for pasting in different formats

Microsoft's main changes to version 0.89 of PowerToys, released in March, involve the Advanced Paste tool, which pastes content you copy to your clipboard in the format of your choice. You can make it easier to paste in specific formats by setting keyboard shortcuts within the tool.

Open PowerToys (install it from **github.com/microsoft/PowerToys/** if you've not yet done so), then click System Tools on the left followed by Advanced Paste (1 in our screenshot). Make sure the blue 'Enable Advanced Paste' slider is enabled on the right, then scroll to the 'Additional actions' heading at the bottom.

Now click the pencil icons next to the 'Paste as' commands for .txt, .png and .html 2 and press the keys you want to use for each command followed by Save. Note that only shortcuts starting with Windows key, Ctrl, Alt or Shift are allowed. When done, you'll see your shortcuts as blue buttons 3.



then type notepad and press OK. The old Notepad will now appear 3.

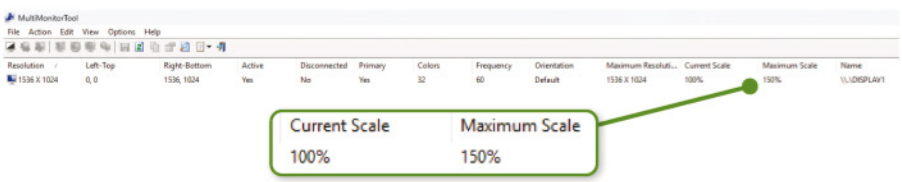
WINDOWS 10 & 11

Check your monitors' current and maximum scales

NirSoft has added Current and Maximum Scale columns to its program MultiMonitorTool, showing you the current scaling of each monitor you use, and the maximum they can handle.

Current scaling is handy when you're switching between monitors that have different resolutions because you can check whether the text and icons are the right size. Maximum scaling is useful when using monitors with a high DPI, like a 4K model, because you'll see if your screen can handle a larger-scaling setting, like 150 or 200 per cent.

Visit **www.nirsoft.net/utils/multi_monitor_tool.html** then scroll down and click either the 32bit or 64bit download link under the Feedback heading. Launch the program, clicking 'More info' then 'Run anyway' if Windows shows a warning. You'll see the new columns to the right at the top (see screenshot below). To change scale settings in Windows, search for and open 'Display settings'. ■



Make Office better

Expert tips for a better experience.

MICROSOFT WORD

Keep paragraphs and headings on same page

When you're working on longer documents, keeping headings and their corresponding paragraphs together on the same page – rather than split over two – makes your content easier to read. You can ensure this happens by activating the 'Keep with next' option.

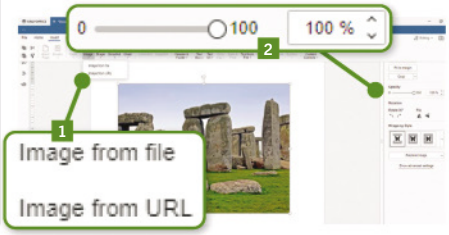
In Microsoft Word, select the relevant heading, then right-click it and choose Paragraph. Now click the 'Line and Page Breaks' tab (1 in our screenshot below) then tick 'Keep with next' 2 under Pagination. Click OK to confirm.

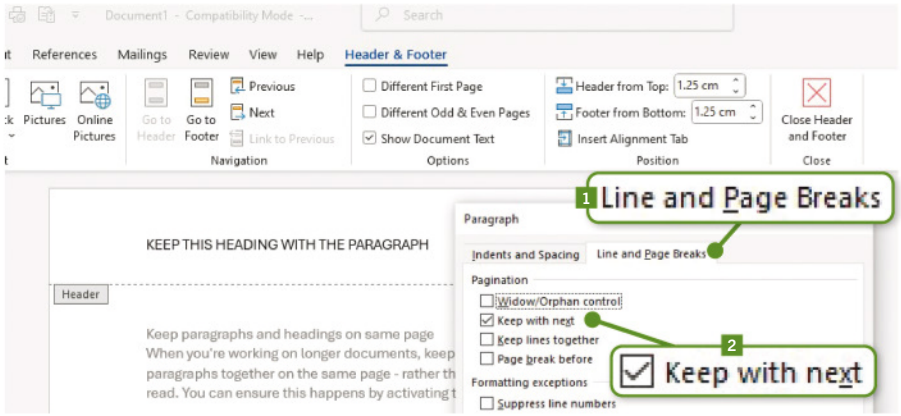
In LibreOffice Writer, select the heading, then right-click it and hover over Paragraph, then click Paragraph. Now click the Text Flow tab and tick 'Keep with next paragraph' under the Split Options heading. Click OK to confirm.

ONLYOFFICE

Change the transparency levels of images

OnlyOffice 8.3.0, released in February, lets you change the transparency of images. It works in the same way across all its tools. To add an image, click Insert at the top, then Image followed by 'Image from file' or 'Image from URL' (1 in our screenshot below left). Now click to select it, then move the Opacity slider on the right from its default of 100 per cent 2. The image's transparency will change as you do so.



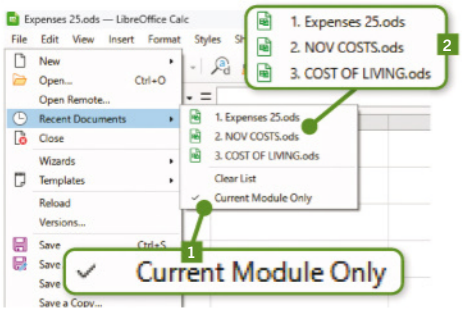


LIBREOFFICE

Only see recent documents from the tool you're in

February's release of LibreOffice 25.2 adds the option to see recent documents only in the tool you've currently got open. So, if you're in Calc, for example, you'll see previous spreadsheets you've had open, but nothing from LibreOffice's other tools (or 'modules'), such as Writer documents or Impress presentations.

Click 'File' at the top left, then Recent Documents and click Current Module Only (1 in our screenshot below). We've done that in Calc so that the only documents shown above are spreadsheets 2. ■



Microsoft Office

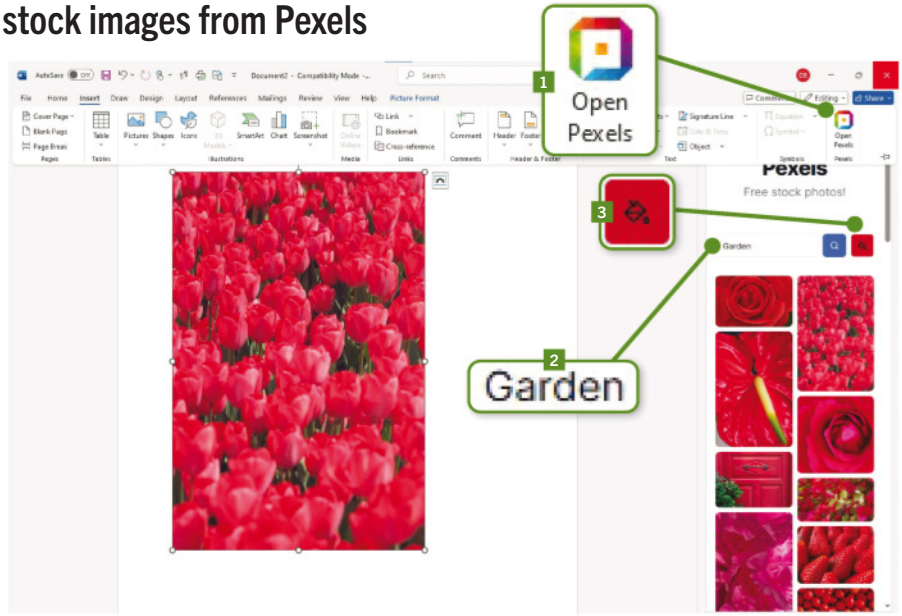
Add free stock images from Pexels

If you regularly need to add images to documents, presentations or spreadsheets, consider using the Pexels add-in. This provides access to Pexels (**www.pexels.com**), one of the best sites for free stock pictures (though it doesn't provide any news photos).

Click 'File' at the top left followed by 'Get Add-ins', then search for Pexels. Click the blue Add button next to the search result then tick the 'terms and conditions' box and click Continue. Now click Insert, then Open Pexels (1 in our screenshot) at the far right.

Next, type what you want to find in Pexels 2 then press Enter. You can also choose a colour by clicking the paint-tin button 3.

Click the photo you want to add, then select a size and click Insert Photo. It will then appear on the left where your cursor is positioned.



Browser tips

Secret settings and best extensions

CHROME

Hear content read aloud in Reading Mode

Chrome 134 (released in March) introduces a feature that Edge and Firefox have offered for years – the ability to hear text read aloud when viewing content in its Reading Mode. The option is already available in the Chrome app for Android, and now you can enjoy it in the desktop browser too.

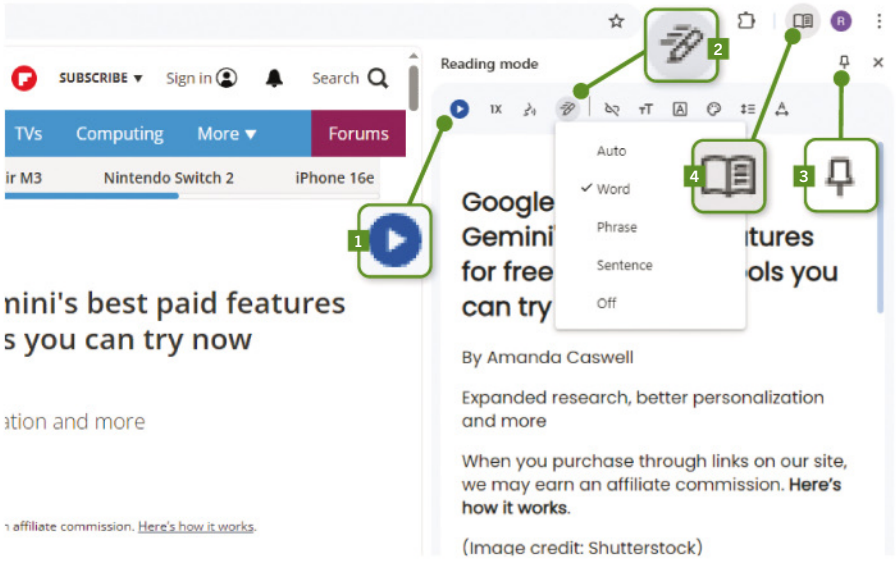
Reading Mode removes everything from web pages except the text and displays the streamlined content in Chrome's side panel. Here you can change the font, size and background colour of the text to make it as easy to read as possible. The new Read Aloud feature lets you listen to it too, by clicking the Play button in the top-left corner of the side panel (1 in our screenshot below).

You can adjust the reading speed to make it up to four times faster, or slow it down, and choose from eight different voices – including the default text-to-speech voice on your PC. Click the highlighter-pen icon 2 to have Read Aloud highlight words, phrases or sentences as it reads them.

To switch to Reading Mode, simply right-click a web page or a highlighted section of text, then choose 'Open in reading mode'. This will open a text-only version of the content in Chrome's side panel, where you can use the new Read Aloud options.

If you don't see them, type **chrome://flags** in the address bar and press Enter to open the Experiments page. Search for Read Aloud, select Enabled in the dropdown menus for both results and click Relaunch.

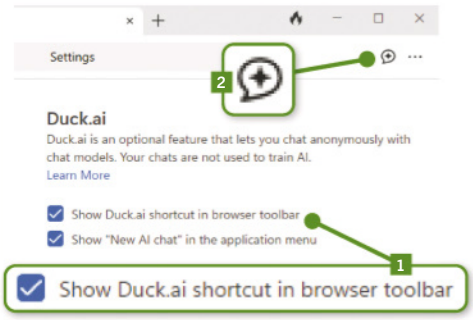
For instant access to Reading Mode, click the 'Pin to toolbar' icon 3 in the top-right corner of the side panel. This adds a 'Reading mode' button 4 to the browser's toolbar, which you can click to open and close the feature.



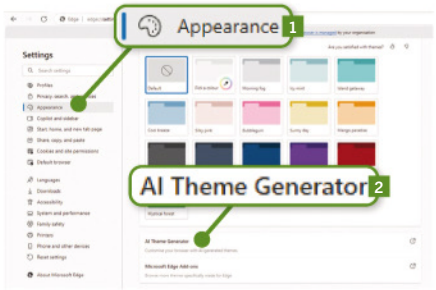
DUCKDUCKGO

Access Duck.ai from the toolbar

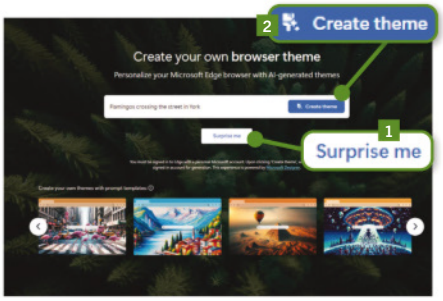
We've previously recommended Duck.ai, which lets you interact anonymously with popular AI chatbots. DuckDuckGo has now integrated the feature into its browser for Windows (**duckduckgo.com/windows**), giving you instant access to Duck.ai wherever you are on the web.



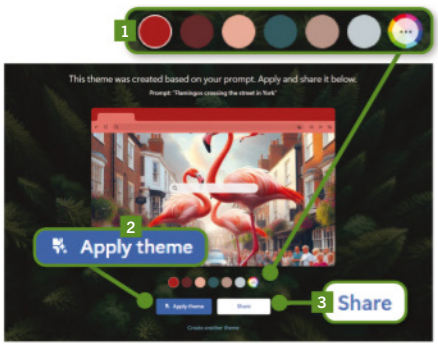
Workshop Create your own themes for Edge using AI



Click Edge's three-dot menu button and choose Settings, then Appearance 1. In the 'Customise appearance' section, select the option AI Theme Generator 2 to open the tool's website in a new browser tab.



Describe the theme you want to apply to Edge or click 'Surprise me' 1 to generate a random one. You can also choose and modify one of the suggested prompts. Click the 'Create theme' button 2 to continue.



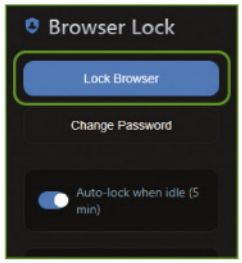
Once your theme has been generated, you can customise the colour of the toolbars using the options 1 below the main image. Click 'Apply theme' 2 to add it to Edge, and Share 3 to download it to your PC.

Best extension for... Locking your browser

SECURETAB

Chromium

tinyurl.com/APC547secure



Your online privacy can be threatened by people around you, especially if you share your computer or use it in a public place. SecureTab protects your browser with a password when you step away for a few minutes, without you needing to lock your whole PC. Once you've set a password, click the extension's toolbar button and choose Lock Browser (see screenshot) – or press Ctrl+Shift+L.This will instantly lock all browser tabs, so they can only be accessed with the password you set.

You can also set SecureTab to lock tabs automatically after five minutes of inactivity. If a determined nosy parker uninstalls the extension, all the tabs will be closed to foil them. SecureTab may prompt an Enhanced Safe Browsing warning, but it's safe to use so click 'Continue to install'.

If you don't like that, try...

BROWSERLOCK

tinyurl.com/APC547lock

BrowserLock offers extra options such as specifying how long to lock your browser.

Just click the browser's three-dot menu button and choose 'New AI chat' to open Duck.ai in a new tab. You can also add a shortcut to DuckDuckGo's toolbar. To do so, choose 'Settings' in the main menu, select Duck.ai and tick the box 'Show Duck.ai shortcut in browser toolbar' (1 in our screenshot below).

A speech-bubble icon 2 will now appear next to the menu button, which you can click to open Duck.ai. To remove the shortcut, right-click it and choose 'Hide Duck.ai shortcut'.

FIREFOX

Delete form data without wiping your history

One of the many improvements in Firefox 136 (released early March) is its Clear History feature. Previously, whenever you wanted to delete information that you'd entered in online forms, then saved in the browser – such as your name, phone number and address – you needed to wipe your entire browsing history.

The updated feature provides separate options for deleting saved-form data and your browsing history, so you can clear one or the other. To do so, click Firefox's three-line menu button and choose Settings then 'Privacy & Security'. Scroll down to the History section and click the Clear History button.

In the window that opens, select the data you want to wipe and deselect what you want to keep, such as 'Browsing & download history', 'Cookies and site data' and the new 'Saved form info' option (1 in our screenshot below).



You can also specify a time range, such as 'Last hour' 2, 'Last four hours' or 'Since 12:00AM' – or simply choose Everything. Click the Clear button 3 to delete the selected data from Firefox.

To stop the browser saving form information in the first place, click the 'Firefox will' menu in the History section and select 'Use custom settings for history'. Untick the box for 'Remember search and form history'.

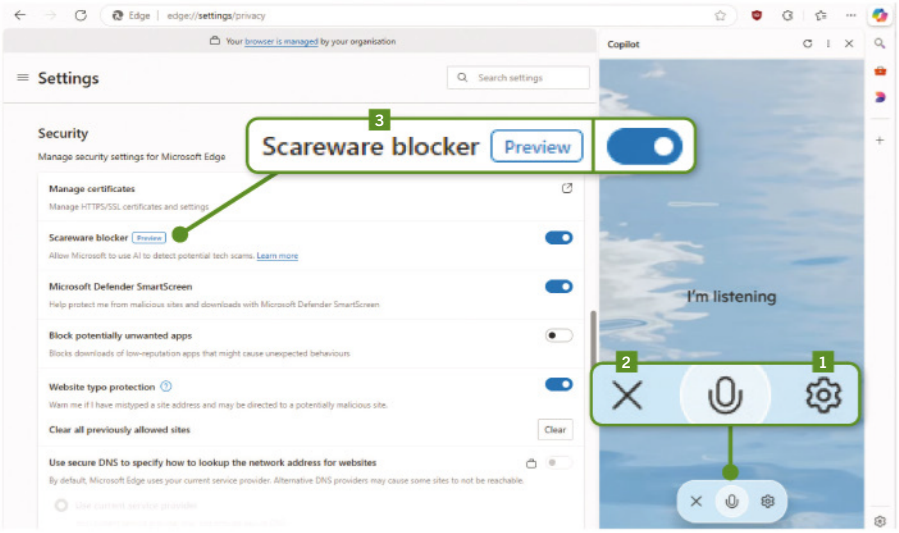
EDGE

Speak to Copilot and block scareware scams

After a series of underwhelming updates, Edge 134 (released in March) brings some interesting new features to Microsoft's browser. Unsurprisingly, most are powered by AI.

Microsoft's AI assistant Copilot now has a Voice mode, so you can chat without typing. The new option is also available in the version of Copilot built into Edge.

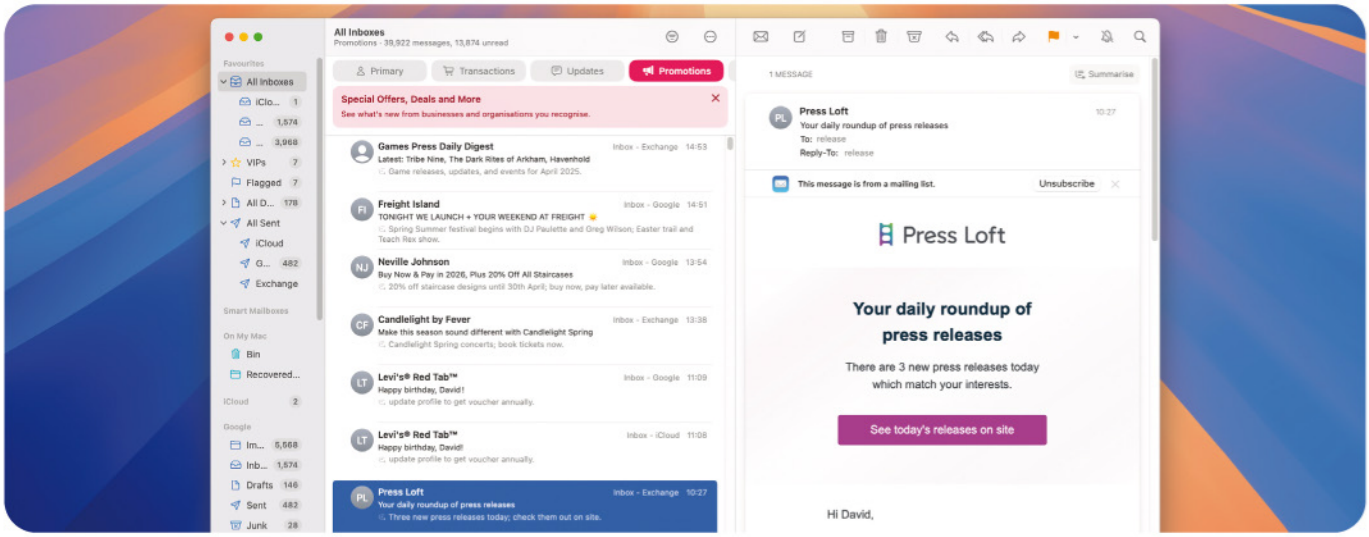
Click the Copilot button to open its side panel, then click the 'Talk to Copilot' (microphone) button to the right of the message box. You can change voices by clicking the 'Voice settings' cog (1 in our screenshot above) – our favourite is Wave, which speaks in a natural-sounding English accent. Click the 'Stop talking' (X) button 2 to end your conversation and view a transcript.



Another new AI feature is Edge's 'Scareware blocker', which uses machine learning to identify and block 'scareware' scams. These usually take the form of full-screen pop-ups that claim your PC's security has been compromised, and try to scare you into calling fake tech-support numbers or downloading malware.

To enable this new security option, click Edge's three-dot menu button and choose Settings, then 'Privacy, search and services'. Scroll down to the Security section and switch on 'Scareware blocker' 3. Note that it's still a 'preview' so may not be completely reliable.

Edge has also integrated a Microsoft Designer-powered feature, which lets you design custom themes for the browser using AI. See our Workshop opposite to learn how it works. ■



Organise your emails with macOS Sequoia 15.4

The Mac has finally got automatic Mail organisation features.

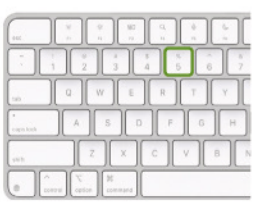
IT WILL TAKE
5 minutes
YOU WILL LEARN
What you can usefully do with this latest Mail redesign
YOU'LL NEED
macOS 15.4 or later

It's common to feel overwhelmed by an overflowing email inbox so any help regaining control over your messages has to be worth considering. When iOS 18.2 arrived, assistance came in the form of a new feature that automatically sorts email messages into one of four categories. Now that function has come to macOS 15.4 (Sequoia) as well, and it should mean you don't miss anything of importance amid a sea of spam.

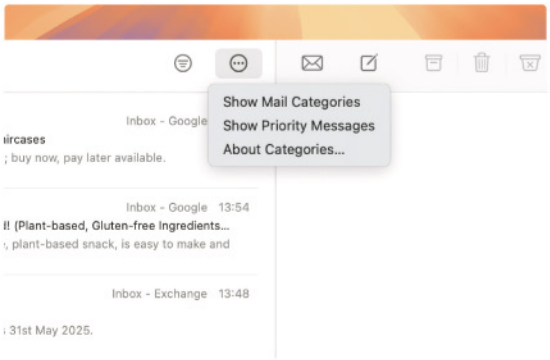
It can take a bit of getting used to and, in the early stages, you may feel as if you could struggle to find specific messages – there have already been complaints about 'disappearing' emails. But with priority messages enabled on devices that support Apple Intelligence, the ability to reassign any misplaced emails to a more relevant category, and with the knowledge that you can quickly switch to All Mail at any time, you'll likely find email management becomes that bit easier. Let's check it out.

David Crookes ■

GENIUS TIP!
You can also quickly switch from any of the mailbox categories to All Mail by doubling-clicking any category or pressing Opt+Cmd+5.

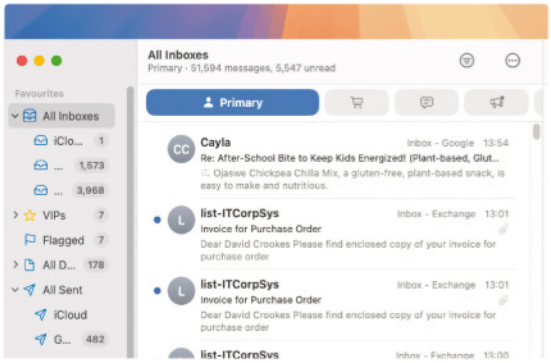


How to Use categories in Mail



1 Keep it turned on

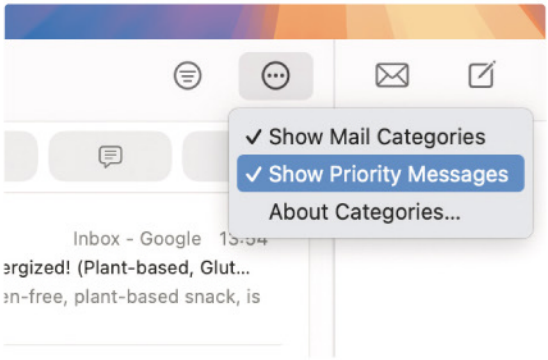
The Mail Categories feature is turned on by default and it's worth keeping it active for now. If you don't like it, you can always turn it off later by clicking the More menu ('…') and deselecting Show Mail Categories.



2 View important emails

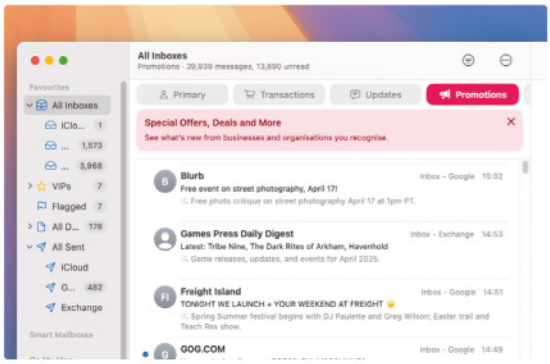
You'll find your inbox has been split into four views, the main one being Primary. This is home to important, time-sensitive, personal messages. By removing less important emails, your inbox will feel more manageable.

Continued... How to use categories in Mail



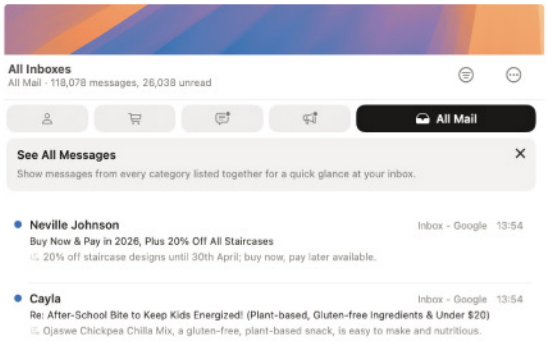
3 Show Priority Messages

Messages in the Primary inbox can be arranged according to how time-sensitive they are. To ensure this happens, click '…' again and select Show Priority Messages. Those crucial emails will go to the top.



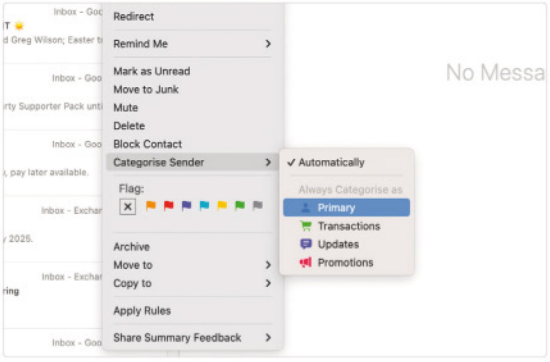
4 Discover other categories

Other emails are auto-sorted depending on whether they're transactions (receipts, delivery notes, etc), updates (newsletters and the like) or promotions. Some emails in these lists will also be found in the Primary one.



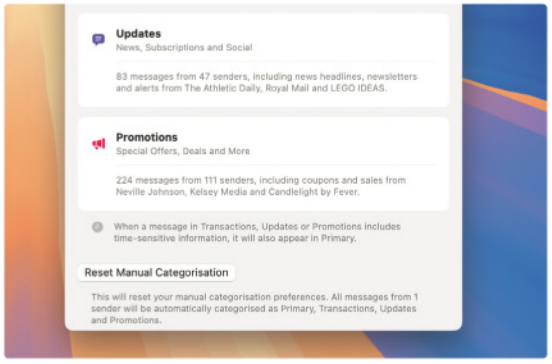
5 See all your mail

You don't need to turn off categories to see your emails in one inbox. To the right of the four categories is an All Mail button so either click this (you'll only see it's left edge) or select the current category button.



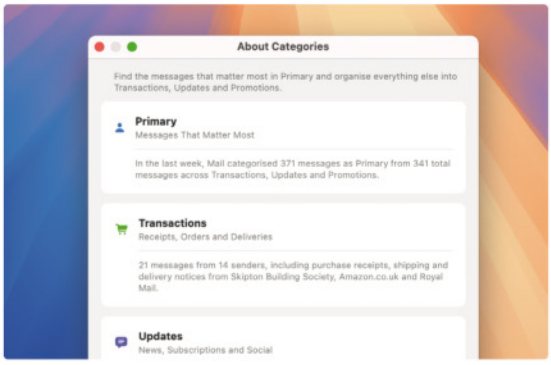
6 Change the category

Has an email incorrectly appeared in the wrong category? To fix this, Ctrl-click the message and select Categorise Sender. Choose one of four categories and all emails from this sender will be appropriately listed.



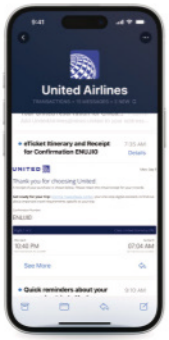
7 Reset manual configs

Manual overrides can be switched back by repeating the previous step. Alternatively, to wipe all changes in one go, you can click the '…', choose About Categories and select Reset Manual Categorisation.



8 Check email stats

The About Categories function also gives you a summary of how your messages have been categorised over the past week, picking out some of the more prominent senders. It's a quick way of monitoring what Mail is doing.



JARGON BUSTER

It should have arrived with macOS 15.4 but **Digest View** – which lets you select a non-Primary inbox and view all messages from a specific sender – is currently absent.

GENIUS TIP!

You can't create your own categories for Mail but you can go to Mailbox > New Smart Mailbox and create an inbox that adheres to criteria you set.



Draw in the terminal

Shashank Sharma's takeaway from years of writing is that if it's to be done, it can be done from the terminal.



As much as one enjoys the company of a spirited and lively nephew, keeping them entertained while on the computer, without turning to *Peppa Pig*, is a challenge. You can't leave them to their own devices for fear of bricking your system, or worse still, deleting or moving files and directories through some aggressive mouse and keyboard manoeuvres. Teaching them to type will only take you so far. Thankfully, drawing is a far more entertaining and enthralling activity. Even better to do it from the comfort of the console. While it might sound novel, you'll probably be surprised to learn that there are several text-based drawing tools on offer.

The main focus of this tutorial is Termpaint, a nifty tool that offers a number of symbols that can be used to draw on the canvas. You can also press any key on the keyboard and draw with that instead, if you prefer. You can also set the colour for drawing different elements using an RGB gradient control. The oldest project on our list is DrawIt, which is distributed as a plugin for the Vim text editor. It can be used to quickly draw shapes such as lines, boxes and ellipses. Finally, the Draw utility can be used to quickly put together colourful boxes, and add text inside them.

Paint your masterpiece

Released under the MIT licence and written in Go, Termpaint stands out from other drawing tools because of the symbols it offers that can be used to draw. With some creativity and a lot of practice, you can create beautiful artwork with Termpaint.

Run the `go install github.com/14Artemiy88/termPaint@latest` command to install the latest version of Termpaint. Once installed, you can launch it with the `termPaint` command. Notice the capitalised 'P' in the command? This isn't a spelling mistake on our part, but the actual command you must run. Use Tab-completion or create an alias if you find yourself mistyping the command.

When you run Termpaint, you're presented with a blank canvas, on which you can start drawing by left-clicking and dragging with the mouse. Press the Tab key to access the menu sidebar, which is split into three sections. At the bottom, the Help section informs you that you can press Ctrl+H to access the on-screen help. All the symbols you can use to draw with Termpaint are featured at the top of the menu sidebar under Symbols. There are 25 in all, and you can also draw boxes in four shades of grey. Left-click on a symbol to select it, then move the mouse back to the canvas to start drawing. You can switch between symbols as required and keep drawing on your canvas.

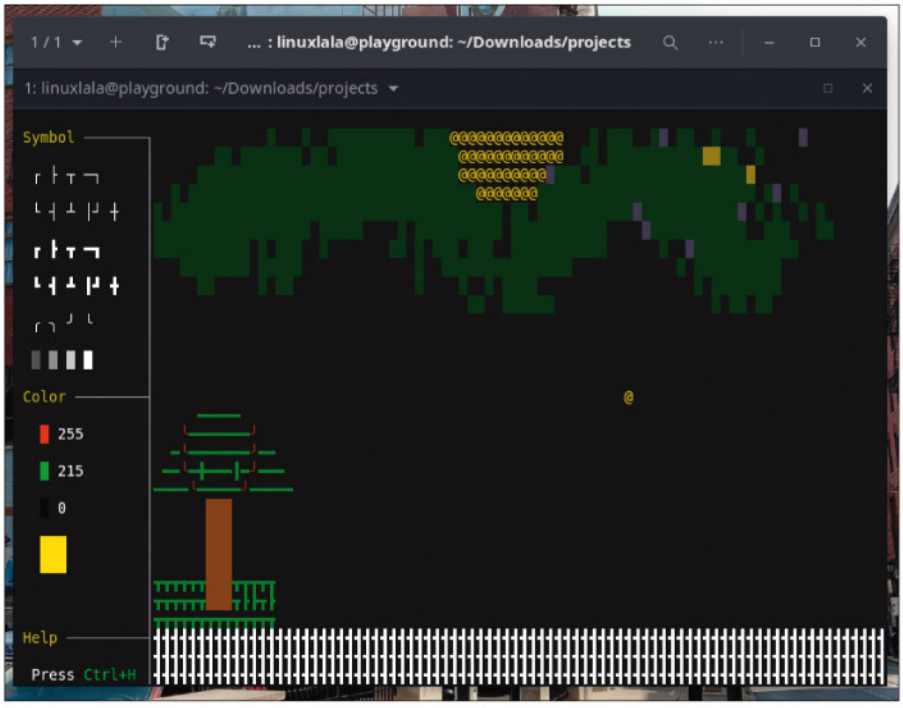
You can also set the colour you wish to draw with using the RGB gradient scale under the Color heading on the menu sidebar. Hover the mouse on either of the Red, Green or Blue values, and use the scroll wheel to increase or decrease the value. By default, the values are set at 255 for each of Red, Green and Blue, which results in white. Left-click a colour to immediately set its value to 0 or reset back to 255. To quickly define the value, hover the mouse on a colour, and type in the value you want. For instance, to set gold, leave Red at 255, hover the mouse at Green and type 215 or use the scroll wheel to decrease the value from 255 to 215, and click on Blue to set it to 0. The colour box at the bottom of the RGB scale displays the colour you've set with your tweaks. You can similarly set the colours to 128,0,128 for purple, or 0,0,128 for navy, and so on.

For occasions when the symbol choices are not enough, hover the mouse on the canvas and press any number or alphabet key on your keyboard to select it.

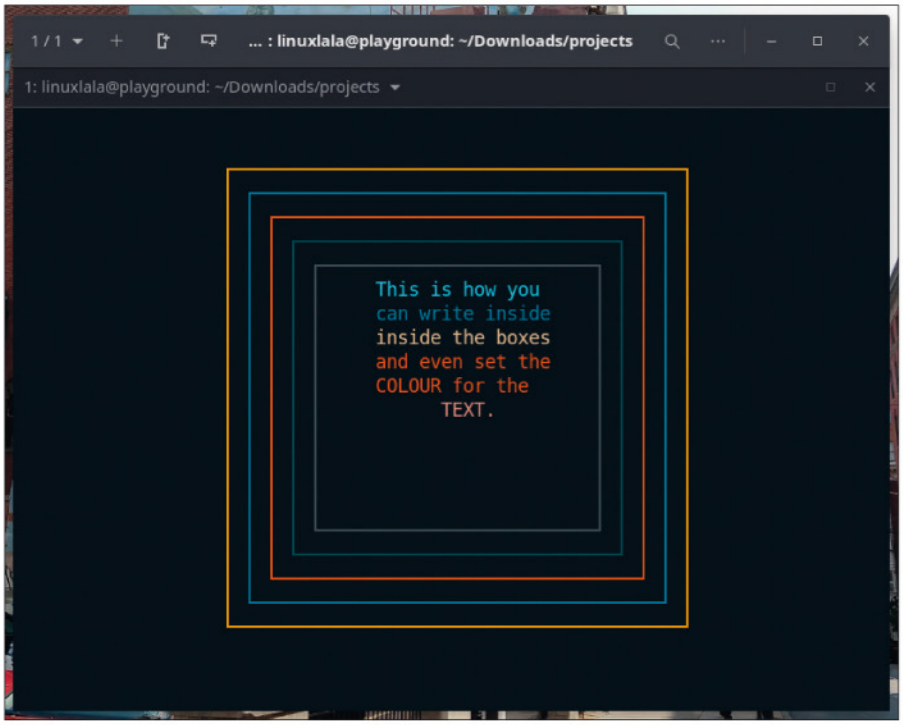
One can't very well draw without the

QUICK TIP

You'll easily find RGB codes for popular colours online (**tinyurl.com/APC547RGB**), which is especially useful if your tiny tot decides to paint in indigo or magenta.



The fence and the tree turned out alright-ish, but the attempt to draw mountains with a sun peeking out from behind proved to be our undoing.



The Draw utility is nowhere near as advanced as Termpaint, but it's still innocent fun for kids.

aid of an eraser, and Termpaint has you covered. Right-click the mouse and move over your drawn elements to delete. Unfortunately, Termpaint doesn't offer an undo/redo option, but the right-click to delete is a useful feature.

To save your drawings, press Ctrl+s and type in the filename. Your work is stored in the directory where you executed the `go instal` command to install Termpaint. You can also open previously saved files with Termpaint by pressing Ctrl+o.

To exit the help, press Ctrl+h again, and you can hit Tab to close the sidebar menu. Be sure to save your work as you progress with your drawings by pressing Ctrl+s, as Termpaint quits without any warning or offering to save your work when you press Esc.

You can draw

Compared to Termpaint, the Draw (**https://github.com/maaslalani/draw**) utility is far more straightforward. It can be used to draw boxes, and you can use the 1-7 number keys to set the colours. The utility also enables you to add text to the boxes. And that's it.

This is yet another Go utility released under the MIT licence. You can run the `go install github.com/maaslalani/draw@latest` command to install it. To launch the utility, run the `draw` command.

By default, the drawings are automatically saved to the /tmp/draw.txt file. You can either move this file to a different location to save it, or you can launch Draw with the `draw art-filename.txt` command, and your artwork is saved in the current working directory.

Draw is configured to work with the right-click of the mouse. You must press the right-click and drag the mouse across the canvas. A box is drawn when you release the mouse. To set a colour, press the keys 1-7.

If you wish to add text, right-click within the box to set the starting position for the text, and start typing. You can also set the colour for written text using the same keys: 1-7. Press Ctrl+c to exit the Draw utility.

There is no option to redo/undo work with Draw. You can press Ctrl+z but the behaviour is erratic, and the shortcut isn't described on the Draw's GitHub page.

You can also try your hand at the Diagram utility. The project has a fair number of dependencies, which can be satisfied from your distro's repositories. Once installed, you can use Diagram to convert ASCII art images into hand-drawn diagrams. ■

"Released under the MIT licence and written in Go, Termpaint stands out from other drawing tools because of the symbols it offers that can be used to draw. With some creativity and a lot of practice, you can create beautiful artwork with Termpaint."

DRAW WITH VIM

One of the best features of the Vim text editor is its extensibility with the aid of plugins. It probably won't surprise you, then, to learn that Vim offers a plugin to help you quickly draw a whole multitude of shapes.

Some Linux distros now offer Vim-tiny instead of the full-blown Vim editor, which is often criticised for being too overwhelming for new users. The minimalist variant of Vim offers a limited number of features, however, so you might want to install the full version from your software repositories when you start working with Vim's plugins.

With Vim itself installed, you can now download the DrawIt plugin with the `wget -O DrawIt.vba.gz https://www.vim.org/scripts/download_script.php?src_id=21108` command. This downloads the latest version of the DrawIt plugin, but we still have to install it.

To do that, run the `vim -c 'so %' -c 'quit' DrawIt.vba.gz` command, and hit `y` when prompted by Vim. When you now launch Vim, you'll be able to turn on the DrawIt plugin by typing `\di`. To stop the plugin, type `\ds`.

You'll notice the 'DrawIt' message at the bottom-left of the Vim interface when you turn on the plugin. 'DrawIt off' is displayed when you turn it off.

You can now use the arrow keys to draw lines. Press the PgUp key to draw diagonal lines moving up and to the right, and the PgDown key for diagonal lines going down. The Home and End keys can similarly be used to draw diagonal lines going up or down to the left respectively.

Phone & tablet tips

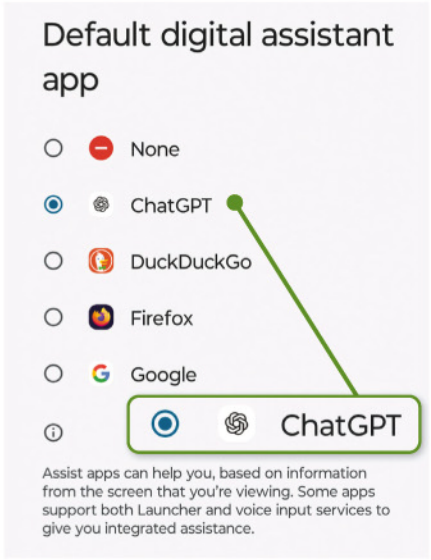
Brilliant things to do on your device.

ANDROID & iOS

Set ChatGPT as your default voice assistant

Google Assistant has long been the default voice assistant on Android devices, but it's being replaced by Google's AI tool Gemini. You now also have the option to make ChatGPT your default digital assistant, if you prefer OpenAI's tool to either of Google's.

Provided you have the ChatGPT app (**tinyurl.com/APC547chat**) installed on your Android phone or tablet, the change is easy to apply. Open the Settings app and tap Apps followed by 'Default apps'. Select 'Digital assistant app' then 'Default digital assistant app' and select ChatGPT (see screenshot below left). Press 'OK' to grant the assistant the required permissions.



You can now launch ChatGPT by long-pressing the Home button on your device and interact with the chatbot using Voice mode. However, unlike Google Assistant or Gemini, it can't control system settings or perform tasks such as playing music, and saying "Hey Google" will still trigger one of those tools.

If you don't want to use ChatGPT, you can instead combine Google Assistant and Gemini features to give you the best of both worlds. Open the Gemini app for Android (**tinyurl.com/APC547gemini**), tap your profile picture and choose Settings. Select 'Google Assistant features in Gemini' and switch on 'Use Google Assistant features'. These features include managing smart-home devices and getting personalised information from Google apps.

On an iPhone or iPad, you can't replace Apple's Siri assistant with ChatGPT, but it's possible to combine them – provided your device is running iOS 18.2 or later and supports Apple Intelligence.

Open the Settings app and tap 'Apple Intelligence & Siri' then ChatGPT. Press 'Set Up' and choose whether to use ChatGPT with or without an account. Siri will now source information through ChatGPT to answer your questions.



ANDROID & iOS

Search across your tabs in Chrome

Google has updated its Chrome mobile browser with a long overdue tab-search option. This means you can now search the titles of all the tabs you have open, when you want to return to a specific page.

To use the feature, open the tab switcher by pressing the square containing a number (which indicates the number of open tabs) in the top-right corner of the browser. Here you'll see a new 'Search your tabs' box at the top of the screen (see screenshot right). Start typing your search query to view tabs containing matching words in their titles. The results will be listed under 'Last open tabs' (in the Chrome app for Android) or 'Open tabs' (on iOS).

In Chrome for Android, the search feature goes even deeper by finding matching pages in your Bookmarks and

Best new apps — What you should install this month

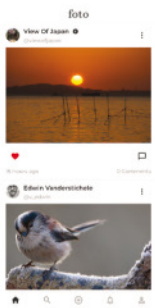
FOTO

Free*

Android tinyurl.com/APC547foto

iOS tinyurl.com/APC547fotoio

Foto is a new alternative to Instagram, aimed at photographers who are tired of the clutter in Meta's app. It lets you share uncropped photos, follow other users to view their shots and search for images with specific subjects such as aircraft, wildlife or sunsets. There are no ads or videos, but premium features require a subscription.

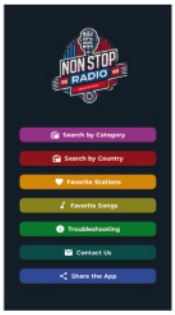


NON STOP RADIO

Free

Android tinyurl.com/APC547radio

This app lets you listen to thousands of radio stations from around the world. You can search the stations by category – such as Rock, Classical or News – or by country (from Afghanistan to Zimbabwe), and tune in with a single tap. Non Stop Radio lets you save favourite stations to return to later and tap through to broadcasters' websites.

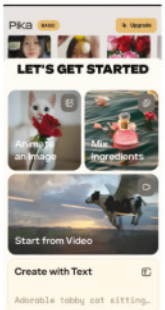


PIKA

Free*

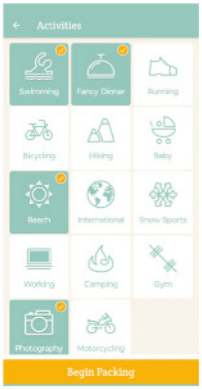
iOS tinyurl.com/APC547pika

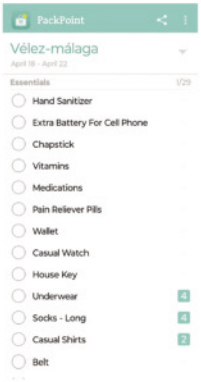
This amazing AI video generator makes it easy to create high-quality clips on your iPhone or iPad (there's no Android version yet). You can turn text descriptions into videos, animate still images, edit existing videos, apply creative effects and much more. Pika gives you 150 free credits a month, with paid-for plans starting at $14.99.

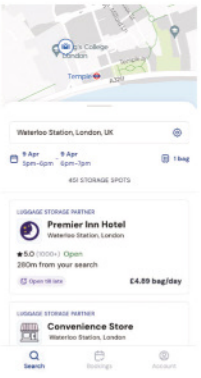


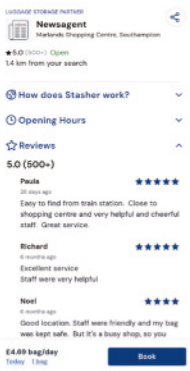
*Contains in-app purchases

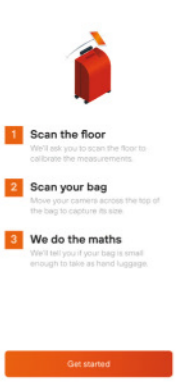
Best apps for... Managing your luggage

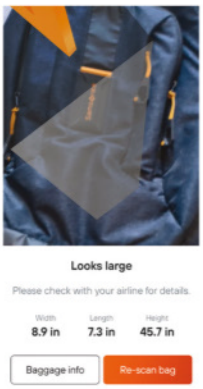












PACKPOINT

Free*

Android tinyurl.com/APC547pack

iOS tinyurl.com/APC547packio

If you often pack too much or too little when you go away for a short break or a long trip, PackPoint can help. Specify your gender, destination, length of trip and planned activities and the app will generate a packing list of items you should take. You can add and remove items as required, and share your list with your fellow travellers.

Best for: Packing your suitcase

STASHER LUGGAGE STORAGE

Free

Android tinyurl.com/APC547stash

iOS tinyurl.com/APC547stashio

Stasher finds you nearby places to store your luggage while travelling. It has thousands of vetted 'stashpoints' in more than 80 countries, including in shops, hotels and restaurants. Just choose a date and time, and the number of bags you want to stash, to view available storage spots, read user reviews and book directly through the app.

Best for: Finding luggage storage

KAYAK

Free

Android tinyurl.com/APC547kayak

iOS tinyurl.com/APC547kayakio

Flying with a cabin bag rather than hold luggage saves you money, but most airlines have strict policies on size. The Kayak app includes a handy 'Measure your bag' tool that uses augmented reality to calculate the dimensions (though not the weight) of your hand luggage and tell you whether it's small enough to take on the plane.

Best for: Avoiding baggage fees

History, which you can tap to reopen. The new tab-search option is also available in Chrome's Incognito mode.

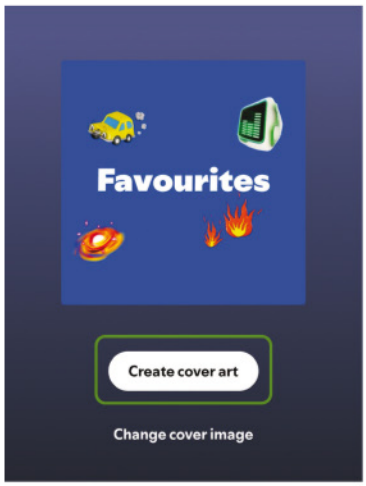
ANDROID & iOS

Create your own artwork for Spotify playlists

Spotify now lets you design your own artwork for playlists, rather than stick with its default grid of album covers. This is to make your playlists "look as good as they sound".

To try the new option, open a playlist, tap the three-dot icon and select 'Create cover art'. Choose 'Create cover art' (see screenshot above) on the following screen to play around with different design elements. For example, you can customise the size, style and presentation of the text in the playlist's title; upload an image or take a photo with your camera; and apply various stickers to the playlist's artwork. Tap 'Save' when done.

Alternatively, skip the customisation and just choose 'Change cover image' to select a suitable picture. You can restore the original playlist image by choosing 'Remove photo'.

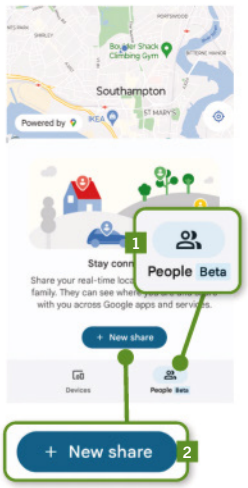


The new cover-art feature is available to all free and Premium users of the Spotify mobile app.

ANDROID

Share your location in Find My Device

Apple's Find My app for iPhones and iPads includes a useful People option, which lets you share your current location with friends and family, and vice versa. Google has now added a similar feature to its Find My Device app for Android (**tinyurl.com/APC547find**), to complement the options for locating lost phones, tablets, accessories and tracker tags.



To share your location, open Find My Device and sign into your Google account. Tap the new 'People (Beta)' tab in the app's bottom toolbar (1 in our screenshot right) and press 'New share' 2. Select the contact you want to share your location with and choose how long to share it for – one hour, today only, a custom length of time or until you turn sharing off. Tap 'Share' to start sharing – or choose 'Share link' to send a link instead. Turn on Location Sharing if prompted.

The other person will now be able to track your location in their Find My Device app or Google Maps. Likewise, you can track them via the 'Sharing with you' section of the People tab or Maps. You can stop sharing your whereabouts at any time.

Google has also updated the Devices tab in Find My Devices, so that it instantly shows the location of your main phone or tablet on a map when you open the app. ■



The scale of the war you find yourself in is frequently epic.

PRICE $119 **PLATFORM** PC, PS5, XBS/X **WEB** tinyurl.com/APC547doom

Doom: The Dark Ages

Indulgent and deliciously violent, yet surprisingly safe.

In a time when the FPS campaign is so vanishingly rare that the only helping of big-budget shooting we can rely on each year is from *Call of Duty*, it'd be easy for id Software to kick up its feet and decide "more *Doom*" is good enough. It'd be good enough for me. But that'd be dereliction of id's duty to the genre it created.

To id, a new *Doom* is an opportunity to demolish a perfectly good sand castle and start fresh. *Doom: The Dark Ages* is the trilogy's sharpest zag yet – recasting the Slayer from a meaty fighter jet, dashing past the hordes of Hell, to a stalwart tank, smashing shield-first into the action.



The transition is successful, but not without major sacrifice. This is *Doom* at its most indulgent and deliciously violent, but it's also dumbed down and undeniably the easiest of the trilogy. Maps are uncharacteristically barren, secrets abnormally obvious, and puzzles so simple that they hardly fit the description. Viewed through the lens of loud feedback that insisted *Doom Eternal* was too complicated, *The Dark Ages* is an overcorrection.

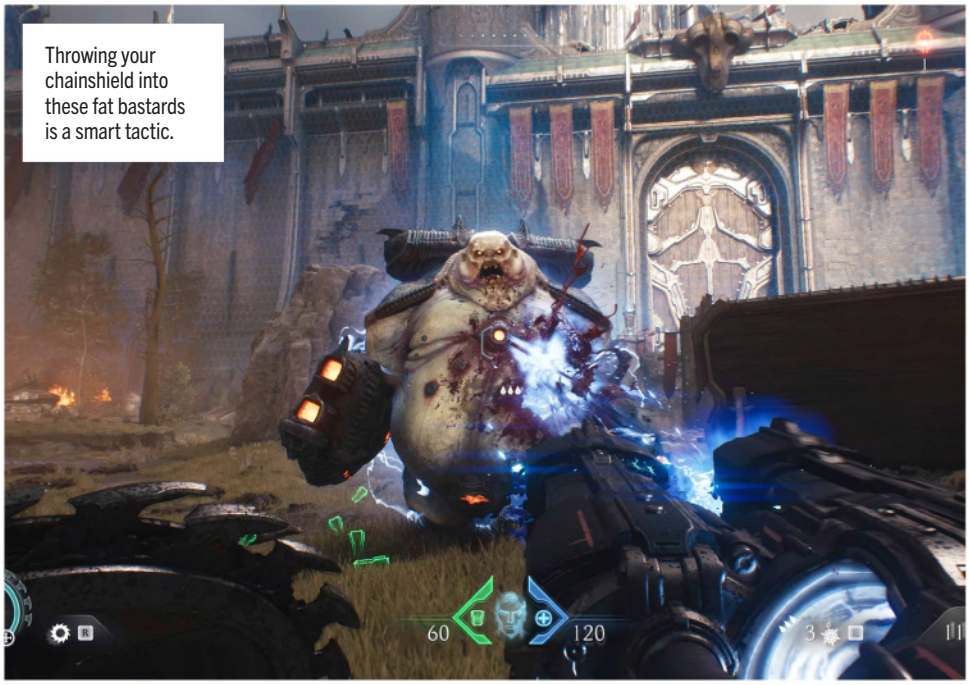
It's appropriately uncomplicated, given the need for some change. The Slayer's otherworldly determination and general freakishness are amplified by his proximity to normal, communicative humans. They treat him like an unknowable demigod, inherently dangerous but effective when pointed in the direction of hellspawn. I loved the dynamic, partly because id is paying off years of mythbuilding, but also because this Slayer adopts the role of a deranged Master Chief, more or less following orders as long as he agrees with the mission.

Close guard

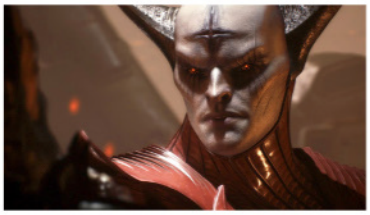
The Dark Ages' rebooted gun ballet revolves around the Shield Saw. Bound to right-click, the shield blocks all damage from the front and sends green projectiles back to their senders. It's a change that ripples through every facet of *The Dark Ages*, anchoring the Slayer to the ground in exchange for survivability.

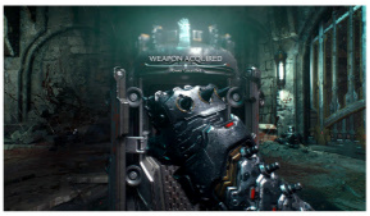
I cannot sing the praises of the Shield Saw loud enough: shrugging off the blows of lesser demons and nailing the timing on parries is empowering from minute one, elevating *Doom*'s brutality and giving the player permission to run toward the biggest threats instead of playing keep-away. In fact, the only move resembling Eternal's air dash is a shield dash that instantly closes the distance on large demons and obliterates fodder on contact. An early upgrade gives the shield its chainsaw teeth, turning it into a throwable that either stuns or slices straight through demons.

The shield slots into *Doom*'s



Throwing your chainshield into these fat bastards is a smart tactic.







deadly dance like it was always there. It's elegant, useful, aggressive... and unfortunately also one-note. Once you can throw it around, the shield is done evolving, my tactics were locked in for the campaign's duration.

Civilised age

What *The Dark Ages* gains with its shield, it loses with its guns. Using right-click to block means guns no longer have secondary fire modes – they're still upgradable, but now focused on passive boosts to reload speed, fire rate, or damage. Besides a few bright spots, like a Shredder upgrade that let me shoot at my thrown shield to ricochet stakes toward enemies, my weapons never improved in ways that encouraged me to alter my game plan.

As much as it pains me to admit, *The Dark Ages*' thematic stand-ins for ballistic guns just aren't as fun to shoot. The Ballista replacement launches stakes that hit hard but have an oddly short range, the Shredder is just a Heavy Cannon that sounds like a nail gun, and those guns that hurl bits of skull are all bark and no bite. The lone exception to this rule is the Chainshot – a monstrous back-half arrival that launches wrecking balls, caving in skulls before reeling back into the gun like a sinful yo-yo. Thankfully id didn't mess with its two shotguns, the rocket launcher, or the plasma rifle, all of which sound and look better than ever.



ABOVE The setting is Argent D'Nur during its war against hell.

Flattened

I get the sense that *The Dark Ages*' heavy mechanical pruning is in service of making it the most accessible, instantly enjoyable *Doom* for the most people. If that's the case, then mission accomplished. It's still *Doom*, so it's still very fun.

I did have more fun after increasing enemy aggression, tightening the parry window, and experimenting with higher projectile speeds, but at some point, I had to accept I was fishing for complexity that wasn't there.

The Dark Ages' levels are simplistic next to the mazes of the last two games. Presumably to accommodate the Slayer's wimpy new jump, most maps are massive, flat, and devoid of hazards – like id took 2016's winding corridors and pressed them into a pancake. I like that they're more friendly to backtracking than ever, with areas spoking off a central platform, but a few of the larger maps had me sprinting across empty deserts way too often.

Secrets are still scattered literally everywhere, but the majority of them are so obviously placed and announced by the map that I rarely felt like I was discovering something. It's another area where *Eternal* had more to offer: those ultra-hard, opt-in challenge rooms? Gone. Now puzzles just give you an extra life or more gold to buy upgrades. At least those platforming sections that a lot of folks hated (but I loved) demanded a quick reflex test to get to the side goodies.

The Dark Ages is fun in totally different ways than its predecessors, and I love that, but its peaks are lower. After rolling credits, I went back to *Doom (2016)* and *Eternal* to confirm the gut feeling. id has done a lot of subtraction with not a lot of addition. *Doom* is a series I associate with taking big swings, but *The Dark Ages* is safe.

VERDICT

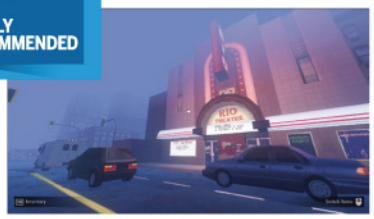
★★★★☆

The ripping and tearing Doom: The Dark Ages is indulgent and deliciously violent, but plays it surprisingly safe.

Morgan Park







apc HIGHLY RECOMMENDED

PRICE Free **PLATFORM** PC, Linux
WEB sunscreen.itch.io/ephemeral-frame

EPHEMERAL FRAME

TAKES PHOTOBOMBING TO ANOTHER LEVEL.

Growing up watching *Narnia* has made me look at paintings in a different way: as potential portals to other worlds. *Ephemeral Frame* has, remarkably, captured that feeling, by turning portal fantasy into a clever puzzle mechanic. Just click on a photo, as you explore these worlds in first-person, and you will instantly be transported to the world inside the frame.

At first, it's merely a tool for getting around. I want to get into the cinema, but the place is currently closed. Perhaps if I click on this flyer that's been hung up outside it I might be able to – yep, that's amazing, I'm now inside the cinema.

Pretty soon you're given the camera, which takes the excitement up another notch. Now you can take your own photographs and enter them whenever you want.

The game has reframed the world in that way that is curiously unique to puzzle games and is something special.

VERDICT

A good puzzle game heightened by an exceptional premise that never feels less than magical.
Tom Sykes



There's no scares, but there's plenty of mystery.

apc EDITOR'S CHOICE

PRICE $43 **PLATFORM** PC **WEB** tinyurl.com/APC547blue

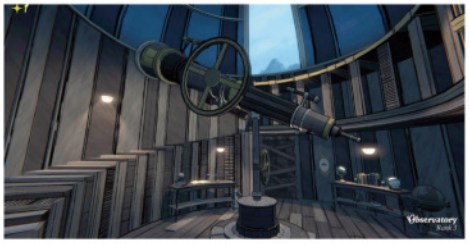
Blue Prince

Unravel the mysteries of a mansion, room by room.

I love *Blue Prince* so much I'm going to spend this entire review telling you as little about it as possible. Unravelling its many mysteries and solving its multitude of puzzles – several of which I'm still working on even after finishing the game – is best done if you go in with nearly no information. Don't watch videos. Don't Google solutions. Just go play it and you'll discover one of the best puzzle games in years.

In this first-person strategy roguelike puzzler, you explore a 45-room manor, then find and enter its hidden 46th room. The tricky bit? You're building the mansion yourself as you explore it. Click on a door handle and you're presented with a choice of three room cards, whichever room of the three choices you pick (or draft, as I'll call it from here on), that's the room you'll find when you open the door.

Every room has different attributes, some positive, some negative, some a bit of both. A darkroom won't let you see which three cards you're about to draft, for instance, while a drawing room, appropriately, will let you re-draw the rooms if you're not happy with what you've drafted.



Doing a little stargazing is always worth your time.

Doorways are important when drafting rooms since you're trying to build a walkable path through the grid to get as deep into the mansion as you can: draft too many rooms with no exits and you won't be able to proceed.

Then there's all the amazing and elegant puzzles, none of which I'll spoil here, because that would be mean. Since the house is different every time you build it, you won't see these puzzles all at once but over multiple runs.

By the time I finally entered the 46th room, I truly felt like I'd earned it. I was the rightful heir, damn it. It really was my house now. And like I said, even finishing the game left me with plenty more puzzles to solve. I'm not done with *Blue Prince* yet, not by a longshot, oh no.

VERDICT

This elaborate and elegant strategy adventure is one of the best puzzle games in years.
Christopher Livingston



PRICE $21 **PLATFORM** PC, Mac, Switch **WEB** tinyurl.com/APC547expelled

Expelled! An Overboard Game

Makes being a monster magnificent.

Expelled places you in Miss Mulligatawney's School for Promising Girls, an elite 1920s training ground for wretched entitled cretins. You're Verity Amersham, the lowly scholarship student, and you've just been framed – possibly – for smashing a stained glass window. Oh, and shoving another girl out of it. You have until the end of the school day to clear your name, frame someone else, and/or discover why this happened in the first place.

Each loop starts at 7.30am with that window smashing and the girl taking a tumble. To start with you can flee the crime scene (probably wise), or hide a crucial bit of incriminating evidence (probably wiser), or even just mill around waiting for someone to catch you (er...).

Whatever you choose will carry a time penalty, whether it's exploring the school, talking with other students or teachers, or even just checking how your hair is doing in a mirror. It's a point-and-click game at heart, a pretty one too, just with an extra layer of time pressure. It gets stressful, particularly in the early runs where you have no idea what you're doing.



The headmistress seems suspiciously keen for you to find a way out of this jam.

With every loop you learn more about each character's schedules, when crucial items can be obtained and the benefits of lobbing a hockey stick out of a shattered window. Oh, but it'll smack that poor girl who's already fallen out of the window in the head, rapping me with some badness points!

But it turns out, you want those points. There's precious little good karma to be found here, and your bad points persist between runs. Once the penny dropped that Expelled wanted me to become an asshole, suddenly things started making sense. Milestones of depravity are steadily reached the more your sins pile up and these in turn unlock more options for increasingly bad behaviour.

A game that starts off as a slightly too accurate simulation of the frustrations of being a schoolgirl in a pompous boarding school steadily blossoms into the origin story of a horrid bitch for the ages.

VERDICT

Expelled is a marvellous and evil detective game for you to explore.
Abbie Stone



PRICE Free **PLATFORM** PC
WEB tinyurl.com/APC547dull

DULL ACRES

DULL IS NOT HOW I WOULD DESCRIBE THIS.

Dull Acres is essentially a series of encounters, as the little protagonist trudges from screen to screen and finds similar stick-people in various dire, strange or funny situations. I happened upon a concert, swapped places with a peculiar tree and met some unlucky people that were dragged into the trees by some sort of monster. I encountered beautiful things and creepy things, as I gave up on reaching a destination and as the forest gradually shifted around me.

In such a repetitive environment, the encounters need to be memorable, and they certainly are here. There are bespoke animations, which are more expressive than the screenshots might lead you to believe, and the writing is thoughtful, concise, and often very funny. Absurdity is hard to do right and it's the shared dilemma of the forest's inhabitants that binds their sad, sweet and strange vignettes together.

VERDICT

Don't let your first impressionst stop you venturing into the woods.
Tom Sykes

GAME CHANGER

Old games, new perspectives





He's just been told the story of itsy bitsy spider.

RELEASE 2013 **DEVELOPER** Red Barrels **PUBLISHER** Red Barrels **LINK** redbarrelsgames.com

Outlast

A lifelong nightmare Kara Phillips won't outlast.

Horror games were never part of my repertoire when I was growing up. I just get scared way too easily. I always have done really. I used to have nightmares after watching *Jumanji*, and I once screamed so much at the Weeping Angel episode of *Doctor Who* that my mum banned me from watching it for two months. Because of this, horror was an instant write-off for most of my childhood. But when you've suddenly got a laptop that can just about handle gaming rather than relying on the family PC, and you have the confidence that you've become that little bit braver now you're a teenager, horror feels a lot less intimidating. That's until you're driving up to Mount Massive Asylum, and suddenly it clicks why horror was advised against.

The first time I played *Outlast*, I felt I had to keep it a secret. Not only was I going against being told I wasn't allowed to play horror games, but it's not exactly a gentle introduction to the genre. Between hallways streaked with bodies and blood, and some of the most perverted dialogue I've ever experienced in my many years of gaming, it wasn't something I felt proud to share. Safe to say It took me much longer than it needed to make my way around the asylum and roll the credits, but I was left pretty scarred from what I'd just experienced.

After I finally escaped, I vowed to leave *Outlast* be and let it fester in a corner of the internet I wouldn't touch for a while. And fester it did. Each time I thought to myself I was ready to face that level of fear again, I was reminded of the rotting smell of *Outlast*. I missed it, in its own twisted way, but it would take a lot more than memories to bring me back to that place. By a lot more, I mean about a decade.

Welcome back, friend

Cut to 12 years later, I'm sat in the driver's seat pulling up to Mount Massive Asylum. Surely *Outlast* couldn't be as scary so many moons on. Surely there's something about it that's ever so slightly outdated to make it harder for me to fully lose myself in the twists and turns of its labyrinthine location. But, no. I can hand-on-heart confirm that *Outlast* is just as tense and terrifying as it was when I was younger, and even more so now I understand its uncomfortable themes and perverse dialogue more rather than just being scared of its tense music and



They can't escape these bars... right?

nightmarish character design.

I've even played through the second *Outlast*, the *Whistleblower* DLC, and spent an exhaustive amount of time dragging my friends through *The Outlast Trials* in the meantime, but nothing compares to walking up to the asylum and shimmying through a window to get in, only to be met with instant darkness and a horrible feeling that something bad is about to happen to me, most likely within seconds.

As soon as your feet land on that clinical lino flooring, the sense of dread is overwhelming. I wanted so badly to close the game and find something much more comforting to play. But I had to push on and prove to myself that I was braver than I was a decade ago. So I made my way in, albeit hesitantly, and suddenly I was transported from my PC setup as an adult to my childhood bedroom hunched over that laptop again.

Cheap thrills

I thought I'd be able to remember or at least anticipate the first few cheap scares. They're a must-have in almost every horror game and serve as a test to see if you've got it in you to continue. The classic 'opens a door and a corpse swings through the doorway', or even the sudden hiss of television static when you step into a room. But no, it was as if I'd just picked it up for the first time. This was definitely helped by the fact I was playing with a headset which is something I lacked as a teenager, so it felt like the audio and, in turn, the setting was completely inescapable.

This also meant I could pick up on cues I had missed before, like whispering in the distance or footsteps, or even heavy breathing indicating something was hot on my tail rather than me clumsily turning around and coming face to face with a monster. This helped make *Outlast* feel somewhat new even though the

WORST NIGHTMARE

Seriously, what the hell is that?



1 TIME FOR A LESSON IN PERSONAL SPACE
One of my least favourite traits some horror game villains have is the inability to just leave you alone. If I wasn't already looking over my shoulder for the priest or even one of the weapon-wielding twins, then I was constantly on the lookout for this meathead. Just as you think you're safe, he's always there waiting to bring you back down to earth.

2 SOMEONE NEEDS A MANICURE
I know his whole thing is ripping people's heads off, but do his nails really have to be so long? All I can think about every time he grabs me is how much dirt and bacteria must be under there. If the pain he inflicts on you isn't enough to kill you, then I don't doubt the infection that comes after will kill you either.

3 WATER WATER EVERYWHERE
Seriously, you'd think this guy would find the time to rinse his jeans at least. You're telling me in a whole asylum, there's not a single washing machine? Even the sewer water would have a better smell than all that crusted blood and all those chunks of entrails. GROSS.









ABOVE The new neighbour seems a little nosy.

RIGHT Easy like a Sunday morning.





dark desolate hallways were ever so slightly familiar.

I had by no means mapped out the place in my head, since a lot of my time there before was spent running around with my eyes practically closed. But there were parts that I felt confident in navigating. That's due to the amount of nightmares I had following the first playthrough, though.

Through the lens

I also discovered this time around that no play-through of *Outlast* is going to be the same, even years on. Of course, you're walking the same paths, facing the same enemies, and you're being told the same story. But you'll still have new moments that make you jump out of your skin. You never know when or where an enemy will rock up while you're patrolling the sewers or what clip you'll manage to capture on your camcorder, which to this day is still one of my favourite elements of any horror game I've played.

Navigating a dark space with nothing but a torch or lamp is scary, sure. So scary in fact, it's now a classic trope of horror games. But when your only way of seeing in the dark is a night vision setting on a lousy, sort of grainy camcorder which you have to use sparingly, you feel a lot more vulnerable.

The fact you have to consider your batteries running out also adds that necessary extra layer of challenge, you know, on top of the impending doom of some deranged 'doctor' with a taste for blood, or a former security guard insisting you're a little pig while chasing after you. This only builds on the experience, too. Even 12 years on, the panic that strikes my heart when I get the low battery icon in the corner of my screen is unmatched. I just know the second I lose power, every single possible Variant within the asylum will come chasing after me and I'll just be stuck running aimlessly into a corner until my inevitable death.

Signs of wear

But it's getting more obvious that *Outlast* is starting to show its age, especially when you take its newest iterations like *The Outlast Trials* or even the older *Whistleblower* DLC in comparison. At the time of release, I remember being amazed by the graphics and how detailed everything looked, and while it still looks good now, there are some moments where you feel like *Outlast* looks a bit crunchy.

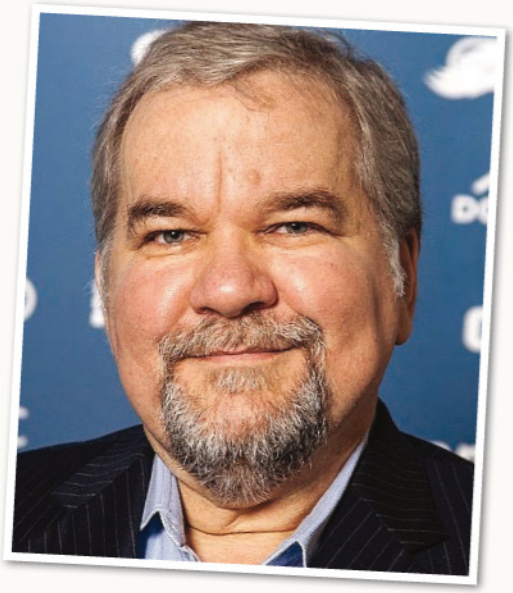
I don't necessarily think that's a bad thing, since the grain lets it naturally look like it was filmed on a camcorder which you obviously spend a lot of time using in-game anyway. But I can understand it not meeting the expectations of horror fanatics who have spent more time with supremely detailed, HD modern horror games that are so visually impressive they might as well be VR.

Yet no matter how dated it may start to look in decades to come, I think *Outlast* will always be that one horror game that haunts me. With that said, if I hadn't been brave enough to try and escape Mount Massive Asylum when I was a teen, there's no way in hell I'd feel attached to anything *Outlast* or even horror for that matter now. It still petrifies me to the very core, but I know in ten years I'll feel ready to come back again. If I haven't had a heart attack in that time, of course. ■

RETRO

Inspirational stories from computing's long-distant past

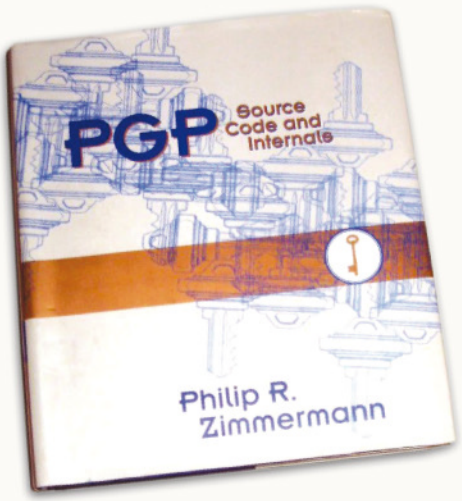
One man's fight for digital privacy



When cryptographer Phil Zimmermann created the world's most widely used email encryption software, US prosecutors sought to lock him up. David Crookes acts for the defence.

If you're writing a personal message to a friend, I'm guessing that you wouldn't be overly happy if someone else was taking a sneaky peek over your shoulder. It's the same online, which is why most people want to protect their privacy. It's also why many of us have come to love encryption software – tools that scramble readable data while it's being transmitted so that only the intended recipients are able to view it.

But if it wasn't for the efforts of activists and talented cryptographers such as Philip Zimmermann, there's no telling what systems we would have in place today. For his is a story of strong principles, political will, technical brilliance, determination and innovation. Not to mention great courage and perseverance.



ABOVE You can read the *PGP Source Code and Internals* book at **tinyurl.com/APC547PGP**.

Born in 1954, Philip Zimmermann was ten years old when he became interested in cryptology. "I'd read a children's book called Codes & Secret Writing and I learned about concepts such as substitution and transposition cipher while discovering how to make invisible ink out of lemon juice," he told *APC*.

He later began writing his own encryption programs at college. "I wrote a program to add random numbers to each letter of a message, using a pseudo random number generator. After sending the message, the recipient subtracted those same random numbers. It was completely, absurdly naive."

As if to underline how much of a learning curve Zimmermann faced at the time, he came across one of the earliest textbooks about cryptography a few years later. The method of encryption he'd used in his college app was included as the focus for a homework assignment.

"I thought, 'ah, great minds think alike' and I felt so vindicated," he said. "But then I came to realise, with a great deal of embarrassment, that developing this algorithm was not the assignment – breaking this algorithm was.

"It was extremely humbling and I thought, 'okay, maybe I'm not so smart after all'. And you would have thought that I wouldn't make that mistake years later. But I did."

ABOVE Zimmermann gave PGP away for free, believing strong encryption was for all.

Bomb the bass

In June 1991, Zimmermann attended the International Association for Cryptologic Research (IACR) conference and he ran into one of the leading academic crypto analysts, Eli Biham. "I'd created my own block cipher, the BassOmatic, and I showed it to him," he said.

Zimmermann had been designing his symmetric-key cipher since 1988. "It was named after a Saturday Night Live skit in which [comedian] Dan Aykroyd was dropping whole fish into blenders to make a smoothie. I thought it was a funny name and used it because my software would scramble data just like the BassOmatic scrambled fish."

But when Biham sat down during the lunch break, Zimmermann was shocked. He'd spent ten minutes explaining how it worked. "Eli Biham then spent two minutes showing me how to break it and that was when I knew, okay, I'm stupid twice."

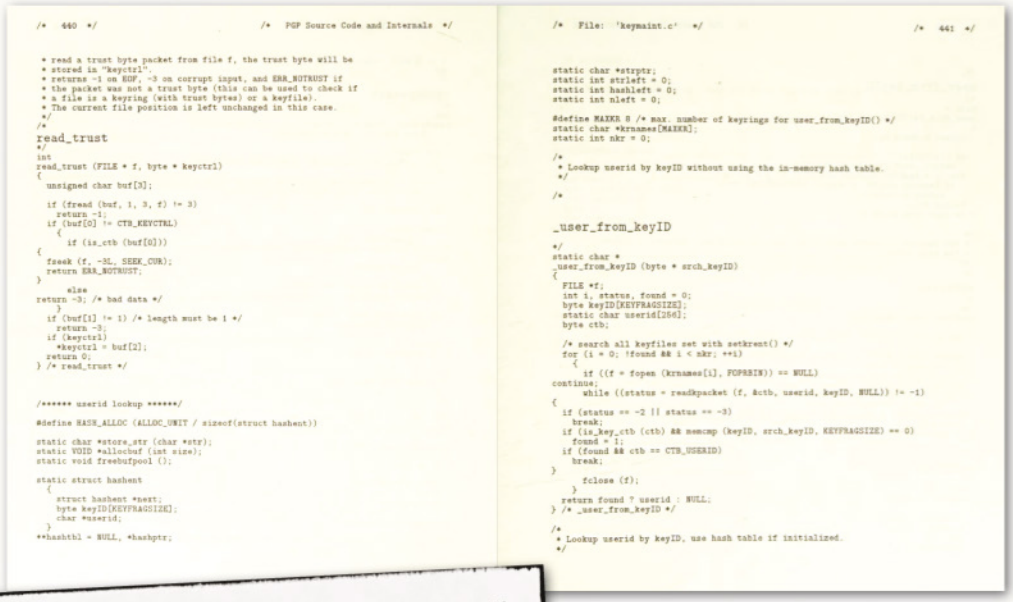
> ""I wrote a program to add random numbers to each letter of a message, using a pseudo random number generator. After sending the message, the recipient subtracted those same random numbers. It was completely, absurdly naive.""

philzimmermann.com

And yet Zimmermann is far from stupid. Quite the opposite, in fact, which makes his conversation – peppered with such self-deprecation – all the more engaging and approachable.

For while he was learning cryptology, finding his feet and inevitably making mistakes, Zimmermann was also willing to take advice on board, thereby avoiding falling prey to the Dunning-Kruger effect – "that's when somebody's stupid and they don't know they're stupid," he said.

It meant he could see the failings of BassOmatic, which formed part of his free mass-market encryption program for securing emails, and use that knowledge to create a rock-solid version. In doing so, this man of great intelligence and motivation was able to help shape the technological landscape forever more.



```
/*  440  */                                  /*  PGP Source Code and Internals  */

 * read a trust byte packet from file f, the trust byte will be
 * stored in "keyctrl".
 * returns -1 on EOF, -3 on corrupt input, and ERR_NOTRUST if
 * the packet was not a trust byte (this can be used to check if
 * a file is a keyring (with trust bytes) or a keyfile).
 * The current file position is left unchanged in this case.
 */
/*
read_trust
*/
int
read_trust (FILE * f, byte * keyctrl)
{
  unsigned char buf[3];

  if (fread (buf, 1, 3, f) != 3)
    return -1;
  if (buf[0] != CTB_KEYCTRL)
    {
      if (is_ctb (buf[0]))
{
  fseek (f, -3L, SEEK_CUR);
  return ERR_NOTRUST;
}
      else
return -3; /* bad data */
    }
  if (buf[1] != 1) /* length must be 1 */
    return -3;
  if (keyctrl)
    *keyctrl = buf[2];
  return 0;
} /* read_trust */


/****** userid lookup ******/

#define HASH_ALLOC (ALLOC_UNIT / sizeof(struct hashent))

static char *store_str (char *str);
static VOID *allocbuf (int size);
static void freebufpool ();

static struct hashent
  {
    struct hashent *next;
    byte keyID[KEYFRAGSIZE];
    char *userid;
  }
**hashtbl = NULL, *hashptr;
```

```
/*  File:  'keymaint.c'  */                                  /*  441  */


static char *strptr;
static int strleft = 0;
static int hashleft = 0;
static int nleft = 0;

#define MAXKR 8 /* max. number of keyrings for user_from_keyID() */
static char *krnames[MAXKR];
static int nkr = 0;

/*
 * Lookup userid by keyID without using the in-memory hash table.
 */

/*


_user_from_keyID

*/
static char *
_user_from_keyID (byte * srch_keyID)
{
  FILE *f;
  int i, status, found = 0;
  byte keyID[KEYFRAGSIZE];
  static char userid[256];
  byte ctb;

  /* search all keyfiles set with setkrent() */
  for (i = 0; !found && i < nkr; ++i)
    {
      if ((f = fopen (krnames[i], FOPRBIN)) == NULL)
continue;
      while ((status = readkpacket (f, &ctb, userid, keyID, NULL)) != -1)
{
  if (status == -2 || status == -3)
    break;
  if (is_key_ctb (ctb) && memcmp (keyID, srch_keyID, KEYFRAGSIZE) == 0)
    found = 1;
  if (found && ctb == CTB_USERID)
    break;
}
      fclose (f);
    }
  return found ? userid : NULL;
} /* _user_from_keyID */

/*
 * Lookup userid by keyID, use hash table if initialized.
 */
```



SCO EXAMINER ★★★ Tuesday, September 21, 1993 D-3

Grand jury is investigating encryption software exports

ASSOCIATED PRESS

SAN JOSE — A federal grand jury is investigating exports of a controversial computer program in a case that could affect how software is distributed worldwide.

U.S. Customs officials asked for an investigation into ViaCrypt of Phoenix and Austin Code Works of Austin, Texas, and the companies' plans for foreign distribution of software, including PGP, a program that turns data into an indecipherable code using encryption technology.

William Keane, an assistant U.S. attorney, confirmed that an investigation is continuing, but declined to comment on the case.

The PGP program has been distributed worldwide over computer networks by some computer enthusiasts who oppose the U.S. government's trade regulations on encryption.

The National Security Agency, which monitors international communications, has supported strict encryption technology export regulations, arguing that it would be difficult to keep tabs on hostile governments and foreign terrorists.

But opponents say the restrictions hurt sales and violate the First Amendment that protects the right to publish information about encryption.

"I wrote PGP to make democracy healthier. I didn't do it to make money," said Philip Zimmermann, a computer consultant who developed PGP.

No puppet

To explain, BassOmatic formed part of what Zimmermann, in his typically modest way, named Pretty Good Privacy (PGP), and it was born out of his desire to ensure electronic communication was as safe and secure as possible.

He'd read the original Rivest-Shamir-Adleman (RSA) cryptosystem paper when it came out in the late 1970s while he was studying for a degree in computer science at Florida Atlantic University. "I wanted to implement RSA but I couldn't because all I had was an Apple II," he said.

In the mid-1980s, however, when he was working as an IT consultant in Boulder, Colorado, he began implementing RSA using the programming language C on the PC. There, he produced "standalone, little petri dish implementations" before deciding to bring it all together, motivated by the political landscape at the time.

"I was quite active in the 1980s," he said, referring to his past as an anti-nuclear demonstrator which saw him working as a military policy analyst on the Nuclear Weapons Freeze Campaign. This mass movement wanted the US and Soviet governments to halt the nuclear arms race, and Zimmermann's involvement saw him arrested twice (he was once in the same police jail as actor Martin Sheen and astronomer Carl Sagan).

"Ronald Reagan was president," Zimmermann said. "And he thought we were Soviet puppets. But I knew for sure that I wasn't a Soviet puppet and I knew a lot of people in the peace movement and I couldn't think of a single one of them who was a Soviet puppet.

"So what you have there is, if you want to try to be politically active on something that you know your government doesn't like, then maybe you need to protect yourself from your government. And if you live in a foreign country where human rights abuses are common, you certainly need protection from a government in those places.

"So my motivation for developing PGP was to protect Americans from their own government. If people were active on something the White House didn't like, they could be politically active and organised with some privacy."

TOP Zimmermann implemented RSA in the C programming language.

ABOVE PGP was embroiled in a legal dispute on its release.

The crypto race

At the time, Zimmermann was earmarking communication via Bulletin Board Systems (BBS) – servers that allowed users to connect via a terminal program. "BBSes were all the rage," he said.

He was also in something of a race against time. "I ran into this rather disturbing thing, Senate Bill 266, which was a non-binding Sense of Congress resolution," he said. "It wasn't going to become law but it said communication technology companies should build backdoors to allow law enforcement to get to everything. Specifically, it wanted backdoors in encryption.

"That increased pressure on me to put pedal to the metal because I figured, well, right now it's a non-binding Sense of Congress resolution, but what about later? This could be an indication that it's going to become law, so I decided I had better release PGP while it was still legal to do so and change the facts on the ground.

"If I made it so that everybody had it, it would become far more difficult for the government to make a requirement to have backdoors."

As such, he worked on and incorporated that homegrown encryption algorithm, BassOmatic, which operated on blocks of 256 bytes and used a key to shuffle and transform data in complex ways such as by blending it based on control bits.

"It was not very good, cryptographically," said

Zimmermann. But while the development nearly sent him under financially – "I'd missed five mortgage payments," he explained, "and I couldn't miss any more otherwise I'd lose the house" – it set the ball rolling.

PGP was then handed to a friend called Allan Hoeltje, who posted it to an ISP called Peacenet, which activists used across the world. Zimmermann also gave a copy to Kelly Goen, who uploaded it to a Usenet newsgroup specialising in distributing source code, marking it as US-only. Zimmermann thought this meant the program could only be downloaded in the US, but it spread globally; everyone was allowed to use it non-commercially without needing a licence.

Work also got under way on version two of PGP. Zimmermann decided to ditch BassOmatic in favour of code based on the International Data Encryption Algorithm (IDEA) – a symmetric-key block cipher designed by James Massey and Xuejia Lai.

"It was presented at the IACR conference and it was getting a lot of peer reviews, so I just decided to use that and it worked so much better," Zimmermann said.

The big difference between version one of PGP (based on BassOmatic) and version two (based on IDEA) was that the latter combined symmetric and asymmetric key cryptography.

Users would have a public encryption key and a private key known only to themselves. Messages sent would be encrypted using the receiver's public key and then unscrambled using the receiver's private key. There was no central bank of private keys, making it very secure.

"Version two was released about 15 months after version one and it implemented the trust model which made PGP famous," he said. Development of the latter component was aided by Hal Finney, a strong advocate for individual privacy. "I knew what the trust model had to do and how it should do it, but he wrote all the code," Zimmermann said.

Trust in me

The "web of trust", as it's known, is a decentralised system that verifies identities. It establishes the authenticity of the binding between a public key and its owner and it was thus explained in the manual for PGP version 2.0:

"As time goes on, you will accumulate keys from other people that you may want to designate as trusted introducers," it states. "Everyone else will each choose their own trusted introducers. And everyone will gradually accumulate and distribute with their key a collection of certifying signatures from other people, with the expectation that anyone receiving it will trust at least one or two of the signatures. That will cause the emergence of a decentralised fault-tolerant web of confidence for all public keys."

Trust was key to Zimmermann, and it's also why he decided to write his manual using the first-person singular. "You don't need trust for word processors or computer games, but encryption software depends on it," he said.

"The idea of writing the manual in first-person singular was to allow people to read it and to hear it in my voice. It was me talking directly to the reader, which I felt would build more trust." Perhaps as a result of all of this, PGP became very popular.

It wasn't long, however, before US government officials got in touch with Zimmermann. "I was contacted by US customs in around February 1993," he recalled. "The customs agent said she wanted to ask me a few questions about PGP so I said, 'sure'.

"I figured they needed some advice on how to deal with it and I was happy to talk but she said, 'well, we'd like to come and meet you in Boulder'. She was calling from San Jose, California, and I suddenly understood that, no, you don't get two US customs agents getting on an airplane, flying from San Jose to Boulder, unless there's something important. This is not to get a tutorial. There must be some other motivation.

"So, because I couldn't just refuse, I contacted a criminal defence lawyer and he negotiated with them and we agreed to meet



ABOVE Zimmermann worked on the Nuclear Weapons Freeze Campaign in the 1980s.

"Trust was key to Zimmermann, and it's also why he decided to write his manual using the first-person singular. "You don't need trust for word processors or computer games, but encryption software depends on it," he said."



ABOVE The software sat under the same export restrictions as munitions.

in my lawyer's office. I thought maybe I could defuse this if I talked to them. And so we did."

He was told that PGP looked to be in violation of the Arms Export Control Act. "It prohibited the export of munitions and there was a list of things that required a special licence from the State Department. If I wanted to export a helicopter gunship, I would need a licence. If I wanted to send Stinger missiles to Libya, I would have to get a licence. One of the many, many things on the munitions list was encryption software."

Since PGP was being used outside the US, it was seen to have been exported. And because the encryption was so strong, the government wouldn't be able to easily break it. As such, it wasn't going to grant a licence. A criminal investigation ensued.

Although Zimmermann wasn't making any money from the project, the Department of Justice claimed PGP would allow terrorists and criminals to hide their activities, and he was looking at up to 52 months in prison if found guilty.

"I was worried. I had a family. I had two small children who would be homeless. I didn't think I would do very well in prison either," he said. "I got a legal defence team and I also decided I needed to talk to the press. I did one interview each day, five times a week, and 100% of the articles were in my favour, not 99%, not 99.9%, but 100%. They were critical of the government's position."

Devil in the detail

Having spent $100,000 in legal fees – the tab was mostly paid for by privacy rights activists – the charges in connection to the posting to Usenet in June 1991 were finally dropped in January 1996.

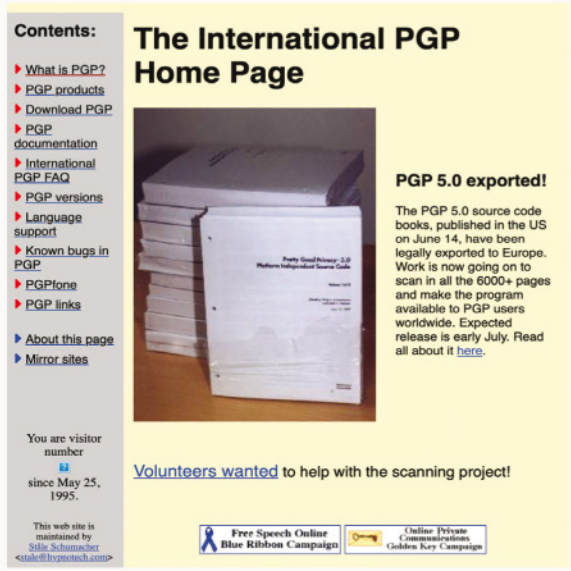
Zimmermann could rest easy and, eventually, strong cryptology was removed from US export restrictions. All western democracies also dropped their restrictions, meaning Zimmermann had truly triumphed.

Would he have written the program had he known the personal problems it would cause? "I did consider the possibility that something like this might happen but I didn't think they would go through with it because it's kind of absurd," he said.

Ingeniously, this possibility had influenced the name of the product to some extent – a name that bore all the hallmarks of Zimmermann's tendency to play down his ability. "People would say, 'oh, shucks, what's all the fuss about – why are you getting so upset about something called Pretty Good Privacy?'

"It was modest. It wasn't claiming to be the strongest thing ever – it just happened to be the strongest thing ever, at least with version two. I could have named it the encryption software from hell. You know, Satan's Diabolical Software. But no, no, no.

"And anyway, if I didn't work on this encryption software, someone else would have later. Maybe it would have just taken a little more time." ■





BELOW PGP was acquired by Network Associates (now McAfee) in 1997.

BOTTOM PGP was available for Unix, VMS, MS-DOS, Windows, OS/2, Mac, Amiga, Atari and Archimedes.

Cornell University Library, US Marine Corps photo by Cpl Joseph Scanlan



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KNOW HOW

Hoping to eliminate Wi-Fi blackspots around his home, Robert Irvine tries to...

Extend Wi-Fi with an old phone

One thing I miss about my tiny, expensive apartment was that I never had any problems connecting to Wi-Fi. Every corner was amply covered by the wireless signal, so I could work without leaving my bed during the winter months – just as well, as the place was freezing.

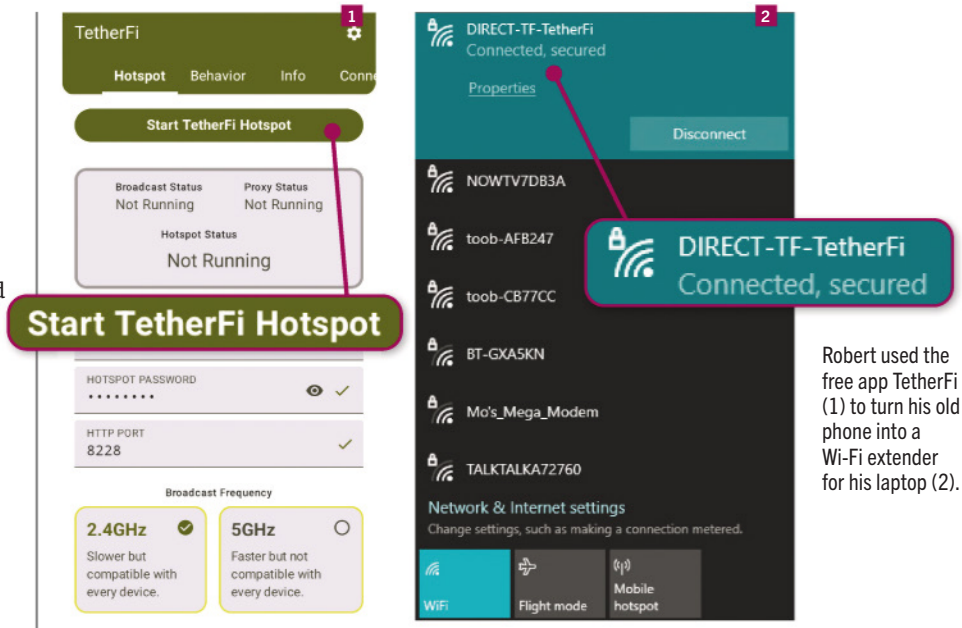
Now that I live in a larger, warmer and cheaper home, I have fewer things to complain about – aside from late bin collections. But I have noticed that my Wi-Fi is spotty and sometimes non-existent in the areas furthest from my router.

I've considered buying a Wi-Fi repeater or mesh system to boost the signal to these blackspots, but first wanted to try a DIY approach. I'd read that you can use an old phone to extend your Wi-Fi coverage, to save forking out for a dedicated device.

To test this method, I dug out my old Motorola Moto G50 Android phone and connected it to my Wi-Fi network. Next, I opened the Settings app and chose 'Network & Internet' followed by 'Hotspot & tethering'. I then tapped 'Wi-Fi hotspot' and activated the option 'Use Wi-Fi hotspot'. The 'Hotspot password' was a random string of characters, so I changed it to something more memorable.

Back on my Windows laptop, I clicked the Wi-Fi icon in the system tray to view available networks. I selected my phone's hotspot and clicked Connect. This showed as 'Checking network requirements' then 'Connecting' before telling me it was 'Unable to connect'.

When I tried reconnecting, Windows prompted me to enter the hotspot password. I did so, clicked Connect and this time it worked – except it said 'No internet'. This was a major obstacle, because a Wi-Fi extender with no Wi-Fi is about as useful as a chocolate teapot.



Robert used the free app TetherFi (1) to turn his old phone into a Wi-Fi extender for his laptop (2).

On checking my phone, I found that enabling the hotspot had disconnected it from my Wi-Fi network. This apparently happens on devices that can't support both connections simultaneously. I searched for a setting in Android's 'Developer options' that reportedly fixes the problem, but this wasn't available on my Motorola phone.

Determined not to give up, I installed the free Android app TetherFi (**tinyurl.com/APC547tether**). This sets up a hotspot on your phone using its active Wi-Fi (or mobile-data) connection. I tapped the Start TetherFi Hotspot button in the app (see screenshot 1) and granted it permission to access my precise location. I then connected to the hotspot on my laptop, by entering my router's PIN followed by the hotspot password. The connection was successful, but again it said 'No internet'.

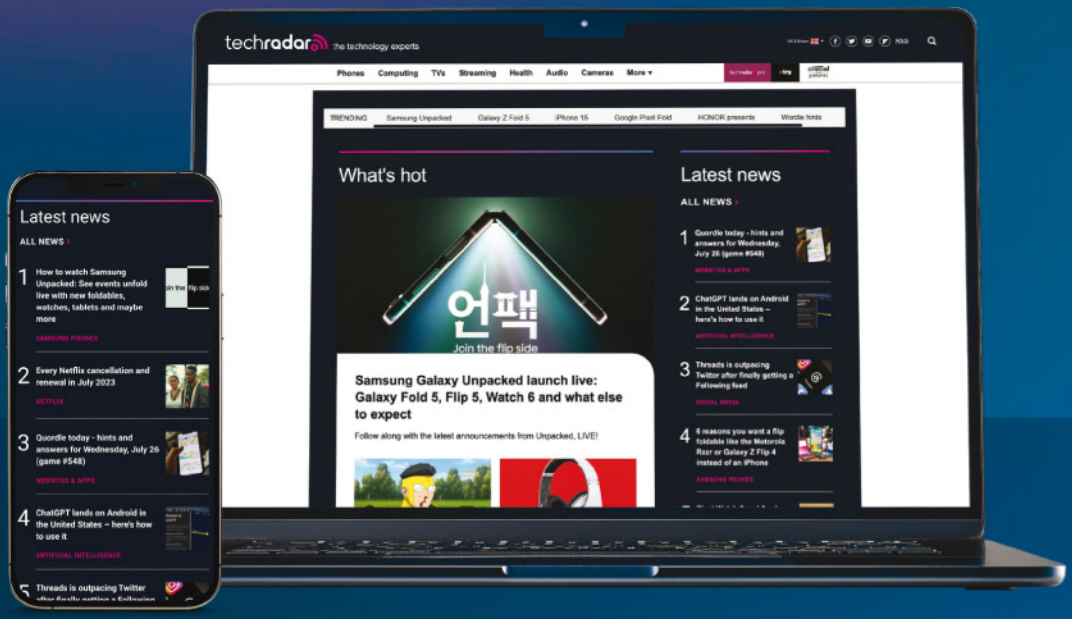
To solve this problem, I configured Windows to use a proxy. I opened the Settings app and clicked 'Network & Internet', then Proxy. I switched on 'Use a proxy server' and entered the IP address and port number provided in the TetherFi app. I then clicked Save and tried connecting to the hotspot again. This did the trick (see screenshot 2) and I was finally able to get my laptop online via my old phone.

To test whether it actually did extend my Wi-Fi, I took my laptop to a corner where reception is weak, and placed the phone halfway between that blackspot and my router. Sure enough, the wireless signal now easily reached the problem area, though it wasn't particularly fast – 12.3Mbps, which is about a third of my usual download speed.

This is presumably because the hotspot and the proxy split the router's signal, significantly reducing the available bandwidth. But at least TetherFi managed to extend my wireless coverage, unlike my phone's own hotspot, and it didn't cost me a cent. ■

"I've considered buying a Wi-Fi repeater or mesh system to boost the signal to these blackspots, but first wanted to try a DIY approach. I'd read that you can use an old phone to extend your Wi-Fi coverage, to save forking out for a dedicated device."

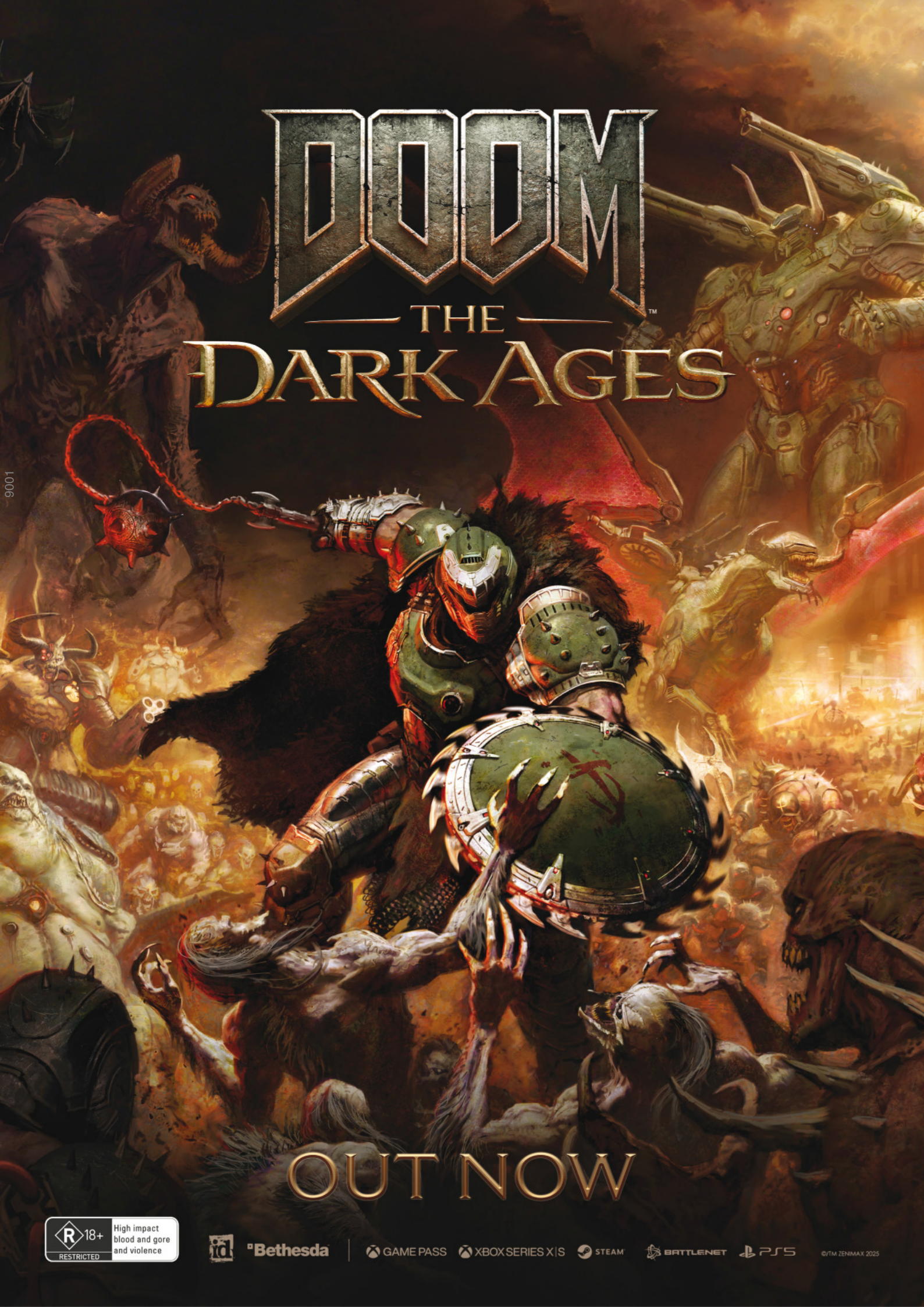
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