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PC power in console form

- Living room friendly chassis
- PlayStation-beating performance
- Power on and play in seconds



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FUTURE
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EFF.ORG

ELECTRONIC FRONTIER FOUNDATION

Protecting Rights and Promoting Freedom on the Electronic Frontier

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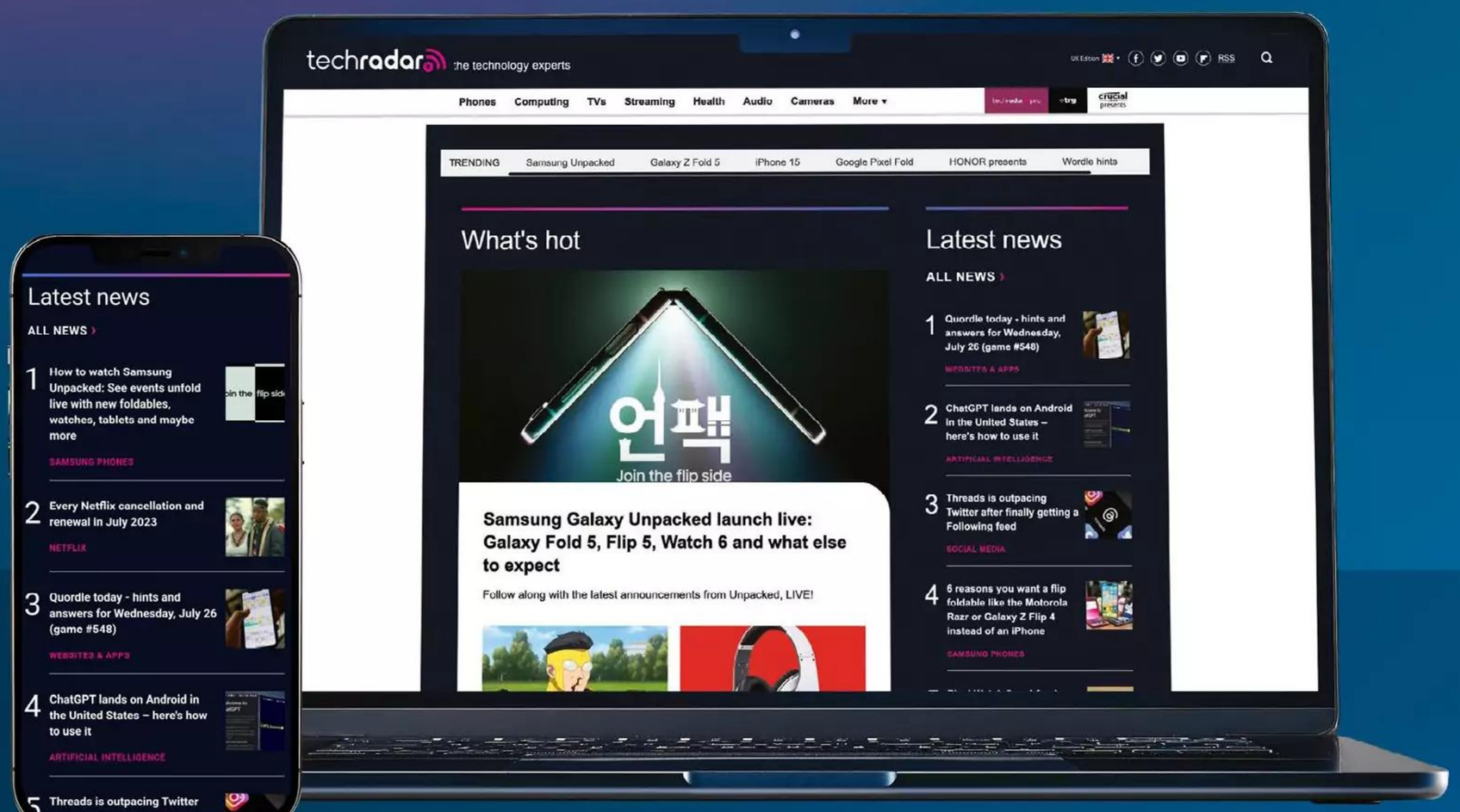




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EXTRA DIGITAL FEATURES

AUDIO FILE PHOTO GALLERY VIDEO FILE

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Guy Cocker

NO NEED TO CONSOLE YOURSELF

A LOT HAS CHANGED since we did our last "Console Killer" cover build in December 2020, as the PlayStation 5 and Xbox Series consoles launched and subsequently remained sold out through much of 2021. I encourage any PC historians to go back and have a read—I actually laughed out loud when I saw our description of the RX 5500 XT, at $210, as "sensibly priced." Today, we'd describe that as an absolute bargain, given the cheapest current-gen AMD card, the RX 7600, costs $270. Combining that with an AMD Ryzen 3 3100 for $99, we put what was then a "next-gen console killer" system together for $1,149—a lot more than a $500 PS5, but pretty cost effective.

To build an equivalent machine in 2024, updated to compete with the brand new PS5 Pro, we had to spend a bit more, mainly due to the increase in CPU and GPU prices. But to be fair, the PS5 Pro has also received an inflation-adjusted price, coming in at $700 without a disc drive or even a vertical stand. It seems as though Sony has learned from Nvidia when it comes to taking advantage of its market dominance—when you're beating Xbox so convincingly, you can charge what you want, and people will pay it. In the interest of balance, it was pleasing to see how much prices for some PC components had come down, particularly RAM and SSDs, which are bargains next to what they cost in 2020.

Our master builder Zak Storey's finished ITX build is as compact as you'd want for a living room PC, thanks to a stunning Fractal Design case housing everything. Zak's also elected not to cut corners to try to match the PS5 Pro on price. Instead, he's gone for mid-range components that should last a lot longer than the three years until the PlayStation 6 is due. He also shows you how to create a system that launches straight into Big Picture mode, so you can be gaming seconds after booting, and navigate using only a DualSense wireless controller. Finally, he looks at how much AI-driven tech like AMD's FSR (and the Sony equivalent, PlayStation Spectral Super Resolution) are allowing manufacturers to push claims of 4K and 8K gaming, even when the underlying hardware is capable of no such thing. Build your own console-like PC by following our guide on page 16.

Elsewhere, we open the news section with info on the latest CPUs from AMD in the mobile space, and Intel on the desktop side. It's interesting to see how AMD is boasting of its AI smarts, keen to keep up with Qualcomm no doubt, while Intel is all about power efficiency, even at the cost of raw performance Hopefully, Nvidia will push the envelope early next year with its rumored 5000-series GPUs, but we only expect true leaps from the 5090 card, the price of which we dread to think about.

We're continuing to review AMD's Ryzen 9000 Series processors (page 74), and next issue the aforementioned Intel chips will be entering the lab. We'll see you next month for our full verdict on the Intel Core Ultra 200S series, as well as our first next-gen Intel build.

Enjoy the issue!

Guy Cocker

Guy is Maximum PC's *editor-in-chief. He built his first gaming PC in 1997 to play* Tomb Raider *on 3dfx, and has been obsessed with all things PC ever since.*

↘ submit your questions to: editor@maximumpc.com

THE NEWS

AMD and Intel unveil next-gen AI CPUs

CPU titans clash again, unveiling chips optimized for AI

BOTH AMD and Intel have announced their latest CPU line-up, with models focused on improving AI integration and power management.

The AMD Ryzen AI PRO 300 Series represents the third generation of the manufacturer's AI mobile chips. AMD boasts of "unprecedented" performance and "multi-day" battery life.

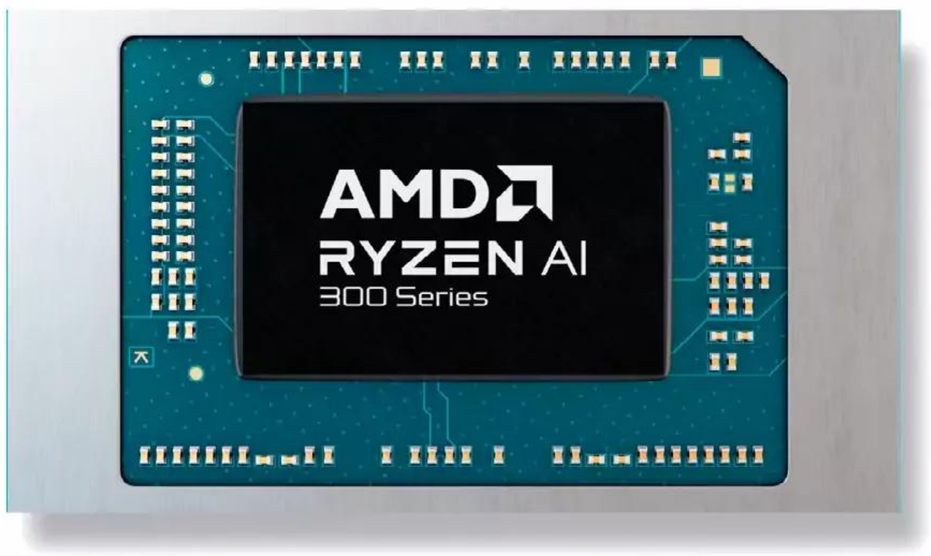
It also claims AI performance up to three times faster than the previous generation.

Indeed, the flagship Ryzen AI 9 HX PRO 375 supposedly offers up to 40 percent higher performance and 14 percent faster productivity performance compared to the Intel Core Ultra 7 165U. It also boasts 12 cores, 24 threads, and up to 5.1GHz boost.

The series deploys XDNA 2 architecture to the integrated NPU, ostensibly delivering up to 55 TOPS of AI processing power.

On the Intel side and its new desktop chips, the company is less reticent about its latest Core Ultra 200S Arrow Lake series, claiming up to 40 percent reduction in package power consumption. Intel also states that Arrow Lake heralds the very first NPU in a mainstream desktop chip.

While AMD has been using chiplets for desktop machines for some time, Intel is a relative newcomer to the tiled approach to CPU construction. The Core Ultra 200S Series adopts a four-tile approach for tying various constituent parts together, using in-house Foveros technology.



AMD claims its flagship CPU delivers up to 55 TOPS of AI power.

Technically, Arrow Lake is the successor to the 14th Gen Intel Core series. Adopting the Core Ultra nomenclature certainly makes it easier to say. Still, it's not clear why Intel dubbed it 200S given there's no preceding 100S series.

The flagship Core Ultra 9 285K features 24 cores/threads (8 P-cores and 16-E cores), with up to 5.7GHz clock speeds. It includes an NPU similar to those found in Meteor Lake processors, with up to 36 TOPS of total INT8 performance in AI workloads.

While this places it slightly behind the latest AMD series, the announcement from Intel also states that the 200S series "brings new overclocking functionality with fine-grain control." Specifically, Intel claims a top turbo frequency in 16.6MHz steps for P-cores and E-cores.

The new memory controller supports the latest XMP and CUDIMM DDR5 memory (up to 48GB per DIMM) for up to 192GB. Intel's euphemistically named "Extreme Tuning Utility" will also apparently enable one-click overclocking.

Users who are keen to deploy Hyper-Threading (HT/SMT) will be disappointed, however. Intel's decision is justifiable, given that Hyper-Threading in any CPU requires a greater number of transistors, resulting in more power usage. A lack of Hyper-Threading also makes the Intel Thread Director's job easier, because it doesn't have to account for additional P-core threads.

Because the Ryzen AI PRO 300 series is made by AMD, it continues to deploy SMT (Simultaneous Multi-Threading) in the flagship AI 9 HX 375 and related chips.

The series is due to be integrated into Copilot+ computers through the manufacturer's partnership with Microsoft.

The announcement also stated that the chips feature in the recently-released HP EliteBook X Next-Gen AI PC, as well as the Lenovo ThinkPad T14s Gen 6 AMD.

Luca Rossi, president of the Lenovo Intelligent Devices Group, has gone on the record to state that the latest ThinkPad "offers outstanding AI computing power" and that together with AMD, the company would "transform the business landscape."

Sadly, it's not currently possible to put the marketing blurb to the test, because the release date for the Ryzen AI PRO 300 series on OEM systems is simply slated as "later this year." Intel has been more definitive once again, promising that the Core Ultra 200S series will be available by the time you read this. Look out for our full review of the new chip next issue. **–ND**

©AMD

AMD-POWERED DUAL-SCREEN OLED LAPTOP LAUNCHES

EARLIEST SHIPPING CONFIRMED AS NOVEMBER

THE NAME GPD most likely brings to mind handheld gaming and miniature mobile PCs. However, in May, the Chinese manufacturer announced it was working on a fully-fledged laptop, complete with two 2880x1800 13.3-inch OLED displays.

Crowdfunding began on IndieGoGo on October 8, and at the time of writing has raised over $245,000. Currently the campaign is scheduled to end on November 22, meaning laptops will start shipping from late 2024 at the earliest.

The flagship GPD Duo model deploys the AMD Ryzen AI 9 HX 370, with 12 cores and 24 threads. It also supports up to 64GB of LPDDR5X RAM (soldered), as well as two M.2 PCIe 4.0 ports supporting up to 2TB of storage if both are used.

Other models and configurations are available for those who can't afford the Ryzen AI 9. Prices start at $1,425 or $1,270 for those who avail of the early bird pre order. **–ND**



FALL IN APPLE SALES

While the PC market is bullish, Apple sales have slumped.



APPLE MAC SALES have taken a significant year-on-year hit of 17.5 percent in Q3 2024, according to data gathered by Canalys. The plummet in sales saw the number of units go from 6.2 million to 5.1 million. This means that since last year, Apple's share of the PC market has dropped from 9.5 to 7.7 percent.

By contrast, the overall PC market has seen modest growth, with 66.4 million units shipped in Q3, a 1.3 percent growth. Canalys reports that while desktop PC sales are down 4.6 percent to 12.9 million units, this is balanced out by notebook sales, which at 53.5 million units, are up by 2.8 percent.

Given the cost-of-living crisis, consumers may be less likely to buy Apple's relatively expensive devices. The pandemic also led to a rise in PC and laptop sales as more people started working from home. This has since subsided.

Apple lovers may also be holding out for the new ultra-fast M4 MacBooks. Appetites were whetted by the inclusion of the M4 in the iPad Pro, early 2024, indicating MacBook performance will also be considerably improved. **–ND**

Tech Triumphs and Tragedies

A monthly snapshot of what's good and bad in tech

TRIUMPHS

STEAMOS VRR SUPPORT
The OS has introduced variable refresh rate for the ROG Ally and ROG Ally X.

JEDI POWER BATTLES
PlayStation classic is coming to Windows, Switch, PlayStation, and Xbox in January 2025.

SUPER-SLIM BATTERY
Researchers at Chalmers University in Sweden have developed a credit-card-sized battery, enabling thinner and lighter phones and notebooks.

TRAGEDIES

EXPANSION CARDS LEAK
Blizzard was supposed to release *Great Dark Beyond* on November 5. A glitch resulted in players who obtained one card seeing all 145.

WORD DOC DELETION
A bug in Office 365 can cause certain Word documents to be deleted instead of saved.

FALL IN DESKTOP PC SALES
Notebook sales have increased, but PC market fell 4.6 percent year-on-year in Q3 2024.

© GPD, APPLE CORP

NVIDIA AND MEDIATEK TEAMING UP?

Tech giants reportedly working on an AI CPU

ACCORDING TO REPORTS on the Chinese social media site Weibo, MediaTek and Nvidia are collaborating on a 3nm AI CPU.

If the rumors are to be believed, mass production is tipped to begin in late 2025.

Naturally, online speculation like this should be treated with a healthy dose of skepticism. It wasn't long ago when reports surfaced that the two companies were working on an AI processor.

However, recent speculation centers on integrating an AI CPU with Nvidia's GPU tech. This is odd, given that MediaTek specializes in mobile products, so would be more likely to develop SoCs.

The company also traditionally partners with AMD, not Nvidia. Indeed, there are separate rumors that AMD and MediaTek are partnering on a 5G notebook. This is plausible, given that AMD uses MediaTek's Wi-Fi 6E in many of its mobile products.

This said, there's logic to the rumor behind the AI chip. Despite the Qualcomm Snapdragon X Elite's success with Windows-on-Arm, it has faced criticism for graphical performance. Integrating Nvidia tech could help resolve the issues.

This would also likely catch the market at the right time. According to Gartner, global shipments of AI PCs are on the rise. Sales are projected to total 114 million units in 2025, up 165.5 percent from 2024.

This may be why the Weibo post by user "Mobile Chip Expert" name-drops Lenovo, Dell, HP, and Asus as potential customers eager to deploy the CPU in OEM hardware. The post hints at a price per chip of $300.

It wouldn't be the first time the two have collaborated. In March 2024, MediaTek announced it was partnering with Nvidia on Dimensity Auto Cockpit, a series of SoCs for vehicles that license Nvidia's graphics IP and Nvidia Drive OS. **–ND**



ELITEMINI AI370 OFFICIALLY ANNOUNCED

Gaming mini PC's specs have been confirmed

IN LATE SEPTEMBER, Minisforum revealed it was working on the EliteMini AI370 but provided no in-depth details. Around the same time, a leaked promotional poster teased what the mini PC would look like.

Minisforum has now ended speculation by officially announcing the release of the AI370, the first gaming mini PC in its line-up with an AMD Strix Point APU.

The specs were also leaked ahead of time, so it was no surprise when the official announcement revealed that the EliteMini AI370 has a Ryzen AI 9 HX 370—a 12-core, 24-thread CPU based on AMD's Zen 5 CPU core design, with a Radeon 890M iGPU.

That iGPU has 16 RDNA 3.5-based Compute Units—a third more than previous-gen iGPUs used in mini PCs. According to synthetic benchmarks by Andreas Osthoff of Notebook Check, this offers around 15% faster performance compared to the previous Radeon 790M.

Minisforum also claims that the new gaming mini PC can easily offer over 60fps in AAA games. We couldn't find official benchmarks to confirm, but we did discover the mini PC will come with 16GB of LPDDR5X RAM, expandable to 32GB.

The AI370 also comes with 1TB of NVMe PCIe 4 SSD storage, and there's an extra NVMe slot, so you can expand the storage further if you have a large games library.

Rear ports include 2x 2.5G Ethernet, DisplayPort, HDMI, and 2x USB 3.0 Type-A. The front has USB 4, 2x USB 3.0, and 3.5mm audio. External GPUs are supported, but there is no dedicated Oculink port.

Despite the assortment of ports, the AI370 can fit snugly on to desks, given it measures just 5.1 x 5 x 1.85 inches.

Pricing details aren't yet available, but the only other Strix Point mini PC (the Beelink SER9) retails for $999. **–ND**

Red Dead Redemption coming to PC

IT'S OVER 14 YEARS since *Red Dead Redemption* first took the gaming world by storm on the PlayStation 3 and Xbox 360.

In 2023, the game was released on the Switch and PS4. This puzzled many gamers who were hoping for a PC version. Rockstar has now rectified this by announcing that *Red Dead Redemption* will be available on PC by the time you read this.

Rockstar has also hinted at a number of PC-specific enhancements to John Marston's travels through the Old West. These include native 4K resolution at up to 144Hz, if you have compatible hardware. The PC game will also include support for both ultrawide (21:9) and super-ultrawide (32:9) monitors, as well as HDR10.

Unlike in the original game, there's also support for Nvidia DLSS 3.7, AMD FSR 3.0 upscaling technologies, Nvidia DLSS Frame Generation, adjustable draw distances, and shadow quality settings.

Readers preparing for the zombie apocalypse will also be happy to learn that the *Undead Nightmare* expansion for *Red Dead* is also being released. Both the game and expansion have been tentatively priced at $49.99.

YouTuber Cycu1 has performed an in-depth comparison of the first trailer compared to similar scenes on the PS5 version of *Red Dead Redemption.* The PC version seemingly has superior color grading, lighting, and shadow depth. **–ND**



The trailer promises a PC version with better lighting and shadow depth.

Internet Archive suffers serious security breach

The well-known repository of virtually all human knowledge has been hit by a series of DOS attacks. Founder Brewster Kahle confirmed the attacks on Twitter. He also reported the website had been "defaced" via JS library.

Once the site started working, visitors saw a notification that 31 million emails and hashed passwords had also been stolen.

Kahle says security is being improved and the JS Library has been disabled for now. At the time of writing, the Wayback Machine is running in read-only mode.

A Twitter account with the ID SN_Blackmeta claimed responsibility "because the archive belongs to the USA." The Internet Archive, in fact, has no ties with the US government. **–ND**

Alpha test of Flight Simulator 2024 announced

On October 8, Microsoft announced a technical alpha test for the latest version of its *Flight Simulator.* The testing period will last 2-3 days.

At the time of writing, the exact dates haven't been confirmed; however, the official release of *Microsoft Flight Simulator 2024* is still pegged for November 19.

Interested parties can enrol via an Insider signup survey. However, the listed system requirements are quite demanding. According to the official site, the recommended GPU is either a Radeon RX 5700 XT or a GeForce RTX 2080.

The alpha is designed for testing online services such as content streaming and career mode. Players won't have access to owned content from the 2020 version of *Flight Simulator.* **–ND**

© AMD, ROCKSTAR GAMES



Jarred Walton

TECH TALK

Could AI 'remaster' older games in real time?

YOU CAN'T SWING A GPU without whacking into something AI-related—not that I recommend swinging your graphics card around. But one interesting new topic is the potential to remaster old games with AI. Take that to the next level and we could see real-time modifications, so that the graphics spit out by a game engine are munged into something radically different.

Imagine firing up *Quake II*, but instead of blocky polygons that are shades of brown—all the rage back in 1997—you get a hyper-realistic rendering of a futuristic soldier blasting through a military base full of menacing alien Strogg and their abominations. Or perhaps that's not your thing and instead you get *Quake II* reimagined as a rainbow-filled world where you throw candy at unicorns.

Such transformations are already possible, sort of. "Ultra-realistic" game reimaginings by AI using Runway ML's Gen3 video-to-video functionality are popping up on YouTube. But I put that in quotes for a reason, as it looks real in the same way as a multi-limbed human with mangled hands and a distorted face generated by Stable Diffusion looks "real."

There are plenty of other interesting AI gaming projects, though. After training a neural network on 5.5 million frames of *Counter-Strike: Global Offensive*—95 hours of gameplay—the Diamond Diffusion world model lets you play the Dust II map rendered purely by AI. OK, "play" is a stretch, as it runs at around 10fps on an RTX 3090 after nearly two weeks of training on an RTX 4090. And there are plenty of 'hallucinations' where the AI model doesn't properly understand what should happen. But as a technical achievement, it's kind of cool.

Of course, an RTX 3090 can run the free-to-play *Counter-Strike 2* at around 150fps at 4K and maxed-out settings—just a bit faster than low-res AI running at 10fps. And if you're thinking you could just take any old game and feed it through a tuned video-to-video conversion tool to get something playable, we're a long way from that level of performance. Runway ML runs on clusters of data center GPUs and can take minutes to spit out a video clip that's only a few seconds long.



An AI rendition of the phrase "turtles all the way down" rendered using ComfyUI and the Flux.1, which took about 15 seconds on an RTX 4080.

If eight A100 GPUs currently render one frame per second and the goal is real-time 60fps gameplay, we'd need a speedup of several orders of magnitude. Replacing eight GPUs with one consumer model and boosting throughput by 60x won't happen overnight. Even if we double the performance of consumer GPUs every two years, it could take the better part of two decades to reach the necessary level of computational power—and you'd still have to deal with the added latency of AI post-processing.

But software algorithms have changed by leaps and bounds in the past few years, so perhaps this is closer than we think. Is it the sort of thing we'd want to enable, though? It might be cool to see what you can do with an old game and clever text prompts, but most of these deep-learning data sets rely on the theft of creative ideas made by billions of man-hours of human endeavor.

Forget the power costs of AI; what happens to art and creativity if we're just relying on processors to crunch numbers and spit out a poor facsimile? Where will new ideas to feed the machine come from if AI models are hoovering up anything and everything, including their own outputs? As the philosophers might suggest, we could end up with AI-generated turtles, all the way down.

> Where will new ideas to feed the machine come from if AI models hoover up everything?

Jarred Walton has been a PC and gaming enthusiast for over 30 years.

© AI GENERATED IMAGE OF THE PHRASE "A STACK OF TURTLES ONE ON TOP OF THE OTHER RECEDING INTO INFINITY, TURTLES ALL THE WAY DOWN" GENERATED BY JARRED WALTON USING COMFYUI AND THE FLUX.1 MODEL.

THE LIST

THE BEST EXTERNAL SSDs

THE BEST EXTERNAL SSDS are much more affordable than they used to be. Not only that, but they're genuinely portable in a way that older external drives never were. And, if your computer boasts a USB 3.2 port or higher, they can be genuinely speedy, often enough to compete with internal SSDs. If you're looking to share files between devices, or just carry a humongous games library with you, here are the best ones you can buy.



3 ADATA SE920

Not everyone will be able to use this drive because it requires a USB 4 port. However, if you have such connectivity, the SE920 is incredibly speedy. You do have to enable on-drive write caching, which could risk data loss over unstable connections, but if it's raw speed you want, and have a budget to match, this is the drive to get.
$180 (1TB), www.adata.com



2 CRUCIAL X6

The X6 has been updated to be even speedier than its first iteration, although it uses USB 3.2 Gen 2x1, so it's not the latest standard. It's been out a while, but given it's pretty consistently on sale, it's one of the best cheap external SSDs on the market. It may be previous-gen, but it should be fast enough for most purposes.
$78 (1TB), www.crucial.com



5 TEAMGROUP PD20

The PD20 is a portable SSD that's so small, it might as well be a USB flash drive. It doesn't maintain peak speeds for as long as some other drives, but it does for up to about 50GB-worth of sequential transfers, and is incredibly easy to carry around. If you're looking for a dainty drive, this is it.
$89 (1TB), www.teamgroupinc.com





4 SAMSUNG T9

The T9 is premium in every way. It achieves fast peak transfer speeds, and when speeds do drop, they remain consistently high. That's because it uses Samsung's in-house storage tech, including its 3D NAND flash memory and Pablo Controller, so you're getting what you pay for. It's also rugged and pleasantly weighty, meaning you don't have to worry about accidental bumps or drops.
$134 (1TB), www.samsung.com

1 ADATA SD810

The Adata SD810 is the best external SSD because it hits the crucial balance between price and performance for most use cases. The frosting on the cake is that it's also a diminutive drive that's dust- and water-resistant, making it very portable. It also supports USB 3.2 Gen 2x2 for lightning-fast transfers. It's simply a stellar all-arounder, and should satisfy most.
$90 (1TB), www.adata.com

© ADATA, CRUCIAL, SAMSUNG, MSI



Jeremy Laird

TRADE CHAT

AMD needs to lower its GPU prices

AMD CLAIMS it wants to sell more graphics cards. The solution is simple: lower prices. Not just lower prices eventually, but from the beginning of a new GPU generation. This may seem like a retina-popping glimpse of the painfully obvious, but it needs saying, because it seems AMD doesn't get it. That needs to change if AMD is to win market share back from Nvidia.

In recent years, AMD's playbook has been depressingly predictable, at least for its graphics cards. A new family of GPUs is rolled out positioned slightly below Nvidia's competing cards. Maybe you get slightly more raster performance for your money, a few more GB of VRAM. But nothing truly compelling against Nvidia's unbeatable DLSS scaling tech and undeniably superior ray tracing.

Duly this new generation of AMD GPUs fails to gain much market traction. Check back in six months to find the usual stories noting that AMD's latest graphics generation has had zero impact on the latest Steam survey of popular gaming hardware. Then wait another six months for AMD to inevitably begin to lower prices, and another six months on top for prices to drop to the point where there's a truly compelling value proposition.

By then, everyone has pretty much lost interest; attention is turning to the next generation of graphics architectures, Nvidia has gained yet more mind and market share, and AMD prepares to repeat the cycle all over again. It's all so pointless.

It can't go on like this, least of all because the latest data shows that AMD's gaming GPU market share has shrunk to just 12 percent, with Nvidia owning the remaining 88 percent. For the record, Intel's fleeting foray into discrete gaming graphics cards with its Arc GPUs has evaporated for now.

Whatever, AMD's predicament feels inevitable. But it isn't. Take the AMD Radeon RX 7900 XT as a case in point. It launched around two years ago at $900, at which price point hardly anyone cared, especially when the 7900 XTX sold for just $100 more. Today, the 7900 XT is less than $650, which makes it a totally different proposition.

I'm not going to claim that AMD would have dominated the market with the 7900 XT selling for around $650 from day one. But it sure would have got my attention. Nvidia RTX 4080 raster performance for slightly more than Nvidia RTX 4070 pricing? Yes, please.

Of course, there's the minor matter of profitability. Could AMD have done the 7900 XT for $650 from day one and still made money? That's hard to tell from the outside. But then pricing its GPUs up near Nvidia levels and not selling any is hardly a winning business strategy, either.

So, here's my plan for AMD. Take a hit with the upcoming RDNA 4 generation of GPUs, due out early in 2025. Launch the new Radeon RX 8800 XT at $400, not $600. Rumor has it the 8800 XT will offer performance akin to the 7900 XT and, if so, at $400 that will be hard to ignore, even in the context of Nvidia's superior feature set. OK, maybe AMD won't make any money at that price. But it will begin to win market share back and build momentum for the release of RDNA 5 in around two years.

AMD has admitted that it's not going to be able to compete with Nvidia at the high end with RDNA 4, so I reckon it makes sense to fully write that generation off, to use it to position AMD more competitively, and then make an almighty effort to really deliver with RDNA 5.

Even if AMD nails all this, it won't suddenly get it back to 50 percent GPU market share. Nvidia is way too dominant for that. But what it could do is begin to turn the narrative and then the market tide. Instead of another mediocre launch, a $400 Radeon RX 8800 XT for $400 will reconnect gamers with the novel idea of AMD graphics being exciting and desirable. More than anything, PC gamers need to feel good about buying an AMD GPU. And the easiest way to do that is offer them a great deal.



The 7900 XT was far too expensive at launch.

© AMD

Six raw 4K panels for breakfast, laced with extract of x86...
Jeremy Laird eats and breathes PC technology.

DOCTOR

THIS MONTH THE DOCTOR TACKLES...

> Switch from Firefox
> Batch app launcher
> Best phone backup

Ditching Firefox

I thought supporting Firefox and Mozilla was the smart thing to do, privacy-wise, but Mozilla's latest 'feature' giving advertisers information about user activity (the so-called Privacy Preserving Attribution feature) has left me unsure I can trust them, particularly as it's been enabled by default. I'm aware of other browsers touting their privacy credentials, like Brave and DuckDuckGo, but what would you suggest—am I being overly sensitive about Mozilla, or should I be looking at yet another browser migration?

–Debra Pendergraft

THE DOCTOR RESPONDS:

Unfortunately, Mozilla's latest move to try to balance privacy with revenue generation through ads has left a sour taste in the mouth for many. The launch of Privacy Preserving Attribution came just weeks after acquiring Anonym, an ad-tech company specializing in so-called "privacy preserving digital advertising", and users were opted in by default. This predictably has left many privacy experts crying foul as Mozilla appears to be caving into the growing trend for putting web advertisers ahead of users.

So, let's assume this makes Firefox unpalatable going forward. What are your alternatives? The Doc assumes one of the attractions of choosing Firefox in the first place is that it's one of the few browsers not using Google's Blink web engine. Assuming you wish to stick with its own Gecko web engine, this rules out browsers from both Brave and DuckDuckGo.

Most Gecko-based browsers are forks of the main Firefox project, which means they're built from the core Firefox code before diverging with their own customizations. Three examples stand out, starting with the Tor Browser (www.torproject.org). This offers the ultimate in privacy, not least when using its own Tor network, and is built from Firefox's ESR (Extended Support Release) branch, which runs alongside the regular stable branch to provide less frequently updated features for large organizations.

Other variants have gone further. For example, Pale Moon (www.palemoon.org) runs on its own Goanna web engine, forked from an older version of Gecko. The good thing about both Tor and Pale Moon is that you can download portable versions and try them without committing to anything—if you then decide they're the browser for you, you can migrate across.

But what if you're broadly happy with Firefox? If you simply want a more privacy-focused build maintained by people not answering to Mozilla, our final choice is the Doc's ultimate recommendation. LibreWolf (https://librewolf.net) is community-maintained and based on Firefox's latest stable release, so it's never more than a few days behind the primary Firefox build.

LibreWolf is simple to install, but there are a few considerations. First, make sure you install LibreWolf WinUpdater alongside the main program when prompted. After installation, launch this and check the 'Schedule a task for automatic update checks' box before closing it.

On your first launch, open 'Settings', where you'll find a dedicated LibreWolf section where you can fine-tune the browser's customizations—for example, check 'Enable Firefox Sync' to bring your Firefox settings across via your Firefox account (your profile is encrypted locally, so there's no privacy trade-off in continuing to use Mozilla's sync engine). Next, visit 'Privacy & Security' and uncheck 'Delete cookies and site data when LibreWolf is closed' to prevent having to log in to every website from scratch whenever you restart LibreWolf.

One final thing: LibreWolf disables HTML5 Canvas by default, and silently blocks any requests from websites to use it. This stops certain websites from functioning correctly—including the terminal component of the Cockpit web interface for Linux (https://cockpit-project.org). Look closely in the Address bar when a site isn't displaying correctly and see if a small canvas icon appears—click this to re-enable HTML5 Canvas on trusted sites, then refresh the page and they should work again. Alternatively, you can allow sites to request access on a case-by-case basis by returning to the LibreWolf section of

↘ submit your questions to: doctor@maximumpc.com

Settings and unchecking 'Silently block canvas access requests' under 'Enable ResistFingerprinting'.

Annoying auto

I'm a big fan of Bitwarden except for one thing. Its autosuggestions often throw up lots of redundant entries for sites, particularly when I'm trying to use my own locally hosted services. How can I prevent these unwanted password suggestions ?

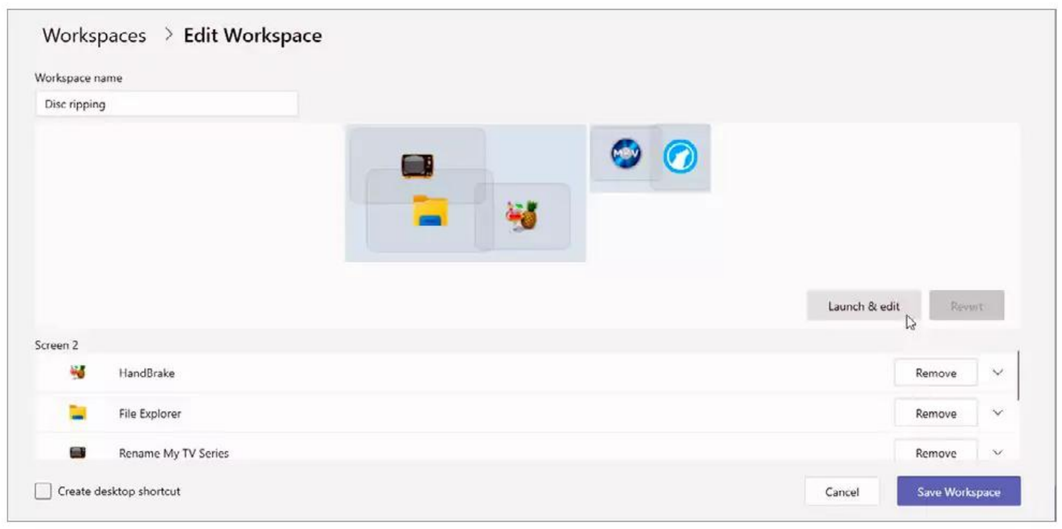
–Andrew A Schmidt

THE DOCTOR RESPONDS:
Each entry in your Bitwarden password vault can be assigned to a website or other URI (Uniform Resource Identifier). This can be assigned automatically when you fill in login details and Bitwarden offers to save them as an entry in your vault, or you can add them manually. Each entry can be assigned to multiple URIs, not all of which must be web URLs—they can also be local IP addresses with ports, or links to apps for mobile use (look for entries such as androidapp:// for Android).

URIs are configured to match to sites according to broad criteria by default, so port numbers are ignored and entries aren't restricted to a specific web address or subdomain. This ensures they'll continue to appear even when websites update or change login URLs, for example, but the downside is that they may crop up where you don't want them to.

Thankfully, you can reconfigure each URI to control exactly when it appears. This is done on an entry-by-entry basis, but doesn't take long—select a login entry and click the Edit button (the pencil button in the desktop app). Locate the URI section and if necessary, click the toggle options button (the cog icon) to reveal a drop-down menu set to 'Default match detection'. Click this to reveal six options that allow you to build quite complex matching patterns.

Ensuring the entry only appears on the site you want it to, however, involves just one of two entries: 'Starts with' for internal IP addresses with port numbers (make sure the URI only contains the IP address and port, such as http://192.168.35.1:81), and 'Host' for subdomains. Click Save and your entries will start to only appear where they're wanted.



Launch multiple apps with a single click in PowerToys.

App launch timesaver

I frequently use a group of apps on screen at the same time across two displays. Although I've worked out the optimum way to run them all together, I still have to launch them one at a time, then position and resize their windows. Is there a tool that can automate all this for me, so I spend less time setting up and more time actually using them? **–Ken Peeples**

THE DOCTOR RESPONDS:
You're in luck, Ken. Microsoft's open-source PowerToys project has just added just the tool you need to its arsenal—Workspaces—with the recent release of PowerToys 0.84. It does exactly what you want. Head to https://github.com/microsoft/PowerToys/releases to download the latest version of PowerToys if necessary—you have a choice of architecture (x64 or ARM64) and installer type (per-user or system-wide).

Once installed, right-click the PowerToys Taskbar notification area icon and choose 'Settings' to view (and enable or disable) all available tools. Make sure the Workspaces module is enabled and note its keyboard shortcut (Win-Ctrl-'). Click 'Launch editor' then 'Create Workspace'.

You'll see the Snapshot Creator appear in the middle of the screen, plus a red border surrounding both displays. Open your choice of apps and arrange them across both monitors as you see fit, then click 'Capture'.

You're shown a screen displaying both displays with the program icons in their relevant spots. Beneath this is a list of apps on each screen, enabling you to remove any that have snuck through. You can also click ˅ next to any entry to reveal further options: a CLI line for entering command-line arguments, as well as checkboxes enabling you to launch the process as an administrator, or have the program window maximized or minimized. Once you're happy, give your workspace a suitably descriptive name and click 'Save Workspace'.

Going forward, you can launch the apps in their relative window positions from the launcher window, or add a desktop shortcut for even faster access. You can also edit or remove the workspace from here, plus add more custom workspaces as needed.

Phone backups

I have both an Android phone and an iPhone to back up. Is it recommended to use the tools that are built in, or are third-party apps better?

–Mick Lyons

THE DOCTOR RESPONDS:
The built-in tools should be sufficient for your needs, as they cover your settings, apps, and most data, such as photos or videos. The downside is the need to subscribe to either iCloud or Google One to obtain enough storage space to store the backups online—unless you're happy to periodically back up your phone to your PC using Apple's new app (Apple Devices) using a USB cable. Android users looking for something similar might like to consider FolderSync (https://foldersync.io), which can sync folders on your phone to your PC or any cloud service you like.

While your apps and settings shouldn't take up much space, it's keeping your phone's photos and videos (plus other files) safe that eats into your data plan. Both Google and Apple charge similar prices for their paid-for plans, the only difference of note is that their entry-level plans vary (50GB for 99 cents from Apple, 100GB for $1.99 from Google).

One workaround is to look at different ways to back up the space-hogging files on your phone—mostly photos and videos—to a different cloud service, whether that's a OneDrive account or even a self-hosted instance, such as Nextcloud and its Memories add-on (https://memories.gallery/). In this circumstance, you need to install the relevant client app, then explore its settings to have it automatically upload any photos and videos added to your phone to your cloud storage. Once done, you can switch off your phone's native photo backup service—iOS users should navigate to 'Settings', tap their user profile, and select 'iCloud' followed by 'Photos' to disable syncing, for example.

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https://content.jwplatform.com/videos/ICsnD9f9-u2lN49He.mp4
Please type this URL into your browser if the link is broken

CONSOLE KILLING IN 2024

The PS5 Pro has landed. Can the modern-day PC compete?

NO DOUBT you've heard the buzz around Sony's latest announcement. The PS5 Pro has landed for pre-order. Grab your hats, because it can supposedly game at 4K 60 fps, and has a 45 percent increase in graphical horsepower versus its predecessor. At least, that's what Sony tells us. The reality is, of course, that a lot of this is still up in the air. We've seen some teasing about its feature set, mention of super-resolution AI upscaling, ray tracing, 8K compatibility, the usual hubbub, but the biggest kicker is that it comes in at $700. That's a lot of cash all of a sudden for a console.

And let's be clear, it's not a massive upgrade on the $500 PS5 Slim. RAM and CPU are the same; it's only the GPU and SSD that are changing. Nonetheless, it got us thinking: There's another arena that's seen continual price increases, and they've been far less forgiving. We are, of course, talking about the gaming PC.

Once upon a time, a well-specced custom build could indeed compete with that generation of consoles. Today, it's a whole other ball game. Still, with the Ryzen 9000 series being a less interesting chip launch than it seems to be, we decided to run something a little different this issue. We just had to see if we could build something unique, a little special, which is why we're seeing what kind of ITX performance we can manage at a reasonable price, and whether or not we can even start to compete with the likes of Sony's undisclosed PS5 Pro. Strap in folks, this one's going to be a serious challenge. –ZAK STOREY

SPECIFICATIONS

PART		PRICE
CPU	Intel Core i5-14600K	$235
Motherboard	MSI MPG Z790I Edge WiFi	$286
CPU cooler	Noctua NH-L9x65 Chromax.black	$70
RAM	32GB (2x 16GB) Corsair Vengeance DDR5 @ 6,000 C36	$100
SSD	2TB Acer Predator GM7000 M.2 PCIe 4.0 SSD	$137
GPU	Gigabyte Radeon RX 7600 XT Gaming OC 16GB	$310
Case	Fractal Design Terra	$180
PSU	600W BeQuiet! SFX L 80+ Gold	$159
Total price		**$1,477**
Core price*		**$1,068**

* Core price refers to the key components generating performance (CPU, GPU, mobo, OS SSD, RAM), not accessories.

CPU

INTEL CORE I5-14600K

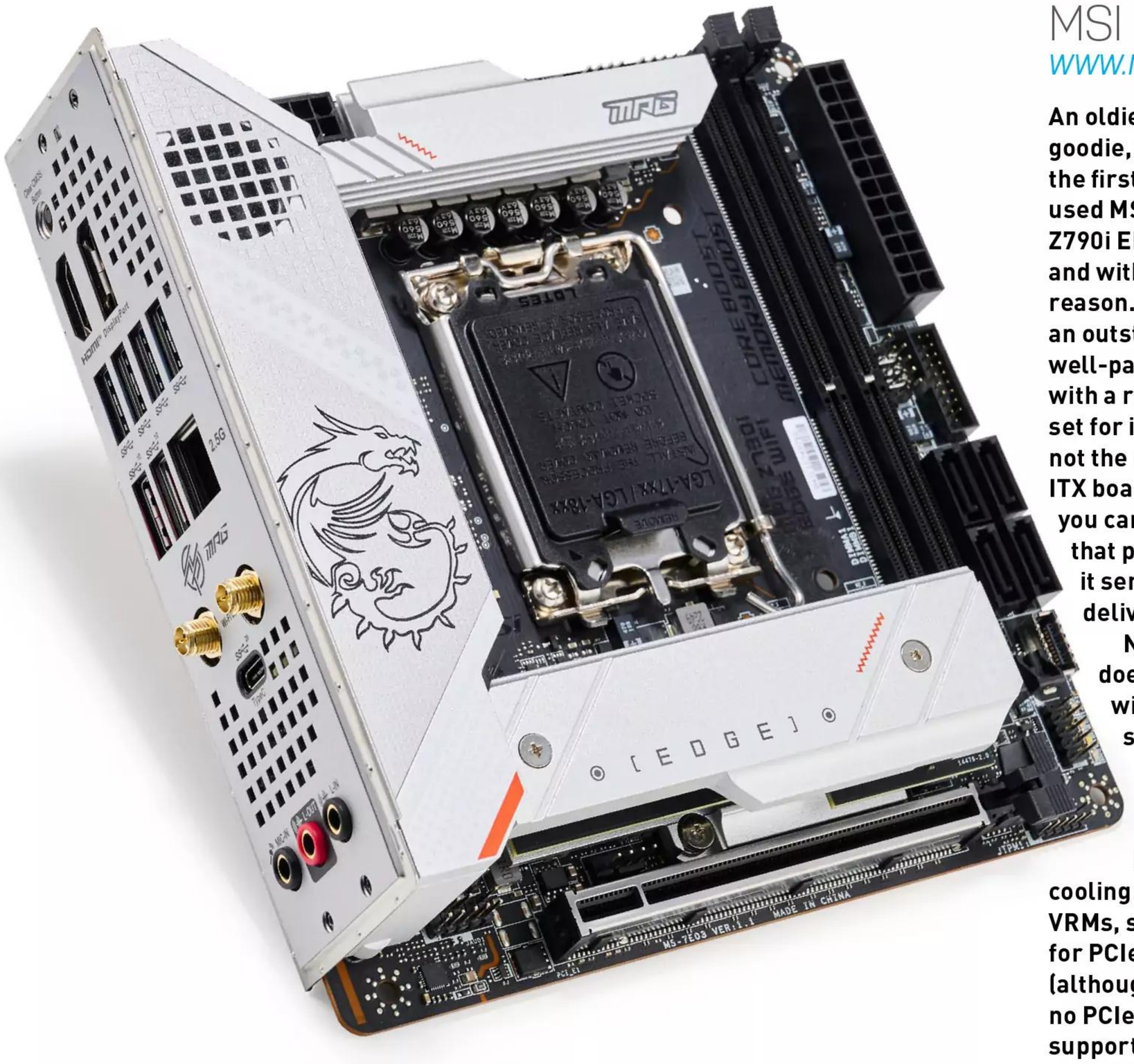
WWW.INTEL.COM



Intel has received some serious flack in the last few months concerning chip stability and potential long-term damage due to overvolting, among a few other issues, but at last it now feels as though that's behind us. We've finally got new BIOS updates that supposedly rectify the majority of issues found in the 14th gen since launch. As a result, we can start recommending you pick up these processors once again.

To match our PS5 Pro's CPU, we've picked up one of the best value budget Intel chips you can get your hands on, the Intel Core i5-14600K. It's no slouch either. With 14 cores—six performance, and eight efficient—it packs in 20 threads, with a max clock speed of 5.3GHz under load. There's 24MB of total cache, and it slides in with a 125-181W TDP overall. You get all the usual bells and whistles as well: DDR5/DDR4 support, integrated GPU for those "oh heck, my GPU's dead" moments, plus the far more critical PCIe 5.0 support, all for an affordable price.

Keep an eye out on the pricing, as the 14600KF and this one trade places from time to time, swapping between $230 and $200 respectively, bringing the price down significantly. The PS5 Pro is utilizing an AMD Ryzen Zen 2 custom processor, featuring eight cores and 16 threads total, with a max clock speed of 3.5GHz. To be clear, that's akin to a declocked Ryzen 7 3700X from 2019, operating at 65W, so from a purely like-for-like comparison, the 14600K in either form will absolutely dominate it.



MOTHERBOARD

MSI MPG Z790I EDGE WIFI

WWW.MSI.COM

An oldie but a goodie, this isn't the first time we've used MSI's MPG Z790i EDGE WiFi, and with good reason. This is an outstandingly well-packed board, with a rich feature set for its price. It's not the cheapest ITX board, but if you can withstand that price point, it seriously delivers.

Not only does it come with a super-clean aesthetic, it's also got built-in active cooling for the VRMs, support for PCIe 5.0 GPUs (although, sadly, no PCIe 5.0 M.2 support), and a healthy amount of USB integration. It's actually the M.2 solution that most impressed us, because it's got a twin PCIe slot on the top side (one running at 4.0 and one at 3.0), plus an additional 4.0 drive underneath the board itself, along with support for four SATA drives as well.

Memory support screams up to DDR5 @ 8,000 and a max of 128GB, and it'll even handle gens 12 through 14 on the CPU front. And don't worry: Intel BIOS bug fixes are available, too. The only downside? We think it could use a few extra USB ports.

CPU COOLER

NOCTUA NH-L9X65 CHROMAX.BLACK

WWW.NOCTUA.AT

Chunky, compact, and seriously powerful, the NH-L9x65 is one of the best small-form-factor CPU coolers there is. We've used it before with the MSI MPG Z790i Edge as it's perfect for small-form-factor builds where an AIO isn't an option (such as in the Fractal Terra case). If you chuck these specs into PCPartPicker, it tells you it's incompatible due to height issues; fortunately, the Terra has an adjustable internal frame that allows you to tweak the depth of either side, so this baby slides in just fine.

It supports pretty much every socket launched since LGA 1150, packs in a fan that shifts some serious air at 57.5m²/h, and doesn't blow your ears off, with a max acoustic noise rating of 23.6db(A), Plus, there's a six-year warranty, with a 150,000-hour mean time to failure rate. It's flawless for $70, and plenty enough for our 14600K.



CASE

FRACTAL DESIGN TERRA

WWW.FRACTAL-DESIGN.COM

When it came to a case, our choices were limited. We wanted something compact enough to fit in a living room without compromising on the look and feel of a console-killing box. There's plenty of ITX chassis, but few that come close to looking like a modern-day console.

Fractal does have the Ridge chassis, which is more tower-esque, and similarly shaped to the PS5 and its Pro sibling, but it offers limited room to work in, and we think the Terra looks a lot better. Fractal's woven in some fantastic aluminum panels in three colorways (black, white, and green), accented with a lovely walnut plate on the bottom. It's without a doubt one of the nicest-looking ITX cases we've seen.

Ventilation is impressive, too. There's no mesh dust guards here, just cutouts, and the internal layout lends itself well to adaptability as well, certainly when it comes to depth positioning, although more on that later.

The only downside is a lack of support for AIOs, but that would have drastically increased the size of the thing, and you're limited to GPUs of around 12.68 inches in length. Oh, and you do need an SFX/SFX-L PSU. Speaking of which...



STEP-BY-STEP GUIDE
PG. 22



PSU

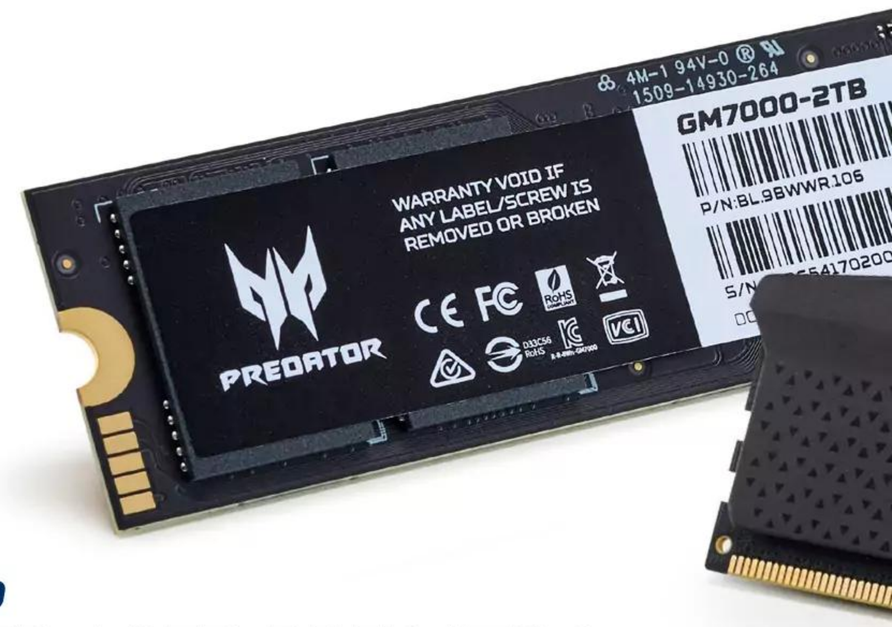
600W BEQUIET! SFX L 80+ GOLD

WWW.BEQUIET.COM

There are a number of small power supplies out there, but certain rules apply: Get one from a brand you can trust, with a solid warranty. And don't ever go for a cheaper option, because although there's a limited number of genuine PSU manufacturers out there (with many providing their solutions to third parties with fresh branding), it's never worth the risk. If something goes wrong here, it can take your entire system with it. All $1,500 of it.

That's why we've picked up a 600W BeQuiet! SFX-L PSU. It boasts an 80+ Gold rating, meaning high efficiency. PCPartPicker reckons the total system spec will top out at about 452W or so at max load—in our testing, we saw max draw sit at 458.9W—making this a good choice for our endeavor.

However, the SFX L from BeQuiet! doesn't come with 12VHPWR cables as standard, so you'll be stuck with adaptors if you're using a modern Nvidia card with that connection standard. In which case, you might want to pick up a different PSU that supports it from elsewhere.



SSD

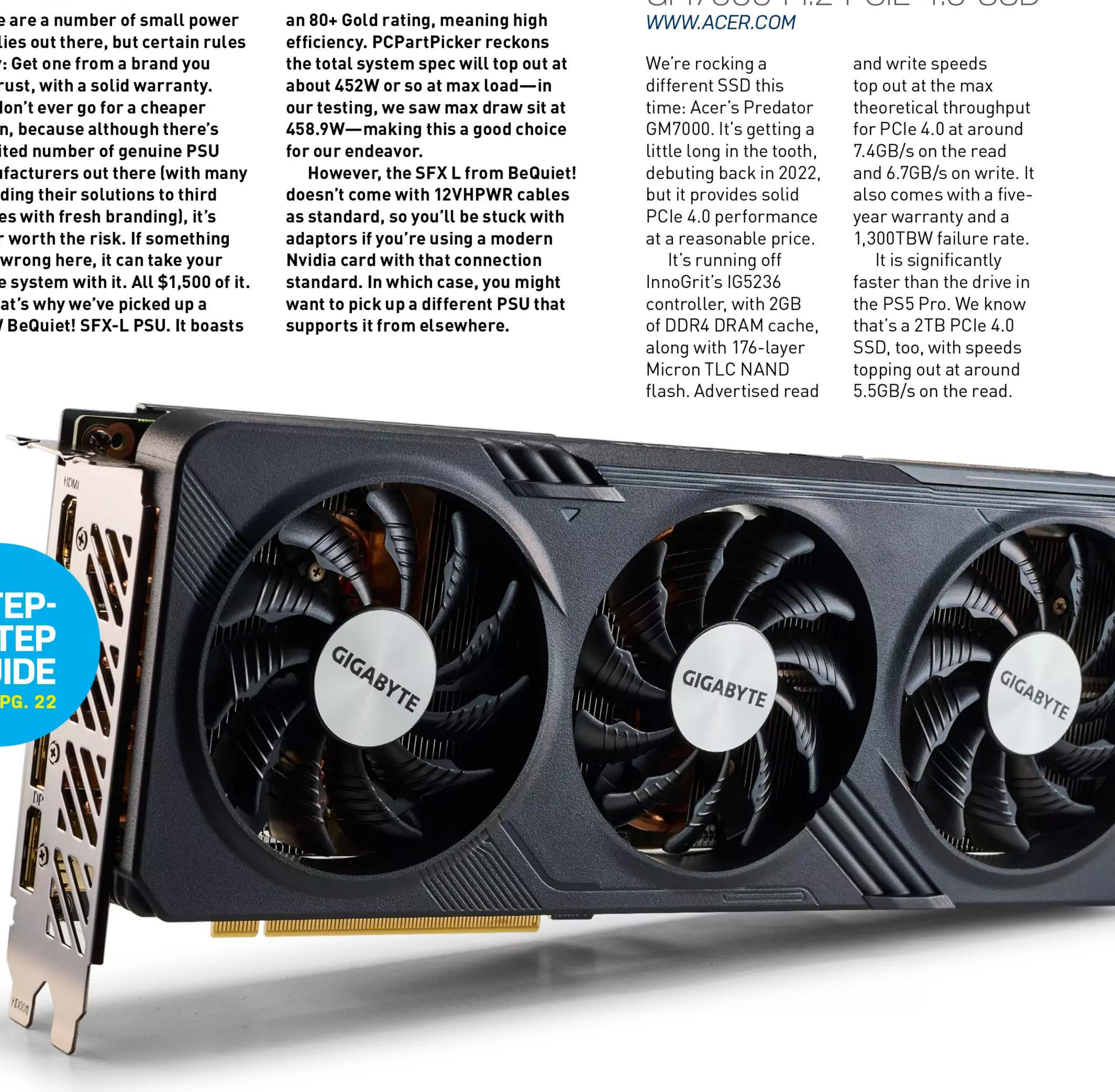
2TB ACER PREDATOR GM7000 M.2 PCIE 4.0 SSD

WWW.ACER.COM

We're rocking a different SSD this time: Acer's Predator GM7000. It's getting a little long in the tooth, debuting back in 2022, but it provides solid PCIe 4.0 performance at a reasonable price.

It's running off InnoGrit's IG5236 controller, with 2GB of DDR4 DRAM cache, along with 176-layer Micron TLC NAND flash. Advertised read and write speeds top out at the max theoretical throughput for PCIe 4.0 at around 7.4GB/s on the read and 6.7GB/s on write. It also comes with a five-year warranty and a 1,300TBW failure rate.

It is significantly faster than the drive in the PS5 Pro. We know that's a 2TB PCIe 4.0 SSD, too, with speeds topping out at around 5.5GB/s on the read.



STEP-BY-STEP GUIDE
PG. 22



RAM

32GB (2x 16GB) CORSAIR VENGEANCE DDR5 @ 6,000 C36

WWW.CORSAIR.COM

Corsair's been making memory kits since the dawn of time (or it certainly feels that way), and it knows how to do it well. This is a unique pick if we're trying to compare a PC versus a PS5 Pro. Most notably because the way the PlayStations are configured means that the RAM is effectively shared between the CPU and the GPU. As such, the PS5 only has 16GB of GDDR6 in it—that's it. In a PC, we don't have that luxury, but then we're going to be doing a lot more stuff with it. To that end, we've picked up this 32GB kit from Corsair, clocking in at a tasty 6,000MT/s at C36, giving it a tidy latency, and at a reasonable price, too. It's also incredibly low profile, meaning it'll fit into our chassis with ease, without us having to worry about clearances.



GPU

GIGABYTE RADEON RX7600 XT GAMING OC 16GB

WWW.GIGABYTE.COM

This is actually perhaps one of the more interesting picks here; not because it's particularly exciting from a graphical standpoint, but from a purely speculative level, we suspect that this might be the GPU that's going into the PS5 Pro. Or at least a souped-up version of it.

According to our sister publication GamesRadar, the current PS5 features an RDNA 2 GPU that pumps out 10 TFLOPs of total performance (at single-point precision), with 16GB of GDDR6. We know the new GPU should produce about 45 percent more rendering performance, with 67 percent more compute units. That suggests we'll be looking at close to 14.9 TFLOPs or so of raw performance, if that's purely based on single point. The closest card to that figure is the 7600 XT under RDNA 3. However, it does lack the bump in CUs. That could suggest it's a GPU floating between the 7600 XT and the 7700 XT, but with a far reduced TDP, with lower max clock speeds to compensate for the form factor and power delivery.

It's not going to be RDNA 2, as that lacks any AI accelerators, and Sony has said that it's leaning heavily into AI resolution upscaling compared to the previous gen—so RDNA 3 is the only logical option. Nonetheless, for our build, the RX 7600 XT is a fine card for 1440p and 4K gaming at a push, as long as you manage settings. And that $310 price makes it close to reasonable(ish) for that performance, particularly if you lean into AMD's FSR upscaling.

A CHEAPER BUILD

Let's be clear here: We've taken some liberties and spent a bit of extra cash across the board to make our system build a little more refined than you would otherwise find in a console or in a budget-busting rig. But there are corners you can cut if you're willing to make the sacrifice.

Dropping to an Intel Core i5-12600KF for one saves a chunk of cash, and pairing that with a Z690-I is definitely a way forward. You could go for 16GB of DDR5 instead, but honestly, we highly recommend staying with 32GB, just for future-proofing (and you really only save around $30 or so). For the SSD, you could drop to a 1TB solution instead—our favorite T500 from Crucial is available for just $88—although that would require you to keep a careful eye on your storage setup. Our last change would be to pivot to Hyte's Revolt 3 chassis, which you can pick up for just shy of $100 on offer. That would bring your total price down to $1,090 (at least at time of writing). Still not quite near that PS5 Pro level, though, sadly, but you'd be left with a system swinging still some way ahead of it, but for a far closer price point, albeit with slightly aging kit.

You can check out the full specs list here: https://pcpartpicker.com/list/qYhHVW

TAKING THE FIGHT TO OUR CONSOLE COUSINS

LENGTH OF TIME: 2-3 hours
DIFFICULTY: Hard

THIS BUILD was a challenge. We did things to the case that you probably shouldn't to get everything sitting how we wanted. Don't get us wrong, it's a flexible chassis, and more than capable of holding the hardware that we needed it to, but we're nothing if not sticklers for good cable management, and anyone who's built in an ITX box like this knows that every inch of well-planned routing can save hours of frustration down the line.

We set out with one goal: To build a gaming PC that you could just connect a display to, whack that power button, and enjoy some premium PC gaming on your big screen. No keyboard, no mouse, no wires, just slick gaming like you'd get on a PlayStation, Xbox, or any other modern-day discount PC.

That said, although the build process for this is complex in parts, and requires some, er, "careful encouragement," it's also remarkably simple. There's not a lot of components that need to go in the system. The cooling solution is incredibly basic with that single CPU tower, then you've got a PSU to worry about, a single M.2 SSD, which will be added to the board itself, a CPU, GPU, a few sticks of RAM, and that's it. So, let's get cracking...

ALUMINUM STYLE

And we'll start by cracking open that case *(Maximum PC* fact: This journalist is contractually obligated to include at least 15 puns per build article). Terrible jokes aside, the chassis strip-down on this is a dream. There's effectively three panels to worry about. The top one slides backwards, then up and out. There is a little leather tab at the very back of the case—simply pull on that and you can remove it in about two seconds **(Step 1)**.

With that panel safely stored away, it's time to work on removing the two gull-wing doors. Yes, the Terra comes with twin gull-wing panels for easy(ish) access to the GPU and motherboard side of the case. These are seriously well designed on hinges that fold upward. On the rear side there's a little plastic tab; pull that back, and one of the pins for the hinges retracts, so you can then lift it out of the case entirely. Smart.

They also lock into position thanks to two pop-pins at the bottom that sit in two plastic brackets. You can also just about spot the two screw threads next to the pop-pins. When the panel's situated down and in position, you can secure it with additional case screws—perfect for safe transport **(Step 2)**.

Inside, everything sits on a main spine that runs through the center of the chassis. You'll spot a screw with a scale etched on it from 1-7. Loosen this and you can shift the internal spine backward and forward. This gives you plenty of room for either thicker GPUs or CPU towers. We've adjusted the tabs to the 4 mark—that's just enough for our CPU tower to sit flush to the side panel, and gives our GPU plenty of breathing room and clearance from that ventilated side panel **(Step 3)**.

HERE BE DRAGONS

With our internal chassis now (seemingly) ready, it's time to start prepping the motherboard. We should preface this by reminding you to always prep your mobo on the cardboard box it came on. Don't place it on the anti-static bag because the outside conducts electricity, while the box acts as a fantastic anti-static workbench.

First, we're going to get the Acer Predator PCIe 4.0 SSD in here. MSI's Z790i Edge WiFi has a fantastic big-block M.2 slot and heatsink between the CPU and the PCIe slot. There's a proprietary connector connecting the elevated platform/PCB to the rest of the motherboard, and the PCB has connectivity for two M.2s, one of which sits beneath (in PCIe 3.0 x4 mode), and the other on top (in PCIe 4.0 x4 mode). Because of that, we're popping our 4.0 drive in the top slot. To access it, we have to remove the heatsink. You need a small Phillips head screwdriver to loosen the screws. Don't do what we did, and accidentally remove one of the retainable screws (it makes it more awkward to reinstall it afterwards); just loosen them, then place the heatsink to one side.

Line up the notch on your PCIe 4.0 drive with the notch in the M.2 connector, and slide it into place. It sits facing upward at an angle when positioned correctly—that's fine **(Step 4)**. You might be tempted to secure it with the included additional M.2 screw in the MSI motherboard box. Don't do that, as it's only required for the drive on the underside of this raised PCB, or the one on the back of the board. The heatsink itself screws directly into that M.2 screw thread, securing the drive and heatsink in position.

If you do want to install a secondary PCIe 3.0 drive, you need to remove two larger Phillips screws with washers attached—you can just about spot them south of the connector **(Step 4)**—then carefully lift the raised PCB up and out of its robust connector. On the underside, you'll spot the additional M.2 slot. It's worth noting there's no heatsink or thermal pad here, but given it's a PCIe 3.0 slot, temps shouldn't be too concerning.

Once you're done with your drive prep, secure the raised PCB down, reposition the heatsink, then re-secure it, making sure to pull off the plastic film covering the thermal pad on the underside of the heatsink block.

CPUs ARE GO

With the SSDs in and secured, it's time to move on to the trusty old processor. As with any LGA socket, the process is simple. Lift the retention arm out to the side and up, raise the bracket, revealing the pinned socket underneath, carefully lower the CPU into position, ensuring to align it correctly (there are notches in the chip, gold triangles, and writing orientation to guide you), then replace the lot, and secure it back into position. Once done, the plastic cover pops off the socket, and you're good to start prepping your CPU bracket for the cooler **(Step 5)**.

Noctua's cooler backplate is super-easy to install. It comes pre-assembled for Intel, it's thick, chunky, and seriously hefty. Stick it through the LGA slots on the board, then place your blue spacers into position on top. With those in, you need to put your two metal mounting brackets on top of them. If you're using an Intel processor, you can mount these either to the left and right of the CPU socket, as we're doing here, or top-to-bottom. You might need to do this if VRMs or the raised PCB get in the way. ITX boards are notoriously limited on total PCB real estate, so liberties are often made when it comes to CPU block clearance. It's imperative that the mounting brackets are positioned and installed correctly, so your CPU heatsink makes good contact with the IHS on your chip, allowing it to fully transfer the heat correctly. Either way, once the brackets are in position, secure them with the included screws, and you're good to go **(Step 6)**.

Now it's time to get the bulk of the tower on. You'll notice there are two notches cut out of the middle of the tower **(Step 7)**. This does reduce the overall surface area available to help alleviate all that heat, but what it does do is give you easy access to the screws on either side of the CPU tower. Simply pop some of the included NT-H1 thermal paste in the middle of your CPU. A small pea-sized blob does

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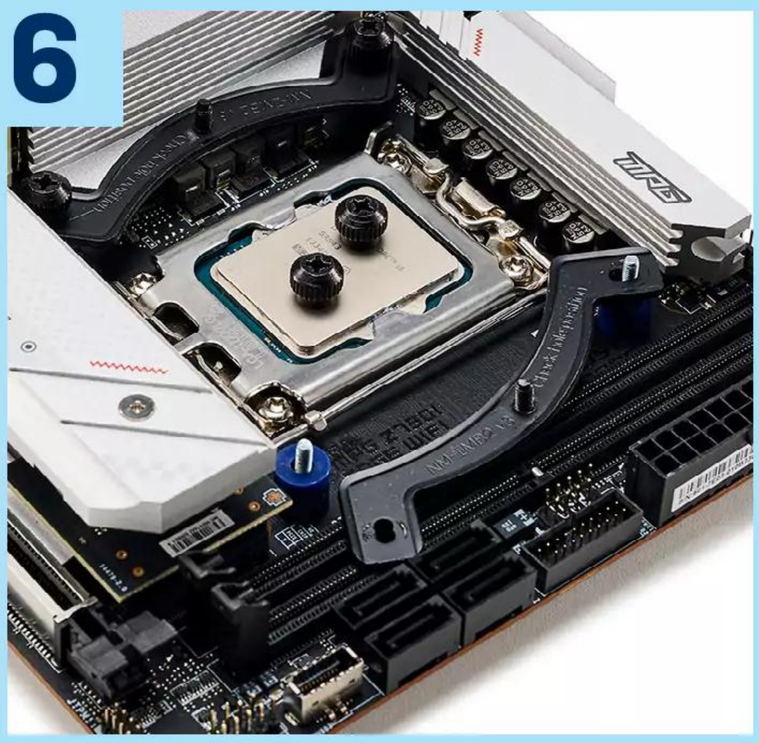
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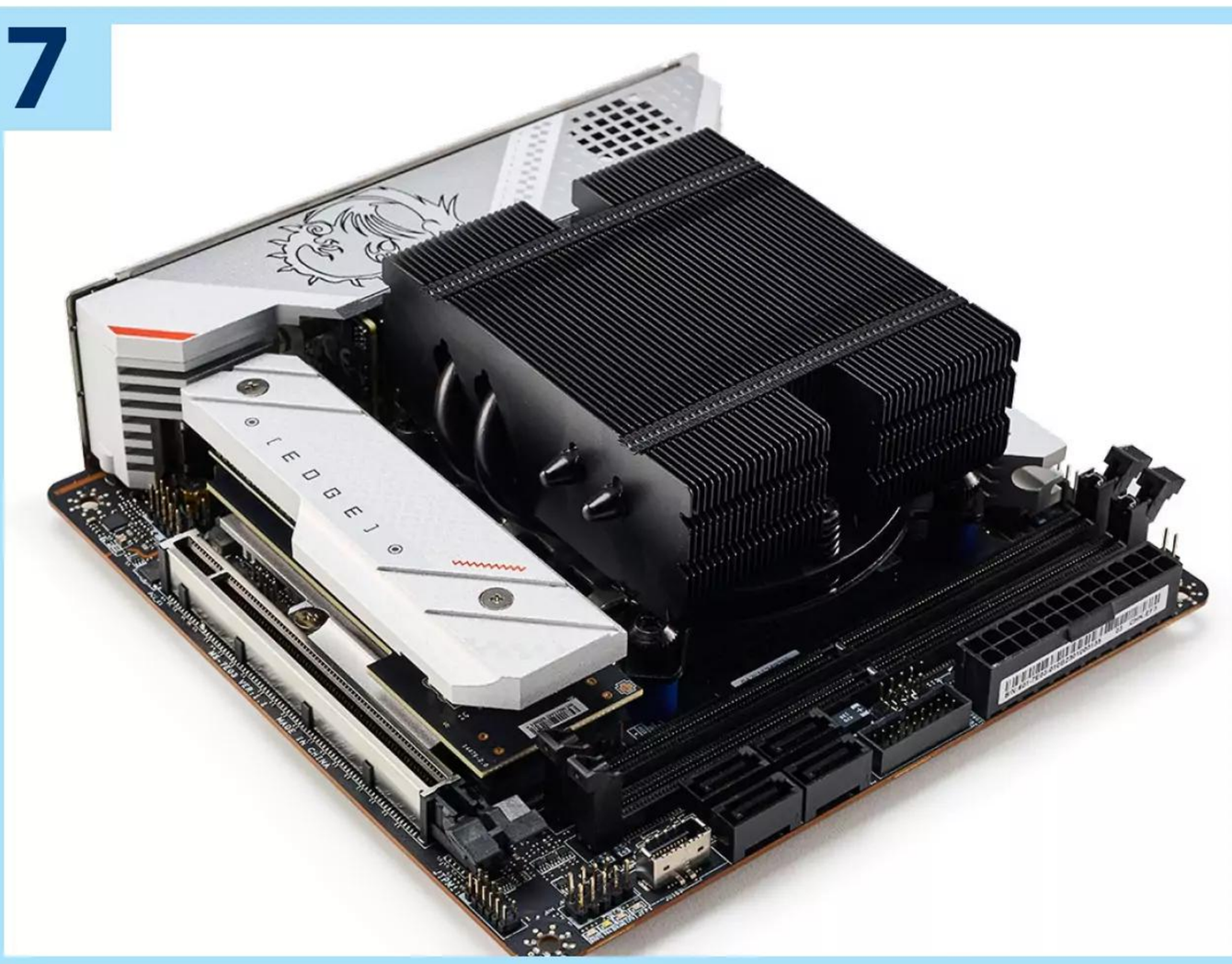
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the trick, but if you're unsure, always add a little extra. NT-H1 is non-conductive, so even if it spreads on to the side, you'll still be good. Then, position the tower over the mounting threads, and secure into position with the screws on either side. Do each side a little bit at a time, to ensure you don't put too much pressure on either side of the board. The fan that goes on the NH-L9x65 fits with clip brackets on either side of it, so we're going to leave this until we've got the motherboard in the case, just for convenience's sake because it's very easy to knock it off.

On to the memory. Super-easy job here: Lift the tab up at the top end of the motherboard, then slide your DDR5 kit into position, being sure to align the notch in each stick with the raised notch in the slot itself **(Step 8)**. With that done, we can start working on the chassis.

TIME TO SCREAM AT PSUs

To quote one famous Jedi: This is where the fun begins. It's time to get everything installed in the case, and where we encounter our first problems. So, you'll see we've installed the motherboard into the chassis **(Step 9)**. Just a bit of a preliminary fit, this. We've installed the PCIe riser cable (the GPU's going to be situated on the other side), and secured it all in place temporarily. To be clear, we did this with the intention of not removing it until the teardown at the end of the issue.

With the motherboard in, we installed the fan into position, utilizing the clips, and orientating it in such a way that the cable could be easily hidden around the CPU tower, behind the DRAM, and up into the CPU fan header.

It was at this point that we moved on to the cabling, most notably the power supply. We're using a full-size SFX-L PSU in this build. The case supports it, but because this is an ITX chassis, cable management is a huge deal, and the CPU power is located at the bottom-right of the chassis **(Step 9)**. There's a small cable cutout there in the metal frame, but annoyingly it's not quite tall enough to get the cable connector head through. You can get the cable through no problem, because that's flat and plastic, but the connector gets stuck.

With a bit of tinkering and deconstruction, however, we noticed that you can actually tear the case down a bit further. To be clear, Fractal doesn't recommend you do this; it's not intentionally designed to look like this. We removed as many screws as we could from that internal spine, then pulled the rear panel out a bit, and pulled the spine up **(Step 10)**. We could then slide the cable underneath, so it ran near the CPU power on the motherboard, and around the back of the chassis, then back underneath again, and into the PSU's modular connectors. Then it was simply a case of rather forcefully pushing the spine back into the chassis, replacing all the screws, and—you guessed it—putting the motherboard back in as well. But this does mean we've got a slightly tidier rig and better cable management, which will be important later.

When it comes to installing the PSU itself, you'll notice the modular connection points are situated at the bottom of the chassis with little clearance. Fortunately, Fractal has thought about this as well—the PSU bracket that faces upward is actually removable. You can fix your PSU to the bracket, attach your cables, then slide it into two hooks, and secure from the rear. It's still a tight fit, but we've gone ahead and pre-routed the cables and connected the USB cables as well for that front I/O (pivotal in a console build). As you can see, it's a tight squeeze **(Step 11)**.

We've also gone ahead and pre-routed the PCIe power cables to save us some time. To ensure our PSU power passthrough actually connects comfortably, we've also had to unclip that from the cable management routes from the front of the case, attach it to the PSU, then try to retidy it after the fact **(Step 12)**.

CABLES ON CABLES

With some preliminary cabling done, we now turn to the back of the chassis. As you can see **(Step 13)**, it's a bit of a mess. We've routed the USB cables as best as we can, but rather annoyingly (given it's Fractal who has added these to the case directly), they're somewhat long, and awkward to route in the chassis itself. At the moment, they're kinda bulging out into where the GPU is going to sit, and this is going to cause us problems later. There seems to be cable cutouts here, too, but again, because this is where our GPU is effectively going to be sitting, they're less than useful. Not that we knew this at the time of this shot.

How did we get the GPU in **(Step 14)**? Well, it was a serious struggle, that's a fact, and, well, we should have read the instruction manual, or used our eyes a little more. On first attempt, there's just not enough room in the case with the cables back there for you to fit the GPU into position and slot it into the riser, without it bending the PCIe connector, or simply not fitting. To get around that, we had to remove the USB cables and headers from the motherboard (slightly damaging the USB C cable), then re-route them through the bottom of the case. There's a tiny cutout you can just about see **(Step 14)**, where we've run those. They've then gone up and into their relevant ports. That would be fine, but the PSU and motherboard are already installed, making it awkward to get to. It's also challenging as we have to think about the PCIe power as well here.

We've also not helped ourselves with that bottom routed CPU power cable, as it gets in the way of the PSU power cable passthrough, and makes things a little awkward. We loosened the two screws holding the PCIe riser bracket to the case just enough to give us 1/5 of an inch of extra clearance behind the GPU to get some cables up there **(Step 15)**. Hilariously, it wasn't until we struggled to install the GPU in the next shot **(Step 16)**—awkwardly trying to hand-tighten a thumbscrew because it was impossible to get a screwdriver to it, due to the case being in the way—that we realized that we could just remove the bracket anyway, and, similar to how the PSU fits in there, take the PCIe riser out, install the GPU to it, then reinstall all of that into the case, securing it with a screwdriver from the side. You live and learn. Still, with all that said, we're finally finished with the physical build. Everything's in, connected, and relatively tidy, all things considered.

CLEAN LOADING AND INSTALLS

The system's built, so how do we get this thing ticking like your standard console? Well, there are a few tweaks we need to make in the install process to get it fully operating as a power-on-and-play device. We should caveat this because it's all going to be centered around using Steam. Fortunately, you can link other games to Steam, even if you've bought them via Ubisoft or EA, but it can be a little awkward to operate solely on a controller. In an emergency, you might need a wireless mouse or keyboard set aside, and you'll definitely need it for the initial setup.

First you need to grab yourself a USB stick (we recommend a 32GB drive at USB 3.0 or above), then on a separate PC, download the media creation tool from Microsoft (www.microsoft.com/en-us/software-download/windows11). Once you're on the web page, download the Windows 11 Installation Media tool, and run that. Select the USB stick, and it creates a bootable USB installer.

At this point, we also recommend going to your motherboard's product page and downloading the relevant drivers. You'll want at a minimum chipset, Ethernet, Wi-Fi, Bluetooth, and audio drivers. It's also worth heading to your GPU

manufacturer's driver page and grabbing the latest drivers there, too.

Once downloaded, and your USB stick is fully Windowsified, open its drive location on your PC, and create a new folder called 'Drivers' inside, then place all of your freshly downloaded drivers in there (don't worry, this won't mess with the install process or anything).

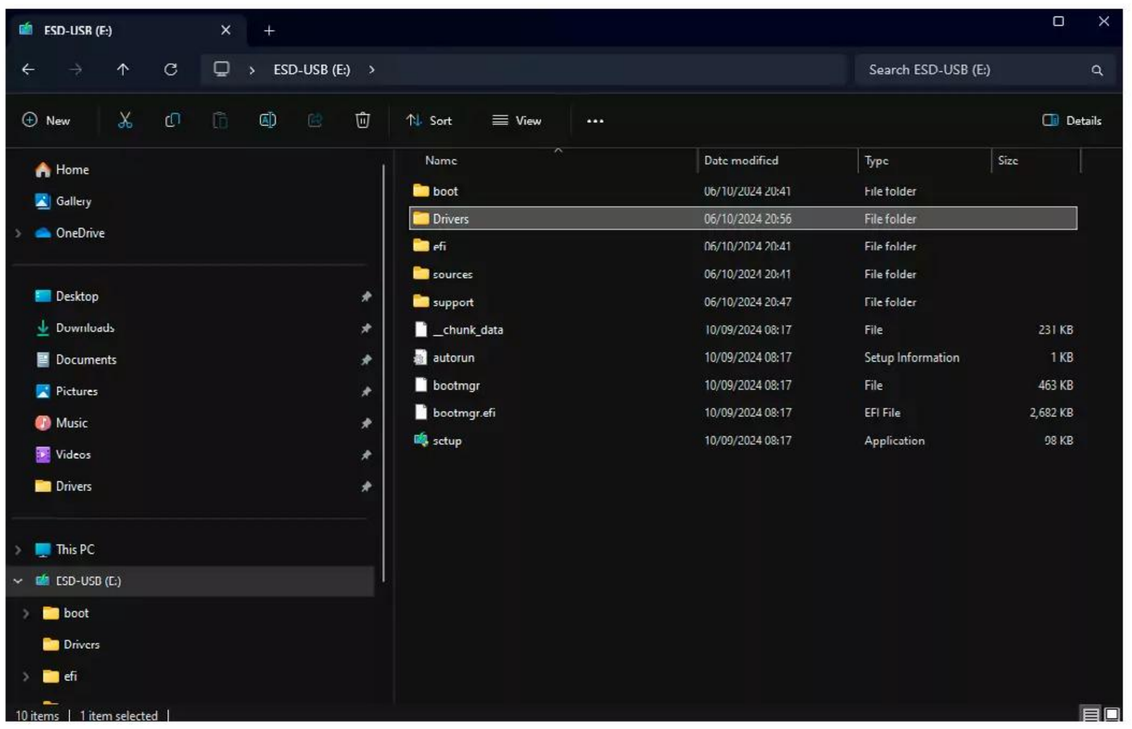
Next, we want to install Windows and set up the new PC, connecting everything but the Ethernet cable to it. We're going to force Windows to create a local account, because this doesn't require a PIN or a password, which will be important later. Plug your Windows installer USB stick into the back of the machine, then power it on. If your SSD is brand new, there shouldn't be an OS on there, and the motherboard will boot directly into the USB stick.

Follow the Windows install process until it tells you to connect to the internet to continue, or select a Wi-Fi network. Do neither of those things. Hit Shift-F10 to open a command prompt on this page, then select the command prompt window using the mouse. Type 'OOBE\BYPASSNRO' and press Enter. This restarts the PC/Windows setup, and allows you to bypass the network requirement.

Once you get to creating an account, select 'Create a local account', and name your PC whatever you want. Windows then asks you to create a password. Don't enter anything; instead just hit Enter. This forces Windows to create an account without a password. Run through the process as normal until you hit the desktop.

INITIAL WINDOWS SETUP

Once on the desktop, still don't connect to a network or plug in your Ethernet—instead, copy the drivers from your USB stick to your desktop, then fully extract them. Now install your processor's chipset, then graphics drivers (AMD does require



It's super-convenient just creating a folder on your Windows Installer stick, and throwing the drivers you need in there.

an active internet connection, so you may have to wait until later for this), then your audio, then Ethernet, Bluetooth, and Wi-Fi. We're doing because if you connect to a network, Windows automatically tries to install older versions of these drivers and chipsets via Windows Update. This way, we can guarantee we have the latest drivers, and it stops Windows from trying to install them at the same time as you're doing it yourself with newer versions.

With drivers installed, you can connect an Ethernet cable or join a Wi-Fi network. Ensure Windows downloads the latest updates, then it's time to head to Ninite.com. Here we recommend you download a few basic programs for your build. Ideally you want Steam and WinRar or 7-zip (depending on your preference). Install Steam, then log in to your account (or create a new one if you don't have one).

In Steam, go to Settings > Interface, then on the right-hand side, you should see an option for 'Start Steam in Big Picture Mode'. Check that option. Now, when you power your PC on, not only does it automatically boot up and log in to Windows, but as soon as you hit the desktop, Steam loads and enters full-screen Big Picture mode, perfect for using with a controller.

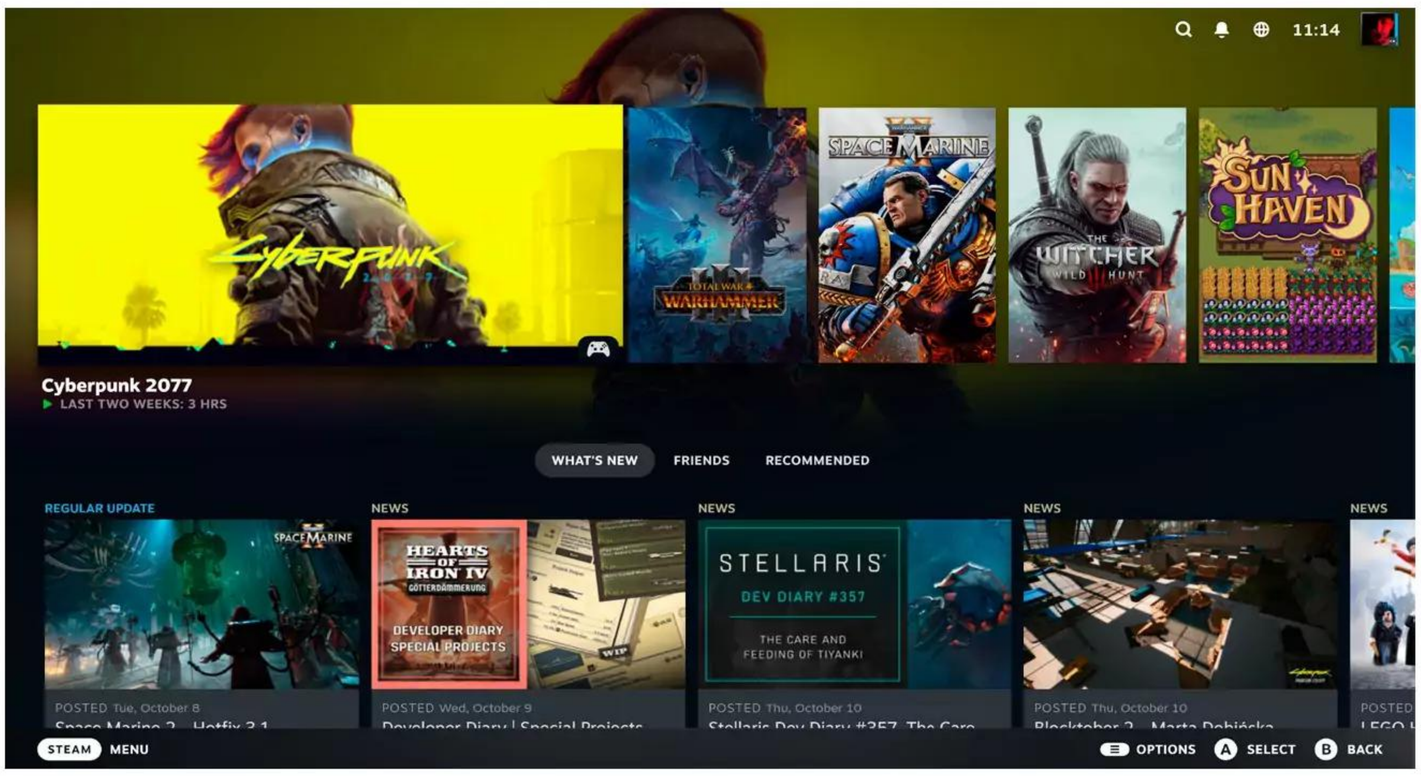
One last thing you might want to do before ditching the keyboard and mouse is download and log in to Origin, Ubisoft Connect, or the Rockstar Launcher. Get these installed and linked to your accounts. With that done, ensure auto-load on startup is disabled in their options. Similarly, hit Ctrl-Alt-Delete, go to Task Manager, select the 'Startup Apps' option on the left, and disable any programs you don't want loading on launch to really optimize your login speed. You'll also want to activate Windows here. Be warned: If you log in to a linked Microsoft account, Windows asks you to create a PIN, so instead you need to use an OEM key to activate Windows. We recommend picking up a Windows 11 OEM key from Kinguin.net—they currently cost around $22 or so.

CONNECTING A PS5 CONTROLLER

Sony's PS5 DualSense controller is one of the best controllers you can get right now, and it's remarkably affordable, too, at just $75 (if you don't have one already). It also supports two types of connectivity: You can either hook it up with a USB C cable or via Bluetooth.

To do the latter, hit the 'Start' menu on your PC, then type 'Bluetooth', go into 'Bluetooth and other devices', then select 'Add device'. Select 'Bluetooth' here, and your PC starts scanning for new devices. With your controller off, hold down the PlayStation button (between the analog sticks) and the Create button (top-left button near the direction pad), until the controller enters pairing mode, and the LED starts blinking. At this point, you can then select it on your PC and the controller is paired with your rig.

That's it—you're all set. One console-killing gaming PC, complete with Sony DualSense controller, and an armada of games that would make even the most enthusiastic back-catalog gamer weep.



Steam Big Picture mode is designed with controllers in mind, and is super-easy to navigate.

© STEAM

MAXIMUM CALIBER

THERE'S JUST SOMETHING awesome about ITX builds. Second only to perhaps liquid cooling, ITX is one of those form factors that takes no small amount of patience and ingenuity to pull off. Inevitably, no matter what you build, or how you build it, you're going to come across problems, refits, part removal, and reinstallation. It's just the nature of an ITX PC. They're awkward by design, because they have to be—they have to fit in that incredibly compact form factor.

If this were any other case in any other form factor, we'd be lambasting it and the manufacturer for being stingy with space to hit some market metric, or push you into buying a more expensive, larger version. Yet in the world of ITX, being as small as possible is the whole point, and that is an idea that permeates all forms of modern tech—it should pack as much power as possible into an ever-decreasing space. Just as transistors get smaller generation on generation, and become more efficient and more powerful, an ITX PC represents that ethos incredibly well. It's the sleeper build, a tiny box that, certainly with the loss of SLI and Crossfire, can pack in as much power as some of the largest builds.

The Terra is beautiful. Those panels, the wood finish, the ventilation cutouts, its feet, even the refined Fractal Design logo—it all gives this chassis a certain prestige that is hard to find in even some of the more premium cases. Compare it to Asus's $600 ROG Hyperion, and it's night and day as to which feels cleaner and more sophisticated (it's this one).

That said, it is not an easy build. If you're going into this as your first system, take your time, don't panic, look at your cable routing, make sure your cables fit, and do what you can to ensure everything goes smoothly. It's quite rare for us to say this, certainly for a case, but read the manual, as you'll have a far better time with it.

What would we do differently? It'd be all about pushing it to the limit. Using one of Corsair's SF1000L PSUs and swapping to something like a 7950X3D, plus an Asus ROG Strix X870-I Gaming WiFi mobo, with 64GB of RAM, and a lot more storage to back it all up. We'd no doubt try to get an RTX 4080 in there as well. Perhaps something like the MSI Gaming X Slim RTX 4080 Super. Combine that with an LED strip, and it'd really shine. To be clear, we're not sure if all that would even fit, but it'd be one heck of a build, and really take that ITX concept to the absolute limit.





1 Although we've managed to make all of this work, changing the PSU out to something half-length would help a ton. Corsair's SF750 PSU is considerably shorter and would be a good pick.

2 We'd love to somehow get an LED strip in here. If you could slide it gently in the roof and have some soft lighting fall out of the side of the chassis, that would look awesome.

3 The PCIe riser under the graphics card is removable. Don't miss it like we did—take the thing out and install your GPU outside of the case first.

4 Theoretically, if you use a smaller graphics card, you can fit a 120mm intake fan on to the side of the case, where the third fan is on the GPU.

PS5 PRO VS. GAMING PC: FIGHT

HOW WE TEST

Each issue of *Maximum PC* features a build, and each of them deserves to be benchmarked to the nth degree. It's all well and good showing you how to build it, but what exactly do you get performance-wise for your investment? We test each and every system across a whole armada of benchmarks, covering everything from 4K and 1080p gaming performance, to CPU tests, SSD sequential and random 4K speeds, power draw, and temperature measurements, and even AI testing, all in the name of science (and because we really love charts).

Every test is run three times, and we take an average from those three runs to calculate the result. In some cases, we may get outlier results, where one result is far outside of our expectations. In those scenarios, we re-test until the results are similar across all three recorded runs.

THIS ISSUE'S ZERO-POINT

This month's zero-point is from the October 2024 issue. This was the build we produced when first looking at our system benchmarks revamp, built inside the NZXT H7 Flow full-sized tower. It might sound like an odd pick, but we wanted to choose a build with a similarly priced GPU.

It features the AMD Ryzen 9 7900X, the B650E NZXT N7 motherboard, a 360mm Kraken Elite AIO, 32GB of Kingston Fury Beast DDR5 @ 6,000 C36, a 1TB Samsung 990 PRO M.2 PCIe 4.0 SSD, and a Sapphire Radeon RX 7800 XT graphics card, all housed in the H7 Flow, with a 1,000W C1000 PSU, and backed up with 2x NZXT

F360 RGB Core Frame fan units. There's also a secondary SSD in this system, the 4TB Western Digital SN5000. However, this month's ITX build doesn't feature a second SSD, so those results will be marked as N/A in the following tables.

Total price for the zero-point build at the time of writing is $2,291 (55 percent more than our console-killing PC), with a core price of $1,281 (20 percent more).

THE ELEPHANT IN THE ROOM

We know what you're thinking: "How the heck are you going to compare a PS5 Pro to a PC on a performance level?" And that's a good very question, because you can't. It's not possible to test one against the other. You can find out more about this in our PC versus PS5 Pro feature on page 22. Basically, in the world of the PC, frame rate is dependent on the end user choosing their optimizations based on the graphical horsepower they have available, and what they're willing to play with. In the case of a console, Sony tells the game developers they need to hit X frames at Y resolution, at all times.

The positive side of this is that all the hardware inside a console is identical on a generational front. That means a dev can fine-tune a game in their own studio to run exactly how they want it, and guarantee that this is the experience the end console user will have. There's no need for graphics options or benchmarking software in the console as a result.

So, it's massively unfair to even try to compare the two on a performance front, outside of those synthetic TFLOPs numbers that are spouted by manufacturers and marketing bods who follow the "bigger number is better" mantra (here's looking at you DRAM MHz).

14600K VS. 7900X

With that caveat out of the way, it's time to look at how these two PCs compare to one another, because it's tighter than you might expect. Jumping into Cinebench 2024, the chips are remarkably close in a number of ways. In single-core, the 14600K, even with its tiny cooler, beats the 7900X by two points: 120 to 118. In multicore, the field widens, with the Ryzen 9 7900X taking the lead, scoring 1,592 to 1,151, but if you compare them on a thread-to-score performance metric (bearing in mind Intel technically has fewer threads due to its efficiency cores lacking hyperthreading), you'll see the 14600K is only 8 points behind— around 12 percent. Not bad for a chip that's $80 cheaper. Geekbench flips the record a bit, however, with the 7900X scoring higher in both single-core and multicore results, but it's worth pointing out that again, on a performance-per-thread basis, Intel has the lead, with the 14600K landing 820 points per thread versus the 7900X's 756.

Storage performance between the Samsung 990 Pro and the Acer Predator was also tight, with the two trading blows on the sequential front, but Acer generally being around 200-300MB/s slower. It pipped the Sammy drive in random 4K reads, at 92.12MB/s to 77.05MB/s, but lost against it in the write test. That's likely due to the increased capacity of the Predator giving it a slight edge.

Power draw was also quite interesting. Our Ryzen 9 build topped out at 509.3W versus the 14600K build landing at 458.9W. That's quite a small difference, all things considered, particularly given the Ryzen system has an additional SSD, and no fewer than 10 fans, a pump, RGB lighting, a larger motherboard, and a more powerful GPU. It just goes to show how hungry these Intel chips are, despite the recent stability updates and improvements in BIOS. That's seen in the temperature tests, too, with the 14600K sliding in at its predictable Rocket Lake 100 C under load. GPU temps were stable across the board, however, with the 7600 XT keeping steady at a max temp of 66.1 C.

As for our AI testing suites, it's still a bit underwhelming for Intel, with the 14600K scoring just 47 on the Computer Vision test versus the 56 (not exactly mind-blowing) from the 7900X. Throw the GPU into the mix and that score increases to 646, still far shy of anything Nvidia can pump out, particularly under the Nvidia TensorRT API. Interestingly, however, when it comes to image generation, the 7600 XT performs far better than the 7800 XT and Ryzen 9 7900X, almost doubling their score. This we suspect is due to an interaction between the CPU and GPU managing image processing a little better, thanks to higher single-core performance and lower latencies, although we're still investigating that.

THE ARRIVAL OF FSR 3 IN GAMING

We've left talking about gaming for its own segment, because a lot of this ties into that PC versus PS5 Pro argument. First of all, the RX 7600 XT—if you're looking to game on PC at 4K on Ultra, just no. You're not going to get more than 30fps on average; the best titles we saw were *Far Cry 6* (which has zero ray-tracing or DXR features enabled), scoring 46.7fps, or *Final Fantasy XIV* (with FSR enabled) landing 34.4fps. *Cyberpunk* with FSR enabled (more on that in a second) landed 25.6fps, and 7.0fps without FSR, while *Total War* sailed in at just shy of the 30fps mark. Although consoles once boasted of 30fps as the norm, they have moved a long way from that, and in 2024, 60fps is the norm. So sadly, at 4K, on Ultra, 60fps just isn't a thing. If that wasn't already obvious.

Those figures do dramatically increase if you reduce the presets, drop the ray-tracing load, or use FSR with more balanced presets. That's the thing. If you drop most presets to medium, then 4K at 60fps is possible, but you need to do this on a game-by-game basis, and it's going to take time, and testing, and clever utilization of those benchmarking tools.

However, 1080p gaming is far more accessible for the RX 7600 XT. Frame rates easily jump up well above that 60fps mark across most titles. However, the most exciting figure is in *Cyberpunk*. If you take a look at our zero-point, using FSR 2.1, frame rates blow up from 44.2fps without it to 73.0fps with it, with a fairly minimal impact on overall clarity. For our 7600 XT machine, however, we tested using AMD's latest implementation of its upscaling tech, FSR 3. This also includes AMD's own AI frame generation (which wasn't possible with 2.1, but Nvidia did have it as part of its DLSS suite). With the 7600 XT build, frame rates went from 24.7fps without it all the way up to 85.4fps, with no harm to visual clarity in any meaningful way. That is huge—an increase of 245.7 percent—for little loss, and arguably what we'll be seeing with the PS5 Pro, certainly if they want to hit those 4K metrics at 60-120fps and above, at which it's advertised.

That does mean that, moving forward, all our AMD GPU runs will be using FSR 3.0 in *Cyberpunk*, but it also dramatically narrows Nvidia's current advantage.

CONSOLE KILLER OR PRICEY PC?

So, is it worth building a gaming PC for the big screen, or just getting Sony's latest $700 console? Unless you're buying older hardware or second-hand parts, it's not possible to match the spec of the PS5 Pro with today's off-the-shelf products.

The custom PC still has its advantages: You know exactly what's going in, you can use it for more than just gaming, the back catalog is ridiculous, and most "console exclusives" are now available on PC as well. But the sad fact is it's hard to compete with a megacorporation capable of buying custom GPUs in bulk.

Also, its software implementation isn't perfect. Even with Steam in Big Picture mode, you don't have access to Netflix or streaming services, as Sony's PlayStation does, without whipping out a mouse and keyboard, and it's not a unified platform.

It still works well, but it requires a little extra effort to get the most out of it.

SYSTEM BENCHMARKS

For our system testing, we use a multitude of separate benchmarks. For our CPU tests, these include Cinebench 2024 and Geekbench 6.3.0. All results are indexes in this case. Multicore per thread is achieved by dividing the total multicore scores by the number of threads on the CPU. For storage testing, we're taking advantage of CrystalDiskMark 8.0.5, the best scores are in bold, and all results are reported in MB/s. Throughout our entire benchmarking process, we test each system with a power meter plug running, and the latest version of HWMonitor installed and up as well. This then allows us to report on the maximum power draw and max temperatures seen over the entire benchmarking process.

CPU PERFORMANCE CINEBENCH 2024 & GEEKBENCH

	ZERO-POINT	
Cinebench 2024 Multi-Core	1,592	1,151 (-27.7%)
Cinebench 2024 Multi-Core Per Thread	66	58 (-12.1%)
Cinebench 2024 Single-Core	118	120 (1.7%)
Geekbench 6 Multi-Core	18,155	16,392 (-9.7%)
Geekbench 6 Multi-Core Per Thread	756	820 (8.5%)
Geekbench 6 Single-Core	2,919	2,832 (-3.0%)

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

STORAGE PERFORMANCE CRYSTALDISKMARK 8.0.5

	ZERO-POINT	
C: Sequential Read/Write Q8	**7,435/6,871**	7,129/6,681
C: Random 4K Read/Write Q1	77.05/**289.64**	**92.12**/280.88
D: Sequential Read/Write Q8	**5,531/5,029**	N/A
D: Random 4K Read/Write Q1	**75.70/248.03**	N/A

POWER DRAW & TEMPERATURE HWMONITOR & DEDICATED POWER METER

	ZERO-POINT	
Max CPU Temperature	95.1	100 (-5.2%)
Max GPU Temperature	78.4	66.1 (15.7%)
Max System Power Draw	509.3	458.9 (9.9%)

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

GAMING BENCHMARKS

Game tests are performed on Ray Tracing Ultra *(Cyberpunk)*, Ultra *(Far Cry 6)*, Maximum *(Final Fantasy XIV Dawntrail)*, and Ultra *(Total War: Warhammer 3)* graphics presets. Three runs are performed per title, per resolution. *Cyberpunk* is always tested with ray tracing enabled regardless. Under its second set of conditions, DLSS/FSR/XeSS is enabled in *Cyberpunk* dependent on GPU manufacturer, with the upscaling preset set to Quality. Nvidia cards also have AI Frame Generation enabled. *FF XIV Dawntrail* is utilizing FSR across the board regardless of GPU, with LOD on Distant Objects enabled, and dynamic resolution disabled. *Far Cry 6* is tested with DXR disabled, and the HD Texture pack downloaded and enabled.

1080P PERFORMANCE

	ZERO-POINT	
Cyberpunk 2077 Stock (Avg/Min FPS)	**44.2/38.1**	24.7/21.2
Cyberpunk 2077 AI Upscaling (Avg/Min FPS)	73.0/62.8	**85.4/73.1**
Far Cry 6 (Avg/Min FPS)	**149.7/104.7**	115.3/95.0
Final Fantasy XIV Dawntrail (Avg/Min FPS)	**174.4**/77.7	127.1/**86.0**
Total War: Warhammer 3 (Avg/Min FPS)	**148.0/113.3**	88.7/69.3

1080P PERFORMANCE

	ZERO-POINT	
1080p Titles Aggregate (Average FPS)	117.86	88.23 (-25.1%)
1080p Titles Aggregate (Minimum FPS)	79.31	68.93 (-13.1%)

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

4K PERFORMANCE

	ZERO-POINT	
Cyberpunk 2077 Stock (Avg/Min FPS)	**13.1/11.4**	7.0/6.1
Cyberpunk 2077 AI Upscaling (Avg/Min FPS)	**25.6**/22.3	**25.6/22.6**
Far Cry 6 (Avg/Min FPS)	**83.0/76.0**	46.7/42.7
Final Fantasy XIV Dawntrail (Avg/Min FPS)	**61.0/39.3**	34.4/22.0
Total War: Warhammer 3 (Avg/Min FPS)	**50.8/36.0**	27.8/19.3

4K PERFORMANCE

	ZERO-POINT	
4K Titles Aggregate (Average FPS)	46.69	28.29 (-39.2%)
4K Titles Aggregate (Minimum FPS)	37.01	22.55 (-39.1%)

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

SYNTHETIC GAMING BENCHMARKS

We're using 3DMark's latest Speed Way, Steel Nomad, Night Raid, and CPU Profile tests. Speed Way represents a DX12 title at 1440p, with ray-tracing elements, Steel Nomad is DX12 4K without ray tracing, and Night Raid (DX12) is designed with integrated GPUs in mind at 1080p. CPU Profile acts as an additional CPU benchmark (reporting on max thread output only), with specific gaming workloads prioritized. Each synthetic test is run three times, and indexes are reported on.

3DMARK PERFORMANCE

	ZERO-POINT	
Speed Way (DX12 + RTX @ 1440p)	3,760	2,063 (-45.1%)
Steel Nomad (DX12 @ 4K)	4,024	2,348 (-41.7%)
Night Raid (DX12 @ 1080p)	83,131	66,064 (-20.5%)
CPU Profile	12,776	9,560 (-25.2%)

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

AI INFERENCE BENCHMARKS

For our AI testing, we use UL Procyon's Professional Benchmark Suite. We focus on its AI Computer Vision (which gives us a gauge on how our systems operate when dealing with inference engine tasks), and AI Image Generation benchmarks. For Computer Vision, we report on the total inferences performed, the average inference time, plus the Index score across all tests. The Index score is more valuable, as it's the time taken between inferences that indicates performance. We run all tests on AI Vision using Float16 precision. We test both the CPU and the GPU under Microsoft's ML API.

For Image Generation, we test under Stable Diffusion 1.5 (Float16 precision), using all engines available. However for comparison, we only include scores from the same engine. We report on the Index score, the time taken, and the image generation speed. All results are averaged across all tests. Best scores, where appropriate, are in bold.

AI COMPUTER VISION PERFORMANCE

	ZERO-POINT	
Microsoft ML API CPU (Index)	56	47 (-16.1%)
Microsoft ML API GPU (Index)	1,084	646 (-40.4%)

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

	ZERO-POINT	
Microsoft ML API CPU (Total Inferences)	**11,278**	10,391
Microsoft ML API CPU (Average Inference Time)	**520.37 ms**	777.02 ms
Microsoft ML API GPU (Total Inferences)	**136,607**	97,897
Microsoft ML API GPU (Average Inference Time)	**13.508 ms**	23.60 ms

AI IMAGE GENERATION PERFORMANCE

	ZERO-POINT	
Stable Diffusion 1.5 ONNX (Index)	381	736 (93.2%)

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

	ZERO-POINT	
Stable Diffusion 1.5 ONNX (Time Taken)	261.885 seconds	**135.745 seconds**
Stable Diffusion 1.5 ONNX (Image Generation Speed)	16.368 seconds/image	**8.484 seconds/image**

LOCK DOWN YOUR DATA, YOUR IDENTITY, & YOUR PC

HOW VULNERABLE do you feel as a PC user? If it's not the constant blitz of malware and adware, it's a steady stream of newly discovered vulnerabilities that could result in all kinds of information leaking out on to the internet. In this feature, we'll show you how to add the layers of security you need to protect yourself and your identity online.

We won't waste time on the basics—we're going to assume you're smart enough to have strong anti-malware software installed, while realizing the key to staying safe is to minimize your exposure and risk. Neither will we tell you how to behave on social media or why you shouldn't hand out your social security number or credit card to anyone who asks for it online.

No, instead we'll delve into ways in which you can tighten things even further, from locking down your Windows user account to ensuring your sensitive data is encrypted, whether it's stored on your laptop or in the cloud. We'll also steer you toward closing any holes in your network, and then finally explore ways of reducing your visible presence online. Armed with these tips, you'll never have to worry about what might show up in the next data breach reported at https://haveibeenpwned.com again...

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Worried about losing control of your computer, data, or even your identity? Find out how to protect yourself with Nick Peers

LOCK DOWN YOUR PC

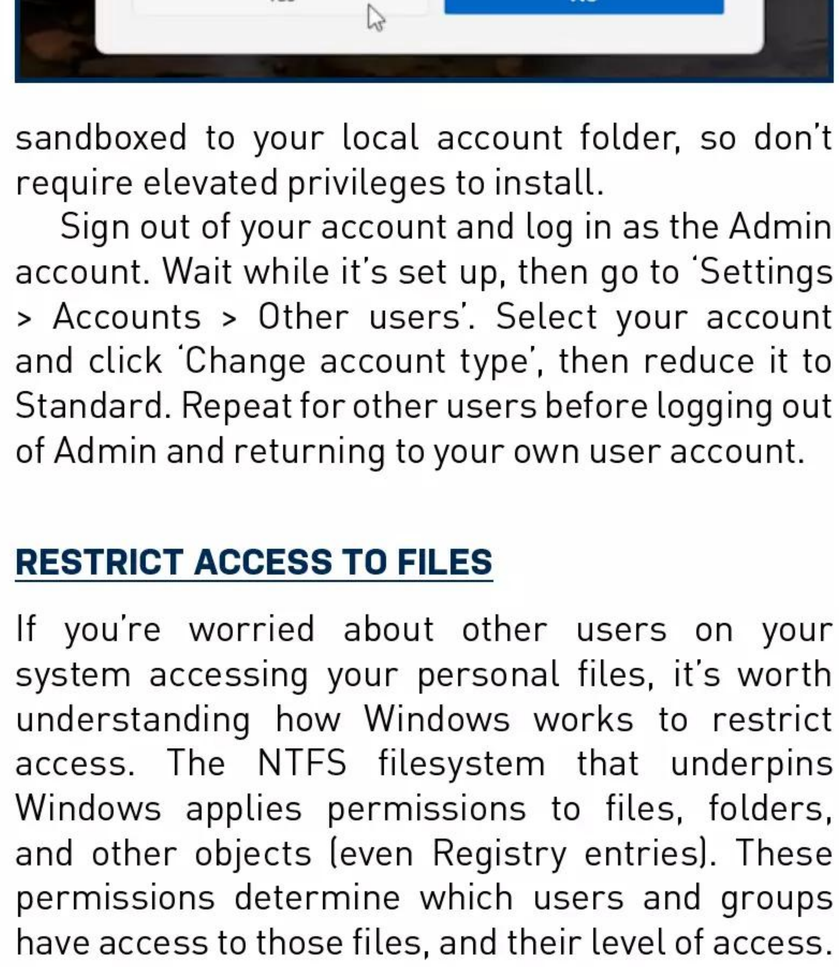
Let's start by implementing a new way of accessing your PC—by mimicking Linux. By default, your user account has system-wide access to your PC. If malware takes root through your user account, it can wreak all kinds of havoc. Although your account runs as a standard user most of the time, it's all-too easy for it to gain administrative access by the easily dismissed User Account Control dialog, which can be swatted away with a click of the mouse.

Linux requires you to enter your user password whenever you try to delve too deeply into your system, and in some distros, requires you to switch to the master administrator user (root) for limited-time access to the deepest parts. Is it inconvenient? Maybe, but it forces you to stop and think why you're being asked for deep-level access—it could be the difference between waving malware on to your system and stopping it in its tracks.

This approach is considered standard on a shared PC where one person takes administrative control and others make do with a standard user account, asking you to input your PIN or password when they attempt to do something that requires administrator-level access. This merely takes it to the next logical step by downgrading everyone—including yourself—to minimize the risk to your PC.

If you're willing to sacrifice a bit of convenience for tighter security, click 'Start > Settings > Accounts'. Step one is to create a new master Administrator account—scroll down to click 'Other users' followed by 'Add account'. You're prompted to sign into a Microsoft Account—we don't want this, so click 'I don't have this person's sign-in information', followed by 'Add a user without a Microsoft account'. Name the account 'Admin', then enter a secure password, with password hint if required, before clicking 'Next'.

With the account set up, you next need to make it an Administrator account—select the account under 'Other users' and click 'Change account type' to convert it to Administrator. You're now ready to log off your own account and reduce it to the level of a standard user. Going forward, the only apps you'll be able to install without administrator privileges are those in the Microsoft Store—they're sandboxed to your local account folder, so don't require elevated privileges to install.



Your new prompt when attempting elevated access.

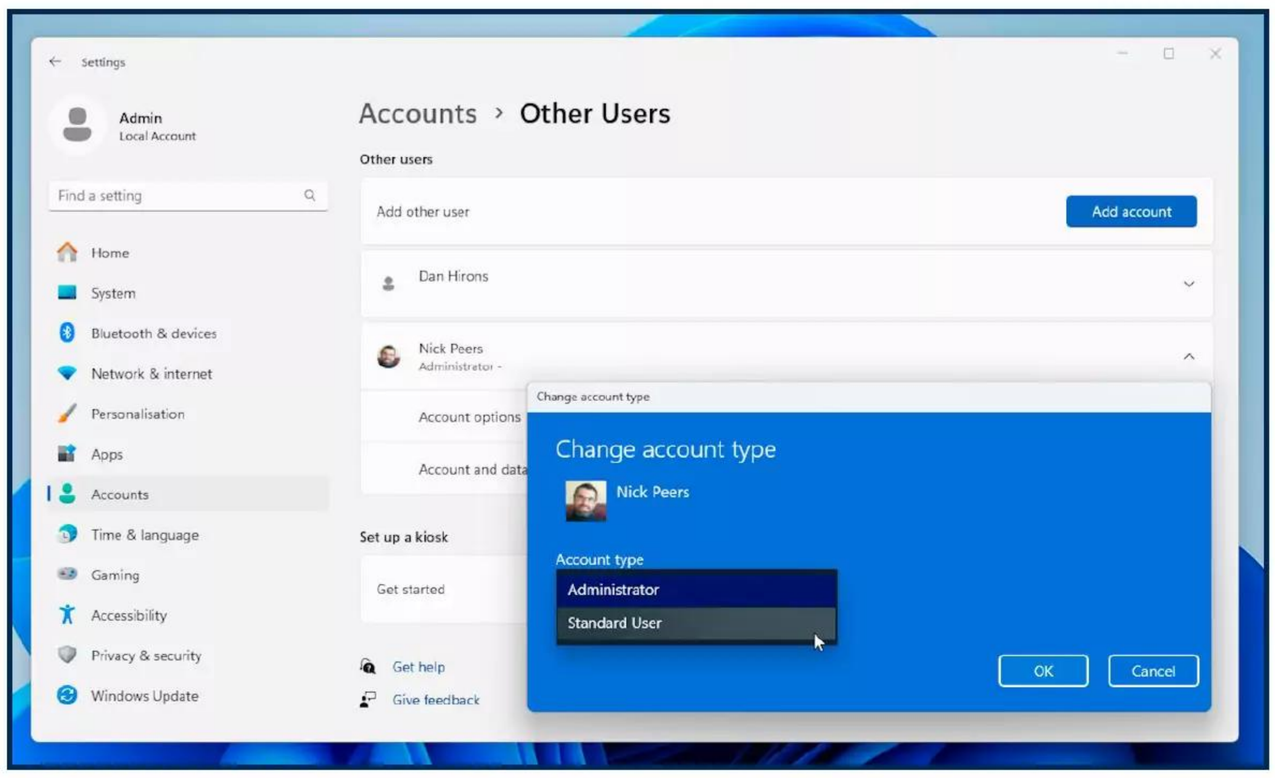
Sign out of your account and log in as the Admin account. Wait while it's set up, then go to 'Settings > Accounts > Other users'. Select your account and click 'Change account type', then reduce it to Standard. Repeat for other users before logging out of Admin and returning to your own user account.

RESTRICT ACCESS TO FILES

If you're worried about other users on your system accessing your personal files, it's worth understanding how Windows works to restrict access. The NTFS filesystem that underpins Windows applies permissions to files, folders, and other objects (even Registry entries). These permissions determine which users and groups have access to those files, and their level of access.

The quickest way to see this in action is on a shared computer. Navigate to the 'C:\Users' folder, click on someone else's user folder, and you'll get a message informing you that you don't have permissions to access this folder. It's worth noting that anyone attempting to access this folder is invited to click 'Continue' to gain permanent access to it. If they're an Administrator, they're waved through; if their account is limited to a Standard user, they'd need to enter an administrator's password to gain access—an early practical example of how you can protect your PC by reducing your level of access.

This prompt appears every time you want to perform an administrator-level action. It's slightly less convenient but provides a visible reminder that someone or something is trying to gain deep access to your system. If you instigated that move, fine; if not, you may just have saved yourself from disaster.



Downgrade everyone to a Standard User—including yourself.

LOCK DOWN YOUR DATA

One way to lock down your personal files and other sensitive data would be to mess around with NTFS permissions, but as part of your new locked-down persona, all Permissions properties are now off-

© MICROSOFT

limits. A better option is encryption. This can be done by encrypting individual files and folders, or locking down entire drives. Which you choose depends on your circumstances—for example, the need to encrypt your entire drive is more pressing if it's on a laptop that's vulnerable to theft as opposed to a desktop PC behind the walls of your home.

You'll find tools for encrypting both files and entire disks in Windows, but these are just some of the settings now hidden from your user account. If you want to encrypt your entire drive, log out of your current user (or choose 'Switch User'), and log in to your newly created Admin account before proceeding. Windows 11 Home users should then open 'Settings > Privacy & security', and flick the 'Device encryption' switch to 'On' to encrypt your system drive using AES encryption; Windows 11 Pro users can open File Explorer, right-click their 'C' drive, choose 'Turn BitLocker On', and follow the prompts (take a drive image first, just in case).

If you'd prefer to encrypt individual files and folders—say for transporting via potentially insecure media, such as USB flash drives or email—it's technically possible in Pro versions of Windows using its built-in EFS (Encrypting File System), which uses your Windows password as the encryption key. However, it's not particularly effective—see the box below for a better option.

LOCK DOWN YOUR CLOUD DATA

One of the most important tools in your backup armory is your cloud storage. It's here you're able to store remote, off-site backups of your data that you can access from any device at any location. The downside to this convenience is the question of just how secure your data is while it's stored on a third-party's server. Most cloud backup services are keen to stress their security credentials, but how do those stand up to scrutiny?

You need to consider the following: Your data may be encrypted during transit to and from your cloud storage, but what about those files that are 'at rest' on the server? Are those files scrambled beyond a hacker or physical thief's reach? Another question concerns the encryption keys that are used to protect your data—who owns those keys and has access to them? If it's your cloud provider, how do you know that it can be trusted never to hand those keys over to anyone else, whether voluntarily through law enforcement or involuntarily through a hack?

The answer is simple: If you're not going to invest in your own hardware infrastructure—namely a NAS or server that you store at a friend or family member's place, and which you keep synchronized with your own PC using a tool such as Syncthing (www.syncthing.net; see the July 2021 issue and our comprehensive backup guide)—then you need to adopt a 'trust no-one' approach to storing data online.

This means adding your own additional layer of encryption to your files before they're uploaded, so even if your cloud's encryption is cracked or bypassed (assuming it has any), the files remain inaccessible. The simplest way to do this is by using

MORE FILE ENCRYPTION OPTIONS

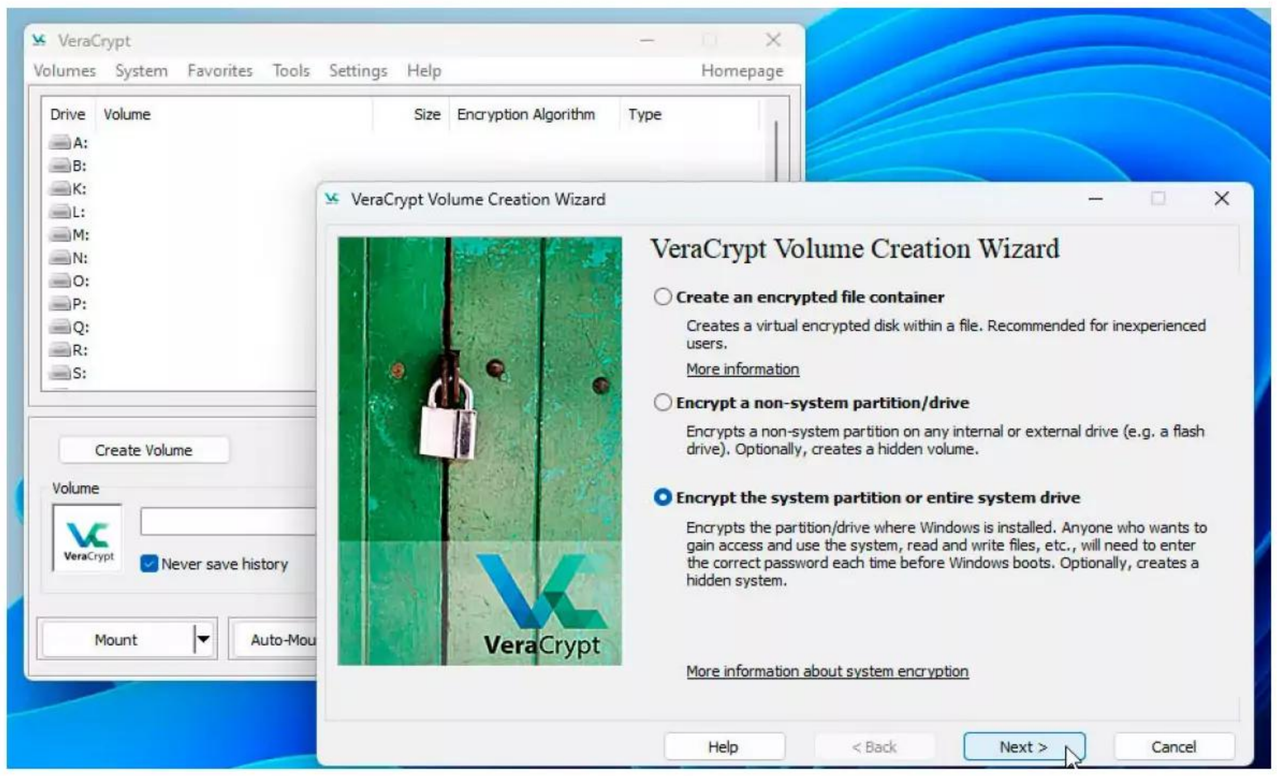
The Windows disk and file encryption tools are OK as they stand, but they're not comprehensive and not available to all Windows users. A better option is VeraCrypt (www.veracrypt.fr/en/), which covers all your file and disk encryption needs, and works on Windows, Linux, and MacOS, too.

The program opens to its Volume Creation Wizard, where you have a choice of three options. 'Encrypted file container' creates a single file that can be mounted like a virtual drive. Any data copied into this vault while it's unlocked is written to the file and encrypted. It's the safest option and best for securing sensitive data without locking down your entire PC.

You can also encrypt individual partitions or your entire hard drive, including boot volumes. Always take a fail-safe drive image before you begin, and make sure you create rescue media when prompted if you decide to encrypt your boot volume, as it's needed to permanently decrypt your drive if needed, as well as provide protection against corruption. Once you've got through the setup process—which includes providing a strong password; the only thing used to encrypt the drive—VeraCrypt encrypts the drive in the background as you continue to use your PC.

It's worth noting you can also encrypt non-system volumes, including flash drives. While it's possible to select 'Encrypt in place', there are drawbacks to doing this on a volume with existing data. If there's space to do so, copy all data off the drive before wiping it, using VeraCrypt to encrypt it, and then finally copying the data back to it.

For a full guide to using VeraCrypt, check out its comprehensive online documentation or dig out your copy of our March 2020 issue.



Encrypt folders or entire drives with VeraCrypt.

© VERACRYPT

Cryptomator (https://cryptomator.org)—see the box below for details.

LOCK OUT RANSOMWARE

Should ransomware ever take hold of your PC, it will rush through every drive it can find, crippling your files by encrypting them using the same technology you use to protect them; the difference being that you don't have access to the key or password.

The ransomware spreads to any backups you have, including those stored on network drives. By default, people tend to save their network credentials to make it easy to reconnect those drives for whatever reason. However, doing so means ransomware can sweep through any connected network drives, too, before you have a chance to react.

The solution, therefore, is once again to sacrifice a little convenience for security. Going forward, get into the habit of leaving the 'Remember my credentials' box unchecked when logging on to a shared folder. Next, remove all existing saved network credentials from your PC—to do this, open 'Search' via the 'Start' menu and type 'credential' to find Credential Manager.

Here you'll find two sections: 'Web Credentials' and 'Windows Credentials'. Switch to 'Windows Credentials' and you'll see a list split into categories, with your network passwords stored at the top under 'Windows Credentials'. Click the down arrow next to each one in turn, then click the 'Remove' button to delete them and protect any data stored on a network drive.

If you're using a backup tool to store a copy of your data over the network, what does this mean? Will you need to input your network credentials each time it tries to run, or will it fail? It depends on the backup tool, but some allow you to store your network credentials securely within the program itself, so they can connect without relying on you exposing those credentials to any malware that might come a-calling. For example, if you use Macrium Reflect, choose 'Open Tasks > Edit Defaults and Settings', and switch to the 'Network Share Settings' tab to input your network details.

LOCK DOWN YOUR NETWORK

Once your PC's security has been locked down, your next port of call is your network infrastructure. Most of this can be applied via your router's configuration tools—this is, after all, the gateway between all your devices and the outside world.

Start by logging on to your router by entering its IP address into your browser—did you use the default username and password as supplied by its manufacturer? Big mistake: These defaults are well known, and routers are easily reachable by hackers over the internet if you don't first lock them down. Let's rectify that—make sure you have your router's manual or online documentation to hand.

First, locate the router's administration settings. Step one is to lock the admin account as tightly as possible by changing its password (choose something strong—a long, random one generated by and stored in your password manager is best) and exploring other options: Can

ENCRYPT YOUR CLOUD DATA

How does Cryptomator work? It lets you create password-protected folders—or vaults—which can be stored in your cloud folder. You place your files inside this, and they're scrambled using AES 256-bit encryption, with a personal encryption key that remains in your possession.

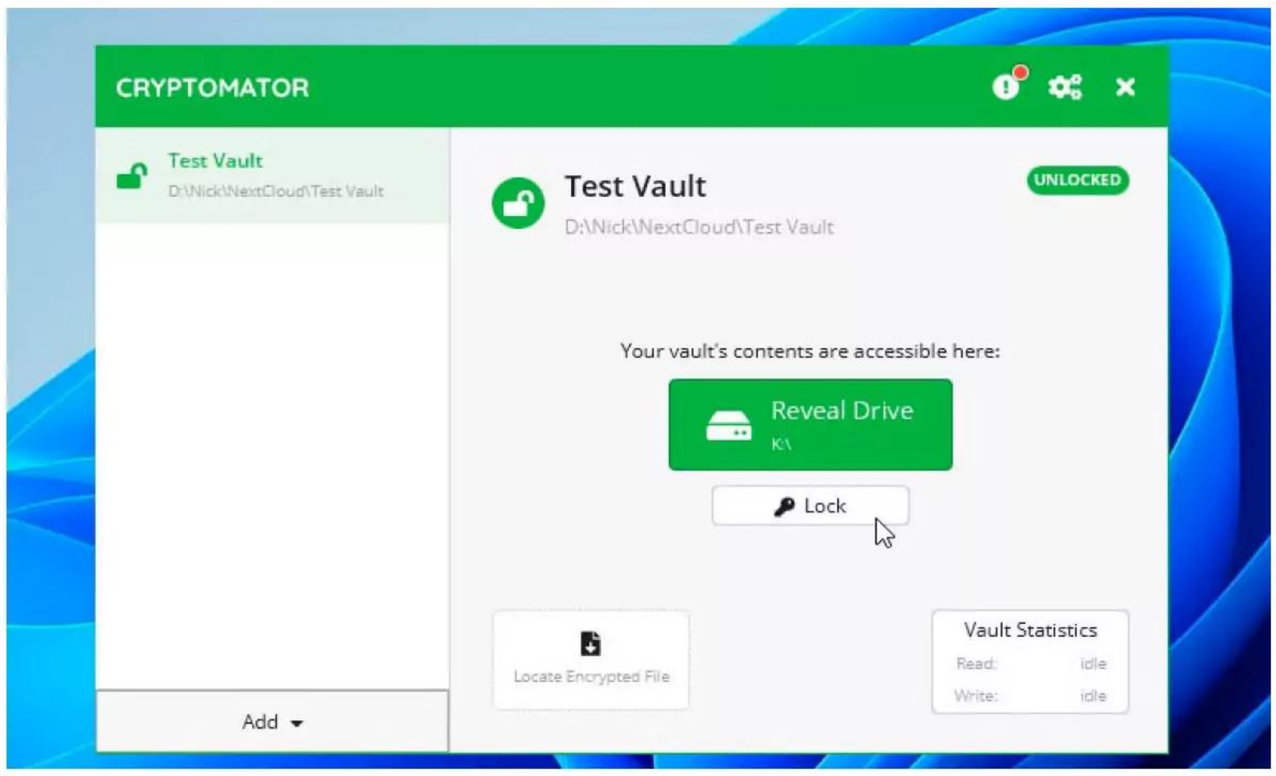
Download and install Cryptomator (or use the portable version), then open the app. Click 'Add', and choose 'New Vault'. Give it a suitably descriptive name, and click 'Next', then choose 'Custom Location', and click 'Choose' to select a folder inside your cloud storage folder (such as 'C:\Users\Username\OneDrive').

Click 'Next' twice, then enter a strong password or passphrase (store this in your password manager), and choose whether to create a fail-safe recovery key. Finally, click 'Create Vault'.

Once created, you're prompted to click 'Unlock Now' to make the vault visible and accessible for use. You're asked to enter the password you just created; you'll also see a 'Remember password' box, which should only be checked on a secure PC where you're the only user.

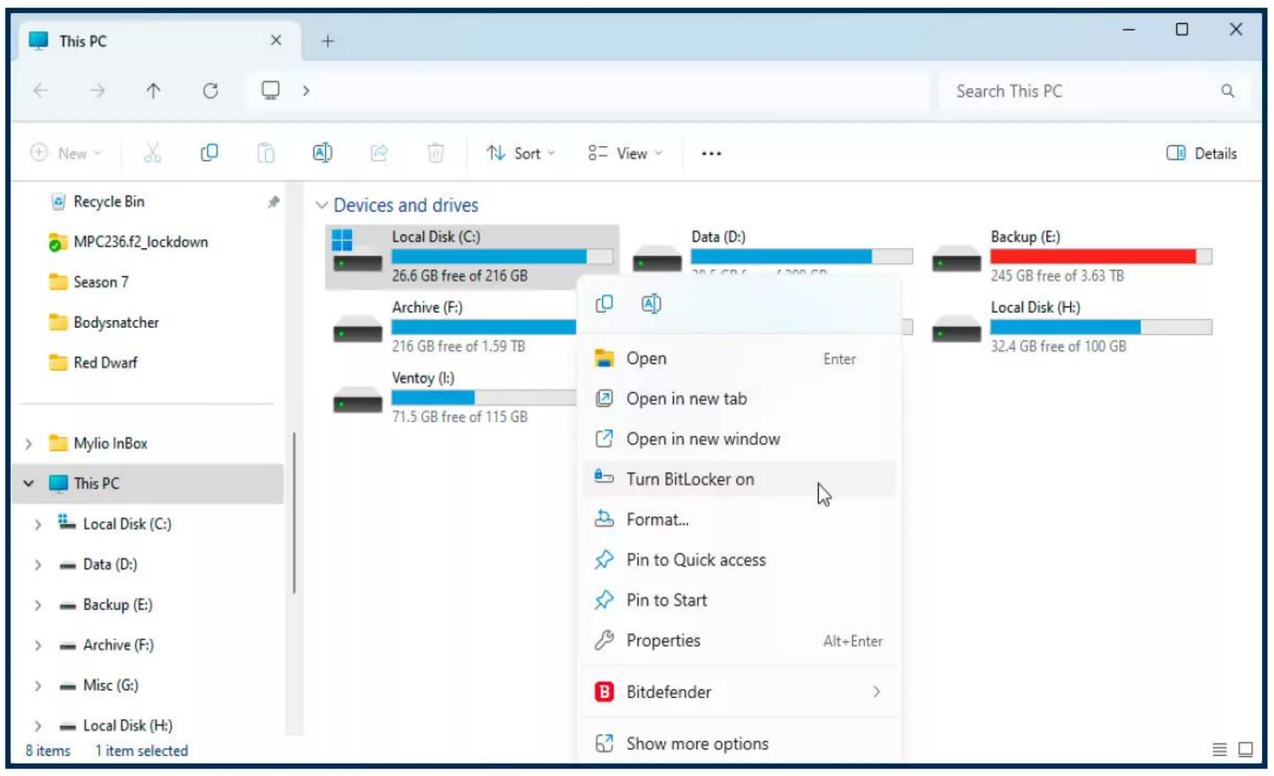
Once unlocked, a virtual drive with its own drive letter is created, into which you can store and access data freely from your own PC while the drive remains unlocked. Reassuringly, your data is synced to the cloud encrypted, where it's completely inaccessible. When you close the vault or Cryptomator, the vault is also inaccessible on your local PC for additional security.

You can also install Cryptomator on other devices to allow access to the vault from other computers and phones; all computer apps are free, but mobile apps cost $22.99 from Google Play (or around $14 for the APK) on Android, and $12.99 on iOS.



Cryptomator protects your sensitive files when stored in the cloud.

© CRYPTOMATOR



you change the username, too? Does it support two-step verification?

These steps all help to protect you against drive-by brute-force attacks, but you can go further: Look for an option that allows you to access and manage your router remotely (outside your home network), and disable it. Explore your router's port forwarding and firewall sections—if practical, disable automatic options such as UPnP forwarding, which whitelists any app's attempt to tunnel a hole out to the internet, leaving those ports open for traffic to come into your network from outside. Try to review existing settings to make sure you recognize existing port forwarding rules, and make the effort to rename the rule to something more descriptive. If you don't recognize a port, disable it, and see which app complains when it can't reach the internet to determine if it's genuine.

BitLocker enables you to encrypt your entire drive.

TIGHTEN WI-FI SETTINGS

Another weak spot is your Wi-Fi. If you live in a populated area, it's likely your Wi-Fi network spills out into neighboring houses, yards, and even the street. Take steps to ensure someone can't piggyback on to your network for whatever purpose—to steal bandwidth or potentially worse.

Visit your Wi-Fi settings to disable Wi-Fi Protected Setup on your router. WPS is designed to make it easy to connect devices to your network with the push of a button, but it's easy to compromise. Get in the habit of only enabling it when you specifically need to connect a new device.

You should also review your encryption settings—if supported, trying switching your Wi-Fi to the latest WPA3 standard, or WPA3 with WPA2 fallback to ensure older devices aren't left behind. Consider setting up a guest Wi-Fi network for visitors, and review its settings to ensure the network is kept separate from your main network (if a client isolation option exists, check that).

Your guest network can serve other purposes, too—for example, if you have any smart home devices capable of eavesdropping, such as smart speakers or baby monitors, placing these in isolation on your guest network effectively eliminates their opportunities to spy on your network should their limited security be compromised at any point.

Your router may also support virtual LANs (VLANs). These enable you to isolate parts of

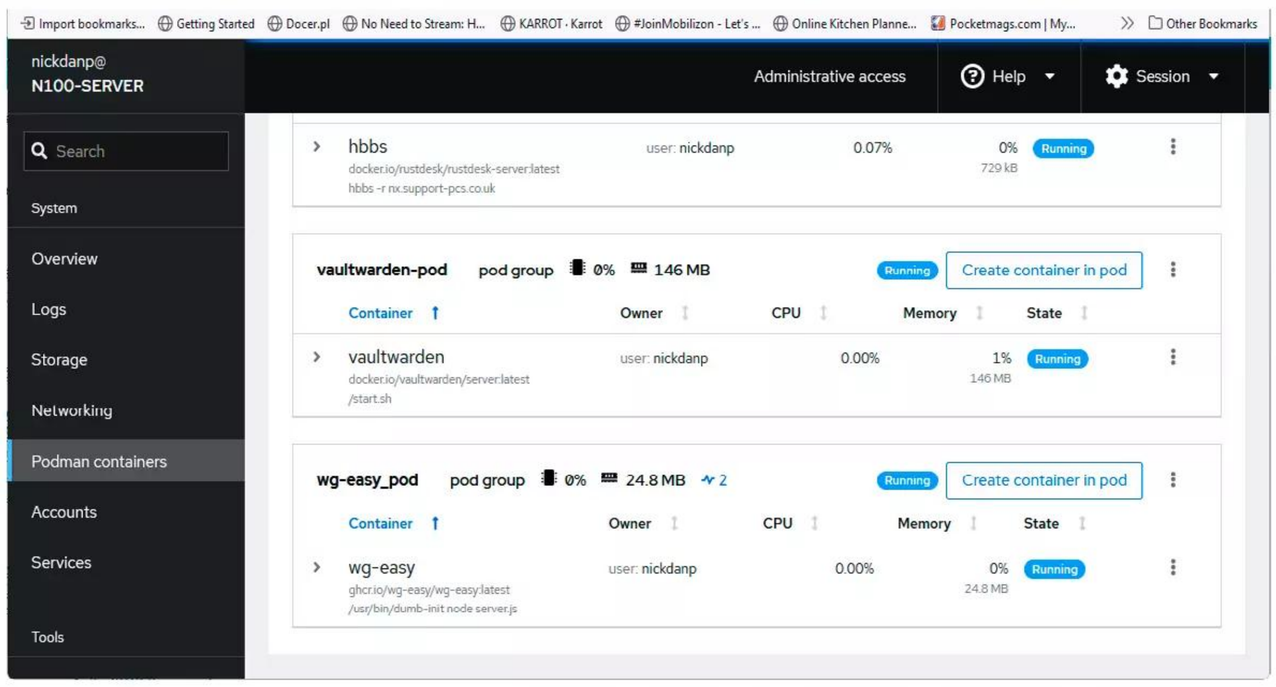
TAKE KEY SERVICES OFFLINE

One of the most effective ways to lock down your online presence is by minimizing your exposure to the internet. Why rely on third parties to host your data or provide certain services you can run for yourself with a suitable server and the right tools? Over the past few years, we've shown you how to build a low-cost, low-powered server for 24-7 use (see the April 2024 issue for its latest iteration), then populate it with services running as isolated Docker or—more recently—Podman containers.

If you dig through your back issues, you will find projects on building your own self-hosted password manager using Vaultwarden, a close derivative of Bitwarden with access to all its premium features. Other services you can bring in-house include cloud sync (Nextcloud), ad-blocking (Pi-hole), remote assistance and access (RustDesk), in-home surveillance (Motion), and streaming (Plex or Jellyfin).

Also check out our guide to building your own VPN server (June 2024 issue) using the fastest and most secure protocol there is: WireGuard. It allows you to securely dial into your home network from your laptop, phone, or tablet when away from home. Not only does this give you access to your network resources without exposing them to the internet, but you can also use your self-hosted services without having to make them publicly available via a subdomain. The most obvious benefit? You can use your Vaultwarden password vault from anywhere without exposing your password manager to potential brute-force attacks.

There is one potential drawback with Vaultwarden: You can't access your vault (and the all-important password auditing tools) through a web browser, as it doesn't support insecure connections. Thankfully, there is a workaround—check out October 2024's Doctor column.



Run self-hosted services from the comfort of Podman and your web browser.

© BITLOCKER

your wired network in a similar fashion to guest networks. This involves plugging your devices or switches into a specific port on the router. Even if your router doesn't have VLAN support, you can still add it via a smart switch such as TP-Link's five-port TL-SG105E V5 ($24.99, www.amazon.com/dp/B00N0OHEMA).

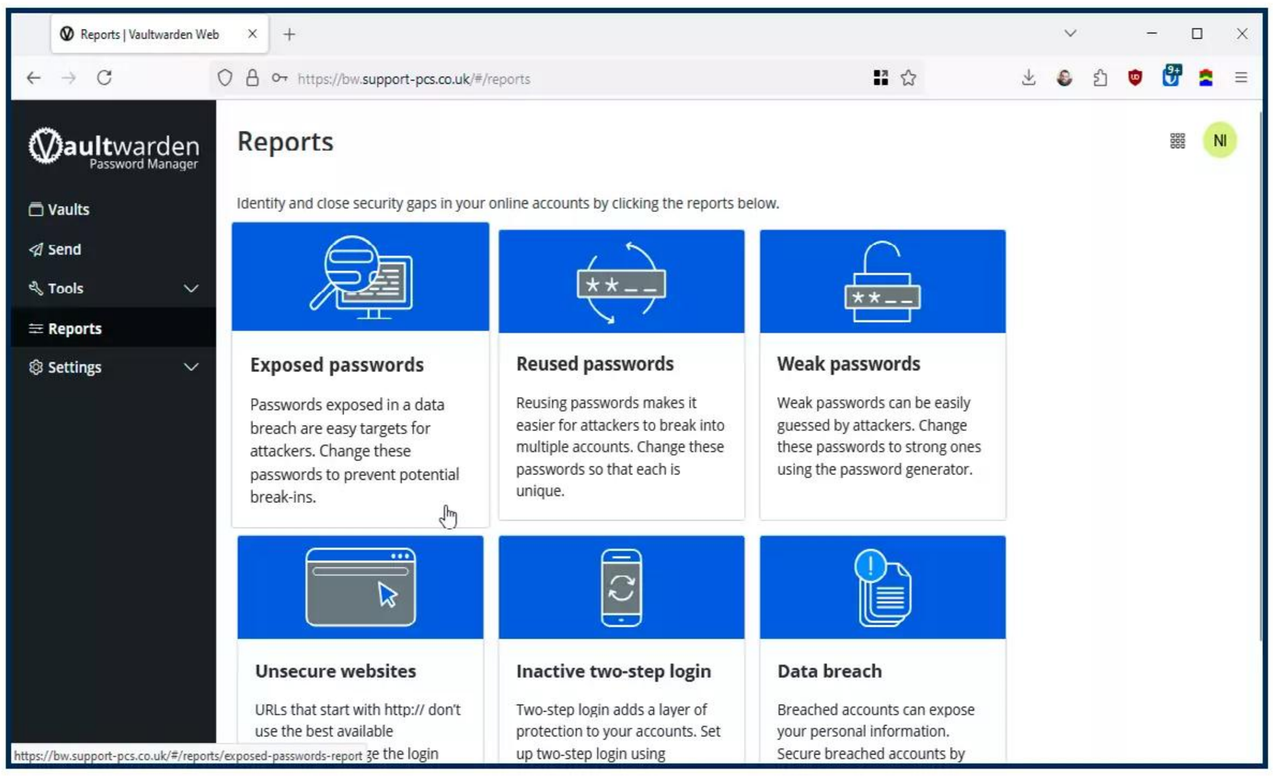
LOCK DOWN YOUR ONLINE IDENTITY

You've reduced your day-to-day access to Windows, locked down your files, encrypted your cloud backups, and taken steps to tighten your network's security. Now it's time to turn your attention to your online presence. The obvious place to start is with your online accounts. Just how secure are they, and how diligent are you at ensuring they're protected with strong, unique passwords that means in the event one is subject to a password breach, it doesn't immediately expose all your others?

The solution obviously lies in taking the time to set up and use a good, strong password manager. Our favorite by far is Bitwarden (https://bitwarden.com), which is completely free and open source. However, we recommend investing in a Personal ($12/year) or Families ($40/year for up to six users) plan to not just support the project, but unlock useful features such as integrated 2FA and security audits on all your stored passwords. If you want to go the extra mile, check out the box on self-hosted services to discover how to set up your own instance of Bitwarden that stores nothing in the cloud.

With Bitwarden in place, take the time to visit all your usual online haunts, logging in when required, and allowing Bitwarden to store your login details. Once done, visit your account section and look for an option to change the password—use Bitwarden's password generator to generate a strong random 14-character password containing a mix of letters, numbers, and, if allowed, symbols. This will put it beyond the reach of any brute-force attack.

Also look to see whether you can strengthen the account further: Consider adding two-factor verification if it's supported (make sure you also do this for your Bitwarden account). Use a trusted open-source authenticator like 2FAS (https://2fas.com) or check your password manager—both the Premium and self-hosted versions of Bitwarden have built-in 2FA support.



Bitwarden can reveal exposed and weak passwords.

If you're worried about giving away personal information when setting up accounts, consider signing up with an anonymous email forwarding service such as Addy.io (https://addy.io). This generates random email addresses you can supply in place of your actual email address, so it's not exposed to potential security breaches. It can also be integrated into Bitwarden's username generator when setting up new accounts.

And what about your other contact data? Check the final box for details on reclaiming control over your home address.

LOCK DOWN YOUR CONNECTION

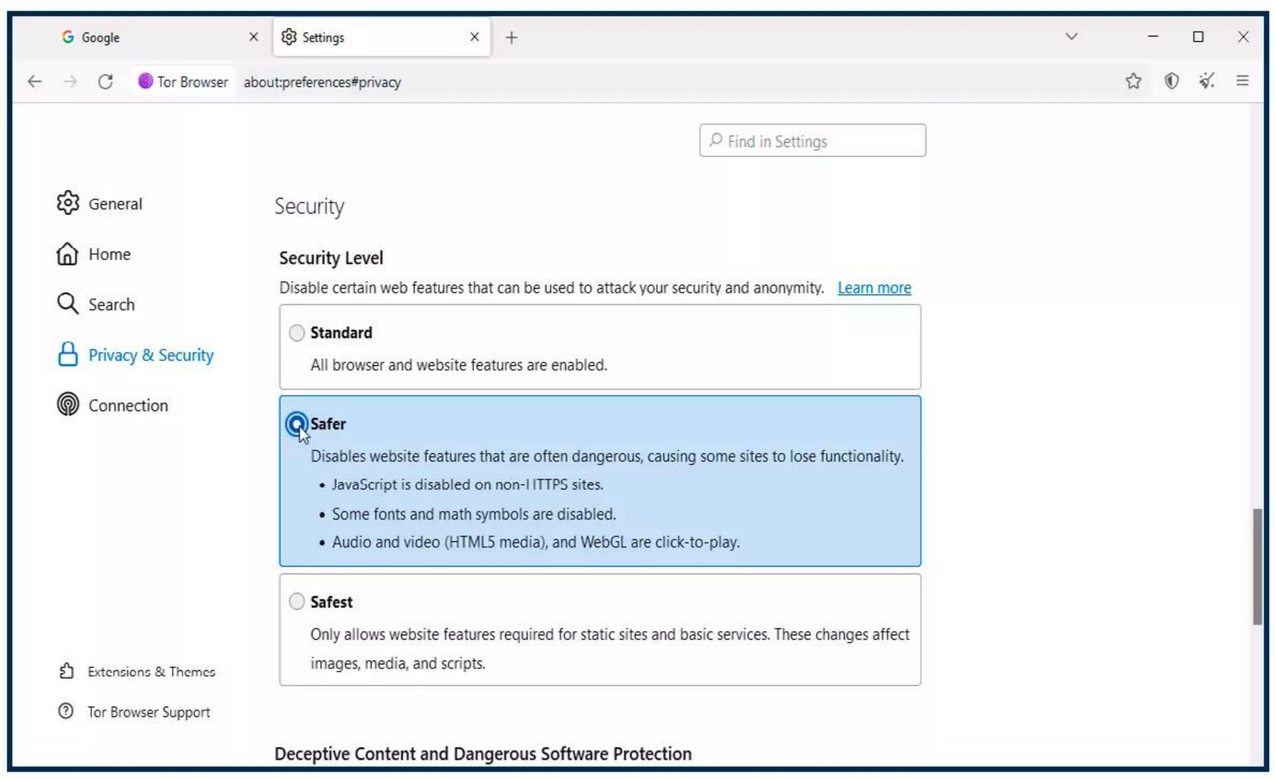
Have you noticed just how much information about you leaks online? The final step in this security audit is to identify the moles and plug the holes, so your online presence doesn't light up like a Christmas tree whenever you venture online.

Let's start by tightening your connection to the internet. This involves investing in a VPN, which encrypts your data to mask it from your internet provider and any potential man-in-the-middle attacks. The encrypted data is then routed to a server of your choice, so it appears to originate from that location instead of your home address (or wherever you are). From here, it's then decrypted and sent on its way—any data returning is then encrypted at this point before being returned to you.

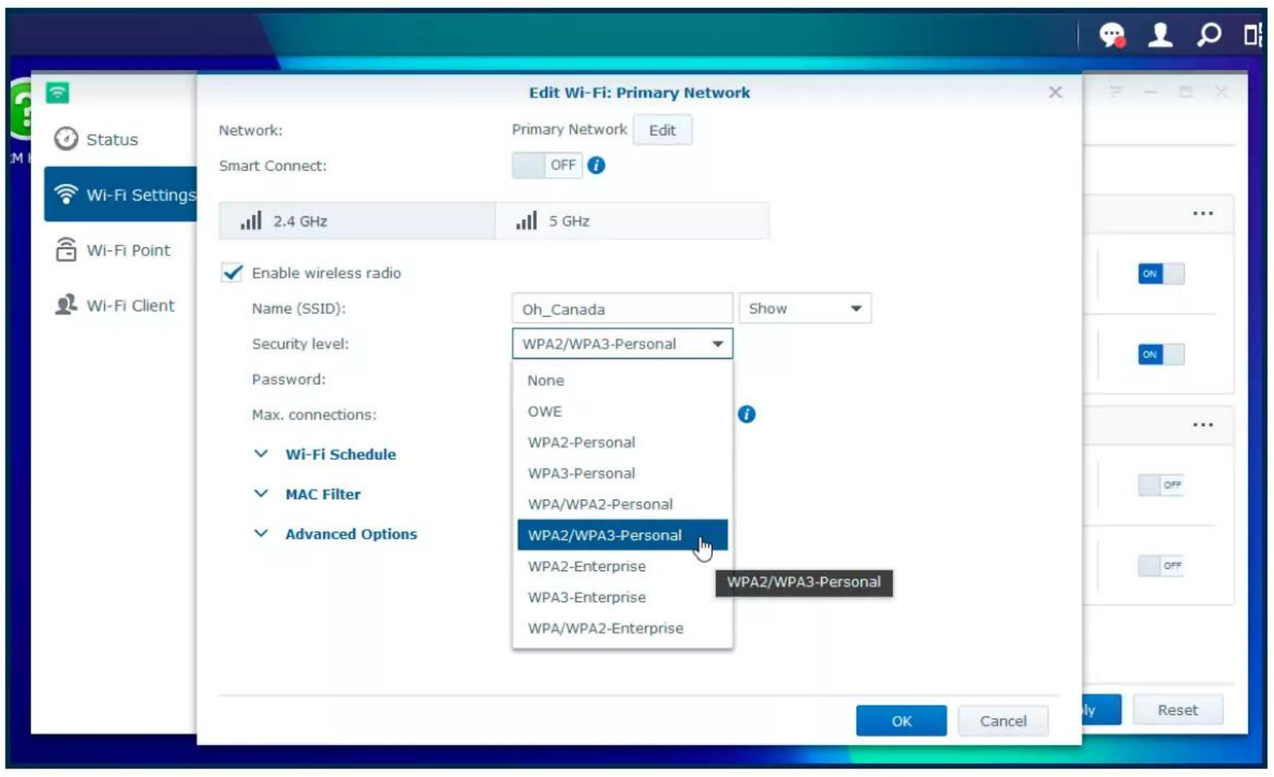
There used to be a significant performance penalty to running a VPN, but newer protocols—particularly WireGuard and its variants, such as ExpressVPN's Lightway—mean you enjoy virtually no performance penalty when connected to a nearby local server. If your budget is tight, ProtonVPN's free package offers unlimited data, but no choice of server (so you're stuck with a fast US server), while WindScribe (www.windscribe.com) offers a choice of servers, but caps your monthly bandwidth to 10GB—generous, but not comprehensive.

For a relatively small monthly outlay, consider signing up to a VPN's paid package by committing for one to three years to save up to 80 percent on the pricey month-by-month cost. We recommend

The most secure way to browse the web is with Tor.



© BITWARDEN, TOR



You can strengthen network settings through your router's configuration utility.

ProtonVPN (www.protonvpn.com), ExpressVPN (www.expressvpn.com), and Surfshark (www.surfshark.com), depending on what features you need. Each allows you to use the VPN on multiple devices simultaneously, from eight (ExpressVPN) to unlimited (Surfshark), covering all your personal devices, and potentially your household's, too.

LOCK DOWN YOUR BROWSER

A VPN does many things, but it's designed to secure the transmission of data to the internet, not mask it from its intended destination (other than to hide the location your data came from), which means you can still be tracked and spied on when browsing the web. That job is left to your browser.

Modern web browsers fall over themselves promising to tighten privacy, but when Google backs out of a plan to block all third-party cookies and even Mozilla is dabbling in what it calls "privacy preserving digital advertising," you might be forgiven for wondering whether you can trust anyone to keep you locked down online.

We recommend sticking with variants of Firefox. We profile one easy switch called LibreWolf (https://librewolf.net) in this month's Doctor column, but if you want to go the whole hog, investigate the Tor Browser (www.torproject.org). It utilizes its own specialist network (Tor) to relay and encrypt your internet traffic for extra protection, then isolates each site you visit, so there's nothing tracked between them. It's also equipped to resist browser fingerprinting, a means of identifying you through your browser and device information.

LOCK DOWN YOUR EMAIL

One final thought: how secure is your email? As a medium, email is one of the most insecure there is. That's because emails are little more than plain text, and easy to obtain. These days, most email providers use TLS to encrypt email in transit, so it's not likely to fall foul of a man-in-the-middle attack, but it does leave your emails open to access while they lay at rest on your email provider's server, in much the same way as your cloud-hosted data.

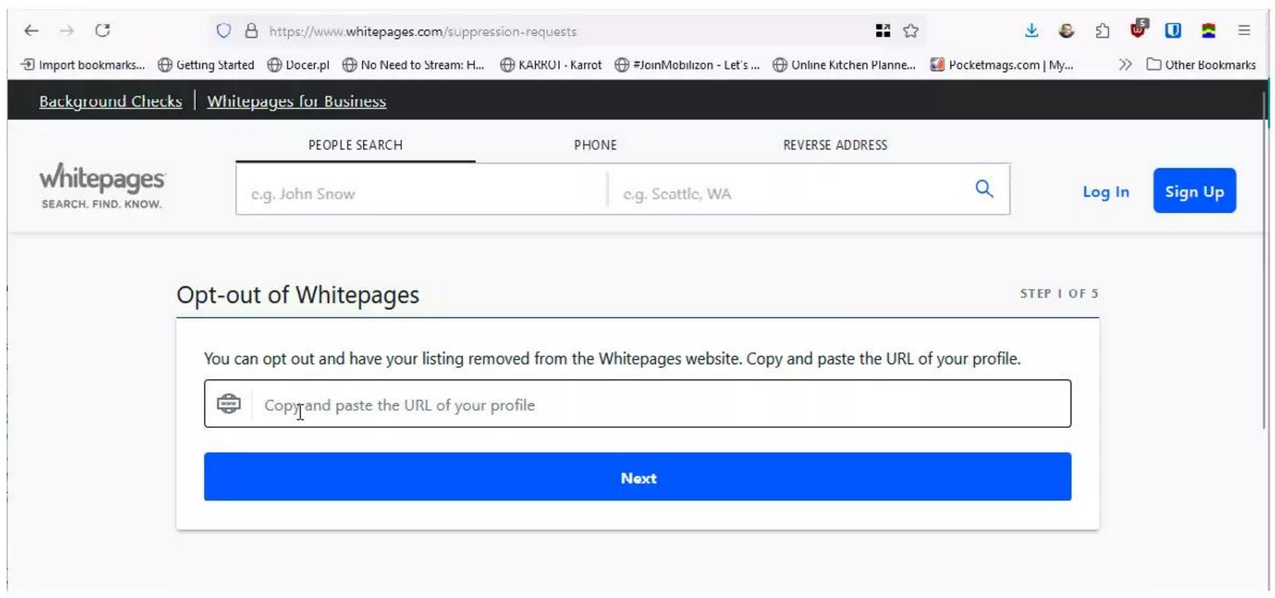
The solution again is to employ your own additional encryption to ensure your emails can only be read by yourself and your intended recipients. The simplest way to set this up is to sign up for an encrypted email address with Proton (https://proton.me), but if you're happy to get your hands dirty, you need to use OpenPGP encryption. OpenPGP provides a series of step-by-step guides covering most major email clients (see www.openpgp.org/software for details), including Outlook and Thunderbird.

HIDE YOUR ADDRESS

Your home contact details may be strewn across multiple websites, so how do you remove them? It's a good idea when auditing online accounts for password strength to also see what personal details are recorded. If possible, remove key info such as your cell number or home address if it's not strictly required. But what about those sites like Whitepages, where your personal details may be publicly visible?

In the case of Whitepages, search for your profile, visit the page, and copy the URL to your clipboard, then visit www.whitepages.com/suppression-requests to request its removal. Other similar places to look include Spokeo (www.spokeo.com/optout) and InstaCheckMate (www.instantcheckmate.com/opt-out/), plus consider entering your contact details into various search engines to see where else they crop up. There are commercial sites that can do a lot of the hard work for you—Deleteme (www.deleteme.com) is one such example—but they have a hefty price tag.

But how do you avoid your address being leaked? The obvious answer is to avoid offering it up, but how will online vendors know where to ship your orders, for example? One solution is to rent a virtual address you can give out to people in lieu of your actual address. Correspondence is shipped here, you get to review what it is, then decide what to do with it, from shredding it to opening it to scan the contents, or have it forwarded. One such example is Traveling Mailbox (https://travelingmailbox.com), which lets you view your mail via a mobile app or in your browser. Plans start from $15/month, which covers up to 40 envelopes (unused credits roll over).



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Yes, we're talking about games consoles again. Don't worry, we know this isn't *Maximum PlayStation*, but with the arrival of the PS5 Pro and its radical shift upwards in pricing, it got us thinking about our console cousins and just how wildly different the two ecosystems are.

As you'll have surmised from our build feature, trying to cram that much power into such a small form factor in the PC enthusiast's world, at an identical price, is both impractical and kind of impossible.

Sony might have bumped that $ figure skyward, but in many ways, it's justifiable, certainly if the GPU is as close to the RX 7600 XT as we suspect it may be. Nonetheless, we're not about to tell you it's that clear-cut, that the console finally has the upper hand, and we should all be swapping our custom-built $3,000 systems for a PS5 Pro, keyboard, and mouse. Nope, we're going to take a deep dive into the PS5 Pro, have a look at where it's at, how it's taking advantage of modern-day tech to hit that 8K marketing buzzword, and figure out where the future of gaming is going. –ZAK STOREY


Why the console wars aren't really a thing
PS5 PRO
vs.
PC

The enigmatic PS5 Pro

The PS5 Pro has finally been announced. It's technically the third iteration of the PlayStation 5, following the initial launch in 2020, and its pseudo-refresh, the PS5 Slim, that landed in 2023.

Here's the thing, though: We haven't had a huge amount of information about the plucky new Pro console, only a few snippets of data from press conferences, all of which are rather ambiguous. So, what are the top-line specs?

Well, we know the CPU is probably the same, as there was no mention of any upgrade in the official announcement, so that's likely an AMD Ryzen Zen 2 chip. That'll come with eight cores, 16 threads, and a 3.5GHz clock speed. This is a custom model, built specifically for the PS5, based on the Ryzen 3000 series processors. It's not too dissimilar from the Ryzen 7 3700X, just with a lower TDP and clock speed.

The SSD has been replaced, with the Pro removing the pitiful 825GB PCIe 4.0 drive and replacing it with a larger 2TB model. It's worth noting that read speeds remain the same, and to be fair, you could add additional faster storage to the old PS5 anyway, bumping that internal spec up. Shared RAM is reported to be identical, with the Pro housing 16GB of GDDR6 clocking in at 448GB/s total memory bandwidth.



The only major differences between the Pro and the PS5 seem to be an updated GPU and more storage.

The question of graphics

Then there's the GPU, the beating heart of a gaming console, what it needs to really drive its performance home. But here's the kicker: The PS5 Pro supposedly supports 8K gaming. Sony has promised that in its marketing materials. Still, detail is incredibly sparse on the GPU in question. As a result, we have to speculate quite heavily on this one as to what it actually is.

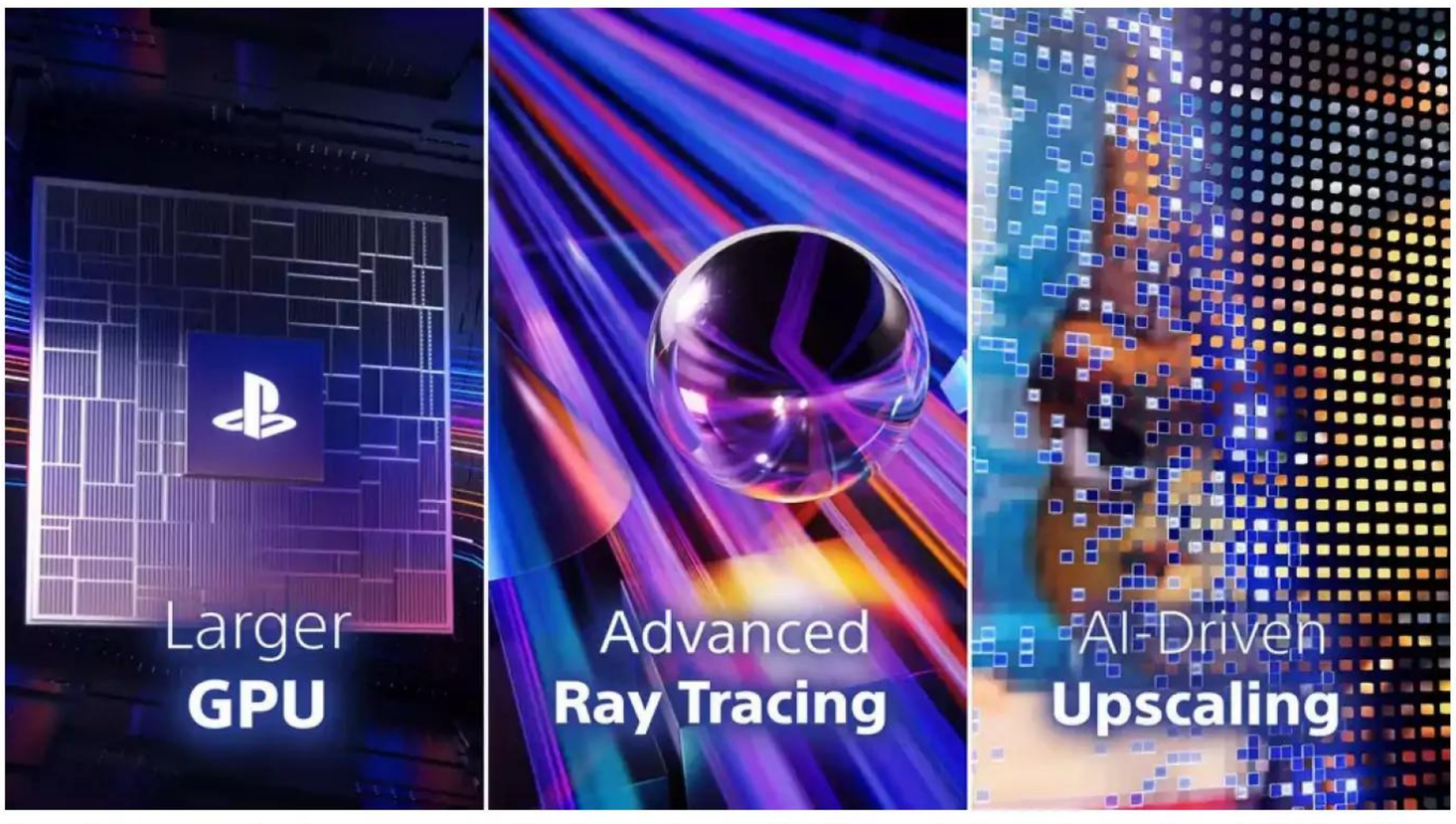
We know that the older PS5 features an AMD RDNA 2 graphics processor, complete with 36 CUs, driving 10.3 TFLOPs of performance under load. The new Pro has an RDNA 3 GPU with a grand total of 60 CUs.

Yet this is where it gets problematic. We know AMD already has a 60 CU GPU, in the form of the RX 7800 XT. A card we tested two issues ago. However, that card draws far too much power, and its TFLOPs spec doesn't add up. According to Sony, we're looking at roughly 45 percent more "rendering performance." That's still ambiguous, as it doesn't specify how that's being measured, or if it applies to just pure rasterization, or ray tracing as well. If we just take that to mean raw rendering performance, that should leave us at around 14.935 TFLOPs, somewhere slightly above the 7600 XT in terms of performance, at least at half precision. So, it's likely we're looking at a custom unit, which has the 7800 XT's base processor design, but with a significantly lower clock speed and TDP, which would make sense given the form factor.

8K, ray-tracing, and PSSR

The real challenge then, particularly given how little grunt that GPU is going to have in the real world, is that 8K resolution. Sony's not pulling its punches on this one either, and it's all over the marketing material, along with a vastly improved 4K 120Hz gaming experience along with it. Similarly, though, along with everything else about this announcement, there's just no information on how exactly it intends to hit that, other than the larger, higher performing GPU, with better ray-tracing hardware, and the introduction of PSSR.

Sony is also introducing its PlayStation Spectral Super Resolution, or PSSR for short. This is a form of supersampling, which we assume is not too dissimilar from the likes of AMD's FSR. According to Sony execs, it's being implemented and patched in on a game-by-game basis, in a very similar manner to how FSR currently operates on PC. As with everything else PS5



Sony is introducing its own upscaling in the form of PSSR, probably a derivative of AMD's FSR.



It's been confirmed that the PS5 Pro will have an RDNA 3 GPU at its heart.



The *Witcher 3* running at 4K max settings will still struggle to hit 40fps, even on an RTX 4080.

Pro, there's no cold hard confirmation on how it operates, other than it rendering the frame at a lower resolution, then upscaling. There's also no confirmation on whether it is just a derivative of AMD's FSR, but given the hardware at play, it's highly likely that's the case. What will be fascinating to see, particularly given modern FSR's backward compatibility, is whether this finds its way to the PS5, and potentially even the PS4 Pro, which similarly features an AMD Radeon GPU.

Even with PSSR, 8K performance isn't a given—we know how difficult it is to drive modern titles at 4K even with supersampling, let alone a resolution with twice the number of pixels. Some insider reports even suggest that 4K120 and 8K60 may well be long-term internal targets for PSSR, and aren't actually possible on the PS5 Pro; instead, these are aims for the PlayStation 6 and subsequent consoles, as Sony intends to keep developing the tech as it moves forward from generation to generation.

Why the console vs. PC argument is a dud

So, why the nonchalant attitude about the battle between the PC and the console? Aside from the massive differences between the two (and how you utilize them), from a gaming perspective, it's almost impossible to compare title performance between them. Not only from a gameplay standpoint, where your physical interface with them is radically different, but also because the graphical fidelity and optimization of the platforms is so diverse.

For any game being certified for sale by Sony, it needs to go through a rigorous optimization and approval process, which requires it to hit certain frame rates and graphical fidelities before it's published. The fortunate part of that, however, is that developers know exactly what hardware is available to them for their game on the console. They can simply go into their title on the PS5, and edit the settings until the game runs smoothly at 4K60, knowing that, no matter where you are in the world, if you own a PS5, you'll experience the same thing that they're experiencing with those settings.

On top of that, they have far finer control over everything from LOD distance, to entity loading, shadow manipulation, volumetrics, god rays, physics settings, you name it. Because of that, there's also no need for them to include graphics settings for the console user outside of separate profiles for 4K60 or 1080p120. As a result, they don't require the inclusion of a benchmark either, as there's no way an end user can actively affect performance.

Jump over to the humble PC, however, and the whole ecosystem is a complete carnival of chaos. There are 10-year-old liquid-cooled systems with Titans still running around, brand-new rigs operating off integrated GPUs, laptops, handhelds, odd combinations of practically every component you can think of, functioning in all manner of different ways. And that's not to mention all the software and OS shenanigans running in the background. It's an inherently difficult platform for a developer to optimize their title for, particularly with all of that hardware and the infinite combinations in between. Even with the help of Nvidia and AMD developing driver optimizations (typically only available for top-tier AAA games), publishers and devs have no choice but to give PC users access to a wide array of graphics options to ensure they don't alienate potential customers if their game is too difficult to run on the hardware that they have at the settings the devs envisioned. Something that's entirely avoidable on console as a result.

Because of that, the PC has a natural graphical edge against even the best console—because you're not in that locked ecosystem, you can ramp up all the settings to the max. What that does mean, however, is that the version of the game you play can look radically different from one PC to another, and certainly from that of a console port. Even our own benchmarking procedures as tech journalists have extensive guides on how to run the benchmarks and the settings involved, to ensure that our results are consistent, because it's so easy to change those variables and invalidate your results.

With that said, there is still a huge array of settings locked behind console commands and in the game's files that may require mods to access as well. It's possible to boost *Witcher 3's* settings so high that you'll only average 30fps at 4K on an RTX 4080, and that's a title that's almost 10 years old. It's just impossible to compare the two platforms, let alone benchmark them against one another, because the experiences are vastly different, even if you had identical hardware, and as we know, consoles utilize custom kit, with shared memory, and all manner

©© SONY, AMD

of OS optimizations to hit price points and the performance levels that they're trying to achieve.

AI supersampling supremacy

Let's say for a moment that 8K gaming is possible, and Sony releases a $300 8K 55-inch TV that'll pair perfectly with its latest-generation console. How on earth is it going to easily hit 60fps at a resolution with 33.2(ish) million pixels?

The answer is simple: upscaling. No matter how you look at it, it's clear that with the current hardware, and the direction that PC gaming is going, AI supersampling in the form of Nvidia's DLSS or AMD's FSR is the future.

There are two popular forms of this: Nvidia's real-time supersampling, which functions by utilizing Nvidia's own Tensor cores, along with temporal feedback, and a whole host of data models to create and upscale images from scratch; and AMD's FSR, which is open source, and instead uses a mix of spatial and temporal upscaling models to supersample images to the target resolution using traditional rasterization hardware. The latter is very similar to certain types of anti-aliasing techniques, but on a grander scale to tackle entire frames.

FSR 3, along with introducing that temporal element, also brought in AI frame generation (DLSS has had this for longer), and again, these are based on deep-learning models. However, rather than Nvidia's real-time computation solutions, as long as you've got the traditional rasterization grunt to handle it, you can use it on any device. Nvidia's DLSS still requires that dedicated hardware operating in a similar manner to a neural network.

To give you some idea of what a difference it can make in reducing rendering load at 4K, check out the table below.

DLSS PRESET SCALES @ 4K

Profile	Frame gen resolution	Total pixels
DLAA	3840x2160 (100%)	8,294,400
Quality	2561x1441 (66.7%)	3,690,401
Balanced	2227x1253 (58.0%)	2,790,431
Performance	1920x1080 (50.0%)	2,073,600
Ultra performance	1267x719 (33.3%)	917,444

As these presets get dramatically more efficient, and have more data to draw on, we're seeing performance rapidly increase with it. Being able to tell the difference between DLSS on its Quality preset versus Performance is becoming challenging at this point. It's still possible to spot, but you really have to be looking quite hard.

With DLSS 4 and similarly FSR 4 likely in the works, and as the AI models become more advanced, with better insight into how to generate those frames, it's only a matter of time before we're rendering 8K games at close to 1080p resolutions, massively reducing the overall GPU load in the process. Intelligent design that shifts away from ever shrinking transistors.

8K itself, although far more dense than 4K from a pure numbers perspective, is perhaps a step too far for modern PC enthusiasts, purely because that extra pixel density is hard to see when you're sitting two feet away from a monitor—and harder to justify the expense.

The extra rendering performance necessary for what amounts to a fairly middling increase in overall clarity is not exactly a fantastic selling point. That's why we're seeing OLED panels, refresh rates, and frame rates balloon into the stratosphere, with manufacturers similarly developing innovative new hardware to take advantage of ray tracing and AI upscaling in response.

Maximum PC alumnus Christian Guyton ruffled some feathers recently with an op-ed on exactly what place the desktop GPU had in the future of PC gaming. Particularly as the rise of AI upscaling seems to be all anyone's talking about these days—and it's an understandable and respectable point of view. Well worth reading if you ever peruse TechRadar. However, it's quite the focused perspective, looking solely at gaming, and the reality is far more nuanced, given how particularly varied the workloads can be for a GPU, from rendering 3D models and video content, to gaming at 4K at silly refresh rates.

Handhelds and portable gaming

Remember the Game Boy and the Game Boy Color? Good times. A long time ago now, but it feels like yesterday that Nintendo was releasing an arsenal of portable handheld gaming consoles, ready to take the world by storm with its latest *Pokémon Red* and *Blue* titles, in all of their 8-bit glory.

The company has not stood still in its endeavors either, and although there have been many imitators, from the likes of Sony with the PS Portable, Vita, and Go, it was with the launch of the

THE 8K BUZZWORD

Marketing hype. 8K is not something anyone is really considering right now from a consumer perspective. Yes, there are products out there, but they're not viable from a gaming standpoint.

If you're on the hunt for an 8K monitor, there's one available: the Dell UP3218K. It's a 31.5-inch 7680x4320 60Hz IPS monitor, with a 6ms G2G response time, and it can be yours for the low, low price of $4,029. Yep. But it's not for gaming, it's a professional design monitor (in fact, you can only connect to it via DisplayPort, which knocks the PS5 Pro out of the running as it only supports HDMI).

8K TVs are similarly a non-starter. Almost all of them are above the 65-inch range, which would be fine if it weren't for the fact that pixel density falls off a cliff at that point compared to a 32-inch 4K panel. And TV and video content hasn't caught up to 8K yet as file sizes are so large. 4K gaming is on the rise but far from the default. Steam's Hardware Survey reveals that 1080p makes up around 55 percent of display resolutions, with 4K at just 3.6 percent, never mind 8K.



Dell is currently the only manufacturer with an 8K monitor.

© DELL

Nintendo Switch that the Japanese giant cemented itself back into the top slot as the portable handheld of choice.

From a hardware perspective, the Nintendo Switch has an interesting spec list. Although AMD dominates most of the top-tier consoles, being the provider of both CPU and GPU for the Xbox and PlayStation alike, Nintendo relies on Nvidia for its GPU and SoC solutions. The Nintendo Switch launched initially in 2017, with a GM20B Maxwell GPU, complete with 256 CUDA cores, along with a Tegra X1 TSMC 20nm SoC. It then received a fairly hefty update in 2019, switching over to a 16nm manufacturing process, significantly reducing power draw, and giving the Switch 1.1 a far superior battery life in the process. That's the same setup as found in the Switch Lite and the OLED as well.

However, the Switch is now utilizing a GPU that was last seen in the GTX 900 series graphics cards (as old as this journalist's career at this point), and with the advent of the Steam Deck and other more powerful portable console solutions, the only thing really keeping portable gamers on their Nintendo devices are those console exclusives, with few outside of the *Zelda* franchise really holding much weight these days.

There's rumors circulating, however, that the Switch 2 is shifting to a far more impressive Ampere GPU instead (RTX 3000 series), on Samsung's 8nm manufacturing process, boosting the total CUDA core count from 256 to 2,048, and likely introducing ray tracing and Tensor cores into the mix as well. Combined with Nintendo's reliance on Arm for its CPU solution, it could be a real contender in the portable space.

It's all about pixel density

Here's the impressive bit, though: You just don't need a lot of performance for a mobile gaming console. Not because the games are inherently inferior, but because the specs themselves are specifically built around lower resolutions.

Take the Steam Deck OLED as an example—it's got an HDR panel, with 1,000 nits peak brightness, a 1,000,000:1 contrast ratio, 90Hz refresh rate, and a 0.1ms response time, all packed into a 7.4-inch diagonal. The resolution? 1280x800. That's only around one million pixels or thereabouts.

Thing is, that gives you a pixel density of 203.98 pixels per inch. A 32-inch 4K screen has a density of 137.68, but with 8.1 times more pixels for your GPU to drive. Now, admittedly your 4K display is going to be a good two feet away from your face, versus your Steam Deck likely sitting halfway between that, but from a pure gameplay experience, it's hard to spot the difference between the two for clarity, and you require far less processing power to get respectable frame rates in game. Combine that with the likes of FSR or something similar to DLSS, and the future is looking incredibly bright for the next generation of portable handhelds.

ARE DESKTOP GPUs COMING TO AN END?

In a way, but also probably not. We're in a golden era right now for gaming. Although graphical fidelity may have side-stepped a little as we focus more on shadows and ray tracing, there's a massive push to improve image quality, color accuracy, and frame rates. That's what's driving the industry forward. Each new generation of graphics card pushes the limits of what's possible on that frontier right now, and it's having a slow yet cumulative effect on the overall experience for the average gamer, regardless of what platform you play on.



Could we be in the final throes of desktop graphics cards? Probably not.

The end of the PC?

Ultimately, even though pricing for the ecosystem is rapidly increasing, the PC has the advantage. It's the Android of the gaming world—massively versatile with a huge array of hardware, and access to the latest and greatest tech, that isn't locked down and out of reach. Because of that, it has far greater flexibility than that of a console, even for gaming.

If you're looking for a good gaming experience, without the hassle of building a PC and tweaking graphics settings, then yes, the PS5 Pro will provide that. But if you want the best possible experience, a PC is the far better long-term investment. But that's no surprise for any of us reading here.



© VALVE

Valve's Steam Deck has brought handheld gaming PCs to the forefront again.

CENTERFOLD

ANCE GEAR LAID BARE



1 AUDIOPHILE DREAMS

The Razer Kraken V4 Pro features the same excellent TriForce Titanium drivers and, crucially, the same ultra-wideband microphone as the Razer BlackShark V2 Pro. Considering that's one of the best gaming headsets available for online comms, this is a serious package.

Razer Kraken V4 Pro

THIS ISSUE is a Razer haptics special—we have the company's first vibrating gaming cushion (seriously) on page 73, and here's the first gaming headset to feature its Sensa HD feedback tech. This means the headset reacts to in-game activities with directional haptic feedback, at least in titles that support it, which currently include *Final Fantasy XVI*, *Stalker 2: Heart of Chornobyl*, and *Silent Hill 2*.

The Kraken V4 Pro joins the fourth-gen lineup along with the standard Kraken V4 and wired Kraken V4 X. The Pro looks like quite a step up in terms of features (and price, at an eye-watering $400). We tested the haptics at a recent Razer briefing, and they definitely felt like an improvement over the Razer Kaira Pro's HyperSense feedback, feeling much more nuanced—and less like you have a bee in your headset.

Razer's justifying the luxury price tag with an OLED Control Hub that provides additional customization options, while displaying system performance, and allowing for easy source switching. We'll have a full review next month, but it's in with a chance of landing on our list of the best PC gaming headsets with its stacked feature set and intelligent haptics. –MAXIMUM PC

2 FORCE FEEDBACK

The new Razer Synapse 4 app can be used to control everything. That includes the audio profiles driving the headphones' 40mm drivers, as well as the haptics. That means you can bump up the intensity of effects within certain sound ranges and create your own presets.

3 LIGHTING THE WAY

The package includes a PC-compatible OLED Control Hub that displays volume, battery life, and other metrics. There's also Chroma RGB on the ear cups, dual audio support, and instant switching between 2.4GHz and Bluetooth, handy if you need to take a quick call while gaming.



SMART CITIES THE LONG HISTORY OF THEIR FUTURE

Nicole Kobie **traces the roots of smart cities back to Victorian London, then takes us on a journey to the concept's present and future**

IT'S VICTORIAN LONDON, and cholera is creeping through the streets of Soho. Famously, Dr John Snow deduced that the disease wasn't spread via bad smells in the air, as believed, but through water—in particular, a single water pump.

He figured it out with data and a map. The doctor simply plotted the deaths of infected people in the district and had the good sense to notice that they lived near the same water pump. As the story goes, he ended the outbreak by removing the pump's handle. And so data analytics within cities was born.

A few years later, in 1868, the world's first traffic light was installed, at Bridge Street near Parliament Square in London. This was before cars, but a thousand pedestrians were being killed each year on the city's roads thanks to carriages. The signal wasn't smart: The 20-foot-high light was manually operated, with gas-powered lights. And it lasted less than a year, taken out by a sub-pavement gas pipe explosion.

Despite such explosive origins, the idea spread. Automated traffic lights were introduced in California in 1920, with signals that used timers. By 1928, the use of automated signals let New York slash its traffic police from 6,000 officers to 500. But it also meant pedestrians and drivers had to obey the directions of machines rather than humans to smooth urban life.

As cars took up more roads, authorities had to do more about traffic. The first computerized road traffic control system arrived in Toronto in 1963. "Toronto has a traffic cop with arms seven miles long and getting longer," explained the local *Star-Phoenix.* "It's a computer that already controls more than 500 traffic lights in an 80-square-mile area."

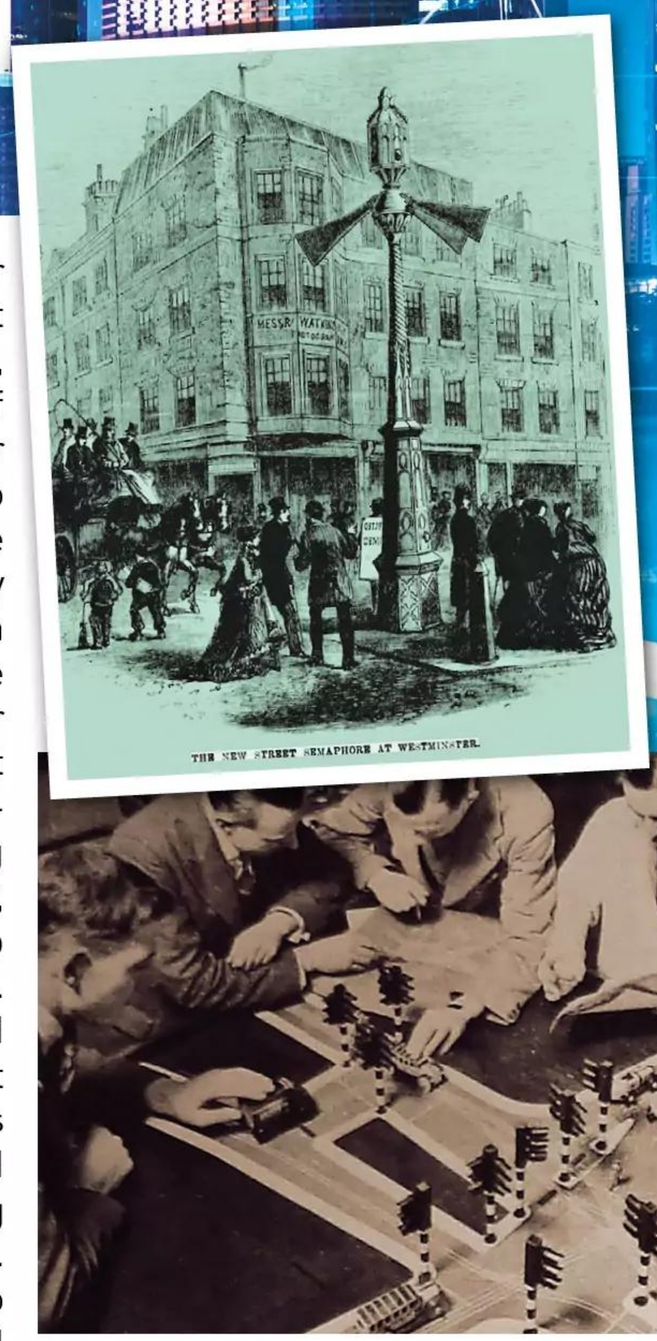
Wires connected to sensors were buried in the road ahead of intersections, tracking the speed and direction of each car using electrical induction, and sending that data to the central computer for processing to decide how long to keep the light green. The $4 million system handled 1.25 million daily trips, with the city aiming to speed up rush-hour traffic by 15 to 20 percent, according to local media reports. It worked even better than that: Trials showed a 38% boost in speeds in downtown Toronto.

> It didn't take long before city authorities decided they could manage much more than traffic jams with computers

It didn't take long before city authorities decided they could manage far more than traffic jams with computers. They started to look at cities as flows of information and people as problems to be solved with models and algorithms. Data was knowledge, computing was science, and whatever the models spat out must then be correct.

GOOD DATA, BAD DATA

In 1969, Jay Forrester's *Urban Dynamics* laid out a scientific way to look at cities as systems based on industrial dynamics, which considers the feedback loops and interactions in a network to understand how to make it work better. It sounds clever, but there was a flaw, and it was likely that he treated all cities the same, when they are very different places. If you





TOP The first traffic light was installed in London in 1868.

ABOVE Automated traffic lights were commonplace by the 1930s.

wanted to solve unemployment, for instance, his models didn't suggest training or government support, but clearing out slums in place of more expensive housing—in other words, gentrification. Trying to systemize, automate, and analyze cities based on data is a flawed way of thinking: There's plenty about a city that can't be collected in the numerical format necessary for a computer to analyze. And not everything can be automated—we've had traffic lights directing cars for more than a century, but crossing guards still help kids cross safely outside schools. Analyzing how a city works and what solutions it needs also can't be done from one angle. This is why we have elected mayors and councils full of people; deciding what to prioritize is deeply political.

LA gave such data gathering a go in the 1960s, noted academic and urban planner Mark Vallianatos in an article for Gizmodo (http://tinyurl.com/359giz), as part of a plan to build an Urban Information System to address everything from poverty to land use. In 1967, the city formed its Community Analysis Bureau (CAB), aiming to give decision-makers insights to help prioritize LA's needs.

The city was broken up into 727 census tracts (neighborhoods), with clusters based on 66 pieces of data to describe them, including ethnicity, crime rate, income, and housing. For example, "post-war suburbs" was a cluster that applied across 76 census tracts; largely middle class, middle-aged, and white, with income and education levels just above average; they tend to own cars and not take public transport. Another cluster is "singles": Younger (average age 33) people living in higher-density apartments, with a high level of education and even higher level of employment. And then there's "high income": Mostly white, with large homes, and incomes three times as high as any other cluster. But there were surprises: This cluster also had the highest concentration of unrelated individuals in poverty, double the city average. The report pins this on low-salaried "live-in servants" or a statistical error. "This is the first time this technique has ever been used to describe a city," wrote Robert Joyce, CAB director, in its first report.

Data sources informing those clusters were varied. The team digitized Census Bureau data, but also used aerial photos to assess the physical environment, with staff scoring it based on characteristics such as litter, vegetation, and whether homes had "convenience structures," such as patios and swimming pools, noted Vallianatos. The scores were checked by driving through a neighborhood to look for signs of neglect—a problematic way to collect data that introduces bias. Graffiti and uncut lawns are signs of neglect in some neighborhoods, and evidence of hipster artists and no-mow-May in others.

The goal was to figure out which neighborhoods needed help, and what sort of help. Vallianatos noted that the bureau didn't actually need all 66 data points. Just three acted as effective red flags: age of housing, average birth weight of babies, and sixth-grade reading scores. But here's where it all so often falls down: Now it was up to politicians to take action. Handily, one thing that data analytics is good at is winning grants—how do you say no to scientific evidence? Hyper-local grants were doled out to improve streets and parks, expand social services, and so on. In the end, the CAB became a way to get grants, rather than a way to inform decision-making. As computers became common, the CAB was folded into wider planning divisions, shedding the original motivation to add to the "quality of life; for each and every citizen of Los Angeles."

FROM DATA TO SMARTS

As a formalized notion, the idea of tech and analytics to run cities came into its own because of Bill and Hillary Clinton. In 2005, the Clinton Foundation handed networking giant Cisco a challenge via its Clinton Global Initiative: Work out how to make cities sustainable.

It sparked the Connected Urban Development program, as well as a series of conferences. Amsterdam, San Francisco, and Seoul were chosen for pilot programs to develop technologies to slash carbon emissions, with the aim of creating techniques applicable in other cities. In Amsterdam, they invented coworking spaces





TOP IBM's smarter cities project in Rio was compared to "a Bond villain's lair."

ABOVE The Rio scheme was used to aid public transportation.

centered on Cisco's TelePresence videoconferencing system, saving carbon emissions from commuting. In Seoul, Cisco built a web app for planning travel that showed carbon emissions for each route. For San Francisco, it built a digital map to track progress on carbon reduction, as well as setting up a Living Innovation Laboratory at the Hunters Point Shipyard residential redevelopment—though health concerns over the former nuclear test lab on the site proved it neither smart nor sustainable.

Now it's no surprise that if you ask a networking company to fix cities, it's going to recommend solutions that involve a lot of networking equipment. Ask Cisco to fix cities, and it will suggest you install superfast broadband to access its videoconferencing system. After the five-year partnership with the Clinton Foundation ran its course, CUD was handed to the Climate Group, an environmental non-profit, and Cisco evolved the benevolent work into commercial products under the Smart and Connected Communities name, though it later also used the term "intelligent urbanization."

Around the same time, the term "smart city" was popularized by IBM, which first started pitching the idea in 2009; before that, there was barely any mention of it. That year, researchers Susanne Dirks and Mary Keeling discussed smarter cities in a white paper for the IBM Institute for Business Value, saying, "To seize opportunities and build sustainable prosperity, cities need to become 'smarter.'"

BIRTH OF SMART CITIES

With that IBM paper, tech suppliers took the idea of governing by consultancy and ran flat out. To be fair to Dirks and Keeling, their argument is sound: Technology can offer better operational controls at lower costs. And it was increasingly necessary: In 2008, for the first time, most of the world's people lived in cities rather than rural areas. That added stress to transport, hospitals, trade, and utilities such as power and energy. According to Dirks and Keeling, that required cities to become "instrumented, interconnected, and intelligent"—which means digitizing, connecting it all up via the web, and analyzing everything—while recognizing that cities were interrelated "systems of systems."

The first major IBM smarter cities project was in Rio de Janeiro, beginning in 2010 as part of the preparations for Brazil holding the 2014 FIFA World Cup and the 2016 Olympic Games. The centerpiece of the project was the control room. According to the *New York Times*, it looked straight out of NASA, while the *Guardian* compared it to "a Bond villain's techno-lair." The operations center had a wall four monitors high and 20 wide, showing weather predictions and mapping car accidents and power failures, as well as displaying video streams of stations and key intersections. Around 70 employees watched this dashboard from banks of desks with their own displays.

Of course, watching a video feed of a busy station doesn't help you do much about the crowds, so IBM pulled together relevant data, and algorithms looked for patterns. Guru Banavar, IBM's CTO for the public sector at the time, told the *New York Times* it was "sense-making software." Rio needed that, mayor Eduardo Paes said, after a landslide and flood hit the city and he realized there was no way to see an overview of what was happening.

While it's neat to see where all your buses are and handy to manage emergency response in a disaster, a real-time dashboard only goes so far when addressing the daily problems facing most people. A study of the Rio smart city system by University of Zurich researcher Christopher Gaffney found it "mostly lacking," in large part because the whizzy dashboard didn't address "problems of radical inequality, or systemic poor governance, or compromised urban planning agendas—all of which continue to be the 'dumbest'

elements of Rio de Janeiro." The system had limited coverage and functions, despite the big displays.

Also, the analysis noted that IBM's software wasn't always suitable, and collaboration was difficult, so Rio city employees largely wrote their own software.

Much of the smart city dream is epitomized by dashboards. They are futuristic, offering a perfect backdrop for interviews during disasters to show that everything is under control. On the other hand, city staff only consider what is on the displays, what can be counted numerically and plugged into an algorithm, leaving more complex aspects of city life out of the room where decisions are made.

Rio's room-sized dashboard beguiled at first, but it soon became clear that even when such a setup technically works, it's often little more than just displays of charts and video feeds, rather than smart analytics. But they often don't work. Antoni Vives helped build Barcelona's smart city system and toured other cities to see their projects, visiting a South American city's situation room.

"It was obvious it hadn't been used in months," Vives wrote in his memoir of the project. "The danger of large companies on the hunt for an unsuspecting mayor is that they might fill the streets with sensors that don't do anything, and offices with screens that do even less."

Or they might build cities out of nothing that no one wants to live in.

THE SONGDO NEW CITY

On the edge of Incheon, South Korea, a new district on a 1,500-acre island was being planned. Announced in 2004, Songdo New City was unveiled as a Korean rival to Shanghai, Hong Kong, and Singapore. By the time of its projected completion, around 2012, costs had risen to $35 billion, with canals mimicking those of Venice, a park modeled on Central Park, and an opera house that nods to the one in Sydney, Australia. It aimed to house 300,000 residents working in sectors such as IT and marketing across a business center the size of downtown Boston.



ABOVE Cisco's video-conferencing tech was well ahead of the curve.

A few years before IBM started using the "smart city" term, Korea had its own: "ubiquitous city," or U-city. That idea would be applied to Songdo by John Kim, a former Yahoo designer who had been approached to build tech into the new city. Songdo would be a test bed for new tech but also show off what life could be like when everything is digitized or, as they called it, U-Life. That included smart rubbish bins that sucked garbage into tubes to be recycled, streetside computers for anyone to use, and smart homes with phone-controlled lights and heating, as well as intelligent road pricing, smart ads that changed to reflect who was looking at them, and automated parcel delivery.

In 2005, while buildings were still being planned, Kim promised a world organized around a cutting-edge new technology: RFID cards. These would be used by residents not only to open their front doors but also to access public transport, pay parking machines, or even just to see a film, Kim said. "It will be anonymous, won't be linked to your identity, and if lost you can quickly cancel the card and reset your door lock," he told the *New York Times*.

Songdo also promised citizens would be able to make video calls, stream video content at any time, and have access to their digital content anywhere in the city. Kim's description of Songdo is the life many of us lead now, we just didn't need to dredge the sea to build an island first. Sure, it's easy to laugh at this as simply what happened as mobile connections improved, but for context, at this point Netflix was still mailing DVDs rather than streaming movies on demand.

In 2005, the plan was to build the technology infrastructure locally and look to overseas tech companies for partners. In 2011, Cisco signed on, beginning with an investment in a new joint venture called Songdo U-Life, including the use of Cisco networking to connect the island's buildings. Over 10,000 Cisco TelePresence units were promised for videoconferencing, so residents could access education and concierge services, as well as sensors embedded in buildings to track energy use. This would allow residents to live a "technology-enabled lifestyle through digital

BELOW Songdo in South Korea was designed from the ground up as a smart city.



infrastructure systems designed and built into the city's framework."

After 15 years of work, it was clear Songdo wasn't the draw its creators had hoped, with only a quarter to a third of the expected 300,000 residents. A local blogger said, "Future South Korean zombie movies could film here without having to worry about anyone getting in the way." Others say it depends on where in the city you go, finding outposts of liveliness among the otherwise quiet streets. The problem appears to be twofold. First, too few companies set up business, giving people little reason to live in an empty area that's more expensive than neighboring ones. And second, streaming movies, video calls, and smart homes are all now widely available—there's no need to move to a lonely "smart city" to access such luxuries.

This is the problem with building a smart city: The "smarts" are often outdated before anyone moves in. The streetside computers, videoconferencing, and RFID tags that sounded cutting-edge when Songdo was first planned are useless now we have smartphones.

It seems the mistake was building Songdo all at once, rather than letting it evolve, while locking in tech that quickly aged. If only there were another solution from another global megacorp....

ALONG COMES GOOGLE

Sidewalk Labs was formed in 2015 to give Google co-founder Larry Page's "urban innovation" ideas a place to live under the umbrella company, Alphabet. Core to his thinking was a desire to rebuild cities without having to deal with regulators and city authorities; Page even joked that building on the Moon would be easier than dealing with municipal governments, according to Josh O'Kane's *Sideways*, a look at the short-lived company's Canadian project.



ABOVE
Utrecht in the Netherlands has pollution-sniffing bikes to monitor air quality on cycle routes.

Pre-Sidewalk, Page's urban solutions included building a libertarian city-state on a ship with controversial tech founder Peter Thiel; installing a monorail with individual pods to better connect the University of Michigan; and installing a massive dome over a city for guaranteed weather, air quality, and so on. Bonkers schemes can spark smart solutions, so there's nothing wrong with sketching out silly notions, especially when you've got hundreds of millions of dollars to play. The problem is finding a city willing to experiment on its citizens.

After nabbing former New York deputy mayor Dan Doctoroff as CEO, Sidewalk's first task was to set its employees building a document they dubbed the Yellow Book. This was a heavily researched selection of urban solutions and futuristic visions to present to Page, including bathroom mirrors that analyze residents' faces for illness, a Yelp-style review system for police officers, and rewards for good behavior based on detailed data collection. After a year of work, the plan was presented to Page, who seemed blasé about it, with the tech exec instead suggesting his own ideas, including buildings on wheels. Buildings. On. Wheels.

Sidewalk started searching for a city, or part of one, that it could rebuild and gentrify. The edges of Denver, Colorado, and an old naval base in California were considered, as were the emptying streets of Detroit. O'Kane reports one consultant, Anthony Townsend, recalled some of the fading Motor City being deemed suitable, but upon closer inspection, realized it would have required the bulldozing of a dozen historic churches. That's a tough sell even for Google.

That left Sidewalk as a city-fixing startup with no sandbox to play in—until Doctoroff got a call from a former colleague asking if the company would be interested in a project in Toronto. The Canadian capital had a small plot of land, just 12 acres, known as Quayside, a slice of a wider regeneration plan tearing up ports and warehouses along Lake Ontario. Toronto is short on land and housing, so Waterfront Toronto was ideal for a smart new higher-density development.

The team set to work, creating a 1,500-page document that included ideas such as covering the district with sensors to track everything from people to air quality, building everything out of wood, underground tunnels for autonomous mail delivery carts, driverless cars, and heated paving slabs. Other ideas: robot trash collectors, automated meters to track waste and incentivize recycling, and dynamic roads that respond to traffic, switching a bike lane temporarily into a pedestrian walkway, for example.

Alphabet said it would build a system that would enable third-party sensor makers to be able to plug into the system, avoiding lock-



Saudi Arabia's planned NEOM project includes a 650-foot-tall mirror-walled city dubbed The Line, stretching for 105 miles but just 650 feet wide. Whether it's ever built is a different matter.

in and a monopoly. And all the data that was collected would be managed by an independent trust.

However, criticism came from many corners. One critic was Jim Balsillie, one-time CEO of Research in Motion. He called the project "a colonizing experiment in surveillance capitalism attempting to bulldoze important urban, civic, and political issues." Then came the activists, led by local civics expert Bianca Wylie, who read an opinion piece by Doctoroff promoting the project and took action, organizing protests and making arguments to government, media, and Sidewalk.

Eventually, Sidewalk's privacy team quit, including Ann Cavoukian, former privacy commissioner of Canada and creator of the Privacy by Design framework that has been used with the EU's GDPR. She signed on to Sidewalk as a consultant, but left after it became clear data would not be entirely stripped of personally identifiable information. "I imagined us creating a Smart City of Privacy, as opposed to a Smart City of Surveillance," she said in her resignation letter.

Even Waterfront Toronto's own board members quit, largely over Sidewalk's unrelenting push for more land, but also citing concerns about process, patent ownership, and legal challenges; others were fired. By the end of 2019, the two organizations agreed on a draft proposal, after two years of work. But six months later, the project was scrapped by Sidewalk, with Doctoroff saying Quayside no longer made sense as Covid hit. "Unprecedented economic uncertainty has set in around the world and in the Toronto real estate market. It has become too difficult to make the 12-acre project financially viable without



sacrificing core parts of the plan we had developed with Waterfront Toronto to build a truly inclusive, sustainable community," he wrote.

Sidewalk at that time had a host of other projects, but it's perhaps best associated with two of them: Flow, a tool to battle traffic bottlenecks; and Link, which offered free local Wi-Fi in New York but surveilled streets with embedded cameras. Despite this, in 2020 Sidewalk itself was subsumed into Google.

While some of the tech suggested by Sidewalk sounds questionable—and stalkerish—the entire point of using a chunk of a city to build a smart test lab is to try new ideas. But it wasn't the tech that was the problem with the Toronto project; it was Silicon Valley corporates clashing with democracy.

SMART WHERE IT MATTERS

We don't need smart cities. We need good ones. Liveable ones. Sustainable ones. And we need them quickly. The UN expects the ratio of people who live in cities to climb from half today to two-thirds by 2050. But it won't happen evenly, notes Ricky Burdett, professor of urban studies at the London School of Economics and director of Urban Age, which runs global conferences on the future of cities. "If you look at a world map, where this urbanization will happen is distributed completely unequally. Over 90% of it will occur in Africa or parts of Asia," Burdett told us, noting that cities such as Lagos in Nigeria and Dhaka in Bangladesh are growing by hundreds of thousands of people each year, adding to burdens on everything from roads to sewers to hospitals.

ABOVE Cities must be sustainable and liveable, not smart.

Tech can help, but it doesn't hold all the answers—especially in places without reliable energy grids or the budgets to fund them. Burdett pointed to India's Smart Cities Mission, which had the goal of providing core infrastructure and improving quality of life, and planned to achieve that by adding smarts to 100 cities. "Everyone came up with autonomous vehicles and smart traffic lights in cities where there were no sewers, or housing, or toilets," he said. "Wouldn't those come first?"

We know what makes a city nice to live in. We know what people value. No one is asking for smart bins that ping a centralized dashboard, with data pulled into an AI decision-making system. But they are asking for clean streets and regular trash removal. If a sensor makes that happen without harming people through surveillance, that's great. But first, make sure you've got an employee to empty that bin with a truck that won't get stuck in traffic.

BELOW Saudi Arabia's NEOM project proposes a huge floating city.







NEOM will also feature a floating island resort in the Red Sea.

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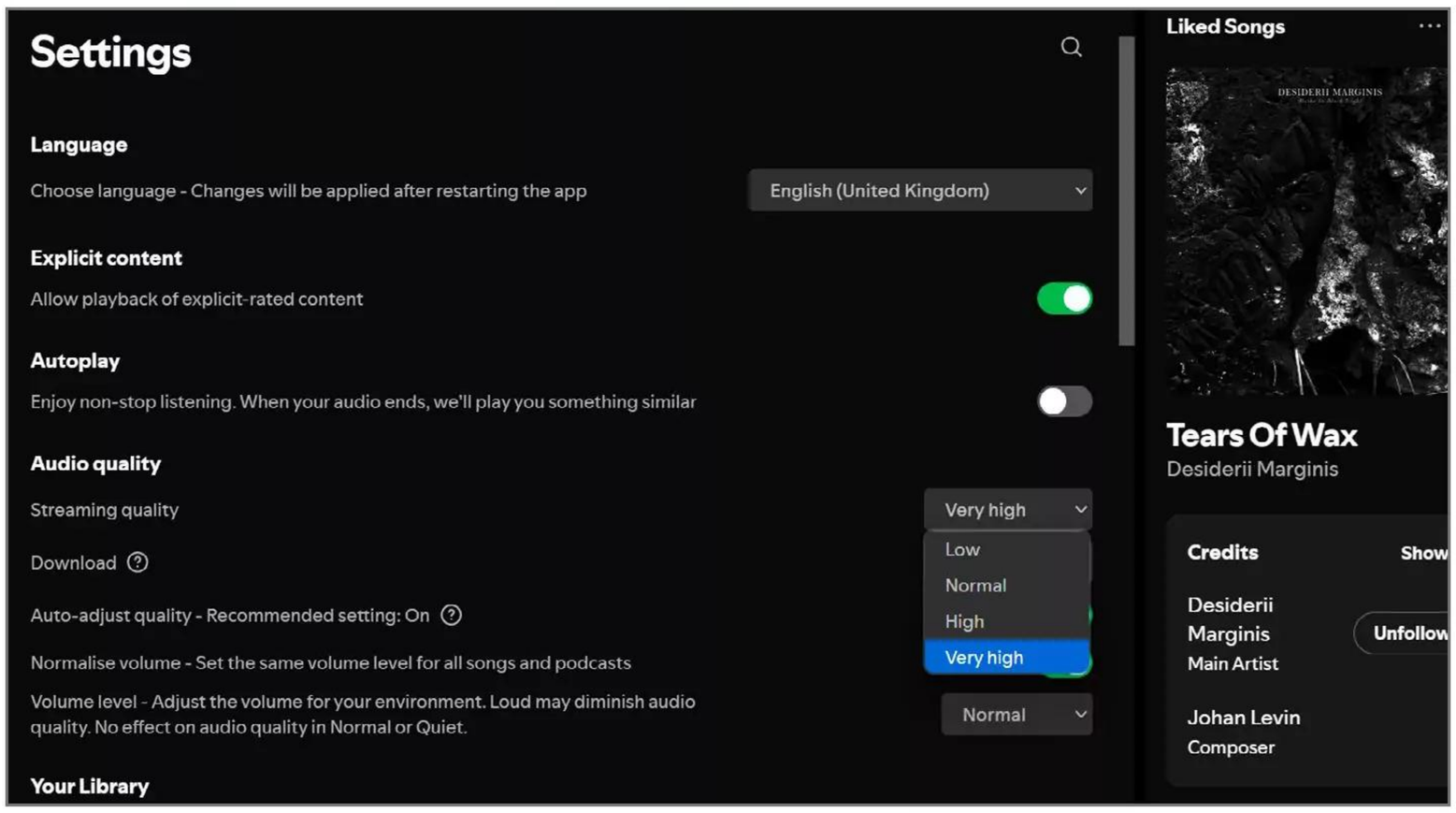
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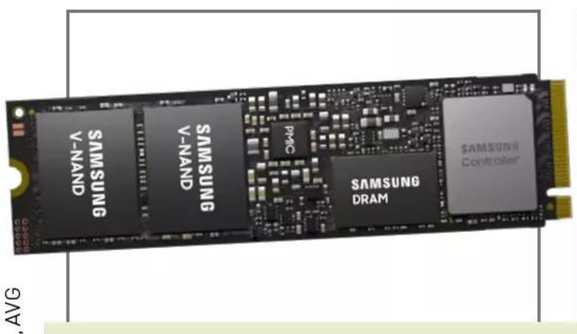
TIP OF THE MONTH

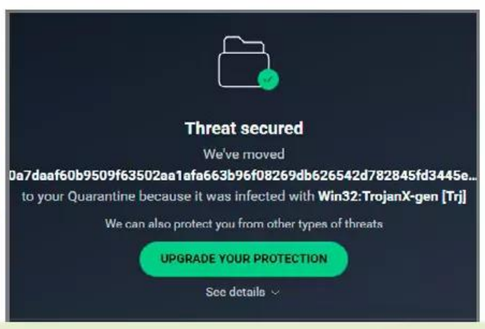


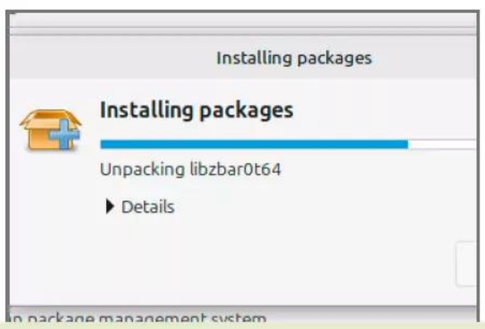
AVOID AUDIO BOTTLENECKS

A PC is only as strong as its weakest link—don't let that be your audio. No matter what you listen to, or how you listen to it, make sure every setting is dialed up to the max. If your speakers support it, ensure they're operating at 32-bit, 192,000Hz in the Windows sound mixer, and if your streaming service or media program has sound options, check they're set to the highest quality playback, or you might be short-changing yourself.

MAKE – USE – CREATE







60 Boost your SSD performance

64 Bench test your security software

68 Make the switch to Linux

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ZAK STOREY
CONTRIBUTOR

FORWARD THINKING

Nvidia's AI dominance is absolute. The immense power leveraged by its on-board Tensor Cores and architecture has given it the edge.

But it got lucky. It takes around two to three years to develop a new GPU line, and likely longer for completely new architectures. The RTX 4000 series probably began life in 2019, launching in 2022, and the upcoming RTX 5000 series probably started either before that or just prior to the AI boom.

It's hard to say whether Nvidia could shift its designs so rapidly in its dev cycle, or if it could predict what was about to arise, but if it can't, the RTX 5000 series may not be as impressive from an inference angle as you'd think.

What can we expect from the new GPUs? Well, we know Nvidia had plans to run the RTX 4090 series harder and faster on the power delivery front, so the likely argument is more juice and higher clock speeds. Hardware-wise, apart from a transistor shrink and a healthy bump up in internal componentry, tweaks to the AI side of things could be average.

I put my money on the real game changer being the RTX 6000 series. With Nvidia having time to assess the marketplace, identify where it can make improvements, and integrate additional AI optimizations, it's that line that'll really be the ChatGPT generation.

↘ submit your How To project idea to: editor@maximumpc.com

IFIXIT presents:

AUTOPSY

THIS MONTH WE DISSECT...

Apple iPhone 16 Pro and



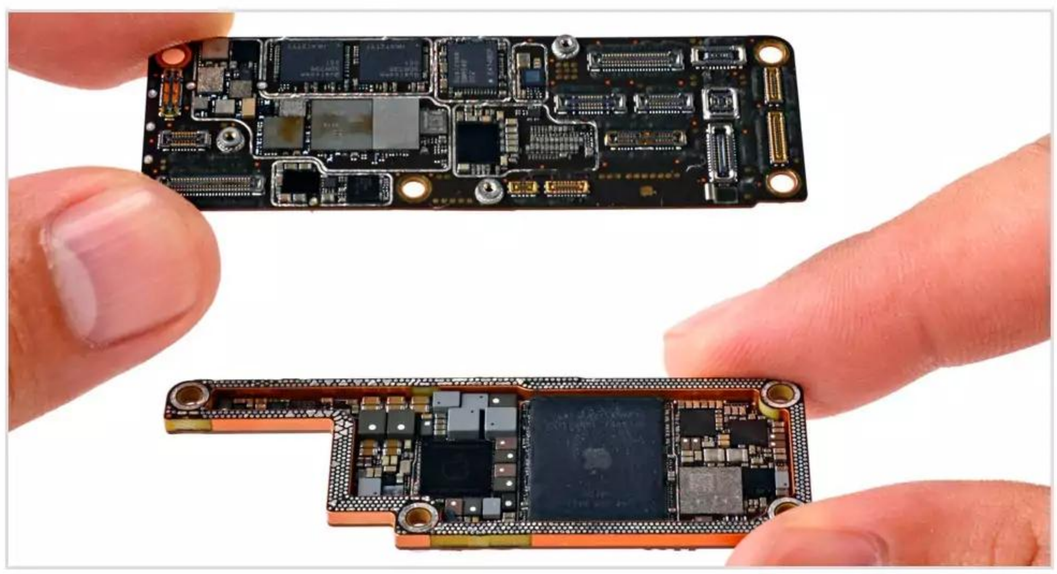


The LiDAR assembly is now its own independently accessible unit, meaning you can replace the LiDAR together with the camera assembly, or replace it on its own.

About iFixit

iFixit is a global community of tinkerers dedicated to helping people fix things through free online repair manuals and teardowns. iFixit believes that everyone has the right to maintain and repair their own products. To learn more, visit www.ifixit.com

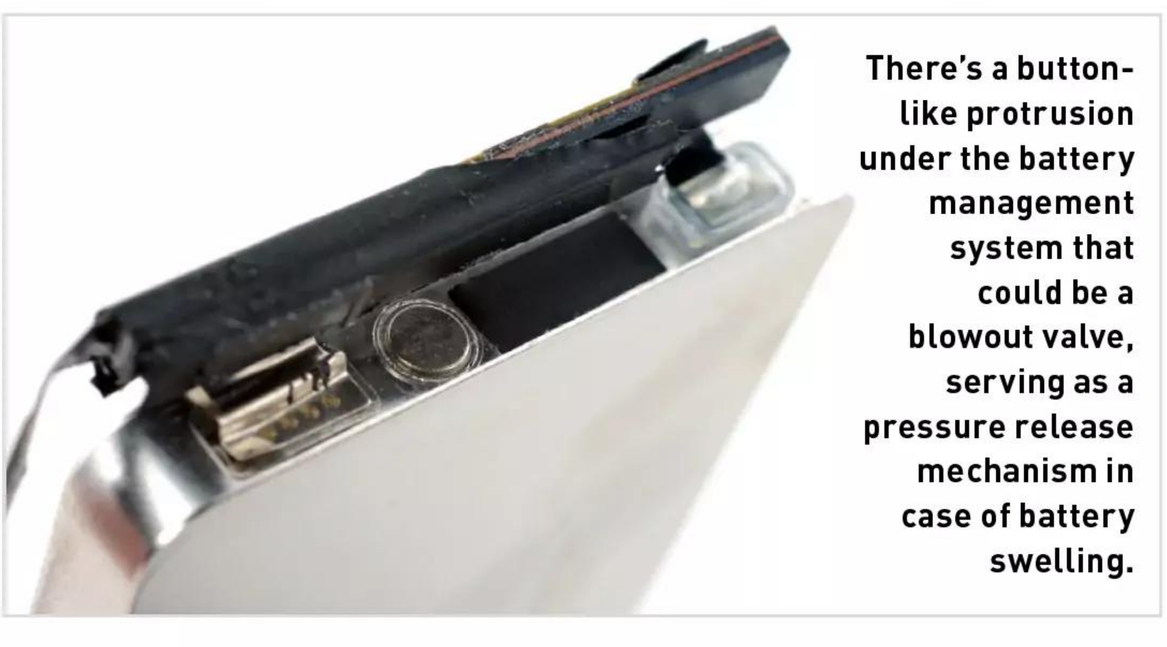
On the logic board, we have the A18 Pro system-on-chip, layered underneath 8GB of LPDDR5 SDRAM. On the reverse side, we have the Kyoxia NAND flash storage.



Pro Max



Previous iPhones had to be opened via the screen, but the 16 Pros are designed so you can access the battery, cameras, and speakers through the less-expensive and less-fragile rear glass.



There's a button-like protrusion under the battery management system that could be a blowout valve, serving as a pressure release mechanism in case of battery swelling.

APPLE IPHONE 16 PRO AND PRO MAX: MAJOR TECH SPECS

- A18 Pro chip; six-core CPU with two performance and four efficiency cores; six-core GPU; 16-core Neural Engine
- iOS 18 operating system with Apple Intelligence
- 6.9-inch (diagonal) OLED display (Pro Max), 6.3-inch (Pro) with adaptive refresh rates up to 120Hz
- 48MP Fusion, 48MP ultra-wide, 12MP 5x telephoto rear cameras, 12MP front camera, shoots up to 4K Dolby Vision video at up to 120fps
- 256GB, 512GB, 1TB storage (Pro Max and Pro), 128GB (Pro only)
- MagSafe wireless charging up to 25W with 30W adapter or higher, USB-C charging
- Rated IP68 (maximum depth of 6 metres up to 30 minutes)
- Dual SIM (nano-SIM and eSIM)
- 3.06 x 6.42 x 0.32 inches, 7.99oz (Pro Max), 2.81 x 5.89 x 0.32 inches, 7.03oz (Pro)

KEY FINDINGS

- The vanilla iPhone 16 earned a respectable 7 out of 10 Repairability Score. It's the most repairable iPhone in years: The fancy new electrically released adhesive makes battery repairs easier. Most repairs can now be completed without having to go through other fragile components.
- With iOS 18, iPhones now have an on-device Repair Assistant that enables you to pair used Apple parts.
- In a major departure from the base iPhone, the Pro battery is encased in aluminum. It's a boon for repair—a slip of a screwdriver won't puncture it, and you don't have to worry about your pry tool bending it if you broke adhesive strips.
- The Pro and Pro Max cameras are identical in specs, but there is one annoying Apple-like restriction that stops you being able to use the modules across both phones—there's one screw hole that's different between the two.
- Perhaps the biggest upgrade to the repairability of these iPhones is the disassembly tree: How buried are the parts you're most likely to repair? For the first time ever, the logic board is removable after taking out just one component, the upper speaker assembly. Fewer removed parts means it's less likely things will go wrong when you reassemble.
- On the downside, Apple's adhesives still create some challenges getting inside—and heat required to open the phone means that it's probably not yet compliant with the upcoming EU Battery Regulation.
- Apple will now sell you a pentalobe screwdriver to get into these phones, and yes, anyone with an iFixit Pro Tech Toolkit has all the bits they need to disassemble an iPhone. But many people don't have a panoply of tiny tools on hand, and having to swap out bits frequently complicates repairs.
- The Pro Max Repair Assistant process also requires a five-minute camera calibration procedure that we didn't see in the vanilla and Plus models, but it worked smoothly and was clearly documented.
- Repairability Score: 7 out of 10 (10 is easiest to repair). We're impressed with the moves toward repairability that all the phones in this iPhone 16 line-up have made. The repairability benefits and drawbacks are similar across the product family. The dual-entry design is standout, particularly now that even the Pro models are built such that most repairs are possible without taking off the screen. The excellent repair manuals for the Pro and Pro Max are equivalent in quality to the manuals for the vanilla and Plus models, and again, we're thrilled to see them available on launch day. Circuit schematics would be a welcome addition, however.

Boost your SSD performance

YOU'LL NEED THIS

CRYSTALDISKMARK
Download it from https://crystalmark.info/en/software/crystaldiskmark

MILLENNIAL *MAXIMUM PC* readers may find it hard to fathom that solid-state drives first hit the market 33 years ago in 1991. SSDs rely on non-volatile memory (usually NAND flash). This means they have no moving parts, resulting in better data transfer speeds and reduced latency compared to mechanical hard drives.

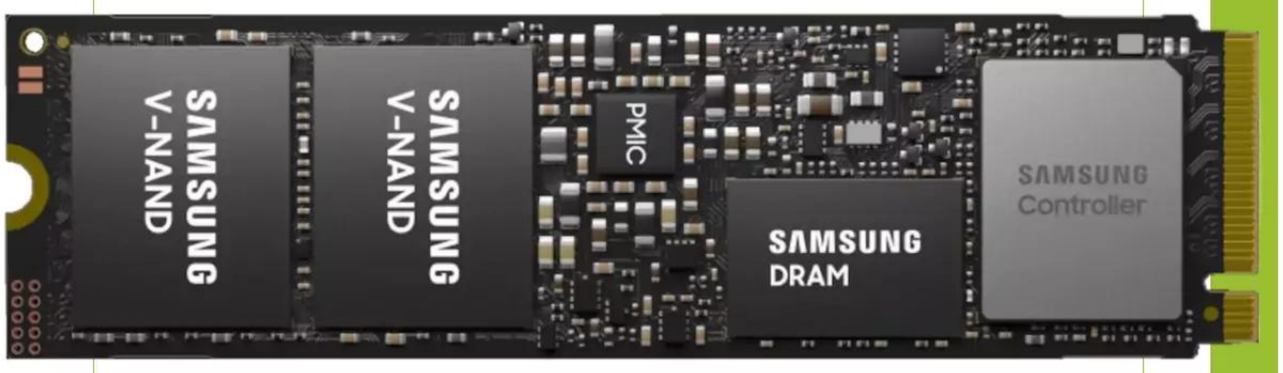
Over the years, SSDs have undergone a number of revisions. The current gold standard is PCIe 5.0, which offers blazingly fast read and write speeds of up to 16GB/s. However, much depends on the number of corresponding PCIe lanes on the CPU. The number of lanes dedicated specifically to the SSD varies by the type of chip used.

This may explain why SSDs using PCIe 4.0 remain a much more popular option, even though optimal read/write speeds are only 8GB/s.

Because of the successive generations of SSDs, there's also a lot of outdated information online on how to truly improve performance. For instance, while enabling AHCI (Advanced Host Controller Interface) mode can increase the speeds of SATA SSDs, NVMe drives using a PCIe interface won't experience any performance improvement.

In this guide, you'll learn the steps to take to increase the effective speed of your SSD. You'll also learn how to benchmark your drive to check your changes have taken effect. **–NATE DRAKE**

A



1 SELECT YOUR SSD

If you're considering upgrading your current device or drive, remember not all SSDs are created equal. Most modern SSD drives follow the M.2 format [**Image A**]. This specification was introduced in 2012 as a replacement to mSATA format. M.2 SSDs have a small, rectangular shape but can vary in size, so most modern motherboard slots can accommodate different lengths.

» M.2 SATA SSDs make use of the SATA interface and are capable of comparable read/write speeds to the old-style 2.5-inch SATA SSDs. They typically reach around 550-600MB/s for sequential read/write operations. This is much faster than traditional magnetic drives but speeds are limited by the SATA interface.

» More recent M.2 NVMe (Non-Volatile Memory Express) SSDs can be attached directly to the Peripheral Component Interconnect Express (PCIe) on a motherboard. This results in much faster speeds over drives using the SATA interface.

» With these types of drives, the overall throughput depends on the number of PCIe lanes on the CPU. These are the physical link between the PCIe-supported device and the processor/chipset. PCIe 4.0 uses four lanes, resulting in maximum throughput of 8GB/s.

» In 2023, the PCIe 5.0 standard was introduced. These types of M.2 NVMe SSDs offer the very best speeds—around twice that of corresponding PCIe 4.0 drives per PCIe lane.

» PCIe 5.0 M.2 SSDs are backward compatible, but to take full advantage of the speed they offer, you need a compatible motherboard and CPU. For instance, while Samsung's PM9E1 (pictured) has reached a staggering 14.5GB/s sequential read and 13.5GB/s sequential write speeds, this would only be possible when connected to a suitable motherboard, such as the MSI MAG X670E Tomahawk Wi-Fi.

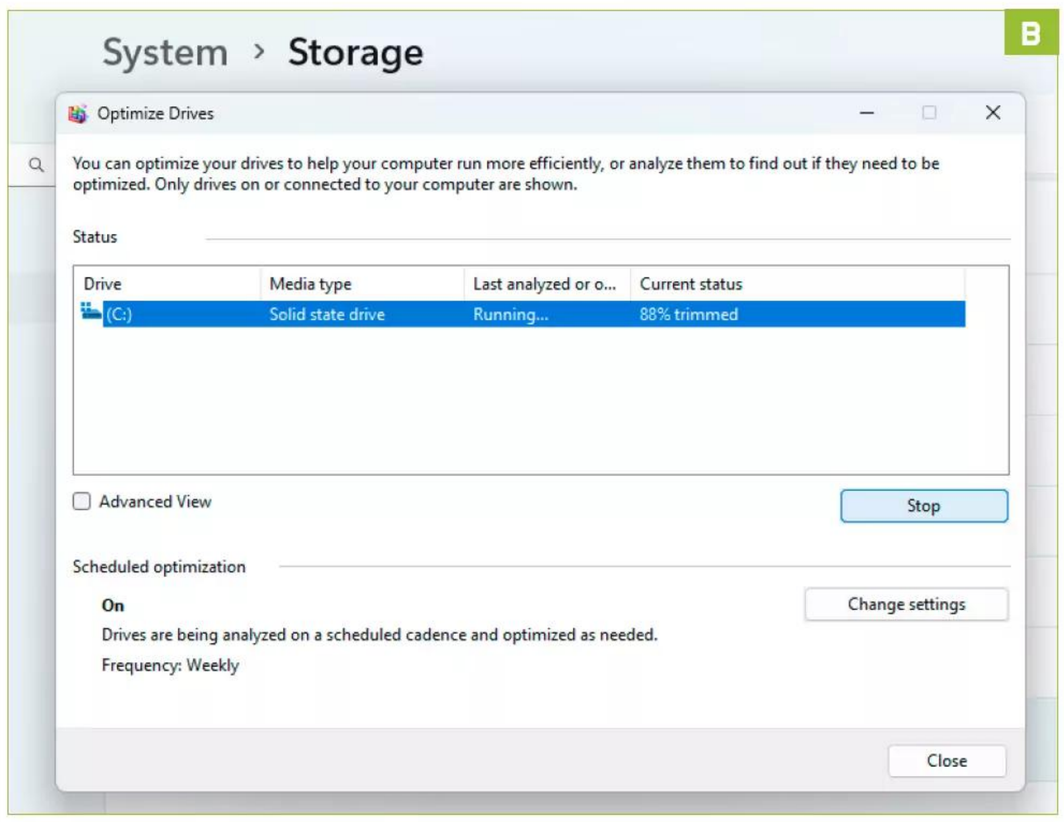
2 DECLUTTER YOUR DRIVE

No matter how superior your hardware, though, your system is going to struggle if your SSD is cluttered.

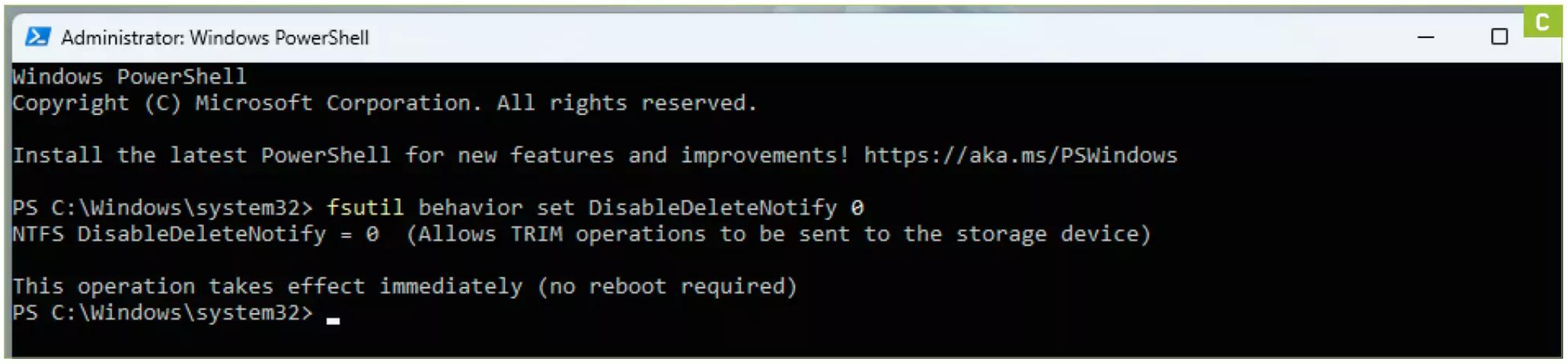
» One of the easiest ways to tackle this is to enable Windows Storage Sense. This periodically removes redundant data, such as files in the Recycle Bin, old downloads, and temporary internet files.

» To get started, launch 'Storage' via the Windows search bar [**Image B**]. Select 'Storage Sense' from the

B



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main window. From here, you can enable user content cleanup. Change the first drop-down menu to run Storage Sense on a regular basis— weekly, for example.

» By default, Storage Sense doesn't remove anything in your 'Downloads' folder but you can set it to periodically remove files that haven't been opened after a set time, such as 30 days. Next, scroll down to 'Locally available cloud content' and double-check the duration to set cloud content to 'Online-only' if it's not opened for a set time (default is 30 days). Choose 'Run Storage Sense Now' to apply your changes.

» Once this is done, click the arrow at the top-left of the settings window to return to the main storage screen. Select 'Cleanup recommendations', then 'Advanced Options'. Windows now lists all potential spaces where you can free up space. Select 'Recycle Bin' and/or 'Downloads' if you wish, then work through the list to decide on other options, such as 'Temporary Internet Files'. Choose 'Remove Files > Continue' to apply your changes.

» Once these are complete, return to the main 'Storage' settings window and choose 'Installed apps' to remove any redundant programs.

» Next return to the main window and choose 'Advanced Storage Settings > Drive Optimization'. From here you can select your main drive and choose 'Analyze' to check if its performance can be improved through Windows' own optimization tool. Enable 'Advanced View' to list specific volumes on your SSD if you prefer. If any volumes or drives list as 'Fragmented', select 'Optimize'.

» From here you can also click 'Change Settings' to optimize your SSD more frequently than the default setting (weekly). Once these changes are complete, close and save any open files, then restart your device.

3 TUNE UP YOUR TRIM

SSDs don't overwrite existing data in the same way as older hard disks. Instead of removing deleted data immediately, they mark it as no longer being in use. So-called TRIM commands inform the system about which parts of the SSD contain invalid data, so it can be removed (usually by an Active Garbage Collection process).

» Without TRIM, the SSD would have no record that certain areas of the drive contained invalid information until the computer programmed it to write new data to that location. This means the SSD would need to erase the existing data, then write the new information, which takes more time.

» Active Garbage Collection processes can run in the background to analyze your SSD and move valid data to another block. This means that invalid data, as identified by TRIM, can be cleaned out.

» Most NVMe SSDs support TRIM but don't necessarily have this feature enabled by default. Double-check this is the case by entering 'Powershell' [**Image C**] in the

BOOST YOUR SSD ON LINUX

SSD manufacturers don't always support more advanced features such as Momentum Cache on Linux.

The best way to view your overall SSD health is to install the package Smartmontools by opening Terminal and running:

```
sudo apt install smartmontools
```

You can then run the check using 'smartctl'. For example:

```
sudo smartctl -a /dev/nvme0n1
```

If you don't enjoy using the command line, you can also install GSmartControl via Terminal, which serves as a graphical front end to Smartmontools. Upon launch, you can select your SSD, then enable SMART as well as 'Auto Offline Data Collection' before running more checks.

You can also check that TRIM is enabled by running:

```
sudo systemctl enable fstrim.timer
```

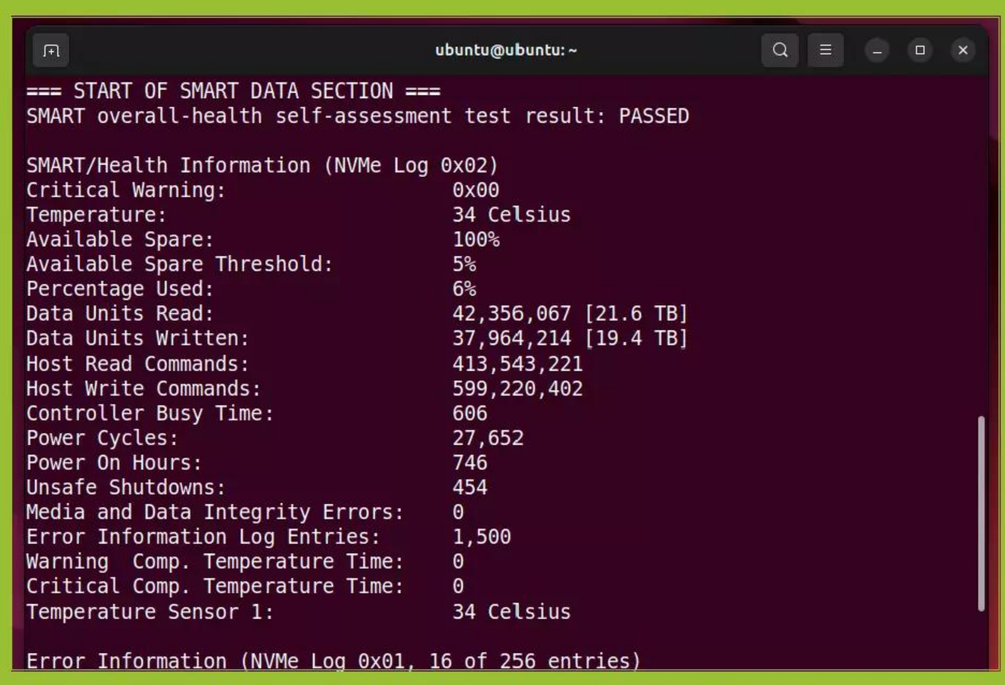
To manually run TRIM, you can also enter:

```
sudo fstrim -av
```

This command will configure Linux to run regular TRIM operations, ensuring unused data blocks are made available once again.

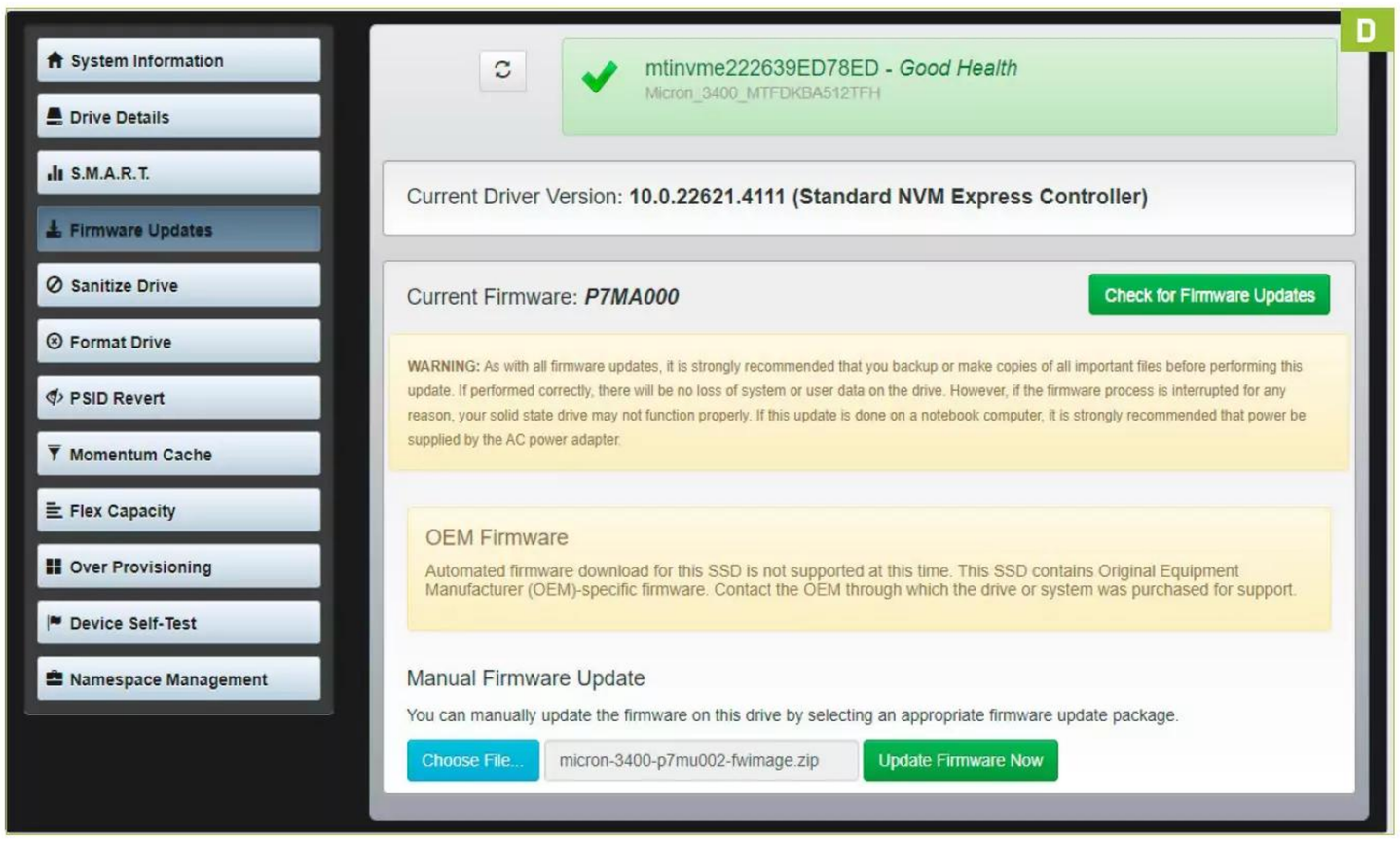
You may also be able to boost your SSD speed by lowering the available swap space, though of course this depends on how much RAM your Linux applications use. This is done through editing '/etc/sysctl.conf' then adding a line to indicate the swap size—for example:

```
vm.swappiness=1-
```



Modern Linux filesystems such as ext4 and Btrfs are also optimized to function best with SSDs. If you're using a legacy install, upgrade your OS for maximum performance.

© CANONICAL



Windows search bar, then right-click the utility to select 'Run as Administrator'.

» Next, enter:

```
fsutil behavior set DisableDeleteNotify 0
```

» If the output is 'DisableDeleteNotify = 0', then TRIM is already enabled.

» If it reads 'DisableDeleteNotify = 1', then TRIM is disabled, so you need to activate it manually. Do this by running:

```
fsutil behavior set DisableDeleteNotify 0
```

» As Powershell states, this command takes effect immediately without requiring a restart.

» During our research for this article, a number of SSD owners advised against regularly using TRIM, instead suggesting that Windows 11 users run the Optimization tool outlined in the previous step to 'retrim' the drive regularly.

» Their concern is based on the fact that unlike with magnetic disks, there's an upper limit to how many times memory cells on an SSD can be subjected to write operations.

» SSD manufacturers nowadays use advanced wear-leveling mechanisms to ensure that this doesn't significantly reduce the lifespan of the drive. Enabling TRIM can also help, as it frees up larger chunks of space for new writes.

4 FIND YOUR FIRMWARE

If you bought your laptop or PC from a retailer, it likely comes with its original OEM firmware. SSD manufacturers do sometimes release firmware updates to optimize performance.

» Updating the firmware is usually safe, but as there's always a small risk of data loss, run a full system backup before proceeding.

» If you're using a portable device, it's also wise to connect it to AC power, as if the firmware update process is interrupted, you risk bricking the SSD.

» If you're unsure which specific model of SSD you own, launch Device Manager via the Windows search bar. If you right-click into 'Properties' under 'Storage Controllers', you'll also see an option to 'Update driver'.

» However, provided your system is up to date, it's unlikely that this will locate any new software. Instead, you need to download the necessary firmware from the manufacturer's website. If firmware is available, make sure you check both the version number and release notes (if applicable) to ensure that updating will improve SSD performance.

» The exact steps to take next vary based on your SSD model. For instance, in the case of our Micron 3400 NVMe SSD [**Image D**], the manufacturer has its own Storage Executive software, which lists the current firmware. However, users must download the firmware file separately, then navigate to it via the software.

» Other manufacturers may offer software capable of detecting your installed SSD model and then download any firmware updates automatically. You may even need to place the firmware file on to a bootable USB to apply the update.

» Once the new firmware update is installed, save and close any open files, then restart your device. You can usually use the manufacturer software (if any) to determine that the firmware update has been successful. Failing this, reopen Device Manager. Right-click your chosen storage controller and/or SSD, then choose 'Properties > Driver'.

5 OVER PROVISIONING

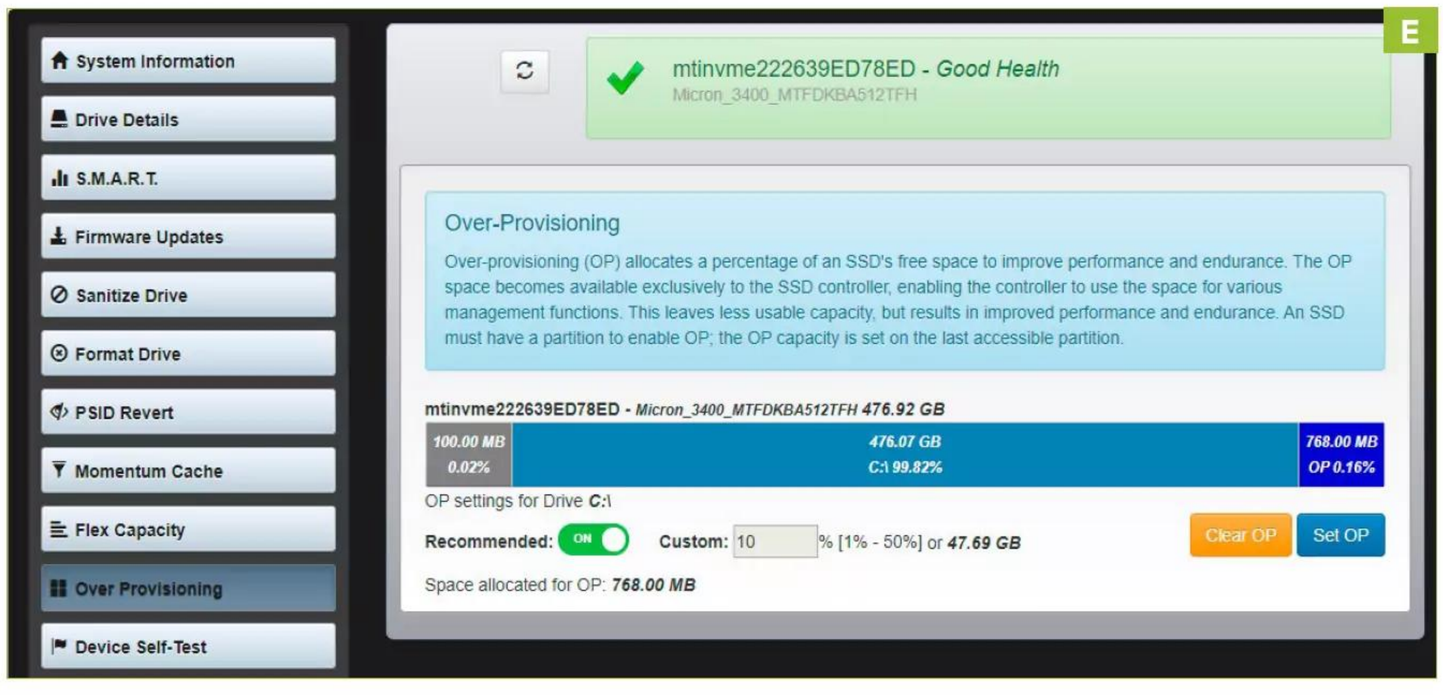
A certain portion of any drive isn't accessible to the user. On an SSD, some space is reserved for the controller to perform essential operations, such as garbage collection and wear leveling.

» This Over Provisioning (OP) capacity is set by the manufacturer. It can vary in size, depending on the application class of the SSD—Read Intensive, for example—and its total NAND flash memory capacity.

» Typically, high-capacity drives have a proportionately bigger OP section, due to the higher resources required for managing larger amounts of NAND flash and more intensive operations [**Image E**].

» Each NAND flash memory die is constructed of multiple blocks that contain a number of 'pages'. Keeping a large quantity of blocks empty and in reserve via over provisioning can help to keep overall SSD performance consistent, especially in random write scenarios.

» This is why some manufacturers provide software to increase the OP allocation on your SSD. Naturally, this shrinks the overall user space for activities such



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as running applications. However, it can also improve your SSD performance and endurance.

» The extent to which it does this is debatable. For instance, Kingston's blog contains details of a battery of tests run on one of its series of Enterprise DC500R SSDs. These were run on drives with a set OP capacity of 7 percent and 32 percent respectively.

» While sequential read/write speeds for the drives didn't increase significantly with a larger OP capacity, it did improve random write operations. Kingston also discovered the effective life of write-intensive drives almost doubled with a 32 percent OP capacity.

» If you're willing to perform your own tests, check the SSD manufacturer website to find the necessary software. As with updating the firmware, we recommend running a full system backup before proceeding.

» The steps you take next depend on the available software. For instance, the aforementioned Storage Executive has a dedicated section for OP. Upon clicking 'Initiate', users can then enable a rocker switch to change the default OP allocation to one of their choosing.

6 CACHING OUT

Certain SSDs support using some of your system's DRAM to buffer random data writes.

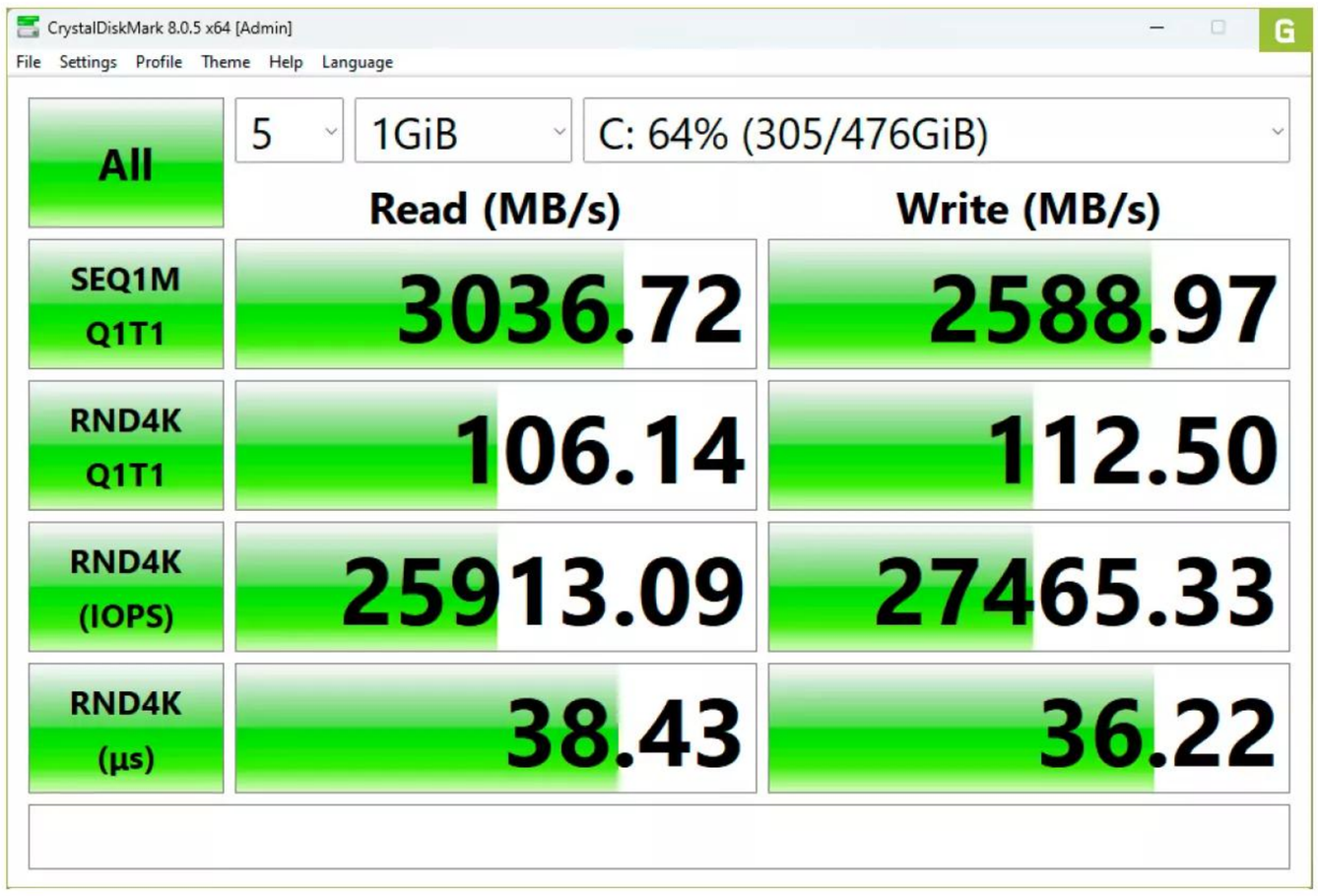
» In other words, whenever the operating system needs to write data to the boot drive, it's actually written to a portion of DRAM instead. Usually the data is then flushed to the SSD for permanent storage.

» I/O operations can increase significantly by buffering random data writes in RAM before sending them to the SSD. As random data writes by intensive applications cause the most wear on an SSD, using the cache in this way can also improve your SSD lifespan.

» Samsung's RAPID mode is also capable of recognizing 'hot' data—that is, frequently used information that can be served directly from RAM. This can hugely reduce bottlenecks and improve data read speeds.

» If you do have a compatible SSD and use intensive applications like games, you need to determine whether allocating DRAM in this way will indeed boost system performance. For example, Crucial's Momentum Cache feature uses up to 25 percent of available system memory but no more than 4GB overall.

» Naturally, enabling features like these can cause data loss if the power is interrupted suddenly. This is why Momentum Cache [Image F] disables itself when laptop battery capacity goes below 25 percent. If you use a PC, we recommend using a UPS before harnessing DRAM in this way.



7 BENCHMARK YOUR SSD

If you want to determine the effectiveness of applying the above changes, it's now time to bench test your SSD.

» There are many tools to do this but CrystalDiskMark (https://crystalmark.info/en/software/crystaldiskmark) is one of the most popular [Image G].

» After install, the interface offers you a suite of tests. The three drop-down menus determine the number of tests to run (default is five), the size of the data block test (default is 1GiB), and the drive to test.

» We also recommend choosing 'Settings > NVMe SSD' from the main menu, to run tests specifically designed for your hardware.

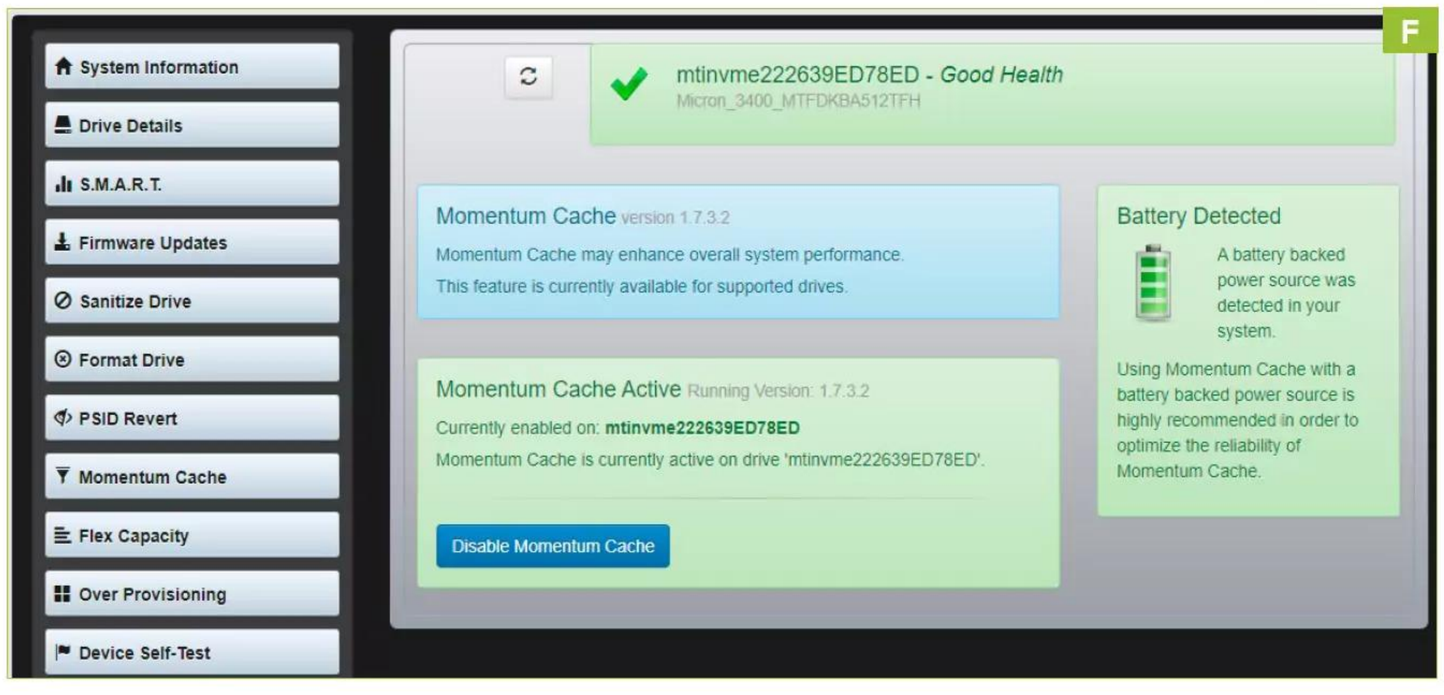
» Save and close down any other programs, then select 'All' to begin. The first test (SEQ1M—Q1T1) determines sequential read/writes—how quickly your SSD transfers information from one location to another.

» The second test (RND4K—Q1T1) measures random 4K read/writes, or in other words, how fast your SSD can access small amounts of data in random locations. The third and fourth tests determine how well your SSD handles large data transfers.

» Some SSDs perform better with larger data blocks, rather than smaller ones, so feel free to run the test again using a larger size. Generally, the greater the number of tests you run, the better idea you gain of your SSD's real-world performance.

» 'Real World Performance' is in fact the default 'Profile' option in the main menu. If you're trying to determine your SSD's optimal read and write speeds, you can change this to 'Peak Performance', then run the tests again.

» If you're running these tests in order to compare your results with other SSD users, you can go to the 'File' menu to export the data either as a PNG image or in a text file.



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Bench test your security software

YOU'LL NEED THIS

VIRTUALBOX
Download it from www.virtualbox.org.

IN THE LATE 16TH CENTURY, King Philip II of Spain submitted a formal complaint to His Holiness Pope Gregory XIII. The complaint concerned an encrypted letter that had been intercepted and decoded by the legendary mathematician François Viète.

The king accused Viète of deploying black magic. Pope Gregory, whose own cryptographers had been reading encoded Spanish letters for decades, quietly shelved the complaint.

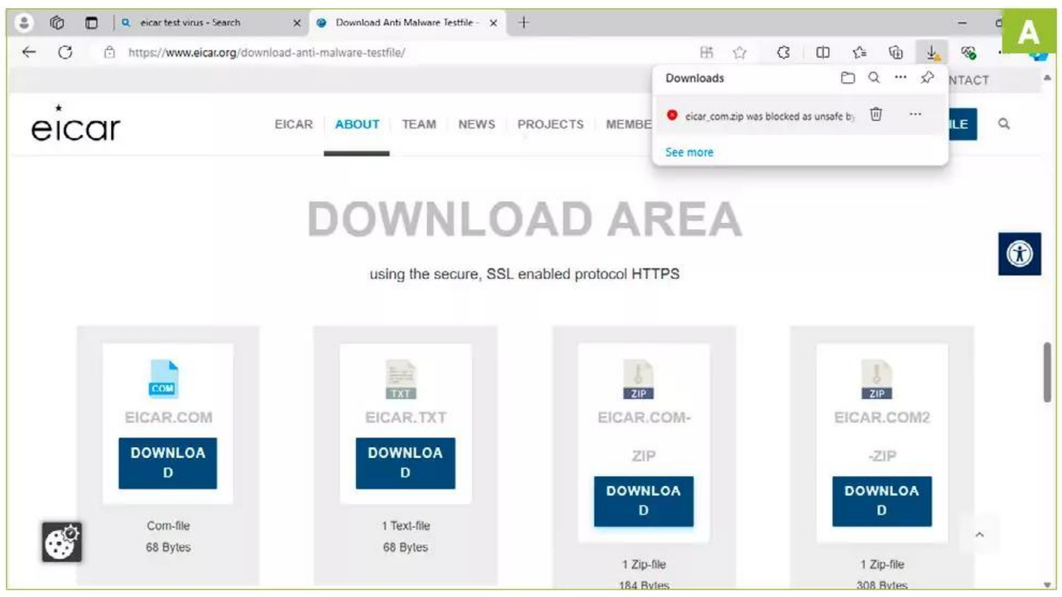
Philip's hubris was an excellent illustration of Schneier's Law, usually phrased as, "Any person can invent a security system so clever that she or he can't think of how to break it."

This is particularly true for Windows users who deploy security-in-a-box solutions, believing installing certain software will protect their system for any manner of attacks.

In this guide, you'll discover how to test your PC security features to ensure they truly are effective against online threats. If any vulnerabilities are present, you'll also learn some best practices to bolster your cyber defenses against would-be hackers.

While none of the steps are actively harmful to Windows, whenever making any major changes to your system, it's always a good idea to run backups.

This is also a good first step to take in protecting your system security, given that if the OS is compromised, you can roll it back to a date before this happened. **–NATE DRAKE**



1 KEEP UP WITH UPDATES

While there's no single solution to protect against all cyberthreats, one of the most important steps you can take is to keep your system up to date.

» For instance, a serious vulnerability (CVE-2024-21302) was disclosed at Black Hat USA 2024 involving an attack that forces Windows 11 to use outdated system components, because they're easier to exploit.

» Double-check your update preferences by going to' Settings > Windows Update > Advanced options'. From here you can also allow restarts immediately as necessary to apply updates, as well as enable updates for other Microsoft products.

» Microsoft Defender also relies on Windows Update to receive the latest threat definitions. If you use a third-party antivirus program, you need to schedule updates manually.

» There are plenty of online vendors who claim their particular antivirus and/or software suite will solve all your security woes. Still, last year, when evaluating 18 mainstream antivirus programs for TechRadar, we found that Defender was able to immediately detect and quarantine harmful files unassisted.

» You can test your chosen antivirus program's detection for yourself safely by downloading a test file from EICAR [**Image A**]. The file is harmless but is included in the signature database for all major antivirus programs.

» To get started, head to www.eicar.org. Select 'Download Anti-Malware Test File', then scroll down to the section marked 'Download Area'.

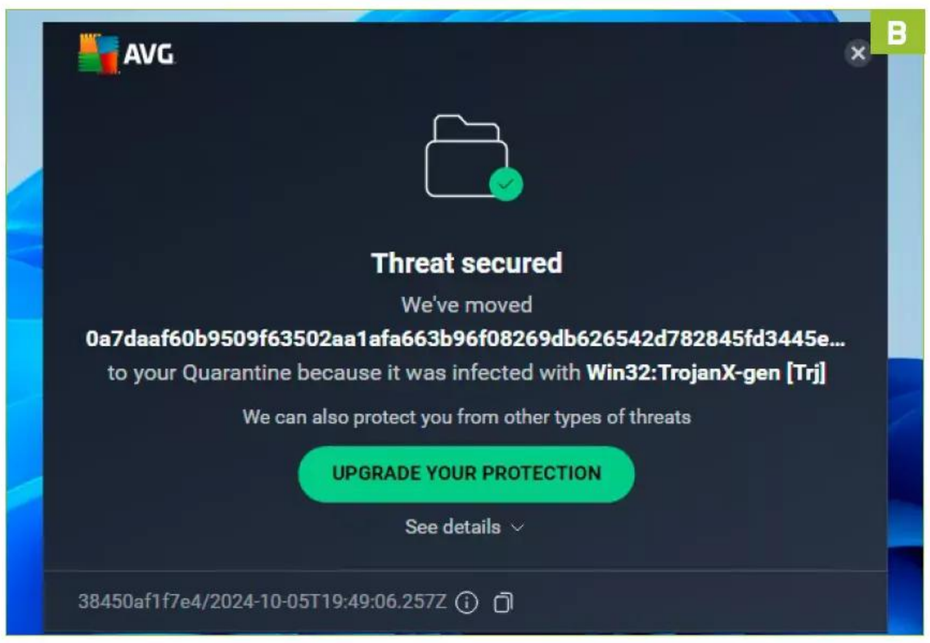
» We suggest trying to download one of the ZIP files to ensure that your chosen malware can scan inside compressed archives. If you're using Edge, the file should be blocked by Microsoft Defender's smartscreen. If so, click and choose 'Keep anyway', so the file is copied to your downloads.

» You should then receive a notification from your chosen anti-malware program to say the file has been automatically quarantined.

2 ADVANCED ANTIVIRUS

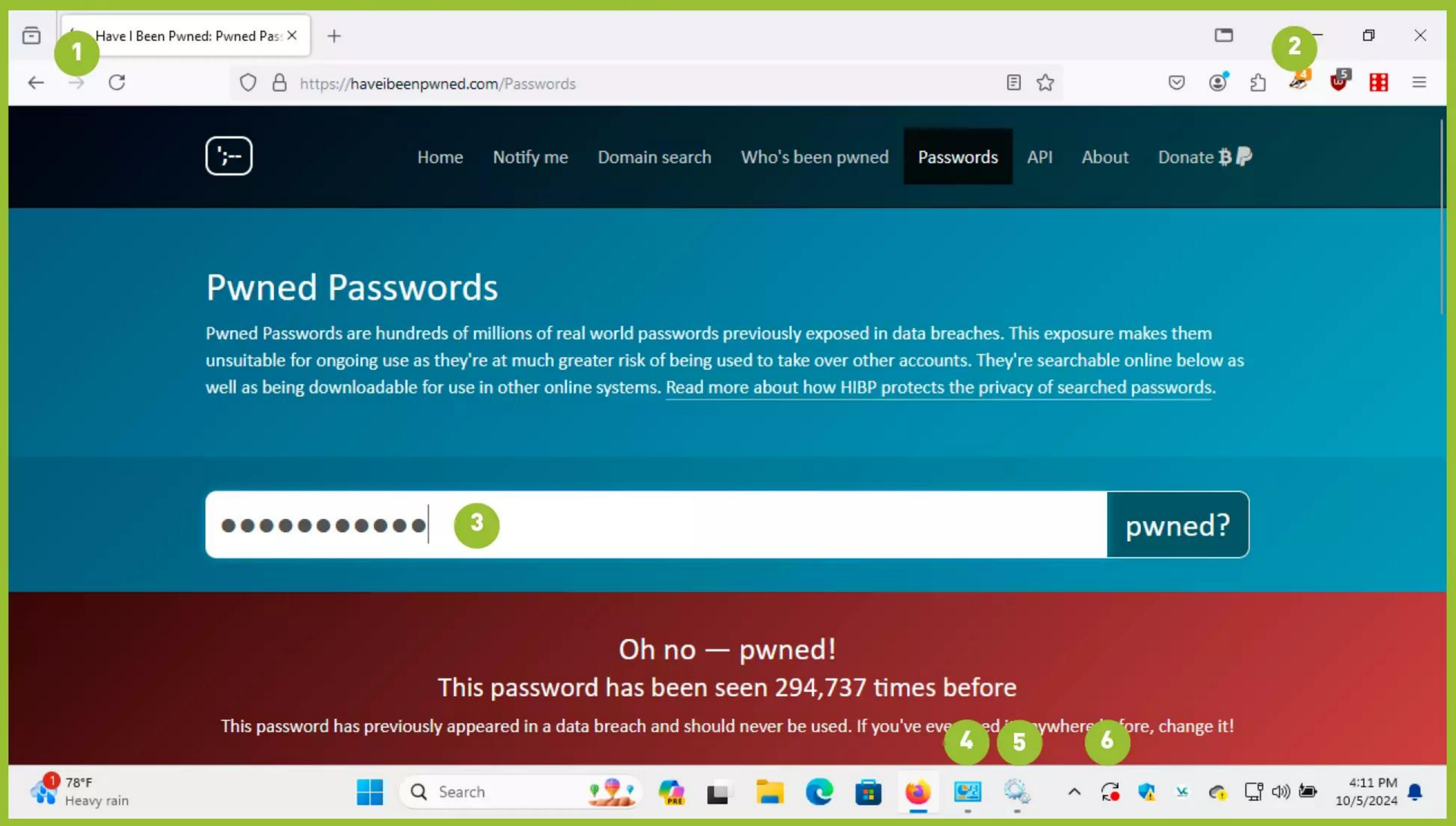
As the EICAR file is known to all antivirus providers, threat detection is relatively simple. More modern programs usually do more than simply check files against threat databases. They also rely on techniques such as heuristic analysis, which looks at patterns of file code for suspicious behavior.

» Unfortunately, the only way to know if your current antivirus solution is proof against such threats is to try to download real malware. This is extremely unwise but



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SECURE YOUR SYSTEM



1. OPEN SOURCE BROWSER
Use browser preferences to check your browser isn't vulnerable to IP leaks through WebRTC. Disable WebGL to prevent browser fingerprinting. Use sites such as EFF's Cover Your Tracks or IPLeak to verify changes.

2. PRIVACY ENHANCING EXTENSIONS
Add-ons such as uBlock Origin and Privacy Badger can both prevent trackers and filter malicious links, like those to ads. Use a testing website such as http://browseraudit.com to ensure they're working correctly.

3. HAVE YOU BEEN PWNED?
Use websites like these to ensure your credentials haven't been leaked in data breaches. When generating new passwords—with Diceware, for example—use www.security.org's online tool to check its strength.

4. CUSTOMIZE FIREWALL SETTINGS
Use web tools such as Shields Up to check for open ports. Windows Firewall supports varying access levels for different network profiles. Tools such as WinDump can check for unusual internet activity.

5. VERIFY WINDOWS SERVICES
Background processes can be used by skilled attackers to remotely exploit your system—by running arbitrary code, for instance. Check and disable unnecessary services, such as the print spooler or Bluetooth.

6. WINDOWS UPDATE
Check your update settings in Windows to ensure that they are applied as soon as they become available. This may cause your machine to restart automatically outside designated active hours.

if you're determined to bench test your current security software [**Image B**], you can do so safely by installing Windows 11 in a virtual machine.

» If you do this, we recommend VirtualBox, which is free and offers an intuitive interface. You can download an ISO for Windows 11 from www.microsoft.com/en-us/software-download/windows11. Once the install is complete, ensure that your copy of Windows 11 is up to date. If you're using a third-party antivirus program, install this next and ensure it's fully updated. We also recommend installing 7-Zip (www.7-zip.org).

» Next, point your virtual machine browser to MalwareBazaar (https://bazaar.abuse.ch). This website is designed for InfoSec specialists to share malware samples. Click 'Browse' in the top menu, then scroll down to find an EXE or MSI file that's recently been uploaded.

» Click the link under 'SHA256 HASH', then scroll down to choose 'Download sample'. The sample will be in ZIP format, protected by a password, such as 'infected'.

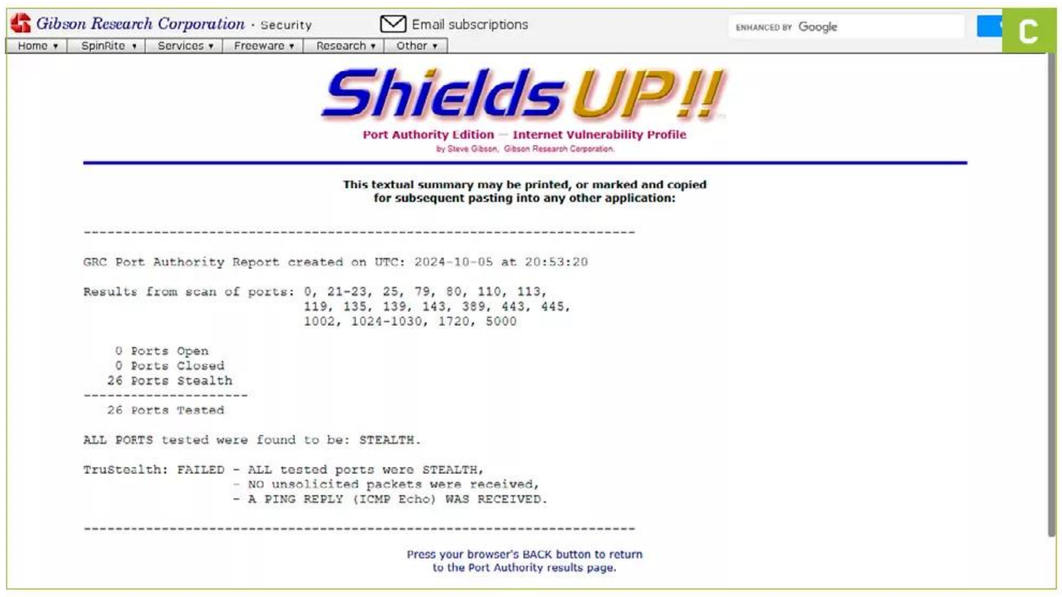
» Once the download is complete, shut down your virtual machine. Return to the VirtualBox main screen, highlight the VM and choose 'Settings' from the top menu. Choose 'Network' from the left-hand pane and disable the checkbox marked 'Enable Network Adapter'. This prevents your VM from connecting to the internet and eliminates the risk of the malware being spread to other machines.

» Next, reboot your VM and click the 'Start' menu. Launch 7-Zip File Manager to extract the file. Once the application appears in 'Downloads', ideally it should be immediately quarantined by your antivirus program. If not, try to execute it.

3 ROUTING OUT ROOTKITS

Although it's relatively simple to run regular antivirus scans, some malware is much more insidious. Rootkits, in particular, are especially fiendish

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to detect and remove. There are many types, such as kernel rootkits and application rootkits. The one thing they have in common is that they hide in atypical locations, such as your device's bootloader.

» Given that rootkits can load in the early stages of the boot process, this poses a serious issue for your PC security. Firstly, rootkits can interfere with scans, meaning that harmful files aren't detected. Even if harmful files are scanned and quarantined, these can also be reinstalled again if the rootkit is in a location your antivirus program can't access.

» These types of attacks are rare these days but can also be difficult to detect. This is because common symptoms such as slow performance, repeated error messages, web page loading issues, and so on can be caused by many other factors.

» Put your system through its paces by running a Microsoft Defender offline scan. This tool runs in a trusted environment without loading your OS, so can't be interfered with by currently running programs.

» To get started, launch 'Windows Security' from the search bar. From here, select 'Virus & Threat Protection'. Under 'Current threats' choose 'Scan options'. From here you can now select 'Microsoft Defender Antivirus (Offline Scan) > Scan Now'. Your device restarts and begins the scan.

» Upon restart, if your device still has performance issues, these may be unrelated to any rootkits. If you're still uncertain, use a packet sniffing tool, such as WinDump (www.winpcap.org/windump). This fork of TCPDump can monitor incoming and outgoing connections, so you can check for any unusual traffic.

» If a rootkit has comprised your device's firmware, the only solution is either to replace your device or to flash it with open source firmware such as Libreboot (https://libreboot.org) or Coreboot (www.coreboot.org).

4 FINE-TUNE YOUR FIREWALL

Third-party firewalls can be useful for automatically suggesting and assigning rules regarding which programs to permit and deny. But Windows' own built-in software is perfectly adequate for security purposes.

» Double-check your settings by launching 'Firewall and network settings' via the Windows search bar. As you'll see, the program offers three main profiles: Domain, Private, and Public. Although our first advice is always not to use public Wi-Fi, if you enable the corresponding profile, all incoming connections such as RDP will be blocked. The Private and Domain profiles are more forgiving.

» Select 'Allow an app through the firewall > Change Settings' to view and edit currently allowed programs. The interface is very simple. Check or uncheck the box next to the app name to permit or deny it respectively. You can also choose to allow an app only on private or public profiles by checking the corresponding box. Be sure to scroll through this list carefully to double-check any unfamiliar programs. Even if you recognize a legitimate app, such as Microsoft To-Do or Remote Desktop, you can disable access if you never use it.

» If you do want to allow a specific program through the firewall, click 'Allow another app', then browse to it. You can also fine-tune your firewall configuration by choosing 'Advanced Settings' from the main 'Firewall and network settings' window.

» From here, you can set more specific rules. For instance, double-click on the entry for Windows Media Player to specify connections only from certain remote computers and/or users.

» As there are hundreds of rules to work through, you can save some time by having a dedicated website probe your ports for vulnerabilities. We recommend GRC's ShieldsUp (www.grc.com/shieldsup). After running the test—on 'Common Ports', for example—request a text summary to get a quick rundown of any potential holes in security [**Image C**].

5 SELECT YOUR SERVICES

Limiting the number of programs that can access the internet and ports that accept remote connections reduces your system's attack surface.

» The same holds true for Windows services. These usually go unnoticed, as they operate in the background, but some can present significant security risks.

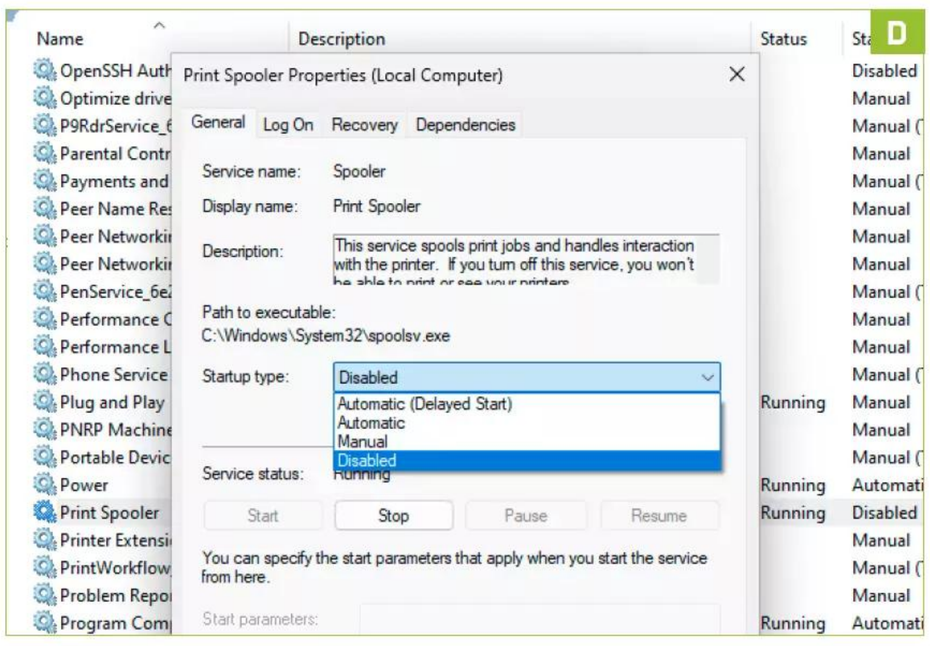
» For example, in 2021 the PrintNightmare vulnerability was discovered in the Windows Print Spooler Service, which could allow an attacker to run arbitrary code as a privileged user.

» The simplest solution is to disable services you don't need. This has the potential to cause system instability, so make sure you run a full backup first.

» Next, use the Windows search bar to launch services.msc [**Image D**]. The interface here is much more intuitive than the firewall. Each service has a detailed text 'Description'. Expand this column and read through what each one does. Right-click any service and choose 'Stop' to halt it for the rest of your session.

» To disable a service permanently, right-click then choose 'Properties'. In the 'Startup Type' drop-down menu, choose 'Disabled'. You can also choose 'Manual' to start services you'll need on an ad-hoc basis, such as the print spooler.

» While you're here, if your device was previously compromised by malware, it may also have disabled essential processes such as the Microsoft Defender Antivirus Service. Make sure the 'Startup type' for this is set to 'Automatic'.



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6 BOLSTER YOUR BROWSER

In August 2024, a US Appeals Court ruled that Google has to face a revived lawsuit over allegedly collecting users' personal data, even after they chose not to sync the Chrome browser with Google accounts.

» It's hard to tell what data Google's browser gathers. Although it's based on the open source Chromium browser, Chrome is proprietary software. The same is true for Microsoft Edge.

» The gold standard for browser security is open source software such as Brave or Firefox. If you opt for Firefox, the setup process offers the choice to install privacy-enhancing extensions. These include Privacy Badger, which can automatically block trackers. We also recommend uBlock Origin for removing annoying ads, as well as filtering malicious URLs.

» Websites such as https://browseraudit.com are capable of running a battery of security tests on your browser to check it for vulnerabilities. If you do this, keep a close eye on any vulnerabilities listed as 'Critical' [**Image E**].

» We found our version of Firefox had a very broad same-origin policy for cookies. This meant sites could change the 'Domain' parameter for cookies to send them to, say, test.browseraudit.com rather than the main domain browseraudit.com. This can raise security issues if the cookies contain personal data.

» The steps needed to address security issues vary depending on your browser and the threat. For instance, in Firefox you can type 'about:config' in the address bar to access advanced preferences. Here you can search for terms like 'webgl.disabled'. In this case, changing the disabled value to 'true' disables WebGL, which can be used by sites to fingerprint browsers.

» If you use a VPN, we also recommend disabling both WebRTC and IPv6 in your browser preferences, as these can leak your IP address. Use a website such as https://ipleak.net to test this is working correctly. IP Leak can also check if your VPN manages DNS requests, thus protecting your device from DNS leaks.

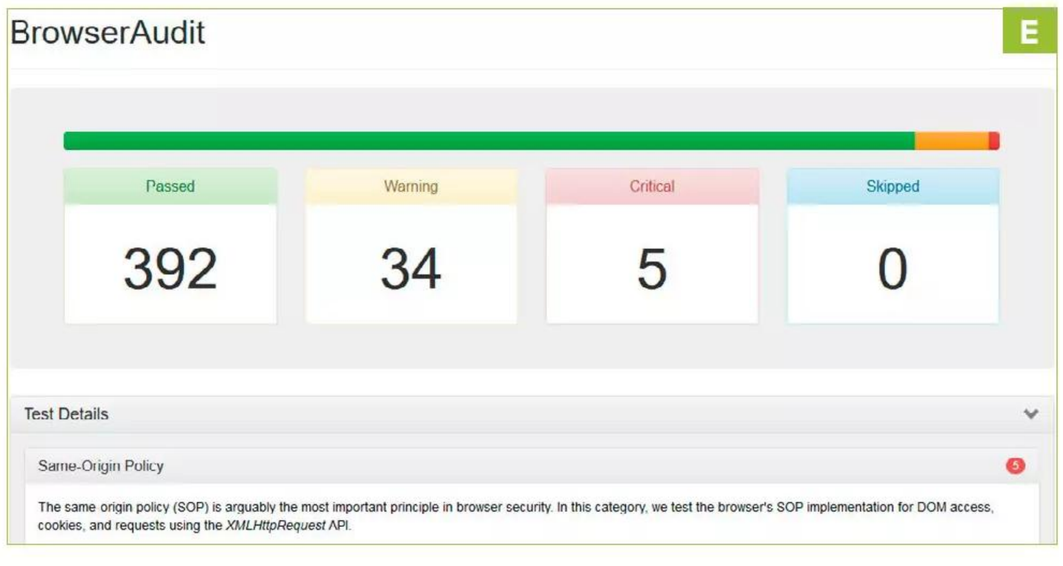
7 PWNAGE PROTECTION

In July 2024, the RockYou2024 database was leaked on to a hacking forum. While much of the data was junk or collections from previous breaches, the file contained almost 10 billion credentials.

» To check if your credentials featured amongst these or other high-profile leaks, visit https://haveibeenpwned.com.

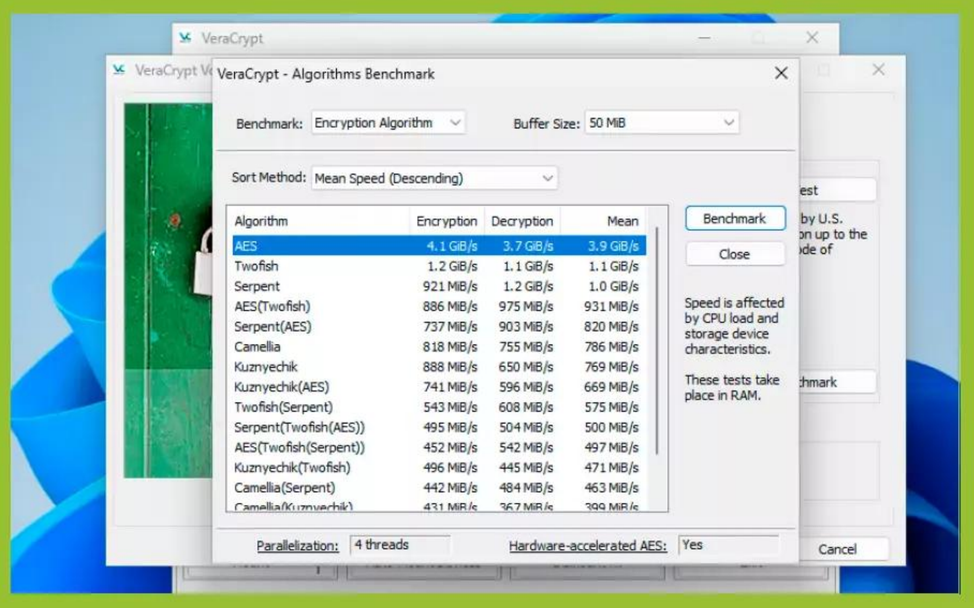
» The risk of data breaches like these underscores the importance of choosing a strong, unique password for each of your online accounts. This is much easier to do if you make use of a password manager. Firefox's, for instance, verifiably encrypts your password database and syncs your credentials to other devices securely.

» If you want to deploy a dedicated password manager to enjoy advanced features such as hardware tokens, open source options include Bitwarden (with browser integration) and KeePassXC (for storing credentials in an offline database).



© VERACRYPT, BROWSERAUDIT.COM

EXTEND ENCRYPTION



Microsoft's own BitLocker software ostensibly offers secure system encryption. This means if your device falls into the wrong hands, an attacker won't be able to recover your data without the correct key.

BitLocker ostensibly uses the open source AES encryption algorithm, but as the program is proprietary, the code can't be publicly verified to be sure AES is implemented correctly. Microsoft also claims it's turned down repeated requests from law enforcement to code a back door into devices.

If you don't want to take this on trust, consider encrypting your system using Veracrypt (www.veracrypt.fr). This program is not only open source but offers a variety of encryption methods. To start, install the software then select 'System > Encrypt System Partition/Drive'.

The setup wizard offers a 'Benchmark' option to test the speed of various encryption and hash algorithms to see which is best for you. The default option of 256-bit AES is usually fastest due to AES-NI, which optimizes modern CPUs to work with the algorithm.

However, you can choose from other AES finalists, such as Serpent or Twofish, as well as choose cascade ciphers—for instance, Serpent(Twofish(AES)).

If you want to use Veracrypt, you need to disable BitLocker encryption first. Launch 'Manage BitLocker' via the Windows search bar, then click 'Turn off BitLocker'.

» Not all password managers are created equal, so use yours to create a new passphrase, then test its strength using a dedicated site such as www.security.org/how-secure-is-my-password/.

» The results can be counterintuitive. For instance, an iPhone serial number like LRYOTR7XYF contains no dictionary words, as well as a combination of letters and numbers. However, it offers only 51 bits of entropy and can be cracked in less than a day.

» Although this can give an idea of how long it takes to brute-force a password, entropy is only one factor when it comes to reverse engineering credentials. In the above example, an adversary would probably try predictable information like serial numbers and license plates.

» If your password manager also doesn't cut it, consider switching to Diceware (https://diceware.dmuth.org). This involves randomly selecting dictionary words from a list. For instance, the passphrase 'Marrow Vegan Spearhead Coasting' provides 176 bits of entropy and would take billions of years to crack.

Make the switch to Linux

YOU'LL NEED THIS

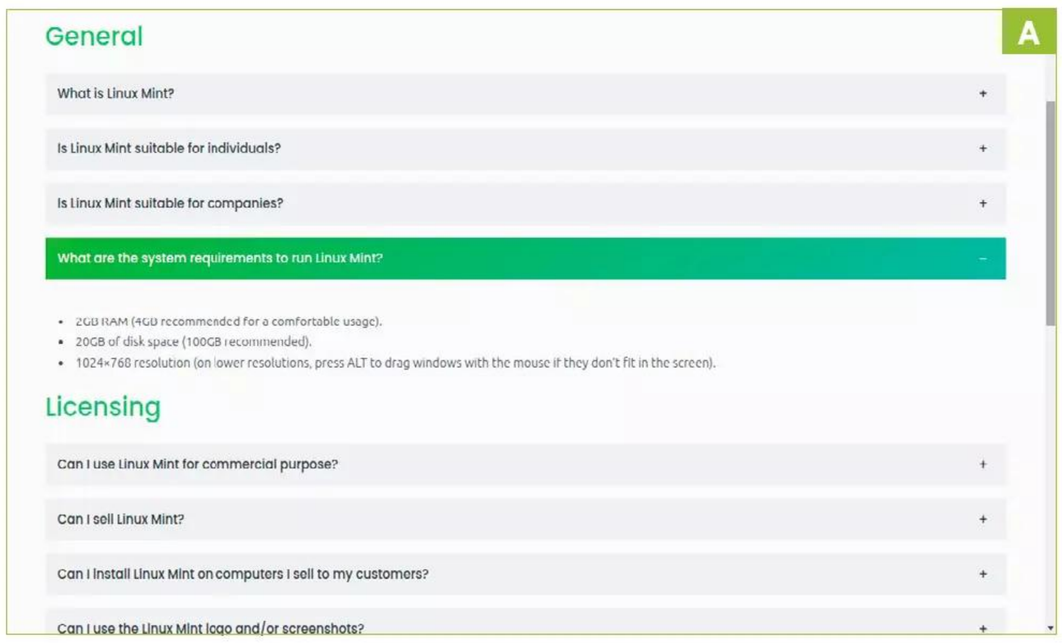
WINDOWS 11
An up-to-date installation.

LINUX ISO/DMG FILE
Installation media.

MICROSOFT HAS ANNOUNCED that support for Windows 10 will officially end in October 2025. This is bad news for users of older PCs, because Windows 11 (and presumably its successor) requires devices to have at least an 8th-gen Intel or an AMD 3015e CPU. Your PC must also support TPM (Trusted Platform Module) v2.

If your computer doesn't meet these requirements, you're not alone. The tech market analysis firm Canalys estimates that roughly 20 percent of devices will become e-waste due to incompatibility with Windows 11—that comes to around 240 million devices.

Luckily, there's a third option besides continuing to use an obsolete OS or junking your current machine. The Linux operating system has much more forgiving requirements, so works happily with older devices. In recent years, it's also become much more user-friendly. In this guide, you'll learn how to prepare your machine, then make the switch to Linux. **–NATE DRAKE**



1 CHOOSE YOUR DISTRO

If you're considering switching to Linux, you probably already have a distribution (aka distro) in mind. Still, the choice can be overwhelming. Ubuntu is definitely the most popular version, but its default Gnome desktop can be difficult to use for newcomers coming from Windows.

» Linux Mint is based on Ubuntu but uses Cinnamon or MATE desktop environments. Both of these offer a more Windows-esque interface with a taskbar, launch menu, and system tray.

» Lubuntu is ideal for running on older machines, because it uses a modified version of the lightweight LXDE desktop environment, while still supporting Ubuntu software.

» Whichever distro you choose, take some time to read the official documentation to check the system requirements match that of your PC [**Image A**].

» Once this is done, you can then download the ISO file for your chosen Linux distro. You need a blank USB drive and a suitable image writing program, such as Rufus (https://rufus.ie/en/), to create a bootable install medium.

» One of the great perks of using Linux is that most versions enable you to boot the OS in live mode. This involves loading system files directly into RAM, so your hard drive isn't affected.

» This is an excellent way to check that your system hardware is supported. Once the Linux distro loads, try to connect to your wireless network (if applicable), as well as connect any peripherals to check they'll work with the OS.

» One of the reasons we've recommended Mint is that it supports proprietary software such as certain media codecs and the Windows NTFS filing system. It also has a built-in driver manager, which can detect and download non-free—that is, proprietary—drivers for certain hardware, such as Nvidia graphics cards.

» In order to boot the Linux install media, you may need to modify your UEFI/BIOS settings. If you have SecureBoot enabled, your PC may mistake the bootable flash drive for harmful software and prevent it from loading, so this may need to be disabled via the firmware settings, too.

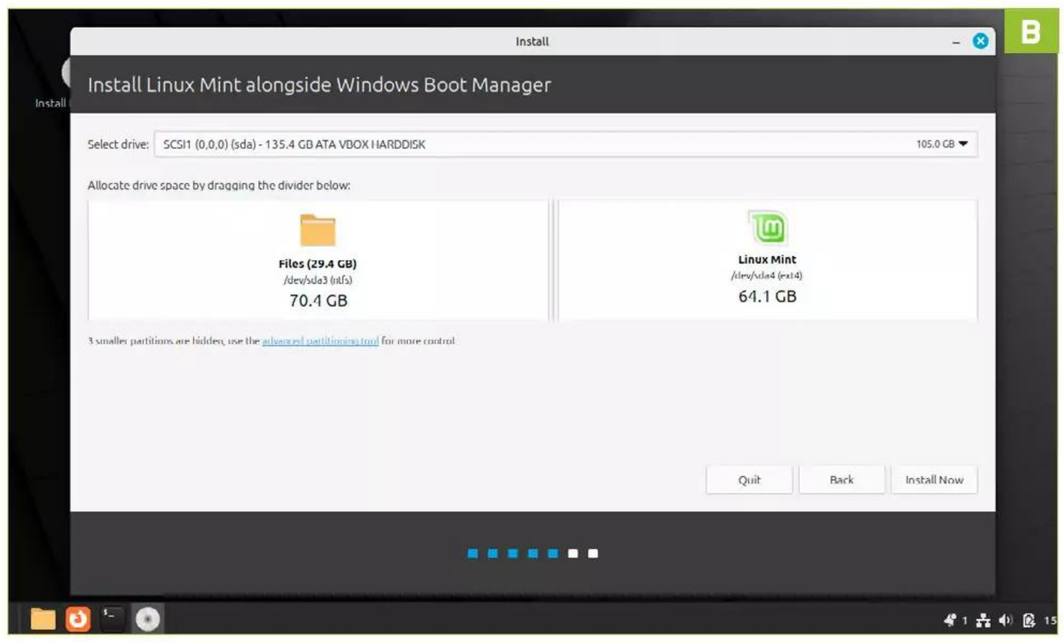
2 INSTALL LINUX ALONGSIDE WINDOWS

Most Linux distros support dual-booting with Windows 11. This keeps your files safe during installation. It also ensures you can still run Windows-only programs as necessary.

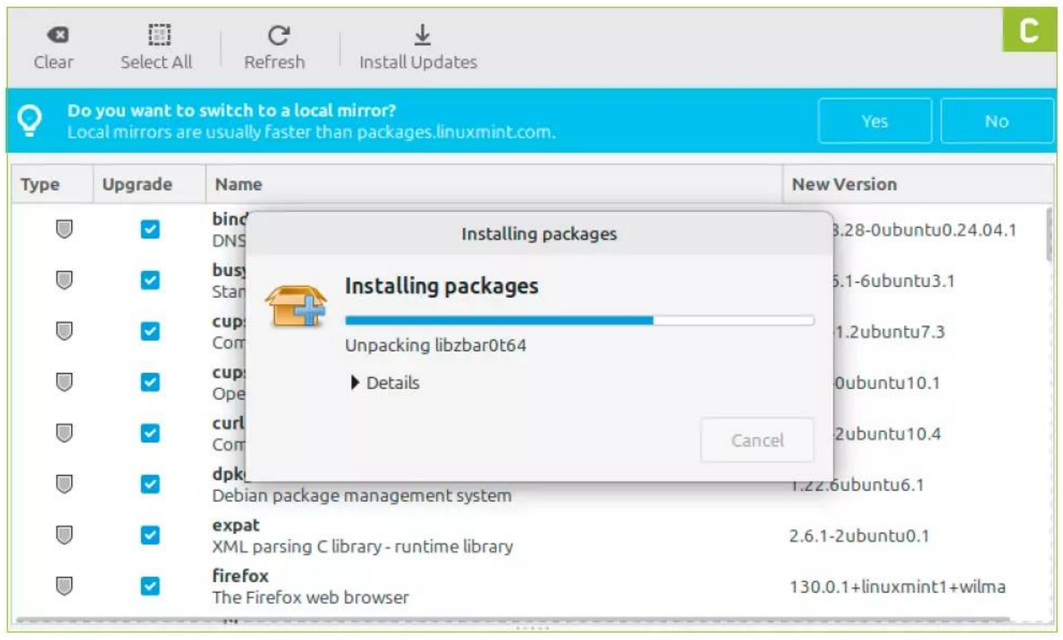
» Assuming you followed our recommendation for Linux Mint, the shortcut to the installer can be found on the live desktop.

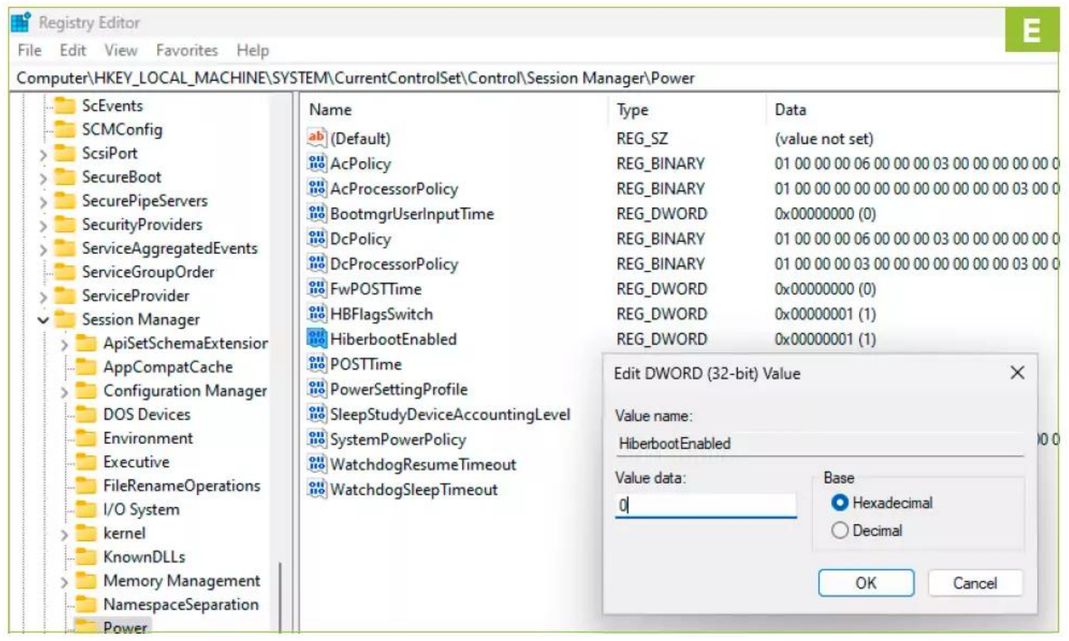
» The setup options such as language selection are very intuitive. Make sure to check 'Install multimedia codecs' to render all video formats and websites properly out of the box. The installer defaults to 'Install Linux Mint alongside Windows Boot Manager'.

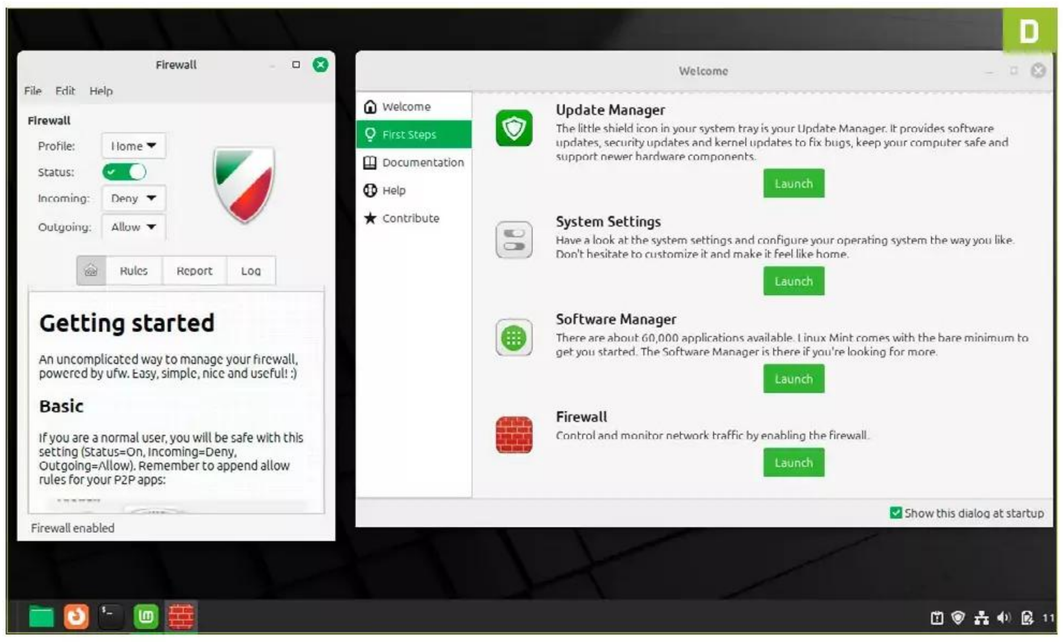
» With this selected, click 'Continue' to go to the next screen, where you can allocate drive space between the Windows and Linux partitions by clicking and dragging your mouse on the divider [**Image B**].

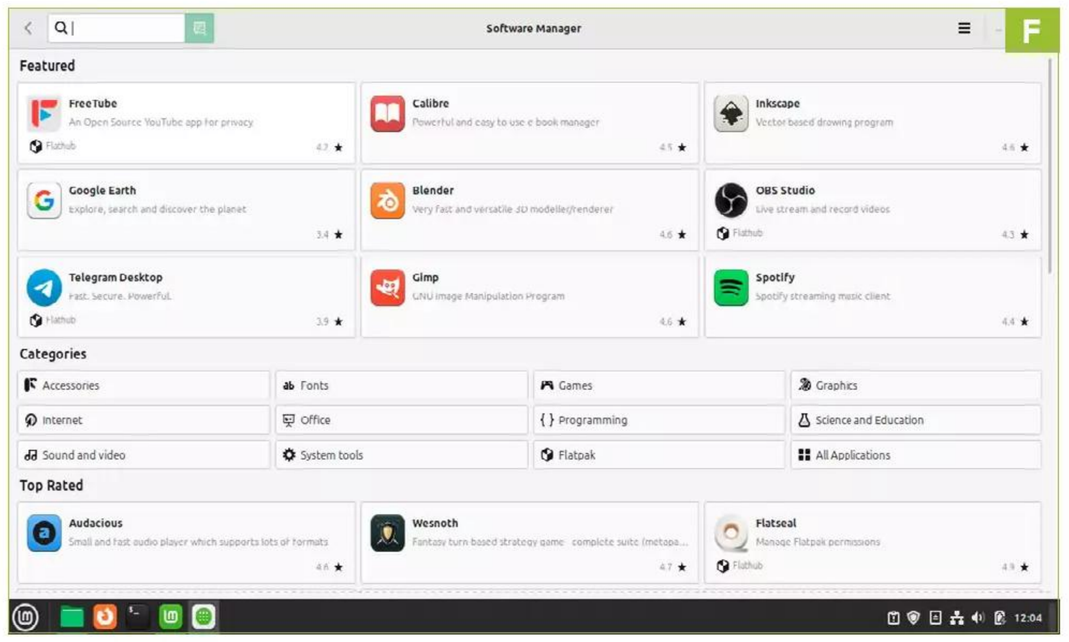


© NVIDIA









» You can then create a user account and password, and proceed with the install itself. Upon restarting the machine, the boot loader defaults to Linux but you can choose 'Windows Boot Manager' to load Windows 11 if you prefer.

» Upon login, Linux Mint displays a welcome screen. Start by clicking 'Launch' next to 'Driver Manager' to have the system check whether there are any proprietary drivers that might offer better performance.

» Next, click 'Launch' under 'Update Manager'. You're asked to enter your user password. Do so and then choose 'Install Updates' [**Image C**].

» Click 'Launch' under 'Firewall', then hit the rocker switch next to 'Status' to enable it [**Image D**].

» Restart your PC to apply updates, then click the folder icon at the bottom-left of the desktop. By default, this launches your 'Home' folder.

» If you want to copy across any content from Windows, you'll see the partitions listed under the 'Devices' section of the File Manager—for example, '70 GB Volume'. Click to mount the drive. You can now navigate to your user folder, such as '\Users\nate\OneDrive', to copy and paste any files to your Linux home folder.

» If you can't mount the Windows drive, this may be because you have FastBoot enabled. To fix this, restart into Windows 11 and open RegEdit. Navigate to 'HKEY_LOCAL_MACHINE\SYSTEM\CurrentControlSet\Control\Session Manager\Power'. Find 'HiberbootEnabled DWORD' and set it to '0' [**Image E**].

3 SOFTWARE SETUP

While Windows programs can't run natively in Linux, the OS has a number of open source alternatives.

» For instance, if you take the time to explore the 'Office' software category in the Mint Menu, you'll find the LibreOffice apps, which are a great alternative to Microsoft Office.

» The days of only downloading software packages via the Linux command line by entering painstaking commands are long gone. In Mint, for instance, you can launch the Software Manager [**Image F**] via the main menu to explore programs for download.

» These are also categorized. For instance, you can find the excellent VLC media player under the 'Sound and Video' category.

» Software centers in Linux usually only host open source software. For example, Mint's repositories offer the open Chromium browser but not the proprietary Google Chrome.

» If you want to install programs like these, you can visit the developer website to download the appropriate package for your system. (In the case of Mint, these are DEB packages, which are compatible with Debian and Ubuntu-based operating systems.)

» As you open new programs, the corresponding icon appears on the dock at the bottom of the screen. Right-click to pin or unpin apps as you see fit. You can also hold and drag to rearrange their order.

» If you need to access web apps such as Microsoft Exchange, these should operate in exactly the same way in a Linux browser as in Windows.

» For PC gamers, the Linux version of the Steam client also now has an option to run Windows games through Valve's Proton compatibility layer (the same as that used for the Steam Deck console). You can check www.protondb.com to see how well your chosen game works in Linux.

» If you do install the client, the 'Steam Play' feature should install the necessary components to let you download and play Windows games automatically.

» If this doesn't happen, go to 'Settings > Compatibility', and check 'Enable Steam Play for all other titles'. Use the drop-down menu to choose which version of Proton to deploy for this.

© MICROSOFT

Lock down your Wi-Fi network

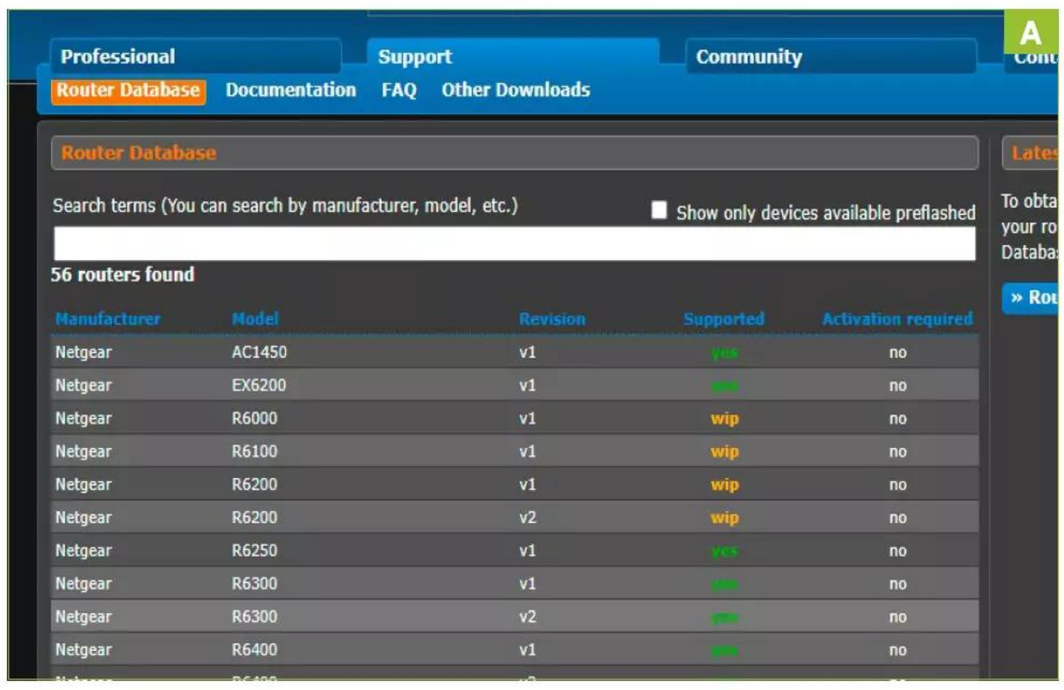
YOU'LL NEED THIS

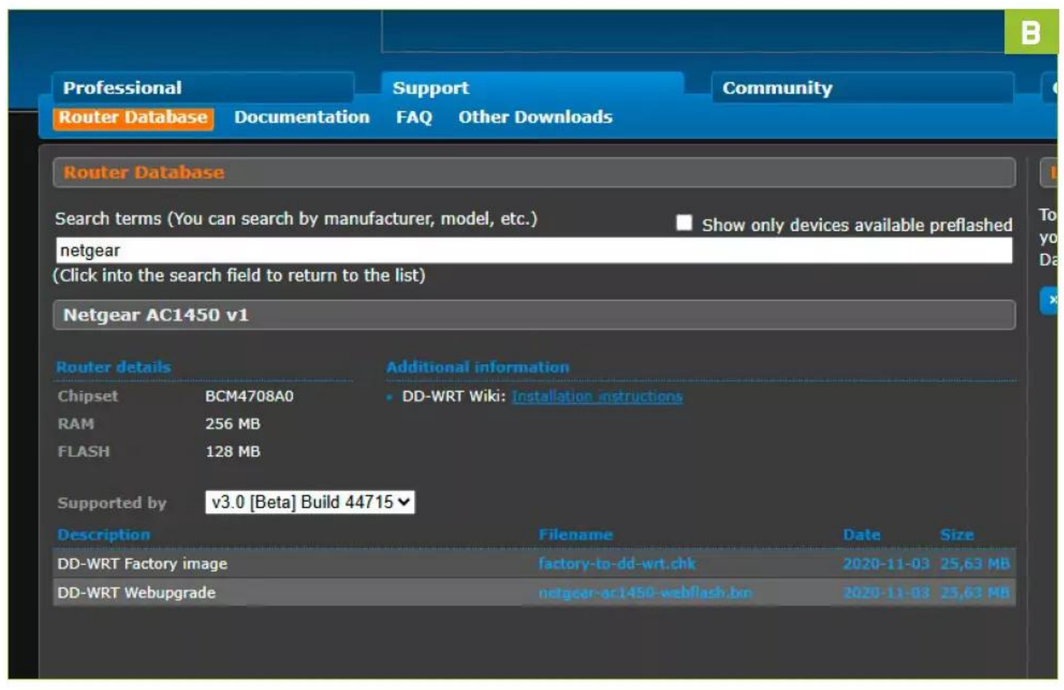
ROUTER
With installation media and open source firmware (both optional).

AT THE OUTBREAK of World War 1 in August 1914, a British cable ship severed Germany's undersea telegraph cables. This offered excellent intelligence opportunities by forcing the enemy to communicate over radio waves, which were much easier to intercept and decode.

Over a century later, the same holds true for wireless networks, which rely on radio waves to communicate with internet-enabled devices. Wi-Fi poses serious privacy and legal concerns.

Germany's *Störerhaftung* (Breach of Duty of Care) law can hold Wi-Fi providers responsible for any unlawful activity by connected users; the law was amended in 2017 to exempt Wi-Fi owners who'd taken reasonable precautions. Even if a your neighbor just "borrows" your Wi-Fi for lawful activities, this could seriously impede your download and upload speeds. In this guide, we explore ways to protect your Wi-Fi network from unauthorized use. **–NATE DRAKE**





1 FLASH YOUR FIRMWARE

The main issue with Wi-Fi security is that most people use the router supplied by their ISP. Many ship with default passwords, which admins never change.

» In 2018, security analyst Harrison Sand found admin passwords being sent unencrypted from his router. His ISP was also monitoring the devices connected to his LAN.

» ISPs also sometimes modify routers' firmware so you can't configure them properly. For instance, the DNS settings of certain types of BT routers in the UK can't be modified.

» This can also affect your ability to upgrade the router firmware, assuming updates are available.

» Luckily, there's an alternative to outdated and restricted stock firmware. Open source alternatives such as DD-WRT and OpenWrt are under constant development and contain a number of security features.

» To get started, check if your specific model is supported by your chosen firmware—for example, via the DD-WRT database (https://dd-wrt.com/support/router-database/) [**Image A**].

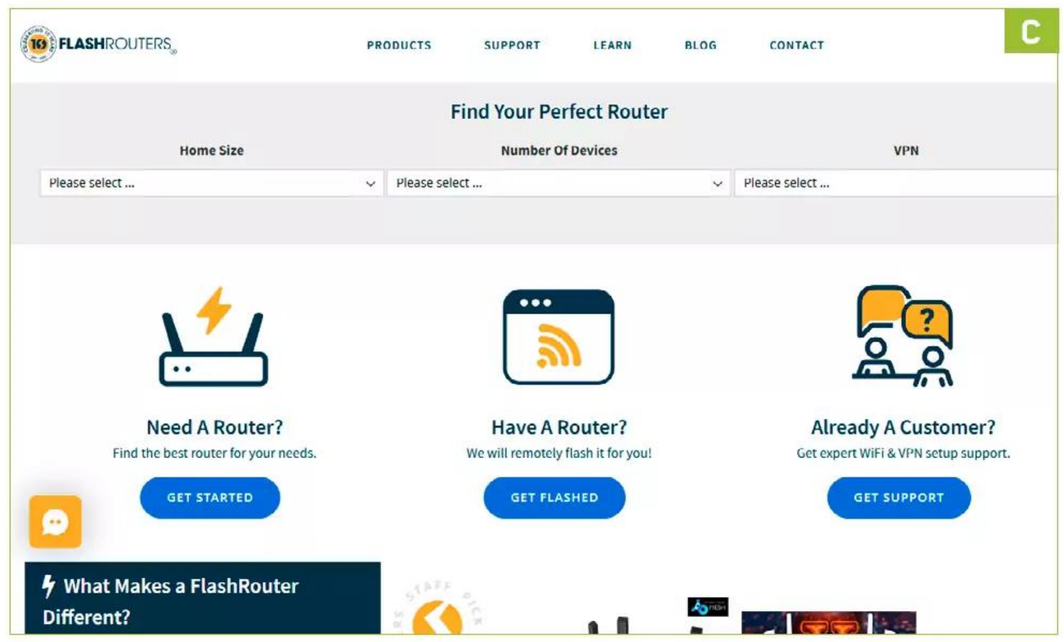
» The specific steps you need to take depend on your particular router. Generally, this involves inserting a USB stick with a file into your router, then using the web interface to perform a firmware upgrade.

» If you're still running the OEM version of firmware on an old router (usually with 2MB flash), you may need to run a "kill" firmware program file first. In the case of DD-WRT, you can find specific installation instructions on the page for your router model [**Image B**].

» Whichever firmware you choose, the site cautions that improperly upgrading the firmware will "brick" it. If you're concerned about turning your router into an expensive paperweight, retailers such as Flash Routers sell devices with open source firmware, such as OpenWrt, pre-installed [**Image C**].

» If your ISP router is incompatible with open source firmware, check via the web interface whether bridge mode is supported. If so, enable this to have the ISP router function effectively as a modem only.

» You can then connect a router with open source firmware to one of the ISP router's Ethernet ports. It can then handle all routing, firewall, and Wi-Fi functionality.



©OPENWRT, FLASH ROUTERS

2 CONFIGURE YOUR WIRELESS NETWORK

Once your router is up and running, check the manufacturer's website to discover the address for the web interface—for example, http://192.168.1.1.

» The first step you can take to hugely improve your router security is to disable WPS (Wi-Fi Protected Setup). In theory, it offers an easy way to connect devices through a numeric PIN (usually eight digits).

» In practice, this makes it easy for attackers to brute force the PIN in seconds using programs such as Reaver.

» The steps to disable WPS vary. For instance, on the Belkin N300 Wi-Fi N router, you can select 'Wi-Fi Protected Setup' from the left-hand pane, then change the 'WPS' drop-down menu to 'Disabled'. If you're using a DD-WRT router, you can skip this step, because WPS is disabled by default.

» By default, most routers use an SSID that identifies the model—for example, "belkin.b72." This can provide clues to attackers about which exploits to try. Instead, use a random dictionary word, such as "crocodile" [**Image D**].

» You can choose not to broadcast the SSID, but hackers can use specialist tools such as inSSIDer to check for hidden Wi-Fi networks. Devices that have previously connected also constantly try to ping the hidden network, which can also be detected.

» Most routers also have a dedicated Wi-Fi security page. For instance in DD-WRT, you can go to 'Wireless > Wireless Security'.

» For home networks, you get the strongest security if you only enable WPA3 Personal (SAE). This stands for Simultaneous Authentication of Equals, and provides a much more secure password-based authentication and key agreement mechanism that's resistant to brute force attacks.

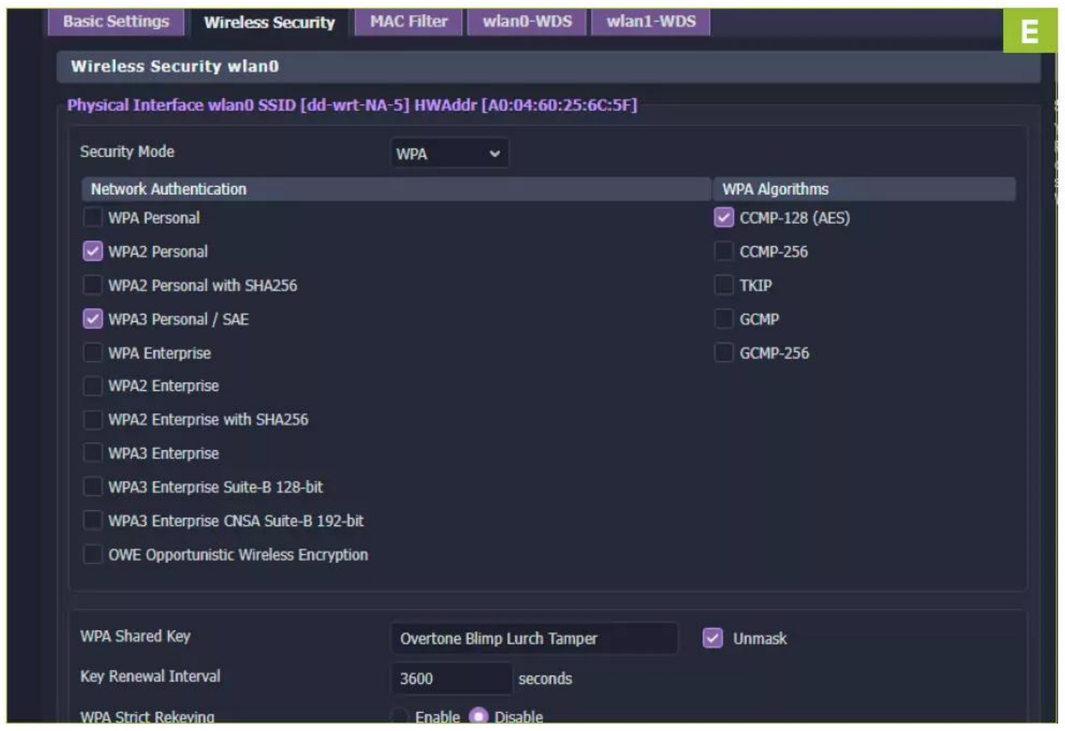
» To receive the full security benefits, all your connected devices need to be both WPA3 and Wi-Fi 6 (802.11ax) compatible. Most routers also support WPA2/WPA3 Transitional, which allows older devices to connect via WPA2-AES instead. Make sure to disable TKIP, WEP, WPA, and any other outdated protocols.

» While you're here, set a new, strong WPA Shared Key using at least four random dictionary words from Diceware (https://diceware.dmuth.org) [**Image E**].

3 SET UP YOUR VPN

While disabling outdated features and using WPA3 hugely increase your network security, internet traffic leaving your router can still be monitored by anyone with access to your ISP's records. You can boost all Wi-Fi users' online security by setting up a VPN connection. This ensures all traffic between your router and the VPN server is encrypted.

» Not all routers support this feature. Those that do may only use outdated protocols such as PPTP (Point-to-Point Tunneling Protocol), which has serious security flaws.



» If you want to do this, use a router that supports OpenVPN. Your provider can then provide you with the necessary configuration (OVPN) files and credentials to connect.

» Once you have these, the steps you take next depend on your firmware. If you've installed DD-WRT, you can find VPN settings under the 'Services' tab. You can then enable the OpenVPN client.

» From here, you can scroll down to 'Import Configuration' to select the OVPN configuration file if available. Alternatively, you can manually paste in information such as the Public Client Certificate and Private Client Key.

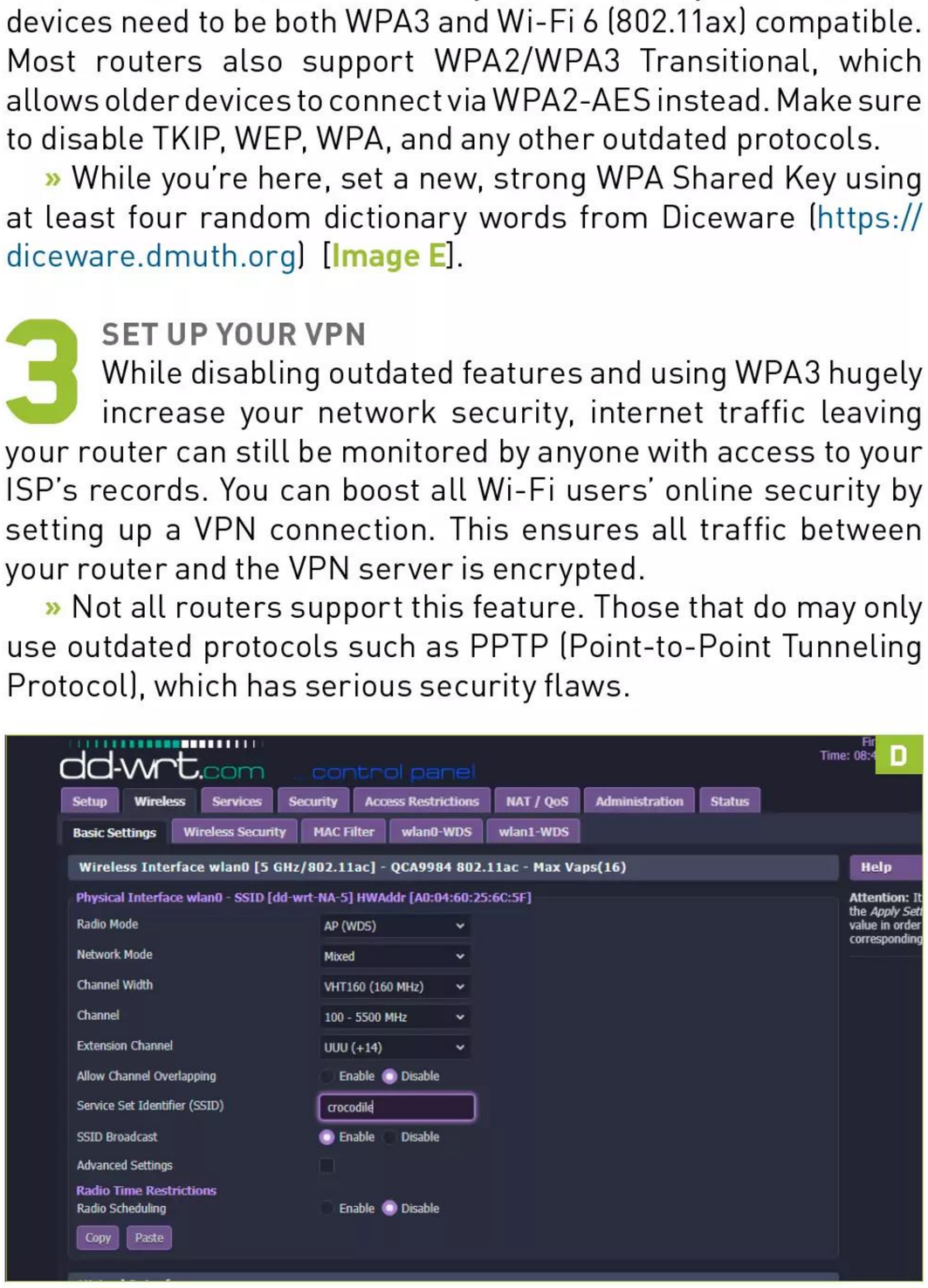
» Most VPN providers also supply a username and password, which you can enter in DD-WRT by enabling 'User Pass Authentication'.

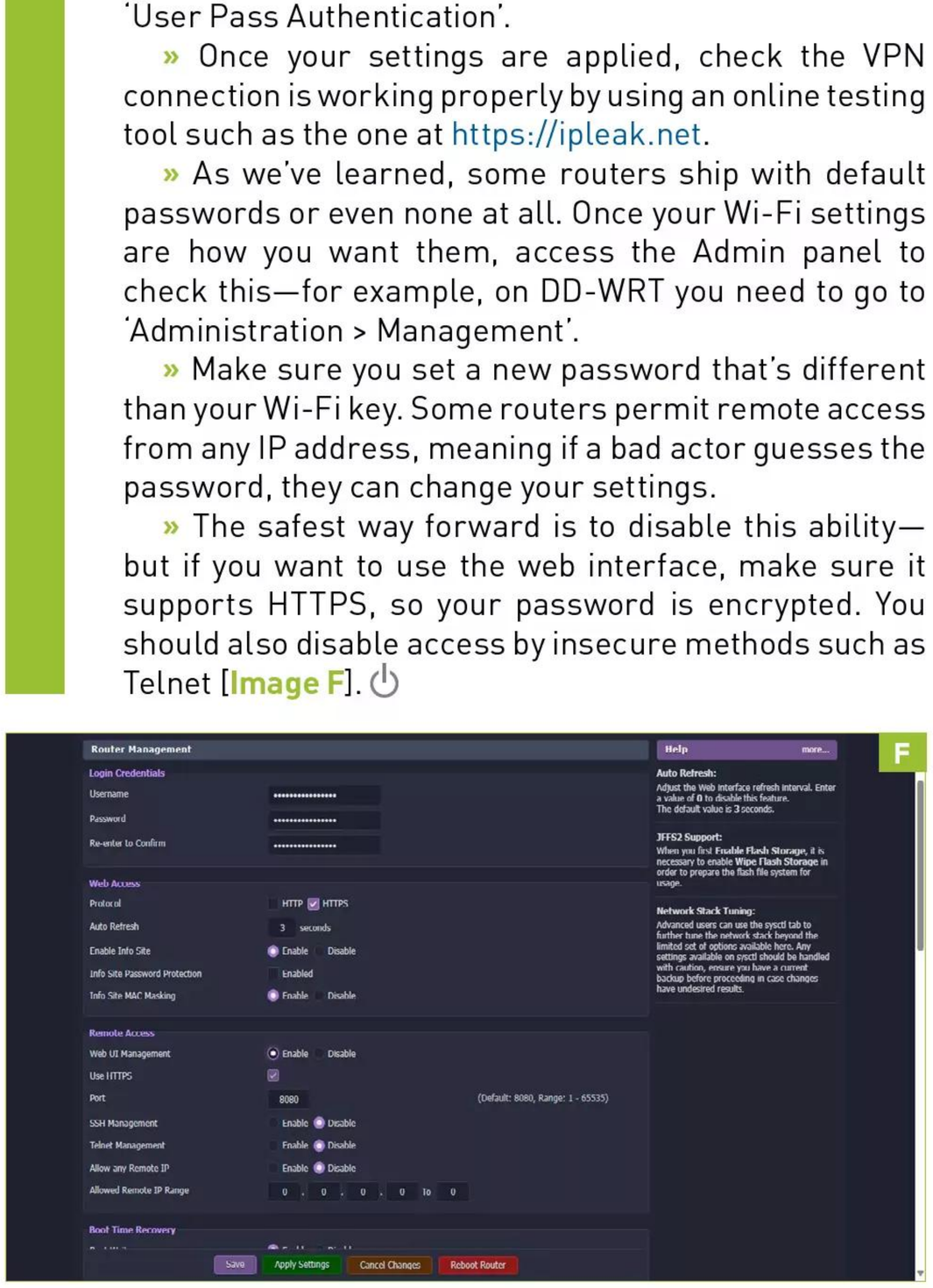
» Once your settings are applied, check the VPN connection is working properly by using an online testing tool such as the one at https://ipleak.net.

» As we've learned, some routers ship with default passwords or even none at all. Once your Wi-Fi settings are how you want them, access the Admin panel to check this—for example, on DD-WRT you need to go to 'Administration > Management'.

» Make sure you set a new password that's different than your Wi-Fi key. Some routers permit remote access from any IP address, meaning if a bad actor guesses the password, they can change your settings.

» The safest way forward is to disable this ability—but if you want to use the web interface, make sure it supports HTTPS, so your password is encrypted. You should also disable access by insecure methods such as Telnet [**Image F**].





LAB NOTES

ZAK STOREY, CONTRIBUTOR



Snapdragon is coming for you

A third player enters the game

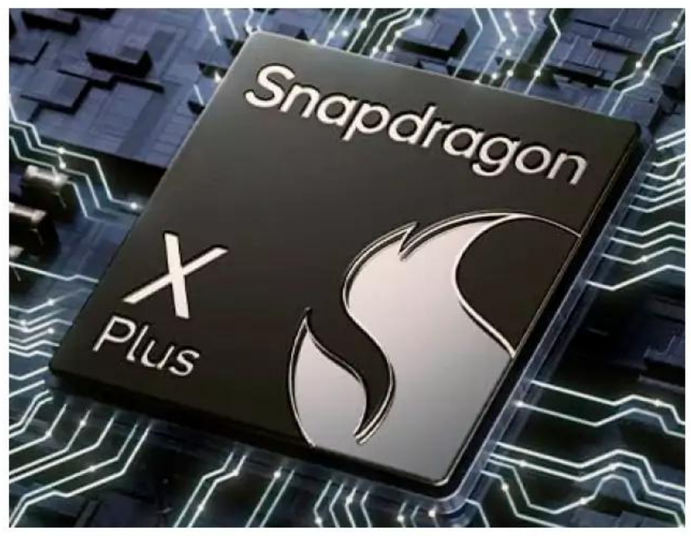
OH MAN, AM I EXCITED. With Intel currently lagging slightly, and AMD's range of 9000 series chips being mildly underwhelming, Qualcomm's unofficial announcement, courtesy of CEO Cristiano Amon, stating that it's targeting the high-end desktop PC fills me with joy.

Right now, my daily driver laptop is anything with a Snapdragon chip. The difference is astounding. Performance is identical to, if not better than, every other laptop I've tested. Plus, the battery life is insane, going from four to six hours all the way up to 11 or 12 hours of video streaming.

Back in October 2020, Neil Mohr, head honcho at *Linux Format*, wrote a fantastic feature for us on why Apple ditched Intel for Arm in its laptop chips. This was the rise of the M1 MacBooks. Time and time again, Arm chips were improving on their IPC and general performance by 50, 100, sometimes 200 percent and above every year. And the trend continues to this day.

In its heyday, X86 saw such leaps. It was a big reason why Moore's Law seemed so tantamount. Yet over time, as the physical limitations and diminishing returns set in, x86 improvements seemingly slowed down. Its major advancements now lie in adding more specialized processing hardware, optimized for certain tasks, such as Tensor cores, NPUs, and ray-tracing cores.

Conversely, Arm and Risc-V are still very much a developing tech, still seeing large performance boosts gen-on-gen, even at such low transistor sizes. Performance per watt, they're generally second to none. If that trend continues, there may come a time where Arm becomes the dominant force in computing, period. Particularly if it increases the size, voltage, and stability of its chips. Imagine a full-sized desktop processor, with a heatsink on top, and it quickly becomes quite scary.



Snapping at the heels of the big two.

The big battle's going to be software compatibility. That's one domain where X86 has the advantage. Arm can emulate software, and do it well, but will it be enough to give it an edge over Intel and AMD?



JEREMY LAIRD

Contributor

I've just taken Sony's new INZONE M10S monitor for a spin, and it makes no sense. We're dealing with a 27-inch, 1440p screen for $1,100. Yes, really. Now, the M10S is a very nice monitor with an exceptionally slick stand. But it's only 27 inches and 1440p.

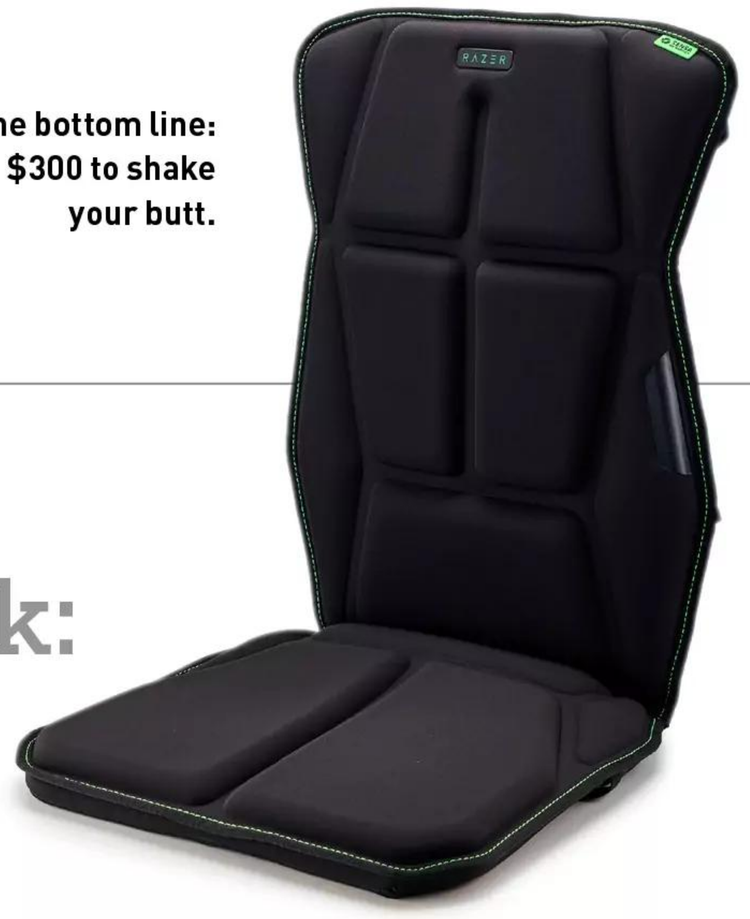
Yes, it's OLED. Yes, it runs at 480Hz. But for this kind of money, you can have a 32-inch 4K OLED. In fact, you can have a 32-inch 4K OLED with a alternate 1080p mode that hits the same 480Hz as the M10S. Heck, for $200 less, you can have Gigabyte's version of the Samsung's 49-inch ultrawide OLED. Twice the monitor for less money.

Maybe I've got this wrong and gamers will be queuing up to unload four figures on a smallish screen with an unexciting resolution that limits its usefulness for non-gaming tasks. But, personally, I see 1440p as very much mainstream gaming these days, not aspirational. And that makes the $1,100 price tag a completely baffling amount of money to spend on a monitor offering such an ordinary form factor.

Of course, Sony isn't alone in setting ludicrously high pricing for a 27-inch 1440p OLED panel. But it is one of the worst offenders, and the M10S arrives just as other brands like MSI are beginning to introduce OLED monitors at lower prices. So, I hope the M10S is an outlier that Sony will rapidly rethink, rather than a sign of things to come.

© QUALCOMM

The bottom line:
$300 to shake your butt.



Editor's Pick: Razer Freyja

New haptic cushion lets you feel PC games in your butt



AT CES in Las Vegas in January, I went to a hotel suite to sit on a padded chair cushion that Razer had dubbed "Project Esther" (see March 2024 issue, page 33). The mat was covered in haptic motors that would either interpret the sound from games, movies, and music to provide pleasing if slightly generic rumbles, or if game makers provided specific coding to send to the chair, very accurate physical cues of what was happening in the game, such as where shots were coming from.

Well, 10 months later, the retail version of the device is out, and in Razer's traditionally esoteric naming fashion, it has called it "Freyja". It has fewer motors than the concept device (six padded regions, each with a motor embedded within it), but at $299, it's expensive without being ridiculous, as some Razer launches can be. Of course, the ideal would be a chair that has all of these motors built in, which may well come, as long as Freyja is a success, of course.

Freyja can be loaded on to a Razer gaming chair (or one with a similar design), and is held on with a couple of adjustable straps. Once we sunk back into the chair, we experienced demos including *Final Fantasy XVI*, where every sword strike has a distinct-feeling vibration that runs through the chair. It's difficult to describe, but it does genuinely feel like you're swinging a giant battle axe, with a pinpoint-accurate slice occurring up your back. This is especially noticeable when you crank the power up to max, as we did in the Razer Synapse 4 app during this demo.

Final Fantasy's developers have specifically coded support into the game and tied it to certain actions. *Hogwarts Legacy* was another game we tried, where magic spells produced what can only be described as a satisfying rumble up our backside (we're not weird, we promise). Other games that we didn't get to try included the new *Silent Hill 2* remake (read our review on page 90), as well as *Snowrunner*. We're told support for future games will be made easier by an Unreal Engine 5 plugin. Though that's still relying on developers to support the thing, even if it's as easy as checking a box in UE5.

If specific support for Freyja doesn't happen for a particular game you play a lot, the haptics can also be set to respond to in-game sounds instead. It's not ideal, and I was left thinking it's a feature I'd turn off when playing games that don't offer bespoke support, or in certain genres, such as cozy games. I have to say, though, it was quite fun listening to bass-heavy music such as dance or rap while sitting in the chair, although again, I can't see myself using it when I listen to music at my desk while I'm working, as I don't want to attract strange looks from my colleagues.

I think one of the best uses for Freyja will be in racing sim setups, where the precise rumble locations should actually help your driving, as well as make things more immersive. We're not aware of any racing sims offering support as yet, although *Snowrunner* could be fun. I wasn't left feeling like I'd want to go home and drop the $300 required to own a Freyja for myself, although I will be watching to see how many games support it over the coming year.

For those who love PC gaming and want to show off a level of immersion that's just not possible on other systems, it's a great way to impress your friends. **–GC**

$299, www.razer.com

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Reviewed...



74 AMD Ryzen 9 9900X



76 Asus ROG Strix X870E-E Gaming WiFi

78 Surface Laptop 7

80 LG UltraGear 32GS95UE



82 NZXT H5 Flow RGB (2024)

84 Acer Swift Go 14

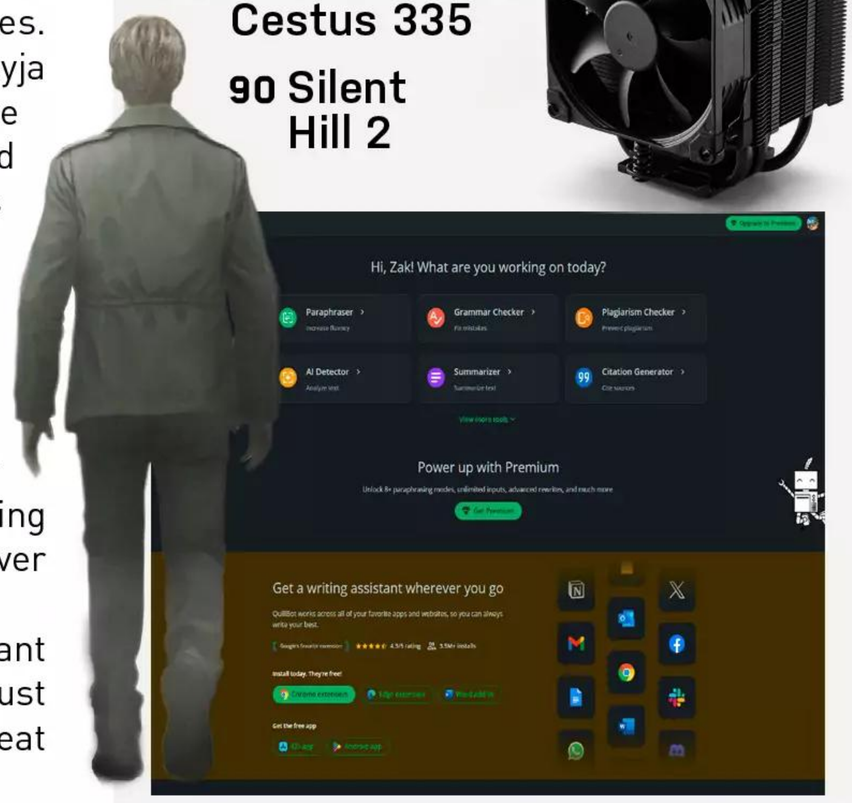
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AMD's 9th gen chips just aren't that exciting.

AMD Ryzen 9 9900X

Evolutionary advancements, but little else

THE CURIOUS CASE of the 9000 series chips. That's what we should call AMD's latest processor launch, because, boy, are these things underwhelming. OK, that's not entirely fair—they are still good processors on the surface—but you have to look at them in a specific light. There are a lot of similarities between how AMD has marketed these chips and how Nvidia launched its RTX 4080 Super card.

What do we mean? Well, on the surface, there's not a whole lot of change here. The architecture has shifted to TSMC's N4 FinFET manufacturing process, down from N5 (theoretically 4nm now), but the I/O is still running on N6. Similarly, clock speeds are close to identical, with the max boost on both topping out at 5.6GHz. The core clock actually dropped to 4.4GHz on the 9900X. Total L3 cache is the same as well, with the only slight tweak being an increase to L1 cache (going from 32KB to 48KB)—not exactly revolutionary. And core and thread counts remain the same.

The big changes come in the form of the TDP and, sadly, pricing—at least, sort of on that last front. Overall power draw has dropped from a rated TDP of 170W down to 120W—that's a fairly substantial 29.4 percent drop on power draw, but perhaps bizarrely it doesn't transfer over particularly well in the benchmarks. The other change is on the pricing front. The 7900X launched at $550, whereas the 9900X lands at $500 total, so again, a slight drop here as well. That's appreciated, sure, but it's not a huge difference—less than 10 percent—and price drops in general have always felt like an overshadowed marketing choice at this level.

In isolation, it's a good chip. Those 12 cores and 24 threads deliver some serious performance—AMD's Granite Ridge architecture has some impressive brute strength in the single-core CPU domain, far outstripping Intel and AMD's own previous generation in the single-core tests, with similar performance across Geekbench as well. On the whole, multicore scores have gone up by around 10 percent as well. Factor in that price cut, and comparatively it's a 22 percent boost from a performance-to-price perspective. At least, if last-gen's AMD chips had remained at their retail pricing, which they haven't.

It's that last element that's the issue. Let's be clear: The 9900X launched at $500. It's now dropped in price—at the time of writing, it's $440. The Ryzen 9 7900X, though, launched at $550, and is now available for $320—that's an absolutely insane drop, and makes the older chip phenomenally good value. If you compare the two, from a dollar to fps or index perspective, on every front the 7900X dominates the 9900X. And unless stock dwindles down to nothing, that's not likely to change anytime soon either.

Power draw tweaks equally aren't quite as exciting as we would hope. Under load in our test bed, the two systems were within 10W of each other, with the 9900X surprisingly pulling more. There was, however, a 30W difference at idle, with the 9th gen coming out on top, but again, it's just not enough to really make it particularly appetizing.

From a generational standpoint, if you're on 7th gen and you're considering jumping on board the 9000 series hype train, we definitely advise against it. It's just not worth it unless you're going from a Ryzen 5 to a Ryzen 9. This very much feels like an old Intel launch—a good effort, but some slight idle power savings and a 10 percent performance boost with some pricing tweaks doesn't exactly fill us with glee. **–ZAK STOREY**

BENCHMARKS

	AMD Ryzen 9 9900X	AMD Ryzen 9 7900X	Intel Core i9-14900K
Cinebench 2024 Multicore (Index)	1,732	1,585	**1,923**
Cinebench 2024 Single-Core (Index)	**136**	117	125
Geekbench 6.3 Multicore (Index)	**20,108**	18,030	20,016
Geekbench 6.3 Single-core (Index)	**3,375**	2,988	2,997
Cyberpunk 2077 DLSS @ 1080p (avg fps)	**214**	208	202
Far Cry 6 @ 1080p (avg fps)	159	139	**171**
Total War: Warhammer 3 @ 1080p (avg fps)	**196**	191	161
3D Mark Speed Way (Index)	7,419	**7,449**	7,246
3D Mark Steel Nomad (Index)	**6,638**	6,553	6,541
3D Mark Night Raid (Index)	92,431	84,925	**95,238**
UL Procyon Computer Vision: ML CPU (Index)	**78**	57	50
UL Procyon Computer Vision: ML GPU (Index)	**2,269**	2,155	1,902
Max CPU Temp (C)	**89**	95	100
Max Power Draw (W)	554.3	**543.7**	618.2

Best scores in bold. Our AMD test bed consists of an Asus ROG Strix X870E-E Gaming Wi-Fi Motherboard, and 32GB of Lexar Thor OC DDR5 @ 6000 C32, and an Nvidia GeForce RTX 4080 Super, along with a 2TB Crucial T705 M.2 PCIe 5.0 SSD. Our Intel test system consists of the above, swapping the motherboard for an Asus ROG Maximus Z790 Dark Hero.

VERDICT **7**

AMD Ryzen 9 9900X

+ ALL THE NANOMETERS Solid all-around performance; power savings at the low end; OK bump in performance overall.

– NO IPC Underwhelming boost compared to last gen; pricing cannot match 7000 series price drop.

$500, www.amd.com

SPECIFICATIONS

Cores	12
Threads	24
L3 cache	64MB
L2 cache	12MB
Unlocked	Yes
Max PCIe lanes	24 usable
Graphics	AMD Radeon Graphics
Memory support (up to)	DDR5 5600
TDP	120W

Asus ROG Strix X870E-E Gaming WiFi

A connectivity goliath that looks beautiful to boot

YEAH, WE'RE A LONG WAY from the days of simple motherboard designs, aren't we? This thing is absolutely dripping with premium-feeling design touches to really make it pop. Pixelated ROG logo carved on the side? Check. Numerous "armor" plates, complete with M.2 heatsinks? Check. Simple and sophisticated RGB lighting solution? Also check. Honestly, though, this thing is more than just good looks—it's an absolute powerhouse of connectivity, and ironically, in our line of work, it makes things a heck of a lot easier.

But before all of that, let's discuss X870 versus X670 for a second. Or, to be precise, the "E" variant. For those uninitiated to the world of crazy CPU manufacturer nomenclature upgrade paths, the E variants include more PCIe lanes, and typically feature greater support for PCIe 5.0 lanes, too. Generally speaking, that's a big part of why the boards are as expensive as they are, at least for the E variants. The X670 boards, for instance, only support eight PCIe 5.0 lanes, versus the X670E's 24, and four of those are reserved for the CPU directly, with the remaining four going to the M.2—the boards themselves only support GPUs up to PCIe 4.0.

In the case of the X870 and X870E, it's a little trickier, because the number of 5.0 lanes supported is the same for both, but the number of total PCIe lanes increases from 36 to 44 respectively (including 4.0 and any chipset-related connectivity). Still following? That's good, because we're completely lost as to why this was entirely necessary.

The difference between X870E and X670E, however, is far more nuanced. Both chipsets support 44 lanes in total and 24 PCIe 5.0 lanes, but X870E has a slight advantage, because its USB support now bumps up to USB 4, pumping out 40Gb/s on those ports. Oh, and there's Wi-Fi 7 as well, for devices that support it. And, er, that's it. Yep...

Still, a new chip launch demands a new generation of motherboards, and Asus certainly has delivered, taking advantage of that 5.0 connectivity. At the top of the board, there's a total of three PCIe 5.0 M.2 slots. Two of those are hidden under a massive secure heatsink at the top-left, and the one on the bottom-right is almost hot-swappable. A little tab pops off the heatsink, then a push tab underneath secures your M.2s in place. We've been testing a lot of SSDs lately, and this thing has made that process an absolute doddle. If you're looking for a board for super-snappy backups, or fancy swapping out cheap M.2s for storage solutions in a similar vein, this thing is super-convenient. Turn off your PC, pop your case side panel off, slide in the new SSD, heatsink back on, window in, power back online, and wham, you've swapped out an M.2 in just a couple of minutes.

Other connectivity is solid, too. There's Wi-Fi 7, along with 5Gb Ethernet, and a whole host of USB 4 ports, too, with 4x USB Type C as well. It's not cheap, sliding in at just shy of $500, but with all these features at its disposal, this board seriously punches.

We've taken some performance numbers (this is the board behind all our AMD Ryzen 9 7900X and 9900X testing on page 74, along with last issue's build), but we can't tell you how it behaves compared to the competition just yet, other than "it's good," because it's the only X870E board we've tested so far. Still, first impressions are solid, and Asus has been quick on the uptake for new AGESA updates, too, minimizing latency issues, and improving general gaming performance.

This board is without a doubt a long-term investment. The one big positive is that we know AMD will be supporting AM5 up to 2027; so it'll be at least two major CPU generations before the AM5 boards give up the ghost. If you're looking for premium connectivity, plenty of style, and slick performance, plus have the cash to spare, this is it, chief. **–ZAK STOREY**

VERDICT **9** KICK ASS!

Asus ROG Strix X870E-E Gaming WiFi

+ NCC-1701-E Phenomenal connectivity; outstanding aesthetics; solid performance; good BIOS updates so far.

– E-E-E-E-E-E-E-E Price still quite high.

$500, www.asus.com

SPECIFICATIONS

Chipset/socket	X870E/AM5
Max memory support	192GB DDR5 @ 8000+
Storage support	5x M.2 slots (3x 5.0x4 and 1x 4.0x4), 4x SATA 6Gb/s
PCIe support	1x PCIe 5.0 x16, 1x PCIe 4.0 x16
Form factor	E-ATX, 12 x 10.9 inches
Rear I/O	2x USB 4 (40Gb/s) ports (2x USB Type-C), 1x USB 20Gb/s port (1x USB Type-C with up to 30W PD fast-charge), 10x USB 10Gb/s ports (9x Type-A + 1x USB Type-C), 1x HDMI 2.1, Wi-Fi 7, Bluetooth 5.4, 1x Realtek 5Gb Ethernet Port, 2 audio jacks + optical S/PDIF out, BIOS FlashBack, clear CMOS



Asus really has nailed the premium aesthetic on this thing.

You can charge it through USB-C, which makes the Surface Connect port even more baffling.

Surface Laptop 7

Snapdragon and Copilot+ in a business suit



MICROSOFT KNOWS how to make a good portable machine, but the Surface Laptop often pales against the funkier Surface Pro tablets. This latest iteration, which brings with it the Snapdragon X Elite processor and the Copilot+ designation, is far from boring. Sure, the keyboard may not detach to enable you to use it like the kind of slate popularized by Apple, but this remains a fine laptop that helps show off the potential of this exciting new processor.

There's one thing in particular that lets the Surface Laptop—and so far all Copilot+ machines—down. And that's the GPU. While a lot of work and marketing budget has gone into supporting the Hexagon NPU, which puts out the 45TOPS necessary for that Copilot+ badge and means your AI workloads aren't shunted off to the cloud, the graphics capability of the Snapdragon X lite chipset is way behind. It posts a score in 3DMark's Time Spy test three times lower than that of an Nvidia GeForce RTX 3050 laptop GPU, and the integrated graphics in Intel's Core i9-13900H beat it, too. Not to be unfair to the Snapdragon—it's not a gaming laptop and nor is it a gaming chipset (when asked about gaming, MS told us to stream using the Xbox app)—it does very well in CPU-based tests, the 12 ARM cores putting it ahead of Apple's eight-core M3 chip from the MacBook Air in multicore benchmarks, although it's a bit slower in single-core tasks.

There's another problem, too, and that's software support. Windows runs very well on Snapdragon, and so do most other things, including Office and web browsers. Microsoft has a software translation layer—Prism—to smooth the transition while software houses catch up, but if you're a user of Adobe's Creative Cloud, you may find some apps unavailable to install, including Lightroom Classic (cloud-based Lightroom is available) and Premiere Pro. We also had trouble using Adobe Camera Raw, which triggered an infuriating and non-specific error message. This will change, and in a year or even a few months, you'll have access to all the software you need on Snapdragon. It's just a little jarring when you're coming from the universal compatibility and wide application selection available on X86 chips.

Elsewhere, this is, of course, a Copilot+ PC, so you get a load of AI. There are the usual chatbots and image generators, which are of variable utility depending on how easily amused you are, though the way image creation has been integrated into Paint—you draw something crude and the system creates a more refined version for you with the help of a text prompt—is very clever. There's the ability to add live subtitles to videos, which is nice, though the Recall feature, which stores all your activity on the PC for later searching, and which has given the more privacy-minded conniptions, is at the time of writing still a Windows Insider feature you can install if you want.

There's a lot that's good in the Surface Laptop 7. The touchscreen is nice and bright, the battery life is very good and will last you all day or more, and the build quality is excellent—though Microsoft's continued use of the Surface Connect port instead of a potentially more useful third USB-C is puzzling. Software updates can and will fix the worst of any compatibility issues, though some unupdated apps will naturally fall by the wayside, and as a first-generation Copilot+ product, it does well to showcase the new tech. As with all early products, you might do well to hang back and see what the second gen brings, but if this is the shape of laptops to come, it's not that different from the old ones. **–IAN EVENDEN**

VERDICT

8

Surface Laptop 7

+ SURFACE A well-made laptop with a good screen and an all-day battery.

– DEPTHS Software support needs to catch up; Copilot+ can be underwhelming.

$1,000, www.microsoft.com

SPECIFICATIONS

CPU	Qualcomm Snapdragon X Elite (12-core)
Graphics	Adreno integrated (4.6TFLOPS)
NPU	Qualcomm Hexagon (45TOPS)
RAM	32GB LPDDR5x
Screen size	15-inch
Resolution	2,496x1,664 (3:2 aspect ratio)
Refresh rate	Variable, 120Hz max
Storage	1TB SSD, MicroSD
Connectivity	Wi-Fi 7, Bluetooth 5.4, 2x USB 4 Type-C, 1x USB 3.1 Type-A, Surface Connect, 3.5mm audio
Dimensions	13 x 9.5 x 0.7 inches
Weight	3.65lb

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LG's take on the 4K OLED thing isn't cheap, but it is stellar.

LG UltraGear 32GS95UE

The new king of 4K OLED gaming monitors, for now...



THE NEW LG UltraGear 32GS95UE is not perfect. But it does a pretty comprehensive job of blowing every existing 32-inch 4K gaming monitor based on Samsung's QD-OLED panel tech into last month. Wait, make that last year.

The thing is, LG's take on the high-refresh 4K OLED gaming monitor riff isn't on a totally different level from those QD-OLED panels. In fact, it's very similar. But it is undeniably and unambiguously, even if ultimately pretty marginally, better.

On paper, the UltraGear 32GS95UE is very similar to the likes of the Alienware 32 AW3225QF or Asus ROG Swift OLED PG32UCDM. Whether it's the 32-inch panel size, 4K native resolution, 240Hz refresh, or 0.03ms response, LG's OLED monitor looks like a dead ringer for those Samsung QD-OLED-based panels.

Heck, even the 250 nit full-screen brightness is the same. But this 32-inch 4K beauty has something none of the Samsung-powered competition offers: Dual Mode functionality, which involves pixel doubling to run as a native 1080p but with an incredibly fast 480Hz refresh rate.

The idea is to provide the best of both worlds. You get both full 4K capability for ultra-sharp and detailed image quality in games, and which benefits things like font rendering day to day, plus the ability to run 1080p at sky-high frame rates and ultra-low latency, but with no need to interpolate a 1080p image over a 4K panel.

Other highlights include 98.5 percent coverage of the DCI-P3 digital cinema color space, Nvidia G-Sync compatibility, DisplayHDR True Black 400 certification, plus HDMI and DisplayPort connectivity, along with a USB-A hub. In fact, the only notable omission is a USB-C port.

What, then, of image quality? First, this LG doesn't suffer from the slightly warm color balance of those other 4K QD-OLED monitors. Second, it doesn't turn slightly gray in bright ambient light, marginally detracting from contrast performance and black levels. Third, it does that while matching if not bettering the QD-OLED competition for full-screen brightness.

It may not seem like an overwhelming roll call of advantages, but we're talking about very expensive displays, so even a small edge matters. Plus, the advantages come with no discernible downsides.

The result is a ridiculously enjoyable monitor for just about anything. The best bit is probably the HDR performance. There's a scene in *Cyberpunk 2077* that's a great test of peak brightness. It's an underground bar scene, mostly dark and moody, but the actual bar is surrounded by banks of neon lights. And they absolutely sizzle on this monitor. It's the most impressive rendering we've seen.

Pixel response is likewise essentially a solved issue with these OLED monitors. Of course, the 240Hz refresh ensures very low latency, provided you have a GPU powerful enough to drive this monitor at high frame rates. And you can improve latency further with the 1080p mode.

Speaking of which, you wouldn't mistake the 1080p mode for native 1080p on a 32-inch monitor. For sure, it looks a bit better than 1080p interpolated on a 4K 32-inch panel in the usual manner. But there's still a softness that belies any true pretence at native rendering.

One last thing: The LG UltraGear 32GS95UE doesn't have a glossy anti-glare coating, something that normally we'd say was a substantial disadvantage on an OLED monitor. But somehow, the matte coating is just fine. The sense of contrast and inky black levels, not to mention highlight dazzle, is barely if at all compromised. Consider our glossy-panel prejudices dismantled. **–JEREMY LAIRD**

VERDICT 9

LG UltraGear 32GS95UE

EXPERT PANEL Improved WOLED brightness; HDR sizzle; 240Hz refresh.

INTERVIEW FAIL Huge price tag; matte panel coating; no USB-C.

$1,399, www.lg.com

SPECIFICATIONS

Screen size	32-inch
Resolution	3840x2160
Brightness	275 nits full-screen, 1,300 nits max HDR
Color coverage	98.5% DCI-P3
Response time	0.03ms
Refresh rate	240Hz (480Hz 1080p)
HDR	DisplayHDR 400 True Black
Features	LG WOLED panel, Adaptive Sync, 1x DisplayPort 1.4, 2x HDMI 2.1

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It's crisp and clean, sure, but an extra half-inch here and there would make a world of difference.

NZXT H5 Flow RGB (2024)

Pristine design in need of more space

TWO ISSUES AGO, we took a look at the H7 Flow in all its ATX glory, complete with support for multiple radiators, extensive fan support, a pristine perforated aesthetic, and exceptional quality-of-life improvements for us system builders. This issue, the H5 Flow is on the block, newly released and newly tweaked, although nowhere near as aggressively as its bigger brother.

There have been some serious alterations compared to 2023's edition, though. Long gone is that bottom GPU directional fan bracket, and the removable front radiator bracket, but in its place, the H5 now supports a full 360mm radiator in the front, plus 240mm in the roof. The PSU shroud area has also had its design tweaked, shifting away from solid metal panels to a fully perforated design to better aid in dust build-up... No, wait, cooling. We meant to say cooling. It's also got a stylized angular design to that PSU cover, which does look pretty stellar.

So, what's the big bugbear about the H5 Flow 2024 edition, then? Well, it's just a little too small, and we mean it when we say that. Take the front 360mm AIO, for instance. It fits in there just fine, as advertised. You can get your three 120mm fans in (and this RGB variant comes with a core frame as standard), but you can't add push-pull, because the cutout in the PSU shroud for those fans and cooler is about a quarter of an inch too small (admittedly, push-pull is fairly niche nowadays, but if you look back at last issue's build, you can find out why we tried it). And then there's the roof and the confusing mess that is. At first glance, you'll notice three cutouts up there, 120mm fan-shaped almost. Unfortunately, you can't install a 360mm radiator in the top at all, or three fans, because the fan cutouts are just slightly too small for three fans. No, instead you're limited to up to a 240mm solution (280mm with LP memory). With some smart cable-tie use, however, you could mount a full-sized 360mm up there, but try to do that and then install a simple triple set of 120mm fans in the front, and you'll immediately run into a clearance issue between the two. Install the AIO in the front and the fans in the roof, and whammo—same problem. Again, the case is just a fraction of an inch too short to allow it.

That's incredibly frustrating and genuinely makes us question the decision: Why have these specific measurements been picked? Why did it have to be 18.31 inches high and not 18.34? Why did that cutout for the front AIO have to be as short as it is? Why not include mounting locations for 3x 120mm in the roof, so you could go with an air-cooler instead?

It's all just a little odd, which is a shame, because overall the chassis meets all of those high-flying NZXT criteria we're used to. Aesthetically, it's stunning, the cooling is top-notch (although the perforated PSU shroud is a dust magnet), the internal cable routing is phenomenal, and unlike the H7 Flow, it even supports a vertical GPU mount. But it's those oversights in chassis design that really let it down. Cases are getting smaller and smarter. We've seen that from Geometric, Hyte, and others. Is this purely a marketing ploy from NZXT to encourage people to buy an H7 Flow instead? It's difficult to say, but ultimately it's these decisions that have taken an otherwise phenomenal case down a peg or two. **–ZAK STOREY**

VERDICT

7

NZXT H5 Flow RGB

+ FLOW-TING MY BOAT Clean look; solid airflow; good cable management; decent pricing; good hardware support.

– GOING AGAINST THE FLOW Clearances suck; cutouts suggest more fan support; perforated PSU cover leads to dust intake.

$120, www.nzxt.com

SPECIFICATIONS

Motherboard support	ITX, Micro-ATX, ATX, E-ATX
2.5-inch/3.5-inch support	2x 2.5-inch, 1x 3.5-inch
Max radiator support	360mm front, 240mm roof (280mm with low-profile memory)
Fan support	3x 120/2x 140mm front, 2x 120/140mm roof, 2x 120mm bottom, 1x 120mm rear
Dimensions	18.31 x 8.86 x 16.93 inches
Graphics card clearance	16.1 inches
CPU tower clearance	6.7 inches
Warranty	Two years limited



It's a beautiful thing, but that chip's still not a patch on a Snapdragon.

Acer Swift Go 14

The trackpad that illuminates your life!

LIKE SHIPS DROPPING out of warp in front of you (excuse our *Star Trek* metaphors this month), Snapdragon really has taken the advantage when it comes to the great laptop wars currently unfolding. Yes, if you want a top-tier gaming notebook, your only choice is to go with Intel or AMD for that battle (and to be honest, Intel is still holding that market well at the moment). Yet for products that lean more on the side of creativity, productivity, and just getting stuff done, it's hard to suggest anything else over those Arm-based processors right now.

Take this Acer Swift Go 14. It's fantastically tempting: $720 straight out of the gate, with 16GB of LPDDR5X @ 6,400MT/s (unfortunately soldered, so not upgradable), along with a crisp 2,880 x 1,800 OLED screen, and the impressive Intel Core Ultra 5 125H under its belt. It's a wee beauty. Build quality is solid and dependable, especially at this price, the aluminum chassis feels plush, and although the edges are a little rougher than we'd like, there are products out there two to three times the price of this thing that feel less premium than it does, that's for sure.

That display really does pack a punch, though, and finally seeing OLED make its way into the mainstream market is a joy. It's not quite the fastest OLED out there, bringing "only" a 90Hz refresh rate, but that's more than enough to provide a comfortable experience on any desktop or web browsing adventure, and it does give it that hint of luxury that you don't feel with a stock 60Hz screen anymore.

SSD SORROWS

The SSD, however, leaves a lot to be desired. It's a 500GBF Kingston PCIe 4.0 M.2 solution (the beautifully named OM8PGP4512Q-AA), and it delivers fairly middling performance, with 4.7GB/s on the sequential read and 3.5GB/s on the write. Random 4K is also low at 66.43MB/s read and 227.22MB/s write, making it mildly underwhelming. Fortunately, you can chuck in another SSD if you so desire.

The big party piece is the adaptive LED trackpad, though. Yep, you read that right. The trackpad has a piercing white LED hidden behind it. Load up some media and it turns into media controls, with play/pause, volume control, scroll, the works. Jump back on to the desktop and you get a lovely white illuminated "Swift" logo appear on the bottom. It's a gimmick, but it's a great one to behold.

Performance is mostly average for this kind of price point. Gaming is an absolute non-starter. At its native resolution on low, you're lucky to get above 20fps, and at 1080p mid, that figure only bumps up to 30fps (although it does put in a good show with 40.8fps in *FFXIV Dawntrail).* Similarly, CPU performance is fairly average, and the AI performance lacks punch, too.

Day-to-day battery life put in an OK showing, particularly for a 65WHr solution at this price point, nailing six hours and one minute in PC Mark 10's Video battery test. Here's the thing, though: The Asus Vivobook S 15 with Snapdragon X Elite and 70WHr battery managed over double that at 12 hours and five minutes, and the Swift 14 AI, in Acer's own product stack, with Snapdragon X Plus and a 75WHr battery, went even further, landing an absolutely staggering 26 hours and 13 minutes under the same conditions. Wild.

And that's the issue right now: Despite the Acer Swift Go 14 putting in a seriously good effort, it's let down by that CPU hardware. If you're looking for the absolute best notebook performance and battery life for light productivity workloads, it's impossible not to recommend a Snapdragon. **–ZAK STOREY**

BENCHMARKS

	Acer Swift Go 14 - SFG14-73	Asus Vivobook S 15 S5507	Acer Swift 14 AI SF14-11-X6YU
Cinebench 2024 Multicore (Index)	636	**925**	742
Cinebench 2024 Single-Core (Index)	99	106	**107**
CrystalDiskMark C: Sequential Read/Write (MB/s)	4,765/3,503	5,068/3,621	**6,381/5,739**
CrystalDiskMark C: Random 4K Read/Write (MB/s)	66.43/227.22	69.82/210.87	**94.42/245.89**
Cyberpunk 2077 FSR @ 1080p Medium (Avg Fps)	29.3	25.1	**39.6**
Final Fantasy XIV FSR @ 1080p Medium (Avg Fps)	**40.8**	37.3	35.9
3D Mark Solar Bay (Index)	**11,644**	10,027	9,945
3D Mark Steel Nomad Light (Index)	**2,943**	1,964	1,970
3D Mark Night Raid (Index)	**25,914**	25,496	25,235
PC Mark 10 Battery Test Video (Minutes)	361	725	**1,573**
Battery Size (WHr)	65	70	**75**
Price (USD)	$720	$1,000	$900

Best scores in bold. All tests performed with a clean install of Windows, with the latest updates and drivers. Games tested at 1080p on the medium graphical preset. *Cyberpunk* does not have ray tracing enabled. Battery benchmark performed at 50 percent screen brightness. Prices correct at time of writing.

VERDICT **8**

Acer Swift Go 14

BOLDLY GOING Awesome trackpad; great screen; decent performance for the price.

NOT SWIFT NOT FURIOUS Not a Snapdragon; soldered RAM; mediocre SSD.

$720, www.acer.com

SPECIFICATIONS

CPU	Intel Core Ultra 5 125H
GPU	Intel Arc Graphics
RAM	16GB LPDDR5X @ 6,400MT/s
Storage	512GB M.2 PCIe 4.0 SSD
Screen	14.5-inch 2,880 x 1,800 OLED @ 90Hz
Connectivity	2x USB 4 Type C, 2x USB 3.2 Type A, 1x HDMI 2.1, 1x headphone jack, 1x microSD slot, Wi-Fi 6E, Bluetooth 5.3
Dimensions	12.3 x 8.6 x 0.6 inches
Weight	2.91lb

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Bag a software bargain

Don't pay full price for software when we can offer you huge reductions on everything from security software to Windows 11 Pro

Norton 360 Premium for $29.99

WE'VE NEGOTIATED a killer deal with Norton. No subscriptions; just a one-off bargain price of $29.99, compared to the regular $109 charge. That buys you 15 months of cover from the Norton Security suite across 10 devices



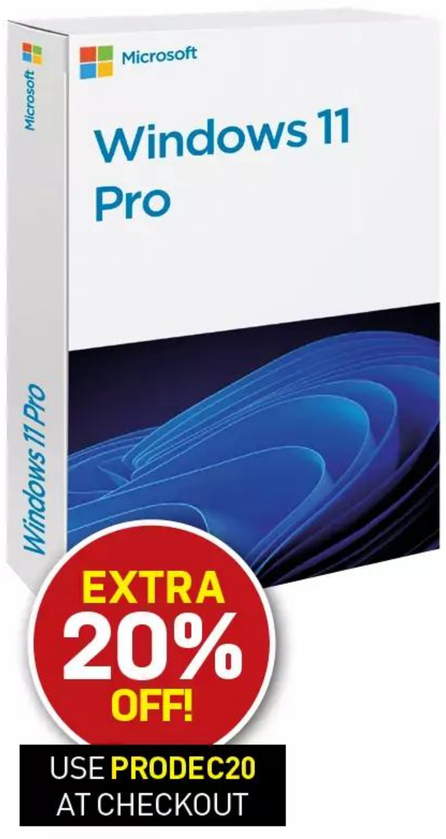
Because it's the Premium version, you get a host of extra tools. There's 75GB of cloud storage for secure backups, plus the full version of Norton Secure VPN, both to protect your identity and provide a way of watching TV from home while abroad.

Norton Parental Control provides tools to see exactly what your kids are up to on their various devices, and you also get GPS location monitoring for Android and iOS.

To round things off, Norton Password Manager generates and stores passwords across all your devices, while SafeCam for PC stops cybercriminals taking photos on your webcam without your knowledge.

ALSO CONSIDER **Avast Ultimate Suite 2024 for $39.99 (10 devices for two years) SAVE 87%**

Windows 11 Pro for $79.99



WANT TO UPGRADE from Windows 11 Home to Windows 11 Pro? Or perhaps you're building a new PC from scratch, or looking to move up from Windows 10? Maybe you want to run Windows on your Mac? Whatever your motives, a Windows 11 Professional OEM license is a great choice.

The first reason is simple: price. Microsoft charges $119.99 for a retail license of Windows 11 Home, and a staggering $219.99 for Windows 11 Professional. By choosing an OEM license—and avoiding the many dubious sources of licenses you may find online—you cut that price substantially.

ALSO CONSIDER **Windows 11 Home for $49.99 SAVE 64%**

Acronis True Image 2025 Advanced for $29.99



ACRONIS TRUE IMAGE 2025 combines both a full backup suite and comprehensive anti-malware protection. It offers the full gamut of backup options, from individual files to complete drive imaging, and active disk cloning for migrating to faster or bigger hard drives.

The Advanced package improves on Essentials by offering you 50GB of cloud storage to back up your most important files and data remotely. You can still back up to local disks, network attached storage, or remote destinations via FTP. You can also back up Microsoft 365 data and set up automatic replication. It includes a one-device license for either a PC or Mac with a one-year subscription.

Remember to use code PRODEC20 at checkout for 20 percent off.

ALSO CONSIDER **Adobe Photoshop Elements 2023 for $70 SAVE 30%**

software.maximumpc.com

Netgear Orbi 770

Affordable Wi-Fi 7 mesh with excellent performance



WHEN NETGEAR'S FIRST Wi-Fi 7 mesh kit launched last year, the Orbi 970 was a hefty $1,700 for a two-pack, and $2,300 for a three-pack. Netgear has now launched a new addition to its range in the form of the Orbi 770, which is considerably less expensive at $1,000 (three units) or $700 (two units).

It's still not cheap—after all, Wi-Fi 7 is still the current state-of-the-art for Wi-Fi tech—but the Orbi 770 provides tri-band Wi-Fi 7 with a top speed of 10.8Gb/s, which should be more than fast enough for most homes and small businesses. More importantly, it's a lot less expensive than previous Orbi models, and can compete with systems from rivals such as Linksys and TP-Link. The main sting in the tail is Netgear's fondness for selling subscriptions that provide additional parental controls and security features.

Netgear states that a two-piece system is capable of covering an area up to 5,500sq.ft. However, we tested the top-of-the-range three-piece system that includes a router and two satellites, covering up to 8,000sq.ft.

The Orbi 770—like all of Netgear's Orbi range—consists of a primary router and two satellites. The router and satellites do look similar, but there's a number of differences between them. The primary router has a 2.5Gb Ethernet port (WAN) port for connecting to your existing broadband router or modem, along with three additional 2.5Gb ports to provide wired (LAN) connections for devices.

In contrast, the satellite units each have just two 2.5Gb ports for wired connections. It's also disappointing that there are no USB ports for file sharing.

Netgear's Orbi app has always been easy to use, so getting started is very straightforward. The Orbi 770 is a tri-band router that can transmit a Wi-Fi signal on the 2.4GHz, 5.0GHz, and 6.0GHz bands, with a top speed of 10.8Gb/s.

To keep things simple for home users, the Orbi app combines all three bands to create a single network, but there are other options. Like most routers and mesh systems, the Orbi 770 allows you to create an additional guest network, but it also introduces a third Internet of Things network that sets aside the 2.4GHz band specifically for use with smart devices such as lights and security cameras.

LINK LOVE

It also supports Wi-Fi 7 features such as MLO (multi-link operation) that enable it to use the 5.0GHz and 6.0GHz bands together to improve performance (although your devices also need to support Wi-Fi 7 in order to use MLO).

But while the Orbi app is easy to use, it's not exactly overflowing with additional features—which allows Netgear to try to sell you additional subscriptions that provide more advanced parental controls and security features. If you want to be able to schedule internet cut-off times, you need to sign up for Netgear's Smart Parental Controls service, which costs $7.99 per month or $69.99 per year. It's the same with Netgear's Armor security service, for which an annual subscription starts at $99.99

There are rival routers and mesh systems that provide some of these features free of charge, so parents, in particular, might want to consider some of the alternatives from the likes of TP-Link and Linksys.

It might be far less expensive than other models in the Orbi range, but the Orbi 770 doesn't cut any corners when it comes to performance. Its 10.8Gb/s speed is more than fast enough to cope with most domestic broadband services, and even many business networks as well, and it's not even slightly bothered by the troublesome Wi-Fi deadspot that we have in an office located toward the back of our building.

Admittedly, the Orbi 770 may still be overkill if you're using older devices that only support Wi-Fi 5 or Wi-Fi 6, but it provides a competitively priced Wi-Fi upgrade for owners of newer devices that have Wi-Fi 6E or Wi-Fi 7. **–CLIFF JOSEPH**

VERDICT **8**

Netgear Orbi 770

MESH Excellent Wi-Fi performance; supports MLO and other Wi-Fi 7 features; lots of 2.5Gb Ethernet ports.

MESS Wi-Fi 7 is still expensive; limited features in the Orbi app; some features require additional subscriptions.

$999.99 (three-piece system, tested), $699.99 (two-piece system), www.netgear.com

SPECIFICATIONS

Wi-Fi standard	Tri-band Wi-Fi 7 (2.4GHz/5.0GHz/6.0GHz)
Wi-Fi speed	10.8Gb/s
Wi-Fi bands	2.4GHz: 2x2 (Tx/Rx), 688Mb/s; 5GHz: 2x2 (Tx/Rx), 4,320Mb/s; 6GHz: 2x2 (Tx/Rx), 5,760Mb/s
CPU	Quad-core 1.5GHz
Memory	4GB flash, 2GB RAM
Ports: router	1x 2.5 Gigabits for WAN/LAN, 2x 2.5 Gigabits port for LAN. Satellites: 2x 2.5 Gigabits port for LAN
Coverage	8,000 square feet
Dimensions	9.9 x 5.3 x 3.9 inches (251 x 134 x 100mm), 2lb (0.9kg)

Noctua NH-U9S chromax.black

A tiny stealth powerhouse



THERE ARE certain brands that have cemented themselves as the true kings of the fields they inhabit. They have a reputation that's almost unprecedented, backed up by years of experience, design, creativity, and brilliant performance. They become iconic. Ferrari for the Italian sports car. Rolex for premium watches. Converse for footwear. Noctua for CPU fan cooling. OK, that last one is a bit niche, but in almost every other sector in computing, there are two massive rivals battling it out in some way or another. In cooling, Noctua's just so far ahead when it comes to air solutions, it's not even funny.

But there's always been a problem. The color scheme. Beige and poop brown, to quote another famous tech journalist (thanks, Linus). The justification for that was simple: Noctua valued performance over looks. The materials and plastic composites it used were specially developed to minimize warp under intense RPMs, and it required them to, well, be that color. It took many, many years of criticism before the company finally released the chromax series to the masses, particularly the black versions. Here, today, we have perhaps one of the most impressive, yet massively under-represented air towers on the market, the NH-U9S.

This is a phenomenal piece of kit. It's a 92mm NF-A9 PWM fan, paired with a super-slick, compact tower that measures only 4.92 inches tall, 3.74 inches wide, and 3.681 inches deep. Those measurements alone make it compatible with pretty much every socket on the market, along with giving it an intense amount of chassis compatibility, plus absolute RAM clearance. And it's that last point that's the real kicker. Noctua's managed to sustain a massive amount of performance in this thing, without dramatically increasing the overall footprint of the tower itself. What that means is not only does it look small, but it won't conflict with any super-tall memory kits either.

How's the performance? Seriously impressive. From a compatibility standpoint alone, Noctua states on its product page that the NH-U9S is more than capable of cooling even AMD's latest Ryzen 9 9950X, giving it the "medium turbo/overclocking headroom" certification on the page. Jump over to Intel, and the 14900KS (Intel's hottest 14th-gen chip) gets the same treatment, and it really shows. Even in our own experience with Ryzen, it was rare for processors to hit over 92 C with this thing.

A lot of this comes down to the way that the NH-U9S is designed. Noctua's spared no expense. Not only are the heat pipe and the fins soldered together, unlike some of its competition, but the materials used and overall fan stats are absolutely wild. The entire unit weighs 21.8oz straight out of the gate. Copper is used for both the base and the heat pipes, with aluminum used in the fins, while nickel acts as a plating material. Noctua also includes its now legendary NT-H1 thermal paste. For the fan itself, it tops out at 2,000rpm at 100 percent load (1,550rpm with the Low Noise Adapter) and is capable of driving 78.9m²/h, all while delivering a suitably quiet 22.8 on the dB(A) front. It's also capable of supporting two fans as well, if you do decide to pick up another NF-A9 for some added extra grunt. Tie all that in with a ridiculously low $79 price point, plus a six-year warranty, and this thing is clearly a winner if you're looking for an affordable, reliable cooling solution for your mid-range machine.

It might not be as flashy as some of the liquid-cooled solutions out there, but the NH-U9S delivers on almost every other level, competing with products two to three times the price, and for that, it gets our highest-rated award. –ZAK STOREY

VERDICT 9 KICK ASS!

Noctua NH-U9S chromax.black

COOL BEANS Super-small footprint; exceptional performance; super-quiet; easy to install; great unboxing experience; huge socket compatibility; solid price point.

COOLANT LEAK Fan clips can be awkward to install.

$70, www.noctua.at

SPECIFICATIONS

Fans included	1x Noctua NF-A9 92mm
Socket support	Intel LGA1851, LGA1700, LGA1200, LGA1156, LGA1155, LGA1151, LGA1150, and AMD AM5, AM4
Dimensions	4.92 x 3.74 x 3.68 inches
Weight	21.8oz
Max RPM	2,000
Max acoustics	22.8dB(A)
Warranty	Six years

Acer Predator Cestus 335

Not quite the mouse we're looking for



FULL TRANSPARENCY: We didn't request this mouse in for review. It was sent to us by Acer, and we're not sure if it might have been a mistake. Still, we decided to throw it under the microscope and give it the ol' *Maximum PC* treatment, with a healthy dose of scrutiny.

It's been a long, long time since we've reviewed an Acer gaming mouse, and in such a crowded, competitive market, bringing anything into the pixel-pointy ecosystem like this is, well, a challenge. Whatever you bring to the table needs to be special; it needs to have an edge. Something that categorically elevates it above the many other brands out there trying to take your hard-earned cash in exchange for a mouse.

The Cestus 335 is a curious amalgam of a whole host of different mice. There are design styles, features, and decisions that we're used to seeing elsewhere, but they've been slightly tweaked and adapted to better fit into this Acer mold. In a lot of ways, that's a positive—taking some of the best attributes of the competition and bringing them into your own product is a sure-fire way of offering something good. But on the other hand, it divides your R&D attention and refinement, particularly if you try to do too much at once.

What do we mean by that? Well, first and foremost, this thing looks and feels like Corsair's M series mice, the almost legendary M60 series in particular. It's got that wide-bodied shape, a heavy feel under the touch, and plenty of support for your fingers on either side. It's ideal for claw and fingertip grips, although given its girth and particularly aggressive back end, it does make palming troubling, certainly for those with a smaller, more efficient hand size (yes, that is what we're calling it, don't judge).

Then there's the scroll wheel. Pick the mouse up and shake it a touch, and you'll notice it rattles. That is a little unnerving, at least until you click the scroll wheel down. That unlocks the wheel entirely, making it very reminiscent of Logitech's infinite scroll. Click it down again, and you're back on normal ratcheted scrolling. That does remove the middle mouse click button from the Cestus 335. Acer has countered that by adding an additional small plastic button right above the scroll wheel that fulfills that function. It's tiny, a little awkward to get to, and requires relearning some of your muscle memory.

MICE IN BLACK SATIN

Overall build quality is a little odd. The mouse has a black satin textured finish, which shines just a little too much for our liking. There's the usual complement of RGB strips and logos, and textured side fingergrips (this isn't rubber or anything similar, just plastic embossing).

Then there's the sensor. Acer has popped Pixart's prestigious PAW 3370 optical sensor in here, giving you full access to 19,000 CPI at 1 CPI increments. It is, without question, one of the best sensors on the market for gaming. If you want precision without compromise, getting something with this inside is a guaranteed win, and the Cestus 335 doesn't disappoint. There's no software or firmware fluff getting in the way, just pure performance.

Here's the problem, though: on the whole, it's merely average. The feel of it, the shape, the scroll wheel—it's all slightly unrefined. It just needs a touch more refinement to it, more beta testing. The reason is that it's $80 at retail, and when you can get something like the SteelSeries Aerox 5 for the same price, the Corsair Sabre RGB Pro for $60, or Razer's Basilisk V3 for $45, it suddenly becomes a much more challenging proposition. It's certainly a good attempt, but in such a heated arena, it needs to be better. –ZAK STOREY

VERDICT **7**

Acer Predator Cestus 335

APHRODITE'S GIRDLE
Impeccable sensor; infinite scroll; generally OK to use; decent lighting.

NAMING MICE AFTER WEIRD THINGS
Pricing not competitive; slightly janky scroll wheel implementation; shape could be better refined; non-removable cable.

$80, www.acer.com

SPECIFICATIONS

Buttons	6
Feet	PTFE
Connectivity	Wired (USB-A)
Sensor	Pixart PAW 3370
Max CPI	19,000
Max acceleration	50G
Max speed	400 IPS
Weight	3.2oz/90.71g
Polling rate	2,000Hz
RGB lighting	16.8 million colors
Warranty	Limited



The puzzles are fresh enough to make the game feel new, yet familiar.

Silent Hill 2

A fun but flawed take on a flawless gem

SURVIVAL HORROR GAME

WE DON'T ENVY BLOOBER TEAM. Nobody actually wants the difficult task of updating something as nuanced, emotionally sensitive, and revered as *Silent Hill 2.* The original has been praised for decades, and picked apart by fans eager to understand every last detail for just as long. It's a game where every strange texture and odd room decoration means something, the game's unforgettable atmosphere held together by the finest of threads.

This modern remake of that legendary tale gets off to a great start, offering an extensive range of graphical settings and accessibility options. It doesn't take long to tweak the game into a smoothly running ray-traced beauty, or to adjust the controls and their behavior so they're just the way you like them. A personal favorite is the option to swap the standard "mash to get monsters off me" action for a simple button hold instead—a small gesture that allowed us to concentrate on the horrors around us instead of being distracted by an aching thumb.

Those horrors look impressively familiar, even decades after the game's PlayStation 2 debut. The rust-covered hellscapes, the signage, the glistening sacks of flesh scuttling past locked-up homes tumbling into the abyss—it's easy to believe *Silent Hill 2* always looked this good, but that illusion takes lots of work.

The remake's treatment of the series's signature fog is just as remarkable. It seems to roll over scenery, pool in dirty corners, and settle on the ground. It's a choking physical presence that can move and change intensity, something protagonist James Sunderland has to force himself through, rather than just a cloudy overlay trying to obscure the view.

In spite of the fog, *Silent Hill 2* is easier to navigate than before, with James's traumatic stroll around town assisted by the returning auto-annotated map—its scribbled notes and eye-catching circles around key features still the best in the genre—and a new visual aid: white cloth. This more subtle take on modern gaming's yellow paint can be found draped over vaultable scenery or wrapped around objects James can interact with, helping to cut though the visual noise that naturally occurs in cluttered, high-detail environments like these. Once we learned to look out for these visual tells, even working our way through the dark nightmares of the Otherworld while being chased by monsters seemed easy.

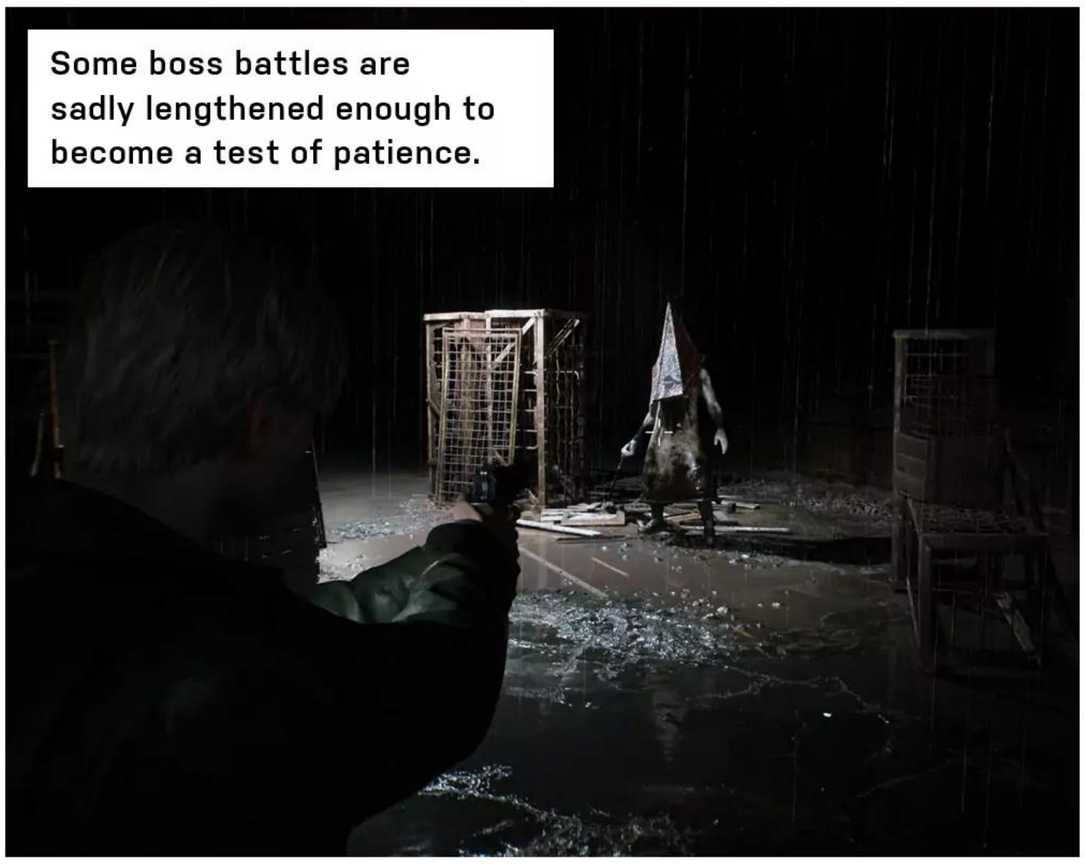
And it's a good thing, too, because while the story's general structure is the same as before, the maps for each major location have been completely redesigned. All of the key features are still in there, somewhere—a doctor's office, an ornate clock, gallows in the middle of an unnervingly large area—but appropriately it plays like a hazy recollection of the original, with snatches of the familiar transformed into something new and different. Much like being trapped in a nightmare, it's a collision of the familiar and unfamiliar, leading you down paths you think you know, only for you to become totally lost. Our old experiences and favorite FAQs were of little use here, and that helped the remake feel as fresh and dangerous as the original.

Some of these curveballs come from the game's mix of new and redesigned riddles. The standard difficulty is pitched just right, giving us something flavorful and satisfying to solve without needing to be tracked in a notebook. Sadly, the new physical puzzles are less successful; too often involving pushing a box from one place to another, and the chance to update or omit a few of the original's less exciting challenges wasn't taken. Dropping a few cans down a third-floor garbage chute to dislodge a key item wasn't a fun, clever, or

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thematically relevant puzzle 23 years ago, and it hasn't got any better with age.

CHOPS AND CLOBBERS

Close-range combat is scrappy and frantic. Technically, it's also simplistic—just keep smashing the attack button until they fall over—but when we're talking about a desperate man trying to fight off unknowable, hideous entities with whatever he has to hand, an elegant, complex system is not necessarily a good fit. Basic, violent clobbering makes a lot more sense. Unfortunately, it also has diminishing returns.

It was great for about an hour. Then the monsters kept coming. And coming. And coming. *Silent Hill 2* mistakenly believes that being assaulted by two pairs of legs fused at the waist is the most exciting thing that could happen to anyone, and forces "surprise" encounters with these monsters (and several other common types) too often, failing to maintain the horror. Before long, we stopped being afraid and just became bored.

Silent Hill 2 always set itself apart from its competitors by being a deep, thoughtful horror game. The original wanted us to take our time, to imagine something awful lurking just out of sight in the fog. The remake seems to think we have no imagination, that only monsters are scary (and only if we can see them), and if it doesn't keep up its high MPM (monsters per minute), it's not frightening us enough.

This misjudged focus on combat has also worked its way into the game's boss battles. These fights were never a highlight in the original but did serve the story well—and tended to be over before any serious grumbles started to form. The remake correctly identifies these segments as a weakness, but then "fixes" them by making them much longer, with a few even going through patience-testing multi-phase, multi-location changes in the process. If there's one part where this remake completely misunderstands the original game, it's here.

But the stumbles can't be ignored, and at times even manage to display a worrying lack of understanding of the source material. A few key cutscenes, the sort that sent shivers up our spine on far weaker hardware, fall flat in their modern forms, the direction stiff and wooden where it used to be raw and emotive. Mystery and suspense are too often replaced with unnecessary close-up reaction shots and another bunch of leggy monsters in the shadows, as though someone was concerned that the one game that can definitively prove it's adored for being a subtle, understated, psychological experience might be called boring instead of brave.

When it's good, it's excellent. Any game that hews as closely as this one does to something with *Silent Hill 2's* high standards can go toe to toe with any other modern horror game. But it relies too much on its repetitive, violent encounters, and we just wish it had been a little more careful to capture the spirit, as well as the look, of the original. **–KERRY BRUNSKILL**

VERDICT **7**

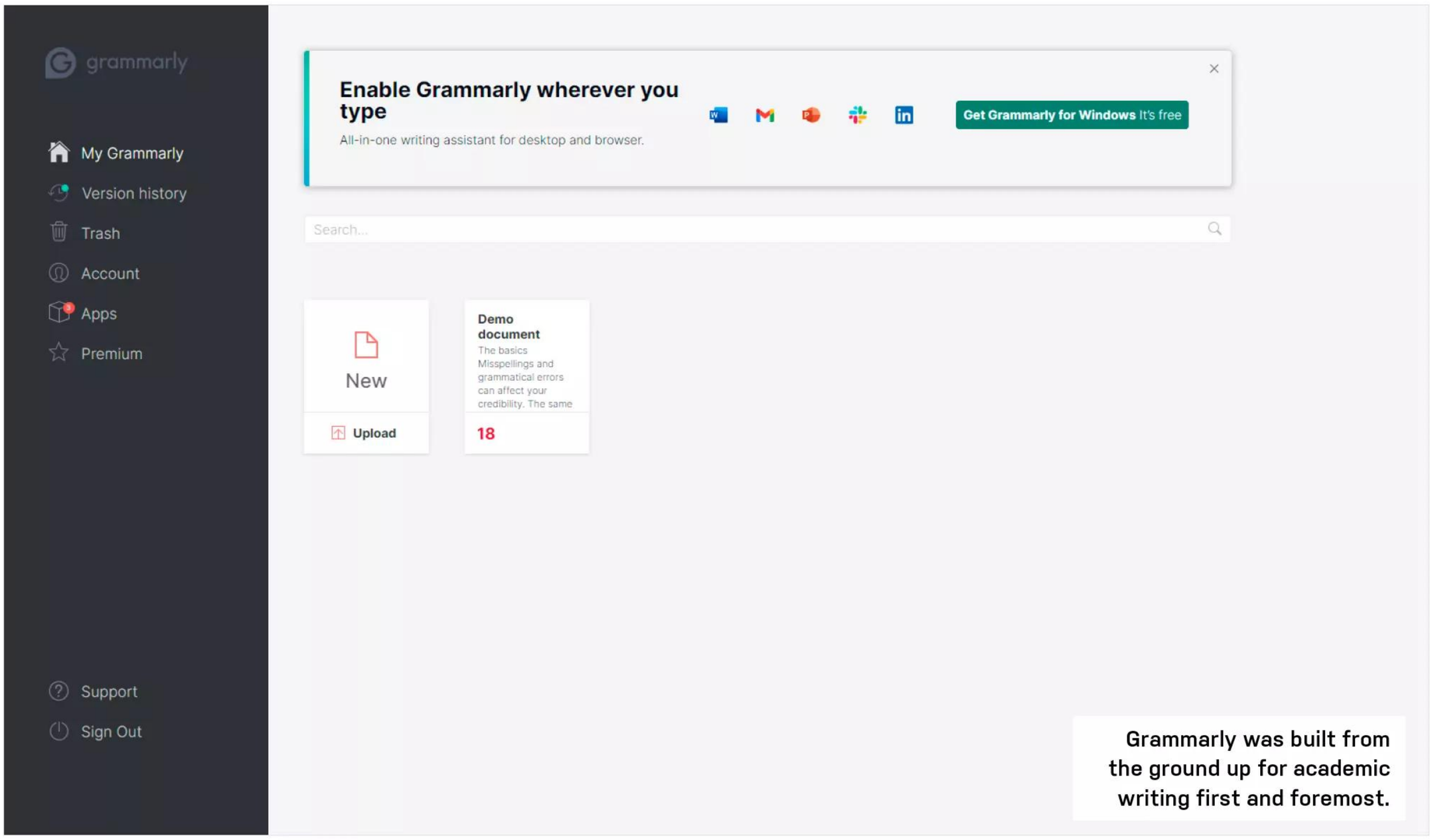
Silent Hill 2

MONSTER MASH Captures the original's vibe; combat is surprisingly great; cinematics look sensational; sound design is brilliant.

SHATTERED MEMORIES Riddled with shader stutter on PC; some puzzles are downright obtuse; first couple of hours feel like a slog.

RECOMMENDED SPECS Intel i7-8700K or AMD Ryzen 5 3600X, 16GB RAM, Nvidia RTX 2080 or AMD RX 6800XT.

$70, www.konami.com/games/silenthill, M-rated



Grammarly vs. QuillBot

Artificially improve your writing

LET'S FACE IT, out of all the languages available, there's a good argument that English is probably the weirdest of the bunch. It's developed in a unique way. An amalgamation of a whole host of different cultures from across the globe, one that's been influenced by war, emigration, empire building, culture absorption, religion, regional variance, and whatever words Shakespeare fancied making up to further his sonnets on the day.

It's odd, and its grammatical structures equally so, certainly compared to the Germanic and Nordic languages that form its basis. To write in it, then apply specific style guides to it is quite the challenge. It takes time, practice, and no small amount of effort. If you're keen to advance in the prestigious field of the written word, it's critical that your work reads well. It is perhaps no surprise that at *Maximum PC*, we highly value well-written prose. After all, getting your point across and doing that well is the foundation of good-quality journalism.

Here's the thing though: It's not easy, and even the very best of us utilize tools such as spellcheckers to take some of the mental load off, and allow us to be a touch more creative. Less time thinking about whether something's an em dash or an en dash, and more time thinking about pithy metaphors to describe how a headset has the audio fidelity of a bag of angry hamsters performing Mozart's 'The Marriage of Figaro' (please don't put hamsters in bags, on a side note).

So, in the world of AI, what options are available? Well, the two top dogs these days are Grammarly and QuillBot, the former of which has been around for some time, initially acting as a grammar and spellchecker, but it has recently received a generative AI update. The latter, QuillBot, is a brand-new LLM-based AI tool, designed to help you be more creative, while featuring a bevy of additional features.

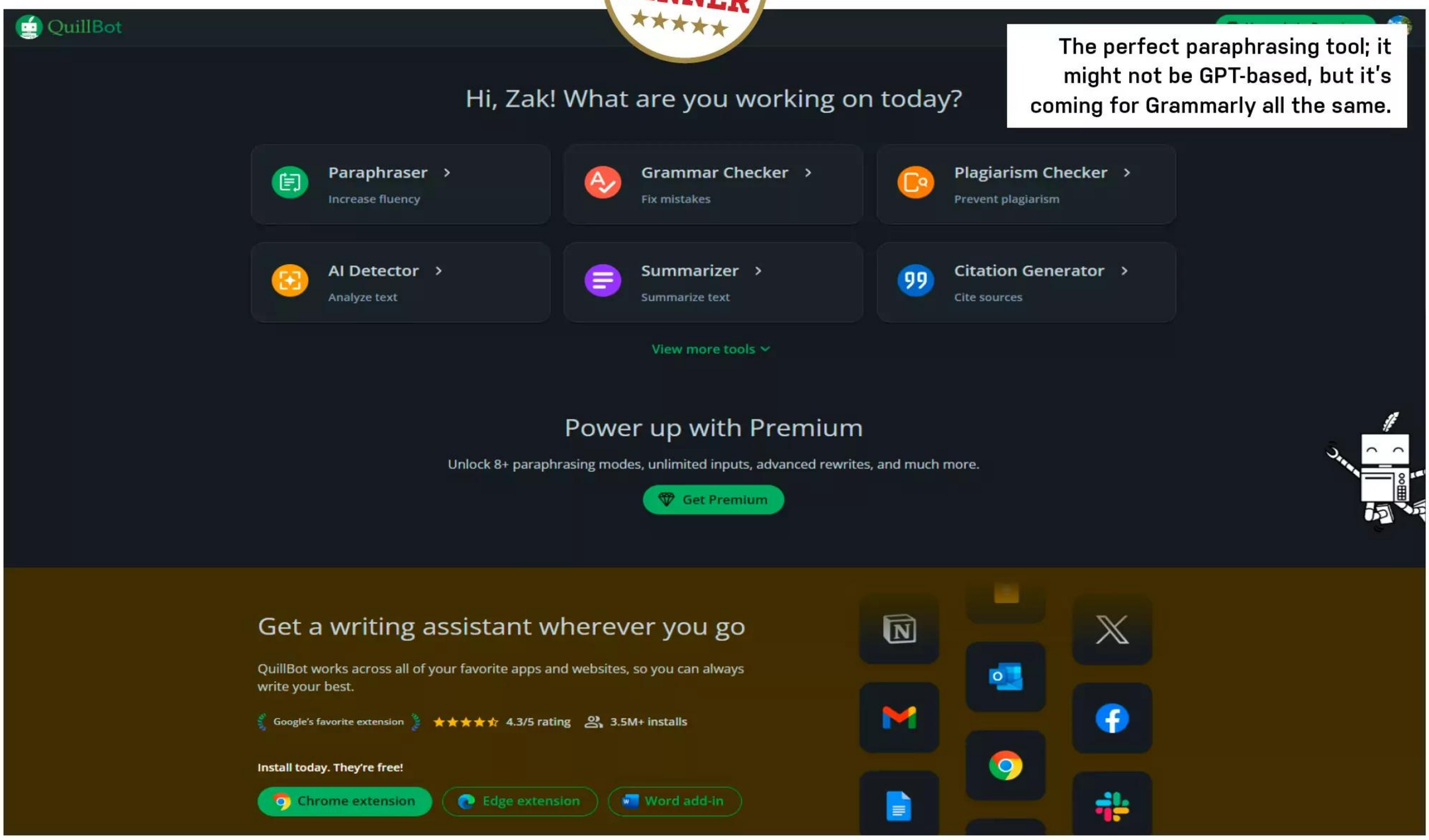
Grammarly was first launched in 2009 in Ukraine by a small team aiming to help university students improve their work through better grammar and spellcheck functionality. Over time, it developed into a seriously successful extension and product, offering both premium and free variants. It focused mainly on improving the general tone of the writing in question, pushing it into a more formal orientation. It wasn't until April 2023 that Grammarly first released its ChatGPT generative AI feature set, followed by a further update in late 2024 that integrated a plagiarism checker, in a similar vein to what's available on QuillBot.

QuillBot is a far more recent venture. Launched in 2017, it was initially developed as a paraphrasing tool. Similarly built for students, the idea was to help them rephrase sentences and improve paragraph structure to boost their written work's proficiency. Interestingly, QuillBot didn't actually feature a full-fledged grammar checker until 2021; however, its AI integration has been present since day one, although it doesn't utilize ChatGPT in any of its software.

HOW ARE THEY TO USE?

Both QuillBot and Grammarly are easy to install, featuring extensions for Google Chrome, Firefox, Microsoft Edge, and Safari. Although both feature support for MacOS and Android/iOS keyboards, Grammarly also has a desktop program

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The perfect paraphrasing tool; it might not be GPT-based, but it's coming for Grammarly all the same.

for Windows, enabling you to edit your work in any program that you work in on our favorite platform, giving it a clear advantage here.

Using Google Docs as our test bed, both are incredibly intuitive and quick to use. QuillBot and Grammarly act in real time, highlighting errors or grammar mistakes. Both Grammarly and QuillBot have style and tone monitoring built in, although Grammarly is far more aggressive in flagging certain language it deems inappropriate. Both identify the context of sentences and sentence structure, and suggest ways to 'enhance' the overall meaning of that sentence.

It's worth bearing in mind, however, that both these tools are still very much acting as formal writing tools for academics. They highlight and flag sentences in red that they believe are incorrect, or that tonally don't correspond to their models on formal writing. For instance, say this journalist made a quick, witty response, such as: "It's odd, and its grammatical structures, equally so, certainly compared..." Both these extensions would flag "equally so" as tonally incorrect as it doesn't pair well with academic prose, and it should be "are equally so," despite it being a grammatically sound written technique to elicit an emotive response from the reader. So, if you're a more informal writer, or utilize concise writing techniques, expect your work to get flagged quite aggressively. Similarly, contractions are often pulled up as incorrect (despite being grammatically fine), along with generic Associated Press formatting techniques equally flagging as errors. Sadly, there's no way of changing that, because those models are what form the basis of both platforms' programming.

QuillBot is far more forgiving in a lot of ways, as it focuses more on the paraphrasing side of things. In the free version, you can rewrite up to 125 words in a formal or fluent tone, where it suggests more emotive language for your written copy. This is something Grammarly can't do without a paid subscription. QuillBot can do unlimited re-writes under a variety of styles, but that does require the paid addition. Additionally, both tools also feature plagiarism checkers and AI checkers. Again, both require a subscription for the plagiarism check.

On the whole, the two are very similar; the big difference comes in the form of pricing. QuillBot starts at $8.33 per month, billed annually, whereas Grammarly starts at $12 per month billed annually (or $30 per month billed monthly).

Ultimately, both tools are impressive at what they do. If you're keen to enhance your written work with more emotive tones, QuillBot definitely has the edge. It also features some pretty nifty translation tools as well if you need them (although Google Translate does exist and is free). On the other hand, Grammarly is more intuitive to use, has far greater compatibility, and generally provides you with slightly more formal copy. Still, as with all AI assistance, you do need to be wary of what it suggests, and, we highly recommend staying away from aggressive paraphrasing. Nothing is more important for your writing than letting your character shine through. **ZAK STOREY**

VERDICT 8

Grammarly

AP STYLE GUIDE Top-tier compatibility; perfect for academic writing; good AI integration via ChatGPT; doesn't rewrite words too heavily.

RANDOM TWEETS Pricing far higher; can't change free version's style/tone.

$0/$12 per month (annual payment) / $30 per month (monthly payment), www.grammarly.com

VERDICT 9

QuillBot

CHARLES DICKENS Paraphrasing is awesome; solid for academic re-writes; strong compatibility; free and paid versions provide more for less; translations included; auto-plagiarism checks.

ZAK STOREY Still based around academic writing; lacks full desktop support.

$0/$8.33 per month (annual payment), www.quillbot.com

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LETTERS

WE TACKLE TOUGH READER QUESTIONS ON...

> Why no AI?
> Wireless travails
> Updated cases

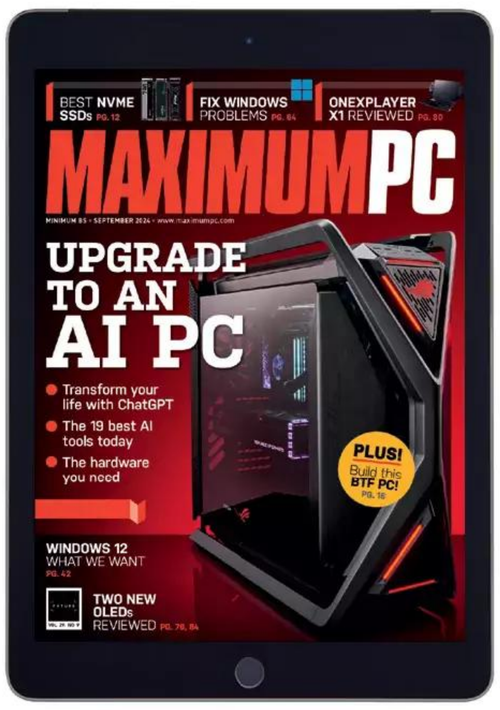
Absent intelligence

I've been reading many articles on AI PCs, but nary a word from *Maximum PC*. When are you going to enlighten us about NPUs, and more specifically, when are you going to show us how to build our own AI PC? I'm waiting breathlessly!

–F. Gunseor

EDITOR-IN-CHIEF, GUY COCKER, RESPONDS:
Thanks for your note, because if anything, I was concerned we'd been running too much AI content! If you look across the last six months, we've featured "The ethics of AI" (November), "AI photo editing" (July), and "The best AI PCs" (June), not to mention our "Upgrade to an AI PC" cover build on the September issue. Also, in our October issue, builder Zak Storey updated our benchmarking process to include a number of AI benchmarks, which we've now been running on every build we've done since.

Obviously, AI is the biggest story in the PC world at the moment, and we've been trying to cover it as thoroughly as possible, from how to build



"Upgrade to an AI PC" cover build on the September issue.

an AI-capable PC and use the latest AI-powered tools, to the ethics of AI and whether we have anything to be worried about. As mentioned, I was concerned that we were bombarding our readers with too much AI content, as I know not everyone is interested in the topic, or just haven't incorporated these tools into their workflow as yet.

From my perspective, I've noticed myself starting to rely on it more and more in my daily life. I'm finding Google's new Gemini-powered summaries at the top of the search results quite useful, especially if I've asked Google a question. I also use the AI summaries of voice notes and interviews on my Samsung phone all the time, and Grammarly (covered in this month's software versus, page 92) is taken for granted in helping me write everything from emails to this answer to your letter.

Anecdotally, I'm also noticing non-techy friends and family starting to use these tools, or at least want them. My father is in the process of buying a new laptop, and told me "it has to have AI." And recently, my partner sent me some cartoonified profile pictures of us to put on hoodies to wear on an upcoming trip to Disneyland. She told me she'd created them using Windows Copilot—I didn't even know she used a Windows PC, let alone Copilot!

The idea of building your own AI PC, though, is admittedly quite an odd concept at this point in time. That's because, if you have a GPU from the last few years in your PC, it's technically going to be way more powerful at performing AI tasks than any of the new NPU-enabled CPUs that are coming out. If you're reading *Maximum PC*, there's a very high chance you already have an AI PC, it's just that it wasn't sold to you in that way. You could download OpenAI's GPT-2 (or many other large language models) and run it on your PC today, if you were so inclined.

It's in the portable space where the term "AI PC" makes the most sense, as the big market is for thin and light business machines (i.e. ones without GPUs in them), so having an NPU on board here is a definite bonus. I was in Germany with Intel recently, seeing its new Core Ultra 2 laptops, and some of the NPU-powered applications, such as McAfee's deepfake scanner to spot malicious video content, is actually a really useful tool.

We'll have lots more AI content in future issues of *Maximum PC*, but if there's something specific you want to see, then drop me an email at editor@maximumpc.com.

↘ submit your questions to: editor@maximumpc.com

Which Wi-Fi?

I work remotely, and recently had the revelation that I was spending way too much money on my city dwelling when I could just as easily get out of my cramped apartment, have more space, and actually have some money left at the end of the month.

However, I've found my old Netgear R7000 Wi-Fi 5 router, bought in 2015, just doesn't cut it now I'm living in a larger home. My internet comes through the wall in the living room, but my office is at the back of the house, where the signal just isn't strong enough to support video calls and large file transfers. I'd also like to host some barbecues next summer and have Wi-Fi in the garden, so I can watch some TV out there.

Having looked at the Wi-Fi 7 options, they all seem so expensive, and I don't even have any Wi-Fi 7 devices to be able to take advantage of it. Also, I'm not sure if I should also be looking at a mesh system, given the house is quite long. Do you have any advice on what I should be looking for? **–D. Price**

EDITOR-IN-CHIEF, GUY COCKER, RESPONDS:
Congratulations on the move to a new home! Hopefully you're settling in, despite your Wi-Fi woes.

You're correct that the Wi-Fi market is a little fragmented and confusing right now, not helped by the fact that, as you noted, Wi-Fi 7 devices are so damn expensive. If you really must have the latest and greatest tech, take a look on page 87, where we've reviewed the new Netgear Orbi 770 mesh system, which is $700 for a two-unit pack. It works great, is easy to set up, and it could be argued is quite reasonable value if you think you'll use it for the same nine-year period as your last router. You do pay a premium for mesh systems, but I've never regretted buying one, given how much I use Wi-Fi around the home. They're also really flexible, so you can start with a two-node kit and add more nodes down the line if needed, say in the garden in your case.

Personally, though, I think Wi-Fi 7 is overkill, as like you say, there aren't a lot of devices that support it right now. I'm currently using two Linksys Atlas Pro 6 Velop nodes to cover my apartment, and they work perfectly, even though they're 'only' Wi-Fi 6, and dual-band at that. My previous systems have always been tri-band, with a dedicated band for backhaul between the nodes, but I've never noticed any slowdown using the dual-band units.

If I were buying a kit today, I'd probably go for a Wi-Fi 6E system, which is the sweet spot between price and performance. I really like the TP-Link Deco XE75 Pro, which you can pick up for $220 on Amazon for the two-pack or $300 for a three-node kit, which is great value. I like the Pro version because it comes with a 2.5G port, so if you ever upgrade to faster internet speeds, this kit will support them, although I do wish it also had 2.5G ports for LAN devices (it only has 1G). This option will cover most homes if you place the nodes correctly.

If you want the super-cheap (and stable) option, you could set up a powerline network by plugging in adaptors where you need them, such as in the office and by the TV in the garden. While Wi-Fi is the simpler option for most people, there's nothing like having wired Ethernet if you're playing games or need a really stable connection. A two-unit kit should cost around $40, and again, you can add more units as and when you need them.

A mesh system like this TP-Link should fix most Wi-Fi issues.



© TP-LINK

Casing the joint

While you do an excellent job of keeping your Blueprint builds up to date, there's one area where I find them lacking—the cases! On the budget end of things, the Corsair 4000D AIRFLOW is great and all (and a pretty good bargain for $90, I have to say), but it's been around for four years at this stage! Surely there's something more exciting from Phanteks, NZXT, or even Corsair itself that, I don't know, has more than one USB Type A port at the front. Perhaps not, but I dare to dream!

You guys have also featured some great premium and mid-range cases on your covers in recent months (perhaps not the $530 Asus ROG Hyperion GR701 BTF Edition in the September issue, but that's just a matter of personal taste), so it would be good to see what you think is king of the hill in those two categories as well.

Sorry to complain, I just always like to keep an eye on the Blueprints section so that if I were to build a new PC tomorrow, I'd know where to start!

–R. Pritchard

EDITOR-IN-CHIEF, GUY COCKER, RESPONDS:
Thanks for your email—we were long overdue a chassis update in our Blueprints section, so I'm glad to report we've made the changes this month. You're right, we've been reviewing a lot of new cases this year, many of which received glowing reviews from our builder Zak after he used them for cover builds, so I was really happy to see them get a 2024 makeover this issue (which you can read on pages 96-98).

The new cases from Phanteks, Hyte, and Geometric Future give the Blueprints section a fresh look, particularly the latter case in its bright green color. As has been the trend over the last couple of years, they're all great value, too—our Turbo case is still only $135, but looks amazing and is a joy to build in.

Hope you enjoy the new Blueprint—there should be a lot more updates to come in the next few months!

THE BUILDS

THIS MONTH'S STREET PRICES...



BUDGET

THIS TIME OF YEAR is the best, and for one reason: hardware launches. And lots of them. We're being treated not only to a new array of Ryzen 9000 processors, but by the time you read this, Intel's latest Ultra 200S series processors will have landed, confusing everything with their new nomenclature and odd architectural designs (see news, page 8). It's not just major change for the two big chip manufacturers either. Yep, we're updating our trusty steeds. All six of our builds are getting brand new chassis, picked from the very best cases we've looked at over the last 12 months (and even one that we've not yet featured, it's impressed us that much).

So, budget build—what are we looking at? First, let's address the case change. We're retiring Corsair's 4000D Airflow for the far more modern Phanteks XT View. There's nothing particularly wrong with the 4000D—it's a mighty fine chassis if you have one; bit it's four years old at this point, and slightly overpriced for what you get. The XT View, in contrast, is a super-affordable dual-compartment, fishbowl-esque chassis, with 360mm AIO support, bottom-mounted fans, integrated RGB, solid cable management, support for BTF, plus a whole host of colorways. Oh, and it's $10 cheaper. That might not sound much, but $80 for a case of this caliber is epic.

Otherwise, genuine price changes have been a bit lackluster this month. Our AMD build saw its price drop by $3 overall, thanks to us swapping out the OS drive for something a little more budget-oriented (reducing the price by $23), but unfortunately that Ryzen 5 7600 bounced up by $16. Our Intel system saw a cleaner $32 drop, thanks to that SSD shift, along with price drops on its processor as well. All the budget B760 boards, however, are now above the $110 mark, and last month's pick costs $130, thus the swap to the PG Riptide.

AMD INGREDIENTS

PART		PRICE
Case	Phanteks XT View **NEW**	$80
PSU	600W Thermaltake Toughpower GX2 80+ Gold	$64
Mobo	MSI PRO B650-S Wi-Fi	$130
CPU	AMD Ryzen 5 7600	$198
GPU	ASRock Challenger D Arc A750 8GB	$190
RAM	32GB (2x 16GB) Silicon Power XPOWER Pulse Gaming @ 6,400 C32	$87
SSD 1	500GB Crucial P3 Plus PCIe 4.0 M.2 **NEW**	$37
SSD 2	1TB Kingston NV2 PCIe 4.0 M.2	$54
OS	Windows 10 Home 64-bit OEM (Windows 11 Compatible)	$32

Approximate Price: $872

INTEL INGREDIENTS

PART		PRICE
Case	Phanteks XT View **NEW**	$80
PSU	600W Thermaltake Toughpower GX2 80+ Gold	$64
Mobo	ASRock B760M PG Riptide **NEW**	$110
CPU	Intel Core i5-14400F	$177
GPU	ASRock Challenger OC RX 7600 8GB	$250
RAM	32GB (2x 16GB) Silicon Power Value Gaming @ 6,000 C30	$85
SSD 1	500GB Crucial P3 Plus PCIe 4.0 M.2 **NEW**	$37
SSD 2	1TB Kingston NV2 PCIe 4.0 M.2	$54
OS	Windows 10 Home 64-bit OEM (Windows 11 Compatible)	$32

Approximate Price: $889



ANOTHER BUILD, ANOTHER NEW CHASSIS. This time, it's the familiar Hyte Y40. The Cyberpower subdivision might be relatively new on the PC chassis scene, but it's made tsunamis in the industry, shaking up case design dramatically, with integrated panels and all manner of unique design twists on classic ideas. The Y40, however, is more traditional, mixed with a little more modern. Still complete with that obelisk-esque mid-tower design, you get pristine tempered glass windows, fantastic build quality, an awesome paint finish, and support for vertical GPUs as standard, with an included PCIe 4.0 riser cable as well. It's also available in four different colorways, and supports dual-rad setup. Our stealth build in the Y40 is still one of our favorite builds of 2023.

As for changes, our Mid-range systems have seen even fewer product swaps than our Budget rigs. There's a good reason for this, too: Pricing is beginning to drop in anticipation of new product launches and Black Friday. Q4 is historically the period when the majority of new products launch and manufacturers try to shift old stock out of warehouses into your homes. We're seeing that happen across both of these builds. Changing very little, we've managed to nab price drops of $47 on our AMD system, along with $44 for our Intel build. Not too shabby.

There is one caveat, and that's our AMD RX 7700 XT pick. Last month's Asus Dual OC Radeon saw a $27 price bump, so we've swapped to the Gigabyte Gaming version, bringing that price down $10 on last month. As for the Intel system, although the 14700F has seen a $28 price drop (likely in anticipation of the new chips), the RTX 4070 has bounced up by $30, and in fact remains the cheapest 4070 option out there. Less than ideal. At a guess, we can only surmise that Nvidia plans on launching new GPUs in early January, rather than in Q4 of 2024, and this price bump is to prepare for some Black Friday shenanigans.

AMD INGREDIENTS

PART			PRICE
Case	Hyte Y40 ATX Mid Tower	NEW	$105
PSU	850W Thermaltake Toughpower GF1 2024 80+ Gold		$91
Mobo	ASRock X670E Pro RS		$210
CPU	AMD Ryzen 7 9700X		$327
Cooler	Noctua U12S chromax.black		$90
GPU	Gigabyte Gaming OC Radeon RX 7700 XT 12GB	NEW	$390
RAM	32GB (2x 16GB) TeamGroup T-Create Expert @ 6,400 C32		$91
SSD 1	1TB Lexar NM790 w/Heatsink M.2 PCIe 4.0		$63
SSD 2	2TB Silicon Power UD90 M.2 PCIe 4.0 SSD		$99
OS	Windows 10 Home 64-bit OEM (Windows 11 Compatible)		$32

Approximate Price: $1,498

INTEL INGREDIENTS

PART			PRICE
Case	Hyte Y40 ATX Mid Tower	NEW	$105
PSU	850W Thermaltake Toughpower GF1 2024 80+ Gold		$91
Mobo	MSI Z790-S Wi-Fi ATX		$150
CPU	Intel Core i7-14700F		$319
Cooler	Enermax Liqmax III 360 ARGB 360mm AIO		$80
GPU	MSI Ventus 2X OC RTX 4070 12GB		$520
RAM	32GB (2x 16GB) Silicon Power Xpower Zenith Gaming @ 6,000 C30		$86
SSD 1	1TB Lexar NM790 w/Heatsink M.2 PCIe 4.0		$63
SSD 2	2TB Silicon Power UD90 M.2 PCIe 4.0 SSD		$99
OS	Windows 10 Home 64-bit OEM (Windows 11 Compatible)		$32

Approximate Price: $1,545



THIS IS AN EXCITING ONE. Our Turbo build has arguably the coolest case we have ever seen, and that's not because it supports up to 420mm radiators and 10 120mm fans (although that is seriously epic). If you've followed our adventures with Geometric, you'll know that we're big fans of the company's outlandish case design, and its willingness to really break the mold when it comes to radical new ideas. Thus, we present to you the Model 5, complete with insane, bright-green paint job (don't worry, it is also available in black, white, or orange—we just went a little nuts on the sample request form).

As with our other case picks, this beauty leans into that plinth case design style, but with a unique twist, hiding the PSU in the front of the chassis, and housing an absolute ton of fans internally. On top of that, it also supports vertical GPUs, with cards up to 460mm in length, and E-ATX motherboards, and it's entirely toolless, too.

As for the builds themselves, we've seen wide-sweeping changes this month—on the pricing front at least—but nothing we could actively swap out. Our AMD build saw price drops in almost every segment, except for the processor. The Kraken cooler fell by $34, the motherboard by $16, the GPU by $50, RAM by $5, and the case by $21 as well. The only downside? The 7950X bounced up by $80 since last month. We'd guess that's because Ryzen 9000 has been a little lackluster on sales, and with seventh-gen pricing so low, AMD is pulling back on those deals.

As for Intel, it's kind of the opposite: The 14900KF saw an $89 price drop, along with the cooler falling by $4, and the case, of course, is also cheaper. We've gone for a set of 64GB TeamGroup T-Create Expert memory again at $160, to shave off even more cash, but the big kicker is without a doubt that RTX 4080 Super. Sadly, the $960 PNY is no more, and it, too, now lies up there at the $1K mark. Still, both builds have seen a $45 and $42 price drop respectively across the two platforms compared to last month, keeping us more than happy.

AMD INGREDIENTS

PART		PRICE
Case	Geometric Future Model 5 **NEW**	$135
PSU	Super Flower Leadex VI Platinum Pro 1,000W 80+ Platinum	$130
Mobo	MSI MAG X670E Tomahawk Wi-Fi AM5	$244
CPU	AMD Ryzen 9 7950X	$530
Cooler	NZXT Kraken 360 360mm AIO	$146
GPU	ASRock Phantom Gaming OC Radeon RX 7900 XTX 24GB	$850
RAM	64GB (2x 32GB) Patriot Viper Venom @ 6,400 C32	$170
SSD 1	2TB MSI Spatium M570 HS PCIe 5.0 M.2	$200
SSD 2	2TB Lexar NM790 PCIe 4.0 M.2	$135
OS	Windows 10 Home 64-bit OEM (Windows 11 Compatible)	$32
Approximate Price:		**$2,572**

INTEL INGREDIENTS

PART		PRICE
Case	Geometric Future Model 5 **NEW**	$135
PSU	Super Flower Leadex VI Platinum Pro 1,000W 80+ Platinum	$130
Mobo	Asus Prime Z790-A Wi-Fi	$265
CPU	Intel Core i9-14900KF	$418
Cooler	Asus ROG Strix LC II ARGB 360mm AIO	$130
GPU	PNY Verto Overclocked RTX 4080 Super 16GB	$1,000
RAM	64GB (2x32GB) TeamGroup T-Create Expert @ 6,000 C34 **NEW**	$160
SSD 1	2TB MSI Spatium M570 HS PCIe 5.0 M.2	$200
SSD 2	2TB Lexar NM790 PCIe 4.0 M.2	$135
OS	Windows 10 Home 64-bit OEM (Windows 11 Compatible)	$32
Approximate Price:		**$2,605**

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