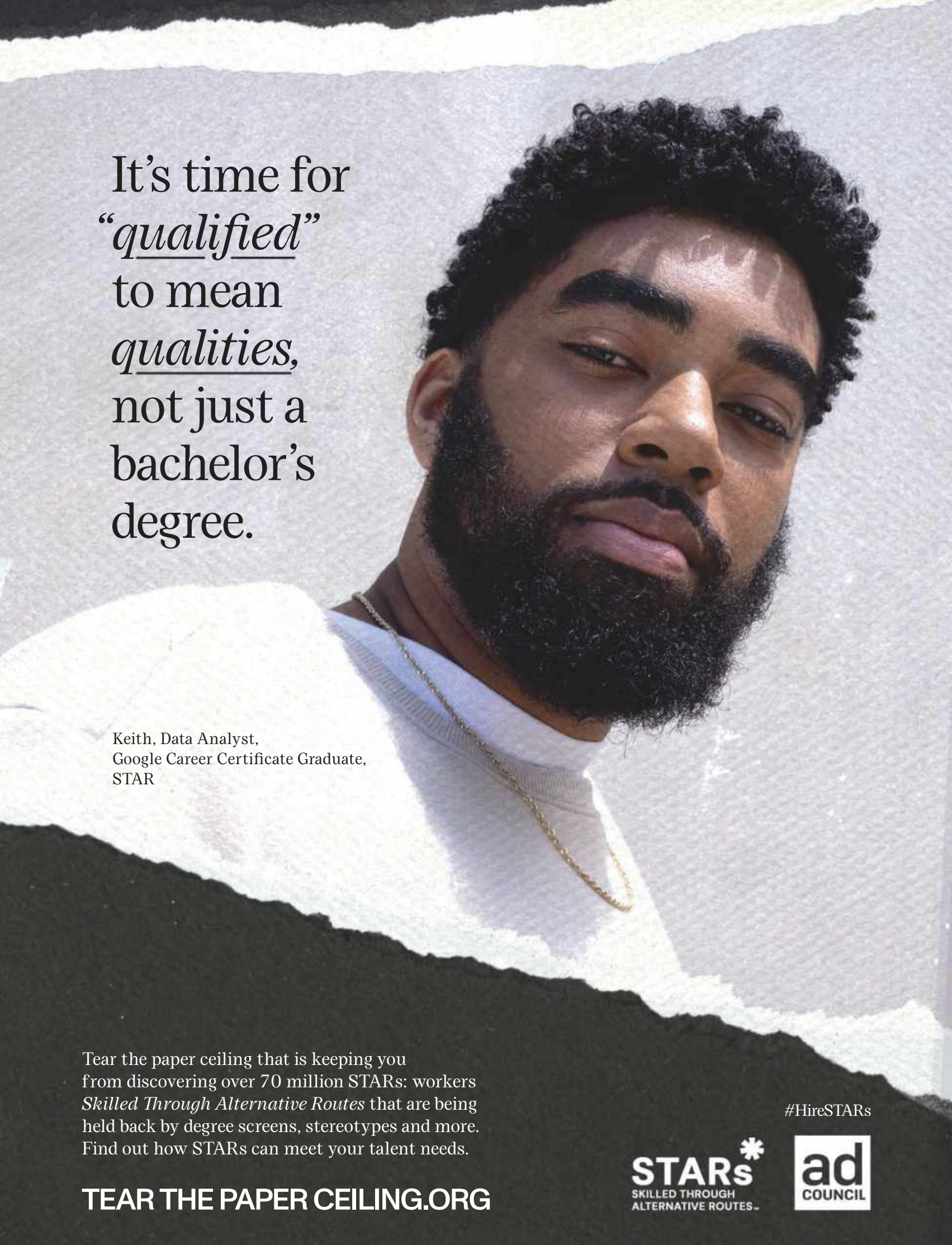**THE BEST PC GEAR**
FROM THE BEST PC SHOW

**REVIEWED: AMD
RADEON RX 7600**

PCWorld

20 AWESOME NEW
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PUBLICATION INFORMATION

MADDY TURNED HATE

Maddy Park
Founder,
@CafeMaddyCab

INTO
HOPE

AND
STARTED
A MOVEMENT

In 2021, the rise of violence against the Asian community made even the simple act of taking public transportation unsafe. So, Maddy started a fund to pay for cab rides for those in the Asian community that needed it most, including women, the elderly, and the LGBTQ+ community. With over $100,000 raised in just two days, she started a movement based on love that lives on today.

love
has
no
labels

ad
COUNCIL

Join Maddy's cause and get the tools
to support the Asian community now at
LoveHasNoLabels.com
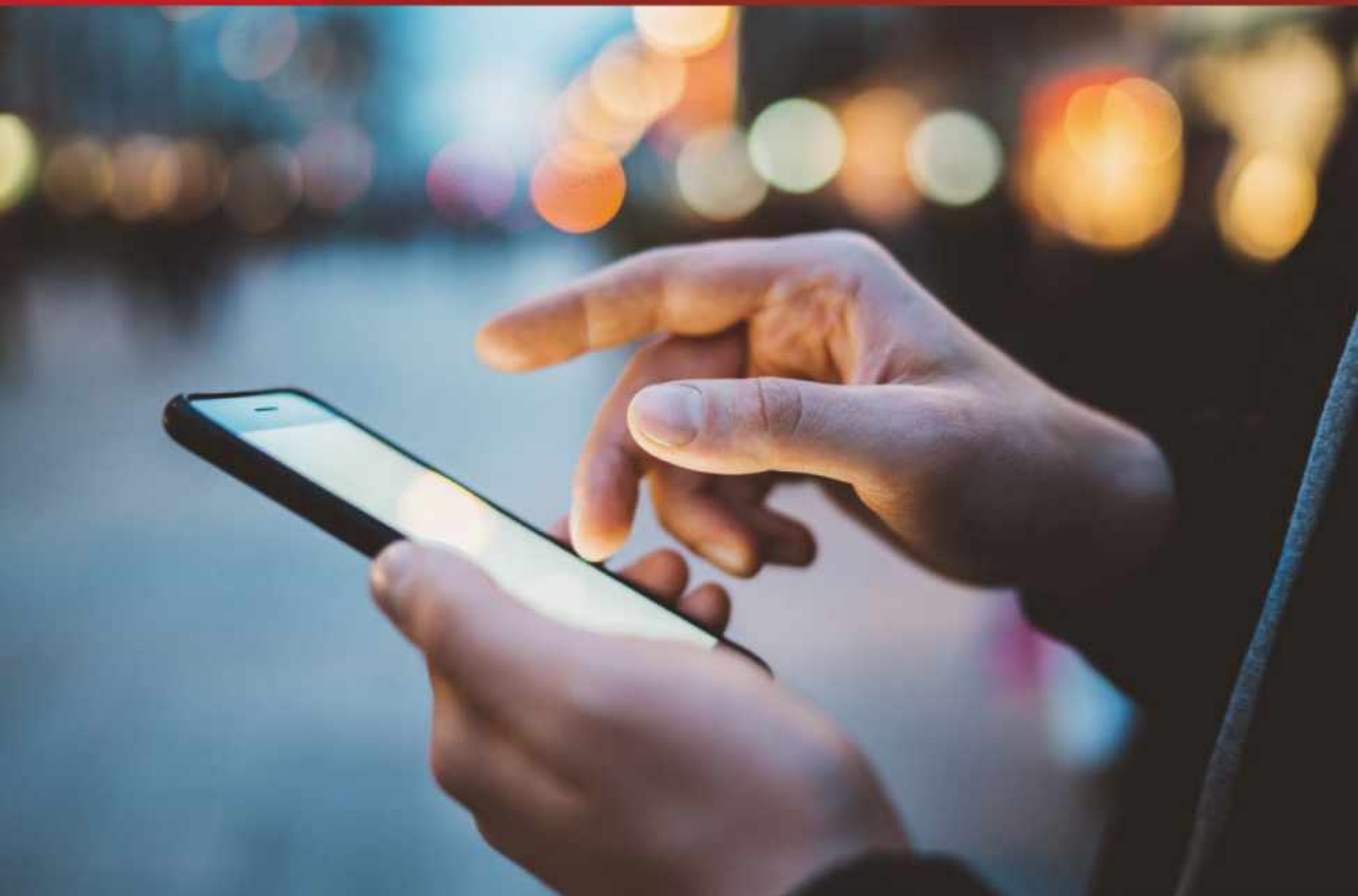
The problem with built-in password managers

Think before entrusting all your logins to Apple, Google, or Microsoft. **BY JARED NEWMAN**

In recent years, it's gotten a lot easier to have better password hygiene without using a dedicated password manager (fave.co/3IRkfRz). Thanks to built-in password management tools on iOS and Android, and at the browser level on Chrome and Microsoft Edge, you can create secure passwords with minimal efforts. These tools are becoming increasingly sophisticated, such that a separate password manager might not be necessary.

But before you tie all your logins with the likes of Google, Apple, and Microsoft, take some time to consider the trade-offs. In exchange for the convenience of their built-in solutions, you'll lose both the

IMAGE: IMYANIS/SHUTTERSTOCK

freedom and features that a proper password manager provides.

BUILT-IN OPTIONS ARE IMPROVING

Relying solely on your web browser for password management used to be a laughable concept.

Sure, the auto-fill features in Chrome, Firefox, and other browsers made logging into websites easier, but they didn't help you log into apps on your phone. They also didn't include some features that were table stakes in dedicated password managers, such as the ability to generate secure passwords when signing up for new services.

As a result, they didn't deliver the main benefit of using a dedicated password manager such as Dashlane or Bitwarden,
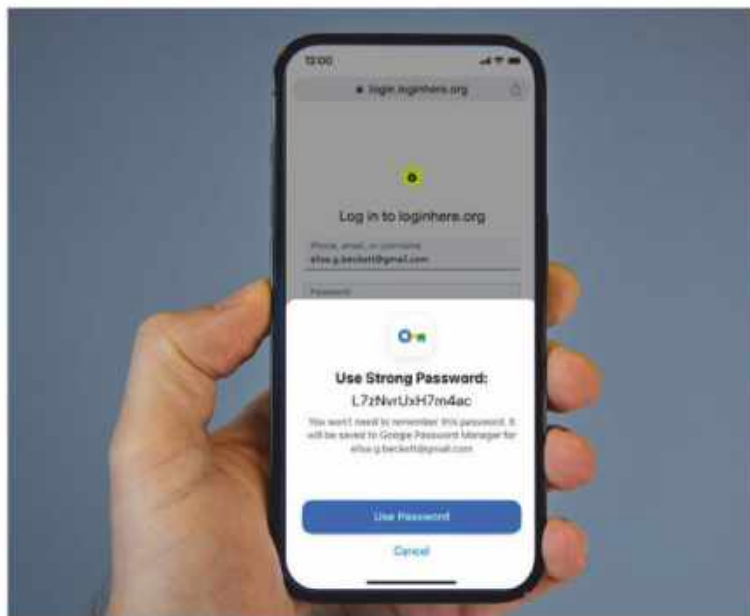

Strong password suggestions are one way built-in password managers are catching up to dedicated ones.

which is to keep you from using the same weak passwords everywhere (fave.co/ 3aXBOgj).

But a lot has changed since then:
- In 2020, Google added auto-fill support in Chrome for iOS (fave.co/3J4jsIj), so if the browser is installed on your phone and synced to your Google account, it can fill out passwords in other apps. (A similar feature launched on Android a few years earlier.)
- Microsoft followed suit a year later (fave.co/43wb5NY), so that Edge's mobile apps (or the separate Microsoft Authenticator app) can fill out passwords for other apps on your phone.
- Mozilla also added auto-fill support in the Firefox mobile app in 2021 after discontinuing its dedicated Lockwise password manager app (fave.co/466Obyq).
- Apple, meanwhile, launched a Chrome extension for iCloud Passwords (fave.co/467XApx) in 2021, so logins you save to iCloud on an iPhone, iPad, or Mac are easily accessible on Windows PCs.

These built-in password managers have also gotten better on the security front. They all have the ability to generate strong passwords on your behalf, and they can alert you to any passwords that are weak, redundant, or stolen. Apple even added two-factor authentication code support (fave.co/45VZXeF) to iCloud in 2021,

Microsoft offers a Chrome extension for accessing your passwords outside Edge.

so you don't need a separate app to help lock down your accounts (fave.co/41SY7rQ).

All of this adds up to a compelling case for whatever password manager is built into your favorite web browser. Compared to dedicated password managers, the setup process is minimal, and they'll likely never cost you anything, so I suspect that lot of people will use those default password tools without even thinking about it.

SO WHAT'S THE PROBLEM?

The main reason I don't rely on any of these password managers is largely about flexibility. I have a borderline obsession with not being permanently tied any particular device or computing platform, and these built-in password managers can ultimately be another mechanism for lock-in.

Since I'm using Bitwarden as my password manager (fave.co/3CkVBAd), bringing my passwords to a new device or web browser only requires installing the Bitwarden app or browser extension, then logging in, and my passwords automatically sync no matter where I am. With built-in password managers, switching can be more of a hassle:

• Microsoft, to its credit, offers a Chrome extension (fave.co/3NiBHMy) for accessing your passwords outside of Edge, but it doesn't offer add-ons for Firefox or MacOS Safari. If you want to use those browsers, you'll need to import your password list from Edge.

• Chrome has no way to sync your passwords in other browsers, so whenever you switch, you'll have to import your Chrome password list.

• With iCloud Passwords, you can't access your passwords on Android or sync passwords in Windows browsers other than Chrome and Edge. And unless you have a Mac, you can't export your passwords to a different service at all.

• Some alternative browsers, such as Vivaldi (fave.co/39Mzhoz), Brave (fave.co/3RBtCTy), and Opera (fave.co/3CDkAiF), don't offer auto-fill features for mobile apps. If you rely on their built-in password managers, you won't have an easy way to log into apps on your phone.
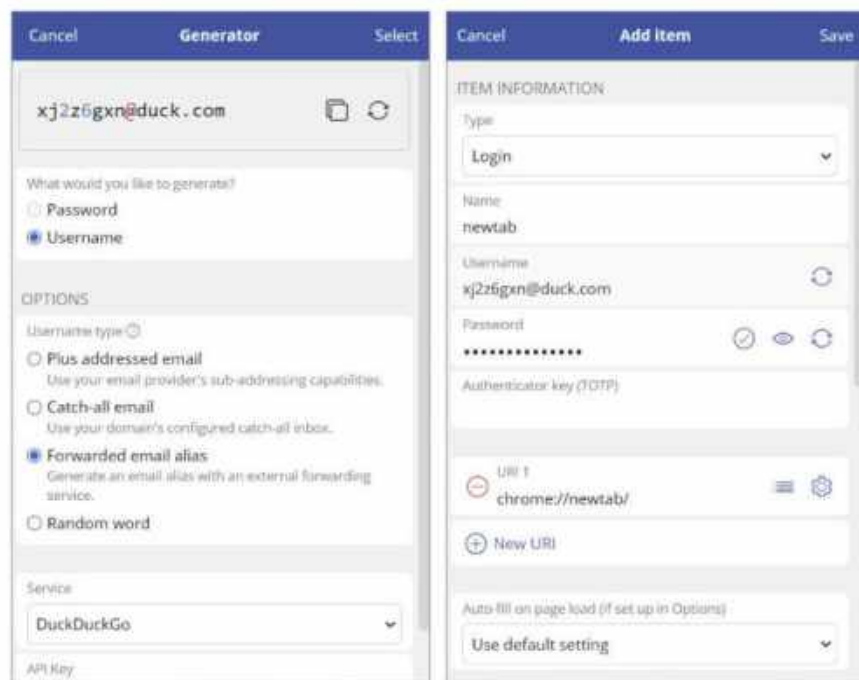
Bitwarden has an array of email masking options.

Lock-in isn't the only reason to consider a dedicated password manager. The major browsers still don't offer group sharing options so that family members can easily log into shared services. Some password managers can also auto-fill passwords in desktop apps—Chrome, Edge, and Firefox can't do this—and they have their own standalone mobile apps that make it easy to view your credentials from anywhere. Bitwarden even lets you plug in masked email addresses (fave. co/3NkYAis) from a wide range of providers, while 1Password integrates with Privacy.com for limited-use credit cards (fave.co/ 3OZXFW3).

But for me, the option to seamlessly switch between browsers or devices is by far the biggest factor. Being able to try new tools—or abandon ones that no longer work well—is important to me, and I never want something as mundane as passwords to get in the way. PCWorld's guide to the best password managers (fave.co/3lRkfRz) can help you find the best option to fit your specific needs. ⏻
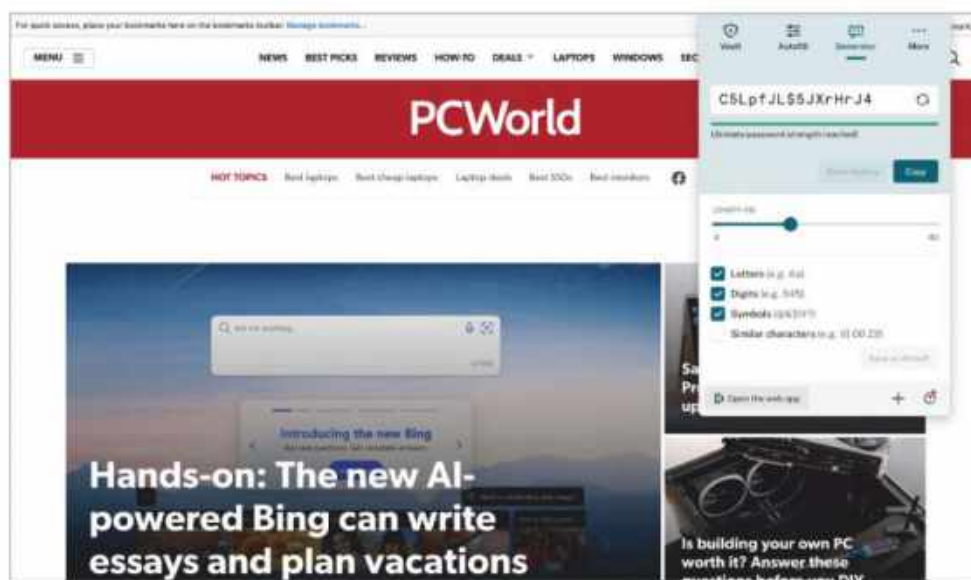
Password managers, such as Dashlane (pictured), relieve you of the burden of having to create and memorize logins on your own.

Apple's Vision Pro rips off the HoloLens, seven years later

What's new here? Microsoft's HoloLens already did a lot of what the Vision Pro does, seven years ago. **BY JARED NEWMAN**

Pinnable windows floating in midair. Three-dimensional dinosaurs. Video calls. 3D castles emerging from the ground. No, I'm not talking about the capabilities of Apple's new Vision Pro VR/AR headset. These are all things Microsoft's HoloLens could do when it launched roughly *seven years ago.*

Apple has a reputation for reinventing technology—and boy, was that underscored by the launch of the Vision Pro at Apple's Worldwide Developers Conference.

For months behind-the-scenes reporting has indicated that even Apple employees have questioned the launch of the Vision Pro, an AR/VR headset that executives said was in

the works for years. But what it actually *is* still isn't as clear as we'd like. Detailed spec pages accompanied Apple's launch of the Mac Studio and the new 15-inch MacBook Air. Not the Vision Pro: We know it supplies more than 12 million pixels per eye, but at an unknown refresh rate. And Apple carefully hid the cable running from the headset to the battery pack—which allows for only two hours of battery life, anyway.

To be fair, the most egregious Apple-esque extravagance, the Vision Pro's price, wasn't that far off the mark. Microsoft originally launched the HoloLens for a whopping $3,000, as a developer device. Apple didn't say so, but the Vision Pro's $3,500 price tag isn't aimed at even a typical Mac consumer.

You'll hopefully hear from our colleagues at Macworld on what the Vision Pro delivers.

Macworld's Vision Pro summary page (fave. co/3J010AI) reveals more about what it is: an augmented-reality headset that can dial into virtual reality at the twist of a dial, with sensors that map the room using a depth camera. The real improvements arrive with how you will interact with content: The Vision Pro tracks your eyes, and external, downward-facing cameras can watch to see if you "click" with your fingers.

Apple has apparently taken a very general approach to what the Vision Pro can do. Can you use it to watch movies? Sure. Can you use it to work in Office, like the Spacetop AR laptop (fave.co/42vdRSm)? Yep. Edit a photo using Lightroom? Why not. Facetime? Sure, including transforming you into an avatar. Bob Iger, Disney's chief executive, even appeared to show a concept reel about watching Disney+ inside AR, and an AR version of Disneyland's Main Street USA.

The Apple Vision Pro will set you back a whopping $3,500.

Is the Apple Vision Pro an entertainment device? A productivity device? Yes.

into a *Minecraft* set, with the ability to "detonate" TNT and "mine" into a coffee table that transformed into a 3D landscape. A demo Microsoft showed off at E3 hints at what we saw, especially the opening snapshot (fave. co/3CnCntX).

It's all cool, I guess. It's just that, compared to the original HoloLens vision, the future that the Apple Vision Pro promises looks so, well, blasé.

HOLOLENS: ONE OF THE BEST DEMOS EVER

The launch of the original HoloLens was something Microsoft never livestreamed. We could only describe it in our hands-on (fave.co/45S17YO), and to my knowledge Microsoft never actually published a walkthrough of its experiences. It was certainly among the best demonstrations I've ever seen, which included the ability to place "holograms" around a room, pin a video window to a wall, and more. The *Minecraft* demo was literally jaw-dropping: The HoloLens turned an ordinary living room

Other demonstrations included participants rewiring a live (as in real-world) light socket, assisted by a pinned Skype window; walking across an AR version of Mars; and more.

Microsoft didn't bring all of these visions to life, including, sadly, the HoloLens version of *Minecraft*. But the original HoloLens sits in my office, and in 2019 I spent a few hours in

The original HoloLens just sits in my office.

our office late at night with Microsoft's AR headset, re-reviewing the HoloLens (fave. co/3P6Ucoz), as it were. Some of the applications were amazing for the time. Even if Microsoft canned *Minecraft*, a similar app, *Conker's Bad Fur Day*, used the depth camera to create platforming AR "levels" out of real-world floors, desks, and chairs.

This video that I captured (fave. co/3CgQQYF), from the HoloLens itself, shows some of the experiences that were available even then. The biggest obstacle? The limited field of view, which made the AR vision more like a porthole than a fully immersive experience.

At $1,500, the competing Meta Quest Pro (fave.co/3oTeqaD) isn't very practical, either. But chief executive Mark Zuckerberg at least reoriented his company around what he called the metaverse, even if Meta Platforms now appears to be refocusing on AI. The Vision Pro looks like Apple doesn't quite understand what consumers will use it for and hopes that developers will come up with an answer. To be fair, that strategy has paid off before, with consumers and developers telling Apple what products such as the Apple Watch are actually good for.

Microsoft, though, didn't care about being dorky. Apple does, and the corded battery pack and weirdly creepy EyeSight—where a front-mounted OLED screen reproduces your face when someone else approaches—don't do Apple's culture of cool any favors. Neither does the battery life. Two hours? That's barely enough time for a movie. Apple also notes that you'll get "all-day battery life" when plugged in. How's that going to work?

The HoloLens could have been the Vision Pro. Again, it had a *seven-year head start*. Microsoft could have trimmed down the weight, added a better processor, and so on. Today, HoloLens is all but dead (fave. co/3MX7jpG). Meta's metaverse isn't that far off, it seems. Apple? Well, it doesn't quite seem to know what sort of device it has on its hands. But some of us, at least, feel like we have seen it all before. ⏻

A 3D T-Rex also made an appearance at Apple's Vision Pro launch.

The War on Cables is the hottest desktop PC trend of 2023

New PC products mean your case's interior will be clean as a whistle. **BY MICHAEL CRIDER**

nternal cable management is the most frustrating part of building a desktop PC. Wait, that's not right—the most frustrating part is making sure all your parts are compatible. Okay, that's not right either—the even more frustrating part is how expensive all those parts are. But cable management is definitely in the top five,

especially if you like to tinker frequently with your setup. There's an emerging trend for PC hardware this year, and the PCWorld editorial staff has christened it the War on Cables (fave. co/43xR09Q).

PC hardware manufacturers are coming up with ever more elaborate tricks to keep your desktop enclosure nice and tidy,

eliminating power and data cables whenever possible, and when not, tucking them all behind the motherboard so the main chamber looks like a minimalist office lobby. (I guess that would make the CPU cooler than the massive reception desk?) You can leave that lobby bare, or fill it up with nerdy stuff to show off through your case's big window.

I suspect this trend really got started years ago, when motherboards started coming with M.2 slots. When system builders could stick primary storage right on the motherboard (fave.co/40dU7Bm) and get rid of both power and data cables for SATA, it started an itch. They're now itching that scratch, and we're seeing it in new design tweaks for motherboards, fans and liquid coolers, lighting, enclosures, and even graphics cards.

GIVING PROPS TO GIGABYTE

For a more recent and applicable starting point, we look to Gigabyte's Project Stealth (fave. co/3WZKmqz), which goes back to 2022. The idea is simple: Take all the cable connections on the motherboard, for the power supply, fans, the case's front panel power switch, USB, and audio, and even SATA ports, and stick them to the back of the board instead of the front. This requires a bit of a

redesign of the case itself, in order to plug everything in the rear. A slightly customized GPU rounds out the package, with the power connections facing the bottom of the graphics card instead of the top or side.

If this is done correctly, you can run every cable in the system through the back of the board, with the notable exception of whatever you're using to cool your CPU. You can actually buy Gigabyte's Project Stealth as a pre-built package right now on Amazon (fave.co/3MXufFd), though it's a bit pricey for just a case, a motherboard, and a last-gen graphics card, and the board's chipset is from 2021. A new Stealth 500 (fave.co/3P2BwpW) kit was announced at CES this year, though it appears to be using most of the same specs,

You can buy Gigabyte's Project Stealth as a pre-built package.

just with a new case design and some included fans.

That's okay. Gigabyte isn't the only company on this train: New motherboard designs from Asus (fave. co/3NIgNwt), Maxsun, and MSI are following the trend. The latter has its own "Project" moniker for this new design language, Project Zero (fave.co/3P4r7dE). Once again, you need a compatible motherboard and case to make it all work—MSI's initial version is in the slightly smaller MicroATX version, though standard ATX is coming. MSI says it's willing to make cases and boards that are compatible with the products of other manufacturers, cementing the hope that this could become an industry-wide trend.

Corsair's RMx Shift power supply line rotates the conventional position of the power supply 90 degrees.

OTHER COMPONENTS FOLLOW ALONG

The case and the motherboard are the biggest pieces of this puzzle, but other components are being redesigned with a clean interior in mind as well. Corsair's RMx Shift power supply line (fave.co/45T6MOh) is notable, as it literally rotates the conventional position of the power supply by 90 degrees. That puts all the modular cable connections on the side of the PSU, facing the same side of the case as the rear of the motherboard.

Again, combined with rear-facing headers on a board, that means every single power supply cable (with the possible exception of your graphics card and any non-M.2 storage) can be handled on the backside of the case, with nothing in the front chamber.

Let's get back to Asus, which has already committed to making at least one motherboard with rear-facing connections. The graphics card has been a sticking point in all of this, especially since it's something you'll probably replace more often than your processor or motherboard. Asus has fixed that with the GPU-motherboard combo it's showing off at Computex. In this iteration there's no cable going to the graphics card at all, because the custom RTX 4070 card plugs into a custom header just to the side of the PCIe port. The power cable is technically still there, hiding the new 12VHPWR standard on the back of the motherboard and transferring

**Asus showed off a GPU with no cables at Computex.**

all 600 watts to the card via the less-obtrusive port.

This solution still requires both your motherboard and graphics card to match, which is probably why it appeals to Asus, maker and seller of both components. But there's no denying that it's the sleekest way to do this we've seen thus far. If you're too young to remember Windows Millennium Edition, you might not remember the days when graphics cards didn't require dedicated power rails. But trust me, it made internal cable management a lot easier. Sadly, there's no indication of whether this idea will make it to retail.

One system that is coming to an electronics store near

you (if there are any such stores near you, anyway—it's not like they're still selling Windows ME) is Corsair's new iCue Link. This "ecosystem" of cooling and lighting accessories uses a custom hub and wiring system to let you daisy-chain any number of fans, AIO heads and radiators, and even coolant reservoirs along the same cable for power and data. Ideally implemented—with Corsair's proprietary and probably expensive gear, natch—this will allow you to string every cooling and lighting element inside a PC case along just one power and data cable. The way fans connect in arrays, like little LEGO blocks, is especially impressive.
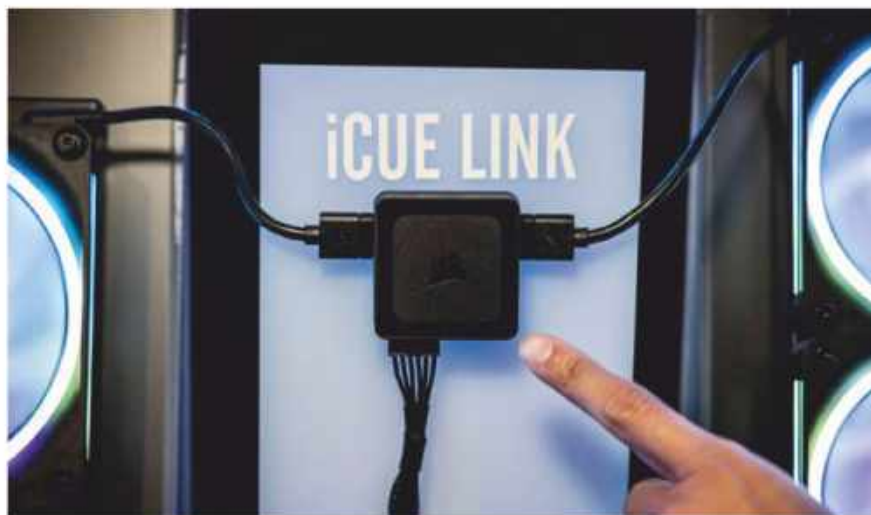
Corsair's iCue Link is designed to simplify the process of PC building.

WHEN WILL THE REVOLUTION ARRIVE?

So when can you get all this wonderful tech for your next desktop build? Hard to say. Corsair's new power supplies are already out, and the iCue Link is scheduled for release within a month or two. The rest of the products shown off at Computex will be arriving in the latter half of 2023 or early 2024, if they progress to retail availability, given their project and prototype status.

I suspect that we'll see this trend evolve more slowly than some would like. Something akin to the shift to tool-free enclosure designs would be my guess. Eventually a super-clean, cable-free primary chamber will be the standard instead of the exception, but it'll take a few years for everyone to catch up. At that point cases will have even more big plastic and glass windows, all the better to show off the Funko Pops and LEGO sets you can now perch on your GPU—contain your excitement, /r/ Battlestations posters.

Will it actually make a difference for performance? Probably not. A big, open chamber looks good through plexiglass, but as far as actual cooling performance it's more important to have your fans

and radiators properly placed and keep everything dust-free. And it's worth noting that a lot of these innovations probably won't make it to small form factor designs, like the gorgeous new Fractal Design Terra. Those cases are pulling every engineering trick they can just to cram components together without catching fire; they can't spare any thought for aesthetic cable management.

And this trend is, at its core, aesthetic. But I for one appreciate a clean interior build a lot more than a techno rave's worth of RGB LED lights, or extraneous screens strapped to every internal component (which, now that I think of it, will only get more numerous without cables in the way). Now if only they can figure out a way to get an all-in-one liquid cooling setup to be "cable free," we can have some real fun. ⏻

MSI's Project Zero removes "any visible circuits or cabling on the front" (fave.co/3J87RYQ).

Getting true USB4 speed is still a huge headache

Apparently there's a big difference between "USB4" and "USB 4.0." **BY MICHAEL CRIDER**

How do you know if a fancy USB4 external storage drive (fave. co/3n5NIMC) is really using the full speed of USB4? If you're just looking at a box on a shelf, the answer is, "You don't." As a standard, especially if you're looking for those fast file transfers, USB4 is still a confusing mess of techno-babble that makes it easy for manufacturers to label a substandard drive "USB4" without delivering

the performance that this implies. Gordon breaks it down for you in the latest PCWorld video on YouTube.

To start with, did you know there's a difference between USB4 (no space, a copyrighted term referring to the specification

> VIDEO: **USB4 ISN'T CUT AND DRY**
> Watch now at fave.co/3Xm6ueO

The ZikeDrive Z666 enclosure.

the huge differences in speed we had back in the USB 1-to-2 days. The delta between a true, maxed-out USB4 drive and one that falls back on Thunderbolt 3 is about 20 to 25 percent—not great, but not the end of

from the USB Implementers Forum) and USB 4.0 (note the space)? Well there is, and it affects which controllers the circuit board inside than fancy drive is packing. To be brief, a drive labeled "USB4" (like the ZikeDrive Z666 enclosure, fave.co/3J7YEzF) can't skimp out on older parts that are merely "compatible" with USB4, while backing up to older USB or Thunderbolt standards.

But there's another element that might prevent you from getting maximum speed, and it's one you might have less control over. Small drives aren't the only hardware that cheaps out on USB controllers, and even an expensive laptop (fave.co/3qL4oHf) or motherboard (fave.co/40dU7Bm) that's a generation or two old might not be able to hit USB4's maximum speed (even if it's certified for USB4).

Granted, we're not talking about

the world, either. But if that difference is important to you, check out some in-depth reviews of both the external drive you want and your own laptop, desktop, or motherboard to make sure you can hit maximum speed. (Our roundups of the best external drives (fave.co/3n5NIMC) and best gaming motherboards (fave.co/40dU7Bm) can help you find great products quickly.)

For more deep dives on the latest tech, be sure to subscribe to PCWorld on YouTube (fave.co/43VPiik). ⏻

Thunderbolt 3 and USB4 aren't the same, just closely related.

After 21 years, Windows XP's activation algorithm fully cracked

The crack lets you use Windows XP unrestricted, but you should let the dead remain at peace. **BY ALAINA YEE**

Microsoft may have sent Windows XP off into the great unknown in 2014, but the operating system never fully went dark. Never mind that yet two more versions of Windows have been put to rest since XP's final days. Against the advice of just about everyone, the efforts to keep XP usable have continued—as evidenced by recent news about a crack that enables offline validation of Windows XP product keys.

Previously, getting Windows XP to activate required circumventing Microsoft's validation process or using a third-party server to fool XP. But as documented by tinyapps (fave. co/3Crem5f), a blog dedicated to floppy-drive-size Windows programs, a new validation technique came to light last year.

A Windows XP desktop, with the "Bliss" image in the background.

An app shared in a thread on the Windows XP subreddit not only performs Microsoft's official activation process, but does so offline. Users can run the app freely, and afterward, they can reset the PC as much as they like without having to revalidate their copy of XP, too.

But as noted by The Register, fave.co/43QPuiX (which first spotted this news), virtually no one should be running Windows XP these days. While this crack is a lifeline for folks stuck supporting ancient software that only runs on an equally decrepit operating system, everyone else should be on a supported version of Windows (that is, Windows 10 or 11). In its heyday, Windows XP had plenty of security issues—and now that it's ostensibly in the grave, it's even more vulnerable to today's online threats.

That won't stop the still-lingering resistance against migration, of course. But for the overwhelming majority of Windows users, you're much better off leaving the past where it lies. If you must indulge nostalgia, you're best off doing so briefly within a virtual machine (fave.co/43zPhRA)—or just gawking at this news and then moving on. ⏻

Everyone should be using a supported version of Microsoft's operating system, such as Windows 11 (pictured).

Meet Spacetop, a radical new laptop with no screen

Sightful's Spacetop AR laptop is brought to you by the chief executive behind the Microsoft Kinect. **BY MARK HACHMAN**
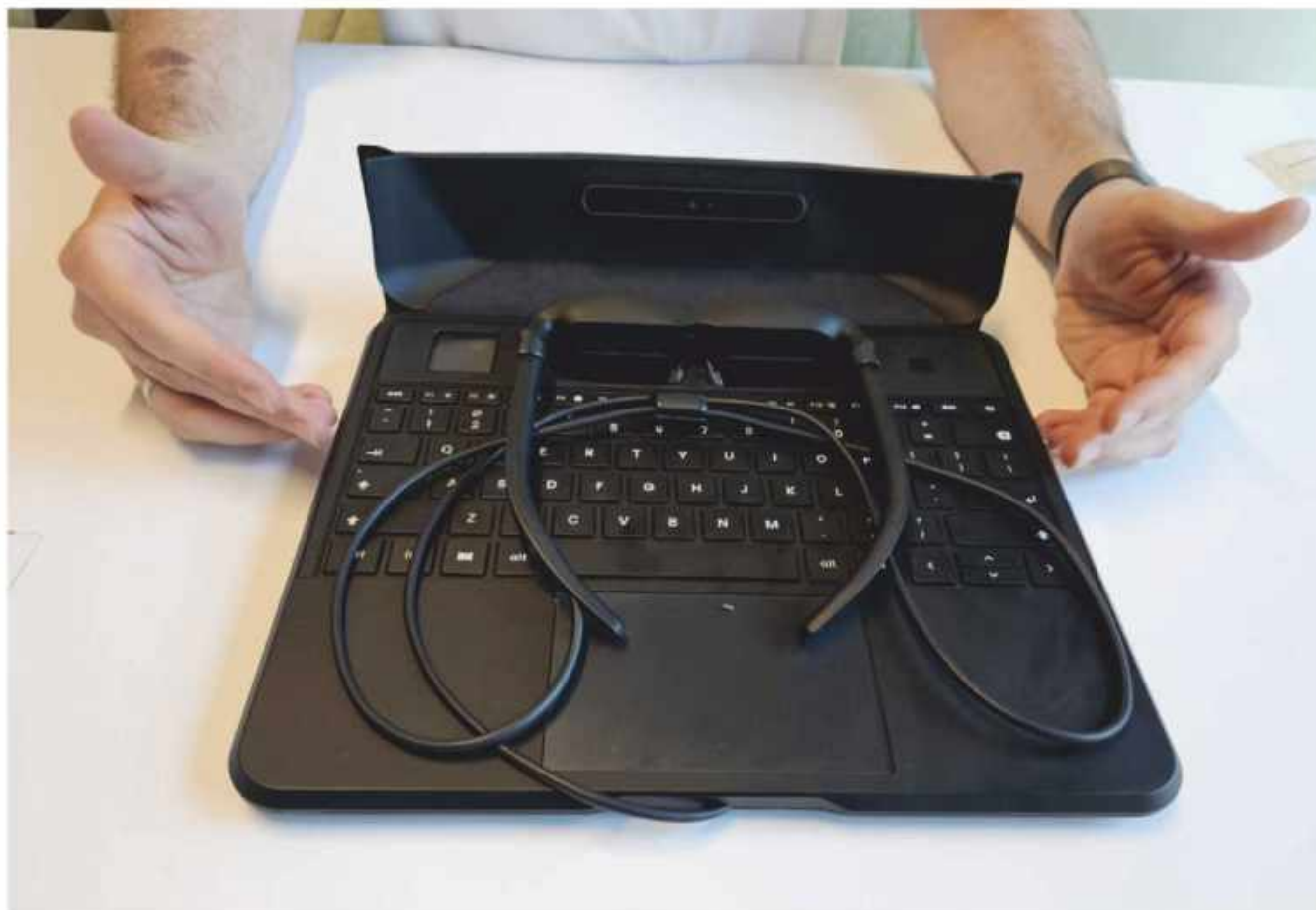
Laptops have a problem: the screen. There's only one, and it's too small, too far away, and too public. Sightful thinks it's solved that problem with the Spacetop, a laptop that gets rid of the screen entirely and uses augmented reality to create a 100-inch virtual display floating in front of your face.

And you know what? It works.

It's immediately apparent that something is different. Clamshell laptops fold flat and thin; the Sightful Spacetop looks more like a rubberized, squarish calzone, wrapped in the sort of protective cover you'd see enfold an Apple iPad or Amazon Kindle. Unfold the cover, and what makes the Spacetop special

is revealed: a pair of thin, tethered, augmented glasses that sit where you'd expect to find the laptop's display planted.

Put simply, the Sightful Spacetop is designed for business travelers who want a laptop with a massive, private "display" that no one else can see. Put the glasses on, and a massive, curved virtual monitor appears before you, reaching above, below, and to the sides. You can pin and resize windowed apps: Gmail, YouTube, Word, Microsoft Teams. The Spacetop is a device you could use on a plane flight (if you don't mind the odd looks), in a business or airport lounge (ditto), or even working in a conference room where you'd like a bigger screen.

Priced at $2,000, the Spacetop is purpose-built as a business tool, with an optimized Arm processor, AOSP (open-source Android) operating system, and, of course, the custom headset. But you'll need to act fast: Sightful is inviting just 1,000 early adopters to purchase the final hardware, enticing them with the opportunity to provide feedback on subsequent products.

SPACETOP'S SURPRISINGLY SIMPLE HARDWARE

We're not here to tell you that the Sightful Spacetop will eliminate the conventional

We're not sure if the Spacetop's soft cover will offer much in terms of protection.

laptop. Facebook (now Meta) made that pitch before, both with its "virtual office" (fave. co/43ziZGi) concept and later with the (failed?) Meta Quest Pro's virtual office environment (fave.co/42D5mod). Having tried both, though, the difference is clear: Spacetop's augmented glasses are both lighter and sharper than what Meta provided, meaning there's less potential fatigue. Text was absolutely legible, unlike with the Quest Pro, and there was little to no lag while moving the headset back and forth.

Beside its unusual silhouette, the Spacetop chassis doesn't look all that different from a conventional laptop—at least the bottom of it. The chassis measures 10.47 inches wide and 9.8 inches deep and weighs 3.3 pounds, including the headset—very similar to a conventional laptop. The base is

The Spacetop's tethered headset, along with its corrective lenses, which magnetically snap in.

connect an external display, if you're dying for one.

But why would you? The most important hardware is what's tethered to the front of the chassis: the headset, which delivers 1080p resolution per eye, at 72Hz. The headset (146×175×44mm, unfolded) weighs 106 grams, which is about a quarter of the weight of the almost-defunct Microsoft HoloLens (fave. co/460FxBc), another augmented-reality device.

certainly thicker, though, at 1.57 inches. Sightful asked Wistron, a Taiwan ODM that makes laptops under other manufacturer labels, to build the Spacetop.

Inside, there's room for future improvement: Sightful built the Spacetop around a Snapdragon 865 (fave.co/3NqnLQA) from 2019, rather than the more advanced Snapdragon 8 Gen 2 (fave.co/3K0wKXk), for example. Specs include 8GB of RAM and 256GB of storage, fairly standard for a laptop. Naturally, wireless (5G NR Sub-6, Wi-Fi 6, Bluetooth 5.1) features heavily. You also get a 2560×1920 webcam, which is slightly better than what other laptops offer, plus a fingerprint reader. There's even a pair of 10Gbps USB-C ports with DisplayPort 1.4 capabilities, so you can

THE SPACETOP HEADSET IS LIGHT, TOO

Looking through the HoloLens was like looking through a porthole: the field of view, fave.co/42AfyOb (30 degrees horizontal, 17 degrees vertical) was much smaller than the 53-degree diagonal FOV the Spacetop provides. That's a decent compromise between focusing on a task and being aware of your surroundings, the excuse Microsoft used (fave.co/3oSiNTA). Sightful puts most of the "viewscreen" to the top of your vision, so there's a clear, unobstructed way of seeing anything at your feet that you might stumble over. VR nerds will appreciate that the Spacetop headset supports interpupillary distances of 56mm to 70mm, as the width between people's eyes does vary.

The Spacetop resolution is somewhat less than that of, say, the Meta Quest, which provides 1720×1890 pixels per eye, at 72Hz to 120Hz. But the Meta Quest lineup is designed for *virtual* reality, and the Spacetop supplies *augmented* reality—which is to say that the default view is like looking through a pair of sunglasses, a neat cheat to darken the background without totally occluding it. That still means you'll prefer a "light" desktop theme to contrast the windows with the background.

No, you can't wear the Spacetop headset with glasses. To get around that, Sightful has made a generous concession: Send the company your prescription, and Sightful will craft a set of personalized lenses that will magnetically clip into the Spacetop frame—for free!

Sightful CEO Tamir Berliner holds the Sightful Spacetop headset.

HANDS-ON WITH THE SIGHTFUL SPACETOP

We had a short time to play around with the Spacetop, guided by chief executive Tamir Berliner and chief technical officer Tomer Kahan. (Their backgrounds bode well for Sightful's success: Berliner co-founded PrimeSense, whose technology gave us the Microsoft Kinect and the iPhone's Face ID. Kahan worked at N-Trig, a company later acquired by Microsoft to develop the Surface Pen. Both employees worked at Magic Leap, then left when the company re-oriented on the enterprise market.)

Put the headset on and the Spacetop environment reveals itself: a large, virtual screen with windows of all sizes, curving around you. It's like a giant Corsair Xeneon Flex (fave.co/3Npr22T)—but about double the size. If you absolutely must have one, two, or even three displays at home, you may very well love the Spacetop.

Inside each window Berliner trustingly put real data: a Gmail window, a calendar, YouTube, and more. Navigating through them is the same as in Windows: You use the trackpad to drag a cursor around, resize windows, and reposition them on the screen. Unlike Meta, there are no goofy controllers; this

experience feels so similar to a laptop that I picked it up almost immediately.

The only key differences are in a gesture: a three-finger swipe up and down on the touchpad brings the curved "screen" closer or further away. This not only helps make the experience more comfortable, but also allows you to "lean in" to a given window for a closer look. In an interesting HoloLens-esque touch, the display can be "pinned" to a given location, then recalled to the laptop by tapping both Shift keys simultaneously.

A small "taskbar" floats in the center of your screen, allowing you to add windows and select apps. Since this is an open-source Android OS, the selection of apps leans heavily on productivity (office apps, basically).

I used the Meta Quest Pro's virtual workspace, and Spacetop blows it away. For

This is a mockup by Sightful, but it's pretty accurate. I recall the background being darker, however.

one, even with a very odd prescription (one eye is nearsighted and one farsighted), the default corrective lenses Sightful had available worked well. Text was sharp and usable, and I'd attribute any blurriness to my eyes, not the hardware. I don't recall any lag when moving my head back and forth, and while the 75Hz lenses weren't as easy to work with as a high-refresh-rate screen, I didn't walk away with any of the vertigo I got with the Quest Pro. In part, that's because of the lens arrangement: There's a clear space at the bottom of your field of vision to see the keyboard; Meta tried to carve out a portion of its VR space to achieve the same effect, and it didn't work.

The headset, though light, felt a bit front-heavy. Kahan said the device will ship with a pair of small weights, which can be clipped and adjusted to balance the headset. While it never felt like it would fall off (a nose clip prevents that), it was slightly distracting. Could I work within the Spacetop environment for hours? I can't honestly say.

There's one neat trick that the Spacetop does that you won't see anywhere else. The small Spacetop logo can be

tapped to dismiss the UI entirely, returning you to "reality mode" to pay close attention to a coworker. But the logo can also *change*, transforming into a glyph that others can scan with their phone to share files—or, as Berliner reveals, eventually it will allow you to join a collaborative whiteboarding session.

Remember, the Spacetop does include a pair of 10Gbps USB-C ports, with DisplayPort 1.4 capabilities—so if you're dying for an external monitor, it appears the Spacetop can assuage those concerns.

There's one key weakness: the battery life. It clocks in at just over five hours, which is quite small for an Arm laptop as well as laptops in general. The Spacetop will charge to 85 percent in less than two hours, however. The headset also includes some small speakers, which sounded tinny and faint. Berliner said the low volume was designed to maintain privacy.

You can use the Spacetop's small logo button to create glyph links to various shared documents and eventually shared experiences.

GRAB A SPACETOP WHILE YOU CAN

We're left with the same impression that Magic Leap instilled (fave.co/43urJgO): This is terrific technology, but at $2,000, it's a steep investment. Sightful's public stance, however, is impressive: Rather than hype up an unproven technology, it's remained very focused on selling the Spacetop as a productivity solution. This is not a frivolous device at all.

Remember, there are only 1,000 Spacetops to go around (right now). If you want one, you'll have to sign up at fave. co/3Nmht4y to apply.

Sightful is launching the Spacetop at a time when many tech companies and consumers are tightening their purse strings. It will take some time with the new headset to tell whether the investment is justified. The Spacetop could be an absolutely novel, potentially game-changing product with the capacity to rewrite the market or just another expensive venture defeated by the status quo. We'll see.
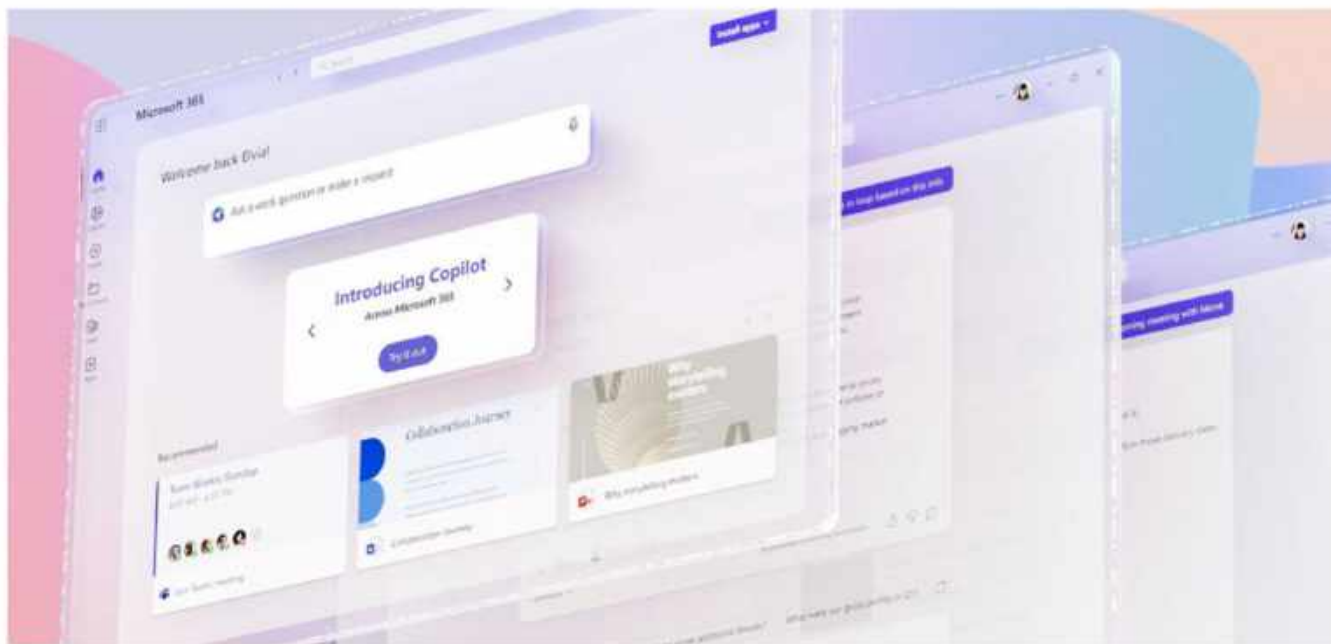
5 ways Windows 11's Copilot AI assistant will make your life easier

Windows Copilot debuted in June. But what kind of a PC will it require? **BY MARK HACHMAN**

Microsoft offered its first look in May at Windows Copilot, an AI-powered assistant that appears to be a one-stop shop for managing all sorts of tasks within Windows 11.

Microsoft showed Windows Copilot (fave.co/3N0trzG) standing in for Bing Chat (fave.co/3JYcfu4), the AI chatbot that's rivaled OpenAI's ChatGPT as the main AI assistant of the Web. But Windows Copilot appears to be much more, as a concierge of sorts for everything your PC *and* its apps can do. There's a real question, however, of what class of hardware

Windows Copilot will demand—and in May Microsoft offered the first hints of how it may manage the diversity of PCs that wish to run it.

Windows Copilot, at least at that first glimpse, appears to be a sidebar that for right now will open up as a column on the right side of your screen, where your Windows notifications typically reside. While Copilot leans heavily on text, Microsoft showed it interacting with photos and even files.

> **VIDEO: ANNOUNCING WINDOWS COPILOT**
> Watch now at fave.co/3r0tZy8

Microsoft chief executive Satya Nadella introduced the following video at his opening keynote, and chief product officer Panos Panay played it again during his keynote address as well. It's a short overview of Windows Copilot's capabilities, before Panay offered more of a hands-on demonstration later on in his speech.

REPLACE BING CHAT

We've already seen Bing Chat, Microsoft's AI-powered chatbot, in Windows—kind of (fave.co/3JYcfu4). Windows Copilot looks like the more sophisticated version we originally anticipated. The video opens by claiming Copilot will offer "answers to complex questions," such as "help me plan my fishing trip." That sounds like Bing Chat to us.

Likewise, Panay copied a bunch of code and asked Windows Copilot to interpret what it is and what it does. Again, that's a capability Bing Chat has been able to fulfill. In his own demonstration, Panay typed in "how can I adjust my system to get work done." Copilot assumed he was referring to a Windows 11 system, and provided an answer accordingly. On the Web, Bing Chat doesn't make the same assumption. That could mean that Copilot is searching local help files rather than looking on the Internet. Why does that matter? We'll talk about that more below.

AN AUTOMATED SETTINGS ASSISTANT

There's a case to be made that Windows Copilot is an admission that Windows is just too complex for ordinary users, who feel like they can't use it to its full advantage. "Control your Windows environment," the next suggestion, will save you from digging through menus and apps for specific tasks like turning on dark mode (fave. co/3CmzYiX), for example, or something a little broader like suggestions to use Windows to ease eye strain (fave. co/3oWYHHA). It's the latter that benefits from Copilot, in that suggestions like "adjust my settings so I can focus" need some intelligent interpretation.

Interestingly, when Panay asked Copilot to adjust his system to get work done, Copilot launched Windows 11's dark mode and its Focus mode by itself.
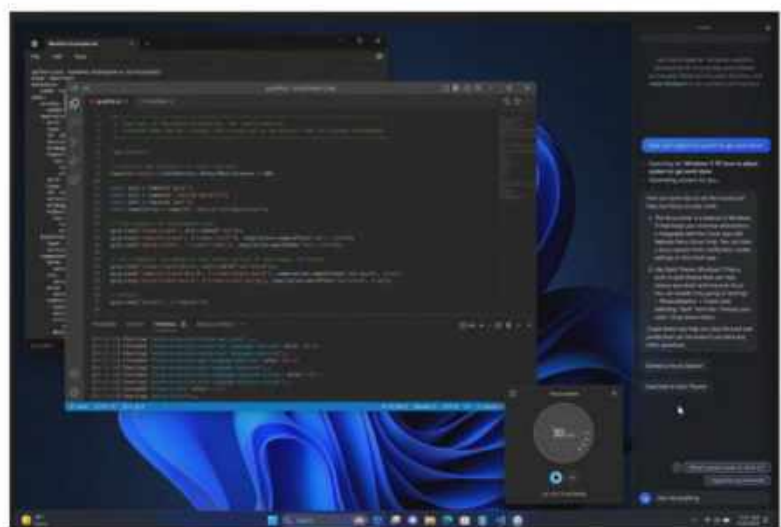
Windows Copilot switched to Windows to dark mode and launched a Focus Session.

WORK ACROSS DOCUMENTS

Windows Copilot will adapt some of the features in Microsoft Edge Copilot, namely AI summarization and content creation (fave.co/3MECho4). This is why we think Microsoft 365 Copilot (AI for Office apps) might be Microsoft's killer AI app (fave.co/3MKgkEd), in that it will save time reading and responding to information. There's no indication that you'll need a Microsoft 365 subscription for this, yet, but we almost certainly expect a Microsoft account will be necessary.

LAUNCH APPS

In his demonstration, Panay asked Copilot, "What's great music to work to?" Copilot responded by opening Spotify and suggesting three playlists. The two big next steps in Bing Chat and OpenAI's ChatGPT are plugins and web browsing—sources of information to supplement what both already know. On the PC, it seems that the "plugin" will simply be apps like Spotify.

Later, Panay asked Windows Copilot "how do I create a logo for my business?" and Windows Copilot not only responded, promoting Adobe Express, but also opened the app as well. It then sent the logo to a coworker, using Teams.

Of course, that suggests the question: What, if any, apps will Copilot not be able to launch or understand?

AUTOMATED TRANSCRIPTION

Voice transcription is near and dear to our journalist hearts, as it's always handy to have a comprehensive, textual record of what someone actually says. Microsoft has made this part of its business services (Teams, mainly) for a number of years now, but it looks like it will come to Windows, too. Panay dragged an MP3 recording into the chat box (interesting in and of itself!) and Windows Copilot began generating a transcription.

WHAT WILL WINDOWS COPILOT'S HARDWARE REQUIREMENTS BE?

All of this begs the question: How will Windows Copilot actually *run*? Recall Windows 11's strict hardware requirements (fave.co/3C7aDbn), and how they evolved: first a Trusted Platform Module, then not (fave.co/2XwO3JY), and finally some middle ground between the two. Likewise, AI art apps like Stable Diffusion (fave.co/3kzk7rZ) can run on local PCs, but they've traditionally run best on laptops or desktops with discrete GPUs and lots of video memory to run the algorithms, plus storage to store the code itself.

CPUs with dedicated AI blocks attached to them add another wrinkle. Qualcomm's Snapdragon 8cx Gen 3 processor has a Hexagon DSP attached to it specifically for AI processing, while the AMD Ryzen 7040U
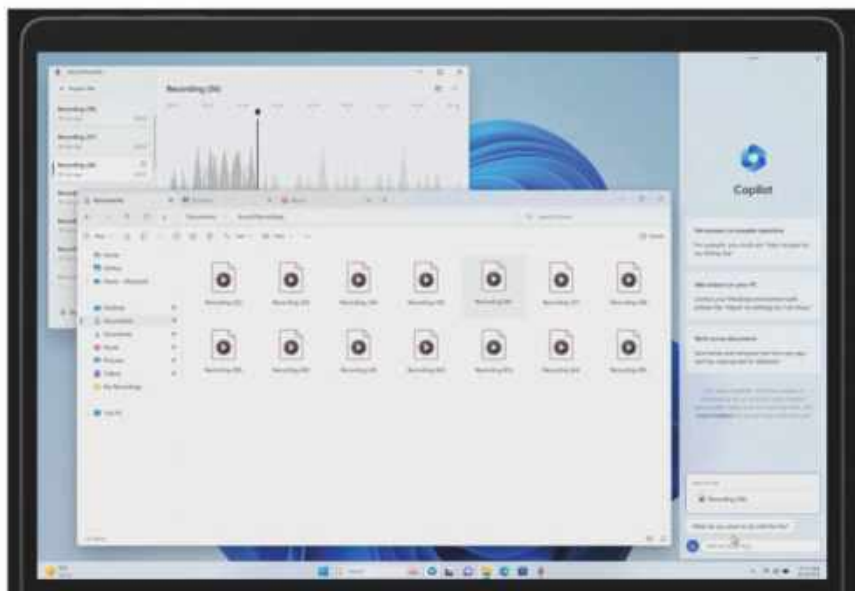
Dropping files into Windows Copilot for transcription or analysis seems pretty cool.

(fave.co/3X3tCPc) and its Ryzen AI block (fave.co/3qINNpl) pack dedicated AI hardware too. Specific Intel 13th-gen Core chips have a Movidius AI card attached, and Intel's Meteor Lake will have integrated AI (fave.co/3XwKbST), according to chief executive Pat Gelsinger. All these, however, make up a small percentage of the available PCs.

We don't know how Microsoft plans to address this disparity, but we do have a few hints. For one, Microsoft launched machine-learning API Windows ML (fave.co/3P7nzav) a few years back to address AI, but without any killer apps, it faded from public view. In May, Microsoft said it's working with AMD, Intel, and Nvidia to optimize their transformer and diffusion models to run AI locally on their hardware. Nvidia's latest Game Driver can double AI performance (fave.co/43Rgv5V)

for apps like Stable Diffusion, and AMD will release optimized drivers for AI on its Radeon RX 7900 GPU (fave.co/3kFEZ0q) and Ryzen 7040 CPU in June, Microsoft said.

There's still the question of whether local hardware can keep up with the demands of Windows Copilot and other AI. For that, Microsoft might apply something called Hybrid Loop, which would allow the cloud and the PC to work in tandem. At Build, Pavan Davuluri, a corporate vice president a Microsoft, said that Hybrid Loop makes Microsoft's Azure cloud "show up just like a co-processor in Windows, just like an NPU or a GPU." That might allow a PC to use a local GPU or AI co-processor for as much processing as it can, tapping the Azure cloud if it can't keep up.

That still doesn't answer the question of how Copilot will work on your PC, especially if you don't have the absolute latest hardware. We asked Microsoft for comment, and company officials responded that they have nothing official to share. Rest assured, however, that if Microsoft is as driven as it seems to make Windows Copilot part of your PC, it will need to solve these problems. The answer, though, might demand that you buy a more powerful PC. ⏻

Bad firmware updates teach PC users the wrong habits

Don't drive people to avoid necessary patches that protect them. **BY ALAINA YEE**

Trust is everything. I'm not an IT expert, but I have spent decades fielding questions and tending to devices belonging to friends and family. They know I'm going to look out for their best interests.

But sometimes when I'm called to action, I discover my nearest and dearest have been making decisions that can harm them—for example, not installing security patches or other firmware updates. And it's because their suspicion of a company outweighs their belief in me.

I can't always talk them out of the behavior, either. That's especially the case when the situation is like that with HP printers.
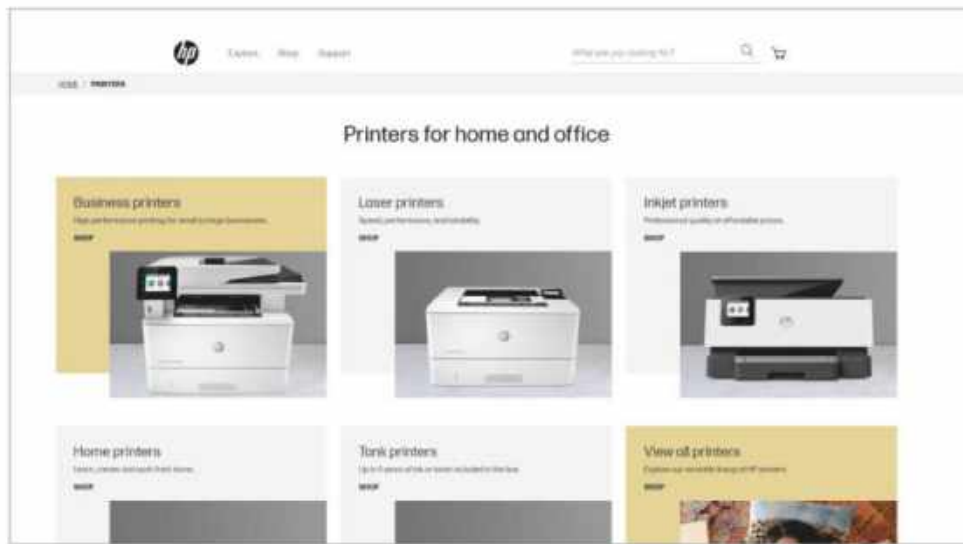
HP has taken to locking down its inkjet printers if you use third-party ink.

Earlier this year, HP doubled down on its so-called "dynamic security" policy, issuing firmware updates for its printers that blocked the use of third-party ink. Instead of issuing warnings about supposed bootleg ink, the printer just won't work.

Understandably, people were put out (including a couple of people I know) about these new draconian measures. They were even more infuriated when they realized that the only thing being protected is HP's bottom line.

"The purpose of dynamic security feature is to protect HP's innovations and intellectual property, maintain the integrity of our printing systems, ensure the best customer printing

experience, and protect customers from counterfeit and third-party ink cartridges that do not contain an original HP security chip and infringe HP's intellectual property," is how HP explains dynamic security on one of its official support pages (fave. co/3CpkzOX).

Adding insult to injury was HP then bricking some of its printers (fave.co/43VthQR) with additional firmware updates, with no fix yet in sight.

Not all HP printers are affected by dynamic security—as my colleague Mark Hachman details, you can reverse this behavior for select

You can disable dynamic security on some of HP's printers, including the OfficeJet Pro 6830 (pictured).

models (fave.co/3XjwVC9). But it adds yet another item to a to-do list, and for most people, figuring out if your printer qualifies for the workaround is an unwanted headache. It's far easier to just ignore the update (if you can catch it before it rolls out), and if you can't, aggressively disabling future updates and even blocking your printers and other devices from online access in frustrated response.

I've seen this happen from the sidelines. It makes me bite my nails in anxiety, because I get where this reaction comes from. But then I have to untangle the mess that results and explain to them why they are stuck with a bug or missing features, or, worst of all, have been exposed to a security vulnerability.

If you want to be trusted, you have to be trustworthy, and when companies like HP poison the well with anti-consumer restrictions, it teaches people to regard firmware updates with suspicion (or in the case of that one friend of mine, open hostility). It's self-defeating behavior, because eroding that relationship with customers means they won't apply updates that keep products working optimally. (Cue an increase in angry customer service calls, forum comments, and social media posts.) Meanwhile, folks in the informal support trenches have to buy hair dye at a faster rate.

Or they just do what I've ended up doing—recommending alternative products. I myself bought a laser printer a while back, and all I have to do is buy a third-party toner replacement. I drop the new cartridge in, see that it works, and go about my life again. I tell my friends and family about this experience, too. It's a reminder that they can take their business elsewhere—no need to change their security habits. ⏻

I don't own this Brother HL-L2300D laser printer, but models like it exist that can take third-party cartridges. Tank printers are a way to evade third-party ink lockouts, too.

Help a lost pet get home

Posting a lost pet notice can reunite a family for a lifetime.

PetsAndPeopleTogether.org

AMD Radeon RX 7600: Finally, a good, affordable graphics card

After years of terrible GPU prices, the $269 Radeon RX 7600 is a breath of fresh air.

BY BRAD CHACOS

Now this is a graphics card release we can finally praise.

AMD's new $269 Radeon RX 7600 delivers fantastic 1080p gaming that can keep even a high refresh rate monitor well fed in a tiny, quiet, incredibly power-efficient package. Better yet, while Nvidia continues to push either stagnant generational performance upgrades or exorbitant prices (fave.co/40gi3UE) for its rival GeForce RTX 40-series graphics cards, AMD's budget champion delivers a massive step-up in frame rates for $60 less than its predecessor's launch price.

Budget gaming requires compromise, and the Radeon RX 7600 isn't good at ray tracing, especially since image upsampling technologies like FSR 2.0 and Nvidia's DLSS don't look great at 1080p resolution. Don't get it twisted, though; other than the ferociously

IMAGE: AMD

powerful (and pricey) RTX 4090 (fave. co/3O1pryL) and Radeon RX 7900 XTX (fave. co/3kFEZ0q) flagships, this modest GPU is the first of this generation worth paying attention to—and the first new sub-$300 graphics card to get excited about since the pandemic threw the world into chaos. Seriously.

Let's go.

SPECS AND FEATURES

AMD built the Radeon RX 7600 using the same RDNA 3 graphics cores that debuted in the flagship 7900-series GPUs (fave. co/3kFEZ0q). This new architecture offers dedicated AI accelerators, AV1 encoding, DisplayPort 2.1 (RTX 40-series has 1.4a), second-generation ray tracing and Infinity Cache hardware, and more.

One difference between this and the RX 7900-series: While the more advanced GPUs use a cutting-edge chiplet design that flanks the main die with memory controllers, this budget chip sticks to a traditional single 6-nanometer die (204mm2) that packs everything in.

As you can see, the Radeon RX 7600 packs in more hardware for a lower price than the older (still good) Radeon RX 6600 (fave.co/ 3nquWvm). Memory and GPU clock speeds are up, stream processor and RT accelerator counts are up, and AI accelerators make their debut as part of AMD's AI push. Spoiler alert: The Radeon RX 7600 delivers a proper generational performance upgrade, unlike Nvidia's $400 GeForce RTX 4060 Ti (fave.co/3oZVIDQ).

SPECIFICATIONS

	AMD RADEON RX 7600	AMD RADEON RX 6600
Architecture	RDNA 3	RDNA 2
Manufacturing Process	6nm	7nm
Transistor Count	13.3 billion	11.1 billion
Die Size	204 mm^2	237 mm^2
Compute Units	32	28
Ray Accelerators	32	28
AI Accelerators	64	-
Stream Processors	2048	1792
Game GPU Clock	2250 MHz	2044 MHz
Boost GPU Clock	Up to 2625 MHz	Up to 2491 MHz
Peak Single Precision Performance	Up to 21.75 TFLOPS	Up to 8.93 TFLOPS
Peak Half Precision Performance	Up to 43.5 TFLOPS	Up to 17.86 TFLOPS
Peak Texture Fill Rate	Up to 339.8 GT/s	Up to 279 GT/s
ROPs	64	64
Peak Pixel Fill Rate	Up to 169.9 GP/s	Up to 159.4 GP/s
AMD Infinity Cache	32 MB (2nd Gen)	32 MB (1st Gen)
Memory	8GB DDR6	8GB DDR6
Memory Speed	18 Gbps	14 Gbps
Effective Memory Bandwidth w/ AMD Infinity Cache	Up to 476.9 GB/s	Up to 412.9 GB/s
Memory Bus Interface	128-bit	128-bit
PCIe Interface	PCIe 4.0 x8	PCIe 4.0 x8
Total Board Power	165W	132W

Like the 4060 Ti (and the Radeon RX 6600 before it), the Radeon RX 7600 is outfitted with 8GB of GDDR6 memory and a narrow 128-bit bus. That means this graphics card really is built for 1080p gaming—a reasonable expectation for an affordable graphics card like this. You can certainly play at 1440p resolution if you dial back some settings, but it may hit its limits quickly with the way modern games have been gobbling up VRAM (fave.co/3J7gcvl). AMD's on-die

The Radeon RX 7600 reference card is so small! (RTX 4060 Ti and obligatory banana for scale.)

Infinity Cache helps keep things humming at 1080p as well. Bumping up to 1440p will result in more data being sent over that pokey 128-bit bus. You won't want that. (We delve into a wonky discussion about memory capacity, bus widths, and on-die cache configurations in the specifications section of our RTX 4060 Ti review, fave.co/3N5TnJU.)

The Radeon RX 7600 should play the vast majority of games at Ultra settings and high frame rates just fine at 1080p resolution, but some especially memory-hungry games may require minor graphics tuning to fit inside the 8GB memory buffer. PCWorld contributor Keith May (fave.co/3NoO8Xa) has been testing the custom Sapphire Pulse Radeon RX 7600 and reports that *Hogwarts Legacy* and *The Last of Us*—two of the worst VRAM offenders—soar at High settings while still

looking spectacular. Again, it's a reasonable compromise at this price point. (It isn't at $400, Nvidia.) You can see his analysis in this video (fave.co/3WZe3ln).

When asked about the 8GB capacity, AMD's Aaron Steinman said, "We still believe (and testing supports) that even the most demanding modern games deliver a very good experience for 1080p gaming. And memory is expensive."

This GPU draws down slightly more juice than its predecessor but delivers much higher performance and the best idle power use we've ever seen—it's wonderfully efficient. Power is supplied via a single 8-pin connector, without needing to use an ugly 12VHPWR adapter like you do on the 4060 Ti. The reference card AMD sent over isn't only a reasonable two slots thick, it's also

adorably tiny at just 8 inches long. Despite the pint-size cooler, the reference card runs damned near silent—another testament to the 7600 GPU's efficiency.

The reference card packs a single HDMI port and three of those speedy DisplayPort 2.1 connections. (Note that this is optional, however; AMD's partners can use DisplayPort 1.4 on custom 7600 cards instead to save money.)

If you're into streaming, you'll appreciate the inclusion of cutting-edge AV1 encoders, especially now that YouTube and OBS support AV1 uploads (fave.co/3P5y79Q). We tested AMD's new RDNA 3 AV1 encoder on the Radeon RX 7900 XTX (fave.co/3P5x6i2) and it's fantastic. The Record & Stream options in AMD's Adrenalin software is a *whole lot better* than it used to be, too, as we covered in the same evaluation by "Stream Professor" EposVox (fave.co/3CkyXlt):

AMD ships their own recording and

The reference card packs a single HDMI port and three of those speedy DisplayPort 2.1 connections.

streaming software with their GPUs, akin to Nvidia Shadowplay. Except, it's far far better than Shadowplay in almost every way. More settings, more capabilities, more features. Nvidia really needs to update Shadowplay ASAP.

Don't sleep on it. Don't sleep on any of AMD's Adrenalin Software, while you're at it. Nvidia gets (and deserves) a lot of credit for excellent software features like DLSS 3, Reflex, and Nvidia Broadcast, but Team Red has some darned beneficial software of its own.

Smart Access Memory (fave.co/3aReZar) boosts performance on modern systems more reliably than any PC combo of Intel and Nvidia chips. A new Smart Access Video feature improves DaVinci Resolve encoding performance by up to 32 percent in Ryzen + Radeon systems. FSR 2.0 gives Nvidia's DLSS a tough fight, while Radeon Super Resolution (fave.co/3P5zRQq) brings the simpler FSR 1.0 technology right inside AMD's driver to let you increase performance via upscaling in any game. Radeon Boost and Anti-Lag keep temperatures and latency low. You can also use Adrenalin to overclock or even undervolt your graphics card (fave.co/43TCh8Z).

The one thing missing is a DLSS 3 Frame Generation competitor (fave.co/3oXUkw6), but AMD is working on it with FSR 3.0 (fave. co/43QYjcw), scheduled to launch

It even has a backplate despite the affordable price.

sometime this year.

Enough talk. On to the benchmarks!

OUR TEST SYSTEM

We test graphics cards on an AMD Ryzen 5900X PC used exclusively for benchmarking GPUs. We test with PCIe Resizable BAR (also known as Smart Access Memory on Ryzen systems) active, as most modern gaming PCs released in the last four years support the performance-boosting feature, either natively or via a motherboard firmware update. Nvidia also recommends turning on the optional "Hardware-accelerated GPU scheduling" option in Windows to let the RTX 40-series stretch its legs to the fullest, so we've made that tweak as well. Most of the hardware was provided by the manufacturers, but we purchased the storage ourselves.

- AMD Ryzen 5900X, stock settings

- AMD Wraith Max cooler
- MSI Godlike X570 motherboard
- 32GB G.Skill Trident Z Neo DDR4 3800 memory, XMP active
- Corsair HX1500i power supply, fave.co/43yvDp7 (and optional $20 12VHPWR 600 cable [fave.co/3CkzaLL] for Nvidia GPUs)
- 1TB SK Hynix Gold S31 SSD (fave.co/3IRPhZM) x2

We test a variety of games spanning various engines, genres, vendor sponsorships (Nvidia, AMD, and Intel), and graphics APIs (DirectX 9, 11, DX12, and Vulkan), to try to represent a full range of performance potential. Each game is tested using its in-game benchmark, sanity-checked by Nvidia's FrameView tool (fave.co/43wo8iG), at the highest possible graphics presets unless otherwise noted, with VSync, frame rate caps, real-time ray tracing or DLSS effects, and FreeSync/G-Sync disabled, along with any other vendor-specific technologies like FidelityFX tools or Nvidia Reflex. We've also enabled temporal anti-aliasing (TAA) to push these cards to their limits.

We run each benchmark at least three times and list the average result for each test. Outside of esports, we've limited our benchmarks to 1440p and 1080p resolutions. With this memory configuration, the Radeon RX 7600 is a 1080p graphics card, but it's worth showing what you get at 1440p as well,

both for practical reasons and to see how the GPU's performance scales as you ramp up resolution. We test features like ray tracing and DLSS in a separate section, as upscaling features like DLSS and AMD's rival FSR tweak the look of games to help them run faster.

Usually we present our data in a series of per-game bar charts, but given some severe time restraints, we're running our data in raw charts today and supplementing it with additional performance commentary instead. (Hit me up on Twitter [fave.co/3XhdtG9] to let me know if you love it or hate it!) Those time restrictions also prevented us from running

new benchmark data for the $330 16GB Intel Arc A770, alas, which is another strong contender in this price segment.

1080P GAMING PERFORMANCE

This is a graphics card built for 1080p gaming, so let's start there!

As you can see, the Radeon RX 7600 delivers spectacular 1080p gaming even at Ultra settings, delivering 80 frames per second or more in all games except the exceptionally beautiful *Red Dead Redemption 2* cranked to the absolute max—and even then, it still hits

1080P MAXIMUM PERFORMANCE

	XFX RADEON RX 6700 XT MERC 319	NVIDIA GEFORCE RTX 4060 TI (8GB)	EVGA RTX 3060 TI FTW3 ULTRA	EVGA GEFORCE RTX 3060 XC BLACK GAMING	AMD RADEON RX 7600	XFX RADEON RX 6600 SWFT 210
Gears Tactics	133.3	158.4	137.7	97	112.5	86
Cyberpunk 2077	87	94	91.4	70	95.5	61.7
Total War: Troy	94.1	88	86.9	69.8	80.1	47.4
Call of Duty: Modern Warfare 2	117	119	98	74	102	80
Horizon Zero Dawn	114	130	125	101	105	76
Hitman 3	198.8	218.2	201	153.1	177.7	134
F1 22	183	189	178	133	155	129
Red Dead Redemption 2	69.4	79.1	71	53.9	59.9	46.1
Counter-Strike: Global Offensive	496.5	508.2	657	486.9	439.4	426
Watch Dogs	85	85	82	62	78	57
AVERAGE	157.81	166.89	163.8	130.08	140.51	114.32
EXCLUDE CSGO	120.17778	128.966667	119	90.4333333	107.3	79.6888889

the golden 60fps mark. If you exclude *Counter-Strike: Global Offensive*'s ludicrously high frame rates, the Radeon RX 7600 averages 107fps across our suite, a properly generational 35 percent increase over its predecessor.

Nvidia's new $400 RTX 4060 Ti is faster than the RX 7600 by another 20 percent on average if you're looking to push a high-refresh rate 1080p monitor even further, but costs $130 more than AMD's offering. The Radeon RX 7600 offers plenty of performance for a whole lot less money—and it holds the lead in *Cyberpunk 2077* performance here!

Note, however, that thanks to its 8GB memory capacity, you may need to reduce graphics from Ultra to High in particularly VRAM-intensive modern games, such as *Hogwarts Legacy* and *The Last of Us*. Games still look great on High, and that compromise is much more welcome in a $269 graphics card than in a $400 one.

1440P GAMING PERFORMANCE

Next up is higher resolution.

The Radeon RX 7600 can definitely be

1440P MAXIMUM PERFORMANCE

	NVIDIA GEFORCE RTX 4070	NVIDIA GEFORCE RTX 3070	XFX RADEON RX 6700 XT MERC 319	NVIDIA GEFORCE RTX 4060 TI (8GB)	EVGA RTX 3060 TI FTW3 ULTRA	EVGA GEFORCE RTX 3060 XC BLACK GAMING	AMD RADEON RX 7600	XFX RADEON RX 6600 SWFT 210
Gears Tactics	125.6	111.5	87.9	108.9	97.7	66.4	75.1	58.1
Cyberpunk 2077	77.8	68.7	56.3	61	59.8	44.5	51.5	37.2
Total War: Troy	115.8	99.3	94.1	88	86.9	69.8	65.4	47.4
Call of Duty: Modern Warfare 2	104	80	82	82	69	53	69	54
Horizon Zero Dawn	139	112	91	102	102	78	78	57
Hitman 3	189.7	159.4	136.2	149.5	137.1	99.7	115.4	88.5
F1 22	182	152	138	144	134	100	117	109
Red Dead Redemption 2	83.1	68.8	57.4	62.8	58.5	43.7	48.2	37.5
Counter-Strike: Global Offensive	470.6	502	418.6	372.8	465.5	364	271.4	369.8
Watch Dogs	84	59	65	58	62	48	54	41
AVERAGE	157.06	141.27	122.65	123.9	127.25	96.71	94.5	89.95
EXCLUDE CSGO	122.222222	101.188889	89.7666667	96.2444444	89.6666667	67.0111111	74.8444444	58.8555556

used to play games at 1440p, as our testing shows—it averages 75fps-plus across our suite, only dipping below 60fps in *Cyberpunk 2077* and *Watch Dogs Legion*. But the 8GB of VRAM and tiny 128-bit bus means you'll already need to drop graphics settings in a lot of modern games (including *Watch Dogs*), and memory demands are only getting higher.

Note how the Radeon RX 6700 XT (which has 12GB and a 256-bit bus for $350 on the street) overtakes the new 7600 in *Cyberpunk 2077* by about 10 percent after falling behind it at 1080p. Averaged overall, the 6700 XT was 12 percent faster than the 7600 at 1080p but leaps up to a 20 percent lead at 1440p.

The RTX 4060 Ti, the only other modern sub-$500 GPU available thus far, is once again much faster than the 7600 for much more money, but since it has a similarly skimpy memory configuration, it shouldn't be considered for 1440p gaming either.

RAY TRACING AND FSR PERFORMANCE

You don't want to use the Radeon RX 7600 for ray tracing or activate FSR to increase performance.

Sure, this GPU packs in AMD's second-gen RT accelerator hardware, which shined in the monstrous Radeon RX 7900 XTX, but as you can see in the benchmarks below, it pretty much sucks down here on more

affordable hardware, especially without an assist from FSR image upscaling. That said, ray tracing is more of a "nice to have" than a "must have" in budget GPUs.

And you shouldn't use FSR (or DLSS) on a 1080p graphics card, in my opinion. As I detailed in-depth in my RTX 4060 Ti review (fave.co/3qAoNRg), image upscaling works wonders at higher 1440p and 4K resolutions, but upscaling games to 1080p from an internal 720p (or worse, in the case of the Balanced preset tested below) resolution results in jagged, blurry visuals. It's ugly and not worth the extra frames.

We included FSR/DLSS data above for you to reference, but recommend leaving both ray tracing and upscaling off on this card. You can enable it at lower settings in more lightly ray-traced games like *F1 22* and *Hitman* if you'd like, but we don't think the hit to performance is worth the visuals ray tracing provides at Medium settings. Also note that only RTX 40-series cards support DLSS 3, and *Watch Dogs Legion* lacks FSR support, hence the various "Not applicable" fields above.

Given AMD's poor showing in ray tracing and our advice to skip upscaling at this resolution, the $400 GeForce RTX 4060 Ti might actually be worth considering if you need those cutting-edge lighting effects—though we would recommend checking to see how the $300 RTX 4060 handles (fave. co/43APC6z) as an alternative.

1080P MAXIMUM PERFORMANCE

	XFX RADEON RX 6700 XT MERC 319	NVIDIA GEFORCE RTX 4060 TI (8GB)	EVGA RTX 3060 TI FTW3 ULTRA	EVGA GEFORCE RTX 3060 XC BLACK GAMING	AMD RADEON RX 7600	XFX RADEON RX 6600 SWFT 210
Cyberpunk 2077, native	87	94	91.4	70	95.5	61.7
Cyberpunk 2077, RT Ultra	24.9	41.5	38.4	39.9	11.6	9.1
Cyberpunk 2077, RT Ultra + DLSS/FSR Balanced	48.1	71.7	70.2	69.6	36.5	17.1
Cyberpunk 2077, RT Ultra + DLSS Balanced + Frame Gen	N/A	122.5	N/A	N/A	N/A	N/A
Hitman 3, native	198.8	218,2	201	153.2	177.7	134
Hitman 3, RT Ultra	58.4	92.6	81.6	61	50.22	38
Hitman 3, RT Ultra + DLSS/ FSR Balanced	93.6	141.5	127.9	99.9	81.8	62.9
F1 22, native	183	189	178	133	155	129
F1 22, RT High	58	82	71	53	52	38
F1 22, RT High + DLSS/FSR Balanced	101	118	116	95	90	67
F1 22, RT High + DLSS Balanced + Frame Gen	N/A	190	N/A	N/A	N/A	N/A
Red Dead Redemption 2, native	69.4	79.1	71	53.9	59.9	46.1
Red Dead Redemption 2, DLSS/FSR Balanced	79.5	93.5	82.4	63.1	69.6	55.9
Watch Dogs Legion, native	85	85	82	62	78	57
Watch Dogs Legion, RT High	38	40	35	37	21	3
Watch Dogs Legion, RT Ultra + DLSS/FSR Balanced	N/A	60	61	54	N/A	N/A

1080P MAXIMUM PERFORMANCE

	XFX RADEON RX 6700 XT MERC 319	NVIDIA GEFORCE RTX 4060 TI (8GB)	EVGA RTX 3060 TI FTW3 ULTRA	EVGA GEFORCE RTX 3060 XC BLACK GAMING	AMD RADEON RX 7600	XFX RADEON RX 6600 SWFT 210
Power Use (Idle)	87	51.2	72.3	66.7	49.2	65.3
Peak Power Use (Full Load)	388	308	391	326	292	253
Peak Temp (Celsius) Under Load	64	65	66	64	75	64

POWER AND THERMALS

Just like the RTX 4060 Ti, they're excellent, though not as excellent as Nvidia's efficiency.

We test power draw by looping the *F1 22* benchmark at 4K for about 20 minutes after we've benchmarked everything else (to warm up the GPU) and noting the highest reading on our Watts Up Pro meter, which measures the power consumption of our entire test system. The initial part of the race, where all competing cars are onscreen simultaneously, tends to be the most demanding portion.

This isn't a worst-case test; this is a GPU-bound game running at a GPU-bound resolution to gauge performance when the graphics card is sweating hard. If you're playing a game that also hammers the CPU, you could see higher overall system power draws. Consider yourself warned.

Yes, the Radeon RX 7600 consumes about 15 percent more power than its predecessor at peak under load, but it delivers a whopping 35 percent average performance increase in return—a superb result. By contrast, the RTX

4060 Ti is only faster than the RTX 3060 Ti by single-digit percentage points. And while we thought the ultra-low idle power measurements of the RTX 4060 Ti were bonkers, AMD does slightly better here. You love to see it from both camps!

We test thermals by leaving GPU-Z open during the F1 22 power draw test, noting the highest maximum temperature at the end.

The tiny AMD reference RX 7600 hits much higher temperatures than the other GPUs we tested, but don't be fooled: 75 degrees Celsius is still plenty cool for a graphics card, and in exchange for the higher temps, AMD gives you darn near utterly silent noise levels. The reference Radeon RX 7600 ran quieter than any other GPU we tested here and was virtually inaudible over the rest of our system fans. Quiet fans offer a much better day-to-day experience than unnecessarily low heat levels, and the reference card's diminutive design can fit into a lot more PCs than the other, longer cards. I'll take it!

BOTTOM LINE

If you're looking for a graphics card with low power and enough *oomph* to power a high refresh rate 1080p monitor, the $269 Radeon RX 7600 is a spectacular option. It's an excellent affordable graphics card. It can handle 1440p gaming as well, but the 8GB VRAM capacity and tiny memory bus width means it will struggle more at that resolution as games become ever more demanding.

Some games are already too demanding, with titles like *Hogwarts Legacy* and *The Last of Us* already blowing past the 8GB memory capacity even at 1080p. In our experiential testing, dropping settings to High results in a highly playable experience that looks and runs great. That's acceptable on an affordable GPU like the RX 7600, but *unacceptable* on a $400 graphics card like Nvidia's new RTX 4060 Ti, which offers a similar memory configuration.

At 1080p resolution, the RTX 4060 Ti runs about 20 percent faster than the Radeon RX 7600 on average, but for 48 percent more money. Considering that the Radeon RX 7600 delivers already-exceptional 1080p gaming performance, it's a no-brainer.

Unless you want to play ray-traced games, that is: The Radeon RX 7600's second-gen RT accelerators offer mostly unplayable performance on this budget card. Considering that image upsampling technologies like FSR and DLSS look terrible at 1080p resolution, you can't use those to claw back performance after flipping on ray tracing—your game will look worse even with those fancy rays flying around, though ray tracing is really more of a fancy extra than an essential feature at this budget price.

The Radeon RX 7600 is the budget graphics card gamers have been waiting for.

If you don't care about DLSS 3 and ray tracing, but you want a beefier memory setup for better future-proofing and the ability to dabble in more 1440p games, the last-gen Radeon RX 6700 XT (fave.co/3WYfzuh) offers 12GB and a big 256-bit for just $350 on the street these days. That's $80 more than the budget-friendly Radeon RX 7600, however (though it's faster as well).

If you need to save even more money, the Radeon RX 6600 (fave.co/3nquWvm) remains a fine option for 1080p/60Hz gaming at around $200. Both last-gen cards lack the newer GPU's AV1 encoding, AI accelerators, and DisplayPort 2.1 capabilities, if that matters to you, but otherwise they offer feature parity.

On the other hand, if you want AV1 encoding along with playable ray tracing and solid 1080p gaming performance—especially in modern DirectX 12 games—Intel's Arc A750 (fave.co/3g2HHuI) is another compelling option, especially now that Intel has slashed its price to just $199 (fave.co/3NnSRs7).

The Arc A750 is currently our top pick for 1080p gaming with ray tracing. It's comparable to the Radeon RX 6600 in gaming, but takes a firm lead in those aforementioned categories, sometimes toppling even the RTX 3060. Intel's debut consumer GPUs launched with troublesome drivers but are in a *much* better place now (fave.co/3X3vO9b).

Final analysis: After years of wandering in a GPU wasteland, and months of tolerating Nvidia's stagnant (fave.co/3oZVIDQ)to downright (fave.co/40h209p) exorbitant (fave.co/40gi3UE) RTX 40-series releases, the Radeon RX 7600 is a breath of fresh air. It offers a truly generational performance uplift (35 percent) for less money than its predecessor (18 percent), along with modern features like AV1 encoding and DisplayPort 2.1, all wrapped in a tiny, silent, affordable package. It's the only GPU we've been excited about this generation aside from flagships selling for quadruple digits.

The Radeon RX 7600 is the graphics card that gamers on a budget have been begging for forever. Go buy it…unless you want ray tracing. ⏻

AMD Radeon RX 7600

★★★★☆

PROS
- Great 1080p gaming performance.
- Power efficient.
- AV1 encoding, DisplayPort 2.1 (optional).

CONS
- Ray tracing performance is bad.
- Upscaling features (FSR/DLSS) look ugly at 1080p.
- 8GB of VRAM; may need to dial graphics from Ultra to High in some particularly intensive games, even at 1080p.

BOTTOM LINE
After years of terrible GPU prices, the $269 Radeon RX 7600 is a breath of fresh air. It offers excellent 1080p gaming in a power efficient package at an affordable price—if you don't mind skipping ray tracing.

$269

Lenovo Legion Pro 7i: Blazing performance, good price

Affordable compared to other top-tier gaming laptops. **BY MATT ELLIOTT**

The Lenovo Legion Pro 7i Gen 8 delivers the latest from Intel and Nvidia for a fraction of the cost of premium models that feature higher-grade RTX 40-series GPUs. We've reviewed two admittedly impressive RTX 4090-based gaming monsters—the $4,300 Razer Blade 16 (fave.co/43YosGx) and the $5,300 (!) MSI Titan GT 77 HX 13V (fave.co/43RawxU)—that are more showpieces than attainable objects for most. This laptop will fit into many more budgets.

You can outfit the Legion Pro 7i Gen 8 with an RTX 4080 or RTX 4090 GPU, but our test model features a RTX 4070 GPU and is roughly half the price of the Razer Blade 16 we reviewed recently. It lacks the striking design of the slab-like Razer as well as its dual-mode display, but the look and build quality is certainly appropriate for a midrange gaming laptop. And the 16-inch display is

spacious, crisp, bright, and fast. After dreaming about owning a $4,000 or $5,000 next-gen gaming laptop, the next-gen Pro 7i Gen 8 is a solid choice for when you snap back to reality and your financial constraints.

SPECIFICATIONS

Our Lenovo Legion Pro 7i Gen 8 test system costs $2,175 from Lenovo and features the following specs:

CPU: Quad-core Intel Core i9-13900HX

Memory: 32GB DDR5 5600MHz

Graphics: Nvidia GeForce RTX 4070

Storage: 1TB PCIe NVMe M.2 SSD

Display: 16-inch QHD (2560×1600) 240Hz display

Webcam: 1080p with electronic kill switch

Connectivity: 1× Thunderbolt 4 USB Type-C, 1× USB-C 3.2 Gen 2, 4× USB-A 3.2 Gen 1, HDMI 2.1, Ethernet, combo audio jack

Networking: Wi-Fi 6E, Bluetooth 5.1

Biometrics: None

Battery capacity: 99 Watt-hours

Dimensions: 0.86×14.3×10.3 inches

Measured weight: 5.46 pounds (power brick weighs 2.65 pounds)

Price: $2,175

The Lenovo Legion Pro 7i Gen 8 starts at $2,070 for a system with the Intel Core i9-13900HX CPU, GeForce RTX 4070 graphics, 16GB of RAM, and a 512GB SSD. Our test system features two upgrades to the baseline model: 32GB of RAM that adds $55 and a 1TB SSD that adds $50. The highest-end model in the line costs $3,600 and features RTX 4090 graphics and a 2TB SSD. The Core i9-13900HX is the only CPU offered and all models feature the same 16-inch, 16:10 display with a 2560×1600 resolution and speedy 240Hz refresh rate.

PER-KEY RGB AND FULL-SIZE ARROW KEYS

The Legion Pro 7i Gen 8 looks more like an overgrown corporate laptop than a gaming laptop until you fire up the RGB lighting. The

The Lenovo looks like an overgrown corporate laptop until you fire up the RGB lighting.

aluminum chassis is dark gray throughout, and aside from a pair of small Lenovo badges and a larger Legion wordmark, there is a distinct lack of chrome accents. The large vents on the side edges and back edge are your only hints that this is a high-powered gaming laptop.

The laptop weighs 5.46 pounds, which is average for a 16-inch 16:10 laptop. The sleek Razer Blade 16 actually weighs slightly more at 5.52 pounds, while two other 16-inch 16:10 models, the Acer Predator Triton 500 SE at 5.29 pounds and the HP Victus 16 at 5.44 pounds, are a bit lighter. The Legion Pro 7i Gen 8's massive power brick, however, will weigh you down. The 300-watt brick weighs a hefty 2.65 pounds, making the overall travel weight a substantial 8 pounds.

The aluminum chassis feels fairly sturdy, although it does flex a bit in the middle of the keyboard. Mashing the WASD keys near the left edge felt more rigid than pressing keys closer to the middle of the keyboard, but there is definitely some flex to the keyboard deck. It lacks the rock-solid feeling of the Razer Blade 16. The keys themselves felt snappy, and I appreciate Lenovo finding room for both a number pad and four full-size arrow keys. It's a smart design choice to take advantage of the added space afforded by

The Legion Pro 7i Gen 8 offers per-key RGB lighting, a fun feature that isn't always offered on a midrange gaming laptop.

the tall 16:10 display and use it to extend the arrow keys.

The Legion Pro 7i Gen 8 offers per-key RGB lighting, a fun feature that isn't always offered on a midrange gaming laptop. Most midrange models let you customize the look of the keyboard with various lighting patterns or perhaps with a four-zone lighting, but the Pro 7i Gen 8 provides maximum RGB flexibility with per-key lighting. You can set up to six RGB lighting profiles and you can cycle through them using the Function key and spacebar. There's also an LED stripe that runs along the front edge of the laptop that you can also customize with RGB lighting. It has six zones you can customize. The per-key lighting and LED stripe along the front edge go a long way toward making the laptop look

The display is fantastic for a midrange model.

like a gaming model and not like an overgrown ThinkPad.

BIG, BRIGHT, AND FAST DISPLAY

The display is stellar, especially for a midrange model. It's big at 16 inches and has a 16:10 aspect ratio that's taller than a traditional 16:9 widescreen display. It's crisp, with a 2560×1600 resolution that's finer than the 1920×1200 resolution found on many midrange 16-inch models. And it's fast and bright, with a blazing 240Hz refresh rate and rated for 500 nits of brightness. My own measurements with a lux meter showed it was actually a bit brighter than its rating, reaching a peak brightness of 550

nits. The colors looked vivid, the edges of images and text looked sharp, and games showed smooth movement.

The laptop features a modern 1080p camera that produces a crisp, well-balanced image. There's also a kill switch for the webcam on the laptop's left edge that interrupts the power to the camera to ensure your privacy when it's not in use.

If the display has you dreaming of getting a premium gaming laptop AV system at a mainstream price, the speakers will snap you back to reality. Some higher-end 16-inch models such as the Razer Blade 16 find room for four speakers—two tweeters and two subs. You only get a pair of 2-watt speakers with the Legion Pro 7i Gen 8 and they produce muddy audio with no separation between the highs and mids. Without any subs, the bass

The port selection is varied and well located.

The audio jack is also conveniently located on the front half of the right side for easy access.

response is predictably lacking.

The port selection is varied and well located. There are two USB-C ports, one of which offers Thunderbolt 4 support. There are four USB Type-A ports—two in the back and one of each side of the laptop. This USB-A arrangement allows left and right mousers to connect their gaming mouse to their preferred side. The audio jack is also conveniently located on the front half of the right side for each access. And with the speakers being what they are, you'll want to keep your headphones nearby.
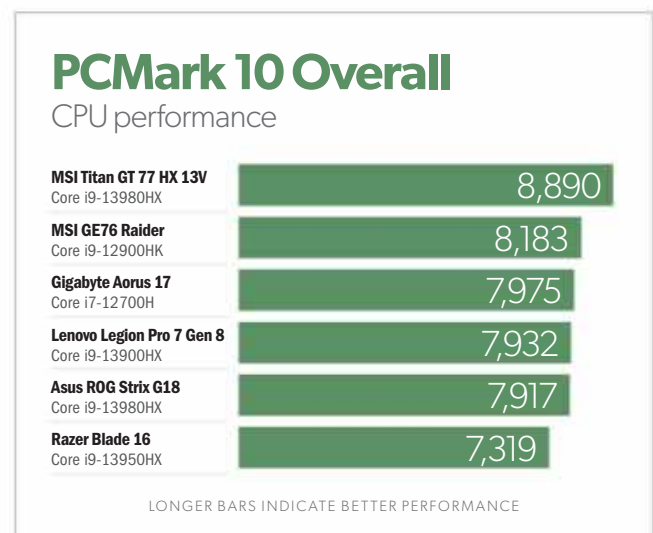
PERFORMANCE

Our Legion Pro 7i Gen 8 test system is based on the Core i9-13900HX CPU and GeForce RTX 4070 graphics. It also supplies a generous 32GB of RAM and a 1TB SSD. The

13th-gen Core i9-13900HX features Intel's hybrid architecture with performance and efficiency cores; it has eight performance cores, 16 efficiency cores, and a total of 32 processing threads. The RTX 4070 is a midrange GPU in Nvidia's latest GeForce 40 series behind the RTX 4080 and 4090 graphics processors. In our test system, it's set to run at its maximum of 140 watts. That's a combination of the GPU's maximum power draw of 115 watts and 25 watts supplied by the CPU via Dynamic Boost.

We started off testing with PCMark 10, which measures performance on everyday computing work including office productivity tasks, web browsing, and video chats. With a score approaching 8,000, the Legion Pro 7i

PCMark 10 Overall
CPU performance

MSI Titan GT 77 HX 13V Core i9-13980HX	8,890
MSI GE76 Raider Core i9-12900HK	8,183
Gigabyte Aorus 17 Core i7-12700H	7,975
Lenovo Legion Pro 7 Gen 8 Core i9-13900HX	7,932
Asus ROG Strix G18 Core i9-13980HX	7,917
Razer Blade 16 Core i9-13950HX	7,319

LONGER BARS INDICATE BETTER PERFORMANCE

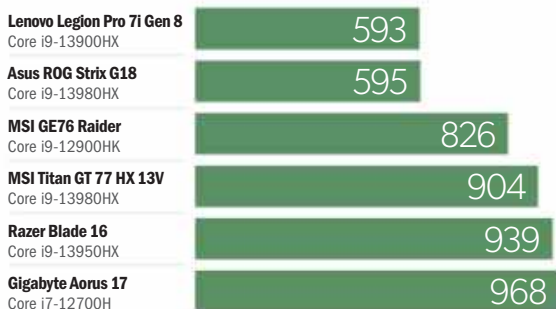Pro 8 proved itself to be overqualified as a productivity machine.

Our HandBrake benchmark tests how a laptop is able to handle crushing CPU loads over a lengthy period—in this case, transcoding a 30GB MKV file to a format suitable for Android tablets using HandBrake, the free video encoding utility. The Legion Pro 7i Gen 8 barely broke a sweat on the test,

edging the Strix G18 as one of the fastest times we've seen on the test. It can pull double duty as a gaming machine and content creation laptop.

Next up is Cinebench, another CPU-intensive test but one that renders a complex 2D scene over a short period of time. The trio of laptops with 13th-gen Core i9 chips crushed the competition, illustrating the power of Intel's latest generation of Core processors.
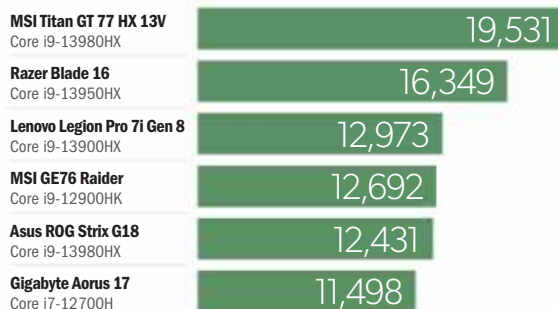
Handbrake 0.9.9 Encode
Seconds

Laptop	Seconds
Lenovo Legion Pro 7i Gen 8 — Core i9-13900HX	593
Asus ROG Strix G18 — Core i9-13980HX	595
MSI GE76 Raider — Core i9-12900HK	826
MSI Titan GT 77 HX 13V — Core i9-13980HX	904
Razer Blade 16 — Core i9-13950HX	939
Gigabyte Aorus 17 — Core i7-12700H	968

SHORTER BARS INDICATE BETTER PERFORMANCE

3DMark Time Spy 1.2
GPU performance

Laptop	Score
MSI Titan GT 77 HX 13V — Core i9-13980HX	19,531
Razer Blade 16 — Core i9-13950HX	16,349
Lenovo Legion Pro 7i Gen 8 — Core i9-13900HX	12,973
MSI GE76 Raider — Core i9-12900HK	12,692
Asus ROG Strix G18 — Core i9-13980HX	12,431
Gigabyte Aorus 17 — Core i7-12700H	11,498

LONGER BARS INDICATE BETTER PERFORMANCE

Cinebench R20
All threads

Laptop	Score
MSI Titan GT 77 HX 13V — Core i9-13980HX	11,863
Lenovo Legion Pro 7 Gen 8 — Core i9-13900HX	11,810
Asus ROG Strix G18 — Core i9-13980HX	11,164
Razer Blade 16 — Core i9-13950HX	6,890
MSI GE76 Raider — Core i9-12900HK	6,678
Gigabyte Aorus 17 — Core i7-12700H	6,291
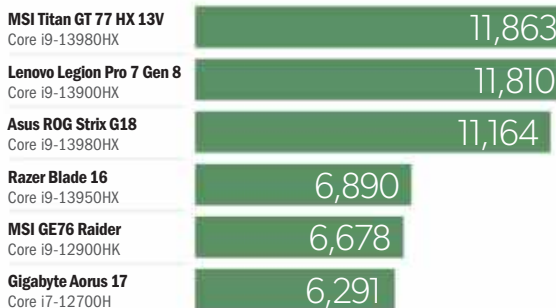
LONGER BARS INDICATE BETTER PERFORMANCE

3DMark Port Royal
GPU performance

Laptop	Score
MSI Titan GT 77 HX 13V — Core i9-13980HX	13,893
Razer Blade 16 — Core i9-13950HX	11,880
MSI GE76 Raider — Core i9-12900HK	7,925
Lenovo Legion Pro 7 Gen 8 — Core i9-13900HX	7,565
Gigabyte Aorus 17 — Core i7-12700H	7,358
Asus ROG Strix G18 — Core i9-13980HX	7,149
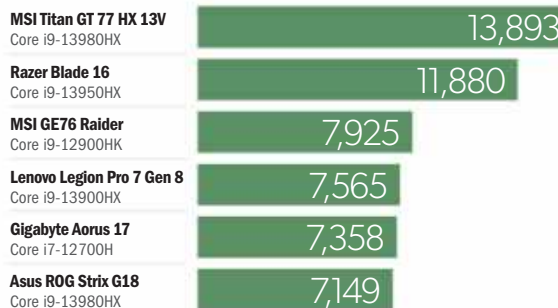
LONGER BARS INDICATE BETTER PERFORMANCE

Shadow of the Tomb Raider; 19x10 Highest
Frames per second

Razer Blade 16 Core i9-13950HX	170
Lenovo Legion Pro 7i Gen 8 Core i9-13900HX	166
MSI Titan GT 77 HX 13V Core i9-13980HX	160
MSI GE76 Raider Core i9-12900HK	155
Asus ROG Strix G18 Core i9-13980HX	154
Gigabyte Aorus 17 Core i7-12700H	128

LONGER BARS INDICATE BETTER PERFORMANCE

Metro Exodus; 19x10 Extreme
Frames per second

MSI Titan GT 77 HX 13V Core i9-13980HX	88
Razer Blade 16 Core i9-13950HX	76
MSI GE76 Raider Core i9-12900HK	53
Lenovo Legion Pro 7i Gen 8 Core i9-13900HX	52
Asus ROG Strix G18 Core i9-13980HX	49
Gigabyte Aorus 17 Core i7-12700H	45
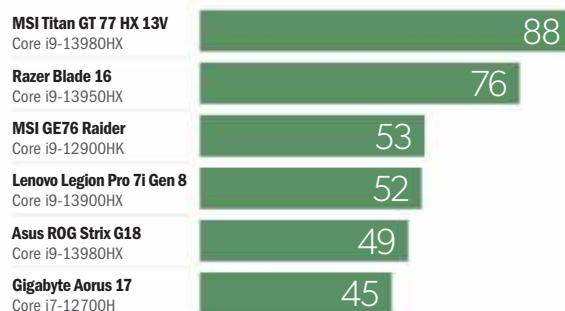
LONGER BARS INDICATE BETTER PERFORMANCE

GRAPHICS PERFORMANCE

Now we get to the goods—3D performance. First up are two synthetic tests, 3DMark's Time Spy and Port Royal. On Time Spy, the Legion Pro 7i Gen 8 trailed both RTX 4090-based laptops but edged the RTX 4070-based Asus ROG Strix G18 and a pair of laptops with previous-gen RTX 3080 Ti GPUs. On Port Royal, the results were largely the same, although the Legion Pro 7i Gen 8 finished in between the two RTX 3080 Ti laptops.
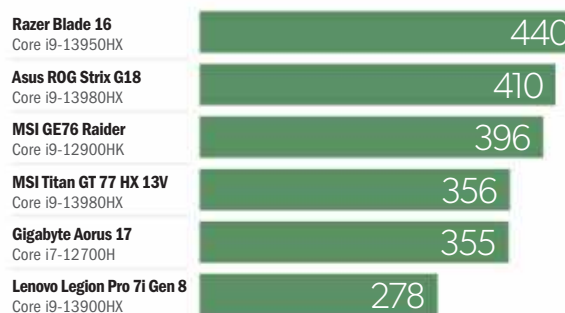
On our real-world game benchmarks, the Legion Pro 7i Gen 8 started off with a bang, averaging 166 fps on our *Shadow of the Tomb Raider* benchmark at 1920×1080 resolution at the Highest quality preset. That was actually better than the RTX 4090-based MSI Titan GT 77 HX 13V and only four frames per second less than the RTX 4090-based Razer Blade 16. The two RTX 4090 machines were able to flex their muscles on the more demanding *Metro Exodus*

test, and the Legion Pro 7i Gen 8's performance fell more in line with the other RTX 4070 laptop and the pair of RTX 3080 Ti systems.

To test a laptop's battery life, we loop a 4K video using Windows 11's Movies & TV app, with the laptop set to Airplane mode and earbuds plugged in. We set the screen brightness at a relatively bright 250 nits to 260 nits, which is a good brightness for watching a

Battery life
Minutes

Razer Blade 16 Core i9-13950HX	440
Asus ROG Strix G18 Core i9-13980HX	410
MSI GE76 Raider Core i9-12900HK	396
MSI Titan GT 77 HX 13V Core i9-13980HX	356
Gigabyte Aorus 17 Core i7-12700H	355
Lenovo Legion Pro 7i Gen 8 Core i9-13900HX	278

LONGER BARS INDICATE BETTER PERFORMANCE

The Legion Pro 7i Gen 8 delivers the goods while staying on budget.

movie in an office with the lights on. Despite using a large, 99Whr battery, the Legion Pro 7i Gen 8 failed to last even five hours on our battery drain test. That's a short runtime even among gaming laptops, which rarely provide decent battery life. Then again, you're unlikely to lug this large, 16-inch laptop around much and will spend most of your time with it plugged in.

BOTTOM LINE

Costs can quickly spiral out of control when shopping for a gaming laptop that offers the latest technology from Intel and Nvidia. The Lenovo Legion Pro 7i Gen 8 delivers the goods while staying on budget. It provides excellent value by pairing a powerful Core i9-13900HX CPU with not RTX 4080 or RTX

4090 graphics, but the more cost-effective RTX 4070 GPU. And its roomy, 16-inch 16:10 display is bright, sharp, and fast enough to extend the laptop's value even further. For a midrange gaming laptop, the rather staid design is sufficient. We'd expect a more interesting and rigid enclosure for a higher-end gaming laptop, which is why we wouldn't recommend scaling up in the Legion Pro 7i Gen 8 line and choosing one of the pricier models with an RTX 4080 or RTX 4090 GPU. As configured, this machine is an excellent example of a mainstream gaming laptop that delivers for the price. ⏻

Lenovo Legion Pro 7i

★★★★½

PROS
- Strong overall performance.
- Display is big, bright, and fast.
- Per-key RGB lighting.

CONS
- Some flex to keyboard deck.
- Poor battery life.

BOTTOM LINE
Armed with a 13th-gen Core i9 CPU and RTX 4070 graphics, the Lenovo Legion Pro 7i Gen 8 is mid-priced powerhouse.

$2,175

Asus ZenScreen MB249C: A versatile 24-inch portable monitor

It's loaded with features that are actually useful. **BY MATTHEW S. SMITH**

Portable monitors are advertised for travel, but in reality, most never leave the home or office they're shipped to. Many people purchase portable monitors not for their portability but instead for their versatility and ease of use. The Asus ZenScreen MB249C leans into this reality, offering unique benefits alongside a 24-inch screen.

SPECS

Asus ZenScreen MB249C is marketed as "portable" but has a 23.8-inch display. Clearly, portability in this case isn't about sticking the monitor in a suitcase but instead refers to moving it across a home or corporate office.

Display size: 23.8-inch widescreen
Native resolution: 1920×1080

Panel type: IPS LCD

Refresh rate: 75Hz

Adaptive Sync: Yes, AMD FreeSync

HDR: None

Ports: 1× USB-C with DisplayPort Alternate Mode and 60 watts Power Delivery, 1× HDMI 1.4, 1× 3.5mm audio out

Stand adjustment: Height, swivel, tilt

VESA mount: Yes, 100×100mm

Speakers: Yes, 2× 1-watt

Price: $349.99 (fave.co/3NoPTDR)

The MB249C's specifications are otherwise average for a 1080p office display. It does improve on the typical refresh rate of 60Hz, instead delivering up to 75Hz, and provides support for Adaptive Sync.

DESIGN

Let's talk about the elephant in the room. Asus' ZenScreen MB249C is a portable monitor, yet it has a 24-inch display panel, measures 21 inches wide, and weighs over 6 pounds. So what gives?

Asus imagines this monitor as a portable display for office and home office use. It may not be suited for travel, but there are still situations where it's handy to move a display around a space. At home, it could let you have two home office setups without requiring two monitors. In an office, it

could be carried to meetings if you need to lead a presentation.

The ZenScreen ships with a stand that clips to the back of a desk instead of sitting on top of it, which makes the ZenScreen MB249C easy to use as a second monitor in any home office setup. The stand is small yet functional, supporting adjustment for height, tilt, and swivel. It also rotates 90 degrees into portrait orientation.

It also comes with two alternative options to the stand: a folding kickstand and an unusual hanger. The kickstand flips out from the rear of the display to support it, as is true of most portable monitor kickstands. The hanger, which Asus calls a "partition mount," is designed to hang from a half-height cubicle partition and effectively functions as a wall mount, placing the display flush with a cubicle wall. I don't have a cubicle in my

The Asus ZenScreen MB249C can be mounted on a desk or set up with its kickstand.

The Asus ZenScreen MB249C comes with an attachable kickstand.

temperature adjustment is slim. Still, many portable monitors only offer brightness and contrast adjustment, so the MB249C is above average.

Connectivity is more mundane. The monitor supports USB-C input through DisplayPort Alternate Mode alongside HDMI 1.4, but that's it. Given the price, an additional video input would be appreciated. The monitor lacks USB-A, which feels like a missed opportunity—there's room.

Those looking to connect over USB-C should note that the monitor supports up to 60 watts of Power Delivery. In my testing, it will require that to operate solely over

home office, so I wasn't able to give this option a try. The MB249C's design is unusual but clever. It's a niche product, but one that many will appreciate.

FEATURES AND MENUS

The Asus ZenScreen MB249C offers advantages to those who want to tweak the monitor's settings. It ships with a reasonably capable menu that includes a variety of image mode presets and control over aspects of image quality such as color temperature and skin tone. Interestingly, it also has a "Shadow Boost," which can be used in games to make enemies in dark areas easier to notice.

That's not to say image quality adjustments are extensive. There's no gamma adjustment, and the color

The Asus ZenScreen MB249C's connectivity and ports.

USB-C. The monitor will function with a USB-C laptop or desktop that lacks adequate USB Power Delivery when the monitor's bundled power brick is connected. The power brick is also needed when only the HDMI video input is in use.

The monitor has built-in speakers, but you won't want to rely on them. Volume is low and the speakers suffer distortion when playing music, movies, or anything more complicated than spoken dialogue and system messages. Weak speakers, though disappointing, are par for the course with an office monitor.

SDR IMAGE QUALITY?

The Asus ZenScreen MB249C targets office productivity and makes few specific claims about its image quality. That left me with low expectations, which, to my surprise, the monitor easily beat.

Brightness comes in at a respectable 264 nits, which, although not amazing, is

mid-pack for a portable monitor and quite good for an office productivity monitor. This level of brightness is sufficient for use in any room with moderate light control. It may appear a bit dim when located near a sunlit window, however.

The monitor delivered a surprise in contrast with a maximum contrast ratio of 1380:1. That's toward the high end of what I expect from monitors with an IPS display panel and no advanced backlight technology, such as Mini-LED.

Don't get too excited. The monitor can still struggle with shadow detail, especially when viewing movies that have a dark palette like *The Batman*. Still, a contrast ratio of 1380:1 is higher than that of most competitors and provides a better sense of depth. An alternative like the BenQ GW2785TC (fave. co/3N1hIk7) will appear flat and one-dimensional by comparison.

Color gamut isn't bad, either, providing 100 percent of the sRGB color gamut and 81 percent of DCI-P3. This isn't enough to be

Maximum brightness
Nits

Asus ZenScreen MB249C	264
BenQ GW2785TC	234
Arzopa A1 Gamut	297
AOC I1601CFWUX	228
Asus ProArt PA279CV	366

LONGER BARS INDICATE BETTER PERFORMANCE

Contrast ratio

Asus ZenScreen MB249C	1,380:1
BenQ GW2785TC	620:1
Arzopa A1 Gamut	880:1
AOC I1601CFWUX	930:1
Asus ProArt PA279CV	930:1

LONGER BARS INDICATE BETTER PERFORMANCE

Color Gamut

Legend: % Adobe RGB | % DCI-P3 | % sRGB

Asus ZenScreen MB249C
- 77
- 81
- 100

BenQ GW2785TC
- 76
- 78
- 99

Arzopa A1 Gamut
- 75
- 74
- 97

AOC I1601CFWUX
- 47
- 47
- 63

Asus ProArt PA279CV
- 98
- 99
- 100

LONGER BARS INDICATE BETTER PERFORMANCE

Average color error

Asus ZenScreen MB249C — 1.89

BenQ GW2785TC — 3.46

Arzopa A1 Gamut — 2.98

AOC I1601CFWUX — 5.21

Asus ProArt PA279CV — 1.41

LONGER BARS INDICATE BETTER PERFORMANCE

considered a "wide gamut" monitor, and not enough for many content creators looking to edit photos or video, but it's a few percent better than most alternatives. The monitor has enjoyable, vibrant color.

It's accurate as well, achieving an average color error that's just a tad worse than that of the Asus ProArt PA279CRV, a monitor specifically built for accurate and realistic color performance. The color error is worst in blue hues, which is often true of LED-backlit monitors, but it didn't jump out in real-world use. The monitor's accuracy is further helped by a gamma reading of 2.1, which means that images appear just slightly brighter than they should. Color temperature came in at
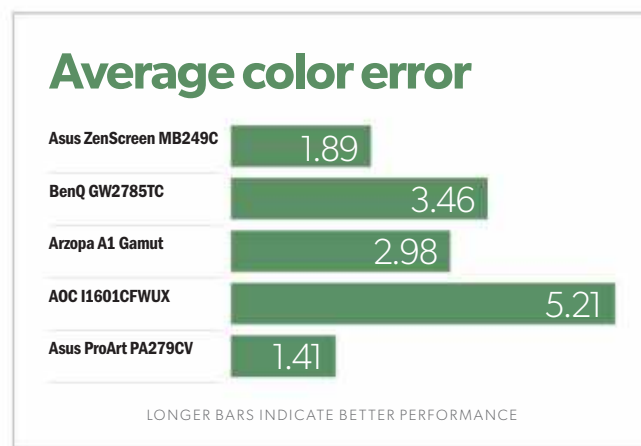
precisely the preferred target of 6500K, so it's neither overly warm or too cool. To put it simply, the monitor appears extremely accurate in real-world use and is well suited to office productivity.

Sharpness is a downside, as the display provides only 1080p resolution with a pixel density of roughly 93 pixels per inch. Many office monitors in this price range can hit 4K resolution, which increases pixel density to 163 pixels per inch. It's a noticeable gap, and the Asus ZenScreen MB249C can look pixelated and soft next to 4K alternatives.

On the whole, Asus' ZenScreen MB249C provides excellent image quality for its intended purpose. It's bright enough and scores well in contrast, color gamut, and color accuracy, all while avoiding notable problems or pitfalls. The only caveat is resolution, as it's possible to buy a similar 4K such as the Dell S2721QS (fave. co/3N25mlG) for less—however, such alternatives lack the MB249C's portability.

The Asus ZenScreen MB249C is a great portable monitor.

HDR IMAGE QUALITY

The Asus ZenScreen MB249C doesn't support HDR. That's to be expected, as the monitor's maximum brightness is well below what's needed for a passable HDR experience. Increasing brightness to levels suitable for HDR also increases power draw, which wouldn't pair well with the monitor's USB-C connectivity.

MOTION PERFORMANCE

Though meant for productivity, the Asus ZenScreen MB249C offers a slightly improved refresh rate of 75Hz and Adaptive Sync support (fave.co/3SRJhPe) for smooth frame pacing in games. Adaptive Sync was functional with the monitor connected to an AMD video card. I wasn't able to test the monitor with Nvidia G-Sync.

BOTTOM LINE

The Asus ZenScreen MB249C is an unusual but useful home and office productivity monitor. Its odd design, which pairs a 24-inch screen with several stand options including a kickstand, makes it easy to tote around a house or corporate office. It also provides good image quality with adequate brightness and strong color performance. The $350 price is a bit much for a 1080p monitor and won't make sense if you have no reason to use its unique features, but it's not unreasonable. The MB249C is a great choice for a second monitor, too, as it offers multiple ways to mount and orient it alongside your primary monitor. ⏻

Asus ZenScreen MB249C

★★★★☆

PROS
- Small, versatile desk stand with unique options.
- Sturdy built-in kickstand for portable use.
- Offers USB-C for easy single-cable connections.
- Good image quality.

CONS
- Lacks additional connection options.
- Only 1080p resolution.
- A bit pricey for its feature set.

BOTTOM LINE
The Asus ZenScreen MB249C's unusual design doesn't come cheap but provides genuinely useful versatility.

$349

OBSBOT Tiny 4K webcam: An absolute joy to use

OBSBOT's Tiny 4K is being discounted in anticipation of its successor, which was designed to address its minor flaws. **BY MARK HACHMAN**

PCWorld EDITORS' CHOICE

The OBSBOT Tiny 4K certainly ranks among the best webcams you can buy, 4K or not, period. It offers so much: 4K video, a 60fps option (albeit at 1080p), and the real magic: an automated gimbal that physically rotates and dips the webcam to center your face. It gets better. The OBSBOT Tiny 4K (sometimes sold as the OBSBOT Tiny PTZ 4K) will soon be supplemented by the Tiny 2, with a larger sensor for improved video (fave.co/3P4eoYj). That should help solve one of the Tiny 4K's only shortcomings: Video quality is good, just not outstanding. On the other hand, OBSBOT is discounting the Tiny PTZ 4K in anticipation of the Tiny 2's launch, so you can save a large chunk off of its regular $269.99 MSRP.

The Tiny 4K ships in two pieces: a magnetic mount and the camera assembly itself, packaged together inside a zipped carrying case that OBSBOT provides.

OBSBOT also provides the choice between a 4.92ft/1.5m USB-C to USB-C cable, or a USB-C to USB-A cable inside the same box. Just be sure to connect the latter to a USB 3.1 port (as opposed to USB 2.0) to ensure that the webcam has enough power.

The OBSBOT Tiny 4K feels exceptionally well designed, with touches you might not need yet provided anyway. The magnetic mount holds the camera assembly fast, with the folding "jaws" long and pronounced enough to handle even thicker displays. The mount assembly even comes with a small, sticky surface that you can peel off to affix the mount, though you probably won't need it.

All told, the webcam and its mount measures 5.59 inches tall and 2.28 inches wide and deep. The gimbal and separate mount weigh 0.37lbs together.

The OBSBOT Tiny 4K looks a little precarious when perched on a laptop, but it sits easily, and you can even stick it to a surface to help secure it.

THE TINY 4K HAS INCREDIBLE, SIMPLE CONFIGURABILITY

This is one of the few cameras whose utility software, downloadable from the OBSBOT website, feels truly necessary. OBSBOT supplies the traditional image controls: brightness, exposure, white balance, and anti-flicker controls, but also auto-focus and exposure controls (metered globally, or else specifically on your face).

The premium features the OBSBOT Tiny 4K includes are also controllable. The real magic of the Tiny 4K is how it locks on and tracks your face, and this can be triggered via the OBSBOT Webcam utility. OBSBOT, however, goes further: Not only can you set the auto-focusing camera to automatically orient itself on your face, but you can manually configure how you appear on camera, too.

A "headroom" setting tilts the camera up a bit to create "space" above your head, if you so prefer. You can even manually adjust the automatic gimbal so that the camera positions your face to one side or the other, for captioning or graphics. (While the camera will track you around a room, for a full 360 degrees, you can manually configure the gimbal 150 degrees with 45 degrees of tilt.) You can also set the field of view (86, 78, or 65 degrees) and optically zoom between 1X and 4X. The Tiny 4K's level of configurability is simply above and beyond

The magnetic mount helps keep the Tiny 4K webcam steady and allows it to rotate around.

that of most competing webcams on the market today.

OBSBOT even allows you to lock the camera on your face through gestures: holding your hand out, palm up, identifies you as the "target." Holding your fingers in the shape of an "L" zooms in and out. All of these gestures worked perfectly out of the box, though I found that I needed to re-identify myself on one occasion.

There is no privacy shutter, though the device will enter sleep mode if not actively being used. You can also manually push the camera down; when it's pointed down, it enters sleep mode, turning off the mic and camera. (Windows' Sound Recorder and Camera apps confirmed this.) The

camera tends to forget your preferences if you unplug it or shut your PC down, though you can save them as a preset.

HOW DOES THE OBSBOT TINY 4K PERFORM?

The Tiny PTZ 4K's face tracking is pretty amazing. The Tiny 4K is slow but dogged; You can literally walk around your display and the camera will follow you, albeit slowly. That's one of the only knocks against this webcam, as you'll grow used to it tracking you as you shift about in your seat and even pace the room. (Just beware if you lean away to blow your nose!) It's a little gimmicky in the fact that most of us don't pace the room while on a video call—and if you do, your viewers may see some odd angles as the camera tracks you.

If it loses sight of you, the Tiny 4K will seek out the last known location of your face, then

The OBSBOT Tiny 4K, with a representative webcam shot at 4K, using the settings shown in the OSBCOM utility to the right. It's not bad, though my face could benefit from a ring light.
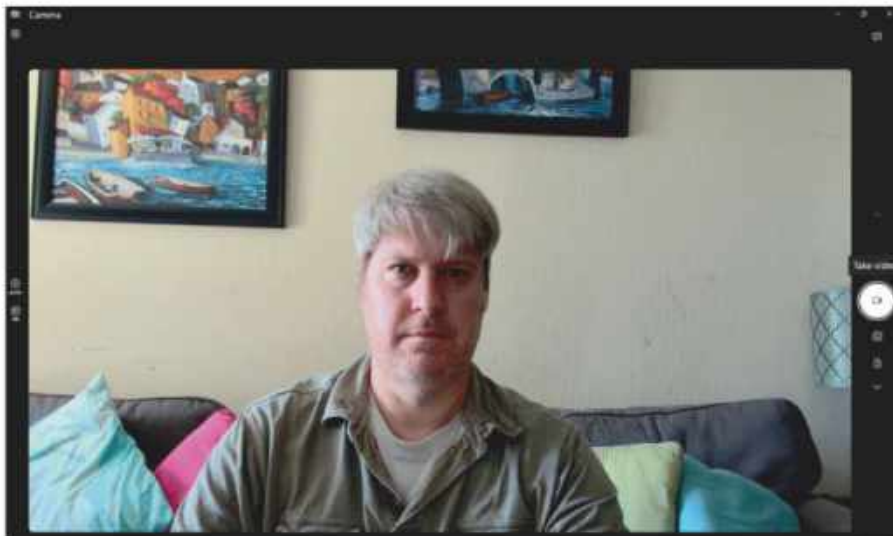
My sidelit face is a little soft here. The Tiny 4K looks a little sharper when its global focus is enabled versus focusing on my face.

swivel left and right and up and down until it re-acquires you. A small array of LEDs on the front signals if everything's okay (green) and whether it's recognized any gesture commands you've made.

The OBSBOT Tiny 4K's video quality is pretty good, on par if slightly inferior to that of the Razer Kiyo Pro Ultra (fave.co/42J0yhi), which looks about as good as any webcam delivers. About the only complaints I have are that the video resolution is only adjustable in the preview mode, and the HDR adjustment can't work wonders in a backlit room. Keep in mind, too, that 4K resolution is only achievable in 30Hz. If you want to capture or broadcast in 60Hz, you'll need to step down to 1080p.

As you can see in the screenshot below, the autofocusing could stand some improvement, too. The dual

noise-cancelling mics, however, filtered out background sounds pretty effectively, though they did a better job paired with the noise-cancelling algorithms in Zoom, for example.

OBSBOT has just released the Tiny 2 (fave. co/3P42PjT), which adds a few new features: voice control, faster focusing, and a larger image sensor, for $329. We'll likely be reviewing it soon. Still, the effortless configurability of the OBSBOT Tiny 4K elevates it to one of the best webcams we've ever seen, and a terrific product in its own right. We strongly recommend the Tiny PTZ 4K. ⏻

OBSBOT Tiny 4K webcam

★★★★½

PROS
- 4K webcam with 1080p/60Hz options.
- Extensive configurability.
- Excellent 360-degree face tracking as you move around a room.

CONS
- No privacy shutter, just a privacy mode.
- Autofocus can be slightly soft.

BOTTOM LINE
The OBSBOT Tiny PTZ 4K webcam offers an incredible array of premium features for a reasonable price, capped off by an AI-powered ability to physically track your face as you move.

$239

Model F Ultra Compact keyboard: It improves on IBM's classic

The return of the buckling spring. **BY MATTHEW S. SMITH**

Modern mechanical keyboards hold endless possibilities in design and function, yet one experience remains rare: the classic buckling spring keyboard. This key switch design was popularized by early IBM keyboards, such as the Model M and Model F, prized for their uniquely clicky, tactile feel.

Enter Model F Labs, a small company set up exclusively to produce buckling spring keyboards. The model I received, the counter-intuitively titled Model F Ultra Compact, retails for an intimidating $420. That's a high price to pay for a keyboard with few modern conveniences—but I'm sold.

WHAT'S A MODEL F KEYBOARD, GRANDPA?

IBM's Model F is the original buckling spring keyboard, launched in 1981 alongside early IBM PCs. It was standard issue for most IBM PCs through 1985, when the Model F was replaced by the more famous and affordable Model M (the Model F was still produced until 1994, however).

The distinction between the Model F and Model M is important, at least to enthusiasts. Though both are buckling spring keyboards, Model F keyboards don't have a membrane but instead rely on metal barrel plates. They're also absolute units: Most Model F keyboards have odd layouts or extra function keys. That's why the Model F Ultra Compact, which is based on the Model F 104, doesn't seem to fit its name. It's large by modern standards but small compared to many original Model F keyboards.

None of this matters if you're not a Model

F enthusiast, but if you are, I think you'll still like what you see. The Model F Ultra Compact's layout offers the feel of a Model F but is condensed into a more modern arrangement. However, it's not a one-to-one reproduction of the original look, as this model lacks the swooping accent lines that border each side of the original Model F keyboard train.

The Model F Ultra Compact subverted my expectations with improvements to the durability of the original design. Original Model F keyboards sold for hundreds of dollars in the early 1980s (adjusted for inflation, some carried an MSRP above $1,000) and were robust, using thick plastic casing over a metal backplate. Yet the new Model F Ultra Compact has them beat with a die-cast aluminum case and backplate that weighs in at roughly nine pounds. IBM's

design was rugged, to be sure, but the plastic inevitably becomes brittle over time and is prone to discoloration, problems the new all-metal keyboard won't have.

Enthusiasts looking for a more accurate reproduction should turn their gaze toward the Classic Style Model F (fave.co/463U9zR) or, if you want an even more obscure and classic layout, models like the F77 and F62. These more faithfully mimic the look and feel of original IBM keyboards.

WHAT MAKES THE MODEL F'S BUCKLING SPRINGS SO SPECIAL?

The Model F Ultra Compact certainly looks like a retro keyboard, but that's not its most important trait. This keyboard lives or dies on the quality of the buckling spring switches underneath each key. Fortunately, they're excellent.

Buckling spring key switches do what they say on the tin. A spring is located beneath each key, as is true of most modern mechanical keyboard switches. However, the spring isn't placed on a stem but instead inside a barrel. The spring provides resistance when pressed but eventually buckles, providing firm tactile feedback with a

You can see how solid and sturdy the Model F Ultra Compact's construction is. It will last a lifetime.

distinctive click.

Whether this is better than modern tactile switches is a matter of opinion. Modern switches are more versatile, offering a variety of options for feedback, noise, and speed of actuation. When it comes to sheer typing enjoyment, however, the Model F's buckling spring feels more lively than modern mechanical switches. The difference is both felt and heard, as this reproduction Model F clicky-clacks like a horse trotting down a brick road.

Personally, I love it. The Model F feels engaging, enjoyable, and accurate. It can keep up when I blaze away at 100 words per minute but feels satisfying when I find myself slowly writing, deleting, and rewriting the same sentence a dozen times over. It's a typist's key switch.

HOW IS THE MODEL F ULTRA COMPACT FOR OTHER TASKS?

The Model F's bucking spring feels less at home playing modern games, like *Counter-Strike*, or scrolling through a video timeline in Adobe Premiere. It requires a heavy force to activate and is relatively sluggish to return, so it's not great in any situation where a user

Replacing the keys and springs on the Model F Ultra Compact is easy, with Model F Labs offering all the replacement parts.

rapidly, repeatedly activates a single key or flips between a few keys quickly. It also lacks the macro buttons or dials that can be found on some modern keyboards, useful add-ons that are handy for many photo and video editors as well as digital artists. The keyboard doesn't even have an LED backlight, so you'll either need to remember the keyboard's layout or keep a light on at night.

Personally, I would never use this keyboard for all tasks—it's just not well suited to gaming. If I owned it, I'd pair it with a compact mechanical keyboard like the Keychron Q5 (fave.co/3cpTSzO). Keyboard enthusiasts may view this as a positive. Finally, a real, tangible justification for not one but *two* expensive keyboards! For those who just want to get the job done, though, it's a bit much.

Model F Labs' website and service feel archaic as well. Though expensive, the keyboard ships in unlabeled packaging with a receipt printed on an old-school dot matrix printer and a simple paper brochure. The keyboard may require setup, as keys may loosen in shipping (two popped off on mine). The manual says this is an unavoidable reality of the buckling spring mechanism, but doesn't jibe with the price tag. Model F Labs suggests users spend up to an hour familiarizing themselves with the keyboard to ensure all keys are operating correctly, which feels positively naive in a world where Twitter and TikTok exist.

The suggestion is not without merit, though, as the keyboard is designed for ease of repair. Individual keycaps can be replaced at a moment's notice, and while a plastic spunger is preferable to ensure the keys aren't scuffed, any moderately wedge-shaped tool can be used to pop off the keys. The buckling spring mechanisms are replaceable, too, as is the entire case should you decide you'd like a different color. Spare parts are available from Model F Labs with replacement spring mechanisms priced at a dollar each (the keyboard ships with two spares).

BOTTOM LINE

The Model F Ultra Compact's retail price of $420 is steep by modern standards. While some new mechanical keyboards are as expensive, they usually pair that with a huge swath of features and a high degree of customization from the factory. The Model F Ultra Compact offers few options aside from the color of the case (currently available in gray, black, red, or blue) and lacks the media, macro, and special function keys found on similarly priced alternatives.

Yet I don't think the price is unreasonable. It's expensive, sure, but far more affordable than the original Model F keyboards were back in the mid-1980s. The reproduction is even more durable than the original, too—a refreshing reversal from most such recreations, which often cut corners to keep the price tolerable.

PC enthusiasts often ironically call hardware an "investment" knowing it will be obsolete in three to five years, but the Model F Ultra Compact is different. This keyboard could last decades. Nostalgic nerds shouldn't hesitate to splurge. ⏻

Model F Ultra Compact
★★★★☆

PROS
- Excellent typing feel.
- Classic layout is instantly familiar.
- Durable die-cast metal chassis.

CONS
- Heavy key feel isn't great for fast-paced games.
- Lacks modern hardware and software features.
- Expensive.

BOTTOM LINE
The Model F Ultra Compact is a hardcore buckling spring keyboard for nostalgic enthusiasts.

$420

Crucial T700 SSD: Record-shattering PCIe 5.0 performance

This SSD from Crucial shattered all our data transfer records—color us impressed, and then some. **BY JON L. JACOBI**

Nothing revs a storage reviewer's engine more than a large jump in mainstream performance. Hitting that long skinny pedal for me was Crucial's T700 PCIe 5.0 NVMe SSD, which transferred data a full gigabyte per second faster than any SSD we've tested to date. All I can say is, "Yowser!"

PRICE, DESIGN, AND SPECS

The T700 is available in 1TB, 2TB (tested), and 4TB capacities. It's sold bare or with a rather beefy heatsink for $180/$210, $340/$370,

The Crucial T700 PCIe 5.0 NVMe SSD without a heatsink.

The TBW (terabytes that may be written) rating for the T700 is 600TB per terabyte of capacity. If you weren't aware, TBW is the mitigating factor in SSD warranties, (five years in this case), as miles are to the years in an automobile warranty.

$600/$620, respectively. Alas, that's nearly twice as expensive as for some very good PCIe 4.0 competition, though you're paying for a genuine leap in performance (see below). Note that those were pre-release prices provided by Crucial, so you might find it cheaper after launch. Look around.

As to the optional heatsink, most users will be fine without it, but if you're going to pound on the drive in a system with lots of other heat-producing components, it couldn't hurt.

The T700's 2280 (22mm wide, 80mm long) form factor uses the brand-new Phison PS5026-E26 controller and Micron's own 232-layer TLC NAND. (Crucial is a Micron brand). There's 1GB of DDR4 primary cache for every 1TB of capacity.

PERFORMANCE

The T700 destroyed the field, including the recently reviewed, formerly fastest Gigabyte Gen5 10,000 (fave.co/3CnSkAg). We're truly talking an entirely new level of performance, which held fast in the real-world tests to a far greater degree than the Gigabyte SSD. I could go on, but
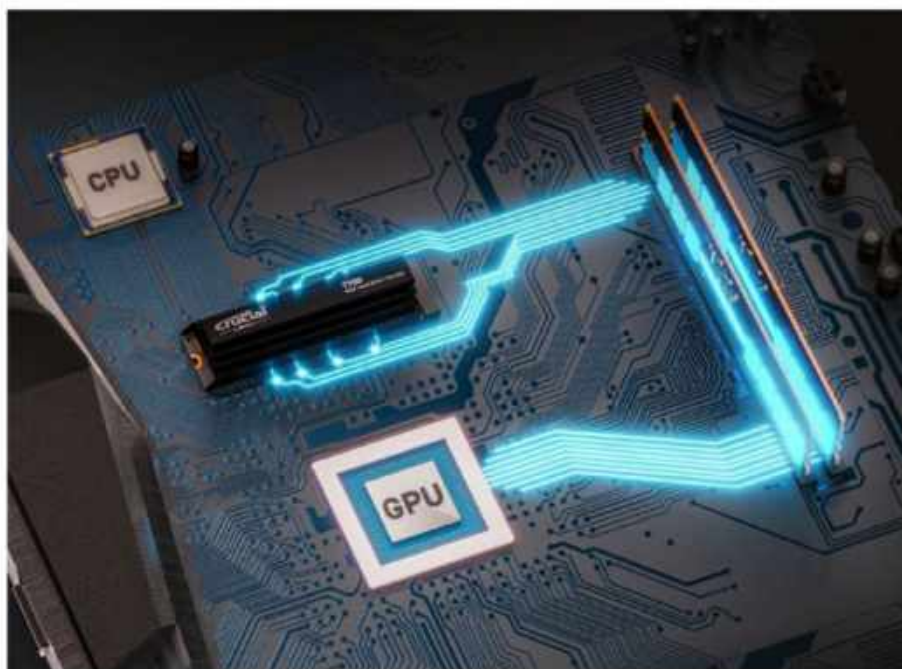
We're talking an entirely new level of performance, which held fast in the real-world tests.

48GB Copies
Seconds

- ■ Crucial T700
- ■ Gigabyte Aorus Gen5 10,000
- ■ WD SN850X

Total Time
- 147
- 199
- 220

48GB Folder Write
- 53
- 85
- 94

48GB Folder Read
- 68
- 78
- 88

48GB Write
- 13
- 17
- 18

48GB Read
- 13
- 19
- 20
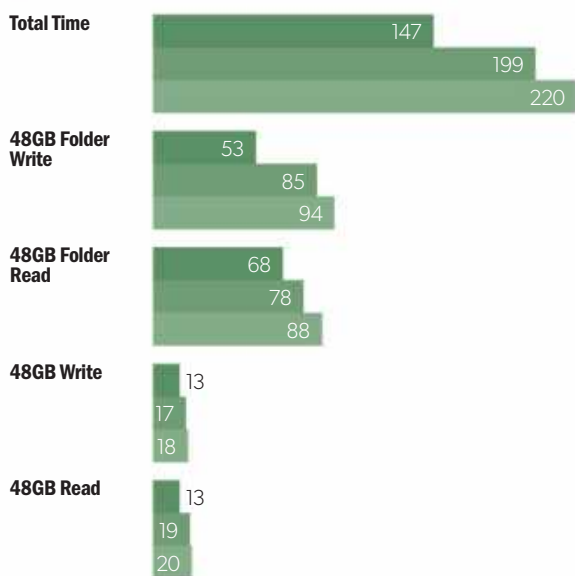
SHORTER BARS INDICATE BETTER PERFORMANCE

The Crucial T700's 48GB transfers showed great improvement in the real world, unlike the Gigabyte.

instead—you can just check out the dark green bars in the charts.

Note that the WD SN850X is a PCIe 4.0 drive included for comparison. It's among the fastest 4.0 SSDs we've tested and was re-tested on our latest test bed. (See the "How we test" section at the end of this article.)

One thing we observed is that formatting the T700 is a tad slow compared to many NVMe SSDs, regardless of PCIe revision. But who cares when you can shave the better part of a minute off a 48GB file transfer and 40

450GB Write
Seconds

- ■ Crucial T700
- ■ Gigabyte Aorus Gen5 10,000
- ■ WD SN850X

450GB Write
- 146
- 186
- 191

SHORTER BARS INDICATE BETTER PERFORMANCE

The T700 shaved a full 40 seconds off the Gigabyte PCIe 5's 450GB write time. That's bookin'.

CrystalDiskMark 8 Sequential Performance
MBps

- ■ Crucial T700
- ■ Gigabyte Aorus Gen5 10,000
- ■ WD SN850X

Sequential Write (Q=1, T=1)
- 9,334
- 6,898
- 5,690

Sequential Read (Q=1, T=1)
- 9,078
- 8,481
- 4,775

Sequential Write (Q=8, T=1)
- 11,719
- 10,162
- 6,580

Sequential Read (Q=8, T=1)
- 12,159
- 10,044
- 6,926
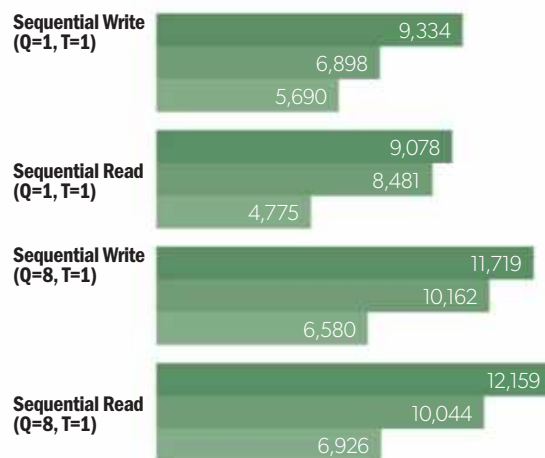
LONGER BARS INDICATE BETTER PERFORMANCE

The T700 dominated the CrystalDiskMark 8 tests, and it wasn't a particularly close contest.

seconds off a 450GB write, as we found?

Note that the 450GB write test is currently using a PCIe 4.0 drive to feed the

The Crucial T700 is the king of the hill, and it's not even a close contest.

file to the other drives. We'll be addressing this soon now that we have several PCIe 5.0 SSDs in house, but regardless, the T700 once again destroyed the competition by a good 40 seconds.

Because of the slightly insane numbers popping up, the test experience with the T700 was just a general hoot—so much so that I also installed a couple of operating systems on it, and they felt snappier. It was not a huge difference but still noticeable.

BOTTOM LINE

The T700 is absolutely the current king of the hill, and it's not even a particularly close contest. If you have the required PCIe 5.0 M.2 slot, it's the NVMe SSD you want—assuming you have the required monetary wherewithal to pay for the privilege.

HOW WE TEST

Internal drive tests currently utilize Windows 11, 64-bit running on an MSI MEG X570/ AMD Ryzen 3700X combo with four 16GB Kingston 2666MHz DDR4 modules, a Zotac (Nvidia) GT 710 1GB PCIe x2 graphics card,

and an Asmedia ASM3242 USB 3.2×2 card. Copy tests utilize an ImDisk RAM disk employing 58GB of the 64GB total memory. Each test is performed on a newly formatted and TRIM'd drive so the results are optimal. Over time, as a drive fills up, performance will decrease due to less NAND for caching, and other factors. The performance numbers shown apply only to the drive of the capacity tested. SSD performance can vary by capacity due to more or fewer chips to shotgun reads/ writes across and the amount of NAND available for secondary caching. ⏻

Crucial T700 SSD

★★★★⯪

PROS
• Breathtaking performance.
• Available with or without heatsink.
• Up to 4TB in capacity.

CONS
• Extremely pricey.
• Requires the still rare PCIe 5.0 M.2 slot.

BOTTOM LINE
Crucial's T700 shattered all our benchmark and real world records and did so by a rather wide margin. If your system features a PCIe 5.0 M.2 slot, this SSD will take your storage performance to another level.

From $180

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A family
communications plan

SIGN UP

For local weather
& emergency alerts

PREPARE

An emergency kit

20

AWESOME
NEW **WINDOWS 11**
FEATURES COMING
TO YOUR PC

SOME
WINDOWS 11
FEATURES
WILL ARRIVE
IMMINENTLY;
FOR OTHERS,
YOU'LL HAVE
TO WAIT.
**BY MARK
HACHMAN**

Microsoft unveiled Windows 11's "Moment 3" at Build in May with a host of exciting new features.

Trying to keep up with all of the latest Windows 11 features (fave. co/3Jcncrn) can be confusing, especially during the Microsoft Build rush in May when Microsoft releases new features, then announces others. This year was no different, with Microsoft unleashing a torrent of new Windows 11 features ranging from practical (fave.co/ 3PaWuTl) to fantastical (see page 30). But what's coming and when?

Microsoft now releases new features in what are colloquially known as "Moments." These Moments can occur at any time, which makes it even more confusing. The company unveiled Windows 11's "Moment 3" at Build with a host of exciting new features coming very soon—but Microsoft also tipped off even more goodies that are due at a future date.

We'll outline which new Windows features are arriving in the current Moment 3, and which will be sent to your PC later on.

THE WINDOWS 11 MOMENT 3 FEATURES

The Moment 3 features, which we'll outline below, are considered optional. They arrived in what's known as the "June 2023 optional non-security preview release for Windows 11," on "Patch Tuesday," or June 13. They arrived without fanfare, but they do require a reboot after you perform a background installation.

Microsoft has typically released smaller quality-of-life features as part of the individual Moments, and Moment 3 is no exception. Microsoft tested these features (fave.co/3X6H6ti) publicly in May as part of the Insider Preview 22621.1776 (Release Channel) beta, and now has published them as a final release.

Widgets will widen within Windows 11.

Wider Widgets: One of the more interesting additions to Windows 11 is a tweak to Widgets, which will allow more room for user-configured apps. Widgets will be wider—three columns instead of two—and Microsoft promises they will have a more personalized feed, too. Microsoft has shown off a new Widgets picker, which will provide a small preview of what the user-picked widget will look like, and guidance to find even more widgets.

Sensor settings: Some laptops have presence sensors, which automatically dim your screen when you walk away from your PC and lock your system to secure it. A new setting in Settings > Privacy & security > Presence sensing will allow you to manage this.

VPN icon: You'll see a small shield icon in the Taskbar when you're surfing on one of our best VPNs (fave.co/3FtTTMs).

USB4 Hubs and Settings: Intel-based laptops usually connect to Thunderbolt docks (fave.co/3vtA0BE). USB4, though, is a nearly identical feature found mainly on AMD Ryzen laptops. Regardless, this new Windows Settings page provides

Windows 11 will add a small shield icon if you have a VPN enabled.

information about the system's USB4 capabilities and the attached peripherals.

Bluetooth expansion: Windows 11 will now support Bluetooth Low Energy Audio, a low-power audio standard supported by earbuds like the Galaxy Buds2 (fave.co/ 3p0O1YE) and Buds2 Pro.

Account badging: You may or may not like it, but you may see a small exclamation point ("!") attached to your account name in the Start menu, alerting you when your Microsoft account needs attention. This has been associated with helpful reminders, also known as ads (fave.co/432Dien), for other Windows features.

Live caption language expansion: Live captions are one of the handier new features of Windows 11, providing subtitles for content that doesn't always have it. Live Captions will now be provided in 10 additional languages, including Chinese, various English dialects, and French, German, Spanish, and more.

Based upon what Microsoft released in the earlier preview, you should see the following smaller changes as part of the Moment 3 release, too:

• **New Print Screen shortcut:** We documented how the PrtScn key will now open the Snipping Tool app.

• **OneDrive storage indicator:** You'll see the full amount of storage space allocated to all of your OneDrive subscriptions show up in the Accounts page within the Windows 11 Settings app (fave.co/3CoMfDw).

• **2FA copying:** If you have a phone connected to your PC via Phone Link (fave. co/43A8Rgh), you can now automatically copy any two-factor authentication (2FA) codes you receive from other services.

• **Touch keyboard options:** The new Settings > Time & language > Typing > Touch keyboard setting allows you to show the touch keyboard always, never, or only when you disconnect the hardware keyboard. This is handy for devices like the Microsoft Surface Pro lineup, which include detachable hardware keyboards.

• **Clock seconds:** Are you dying to see the actual seconds in the System Tray's clock app? Now you can.
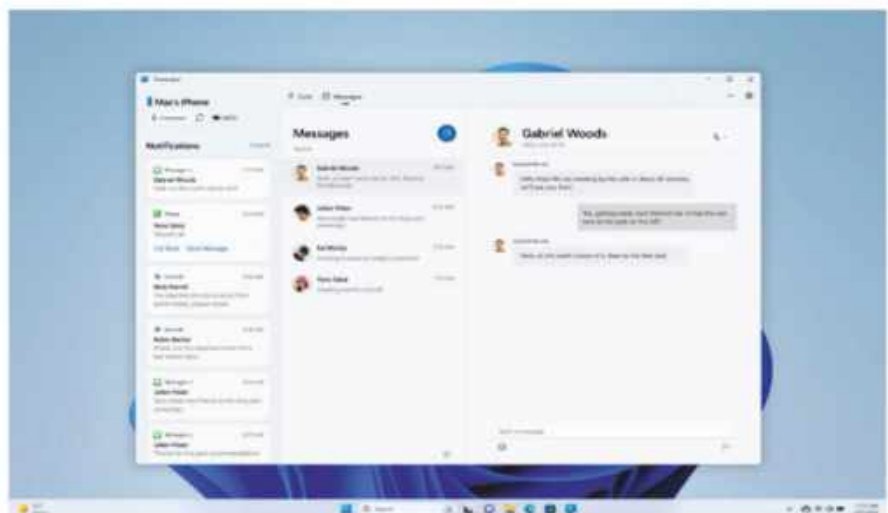
If a service sends you a 2FA code, you should be able to click and copy it from Phone Link.

- **Bing Chat AI shortcut in search:** Just as the Bing Chat shortcut appears in the search box after it's been clicked, you should now see a small Bing Chat icon in the search box. That should change to your corporation's icon if you're logged in with a corporate account.
- **Content Adaptive Brightness Control:** If you own a two-in-one or a laptop, this feature lights or dims regions of the display depending on the content. It's not quite HDR, but it's close.

NEW WINDOWS 11 FEATURES BEYOND MOMENT 3

Microsoft has also disclosed additional features that will be coming to Windows 11, but at an undisclosed future time. Some we've seen or expect to see in Windows Insider beta code, while others may be pushed to Windows PCs via the Moments mechanisms.

WinRAR support: Windows will integrate WinRAR, 7-Zip, GZ and other compression formats, thankfully (fave. co/43FfM8i). Microsoft expects that this will be available to test soon, with a full Windows 11 release for decompressing these files in September. The company hopes to let you create rar, zip, and other archives sometime in 2024.

Windows Copilot: The big new feature of Build, Windows Copilot (fave.

co/3N0trzG) will bring AI within Windows. Microsoft is shipping Copilot to testers soon, possibly by the time you read this article. We'd expect this to be a fairly major Windows Insider build.

Taskbar app ungrouping: Windows 10 allows you to show multiple apps on the Windows taskbar, individually labeled. Windows 11 is gaining that back, too. This feature debuted (fave.co/3X5JcKb) in an Insider build (Dev Channel) release in late May, hopefully meaning we'll see this one before too long.

Right-clicking to close a Taskbar app: A related Taskbar trick will allow you to right-click a Taskbar app and kill the process, as you would from Task Manager.

Windows Backup: Microsoft is testing Windows Backup (fave.co/3X5JcKb) in an Insider (Dev Channel) build. Windows Backup saves files, folders (and their layout locations on your desktop!), apps, and more to the cloud, and then reinstates them on a new PC.

RGB lighting controls: You may not own a bunch of blinged-out PC peripherals with colored lights running up and down like a Christmas tree, but for those who do, we salute you. Microsoft said in late May that it would be adding RGB lighting controls to Windows (fave.co/3X5JcKb), providing standardized settings for an industry that is badly in need of them (fave. co/3Jdgn8N). ⏻

BEST OF COMPUTEX 2023

THE MOST INTRIGUING AND INNOVATIVE PC HARDWARE

THE BEST PC GEAR FROM THE BEST PC SHOW.
BY BRAD CHACOS

Computex is the most vital PC show of the year, every year. Just look at the name! Taiwan's trade show is where computer vendors large and small unveil their latest, greatest gear ahead of the crucial back-to-school and holiday shopping seasons. If CES is where the industry showcases its vision for the future, Computex keeps it real (fave.co/3MZ9UiW).

Product cycles for the world's biggest chip vendors made this Computex, held in late May and early June, feel somewhat muted. Intel and AMD skipped keynotes all together, while Nvidia spent two hours talking about AI rather than games. With no new CPUs or GPUs on tap, the usual barrage of fresh PCs packing new tech slowed to a

trickle this year, as the next generation had already arrived earlier in the year.

But that gap also provided fresh opportunities. With laptops and chips taking a backseat, innovative peripherals flourished at Computex 2023, bolstered by exciting new software that promises to let you do even more with hardware. Which reveals got us deeply, personally excited? This is the best hardware and software of Computex 2023.

1. CORSAIR ICUE LINK

There's a definite trend in PC building this year, something we're calling the War on Cables. And while we're still months away (at least) from new motherboards (fave.co/3P4r7dE), cases, and even graphics cards (fave.co/4601qRc) designed to get cables tucked away from your central tower build, Corsair's cooling solution should be out this summer. The iCue Link system (fave.co/43X8jkx) lets you daisy-chain multiple fans, AIO coolers, and even coolant reservoirs along a single cable line.

The system can manage disparate cooling and lighting duties from its central hub, all accessible in Windows via the iCue software. I love the way that multiple adjacent fans don't even need cables; they just snap together with electrical contacts like LEGO blocks. The only downside is that it's a proprietary system, so you'll need to go all in on Corsair-branded hardware to see the benefit.—*Michael Crider*

1.

2.
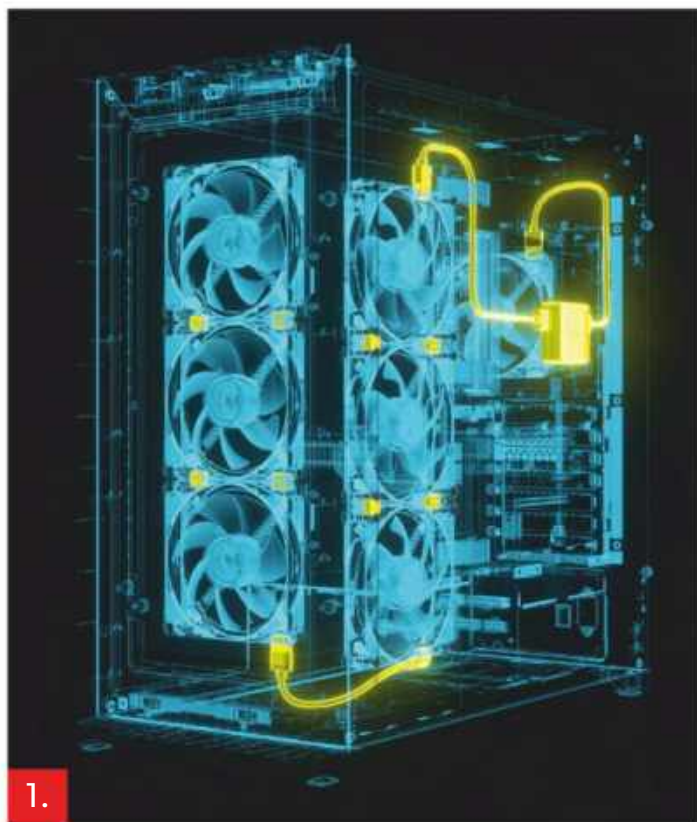
2. FRACTAL DESIGN TERRA CASE

Hot off the heels of winning The Full Nerd award for Best Case of 2022 (fave.co/3J6xo4n), Fractal Design follows up the popular North with Terra (fave.co/3qBu9M1).

Terra is the company's newest small form factor case, coming in at 10.4 liters and sporting the same Scandinavian design features and wood grain accent that made the North so drool inducing. This sandwich-style case features anodized aluminum, gull wing doors, and configuration options that allows for unique mixes of hardware configurations. It's a perfect mix of style and

functionality and is easily the next SFF case I'm going to build in.—*Adam Patrick Murray*

3. ACER SWIFT EDGE 16

Acer's Swift Edge 16 refresh (fave.co/3p50A59) was one of the most interesting laptop announcements at a Computex that was light on laptop announcements. No matter: The latest Swift Edge 16 squeezes a 120Hz 3200×2000 OLED display into a chassis that's somehow even lighter than last year's model, and offers an AI-enhanced AMD Ryzen 7 7840U to boot.

Yes, it's just a tad thicker depending on how you look at it. But that means a deeper keyboard (increasing from 1.0 to 1.3mm of key travel) and better cooling, too. It all

3.

implies a more comfortable, more powerful laptop—and did we mention that at $1,299, it's cheaper, too?—*Mark Hachman*

4. FRORE'S SOLID-STATE AIRJET COOLING GETS REAL

I'm deeply intrigued by the War on Cables that Mike mentioned above, but for me, the single most exciting part of Computex 2023 is Frore Systems' radical "solid-state" AirJet cooling technology finally getting real. (That's what happens at Computex, remember!)

We've been following AirJet from the jump, covering the initial reveal, digging deeper at CES 2023 (fave.co/3qLpabB), and even going on a Frore Systems lab tour (fave.co/3qwZ3VO). The magic of AirJet is a combination of exotic materials, geometry, and physics: The 2.8mm chip has cavities in the top full of vibrating membranes, which blast cool air across the heat spreader underneath, cooling down a CPU or other

component. Despite its minuscule dimensions, it can send individual air particles whooshing over the heat spreader at up to 200 kilometers per hour, letting PC vendors cool compact components much more effectively than ever before.

And boy, does it ever. AirJet started showing up in actual products at Computex 2023. First, Zotac's previously passively cooled PI430AJ Pico mini-PC embraced AirJet (fave.co/43Dnmjz) to upgrade from a two-core Atom processor to an Intel Core i3 with *eight* efficiency cores. That's a monumental leap in performance. Gordon also got a chance to see a Sabrent Rocket SSD running in a Thunderbolt enclosure to see the difference AirJet's active cooling can provide versus traditional passive designs.

Watch it in action in the videos above, but spoiler alert: AirJet is some of the most exciting PC technology I've seen in years. —*Brad Chacos*

4.

5. NVIDIA ACE FOR GAMES

Nvidia's Avatar Cloud Engine (ACE) for Games (fave.co/3CoGohN) offers us what feels like one future of PC gaming—and it's an odd one that may not come to pass. That's not because it's not possible: ACE envisions a future where NPCs are actually AIs, with natural language interactions powered by the cloud

5.

but the Mobile Pixels Geminos has me doing just that. And this stacked pair of 24-inch 1080p displays makes a strong case for itself.

There's the ergonomic advantage of having both screens dead center in your field of view. (Both height and angle of the screens are adjustable via the stand's hinged and sliding mechanism.) There's the space-saving aspect for crowded desks. And there's the extreme versatility enabled by all the extras: a built-in webcam and mic, a 10-in-1 dock, both USB-C and HDMI inputs, and compatibility with Windows, macOS, and game consoles, so you can even have each screen connected to a separate device.

It's a thoughtful design that takes into account many common use cases. All things considered, it's not that expensive either.

and/or your GPU. Imagine getting into a prolonged debate with a generic RPG merchant about the merits of lagers versus stouts, and you get the idea.

That means, conceptually, that the merchant might know everything there is to know about the world, including the game's major twists and turns. Or not. Or maybe just a piece of gossip that will advance the story. Narratively, AI characters may bog down the main story or completely undermine it, meaning that game designers may simply refuse to use ACE. But if AIs enter society, they'll eventually make their way into gaming. ACE could be the way.—*Mark Hachman*

6. MOBILE PIXELS GEMINOS

I wasn't prepared to reimagine the tried-and-true side-by-side dual-monitor setup (fave.co/3cocOPE),

6.

7.

Mobile Pixels has the Geminos (fave.co/3CpyNzl) listed on its site for $629.99. —*Katherine Stevenson*

7. AZZA SANCTUM 810 CASE

I'm super pumped about Azza's funky new PC cases (fave.co/45ZkjE0), specifically the Sanctum 810. It kind of looks like a futuristic terrarium at first glance due to its glass panels. The square build and angled top piece set it apart from more traditional-looking cases as well.

The unorthodox design is intentional, as it's meant to hold larger components and water-cooling systems. There's even quite a bit of space for cable

management. The front fans are also positioned in a way that allows airflow through a mesh cover, which helps keep everything nice and cool. If you're serious about showing off your PC and have the space for it, the Sanctum 810 looks mighty fine.—*Ashley Biancuzzo*

8. ASUS ROG STRIX SCOPE II 96 KEYBOARD

By the time you finish saying "Asus ROG Strix Scope II 96 keyboard" (fave.co/3Ns9OSw), you may well be able to buy one. Despite the long name, Asus' first 96 percent ROG wireless gaming keyboard packs in some very spiffy features.

The keyboard's ROG PBT doubleshot keycaps and soft comfy wrist rest sound very appealing, but the main jam for most gamers will be the hot-swappable, mechanical ROG NX Snow Switches. ROG's latest mechanical switches use new composite materials on the top and bottom switch housings to dampen

8.

sound. But they also have factory-applied lubrication for smooth linear keystrokes and "thocky" acoustics.

But the real draw for me is the keyboard's Tri-Mode connectivity with ROG Omni Receiver. I'm hoping the latter will mean I can forget worrying about USB passthrough. While the Tri-Mode connectivity gives you three connection types—2.4GHz RF wireless, Bluetooth (up to three devices simultaneously) and a USB connection—the ROG Omni Receiver allows you to connect three devices wirelessly using a single USB dongle and "without compromising performance."

The keyboard layout looks promising too, offering all the functionality of a full-size keyboard, but with bonuses like rad hotkeys preprogrammed for Xbox Game Bar and recording.—*Dominic Bayley*

9.

9. MSI MAG A850GL POWER SUPPLY (AND ITS YELLOW 12VHPWR CABLES)

It's the simple things in life that always amaze you. MSI's answer to what is widely believed to be the root of melting GPU cables last year (fave.co/3PyrLOL) was a little color. With the company's new 850-watt MAG A850GL

power supply, the company has changed the 12VHPWR connection tips to a bright yellow (fave.co/3p0qbwa).

That little splash of color works as a visual indicator to let PC gamers know if the cable has worked loose or possibly was not fully inserted. While some people still resist the 12VHPWR cable, the ship has sailed, and the MSI MAG A850GL's simple yellow cables could go a long way toward helping people avoid problems.

10. COOLER MASTER MOTION 1 HAPTIC GAMING CHAIR

Say hello to a new frontier for immersive gaming. Motion 1, a "haptic engine gaming chair" collaboration (fave.co/3J6yjll) between Cooler Master and D-Box, aims to get your whole body in the game.

It uses more than 65,000 haptic effects such as movements, waves, vibrations, and

10.

wonder chair, so you'll need to really be invested in the haptic technology to justify the expense. But at the end of the day gaming is about having fun, and a chair that makes the experience more immersive looks like a hell of a lot of fun.—*Sam Singleton*

textures. All of these supposedly combine to simulate the entertainment you're experiencing on screen. And just in case you're concerned about ergonomics, the Motion 1 includes magnetic lumbar support and a headrest as well. So at least you can save your actual body even if your in-game body gets pulverized in the virtual world.

The chair is already up for pre-order (fave. co/42ErQ8r) on Cooler Master's CMODX website retailing for $2,229.00. That's more than the Herman Miller Aeron ergonomic

11.

11. PC COMPONENTS IN ACTUAL COLORS!

For the longest time, PC components have been limited in color. You'll see lots of black, and sometimes (but not always) some white and silver as well. Computer cases get more variety, with occasional options in wild shades like blue or red. (Ahem.) Inside the case? It can be work to find enough worthy components to do an all-white build, much less one with fun color accents.

But at Computex 2023, vendors are branching out, and it's wonderful. We saw multiple cases sporting midcentury modern hues, with Thermaltake even offering matching AIO coolers (fave. co/42wXYuw). Think pale turquoise, matcha green, forest green, and pastel pink—shades that can really pop against a white build or add a subtle flavor to

12.

everything will fit at the same time, of course, but a lot will.

You can also swap the included panels for other colors, and the options include several fun shades. There's a bright yellow (aka "Bumblebee"), and then three dessert-colored pastel hues (mint, pink, and cream). With this mix of good looks and smart design, the Qube 500 could go a long way in popularity, especially with the company's encouragement of 3D-printed accessories. If it kicks off a new trend when it launches on September 15, I won't be surprised. —*Alaina Yee*

a black one. (A dark forest green AIO in an otherwise all-black PC? Yes, please.) Fingers crossed that this becomes a lasting trend— and one that brings even more colors into play.—*Alaina Yee*

12. COOLER MASTER QUBE 500 FLATPACK

Adult Lego is popular, and for good reason— assembling a kit into a full item can be relaxing. Cooler Master is capturing that same vibe with its Qube 500 Flatpack case (fave.co/3PaaxJ7), which comes deconstructed. You put it together yourself.

The novelty of the design is compelling, especially since this fully modular case is simple yet flexible in both configuration and aesthetics. This 33L minitower can fit plenty of hardware inside—an E-ATX motherboard, a CPU cooler up to 172mm in height, a GPU as long as 365mm, a 280mm radiator, and up to three 3.5-inch drives. Not

13. COOLER MASTER SNEAKER X

I mean, it's everything you need to house a high-end gaming rig, but it looks like a gigantic sneaker (fave.co/43RkiRf). What else needs to be said? (Maybe that it'll be $5,999 when it launches in July.)—*Brad Chacos* ⏻
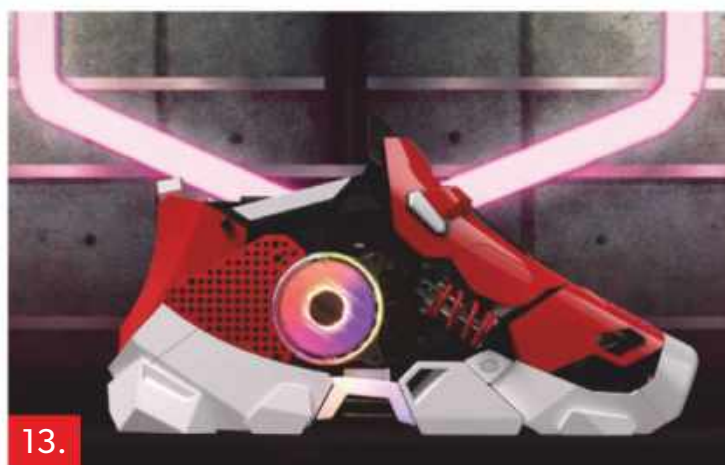
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Vaping can
cause irreversible
lung damage.

TalkAbout
Vaping.org

Get the facts
about youth vaping.

American
Lung
Association.

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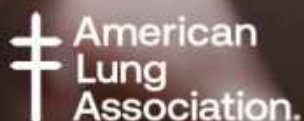
#DoThe
VapeTalk

How to link your iPhone with Windows 11 and use iMessage

The sync isn't full-featured as within Apple's ecosystem, but it's definitely better than nothing. **BY ALAINA YEE**

At long last, you can link your iPhone with a Windows PC—at least, you can if you're running Windows 11.

Anyone still on Windows 10 isn't missing out on as much as you might think, though. You don't get the same experience as when pairing an iPhone with a Mac. So while you can use Microsoft's Phone Link app to interact with your iPhone's text messages, make phone calls, and see phone notifications, some functions come with caveats, particularly texts:

• Group, picture, and other media messages won't show in conversation threads. You will see notifications for those kinds of incoming messages, though.

• Message conversations only show texts that were sent and received after pairing, and only upon the second message received from a contact—even if you have an ongoing thread with that person.

• Texts sent through your phone won't show in the conversation history shown on your PC.

• Not all iPhone apps currently support passthrough of notifications to a PC.

But even with these limitations, being even partially untethered from your phone while on your PC is very freeing. You won't need to look at your iPhone (or Apple Watch) as often. And connecting the two devices is easy. Here's how to try it out for yourself.

Note: If someone knows your iPhone passcode, they can pair the Phone Link app with your phone to see your communications and notifications unbeknownst to you. To avoid unwanted monitoring, protect your PIN and check your Bluetooth settings periodically for any unknown devices paired (and connected) to your phone.

STEP 1: OPEN THE WINDOWS 11 PHONE LINK APP

You need Windows' Phone Link app to pair your PC and your iPhone. (Sorry, no iPads and macOS devices; they're not supported.) The program should be preinstalled on your computer—if not, open the Microsoft Store app and download it.

On the opening screen, click on the iPhone button under Pick your phone to get started. If that button is missing or grayed out, you'll need to update Phone Link. In the Microsoft Store app, choose Library at the bottom left of the screen. If you don't already see a pending update for Phone Link, click on the "Get updates" button.

STEP 2: PAIR YOUR DEVICE

The next screen that appears should say "Pair your devices with Bluetooth." You can perform the pairing in one of two ways: by using the QR code that shows on this screen, or
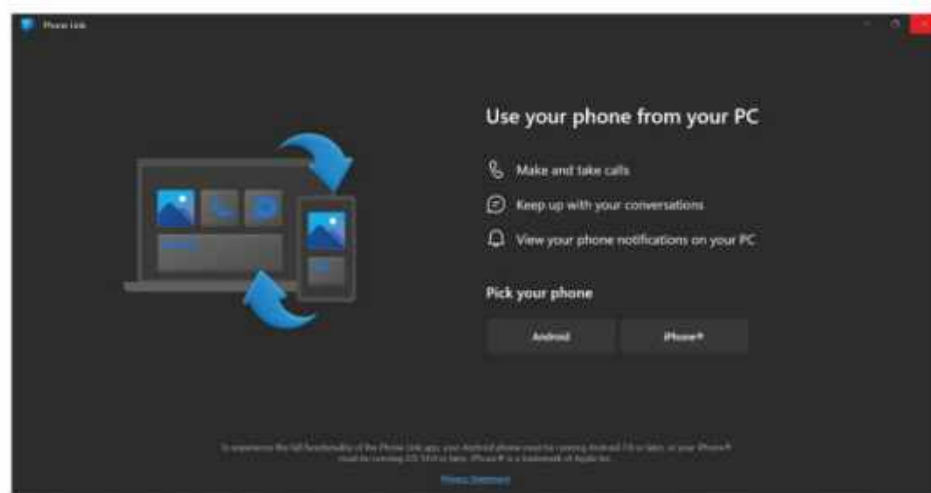
To pair an iPhone with a Windows 11 PC, you'll need Phone Link version 1.23032.196.0 or higher. You can verify this information on the app's product page within the Microsoft Store app—scroll down to the "Additional information" section.

by clicking the "Continue manually without a QR code" link.

Each method has its pros and cons. The QR code method is simpler, but it's currently buggier, too. (When we used this method, phone call controls wouldn't work properly.) Meanwhile, the manual method requires more steps but offers a more stable, consistent experience.

If your pairing process gets stuck, your QR code may have expired.

QR code method:

1. On your iPhone, open the Camera app.

2. Scan the QR code.

3. Tap the yellow "Pair your devices" pop-up that appears.

4. A pop-up window will appear on your iPhone that asks if you want to pair your device. Tap the blue Open button (**1**).

5. Verify that the pairing request codes shown on your phone and on the PC match up. You'll need to confirm by clicking and tapping the codes on both your PC and your phone.

6. Tap Allow for notifications.

1.

If the pairing process becomes unresponsive at any point, your QR code may have expired. You'll need to go back in the Phone Link app to the beginning screen and start over again.

Manual method:

1. Install the Link to Windows app on your iPhone. You can do this in one of three ways:

• Scan the QR code on the Phone Link app with your phone's camera. Tap the "Pair your devices" yellow box that appears. Then, in the bigger pop-up window that shows up next, tap on the tiny gray App Store link at the bottom right.

• Point your iPhone's browser at fave. co/3X0Wc3H. The first result should send you to the Link to Windows entry in the App Store (**2**).

• Open the App Store on your iPhone, then search for Link to Windows. (Confirm that it's created by Microsoft Corporation.)

2. Open the Link to Windows app, then tap on the Scan QR code button.

3. Grant the app permission to use your camera.

4. Scan the QR code in the Phone Link app.

5. On your iPhone, a new screen appears that says "Continue pairing with Bluetooth." Tap the blue Continue button.

6. Grant the app permission to access Bluetooth.

7. Verify that the pairing request codes shown on your phone and on the PC match up. You'll need to confirm by clicking and tapping (respectively) on both your PC and your phone.

8. Tap Allow for notifications.

STEP 3: SET YOUR PHONE PERMISSIONS FOR FULL SYNC

To get all the notifications from your phone—and for contacts to show up properly in your Messages and Calls lists—you'll need to first tweak a few permissions on your iPhone.

Head to Settings > Bluetooth (**3**). Find the name of your Windows PC, then tap on the
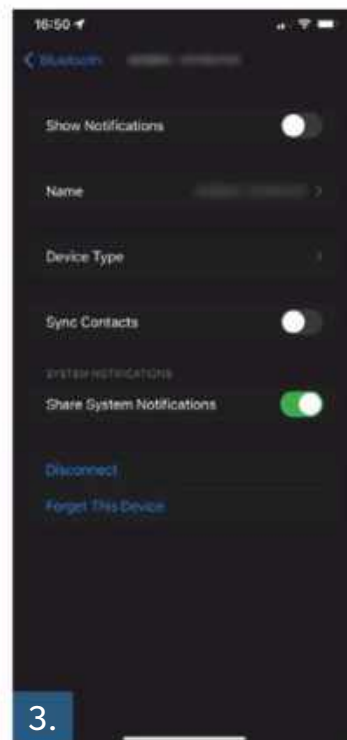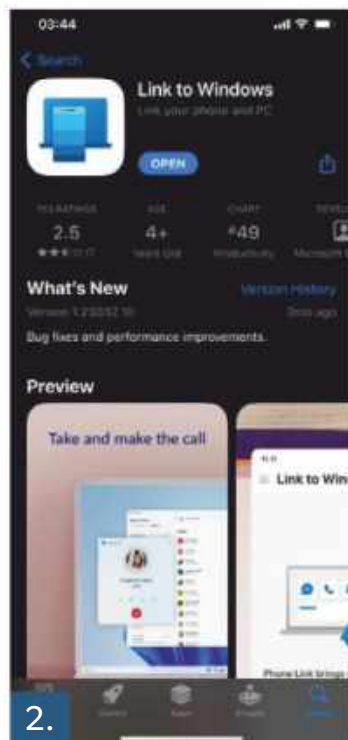
information icon (the "i" with a circle around it) to the right of it.

Flip on Show Notifications, Sync Contacts, and Share System Notifications. In the previous step, if you clicked Allow, you should see the Share System Notifications option already turned on.

STEP 4: USE PHONE LINK

After passing through the final setup windows, you'll see Phone Link's main screen. It's divided into two sections: The left-hand bar is a running list of notifications, while the main section shows your messages and your calls. By default, you'll start on the Calls tab first. If you click on the gear icon in the upper right-hand of the window, you can tweak your settings—like customizing how iPhone notifications appear in Windows 11, changing Phone Link's startup behavior, and the theme color of the Phone Link app. You can also see the devices that are linked to Phone Link and add more.

You can refine which iPhone notifications you'll see on your PC, too, though not all apps are supported. On our iPhone, only 13 of the

50-plus apps installed were compatible with PC notifications. Several popular messaging apps like WhatsApp, Discord, and Google Chat were missing.

How to use iMessages on a Windows 11 PC

Message sync on Windows 11 is currently basic. You can only exchange text messages (SMS and iMessage) through the Phone Link interface—you'll type your replies in the text field at the bottom of the screen. Incoming group, picture, and other media messages won't show in the conversation threads. Instead, you'll only see a notification when you receive an MMS message (along with a preview of the text, if you have that setting on).

Any messages you send from your iPhone will not show on your PC's running list of messages, either, nor will the first message you receive after syncing your iPhone with your Windows 11 PC—even if you have an existing running thread with that contact.

How to make (and accept) iPhone calls on a Windows 11 PC

In the Calls tab, you can start a call in a few different ways: You can click on any contacts in your recent call history, search your contacts, or use the dial pad. You can also answer incoming calls by interacting with the pop-up window that will appear.
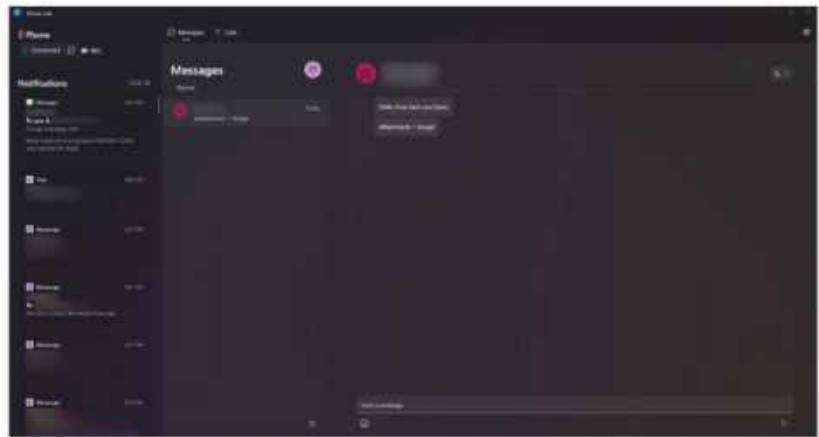

You can't see images from picture messages, only a notification telling you how many pictures you received.

Calls initiated or answered through your computer will be taken on the PC. Calls started on your phone will be accessible and controllable through the PC, including switching between the two.

If you're experiencing bugs (as we did when going through the easy QR code pairing method), you may notice issues with controlling calls through your PC. If this is the case, unpair your device from Phone Link, download the Link to Windows app in the App Store on your iPhone, then pair your PC and your phone again. It should solve your call issues. ⏻
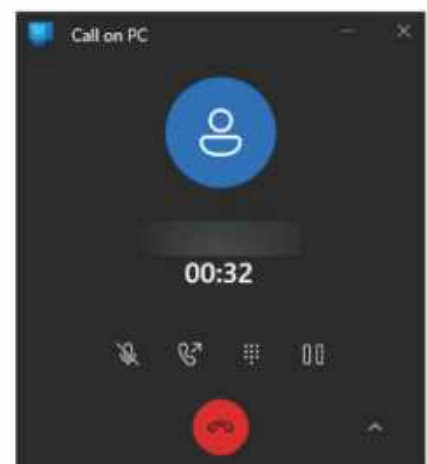
You can switch control of the call between your PC and iPhone.

5 free Chrome browser extensions we can't live without

These are the first add-ons I install on any new PC. **BY ALAINA YEE**

Browser extensions improve the experience of internet trawling. Just a handful can save you time, money, and sanity, plus protect your security and privacy.

Everyone has their favorite add-ons. And as you might expect, the PCWorld staff's faves tend to overlap. For example, my colleague Mark Hachman's list of top 5 Edge extensions

(fave.co/462L8as) is kind of a sneak peek of my own lineup.

But while you'll see the same themes come up, my actual picks differ. There's a lot of choice on this planet, and that means you can tailor your experience to fit your needs and interests. Mine revolve around staying safe on the web, deal hunting, and not letting social media get the best of me. (None make

my cut here, but if you need to protect your traffic from prying eyes, check out our list of the best free VPNs for Chrome [fave.co/3X6qDW0].)

Oh, and Edge users—you can join in on this party as well. Most of these exist as native Edge add-ons, but you can also install them from the Chrome Web Store, too.

UBLOCK ORIGIN

Ads are an unfortunate vector for internet diseases—that is, viruses, malware, and exploits. You can stay safer while on the web by installing an ad blocker, which cuts off that route for malicious activity. Combine it with direct support for sites you love, such as a subscription or a periodic donation, and everyone makes out better in the end.

Using an ad blocker also supercharges your browsing experience. Your computer may feel sluggish or slow due to how long it takes to fully load a website's extra advertisements and scripts. Without ads, sites come up fast and also look sleek and polished.

You still retain a lot of flexibility over

what gets filtered. Can't afford to donate cash to a site? You can add it to an allow list so that their ads still show. You can also fine-tune the settings to permit some tracking sites to load, which can be necessary for newsletter links or a search engine's shopping suggestions to work.

The strength of uBlock Origin (fave.co/3YGXiSc) is that compared to rivals like Adblock Plus, it actually blocks *all* ads. (ABP allows some "non-intrusive" ads to slip through.) It also has less impact on your system resources. I switched over from Adblock Plus years ago and haven't looked back since.

(Note: If you go searching for this particular extension, make sure to find the one created by Raymond Hill for Chrome
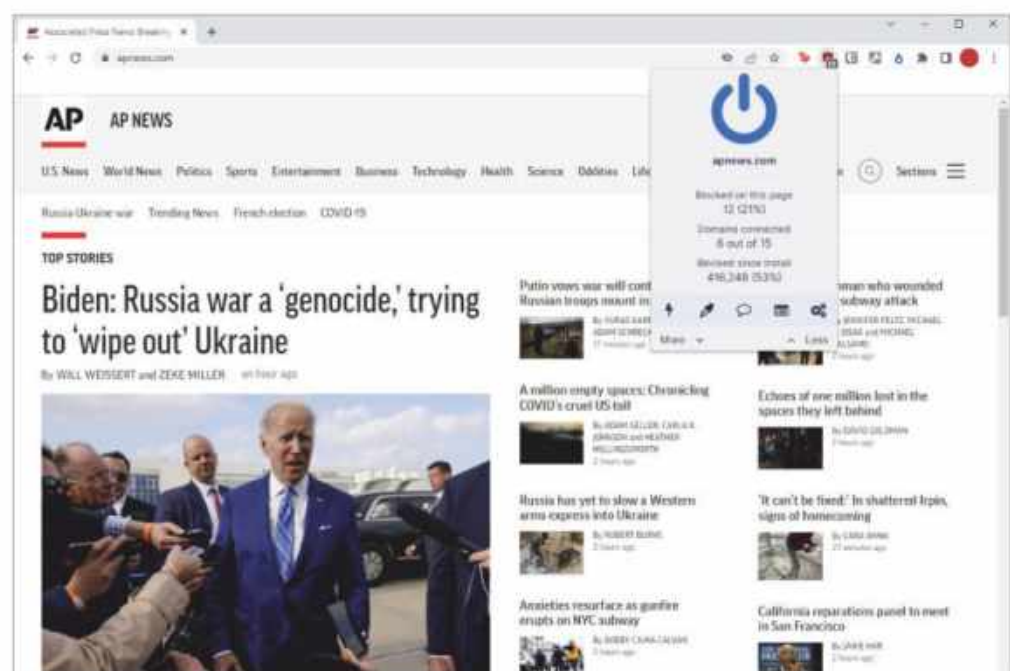
Clicking on the uBlock Origin icon in the toolbar allows you to add a site to the allow list, check your stats, and more.

and by Nik Rolls for Edge. Be wary of lookalike options.)

Tip: Tired of cookie consent notices? Turn on the EasyList Cookie filter in this extension's options (Filter lists > Annoyances). You can also turn on Fanboy's Annoyance filter at the same time, which blocks things like social media content and in-page pop-ups.
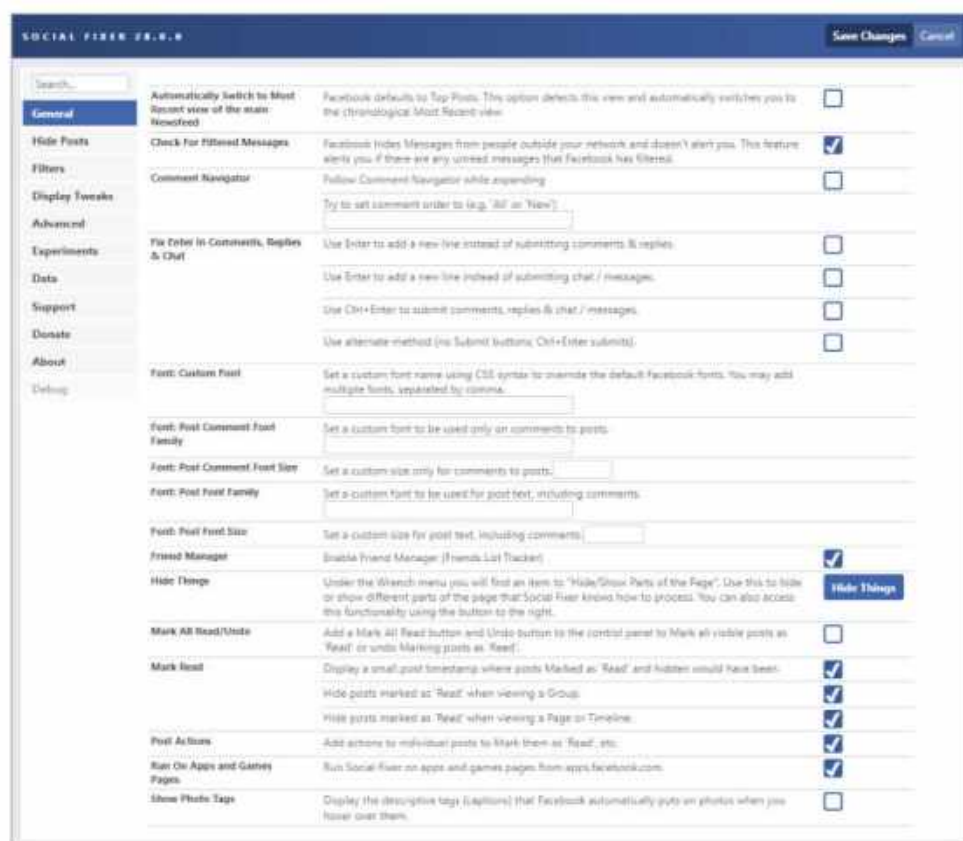
SOCIAL FIXER

Facebook can drive a person crazy, especially when you're only on the service because of certain people or commitments. Social Fixer (fave.co/3X3wCLj) makes the experience a lot more tolerable. No longer must you wade through what the algorithm feeds you—this extension lets you control the content that appears on your feed. (Yep!)

Want to hide posts based on keywords? Easily done. Tired of seeing "People You May Know" or "Suggested Posts"? Gone in a heartbeat. Want to filter posts based on what's in them, who wrote them, or something else? Absolutely possible.

You can also customize the interface, force Facebook to list posts in order of most recent, make timestamps show as exact dates, and remove all interactive fields so you can browse without accidentally commenting or liking a post—among other things. The result is a properly curated feed, free of endless politics, spoilers for TV shows and movies, nonstop posts gushing about a significant other, or anything else that drives you up a wall. You also can save yourself from your worst tendencies and not comment on things that you know will start fights. (I'm speaking purely hypothetically.)

As you can see, Social Fixer offers a ton of customization options. To speed up the process, you can choose from premade filters, like those that hide posts with politics or spoilers.
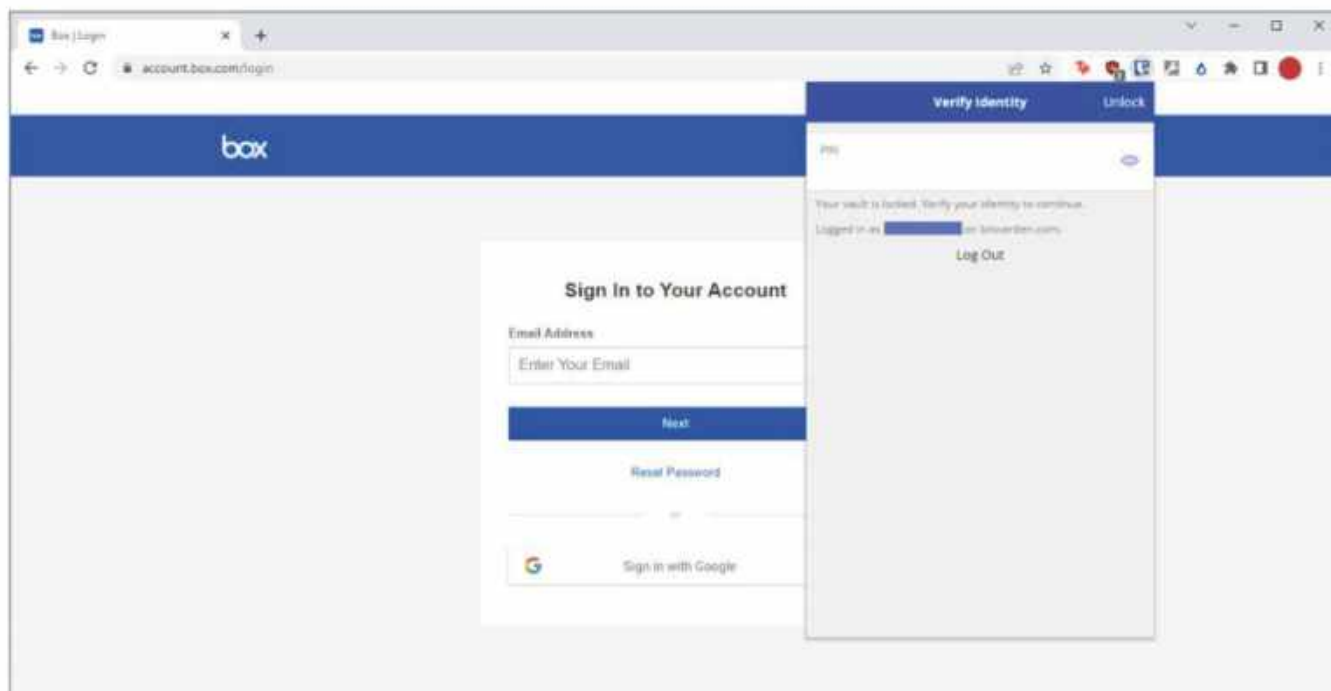
The browser extension for your chosen password manager will simplify using strong, unique passwords.

The best part? Developer Matt Kruse constantly works to keep up with Facebook's changes and add more features, and he does all this for free—you'll only see a small request for a donation when you first install or when a new version launches. (While a donation isn't required, it's a good way to show gratitude.)

Tip: While you can create your own filters from scratch, you don't have to. Social Fixer's settings have a list of predefined options in the Filters tab. I always apply Hide Sponsored Posts, Hide "People You May Know," and Saved Post Reminder, but you can also hide reels, suggested posts, and more.

BITWARDEN

I list Bitwarden (fave.co/3qB78ZD) here because its free service is great and its

premium features cost only $10 per year, but really, you can swap in any password manager. Dashlane (fave.co/43TeG8u), 1Password (fave.co/3N3Rlu2), and other services also offer browser extensions. Heck, even KeePass (fave.co/3NoB6ZU) has browser extension plug-ins.

Browser add-ons play a huge role in how seamlessly a password manager fits into your life. With one installed, you don't need to log into the service's website and hunt for the entry needed, or manually type out that info while looking at a phone app. Instead, the extension recognizes the site you're on and autofills your credentials. You can also easily create new passwords on the fly or change existing ones.

Safeguarding your password vault is a snap, too. Just set the extension to auto-lock

after a certain period of time, with a passcode or your full password needed to regain access. That reduces the likelihood that someone borrowing your PC (or someone who gains remote access unbeknownst to you) can wreak havoc on your digital life.

Tip: For better security, change your settings to automatically clear your clipboard after copying a password. That prevents you from unintentionally pasting that sensitive information somewhere else. Head to Settings. Then, in the Other section toward the bottom, choose Options. Under Clear Clipboard, pick the amount of time delay you want to set before the clipboard gets wiped clean. (Give yourself enough time to copy and paste. You can go as short as 10 seconds or as long as 5 minutes.)

TELEPARTY

Many excellent browser extensions exist for creating watch parties, including my previous pick, TwoSeven (fave.co/3CrmjaE). But these days, I don't participate in watch parties as often, making my subscription to TwoSeven unnecessary—especially since Netflix Party evolved into Teleparty (fave.co/4601joQ).

Teleparty works with Netflix, Disney+, Hulu, HBO Max, and Amazon Prime, which amply covers the occasional movie night or drops of highly anticipated series. It also offers a simple interface that lets you get straight to watching, with support for up to 1,000 users in a single party. You simply log in to your streaming service *du jour*, as does everyone else. To start a party, you click on the extension's red TP button next to the address bar and share the link generated. (Don't see the Teleparty icon? You may need to first pin it to Chrome's
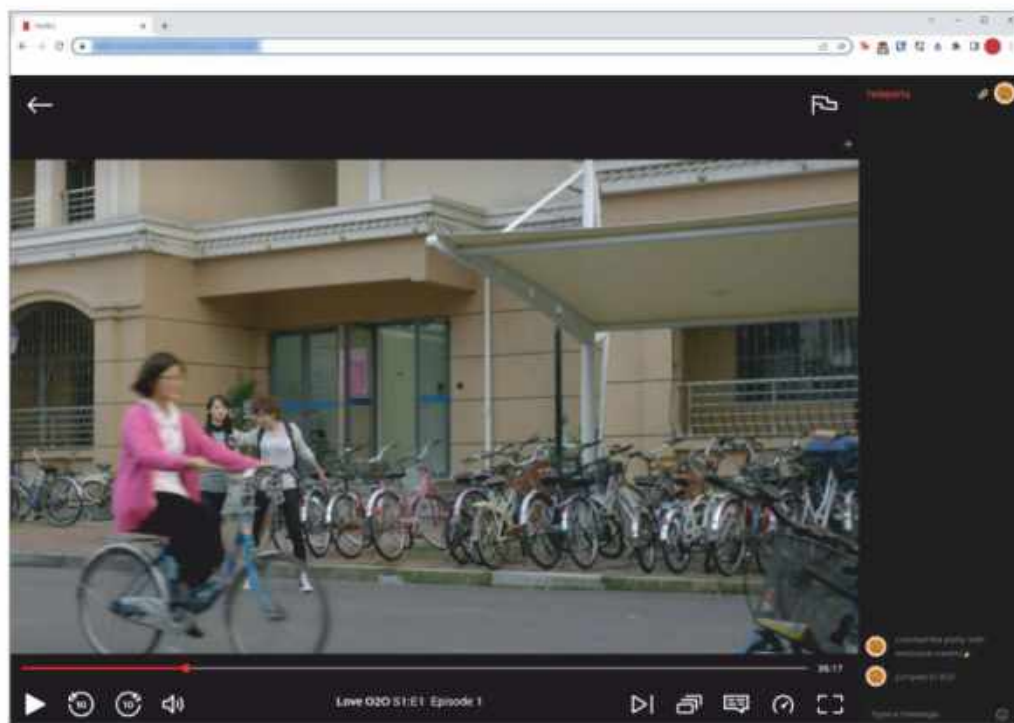
By default, everyone can control playback in Teleparty, but you can also indulge latent despotic tendencies by restricting control to just you—as I've done here.
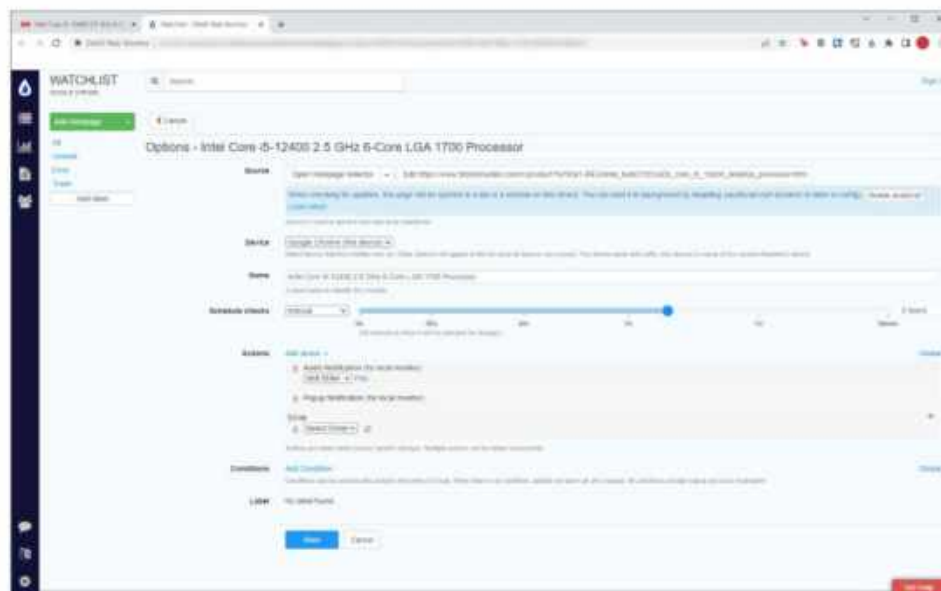
toolbar; see fave.co/42ERo54.)

The extension does have its limitations. Choosing who can control playback must be set before creating a party—you can't change the setting after the room is created. Refreshing the page also boots you from the room, and you'll need the direct link to get back in. (Sometimes I do miss TwoSeven's reusable watch party rooms.) But it works very smoothly, which is all you can really ask of a free service.

Distill.io can work like Keepa or CamelCamelCamel, but on any website.

Tip: Want Netflix to output in 4K during a watch party? Use Edge. Cross-browser parties are supported, so your friends can still be in Chrome. Also, if you want to share a YouTube video (which Teleparty does not support), you can turn to fave.co/3p3Axvi.

DISTILL.IO

This extension is the newest addition to my lineup, and one that came as a tip from PCWorld head honcho Jon Phillips. Distill.io (fave.co/43CbKgS) can be used to track any changes on a website—which is extremely useful for staying abreast of price changes on hard-to-track items. (Its developers even promote it for this purpose on their website.)

Before then, my bargain-hunting system had nothing in the way of direct tracking. I instead trawled crowdsourced sites like Slickdeals (fave.co/3H3Nqds) and /r/buildapcsales (fave.co/3CrlX2y), followed Twitter accounts and joined Discord servers, and waited for alerts to hit my phone. Distill.io reduces that work, as well as the delay in jumping on a deal. I haven't needed to use it often, but it has added one more tool to my arsenal. And with inflation currently wreaking havoc on prices, I imagine I'm not the only person who'll be using every trick in the book to save money.

Tip: Creating a login syncs your tracking across devices, which is handy if you bounce regularly between, say, a laptop and a desktop PC. This basic cloud syncing is available to free users, so it won't cost you anything. ⏻

Setting up a local account in Win 11 is tricky. Here's how to do it

Sometimes you just can't get online while setting up Windows. **BY ALAINA YEE**

Microsoft might want everyone on an active internet connection while setting up Windows 11, but that's not always possible. Some people have limited internet connections, while others may find Windows doesn't recognize their ethernet and/or wireless hardware.

Having no internet can seem like a big problem, too, since Microsoft doesn't want people creating local accounts during Windows 11 setup. Even when disconnected from the internet, the setup screen insists you sign into a Microsoft account.

Fortunately, you can get around this restriction. Turns out local accounts *are* still available during Windows 11 setup if you put in a little bit of keyboard work.

During setup, when you reach the "Let's connect you to a network" screen, it will appear that you can't go further without an internet connection. But you can—start by typing **Shift + F10** to open a Command Prompt window.

Next, type **OOBE\ BYPASSNRO** into the Command Prompt window. (This command is not case sensitive, so you can enter it in lowercase and it will still work.) Your PC should reboot, then show the start of the Windows 11 setup again. Go through the same steps as before to reach the "Let's connect you to a network" screen once more (**1**).

1.

You should now have a new option at the bottom right of the screen: "I don't have internet." Choose it, then select "Continue with limited setup." A screen with Microsoft's terms and conditions will appear. Accept to move on to the next screen, which lets you pick a name for your PC (**2**). After you create a password and security reminder questions, you'll finally arrive at the desktop.

By the way, if Windows 11 didn't recognize your ethernet and/or wireless hardware, you likely need to install their drivers. For prebuilt PCs, head to the product page for your specific model on the vendor's website (such as dell.com, hp.com, and so on) to find a link to related downloads. For a DIY PC, visit the product page for your motherboard for a link to the downloads.

Afterward, you should probably switch to logging into Windows 11 with a Microsoft account. (You can do so in Settings > Accounts.) This sign-in method offers extra protection against dangers like loss, theft, and ransomware—for example, you get automatic device encryption on compatible PCs, as well as automatic backup of your documents, photos, and videos to your OneDrive account. You never know when having better security and rudimentary backups will bail you out of an unexpected bad situation. ⏻
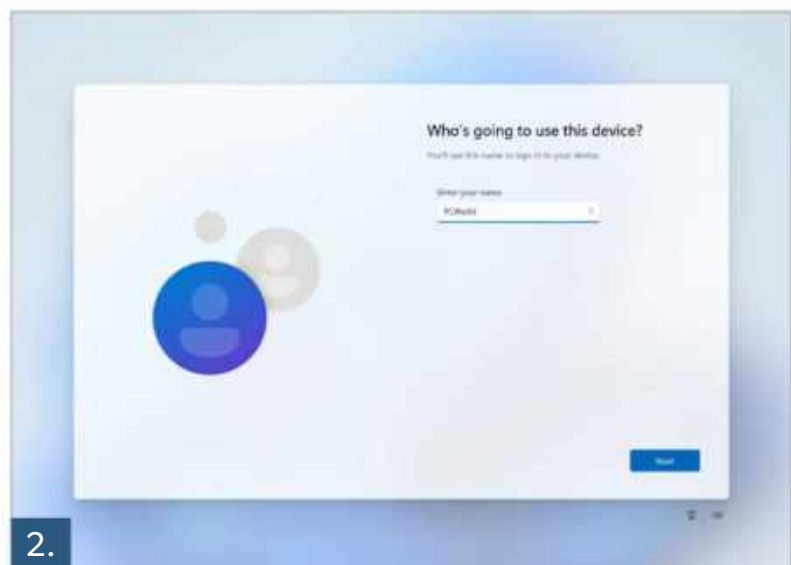
2.

This Gmail trick reveals which companies sell your data

If you want to know which firms are selling your data, use this Gmail trick. **BY DENNIS STEIMELS**

Have you ever registered with a new website and suddenly started receiving emails from companies and providers you've never heard of? If so, it's highly likely that your data has been sold. Data is a valuable business these days, and companies can make a lot of money selling your information to data brokers and other interested parties. This uninvited spam is certainly annoying, but don't worry. Here we'll show you how to stay one step ahead of spam and untrustworthy websites. And even if you don't use Gmail, the following trick works with Outlook and iCloud as well.

HOW TO FIND OUT WHO IS SELLING YOUR DATA

You might not know it yet, but your personal Gmail address has countless variations. By

simply adding a "+" and a word or number in front of "@gmail.com" to your own mail address, you'll be able to change your address, but all email sent to this new variation will still land in your mailbox as you're used to. With this method, it's now extremely easy to trace how and by whom your data has been passed around. Sounds too good to be true? Honestly, it's really that simple. We'll explain.

When you register with an online service, shop, or other website, you have to enter your email address. With this trick, instead of using your original Gmail address, add a "+" and the name of the provider or website.

So for example, instead of using "dennis@gmail.com," you can log in with "dennis+firma1@gmail.com" (**1**). You'll continue to receive all emails from that provider or service to your normal mailbox,

1.

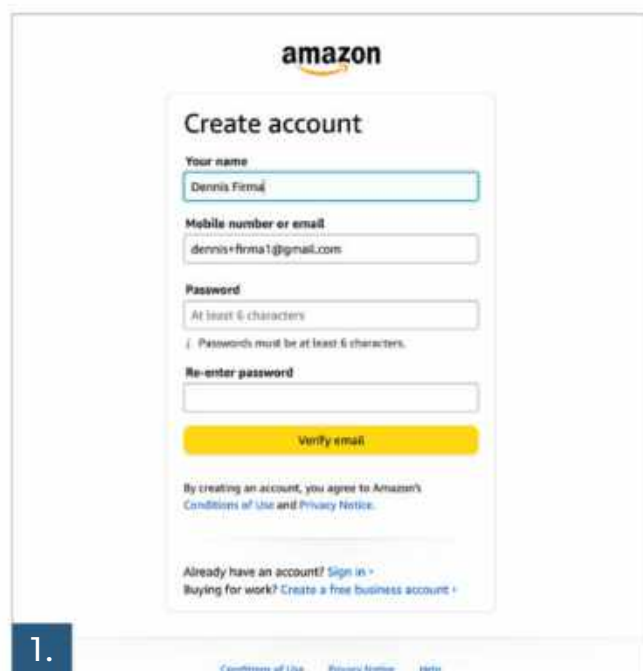but you'll also be able to identify exactly to whom they may have passed your data.

So if you've registered with "Firma1," and shortly afterward you receive spam emails from company 2, company 3, and company 4 with whom you have neither registered nor heard of, you can easily identify the culprit. If you open one of these spam emails in your inbox, you'll see your mail address under "To." If in this case it says "dennis+firma1@gmail.com," then you know for sure that this service has sold your data to company 2, for example, which is now sending you spam messages.

To easily solve this, just unsubscribe and delete these spam emails from your inbox.

DATA TRADING IS NOT FORBIDDEN IN PRINCIPLE

Yes, companies are allowed to sell certain data under strict conditions—email address trading is particularly popular. As a rule, you typically knowingly or unknowingly agree to your data being passed on to third parties by accepting the privacy policy of a service or website. Often users don't even know this because the notice is hidden somewhere in the statement and most users don't bother reading it completely.

The above trick is therefore particularly well suited to finding out which service passes on your address data to third parties—whether it was with or without your knowledge and consent. ⏻

Tech Spotlight

A video showcase of the latest trends

Watch the video at youtu.be/ U-kOnocXJxY

Origins of the First PC Microtower

It's been almost 20 years since HP purchased the boutique computer maker VoodooPC, bolstering both HP's gaming and design offerings. And in 2009, that purchase bore fruit: The company's "Blackbird" design was refined into a superpowered, supermodular microtower called the Firebird 803. We're joined by VoodooPC founder Rahul Sood (currently CEO of Irreverent Labs) for a personal tour of this unique desktop design.