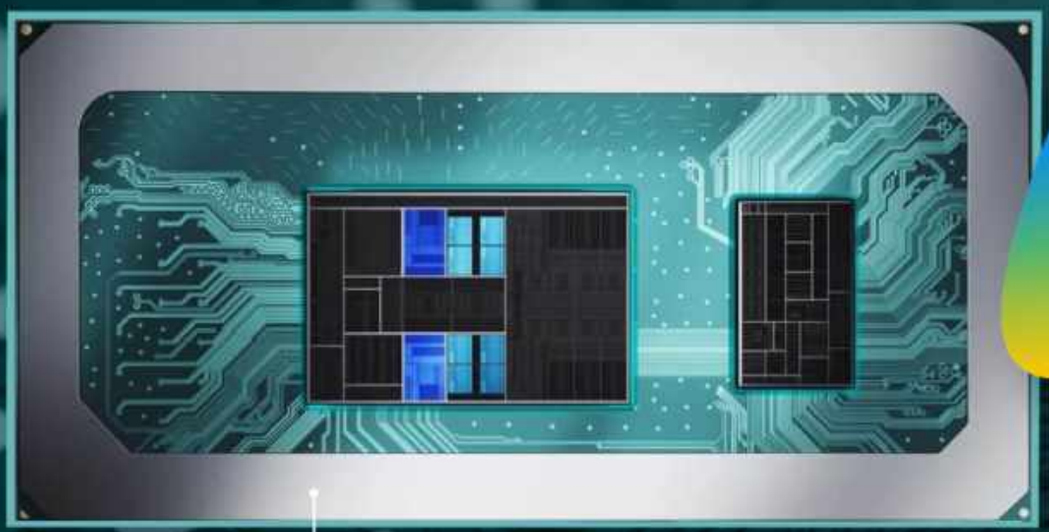
INSIDE: MICROSOFT SURFACE LAPTOP STUDIO 2 REVIEW

PCWorld

NOVEMBER 2023



INTEL'S METEOR LAKE CPU

WINDOWS COPILOT

MEET THE AI-POWERED PC *of* TOMORROW

MICROSOFT, INTEL UNVEIL GRAND AMBITIONS

PLUS: 22 AWESOME OPEN-SOURCE PROGRAMS THAT DO EVERYTHING

RISK OF LIGHTNING STRIKE:
1 IN 500,000

LIFE DOESN'T ALWAYS GIVE YOU TIME TO CHANGE THE OUTCOME.

PREDIABETES DOES.

RISK OF PREDIABETES:
1 IN 3 ADULTS

TAKE THE RISK TEST TODAY AT DoIHavePrediabetes.org

ad COUNCIL

AMA AMERICAN MEDICAL ASSOCIATION

CDC CENTERS FOR DISEASE CONTROL AND PREVENTION

CONTENTS

PCWorld NOVEMBER 2023

DEPARTMENTS

FEATURES

MASTHEAD

PCWorld

EDITORIAL DIRECTOR Matt Egan
EDITOR IN CHIEF, CONSUMER BRANDS Jon Phillips
DESIGN DIRECTOR Robert Schultz

EDITORIAL

EXECUTIVE EDITORS Brad Chacos, Gordon Mah Ung
SENIOR EDITORS Michael Brown, Mark Hachman
ASSOCIATE EDITOR Ashley Biancuzzo
STAFF WRITER Michael Crider
CONTRIBUTOR Adam Taylor
COPY EDITOR Gail Nelson-Bonebrake

DESIGN

ART DIRECTOR Steve Traynor
DESIGNER Rob Woodcock

ADVERTISING

SALES INQUIRIES foundryco.com/contact-us/

FOUNDERS

FOUNDER David Bunnell
FOUNDING EDITOR Andrew Fluegelman

INTERNATIONAL DATA GROUP, INC.

CHAIRMAN OF THE BOARD Walter Boyd
CEO, FOUNDRY Kumaran Ramanathan

REPRINTS AND PERMISSIONS

You must have permission before reproducing any material from *PCWorld*. Send email requests to permissions@pcworld.com; please include a phone number in your message.

BACK ISSUES

PCWorld back issues can be downloaded in digital format from www.zinio.com at $6.99 per issue.

SUBSCRIPTION SERVICES

Access your subscription account online—24 hours a day, 7 days a week. You can use online subscription services to view your account status, change your address, pay your bill, renew your subscription, get the answers to frequently asked questions, and more.

WEB simplecirc.com/subscriber_login/pcworld

EMAIL support@pcworld.zendesk.com

(Send your full name and the email address at which you subscribe; do not send attachments.)

QUESTIONS AND COLUMNS

Send material electronically to the appropriate online address listed below, or mail it to *PCWorld*. We reserve the right to edit letters.

MAILING LISTS

Occasionally we make our magazine subscribers' names available to other firms whose products may interest you. To have your name excluded from these mailings, send a request and your email address to PCWorld Subscriber Services at support@pcworld.zendesk.com.

CONTACT

PHONE 415/243-0500; FAX 415/442-1891

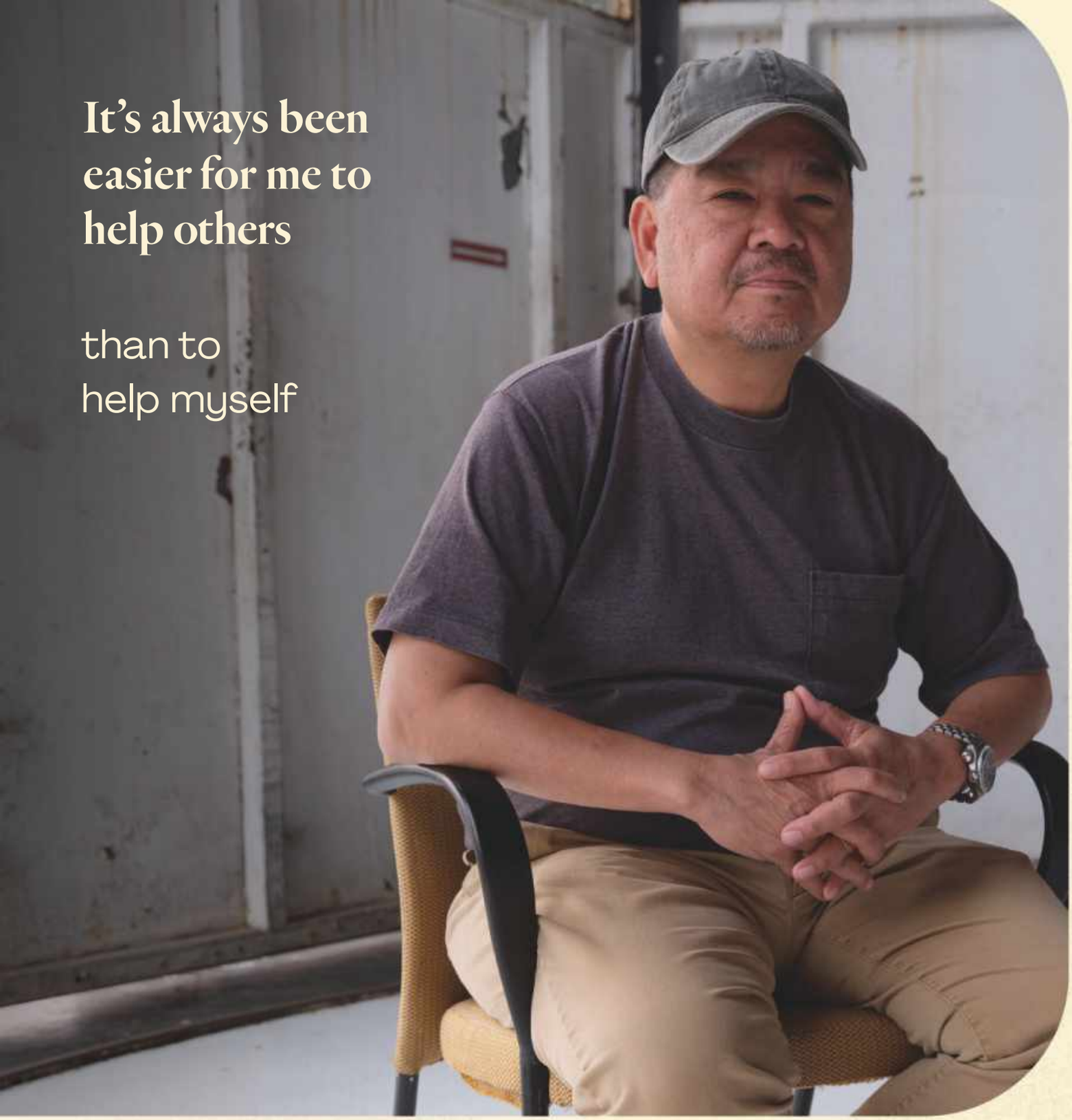
MAIL Editorial: 501 Second Street #650, San Francisco, CA 94107

STAFF ADDRESS To contact any *PCWorld* staff member, simply format the address as follows: *firstname_lastname@idg.com*

PUBLICATION INFORMATION

Volume 41, number 11

PCWorld™ (ISSN 0737-8939) is published monthly at $24.95 for one year (12 issues) by Foundry (formerly IDG Communications, Inc.)



As a Veteran, when someone raises their hand for help, you're often one of the first ones to respond. But it's also okay to get help for yourself. Maybe you want or need assistance with employment, stress, finances, mental health or finding the right resources. No matter what it is, you earned it. And there's no better time than right now to ask for it. **Don't wait. Reach out.**

ad COUNCIL

VA | U.S. Department of Veterans Affairs

Find resources at **VA.GOV/REACH**

Microsoft unveils the AI-powered future of Windows

Microsoft is preparing to launch the next feature update for Windows 11, code-named Windows 11 23H2. **BY MARK HACHMAN**

Microsoft's next huge Windows 11 feature update, code-named Windows 11 23H2, has a big addition: artificial intelligence. Microsoft is readying for the era of the AI PC with the addition of Windows Copilot, powered by Bing Chat. The update debuted on Sept. 26 in preview form before its wider release in the fourth quarter, when it will be called the Windows 11 2023 Update.

It's the closest thing to a theme that we've seen within a Windows 11 update in

IMAGE: MICROSOFT

some time. AI will power Windows Copilot, of course, but also recommended files in File Explorer and Start as well as a designated AI-specific section within the Microsoft Store app. You should also expect various small improvements across Windows in terms of both ease of use and functional updates, like the ability to restore apps from a backup.

Microsoft unveiled the new update during press event on Sept. 21 in New York, showcasing some of these new features. However, there's a small twist: The features that are coming to Windows 11 arrived first in an update to the current version of Windows 11, Windows 11 22H2. Windows 11 23H2 will then roll out in the fourth quarter as a cumulative update that rolls up all of the new features. What does this mean to you? Not a whole lot, but the point is that you probably won't see all of these features right away.

When can you expect Windows 11 23H2 to arrive on your PC? Microsoft released Windows 11 23H2 in the Release Preview Channel on Sept. 26 as an update to Windows 11 22H2, and will roll it out in the fourth quarter to all Windows 11 PCs.

What will Windows 11 23H2 be known as? Windows 11 23H2 will be known as the Windows 11 2023 Update. The Windows 11 22H2 update is being delivered as KB5030310, also known as the "Cumulative Update Preview for Windows 11 Version 22H2 for x64-Based Systems."

How much will Microsoft charge for Windows 11 23H2? It will be a free update, and we have seen just a single small update feature that is reserved for the more expensive Windows 11 Pro.

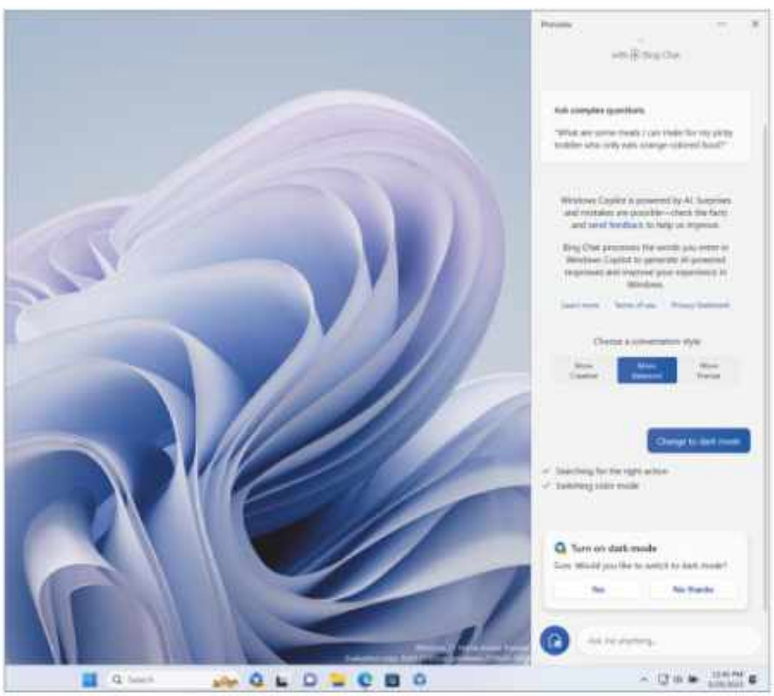
How long will Windows 11 23H2 take to download and install? Though downloading Windows 11 23H2 can be done in the background, the installation and reboot process could take 20 minutes to a half hour, depending on how long Microsoft takes to apply the updates to your PC. Installing the Windows 11 22H2 patch (with Copilot included) took about five minutes on a 13th-gen Intel Core laptop with an SSD.

Microsoft made Windows 11 23H2 available as a preview on Sept. 26 ahead of a larger rollout in October. Previously, Microsoft has pushed updates via the Windows 11 update stack, shooting incremental code updates to your PC in a matter of moments. But with some of the fundamental changes Microsoft is adding to your PC, it's possible that Windows 11 23H2 may be a bit more involved. To date, Microsoft hasn't released Windows 11 23H2 to testers in its Release Preview Channel in one fell swoop, but in incremental updates alongside its more experimental Beta Channel.

As @Microsoft's Yusef Mehdi announces, #Copilot is coming to @Windows shortly, with both a chat-style interaction model for settings

and a number of new #genai powered creative apps. pic.twitter.com/1JYTXlZ5o8

—Bob O'Donnell (@bobodtech), September 21, 2023



Copilot appears to be smart enough to help you through a few common tasks on your PC.

Although Windows 11 23H2 will include fundamental changes to Windows, it will also include app updates as well. Here are what we believe the new features of Windows 11 23H2 will include, based upon what Microsoft has released publicly to its Windows Insider Release Preview channel and then what Microsoft has subsequently announced.

We've also noted what features we're seeing first in the Sept. 26 update of Windows 22H2.

WHAT'S NEW IN WINDOWS 11 23H2 (AND THE SEPT. 26 UPDATE TO WINDOWS 11 22H2)

Windows Copilot (now just Copilot)

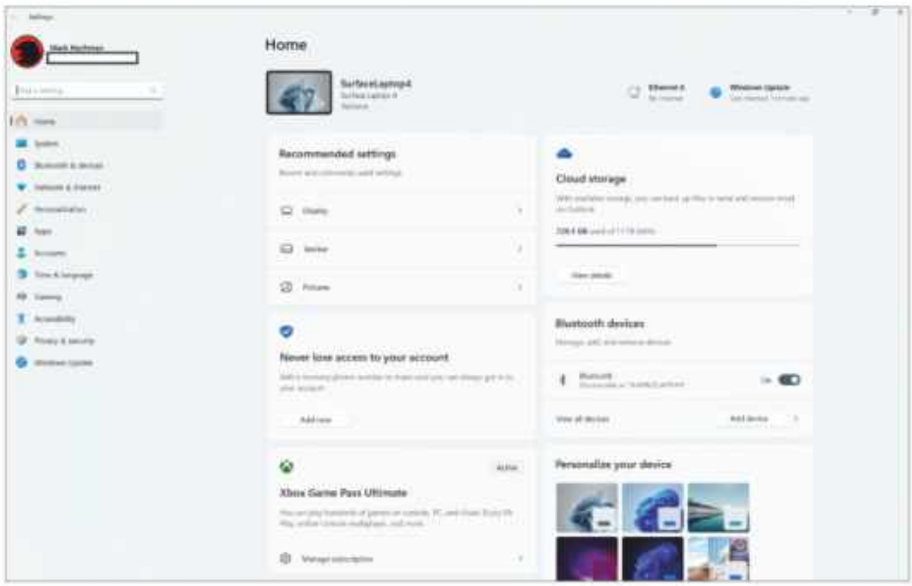
Think of Windows Copilot as a combination of Bing Chat and Cortana: part cloud AI assistant, with the ability to process a few tasks locally on your PC. Make no mistake: Launching Windows Copilot requires an internet connection, and you'll have the same neutral experience you would using Bing Chat on the Web. (This is in our Windows 22H2 update build, KB5030310.)

New logo for @microsoft's Copilot which, as @satyanadella says, we're going to see a lot of today. #Microsoftevent pic.twitter.com/NW8cUQvmct

—Bob O'Donnell (@bobodtech), September 21, 2023

Microsoft previously referred to Copilot as "Windows Copilot," with Copilots for Edge, and so on. Now it's all just one Copilot for your Windows PC, and without the "Windows."

The difference is that Copilot appears to be smart enough to help you through a few common tasks on your PC, without the need



Microsoft has updated the Settings Home screen.

to dig through setup menus and control panels. When we tested Windows Copilot in June (fave.co/46KXFPW), it could switch to light or dark mode, take a screenshot, and little else. Copilot is more about potential than what it can do right now. If Microsoft adds enough to it make it a real-time, robust help tool, then Copilot could be really something.

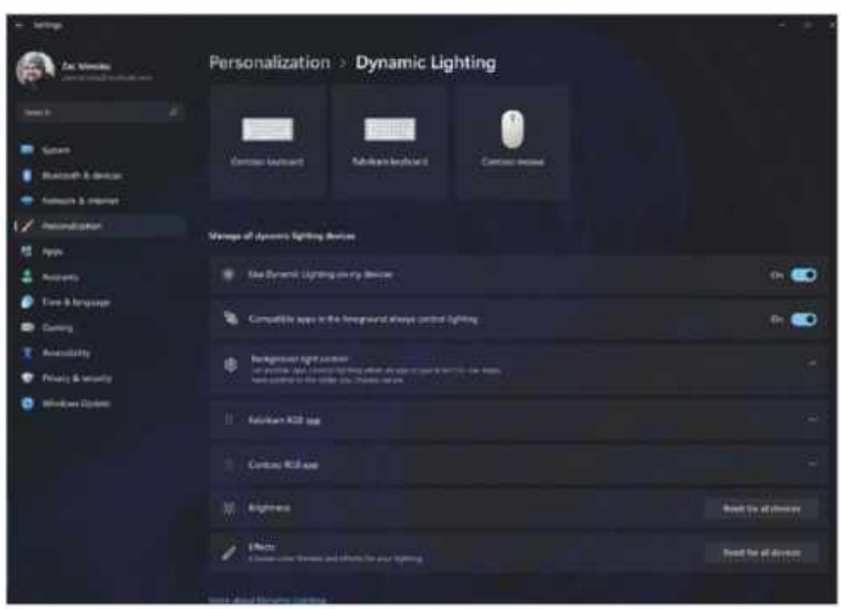
There's one hitch: Microsoft released Windows Copilot as a Dev Channel preview to date, though that might change soon.

An updated Settings home page

We know that there will be an updated Settings Home screen, as it's already there now in public Release Preview builds. (This is in our Windows 22H2 update build, KB5030310.) It might not be anything profound—just a summary of the various subpages within the Settings menu, all bundled together in a nice single-page summary that uses the available space on your screen. But it's a handy improvement anyway.

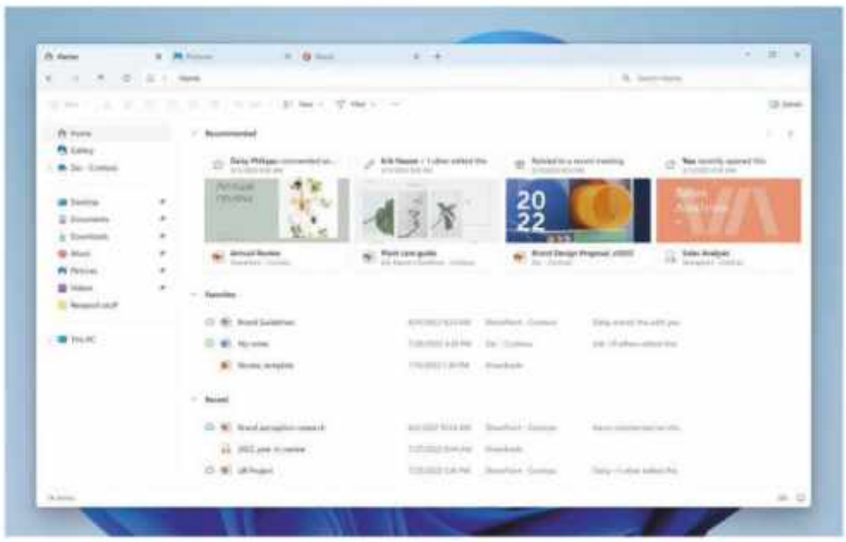
RGB lighting controls

Some people adore RGB lighting (fave.co/48UadFO), especially those who don't have to sleep in the same room as their PC.



Dynamic Lighting allows you to manage RGB lighting across various peripherals.

Some people despise it. What we haven't had, to date, is a unified Windows control panel to manage RGB lighting across various peripherals, even though we've asked for it for years (fave.co/3Ff90LH). Dynamic Lighting is Windows' answer to this longstanding problem. (This is in our Windows 22H2 update build, KB5030310.)



File Explorer will have a new carousel view.

What peripherals will support Windows 11's Dynamic Lighting control? Unfortunately, this still appears to be a long list of Razer peripherals (fave.co/3RXHZ73), but perhaps more will be added soon.

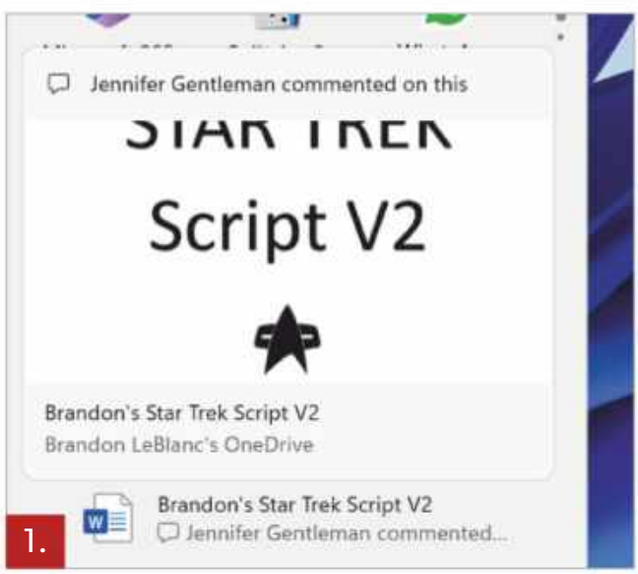
AI-powered recommendations in File Explorer

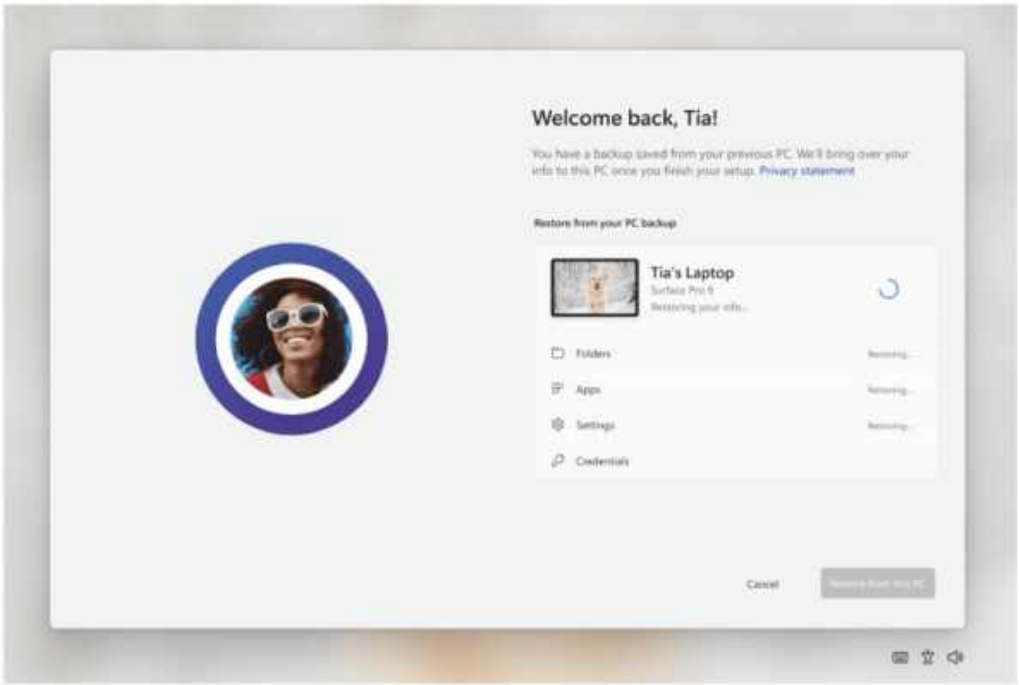
In March (and then later in May, fave.co/3RXI3nj), Microsoft told us that it was bringing AI-powered recommended files to File Explorer. You should see these as a new carousel of images at the top of File Explorer—though there's a catch: You have to have a SharePoint account as well, which Microsoft will tap to prioritize files based upon their importance.

While we're not seeing the carousel view that Microsoft shows here, we are seeing Recommended files (or at least a section for them) and a new Gallery view that looks like Photos. (This is in our Windows 22H2 update build, KB5030310.)

Microsoft has also been making changes to File Explorer to better show off which files live in the cloud and which are on your PC. Pressing **ALT + Shift + P** to bring up the Properties menu of a file now emphasizes who you have shared it with. Weirdly, this is where Windows 11 Pro comes into play.

If you have a Sharepoint account and





This is the OOBE Restore experience in 23H2.

Windows 11 Pro, you'll see this richer file preview. An example is below (**1**).

Windows Backup and Restore

Migrating to a new PC is something we've all done, and it can take time out of your day. Microsoft is introducing a new Windows Backup app—push everything to the OneDrive cloud! (fave.co/3tBXgjH)—as well as a new Out of the Box Experience (OOBE) to migrate that backup to a new PC during the Windows 11 setup process. We haven't tried migrating from one PC to another, but we are seeing the Windows Backup app on our Windows 22H2 update build, KB5030310.

Users will see pins for their desktop apps restored on the taskbar and Start Menu, including those apps that were not installed from the Microsoft Store, Microsoft says. Click on the pin and the app will download and install. (We wouldn't expect this for games you installed, say, via Steam, though.)

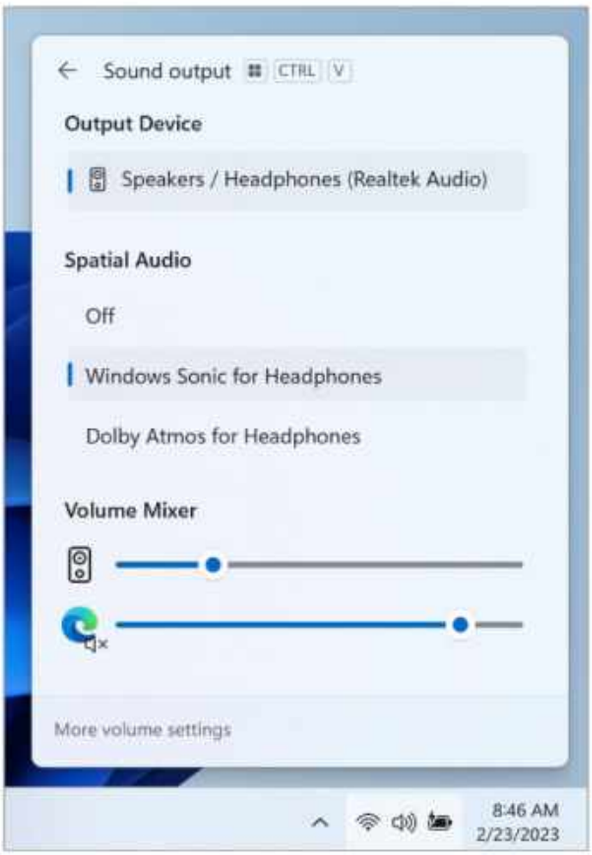
Passkeys

Passkeys are a simple, powerful tool: Instead of asking for a password, a passkey can authenticate you to a website using biometrics—we've already seen this with some mobile apps, which require a fingerprint to log in. Windows is promising this, too.

Well, sort of. Microsoft has implied that we should be seeing a Settings page (**Settings>Accounts>Passkeys**) similar to how Edge stores passwords, where passkeys are stored instead. (This feature is in our Windows 22H2 update build, KB5030310.)

A new Volume Mixer in Quick Settings

I wrestle with the Volume Mixer on a regular basis, especially when I swap between headphones, earbuds, an ANC pair of headphones, or an old Hardon Karmon Invoke that's now just a Bluetooth speaker.



The new volume mixer in Windows 11 23H2.

Microsoft appears to be bringing better audio controls to Windows, even potentially on a per-app basis. (This is in our Windows 22H2 update build, KB5030310.)

There's a new shortcut (**WIN+CTRL+V**) to control it all, too.

In-field inking for Windows Ink

It's easier to just say what this does. li you write "cat" inside a Windows field (like a search box), Windows will interpret your inked word "cat" as you typing "cat" into the same field. Simple, right? That's how you would expect inking to work, anyway, but historically it hasn't.

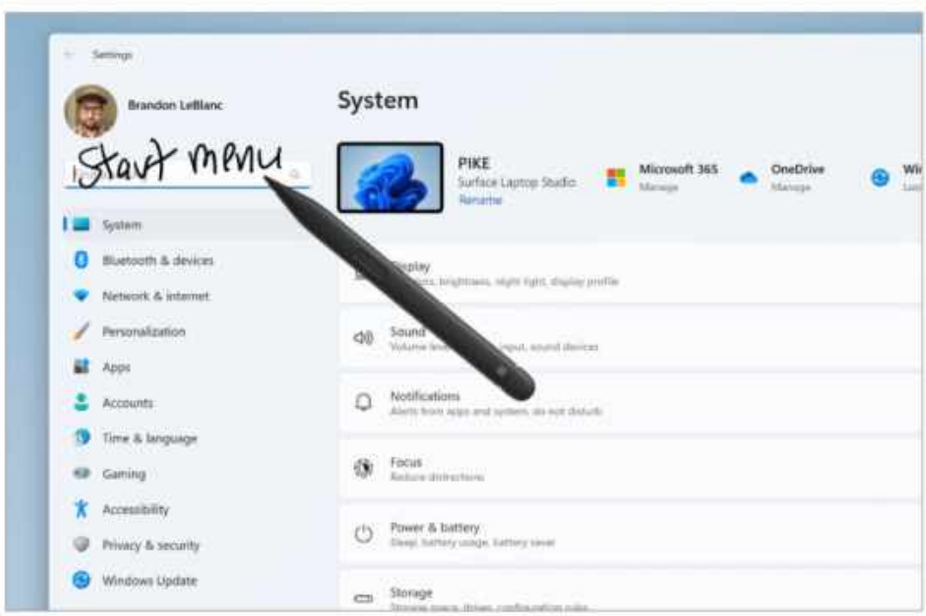
Microsoft has signaled that this feature is headed to Windows 11 23H2, and for those who ink on a regular basis (hello, Surface Pro 9 users: fave.co/3ghcbtC), this is welcome news.

Our test laptops don't include inking capabilities, but we'll try this feature later.

Improved voice editing and Controls

Voice editing with Windows is kind of fun (fave.co/3LZzXH5). But it can always get better. Microsoft is adding new voice controls ("Select from [text 1] to [text 2]" or "bold that"), as well as revamping the Voice access home page to make the list of commands easier to understand.

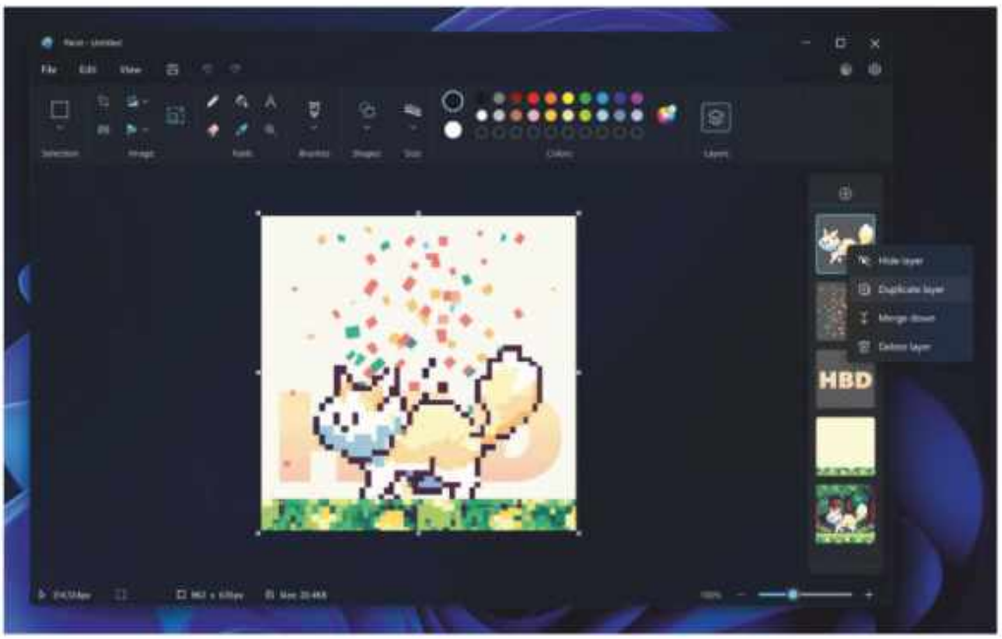
Microsoft is also expanding the list of



Microsoft has improved its handwriting recognition.

English accents that are now supported, including the U.K., India, Canada, Australia, and New Zealand.

Voice access (or voice control) is gaining more of a foothold, too, with Microsoft promising you'll be able to log in with your PIN, via voice, if your PC is set up for it. In Windows Settings (**Accessibility > Speech**) you can turn on voice access before you sign into your PC. (This is in our Windows 22H2 update build, KB5030310.)



Paint with layer support in Windows 11.

WHAT'S NEW IN WINDOWS 11 23H2

Microsoft has told us which features are arriving within Windows 11 23H2, and some of the features above have already been released. We can assume that those below will either be released when Windows 11 2023 Update (23H2) launches or before.

Snipping Tool's new audio and text extraction features

The Windows 11 Snipping Tool added screen capture (fave.co/3RVRTGg) late in 2022. Now you'll be able to capture audio from the screen and your mic as well.

Snipping Tool is also adding the ability to extract text via OCR from anything you've captured and, conversely, redact it. That's good news for those of us who capture screenshots containing potentially personal, confidential information.

Photos' AI background blur and search

Microsoft announced that background blur (fave.co/3tr7e7v; aka the portrait mode found in smartphones) was coming to the Photos app. It's not quite here yet, though. Microsoft will also allow you to search the Photos archive by scene information, such as a "beach" shot.

An improved Paint app

Paint (Paint!) is getting transparency and layers (fave.co/46rvw01), a real surprise

for an app that was once left for dead. When combined with the recently added background removal tool (fave.co/3ttqIlO), these new features now let you create rudimentary composite images in Paint. So far, we're seeing this in just a Windows Insider preview, but we think this updated Paint should be there on or about the time Windows 11 23H2 launches.

Unfortunately, we're not seeing the updated Paint in our Windows 11 22H2 update, which is probably consistent with Microsoft's timeline (fave.co/3PRbJzX).

Other tweaks in Windows 11 23H2:

Taskbar badging: Some people (me included, on occasion) like when an app pinned to the Taskbar shows you what it actually is, instead of displaying just an icon. This feature is in Personalization > Taskbar within the Settings menu in the Windows 11 22H2 update.

Wake on approach: Microsoft will dim your screen if you look away and wake up your PC if it senses you nearby. You'll need a webcam that supports this, though, and Microsoft hasn't really detailed the hardware requirements. We're not seeing this yet in Windows 11 22H2.

Windows Spotlight improvements: I love Windows Spotlight (fave.co/3S9hnN4), which gives me new, beautiful 4K wallpaper images daily. Microsoft is promising a better preview experience at full screen, with "multiple opportunities to learn more about each image and a minimized experience."

Sharing improvements: When you right-click to share a file, Microsoft is leaning harder on making files available for Nearby Share, Windows' answer to AirDrop. This appears to be in Windows 11 22H2's update.

Instant Gaming: Microsoft is promising a tweak to the Microsoft Store app that will allow very small games to "instantly" launch. So far, this update seems to be reserved for Windows 11 22H3.

Screen casting: If you do a lot of switching between desktops, Microsoft may pop up a screen reminding you that screen casting to other devices exists.

Emoji 15: Microsoft implied that Emoji 15 (fave.co/3FgAoJl), released on Sept. 15, would arrive in Windows 11 23H2, though it has only debuted in the Beta Channel.

Copying 2FA codes from Notifications: If Your Phone is connected to your PC and you receive a 2FA code via text, Windows will recognize it and offer to copy it.

VPN logo: If you're running a VPN, Windows should show you a small logo to identify it.

Bing improvements: Bing is a cloud service, and not part of Windows, but it will add text-based image creation with Dall-E 3.

Clipchamp's AI composer: This is not tied to Windows 11 22H2 or even 22H3, but you should see an AI-powered creation option if you open Clipchamp.

Intel's Core Ultra CPUs kickstart the AI PC era. Software will determine its future

Intel has a monumental job to do convincing consumers they need AI on their PC.

BY MARK HACHMAN

The AI PC, propelled by Intel's Meteor Lake, is almost here. So why should you care?

It's the billion-dollar question. Intel is building NPU AI inferencing engines into its processors beginning with its 14th-gen Core chip, Meteor Lake, also known as the Core Ultra. Robert Hallock, an AMD veteran now overseeing technical CPU marketing for Intel's microprocessors, has said that Intel's goal by 2025 is to ship 100 million "AI PCs," a term Intel CEO Pat Gelsinger began using (fave.co/3PI7gkh) in July.

Intel announced the architecture behind the 14th-gen Core Ultra chip (fave.co/

VIDEO: **HANDS-ON WITH CORE ULTRA LAPTOPS RUNNING AI DEMOS**

Watch now at fave.co/3QfgUeg

IMAGE: INTEL

3PUqbHI) on the same day its Innovation conference began in San Jose, California. Intel used the conference to pitch developers on what an AI-powered future will look like, especially one powered by Intel.

Intel's Core Ultra is notable for several things, including its move to the Intel 4 process technology and the disaggregation of the traditional two-die design for four separate tiles all mounted on an interposer. Moving to Intel 4 helped cut power by half over the 13th-gen Raptor Lake, assisted by new low-power E-cores. But the key addition is the NPU, the AI inferencing engine that will help bring AI to the masses.

Intel CEO Pat Gelsinger holds up a wafer fabricated on the 18A process node.

"We see the AI PC as a sea change in tech innovation," Gelsinger said during his opening keynote.

That's the hope, anyway.

A FOURFOLD STRATEGY TO WIN OVER CONSUMERS

The implicit theme of Intel's Innovation conference was AI, AI, AI—from Gelsinger's opening keynote to the late-afternoon panel discussions. Intel is trying to carve out a new market for AI on the PC where none has previously existed: "This is category creation, at its finest," Gelsinger said in response to a PCWorld question on how it would do just that.

But AI has primarily existed in the cloud, led by ChatGPT, and on smartphones, with portrait mode and various filters. On PCs, it's confined to a few Windows Studio Effects technologies. Intel is trying to establish local AI on the PC as something that eliminates the round trip to and from the cloud while being private enough to talk to only you. But what, exactly? Well, *something*.

The strategy appears to be fourfold. First, design the hardware. Intel unveiled the design of the NPU to press and analysts at an event in Malaysia, promising that the NPU would offer a more energy-efficient approach for processing AI tasks than a standalone CPU or a GPU would. Done. Intel's Gelsinger also showed off 2024's Meteor Lake successor, Lunar Lake (fave.co/3xFbIXu); Arrow Lake, a

chip on the 20A process node, and 2025's Panther Lake, heading to the fab in 2024 for later production. The CEO also demoed an AI task running on Lunar Lake's AI engine.

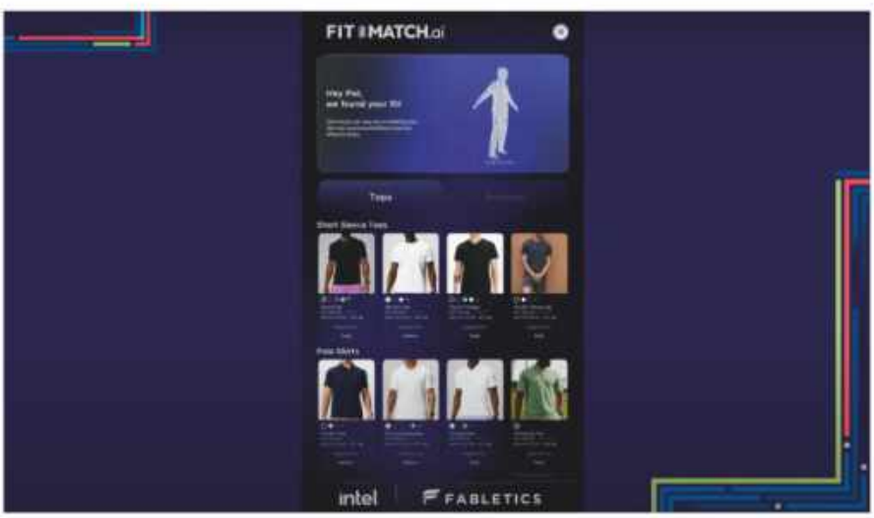
(There's a slight twist. While Intel talks about the NPU as an "AI engine," it's really only one part of that engine; a video codec, for example, performs decoding and encoding functions. There are two parts to AI: the training, and the inferencing—predictions—based upon the trained models. For now, the AI engines in PC processors can only perform inferencing.)

Second, show off the AI apps that exist today and tomorrow. Gelsinger's keynote showcased several applications that could use AI in various capacities: Deep Render, which uses AI to compress files by 5 times; Rewind.ai, a hearing aid that also transcribes what it hears for future reference, including ChatGPT-like queries; and Fabletics, which together with partner Fit:match AI creates a virtual avatar of you that can try on clothes.

Notably, most of the applications avoided the traditional uses of AI: generative AI art (fave.co/40aXZTV) and ChatGPT (fave.co/3zZoOQ1). Instead, they showed off how AI could be used to enable revolutionary new applications. (Check out these 12 AI services that can improve your life right now: fave.co/3S3b8Ot.)

That's where the rubber will meet the road. At some point in time, consumers are going to ask what they can actually do with AI. To some extent, that question has been answered with ChatGPT and related apps. But the next question is why a consumer would need AI on *their* PC, and not just via a connection to the cloud. It's that question that Gelsinger's demos attempted to answer, with middling success.

The third part of Intel's AI strategy appears to try to elevate the APIs that enable AI. Executives talked about how the Core Ultra's NPU would accelerate various APIs, including OpenVINO, which Intel has helped develop as an AI-centric API. (If a developer supports it, that could potentially give Intel an advantage, analysts at the Innovation conference said.)



In this demo, Fabletics created a virtual avatar of Gelsinger and suggested some new clothes.

Finally, deliver at scale—if you build it, they will come.

"I'm going to deliver a cadence of products yearly, I'm going to deliver millions of units next year, and I'm going to deliver billions of TOPS [tera operations per second, a measure of computing speed] that developers can design to, and that really opens the ecosystem up," said Michelle Johnston Holthaus, an Intel executive vice president and general manager of Intel's Client Computing Group.

A glimpse at Intel's AI road map.

EARLY DAYS FOR AI

Will it all work? Intel executives are also realistic. Gelsinger referred to being in the "first inning" of AI. Hallock said that Intel would release its first AI/NPU benchmarks in October—without saying how Intel was expected to fare or even what benchmarks would be used.

The message is that Intel provides open AI, trustworthy AI, and competitive AI—but there's still quite a lot that Intel appears to be leaving to faith. The question of what "good AI" is, or how consumers are expected to compare it to AMD and Qualcomm, is one that Intel hasn't really answered yet.

"I mean, these are substantive gains that we're seeing for the platform, where we're quite excited about it, and our products are comfortably ahead of the competition for it," Gelsinger said in response to PCWorld's question on how it would sell AI to consumers. "So we're going to differentiate on the merits of the products and on the market integration and the work that we do."

Is that the answer you want? Probably not. But consumers probably won't run out to buy a Core Ultra laptop just because it has AI, either.

What AI's rapid adoption has taught us, however, is that once a viral app like ChatGPT takes hold, everyone rushes to try it out. Intel and its rivals are building out AI's foundation, hoping that next viral app is waiting in the wings.

Google just gave Microsoft Surface a budget laptop beat-down

The ridiculous price increase for the Surface Laptop Go 3, combined with the Chromebook Plus announcement, makes Microsoft look foolish. **BY MICHAEL CRIDER**

In the span of a long weekend in September I took two separate trips to New York City. First, to see Microsoft's latest offerings for the Surface line (fave.co/3tt8Dul), which took a backseat to the AI-infused update to Windows 11. And second, to see Google reveal its Chromebook Plus push (fave.co/3QevGBY), a new standard for the company's operating system along with its hardware partners. At the end of it all I had to ask myself: What the hell is Microsoft thinking?

Never mind the underwhelming implementation of the AI Copilot in Windows (fave.co/3Qfj3GQ). As both an old-school Photoshop user and a professional keyboard jockey, I found its image- and text-generation powers less than compelling. No, it's the newly revealed Surface Laptop Go 3 that really sticks in my memory. Specifically the price—800 American buckskins. In a word: Oof.

IMAGE: LENOVO/MICROSOFT

THE SURFACE LAPTOP GO IS NO LONGER 'BUDGET'

Why this price seems ridiculous requires a little context. First, the Surface Laptop Go is supposed to be the value play in Microsoft's first-party laptop line. The original Laptop Go was revealed three years ago as a more conventional alternative to the Surface Go tablet. At $550 for the 4GB entry model, it was more expensive than both the Surface Go and other budget-minded Windows laptops.

But given the Surface's polish and the general goodwill for Microsoft's hardware after nearly a decade, it didn't seem too outlandish. Even with its 4GB of memory, which I wouldn't wish on anyone who actually needs to run a modern browser in Windows, you could position the Surface Laptop Go as a style-focused upgrade to the kind of machine you'd see on a Walmart shelf. The Surface Laptop Go 2 raised the base price to $600 in 2022 (fave.co/46LxdF3), with a mild processor and storage upgrade, but sans any bump to that all-important RAM on the base model.

Fast-forward to this year with the Surface Laptop Go 3. Graciously, Microsoft has increased the base RAM to 8GB, which I would consider the absolute minimum to run Windows 11 comfortably. (Take this judgment for what it's worth, since I'm currently using 32GB on a triple-screen desktop with more browser tabs than I can count.) But the rest of the specs remain more or less the same, aside from a mild upgrade to last year's Intel processors. That includes the underwhelming 12-inch touchscreen, which has a resolution that would shame a budget Android phone.

For this modest upgrade to the bare minimum of Windows functionality, Microsoft asks $800. That's a full one-third increase over the price for last year's model, for a bump in DDR4 RAM that would cost about $17 off the shelf (fave.co/3txFv5l). And that's without access to a modern manufacturer's enormous economies of scale. The entry-level, ostensibly "budget" Surface Laptop Go now costs as much as the original Surface Laptop did in 2017 (fave.co/3PXybYg).

The Laptop Go is Microsoft's entry-level model in its Surface line—here pictured on top of the 15-inch Surface Laptop.

For years, the Dell XPS 13 has been the go-to workhorse for Windows ultraportables.

SO MANY BETTER CHOICES

Yes, a lot has changed in six years, particularly in terms of inflation. But it hasn't changed so much that the Surface Laptop Go 3 makes sense as a purchase for anyone, particularly anyone who needs a budget laptop. A three-second search on Amazon—without any real deal-hunting, mind you—turns up a Windows laptop with a 12th-gen processor and 8GB of RAM, double the storage, and a far more usable full-HD screen for about half the price (fave.co/3QfXLZK).

Sure, this budget Lenovo model isn't as stylish and doesn't have a touchscreen, but anyone in the budget category that Microsoft is allegedly targeting won't mind if they can save over 300 bucks. But let's assume you have $800 to spend. Does the Surface Laptop Go 3 make sense as a stylish ultraportable purchase? To be as kind and charitable as possible—hell, no.

Dell's XPS 13, the go-to workhorse for Windows ultraportables for years, can be had at the same retail price. It's frequently less expensive—at the time of writing you can get an 8GB model with a 12th-gen Core i5 and double the storage for just $599 (fave.co/46zuQpu). For just 50 bucks more than the Go 3, you can upgrade to a far more comfy 16GB of RAM and 512GB of storage. A bargain in anybody's money. My personal laptop, a ThinkPad X1 Nano (fave.co/3QpwS5X)—the one I brought to both New York events and relied upon for live writing, research, and photo editing—can frequently be had for less than Microsoft wants for that "budget" ultraportable.

A TALE OF TWO BUSINESS TRIPS

So yeah, someone at Microsoft is taking crazy pills if they think the Surface Laptop Go 3 is still any kind of "budget" machine. But the second hit in this one-two punch combo came from Google's presentation, where it unveiled the Chromebook Plus line. The Chromebook Plus is Google's attempt to reframe Chromebooks as ever-so-slightly more capable machines, moving away from the ultra-budget image they've been saddled with since premium options like the Pixelbook disappeared.

But crucially, Google is expanding the base level of Chromebook capability and polish without ballooning the prices. The bare minimum of specs required to hit that "Plus" benchmark is 8GB of RAM, 128GB of storage, a 1080p IPS screen, and either an Intel Core or an AMD processor. Sound familiar? That's basically the same level of x64 hardware as you'll find in the new Surface Laptop Go 3, minus the touchscreen—in fact, that 1080p resolution requirement is actually better. This Plus push isn't a reach into premium laptop territory, it's an attempt to redefine what the average user expects from a Chromebook at any price.

And Chromebook Plus models start at… wait for it…$399. In fact, all eight of the initial Chromebook Plus models are cheaper than the Surface Laptop Go 3, despite being the "premium" option. Seven of them are under $500—all with 8GB of RAM at the base price, which goes a lot further on Chrome OS than it does on Windows.

All of these Chromebooks, with upgraded Plus capabilities, are cheaper than Microsoft's budget laptop—some by half.

Directly comparing Windows laptops and Chromebooks (fave.co/3RXkhnL) isn't exactly apples to apples. Chromebooks are far more capable now than they used to be, and they are only getting better with those Plus upgrades (also coming to older machines that meet that standard via a software update). Even so, there are plenty of people who need one or two specific tools that are still only available on Windows, or just want to play the occasional Steam game. But as I demonstrated earlier, even if you absolutely need Windows, there are better budget options than Microsoft's allegedly budget laptop.

These two announcements in such close proximity make me think Microsoft has lost the plot when it comes to trying to get budget users—the largest market segment of laptop buyers by far—interested in its products. The fact that the Surface Laptop Go 3 comes at a time of historically low PC shipments (fave.co/46zuXRW) can't be ignored.

This kind of blindness to both low-end users and the market as a whole is something I'd expect from Apple…whose MacBook Air can frequently be found on sale at the same price point. And as a lifelong Windows user, I can't think of any insult more grave than that.

Firefox starts sniffing out fake Amazon product reviews

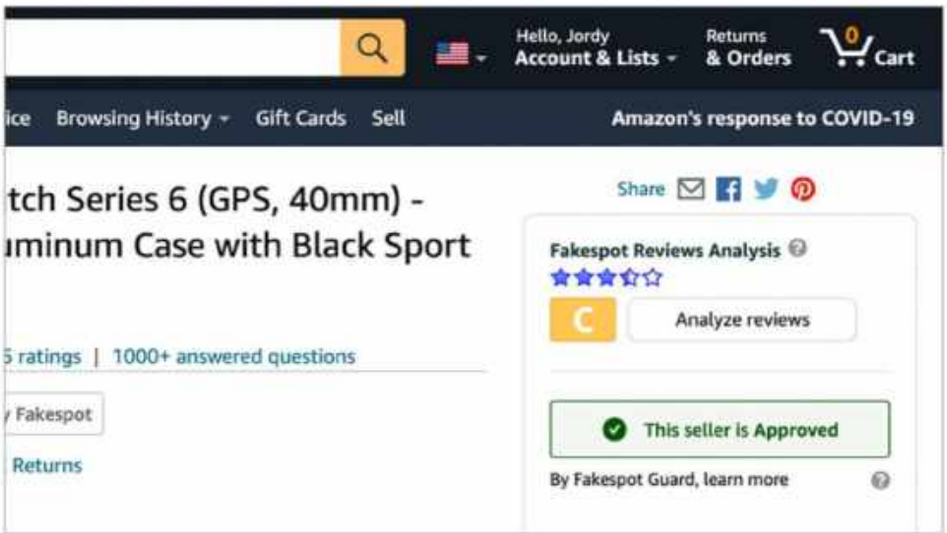
With the new Review Checker feature, Firefox users will soon be able to check product reviews for authenticity. **BY DENISE BERGERT**

With Mozilla's takeover of the online service Fakespot (fave.co/3ZRIJN6), a new security feature will soon find its way into the Firefox browser. With Review Checker (fave.co/3txJAGH), Firefox users will in future be able to check whether a product review is fake or genuine.

GRADING FROM A TO F

Fakespot's technology will be integrated into the Mozilla browser as a new Review Checker feature. The tool grades whether product reviews come from real customers or were possibly written for payment or to artificially pump up overall review ratings. The product reviews will be rated by the

IMAGE: PREMIO STOCK/SHUTTERSTOCK



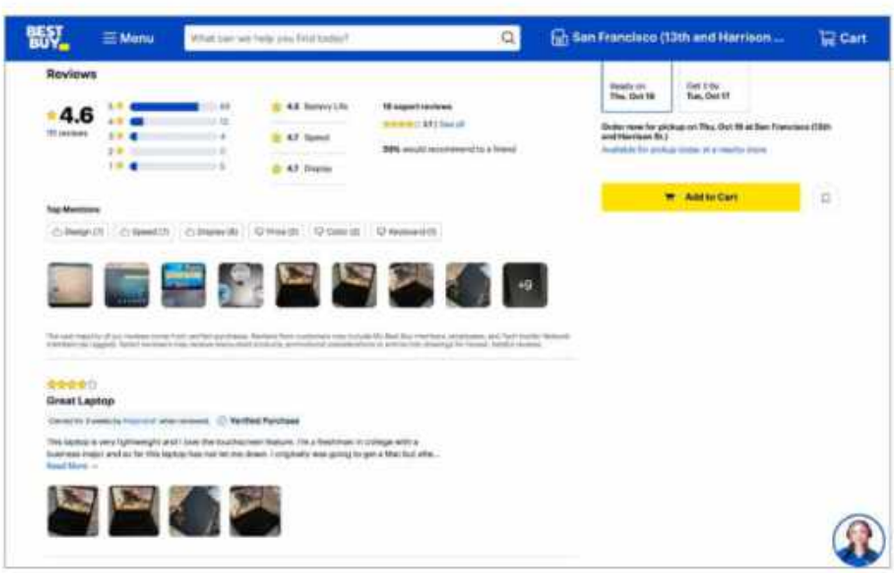
Review Checker will allow Firefox users to check whether an Amazon product review is fake or genuine.

Review Checker with grades ranging from A to F. A and B stand for "reliable reviews," while "unreliable reviews" are graded with D and F. Product reviews with a murky grade of C fall in between.

In its current test stage, Review Checker is currently only compatible with the U.S. websites of Amazon, Best Buy, and Walmart. Here, a small price tag symbol is displayed at the top of the browser. When you click it, all reviews on the product page are checked and graded from A to F. You should be able to see all reviews at a glance, and thus be able to see at a glance whether the reviews on the page are reliable.

RELEASE IN NOVEMBER

According to Mozilla, the new feature respects the privacy of users. By using Oblivious HTTP (OHTTP), the products are not linked to the users' devices. Mozilla also says Review Checker should not have a negative impact on browser performance. The Review Checker feature is scheduled to be released on November 21, 2023, with Firefox version 120 for Android and as a desktop application for all users.



Review Checker is currently only compatible with the U.S. websites of Amazon, Best Buy (pictured), and Walmart.

Hands-on: Windows 11's new AI tools aren't ready for prime time

Copilot and other systems integrating into Windows and Office are neat but niche, and their inconsistent results don't inspire confidence. **BY MICHAEL CRIDER**

Artificial intelligence will change the way that we work. Or so say the most fervent purveyors of the tech, now including Microsoft. But after seeing ChatGPT, Dall-E, and other AI systems integrated into the latest versions of Windows 11, Office, and the company's Microsoft 365 platform, I can't say I agree.

Make no mistake, Microsoft is pushing new tools like its Copilot system hard (fave.co/3rYQmVg), integrating it into systems that are staples for the company and hundreds of millions of users. But speaking as a power user—and accepting the limited perspective that gives me for many who are not —I can't see these new tools being anything more than an occasional curiosity.

They won't change the way that I work, and I think even those who stand to benefit the most from them will be hesitant to try.

IT WORKS, UNTIL IT DOESN'T

To be sure, there are elements of the system that can be beneficial. ChatGPT-based AI text generation is dramatic, filling in pages of information in just a minute or two, far faster than the most frantic keyboard jockey could manage. Image generation is just as

IMAGE: MICROSOFT

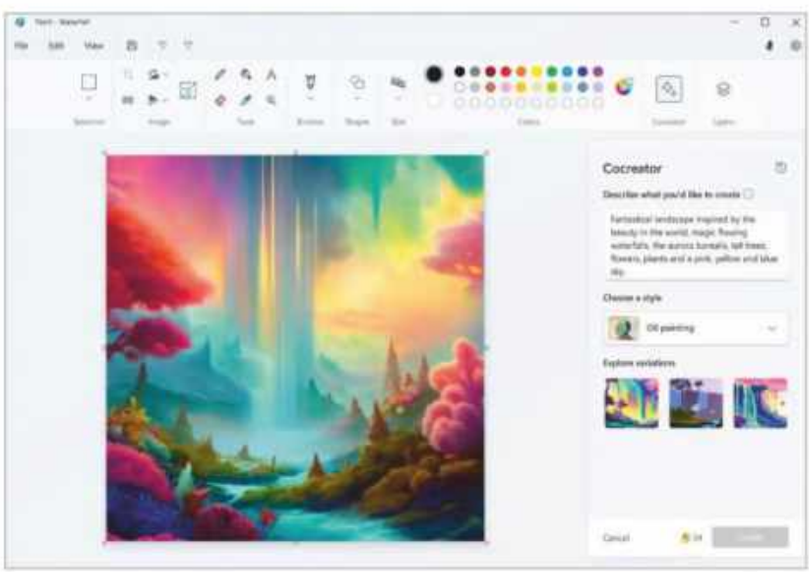
impressive, spitting out incredibly detailed and photorealistic images with just a few lines of text prompt. If you're not a natural writer, and you can't navigate your way around Paint, this stuff seems, like Arthur C. Clarke's classic technology, "indistinguishable from magic."

Until it doesn't. The term "artificial intelligence" brings science fiction staples like Star Trek's Commander Data to mind. But this is a misnomer, and frankly, I think it's a deliberately misleading one. Even the most impressive things AI spits out in its current form are based on pre-existing algorithms—incredibly and near-incomprehensively complex algorithms, but algorithms nonetheless. And they follow a law of computing that hasn't changed in the better part of a century: They can't do anything they haven't been designed or told to do.

I'll use the new AI-infused Paint as an example. At Microsoft's fall Surface event in New York (fave.co/3tt8Dul), I was shown Paint automatically distinguishing between the foreground and background, effortlessly blurring the beach in a photo of a dog running across it. Impressive, and useful for those who aren't acclimated to Photoshop's tools (or don't want to pay for them). But these are tricks mobile apps have been doing for years, which don't require the massive resources of a remote data center and an always-on connection.

Something that *does* require that "big iron" power is image generation. A photo of a large ornate building was separated from the sky in just a few clicks, with the new layering tools allowing the demonstrator to put in anything I asked for behind it. I asked for a tornado, and it delivered a Dall-E–generated image of a twister right out of a Texas tall tale.

But this was a separate image from the building, on a separate layer (fave.co/3ttqllO), not using the building as a reference at all. I could place it behind the building, squishing together two completely different images with lighting and perspective that didn't match up. What the new AI-infused Paint can't do, and what I suspect Microsoft would like you to imagine that it can, is place that tornado in the existing image of the building as if it was an effect from a movie or a professional marketing studio.



Paint Cocreator adds AI art capabilities to Paint.

The limits the AI image generation tools are hitting are the kind of thing even an intermediate user could learn to do with half an hour of tutelage on YouTube and an image search. What does that do for you? It saves you about half an hour, at best, for a result that looks like, well, half an hour's work in Paint. For someone who uses graphic design tools daily, it didn't inspire any immediate fears of human obsolescence.

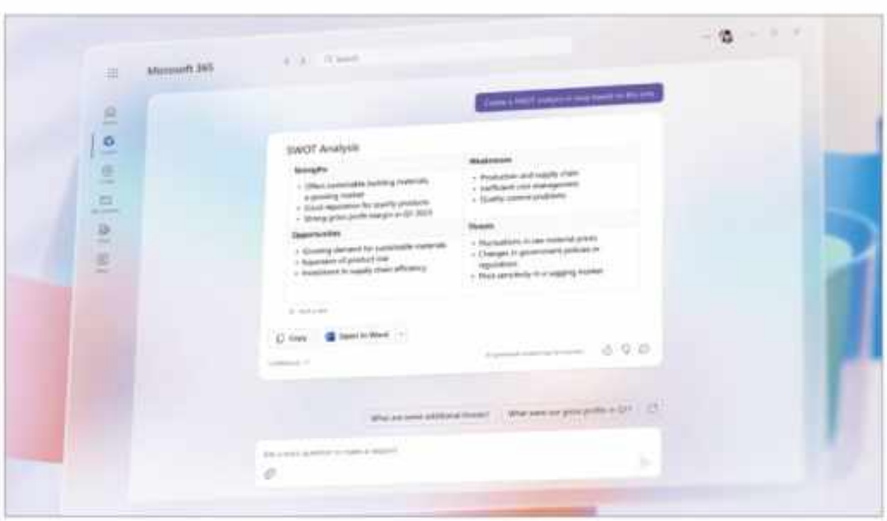
SIFTING THROUGH THE WORD SALAD

Speaking of which, let's look at text generation. ChatGPT's ability to gobble up and spit out huge amounts of textual information is, indeed, impressive. But when you want to do more nuanced things with that text—things that humans need a lot of time and attention to do—it falters. A demonstrator took a 5,000-word written document and told Copilot to summarize it in Word. This brought the count down to a little over 2,000 words… which is still more than you'd want to read in front of a full table of your co-workers or across a Zoom screen.

When I asked him to chop it down to under 1,000 words, the system choked. There was simply too much information for it to compress without losing the essentials. A human could do it, even if you needed someone who's skilled enough to sift the croutons of actionable and immediate information from the word salad. Copilot couldn't, giving near-identical, nonrequested results several times.

And after several minutes of a Microsoft Azure server thinking to itself, the demonstrator noted that you'd still need to read through the resulting wall of text to check that it's accurate—or perhaps more distressingly, to make sure the system didn't wholly invent information that wasn't there at all.

An Outlook demonstration did just that with an auto-generated reply of a few hundred words, inserting ideas the human operator never had—ideas that might have gotten that person in trouble if they claimed they were their own, and that they didn't remember later. We've seen this kind of thing happen already for people eager to replace



Copilot is a great timesaver.

their online selves with AI-powered facsimiles (fave.co/45vLGUO).

So how much work is this actually saving, if the system's limits are well below that of a human operator and its output still needs to be checked by hand and eye? Not enough for a manager to confidently chop headcount, which I suspect is the outcome many executives were hoping for. And that's in the best-case scenario, when the system worked without returning an error from the remote server. That happened more than once, and *at least once* at every demo I was shown.

Copilot's ability to save time is remarkable in highly specific situations. For example, working with that same 5,000-word document, the demonstrator was able to generate a 20-slide PowerPoint deck with relevant bullet points. It even had fairly attractive formatting, complete with noncopyrighted image backdrops that were unspecific but broke up the black-and-white slides nicely. The system could insert auto-generated images, license-free images from a Bing search, or images saved in a local folder.

That's a timesaver. In the span of a few minutes, the system generated a PowerPoint presentation that would have taken an expert around an hour to put together. But again, the result would require almost as much time to check manually…and its results weren't entirely reliable or repeatable. And a system that can't be consistently relied upon isn't one that can replace a human worker, even a low-level one, though it might augment your work on occasion.

REMEMBERING THE LESSONS OF WINDOWS 8… OR NOT

That brings up another point: Why is Microsoft demonstrating all this new technology, and pushing it so quickly into its corporate tools, when it's clearly missing so much functionality? The closest comparison that comes to mind is the quick shift to touch-based interfaces in Windows 8, which anticipated a world full of people working on touch-primary tablets in the wake of the iPad's launch.

A world that, a decade later, doesn't seem to have arrived. We're back to the old Start button and menu, as gently evolved as it might be, and work in Windows is still primarily driven by mouse and keyboard. Even its impressive support for touch is, largely, replicating existing tools like cursors and scroll wheels. That mobile-inspired revolution never came.

So after Microsoft learned from that experience and walked much of its concepts back in Windows 10, why is it so eager to leap off yet another uncertain technological precipice? I can't say with certainty. But if I were to put on my tech analyst hat—a big, floppy, somewhat ridiculous hat, worn in the hopes that no one confuses what I'm about to say for investment advice—I'd put the

blame on a lot of hot air blowing around in the tech market.

I suspect that investors, eager to get on the AI trend and hoping that its most fantastical promises come to fruition, have caught the ear of Microsoft's executive team. Those promises include replacing a huge portion of jobs filled by squishy, entitled humans, demanding such unreasonable expenses as office space and health insurance benefits. Even a small amount of low-level workers replaced by an Azure cloud would represent a huge savings, and a huge potential profit for Microsoft if it can get the monetization right.

Microsoft, its investors, or some combination of both may be experiencing a fear of missing out, motivated by AI tools of questionable utility cropping up at more or less every competitor. Perhaps the company has more applications at the enterprise level, where huge, number-crunching systems that have been in place for decades might benefit from a new generation of algorithmic processing. But here at user level, the big change—and the big dread—is AI replacing low- and middle-level human workers.

We're already seeing attempts at this (fave.co/46NJ6ud). And so far they've resulted in problems so predictable, ChatGPT itself could have told you they were coming. As impressive as these tools are becoming, and as much as they'll be refined in the future, I can't see them effectively replacing tons of human writers, analysts, artists, and so on.

Not that people won't try—especially people who hold the purse strings. It's going to come down to how much of a reduction in quality those making the final call are willing to tolerate in order to save money on employees. It will also depend on how expensive those results will be to produce, even if they're inevitably cheaper than using squishy humans. Azure data centers don't grow on trees, and neither do the terawatts of power needed to run them.

FULL SPEED AHEAD, WHEREVER WE'RE GOING

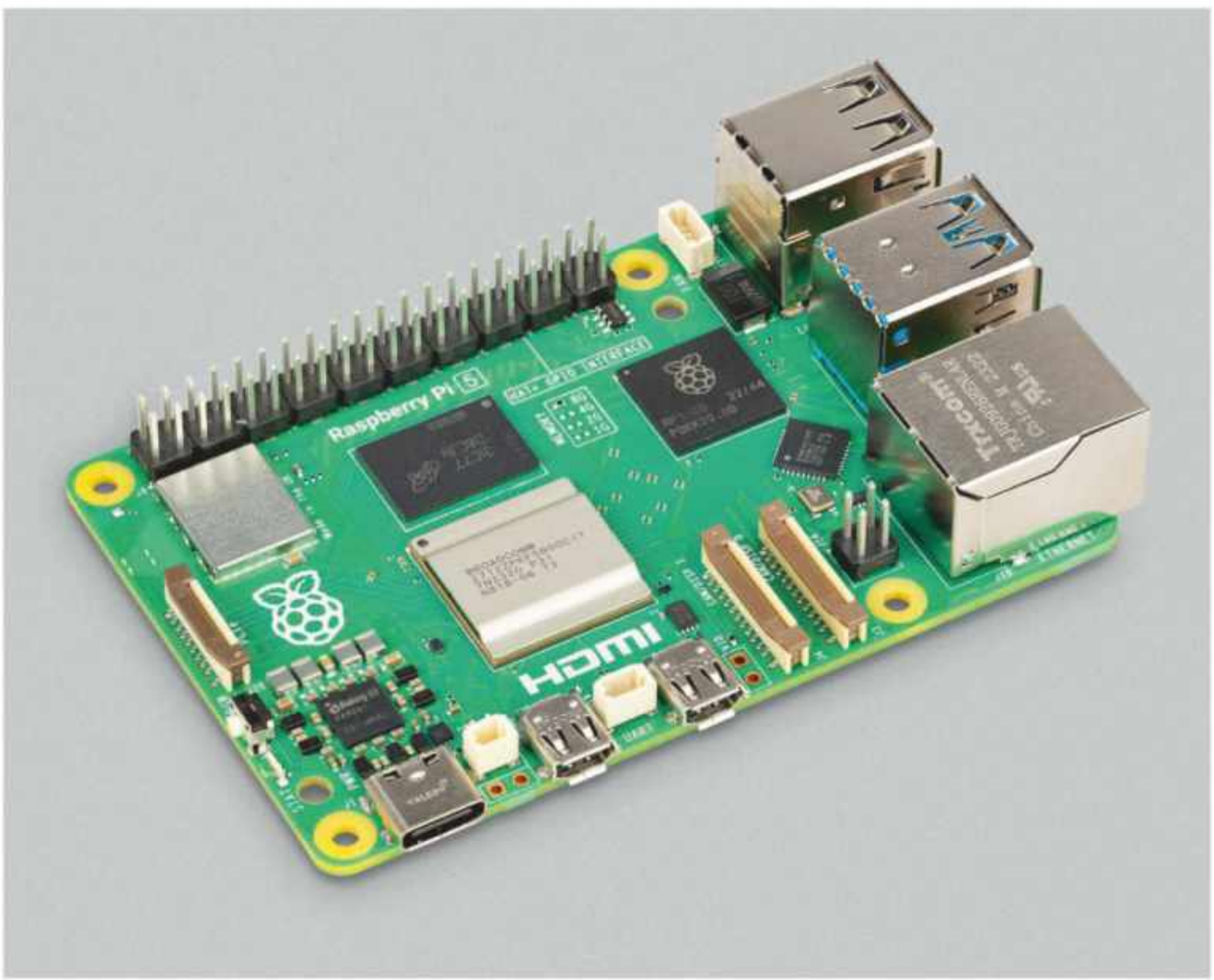
Microsoft executives are well aware of all these issues, to a far more nuanced degree than you and I. But I think someone's told them to go full speed ahead on AI, and damn the torpedoes of actual functionality and results. The push is coming from the top, and a certain amount of pain at the bottom (for both Microsoft's product team and its corporate customers) will be tolerated—at least for now.

We won't see the aftermath for a couple of years at least. Will this be a Windows 8 moment, remembered mostly as a painful lesson in what not to do? Or will I be proven wrong, and will AI become an essential part of every worker's digital worker's toolkit… what workers remain after so many of them are replaced?

Time will tell. I hope I'll be around to help time tell it.

The just-announced Raspberry Pi 5 is a mini PC monster

Forget the holiday pie—this is what I want on my table for Thanksgiving. **BY ALAINA YEE**



Holiday cheer is coming early for makers and single-board computer enthusiasts: The Raspberry Pi Foundation recently announced the successor to the Raspberry Pi 4, and it looks totally badass.

The new Raspberry Pi 5, which arrived at the end of October, has been unveiled with just two variants named so far: a $60 4GB version and a $80 8GB option. It's a departure from leading with a $35 model (currently the 1GB Raspberry Pi 4, fave.co/3Q2qb8u), but

IMAGE: RASPBERRY PI FOUNDATION

given the long history of that entry price, it's not unlikely that we'll see additional variants announced down the road.

Right now, the focus is on power, and it's understandable why. Not only does the Raspberry Pi 5 appear ready to deliver a sizable step up in performance compared to its 2019 predecessor, but its new silicon was designed in-house by the Raspberry Pi team. The specs show tangible upgrades across the board:

- 2.4GHz Arm Cortex-A76 CPU (quad-core, 64-bit)
- VideoCore VII GPU (supports OpenGL ES 3.1, Vulkan 1.2)
- Dual 4K60 HDMI output
- 4K60 HEVC decoder
- Dual-band Wi-Fi 5 (802.11ac)
- Bluetooth 5.0/Bluetooth Low Energy (BLE)
- High-speed microSD card interface (with SDR104 mode support)
- 2x USB 3.0 ports (supports simultaneous 5Gbps operation)
- 2x USB 2.0 ports
- Gigabit Ethernet (supports PoE+ with separate PoE+ HAT)
- 2x 4-lane MIPI camera and display transceivers
- PCIe 2.0 x1 interface
- Raspberry Pi standard 40-pin GPIO header
- Real-time clock
- Power button

For hardware nerds, there are plenty of details to dig into, like the fact that the application processor (the chip powering the board) sees a die shrink from 28nm in the Raspberry Pi 4 to 16nm in the Raspberry Pi 5. The architecture also moves from a monolithic design to a chiplet design. But overall, the performance boosts can be described by the number 2—for starters, you can expect the Raspberry Pi 5 to be about two to three times faster. Memory bandwidth also doubles, running at 4,267 MT/s versus the RPi 4's effective speed of 2,000 MT/s. And you can drive up to two 4K60 displays, compared to just one 4K60 or two 4K30

The Raspberry Pi 5's application processor.

The official case now includes an integrated fan.

displays before.

There are noteworthy practical changes, too. The board now sports mounting holes for a heatsink, along with connectors for a coin battery to power the real-time clock. And I don't know about other Raspberry Pi fans, but honestly, that power button is as exciting to me as the hardware updates.

(Itching for more info? You can dive into the Raspberry Pi 5 announcement post [fave.co/3Fg7edj], which has a full rundown of the board, including a comprehensive technical overview.)

The Raspberry Pi 5's accessories have gotten souped up, too. The official case now includes an integrated fan, and it's also been tweaked to allow insertion of the board without having to first take out the SD card. Oh, and you can more easily stack other cases or add-on boards (formally known as HATs, or hardware attached on top) by removing the lid. It will run you more—$10 versus the Raspberry Pi 4's $5 case—but you definitely get something for the money.

You can also now buy an active cooler for the RPi 5's chip, which is an adorable and affordable addition to the board. At just $5, it's the same price as a set of passive heatsinks (fave.co/3FhpseE). And you're likely going to need it if you push your board. Though it generally consumes less power and is more efficient, the Raspberry Pi 5's application processor hits higher peaks when pushed to its limits (about 12

You can now cool the processor in a Raspberry Pi with an official active cooler.

watts, compared to the RPi 4's 8W).

Speaking of that, if you have an older Raspberry Pi power supply, you'll likely want to upgrade to the new $12 27W (5V, 5A) power supply. The previous 15W (5V, 3A) model won't cut it, as the current fed to the USB ports will drop down to 600mA. The 27W version allows the USB current to reach 1.6A, plus provide an additional 5W of power to the board…which you can use for overclocking.

Yes, overclocking.

Also, did you think we were done yet? Not quite, because there are new HATs coming, too, and the best of the bunch (in my humble opinion) is the M.2 HAT that enables the use of an NMVe SSD (or any M.2 module).

Truly, if you didn't catch the theme, the Raspberry Pi 5 is leaning hard into high-octane mini-computing. And the good news is that the Raspberry Pi Foundation is going to sell first to individuals through the end of the year, as a thank-you for being patient with RPi 4 supply issues. (*Update: Some retailers have already begun offering pre-orders for the Raspberry Pi 5. If you're in the U.S., head over to Sparkfun* [fave.co/46KoG5p] *or PiShop.us* [fave.co/3Mnq8Dd]*. U.K. enthusiasts can hit up The Pi Hut* [fave.co/3LVZJMr] *and Pimoroni* [fave.co/3M14mox].) Print subscribers to The MagPi (fave.co/3RXIkaU) and HackSpace (fave.co/3M1julQ) magazines get priority access, too, via a single-use code.

Honestly, I can't wait—and to whet our appetites, a new official first-party operating system launched ahead of the Raspberry Pi 5 in mid-October. Called Raspberry Pi OS, it's based on the Linux Debian distro, as well as the Raspbian derivative that's existed for years. The newest Raspberry Pi is heralding a glow-up of epic proportions.

These M.2 HATs (hardware on top add-on boards) are new for the Raspberry Pi 5.

Risk level 10: Critical security hole affects widespread software

Numerous applications are probably affected, many of which have not yet received a security update. **BY KRIS WALLBURG**

Google has given an already-known security vulnerability a new CVE ID with the highest severity level. The reason for this is that the vulnerability, originally classified as a Chrome bug, affects significantly more applications, because it's a WebP vulnerability instead.

The WebP image file format is particularly popular on the web because it offers a good balance between storage size and quality. But the vulnerability allows attackers to use a specially crafted WebP image to create a heap buffer overflow and execute malicious code. To do this, the image must be opened in an application; in browsers, simply calling up a website is sufficient. The code executed in the background can then install malware, for example.

NUMEROUS KNOWN APPLICATIONS AFFECTED

The vulnerability, which was discovered by Apple's Security Engineering and

IMAGE: SOLARSEVEN/SHUTTERSTOCK

The vulnerability was initially wrongly classified as a pure Chrome bug.

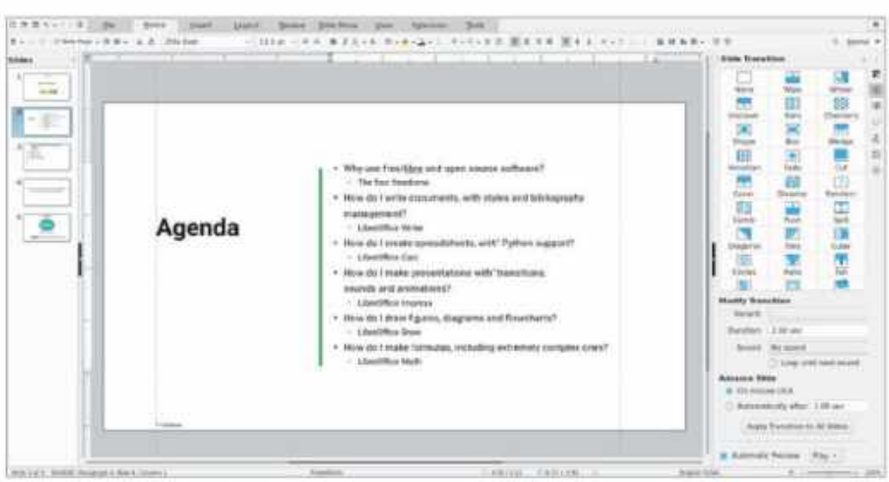
Architecture (SEAR) and the Citizen Lab at the University of Toronto's Munk School, was initially wrongly classified as a pure Chrome bug; common web browsers were quickly protected (fave.co/3rQxYOs) with a security update. But as it has now turned out (fave.co/3Fh5WyQ), significantly more applications are affected.

The vulnerability is related to the open Libwebp library, which numerous programs use. Thus, applications such as Gimp, Libreoffice, Telegram, 1Password, and many others could also become targets of an attack. As a result, the CVSS, a standardized score for evaluating security vulnerabilities, has been raised to the highest level, 10.0 (fave.co/3ZQYILr).

HOW TO PROTECT YOURSELF

As a user, you basically have only one way to protect yourself from this vulnerability: Make sure you have the latest patches installed. Many affected applications have already released security updates that close the security hole, including browsers and Libreoffice (fave.co/3tnmlPl).

Otherwise, what should always apply when surfing the net still applies here. Do not download files from unknown sources, and make sure that links in emails only lead to trusted sites before you follow them.



Many affected applications, such as LibreOffice (pictured), have already received security updates.

IMAGE TOP LEFT: WACHIWIT/SHUTTERSTOCK

Hands-on: HP's Envy Move is an all-in-one PC you can take anywhere

Is this the world's first truly portable desktop PC? **BY DOMINIC BAYLEY**

It's not easy to move a desktop PC and its monitor from room to room, and even if you do, there's usually a bunch of cords and setup to deal with afterward. TV manufacturers have overcome that problem by releasing portable lifestyle options. But what about desktop PCs? Enter the radical new HP Envy Move.

Announced during a press event on Thursday, HP's Envy Move All-In-One PC is a computer-centric spin on that portable lifestyle TV concept. It's a lightweight

IMAGE: HP

standing PC with a handle on the back that you can essentially cart from room to room like a suitcase, to fit your different work or entertainment needs.

I'm not going to lie to you—it originally seemed like a strange concept when I first heard about it at HP's Global Headquarters in Palo Alto, California. I mean, why not just use your laptop (fave.co/3qL4oHf) and/or a laptop with a portable monitor (fave.co/3rOxecA) instead? But, having had a hands-on preview, I can now see the appeal—especially for families.

The Envy Move All-In-One sports a large 23.8-inch QHD (2560×1400) LCD touch-sensitive display but weighs just 9.04 pounds, which means it's about as light as a gaming laptop but with a much bigger panel—it was quite easy for me to pick up and carry. It also has a built-in rechargeable 6-cell, 83WHr battery with fast-charge support. HP estimates you can charge it to 50 percent in 45 minutes.

Basically, the Move All-In-One gives you the benefit of a large desktop-like monitor, but with PC smarts, so you can use for a range of lifestyle or work-related activities without the hassle of much setup or cords. HP's senior vice president and division president of personal consumer solutions, Josephine Tan, said in the case studies HP carried out, the device proved popular for "yoga, TV, study, work, gaming, and even for watching stuff in the bath."

"Its versatility lets it act as a work device, an entertainment device, and even an exercise companion for on-demand workouts. And for homes with multiple members, this form factor lends itself to be a shareable hub that anyone can use in any part of the home."

The Envy Move has a 23.8-inch touch-sensitive display.

Personally, I was interested in its gaming capabilities, which it can handle—but with a caveat.

The starter configuration is powered by a 13th Gen Core i3-1315U mobile processor, 8GB of DDR5 RAM, and 256GB of SSD storage. It also comes with Windows 11 Home and Wi-Fi 6, and ships for

$899. Otherwise, the top-of-the-line configuration comes with an Intel Core i5-1335U CPU, 16GB RAM, Windows 11 Pro, and Wi-Fi 6E, and ships for $1,119.99. Either one should run lighter games.

The caveat is that both units only have Intel UHD graphics—there's no discrete graphics card onboard, but HP is pushing its use with game-streaming services like Nvidia's GeForce Now (fave.co/3CbTcJz) for those not wanting to miss out on high-end framerates.

The PC's Bluetooth keyboard slots into a pouch on the laptop's back.

Additionally, the HP Envy Move has modest but workable ports for work and play. It includes single USB-A and USB-C ports as well as a HDMI video-in port. It also has Bluetooth 5.3, but no 5G, since "the aerial would have been too difficult to fit into the panel." A white HP 720 Bluetooth keyboard fits into a pocket behind the PC, so that it can be easily taken and used anywhere the device goes.

Another vital component to the HP Envy Move All-In-One's portability is its standing design. As well as providing a handle on top, it has two mechanical feet that surprisingly autodeployed when I placed it down. They're based on a gaming laptop's hinges, so that it sits flush on carpets and harder surfaces.

The Envy Move's AI integration is also a highlight for me—it features an 5MP HP Wide Vision camera with an integrated AI image signal processor that turns it off when you leave and back on again when you return. What's more, it registers two viewing proximity sweet spots—when you're either two feet or six feet away—and switches the speaker's audio between stereo (two feet) and spatial audio (six feet), so that you can enjoy it alone or with your family. Ambient light sensing also automatically raises the screen brightness for gaming in dimly lit rooms.

The HP Envy Move 23.8-inch All-In-One comes in just one color, Shell White. It's available now on HP.com, or you can buy it from Best Buy.

Smokey Bear is within us all.

For wildfire prevention tips, visit
SmokeyBear.com

ad COUNCIL

Microsoft Surface Laptop Studio 2: Still ahead of its time

Microsoft's latest Surface Laptop Studio 2 feels like it's a year too early. **BY MARK HACHMAN**

Microsoft's Surface Laptop Studio 2 (fave.co/46Skf8R) will probably be too expensive for what it can do, comparatively. But this creators' laptop still offers a nearly unique opportunity to create movies, edit and watch them, then scribble notes all over the screen. Any criticism of its performance dies down once you remind them of Windows' performance slider, too.

It arrives at an odd time, though. The Windows world is making waves about artificial intelligence, and the Surface Laptop Studio 2 calls out the Intel AI chip inside in its

IMAGE: MICROSOFT

specifications. But an even better Intel AI chip—Intel's 14th-gen Core Ultra processor, known as Meteor Lake (fave.co/3PUqbHI)—is just around the corner…though Microsoft's Windows Copilot AI chatbot (fave.co/3saaN1k) won't use it, either.

So this 14-inch laptop with a high-resolution (but not *that* high-resolution) screen, superb inking capabilities (but no pen in the box), AI (but only Microsoft's own basic AI apps for now) and excellent performance potential (but only if you enable it) demands more than $3,000 from your wallet to bring it home. And much of it is the same as the original Surface Laptop Studio. It's a knot. This review will tell you how we unraveled it.

CONFIGURATIONS

Microsoft's Surface Laptop Studio 2 begins shipping today, although pre-orders began about two weeks ago. Prices will range between $1,999 for a version with a 13th-gen Core i7, 16GB RAM, a 512GB SSD, and basic Iris Xe graphics. Users also have the options of versions with 32GB and 64GB of RAM, which may be a new high point for a laptop—even a creator-class one. Microsoft's Surface Laptop Studio offers expansive storage options as well: 512GB, 1TB, and 2TB options.

Finally, there are the graphics options—an interesting range, from integrated graphics to a much older Nvidia GeForce RTX 2000 chip to either an RTX 4050 or RTX 4060. (Microsoft may be choosing the old RTX 2000 option to keep prices down, but we've now seen the RTX 2000 GPU in at least two laptops: the Acer Nitro V [fave.co/3M4EGqX] and this one). A version of the Surface Laptop 2 with all of the bells and whistles will cost a whopping $3,699.99.

It's important to note that many aspects of the Surface Laptop Studio 2 are identical or nearly so to the first-gen Surface Laptop Studio (fave.co/3RZoDi6), including the size and resolution of the display, most of the chassis dimensions and other aspects. The Surface Laptop Studio 2 is about a third of a pound heavier and slightly thicker, with two new ports: a USB-A port and a microSDXC slot. Otherwise, the key differences are inside the laptop. It also boasts new 13th-gen Core i7 processors and new GeForce GPU options.

Keep in mind that unfortunately you'll still need to pay $129 or so for the Surface Slim Pen 2 (fave.co/48Otrwx), optimized for inking on the Surface Laptop Studio 2. Fortunately, you can simply skip this extra purchase if that's not your thing.

SPECS

Our review unit came with an Intel Core i7-13700H CPU, an Nvidia GeForce RTX 4060 GPU, 64GB of RAM, and 1TB of SSD storage. For more information on the hardware, check out the list below:

Display: 14.4-inch PixelSense Flow touch display (2400×1600 (201 PPI), up to 120Hz)

The Laptop Studio 2 is compatible with the Surface Slim Pen 2.

Processor: Intel Core i7-13700H/Core i7-13800H (Core i7-13700H as tested)

Graphics: Nvidia GeForce RTX 4050 6GB/4060 8GB, or RTX 2000 or Iris Xe (RTX 4060 as tested)

NPU: Intel Gen3 Movidius 3700VC VPU AI Accelerator

Memory: 16GB/32GB/64GB LPDDR5X RAM (64GB as tested)

Storage: 512GB, 1TB, 2TB SSD (all removable) (1TB as tested)

Ports: 2 USB-C (Thunderbolt 4/USB 4.0), 1 Surface Connect, USB-A, microSDXC, 3.5mm headphone jack

Camera: User-facing: 2304×1296 with Windows Studio Effects

Battery: 56.3Wh (design), 57.2Wh (actual)

Wireless: 802.11ax (Wi-Fi 6e); Bluetooth 5.3

Operating system: Windows 11 Home

Dimensions (inches): 12.7x9.1x0.86in

Weight: 4.37lbs

Color: Platinum

Price: $1,999 to $3,699 ($3,299 as tested)

EXPERIENCE

There's one distinguishing feature of the Surface Laptop Studio 2 that hardly any other device (besides the original Surface Laptop Studio [fave.co/3RZoDi6] and the Acer ConceptD 7 Ezel, fave.co/3vmS3JC) offers: the pull-forward, inclined display.

There's a clear distinction between work and play. With the display set back, the Studio 2 is indistinguishable from an ordinary clamshell notebook. But pull it forward and the display is almost in your lap. There, the display inclines at about 45 degrees, covering up the keyboard but leaving the trackpad exposed. In that context, the Surface Laptop Studio 2 transforms from a productivity into a media consumption device. (Let's be clear: This is the same experience the Surface Laptop Studio 1 offered.)

And here, the experience is really unparalleled. No other laptop features the pull-forward display. Microsoft has never

With the display set back, the Studio 2 is indistinguishable from an ordinary clamshell notebook.

skimped on speaker quality, either, and the four top-facing Omnisonic speakers mounted in the chassis offer a satisfying punch enhanced by Dolby Atmos. They're bright and loud, and they sound fantastic for laptop speakers. You can watch movies or video on other laptops, but I promise you'll enjoy it more on the Surface Laptop Studio 2.

About the only thing you can't say about the laptop is that it has a conventional display. Microsoft's PixelSense Flow display features two color modes, 2400×1600 resolution, and up to a 120Hz refresh rate for content creation and inking. Rival laptops, though, have made the leap to 4K—which is really only achieved by squishing the display into a 16:9 aspect ratio. An OLED could really improve the laptop's movie playback and multimedia experience, too.

But if you *do* want to ink, you can. The display also folds down flat, facing you. Microsoft has always seemed a little boastful when it comes to its display hinges, but again, there's really nothing else like the Surface Laptop Studio. And did we mention that the Studio 2, like the earlier model, magnetically tucks away its flat Surface Slim Pen 2 underneath the keyboard?

WHAT'S NEW?

As we mentioned above, the Studio 2 refreshes the guts of the device—the CPU, GPU, memory, and storage—with a new microSDXC and legacy 5Gbps USB-A port on the side of the device. It's an acknowledgment that not everyone wants to spend some extra cash for a USB-C hub or a Thunderbolt dock (fave.co/3vtA0BE) just to add those additional ports. You can certainly use the extra ports for a mouse or printer, but also to easily "sneakernet" in the microSD card with photos from an external SLR camera.

There's faster wireless (WiFi 6e versus WiFi 6) and Bluetooth 5.3 as opposed to the older Bluetooth 5.1. The memory is faster, too, with a jump from LPDDR4X to LPDDR5X.

Aside from that, the Surface Laptop Studio 2 on paper feels very much like the Samsung Galaxy Book3 Ultra (fave.co/3XOG7yE) from earlier this year, with a Core i7-13700H option, 16GB or 32GB of RAM, up to 1TB SSD, and an RTX 4050/4070 GPU. (The Studio 2 outshines it with 64GB RAM options and a 2TB SSD option.) Microsoft says that the SSD is "removable," but only officially by a qualified repair technician.

Unfortunately, the timing means that the laptop lands after Intel announced its 14th-gen Core Ultra (Meteor Lake, fave.co/3PUqbHI) notebook processor.

OUT OF THE BOX

The Surface Laptop Studio 2 is a solid device, whose anodized aluminum chassis rests heavily in the hand at over 4.37 pounds, versus the 4 pounds in the first-gen Surface Laptop Studio. Sometimes tech reviewers lean too heavily on minute details, but comparing the first-gen to the second-gen hardware in the hand—yes, it's noticeably heavier due to the extra cooling Microsoft engineered in. The Surface Laptop Studio 2 is more Studio than Laptop in that regard.

You can choose only one color, Platinum. Microsoft's clean aesthetic also means that this Evo (fave.co/3PRNkKB) laptop won't advertise that fact with any stickers on the chassis, either.

The RTX GPU and aggressive CPU means that the Surface Laptop Studio 2 also features the side-mounted venting that others in its creator class do, separating it from the smooth lines of mainstream notebooks like Microsoft's Surface Laptop. As we note in our performance tests, Microsoft usually ships new Surfaces in their slowest, quietest "recommended" settings in the Windows 11 performance slider (fave.co/3DOnyiE). In normal use, the laptop is essentially fanless and whisper quiet. In games, though, the fan will rev up quick and loud, regardless of the setting. Where we

The Surface Laptop Studio 2, laid almost flat in Studio mode, for inking. A new microSDXC slot sits next to the headphone jack and the Surface Connector for charging.

could, we've tested the laptop both in its default setting and in performance mode—it can make a big difference!

The SLS2 includes a 127W Surface charger inside the box (with a USB-A charging port), though you can power the laptop via a standard 100W USB-C charger. The Surface charger supplies enough juice to power the laptop without drawing on the battery during intensive tasks.

The Surface Slim Pen 2 (fave.co/45KQxSh)—the same model found in the previous iteration—can be stored magnetically in a small niche under the bottom chin of the laptop. (The pen is still sold separately, sadly). The laptop grips it absolutely securely, about the same as the former model—whose pen has survived many trips as a test and travel notebook. Don't worry about it falling off accidentally, as its grip is almost too tight. When detached, it connects to the Studio 2 for inking via a Bluetooth connection.

The Surface Laptop Studio 2's new USB-A port sits alongside the two existing Thunderbolt 4 ports. The display is in Stage mode, pulled forward.

DISPLAY AND PORTS

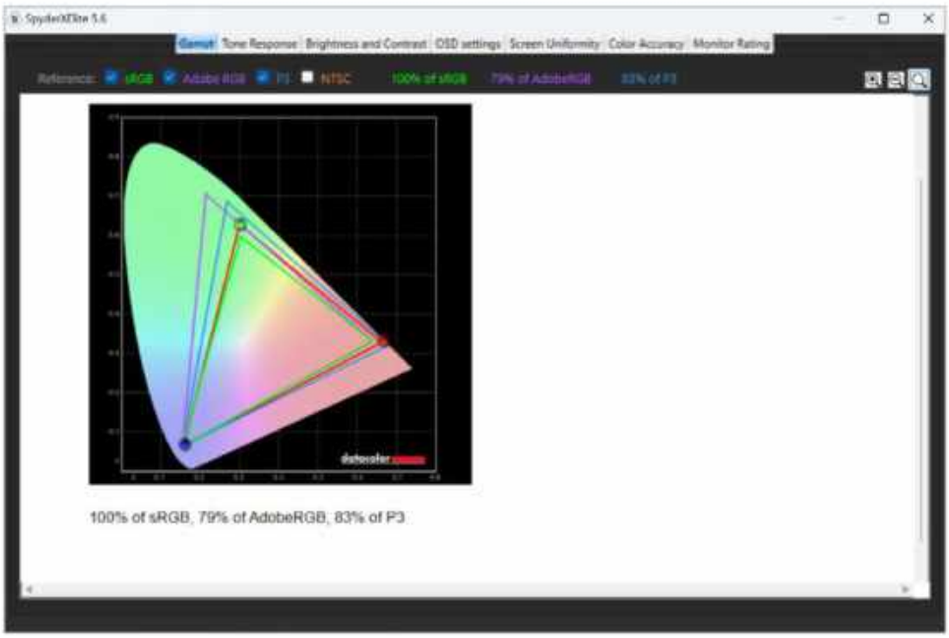
Microsoft has always marched to its own beat where its chassis designs have been concerned, and its displays have also taken it off the beaten path.

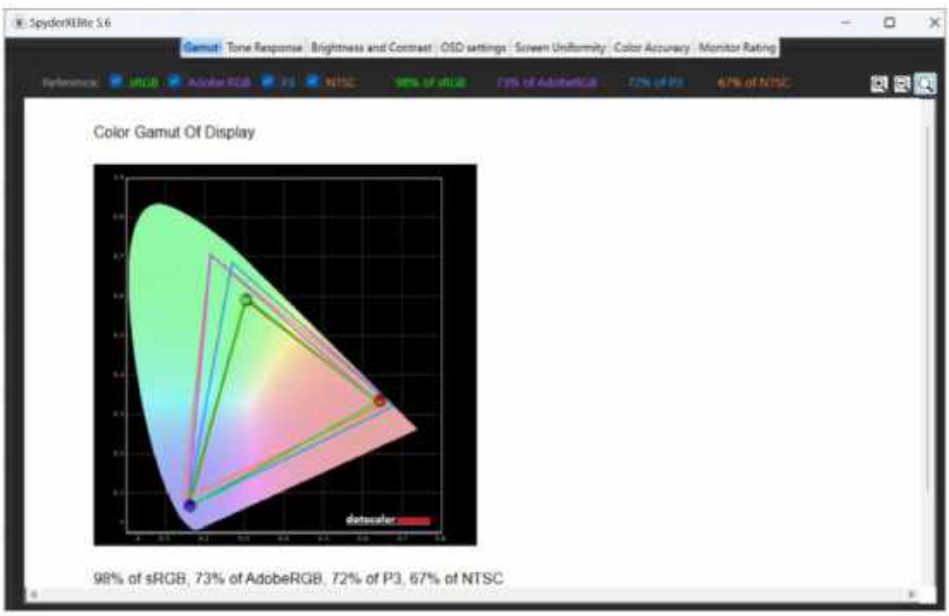
Most laptops use one of three displays: a conventional 1080p (1920×1080) display; a 1200p alternative, or a leap to a full 4K (3840×2160) display. Microsoft includes a 2400×1600 PixelSense Flow 10-point multitouch display within the Surface Laptop Studio 2, which falls somewhere in the middle. The display still uses a 3:2 aspect ratio, a staple of Surface devices, which means you'll typically see letterboxed video. All told, the display offers about 201 pixels per inch, about 65 percent of the 306 pixels per inch a comparable 4K display would offer.

We measured the Surface Laptop Studio 2 offering 483 nits of maximum brightness, exactly the same as its predecessor. The display

is DisplayHDR 400 certified, the bare minimum for HDR capabilities, with Dolby Vision IQ support.

Microsoft was also one of the first to tune its displays for content creation with sRGB and Vivid color profiles that tune the display a bit like the various color modes on a TV. Unfortunately, many of Microsoft's rivals now do this, too. Microsoft was also one of the first to market with a standard 120Hz display, which cycles back and forth between 60Hz and 120Hz depending upon the application. (In inking, for example, the display flips to 120Hz for smoother e-ink). Again, this is now a feature that rivals offer, including the earlier Samsung Galaxy Book 3.





The color gamut of the Surface Laptop Studio 2 in both of its color modes.

All this means is that a number of Microsoft's premium features are now becoming table stakes across this new creator class of notebooks. That undercuts the price Microsoft asks you to pay for the Surface Laptop Studio 2.

When the Surface Laptop Studio shipped in October 2021, Thunderbolt was still somewhat of a novelty. Now it's a staple, and Thunderbolt docks (fave.co/3vtA0BE) and

The (optional) Surface Slim Pen 2 sits underneath the Surface Laptop Studio 2, in a special cubby that also charges the pen.

even some USB-C displays are becoming more common. Two Thunderbolt 4 ports grace the laptop; we'll assume that Thunderbolt 5 (fave.co/3txpsEA) will be designed into 2024–25 models. It's rather interesting that Microsoft decided to break up its clean lines with the 5Gbps USB-A port, which feels like a Surface of old. The microSDXC port is a concession to mobile photographers, but a smart addition.

The Thunderbolt ports deliver 9.3W, enough to charge a smartphone. The USB-A port delivers only 2.4W, only good for powering USB keyboards and mice.

A GOOD KEYBOARD AND HAPTIC TOUCHPAD

Microsoft's Surface keyboards have always been among the industry's best, though they've slightly diminished in quality over the past few generations. The Surface Laptop Studio 2's keyboard seems to have slightly improved, however. The older keyboard feels like it's more resilient throughout the entire length of the key press, which gives it a more rubbery feel. The older Laptop Studio feels a bit more splatty, where there's a bit of give. Maybe I'm just being picky.

Microsoft also seems to have used a different coating for the surface of the keyboard base, with a slight corresponding change to the keyboard key colors as well. There are also two changes to the physical keyboard: A mic mute button has been swapped in for the backlight control, which now replaces the media play key. There are three levels of backlighting, but backlighting appears off by default.

I'll continue to whine about the perpetual decline in key travel. Older Surface devices like the Surface Book offered well over 1mm of key travel, the difference between a flat sole and the comfortable padding of a running shoe. I still agree with my earlier perspective: The Surface Laptop Studio's keys feel springy and resilient, and the 1.3mm of key travel somehow feels better than the Surface Laptop. The pitch and key width is unchanged. Surface keyboards are among

the best that you can buy, but they're not as good as they once were.

I'm still impressed with the massive size of the haptic touchpad, a carryover from the first-gen Surface. The haptics simulate the "click" of a touchpad, without it being there. Gestures worked as expected.

Unfortunately, just weeks after I completed the review of the first-gen Surface Laptop Studio review, I spilled a bit of water on the touchpad, which killed the haptics. The previous iteration's touchpad still works as expected, but without any clickiness at all. You simply have to tap it to make it work. I therefore do not have high hopes for the Surface Laptop Studio 2 and suspect that the haptics (which simulate the depth of a touchpad) won't be as successful as Microsoft hopes.

Note the changes to the function keys on the Surface Laptop Studio 2.

GREAT AUDIO CONTINUES

As mentioned above, the Surface Laptop Studio 2 uses four omnisonic speakers, enhanced by Dolby Atmos. As other Surface devices have demonstrated, Microsoft tunes its speakers well, and the Surface Laptop Studio 2 is one of the few laptops you'll enjoy listening to as an audio device. I listened to a few tracks to test the highs and the lows, and the audio quality sounds very good even at maximum volume—which packs a good punch. In live tracks, I was able to pick out specific instruments and chords.

I was a little worried that the additional cooling inside the Studio 2 would diminish the audio quality, but that's not the case. My only nitpick is that Dolby Atmos doesn't really seem to make a difference whether it's off or on.

Calls made with Teams or Zoom sounded great, and the people I spoke to said my voice sounded fine. Remember, Microsoft is using AI to filter out background audio, too. You'll still have better luck with a dedicated mic or headset, though.

THE WEBCAM GETS SMARTER

The Surface Laptop Studio 2 uses a 1080p webcam

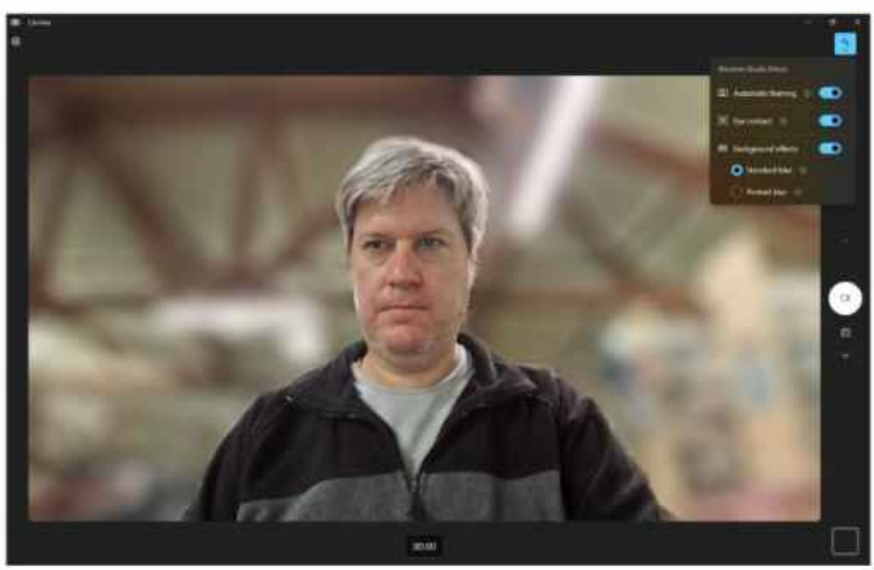
How well does the Surface Laptop Studio 2 choose between the subject (me) and the background? Not too badly.

(correction: a 2,304×1,296 webcam) which does a very nice job of both isolating you (the subject) and presenting you well. For this review, I tried a different venue to test out the webcam. On one scene, it blows out the background to focus on me, the subject. That's the right choice.

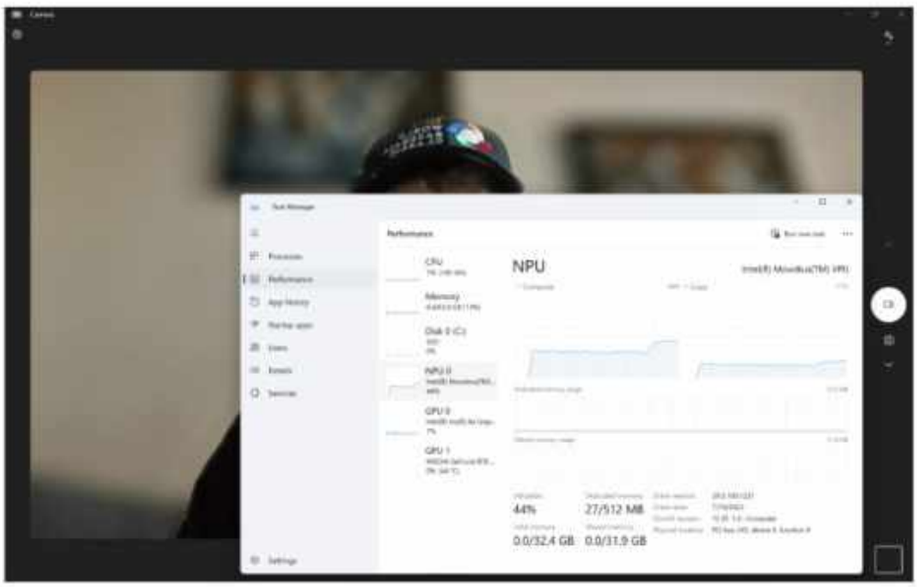
There's a reason that the best webcams (fave.co/3LZ3Gjk) are now pushing above 1080p. Finally, integrated webcams are improving! I doubt you'll have any complaints with either the webcam in the Surface Laptop Studio 2 or the associated mic, as both are excellent.

The webcam is also (for now) the only obvious venue for Microsoft's AI effects, also known as Windows Studio Effects. None of them is really that unique. The webcam can use the NPU to distinguish you from the background, something that virtually every videoconferencing app already does, using the laptop's CPU instead. Automatic framing centers you in the screen. Eye contact makes it appear that you're focusing in on the webcam and who you're talking to, even if that's not the case. Background blur—well, you already know what this does.

Microsoft is indeed using Intel's Movidius NPU AI chip to perform these functions; turning all three Windows Studio Effects functions on at once used about 40 percent



The SLS2's webcam, again, with indoor lighting. Eye Contact is turned on, though, and it doesn't seem to work quite right here.



No one will care, but here (with Windows Studio Effects turned on) the Surface Laptop Studio 2's NPU is used.

of the NPU's available computing power. For whatever reason, the automatic framing had issues parsing my hat (I guess) and the NPU usage spiked as the camera panned back and forth.

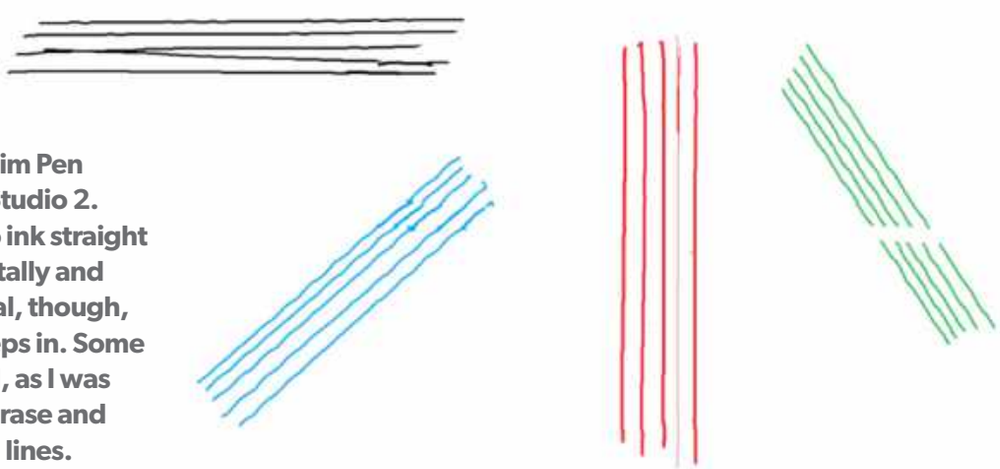
The Surface Laptop Studio 2's webcam includes Windows Hello, and supposedly an updated version that can better accommodate masks and beards. We just so happened to test the device in a public venue that asked customers to wear masks, and the laptop couldn't identify me.

INKING EXPERIENCE

You don't have to buy the Surface Slim Pen 2. If you do, however, you can store it within the built-in pen cubby.

Interestingly, Microsoft didn't supply us with a Slim Pen 2, but agreed that using the one shipped with the original Surface Laptop Studio would work just fine. When we removed it from the older unit and clipped it to the new unit, it automatically paired without assistance. Granted, I was logged into both machines.

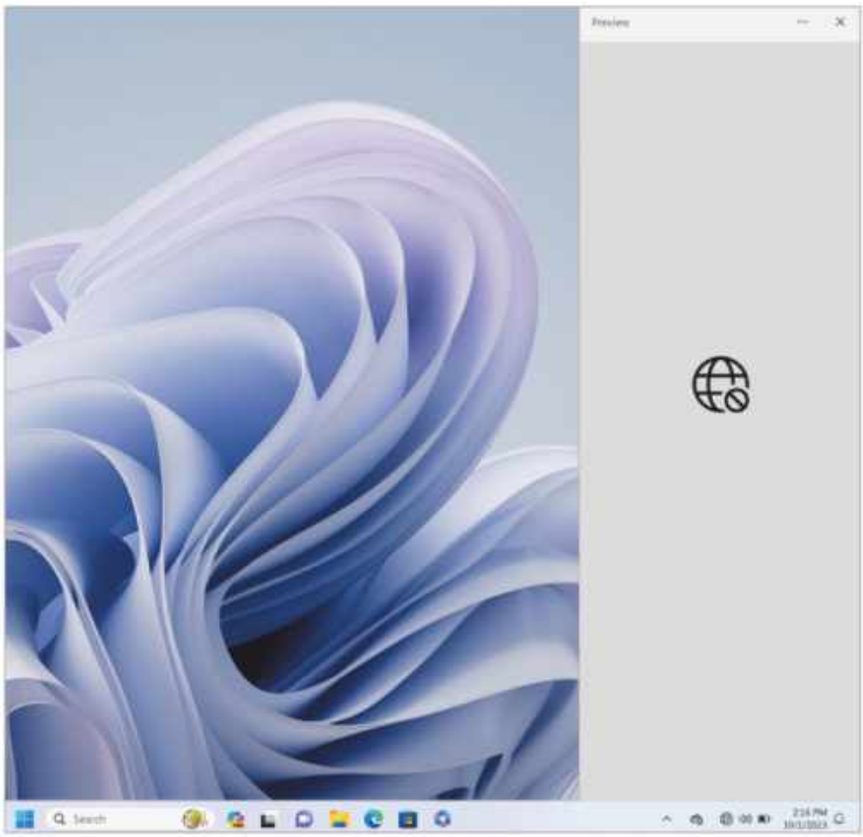
According to Microsoft, the company made no changes to either the pen or the



Inking with the Surface Slim Pen 2 on the Surface Laptop Studio 2. Usually it's no problem to ink straight lines slowly both horizontally and vertically. On the diagonal, though, sometimes pen jitter creeps in. Some of the lines appear joined, as I was testing how well I could erase and then connect the existing lines.

inking in the Surface Laptop Studio 2.

On the Studio 2, we used Microsoft Paint to ink a series of lines. (The fact that Whiteboard requires you to be logged in to use it is kind of dumb.) Inking seems pretty much the same as with the first model: The ink placement seems to be on target, but there's some judder (waviness) when you're slowly inking diagonal lines. Remember, though, that you're inking directly onto the display, as opposed to buying a separate inking tablet that translates those strokes onto a PC.



Don't use Windows Copilot without a Web connection.

PERFORMANCE

The Surface Laptop Studio debuted Windows 11. Its successor introduces Windows 11 22H2's September 2023 update, which will transition into the (nearly identical) Windows 11 23H2 update, aka the Windows 11 2023 Update (see page XX). We update each laptop when we get it to make sure it has the latest apps and firmware. In this case, the update process brought with it the Windows 22H2 September update/23H2.

There's no way around this. The Surface Laptop Studio felt laggy, especially when launching new applications or just navigating around the operating system like File Explorer. Starting up apps took longer than it felt like it should. But as our performance numbers bear out, the faster components inside it absolutely make a difference when actually *running* the apps. It's possible that there's an early bug in the 23H2 OS itself or in the Surface firmware that's making navigation slower than it should.

My early take on the new AI features isn't positive, either. Windows Copilot is slow, period, requiring several seconds to generate a response. While this has nothing to do with the laptop itself (as Copilot connects to the cloud), it just isn't a great experience. And

without an Internet connection, Copilot won't work at all—it connects to a server, not the Movidius chip inside your PC.

Because of our limited review window, I haven't tested any AI generative art apps on the Surface Laptop Studio 2. As far as I know, though, no AI art programs are currently set up to take advantage of the NPU. We expect that will change over time, but I can't say when or how.

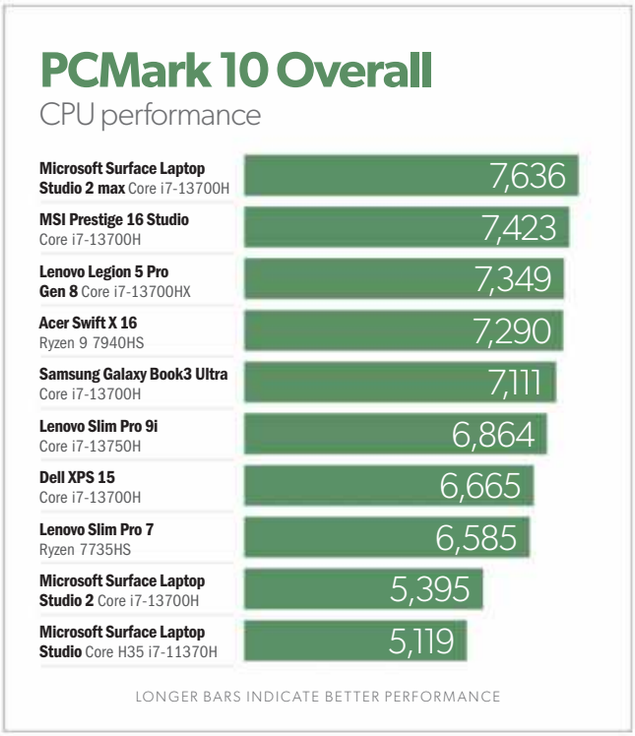
As noted above, I tested the Surface Laptop Studio 2 in its default recommended power/performance setting, the lowest of the three power/performance settings Windows 11 provides. I then retested at the highest performance setting (fave.co/3DOnyiE)—and boy, did it make a difference! We'll call out those results in our charts using a black box.

Are we giving Microsoft an unfair advantage here? Maybe—other laptops are usually configured at the middle setting, so there's headroom there, too. On the other hand, you could argue that there's a lot of untapped power under the Surface Laptop Studio 2's hood.

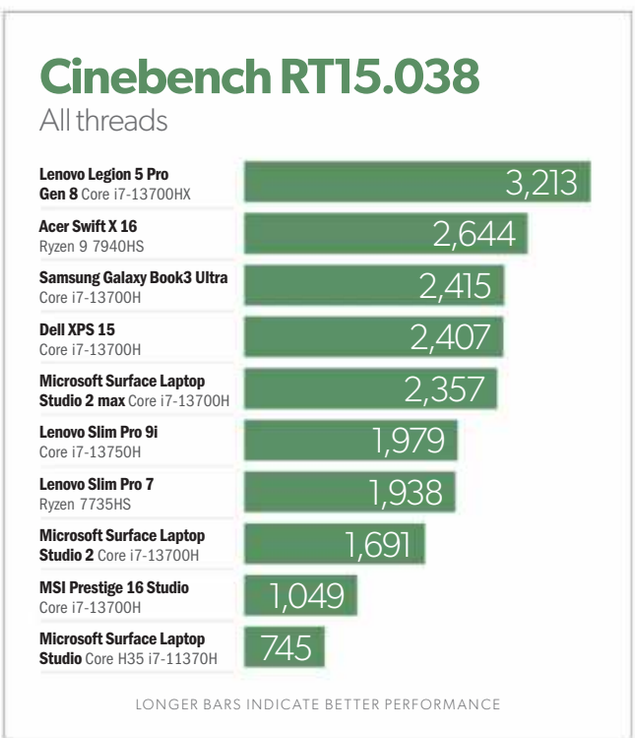
We've chosen to compare Microsoft's Surface Laptop Studio 2 against several other creator-class notebooks that use a recent AMD or Intel GPU paired with a low-end discrete GPU. If possible, we've selected the 14-inch version. A couple of gaming notebooks crept in, and we've tested a few games to give you an idea of how the laptop will fare after hours. Keep in mind, though, that few competing devices are optimized for inking on the device. Nor do they feature the same chassis design. These are the caveats that Microsoft hopes will inspire you to pay a hefty premium for the Surface Laptop Studio 2.

We compare the $3,299 Surface Laptop 2 to the $2,099 Samsung Galaxy Book3 Ultra (fave.co/3XOG7yE), plus a trio of Lenovo devices: the $1,199 Lenovo Slim Pro 7 (fave.co/3MylQIg), the $1,899 Lenovo Slim Pro 9i (fave.co/46uRizJ), and the $1,699 Lenovo Legion 5 Pro (fave.co/3twpfkW). We also include the $2,799 Dell XPS 15 (2023; fave.co/46SIKUx), the $2,000 MSI Prestige Studio (fave.co/3PTkF7N), the $1,599 Acer Swift X 16 (fave.co/46OOA85), and the $2,799 Razer Blade 14 gaming notebook (fave.co/401YPnI). Our German counterparts at PCWelt have also reviewed the $2,299 Asus Zenbook 14 Pro OLED (fave.co/48OXp3B), though with differing performance benchmarks. We also include benchmarks from the older, original Microsoft Surface Laptop Studio (fave.co/3RZoDi6)—now two years out of date.

We test laptops using several benchmarks. The first, PCMark 10, applies real-world tests from videoconferencing to app startup to CAD work to light gaming and generates a final score. This generally taxes the CPU, but some of the tests stress the GPU as well. Historically, the Surface Laptop Studio appears in the middle to the bottom third of these tests.



The Surface Laptop Studio 2's results look relatively poor…that is, until you turn on performance mode.



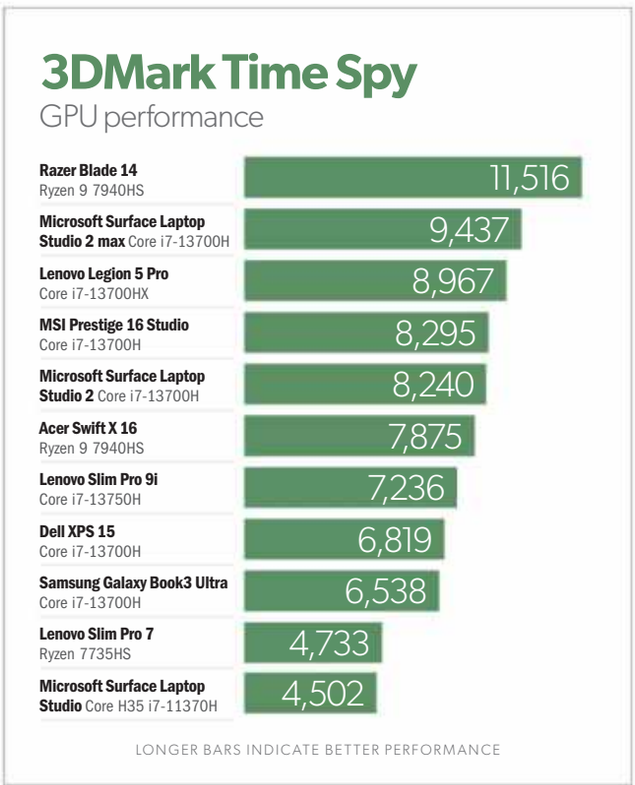
Dialing up the performance slider improves the spreadsheet and content creation performance portion of the PCMark benchmark considerably, which elevates the score as well. This is the benchmark that shows the most improvement when the Windows performance slider is increased to maximum. That's a dramatic improvement!

The Cinebench benchmark asks the CPU to "burst" through a rendering benchmark, using all of its cores to render the scene as quickly as possible. A second test (not shown) uses a single thread to perform the same task. We use the R15 test, though we test the R20 (4,317 multi, 456 single-thread) and R23 (11,095) as well.

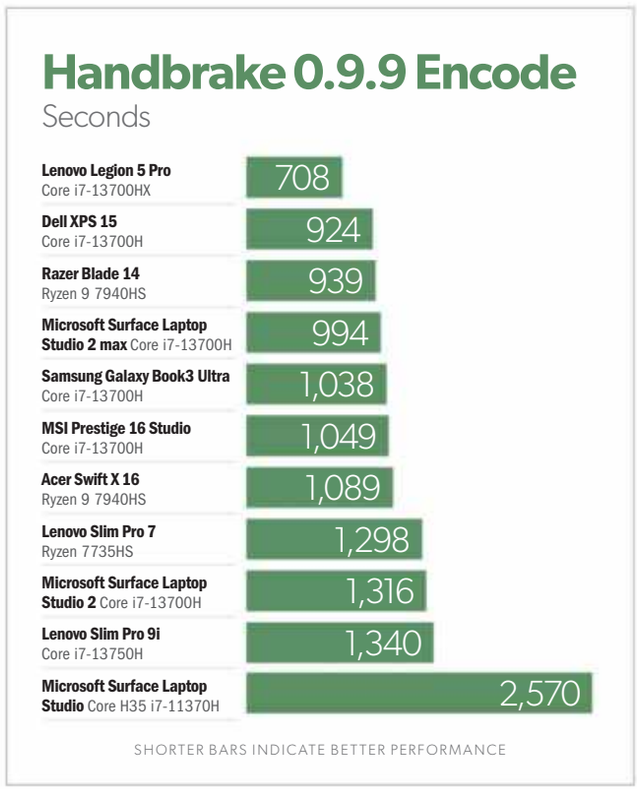
The latter R23 test offers a single run and a looped test, which cycles through multiple iterations. The key here is how well the laptop fares under prolonged load: Will it throttle itself over time to prevent overheating? In this case, it does: Performance dropped by 9 percent after ten minutes. On the other hand, pushing the performance slider to the maximum improves performance significantly.

The story is decidedly more mixed in 3D graphics performance. Here, the Surface Laptop Studio 2's base performance using the 3DMark "Time Spy" benchmark is pretty good.

But if we loop the same test over and over again, as we did in Cinebench, average frame rates dropped from a sustained rate of about 54 fps to about 42 fps. That shows that the



The story here is the Surface Laptop Studio 2's gen-over-gen leap in 3D performance, and it's a massive one.



Again, the Surface Laptop Studio 2 doesn't look all that hot against the competition, until you dial up the performance.

laptop is slowing itself down to prevent harmful overheating.

Again, we can push performance higher by putting Windows into its highest-performance mode. Our tests show a more consistent experience here: The average framerate did drop from 61 fps to 57 fps when we looped the benchmark, which isn't that much. You'll hear a lot more fan noise, though.

Handbrake is an open-source video conversion app that transcodes a Hollywood movie into a smaller size and bitrate—a practical test that's somewhat diminished in an age of Netflix downloads to your PC (fave.co/3rODaIS). But it also measures sustained performance because the laptop will again slow down the entire task to avoid overheating.

This result is a little disappointing until you consider that two of the top laptops in this list (the Razer Blade 14, and the Lenovo Legion 5 Pro) are specialized gaming laptops.

GRAPHICS PERFORMANCE

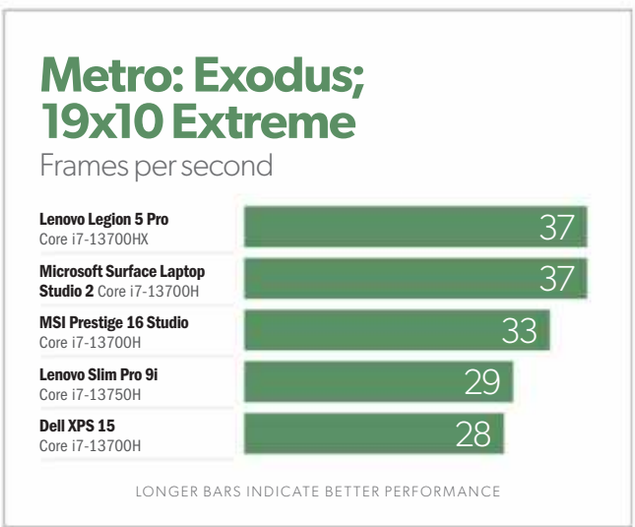
One of the things you may find most appealing about this creator niche of laptops is that it does offer the best of all worlds:

enough performance to enable some decent gaming without the price or blingy aesthetic of a gaming laptop.

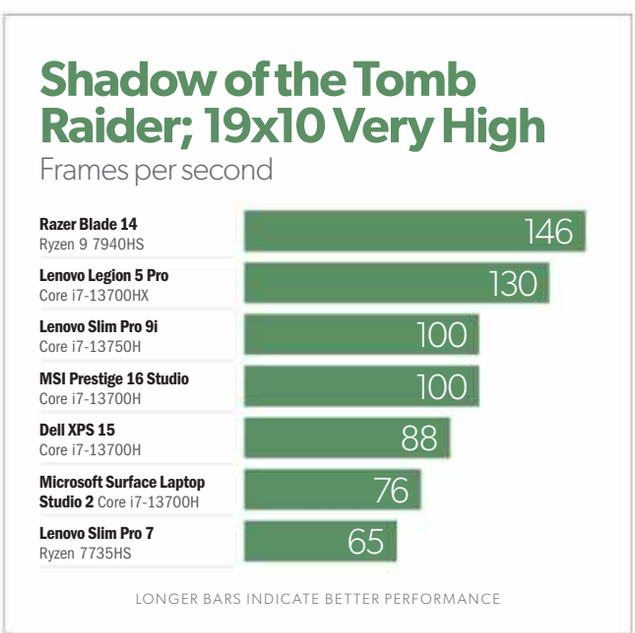
Some of our gaming and content creation laptop reviews now incorporate a couple of relevant games to measure light gaming performance, a term that obviously changes over time as certain games get older and laptop performance increases. Here, we've compared a smaller sample of our test laptops using two games: *Shadow of the Tomb Raider* and *Metro: Exodus*.

Both games demonstrate two things: one, that the Surface Laptop Studio 2 can indeed be used for gaming, and two, that it can keep up with its rivals. Don't get too excited, though. In *Metro: Exodus*, for example, the game's 37 frames per second may be a little choppier than you'd prefer.

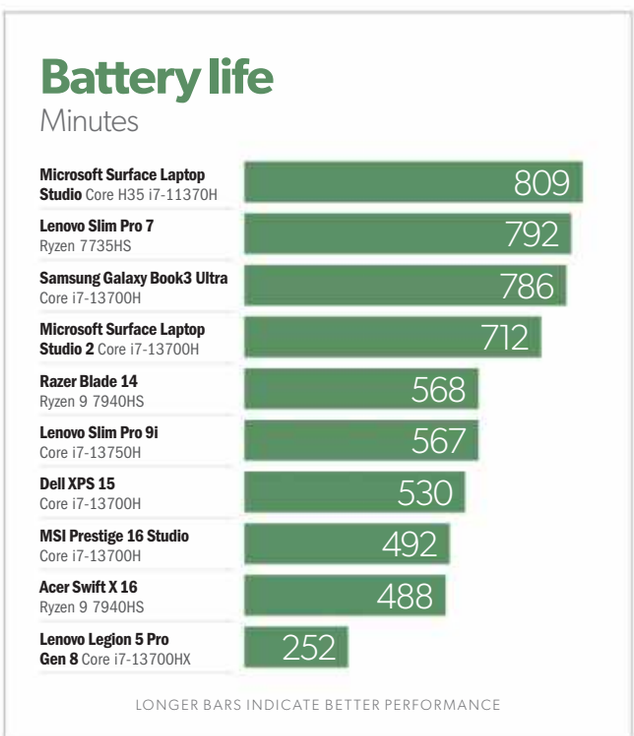
Finally, there's battery life. We loop an open-source 4K movie over and over until the



Gamers usually consider 60 fps as "playable," but you might eke out higher frame rates at lower image-quality settings.



Though 76 fps is a very playable frame rate, we expected a bit better here.



The Surface Laptop Studio 2 still has admirable battery life, even if it's not as great as before.

battery expires, with the display brightness set at a constant level.

By default, the Surface Laptop Studio 2 will adjust the screen brightness as well as tweak the content to improve battery life. We adjusted these options to create a scenario in which we turned off the brightness sensor for repeatability, but left the content options unchanged. We've also left the performance slider at its basic Recommended setting. Battery life will fluctuate based on a variety of factors, including the screen brightness, whether the laptop is connected, the activity it's performing, and so on.

Dial up the performance slider, and it transitions from zero to hero.

Historically, battery life has been a real strength of the Surface Laptop Studio. This continues somewhat with the Surface Laptop Studio 2, whose battery life falls to 712 minutes, or a bit under 12 hours. (By default, battery life was a massive 892 minutes with Microsoft's default adjustments for content and adaptive lighting, and just 528 minutes for running under maximum power.)

Even though the Surface Laptop Studio 2 has the same battery capacity as its predecessor, it's possible that the processor and GPU suck up more power than before.

BOTTOM LINE

Deciding whether the Microsoft Surface Laptop Studio 2 is right for you comes down to two key questions: Does the Surface name deserve a premium? And does the design of the Surface Laptop Studio 2, namely its pull-forward design, justify that premium? Remember that a number of competing devices might require the purchase of a separate tablet for inking, if that's important to you.

You could argue that there's no way anyone should pay $2,000 for the entry-level Surface Laptop Studio 2, which has 16GB of RAM, 512GB of SSD storage, and integrated graphics. Even with the unique design, that's a lot to swallow. But with a content creator's

The Surface Laptop Studio 2 is a nearly uniquely configured pull-forward laptop.

budget, even the higher-end Surface Laptop Studio 2 looks a lot more interesting.

The real wild card is the laptop's performance. By itself, the Surface Laptop Studio 2 simply doesn't have the performance to keep up with its cheaper competitors. But dial up the performance slider, and it transitions from zero to hero, or something along those lines.

So the Surface Laptop Studio 2 is a nearly uniquely configured pull-forward laptop with superior inking and audio, with performance that really demands that you tweak an often-overlooked Windows setting for best effect. Plus, it has 64GB of RAM. Is all that worth $3,200? I still say no, not for the majority of users. But drop down to the 32GB ($2,799) model, and you're at the price of the Dell XPS 15. You could make a case for the Laptop Studio 2 in that matchup.

So no, I'm not recommending that the average reader buy the Microsoft Surface Laptop Studio 2 we reviewed at the price it's offered for, even those in content creation.

But I still applaud the design, the performance improvements, and many of the laptop's other features. Shop smart and look for a sale, and Microsoft's flagship Surface Laptop Studio 2 becomes that much more compelling as a purchase.

Microsoft Surface Laptop Studio 2

★★★½☆

PROS

- Almost unique pull-forward display.
- Excellent content consumption experience.
- Designed for inking.

CONS

- The Surface price premium persists.
- Pen costs extra.
- AI features aren't all that yet.

BOTTOM LINE

Microsoft's Surface Laptop Studio 2 is both an overpriced content-creation laptop and an underappreciated content-consumption device with a hidden turbo boost.

$1,999

Meta Quest 3: Mixed-reality game changer

The best standalone VR headset for most people. **BY JIM MARTIN**

PCWorld EDITORS' CHOICE

If you somehow missed the announcement of Apple's Vision Pro earlier this year, you might not be aware of the current drive toward mixed reality. For the uninitiated, it's basically another name for augmented reality, which means the addition of virtual elements atop your normal surroundings.

That could be anything from a virtual screen playing a video to a plant in the corner of the room. It really doesn't matter: The important part is that you can see both your real environment as well as elements of a virtual one at the same time.

It's funny, because mixed reality isn't even remotely new. Microsoft rolled out Windows Mixed Reality six years ago and

IMAGE: META

there have been a bunch of mixed reality VR headsets you could hook up to a suitably beefy PC or laptop.

The Meta Quest 3 might sound like a mere evolution of the Quest and Quest 2, but it isn't. It's a proper game-changer because it supports mixed reality.

Where the Quest 2 and original Quest had low-resolution monochrome cameras that offered a grainy, monochrome representation of your room, the Quest 3's much higher-resolution color cameras produce an almost lifelike representation where you can walk around and interact with things just as if you weren't wearing the headset.

Almost. It isn't perfect: There's too much video wobble unless you stand still, which can make you feel queasy. Plus, quality quickly becomes grainy when the room isn't bright enough. You really need a lot of light for video passthrough to look its best.

The most obvious change from the Quest 2 is the three pill-shaped protrusions on the front of the Quest 3.

And while the main components of the Quest 3 are slimmer, they're still pretty heavy and the headset gets uncomfortable after a while. You need the headband to be tight to keep the lenses from moving around on your head and I really disliked the pressure on my cheekbones. Having tried out the optional silicone facial interface along with the Elite strap, I'd recommend making both upgrades if you find the standard Quest 3 uncomfortable.

Fortunately, the jump in graphics quality alongside mixed reality is plenty to offset the Quest 3's downsides, and they go a long way to justifying the price hike over the Quest 2.

FEATURES AND DESIGN

The most obvious change from the Quest 2 is the three pill-shaped protrusions on the front of the Quest 3. These house the cameras and a depth sensor, which are used for mixed reality.

But the front of the device is also 40 percent slimmer, which Meta says improves the weight balance on your head. The fabric strap has been slightly redesigned, too, with a y-shaped piece at the back. It's still too large for people with small heads, and the center strap still doesn't have enough adjustment to cater to those of diminutive proportions.

The orange straps pictured here are accessories.

However, it's fine if you have a normal or large head, and you can replace the strap with either Meta's own Elite one or an aftermarket one if you really can't get on with it.

My main complaint is that it's too difficult to adjust the precise fit once it's on, which is exactly what the Elite strap addresses with its dial.

As an aside, the orange and blue straps and "facial interfaces" you see in some of the photos are accessories: You cannot choose these when you buy a Quest 3.

The good news is that the IPD wheel is back. That means you can adjust the interpupillary distance while wearing the Quest 3 and it goes from 53mm to 75mm—officially, that is. The actual range is 58mm to 70mm, as shown on the on-screen display.

Meta says the 58mm setting works for people with IPD from 53mm to 63mm and the 70mm for those with pupils 65mm to 75mm apart. The range seemed to be fine for everyone who had a play with the Quest 3 that Meta sent for review, too.

As a glasses wearer, I particularly appreciate the ability to adjust the distance of the lenses from your face, with no need to fit a special insert, then remove it when

The IPD wheel (highlighted here) makes a welcome return, letting you adjust the interpupillary distance while wearing the Quest 3. The other button lets you control the volume.

someone else is using the headset. Buttons on either side allow four different settings: They're a bit fiddly to adjust, and must be done one at a time.

Speakers are built into the strap and they're fine. Not great, just fine. Because they're not actual headphones, you can still hear what's going on around you. That's great in some situations, but it ruins the immersion in others. There's not much bass, either, but spatial audio still works well.

The good news is that there's still a 3.5mm output for connecting your own headphones if you do demand better quality and total immersion.

You can also pair Bluetooth headphones, but make sure you use some VR-specific ones to avoid an audio delay that could similarly ruin the experience.

The final physical control is a volume rocker on the underside of the headset at the front.

Buttons on either side of the headset allow you to adjust the distance of the lenses from your face.

The Quest 3's controllers are more compact than before on account of not having tracking rings at the top. The headset can still track the controllers, of course, but the real benefit is that they don't bash into each other when you cross your hands over or bring them close together.

They're each powered by a single AA battery. It's a shame Meta hasn't made them rechargeable. You can upgrade to the Quest Touch Pro controllers, which *are* rechargeable, among other benefits, but the battery life is quite a lot shorter than for the regular Quest 3 controllers.

If you prefer, you can ditch the controllers entirely and let the Quest 3 track your hands. This works best in a brightly lit room where there's plenty of contrast between your hands and the walls or floor.

Hand tracking is improved with the Quest 3, so you can now interact with things using your fingers. Of course, this requires the app, game, or whatever you're doing to support that. It takes a little while to get used to controlling things with your hands, but it feels quite natural after that.

Once you've enabled hand tracking in the settings, you gently tap the controllers together twice to switch into hand-tracking mode. Using

The Quest 3's controllers are more compact than the previous model's on account of not having tracking rings at the top.

just your hands, you can bring up a quick-action menu by touching your thumb and forefinger, swipe lists of icons around, and select things by prodding them or by pinching your thumb and finger together for controls too far away to "touch."

Meta is improving the speed of hand tracking so it isn't far behind the controllers, allowing you to play more fast-paced games without lag. Plenty of titles don't support hand tracking, sadly, so you still need to use controllers for favorites such as *Beat Saber* as well as newer ones like *Les Mills Body Combat*.

Some titles, such as *Xponential+*, are exclusively hand tracked. This workout app works in mixed reality so you can see your living room, say, and place the instructor wherever you want in the room.

Another handy feature is the ability to double-tap on the side of the headband to switch between full virtual reality and passthrough. This means you don't have to take off the Quest 3 if you need a break, or if someone needs your attention briefly.

Room scanning

Yet another feature, enabled by the Quest 3's depth sensor, is the ability to automatically scan your room and detect the walls and furniture. You simply look around until the scan is "good to go," at which point mixed-reality apps understand what's where, so zombies can climb through your windows in *The Cabin*, and monsters can hide behind your sofa.

This all takes less than a minute, but it's frustrating the Quest can't store multiple rooms. If you move to a new one, the old one is deleted. That's a real pain if you go the extra mile and manually draw around each table, sofa, and shelving unit to get the most accurate mixed reality. Hopefully this is something Meta will address in a future update.

The other problem is that it only works well in rectangular rooms with flat ceilings.

Many are, but if yours isn't, as some of mine aren't, then it ruins the immersion when monsters burst in through a nonexistent ceiling or wall.

PERFORMANCE

The Quest 3 makes a massive leap in terms of graphics quality. If it's your first VR headset, you won't appreciate just how much of an improvement it is. Although resolution isn't quite 30 percent better than the Quest 2, everything is noticeably sharper and text is much easier to read.

And if you're coming from the original Quest, it's a completely different league. Where details were fuzzy and indistinct, they're clear and precise in the Quest 3. Again, there's an element where developers need to optimize their apps and games for the new headset, but much of the time it's an automatic improvement, so games you might already own, such as *Beat Saber*, simply look better on a Quest 3.

Each eye sees a resolution of 2064×2208, up from 1832×1900 in the Quest 2. The original Quest had a per-eye resolution of 1440×1600, and was limited to a 72Hz refresh rate. The Quest 3 goes up to 120Hz, although as with the Quest 2, that's still currently in the experimental phase and requires apps to support it.

Resolution and refresh rate are only a tiny part of the story, too. With a field of view around 15 percent wider than that of the Quest 2, Meta's latest headset lets you see more of your surroundings. It feels more natural, and I barely ever noticed that my peripheral vision was restricted, something that happened fairly frequently on the original Quest (and the original Oculus Rift).

Quest 3's superior graphics quality makes objects on the Quest 2 look flat and unrealistic in comparison.

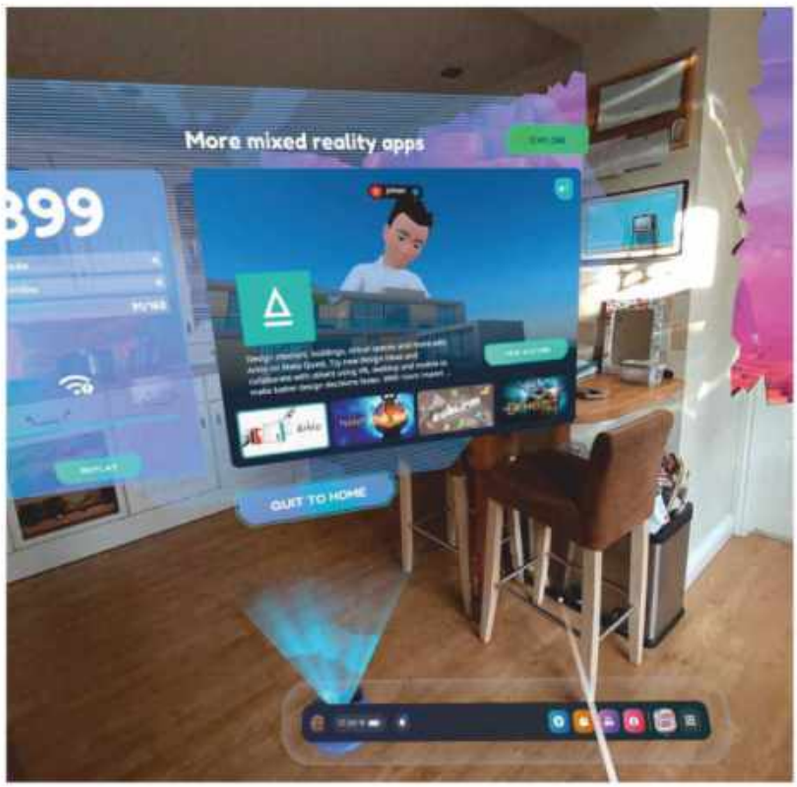
Arguably more important than this is Qualcomm's Snapdragon XR2 Gen 2 processor, the other major upgrade in the Quest 3. It packs a new GPU with twice the performance of the Quest 2's GPU. It should be obvious that higher-resolution screens and higher refresh

rates need more processing power, but that isn't all the extra grunt is useful for.

It's also needed to support the full-color, high-resolution passthrough video that provides mixed reality, but crucially it also enables much better-quality graphics.

In specially prepared demos, I was able to press a button on the controller to switch between the Quest 3's visuals and an emulation of the Quest 2. Reader, the difference was night and day.

To put it simply, the Quest 3's graphics quality makes objects on the Quest 2 look flat and unrealistic. They're much more detailed with dynamic lighting and shadows, much improved texture quality, and more. These upgrades make a big difference in enhanced titles such as *Red Matter 2*.



Meta's latest headset lets you see more of your surroundings.

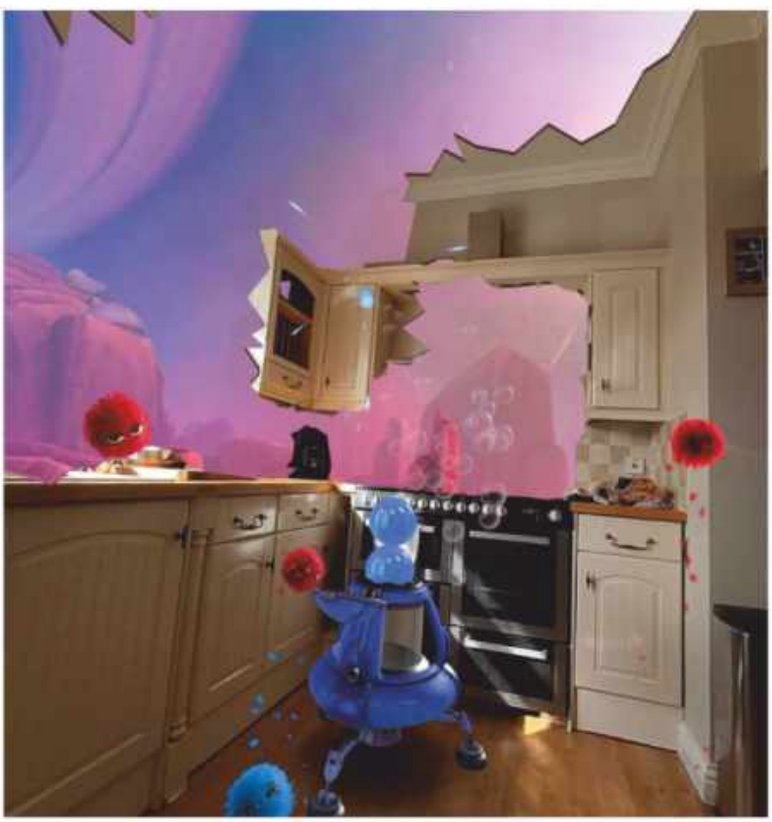
Developers don't need to do anything for the Quest 3 to render their apps at its higher resolution, but they do need to update them to take advantage of features like dynamic lighting.

Although there's only 2GB more RAM than in the Quest 2, this doesn't seem to be a limitation for the Quest 3, at least in the games and apps I tried out. Loading times were generally acceptable, with the vast majority taking just a few seconds.

Right now, there aren't very many mixed reality games. Meta promised 50 at launch, but that seems optimistic: There certainly weren't anywhere near 50 in the store the day before the headset's release. Some of them are Quest Pro apps for business use, which won't appeal to consumers.

It's likely to be a chicken-and-egg situation where developers are waiting until the hardware is in people's hands before spending money updating existing titles for mixed reality or creating new ones. Either that, or they're just late to the game. It doesn't matter much: The fact is, only a handful of games (including demos like *First Encounters*) support mixed reality.

Right now, there aren't many mixed reality games.



We were impressed by the *First Encounters* demo.

COMFORT AND BATTERY LIFE

It's worth addressing one of VR's biggest problems: comfort. I've already talked about the physical aspect, but there's also the fact that VR causes some people to feel sick.

The Quest 3 doesn't really change anything here: The issue is the disconnect between what your eyes are seeing and what your body feels. That's why it's a terrible idea to choose a rollercoaster app or video for your first experience.

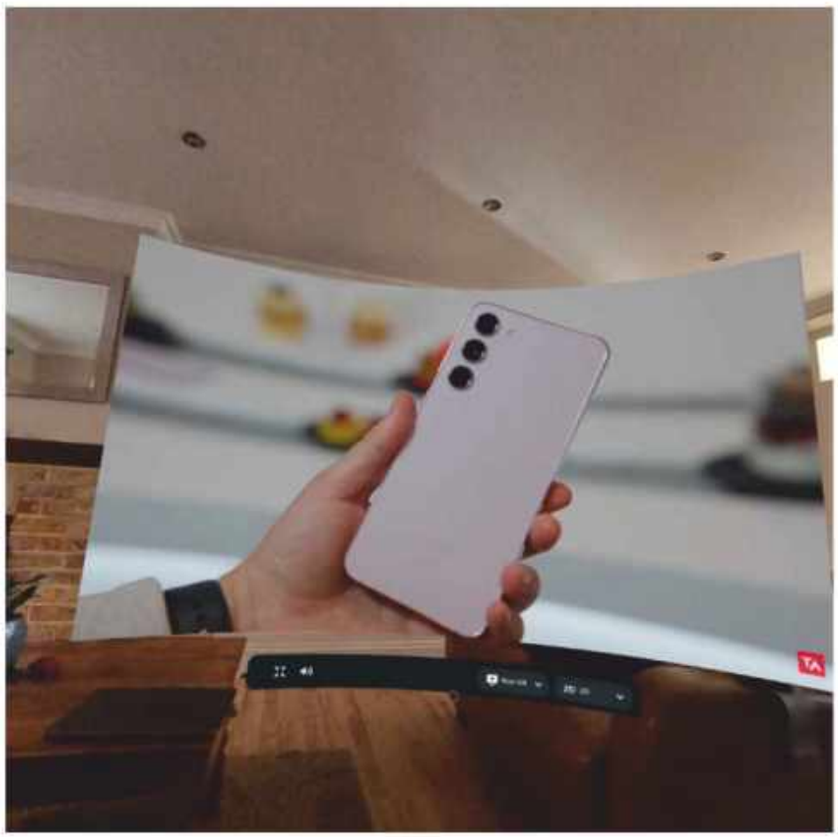
Apps and games are marked in the store so you know if they're "comfortable" or not. With mixed-reality apps, the comfort level is generally much better because you can see the room you're in, and it doesn't move or shift position.

You can move around in it—brilliant in the *First Encounters* demo—without feeling nauseous. The problem, as mentioned earlier, is the quality of passthrough video. It's impressive that everything is in the "right" place: You can pick up your coffee and drink it and avoid furniture just as you would if you weren't wearing a headset.

The trouble is that the video does sometimes jerk and stutter, as well as bend, warp, and wobble. It's

worse if there are objects both close and far away from the cameras in your line of sight. For example, if you're in a room where a door is open and you can see into another room, objects far away can wobble and bend. It might be only for a second or even a fraction of a second, but it's enough to make you feel queasy. My advice is to avoid walking around your home and stay in one place, preferably in a room with the doors closed.

If you want to watch videos in mixed reality, either you'll need an app that supports it or you'll have to use the built-in browser and head to a website such as YouTube. I found the Netflix app hadn't been updated for the Quest 3 and was still showing the Quest 2 controllers, although this was pre-launch. Hopefully Netflix will update the app to support MR.



If you want to watch videos in mixed reality, either you'll need an app that supports it or you'll have to use the built-in browser and head to a website such as YouTube (pictured here).

The improved resolution makes it much more enjoyable to watch videos: In full-screen mode, they appear as a massive curved display in front of you. I wouldn't watch a movie, though, because the Quest 3 just isn't comfortable enough.

Battery life should be good enough for most movies, however, at around 2.5 hours. Exact battery life will vary depending upon what you're doing with the headset, but I found it was in line with Meta's claims.

An 18W USB-C charger is included in the box, but it's hardly fast charging, taking around two hours to go from empty to 100 percent.

PRICE

As you probably know only too well, the Quest 3 costs $499. If history is anything to go by, don't expect to find any significant discounts even a year down the line. You can buy it from Meta (fave.co/46ORSrP), as well

as other retailers. Here's where to buy a Quest 3 (fave.co/3FfRuqO).

This means it's $200 more than a Quest 2. That's a big difference, but it's certainly worth it.

Most people should be okay with the base 128GB model, as that's enough to install plenty of games at the same time. Most VR games are a couple of GB at most, so it's probably not worth paying $649 to have 512GB.

BOTTOM LINE

The Quest 3 is one of the easiest devices to recommend, even if you already have a Quest 2. I would say there's at least the same leap in quality between the Quest 2 and Quest 3 as there was between the Quest 1 and Quest 2.

Sure, there's still room for improvement. In a perfect world, the Quest 3 would be lighter, more comfortable to wear for long periods, and last even longer between charges. The other criticism, and almost certainly something Meta will improve on the Quest 4, is the resolution and quality of passthrough video. It's good, but it's not stunningly lifelike.

Similarly, and I've deliberately left this until the very end, there's the absence of eye tracking. That's something found on the Quest Pro, Apple's Vision Pro, and the PSVR2. It isn't a feature of the Quest 3 for a number of reasons, but the real question is: Does it matter? As far as I'm concerned, it's a nonissue. The Vision Pro uses eye tracking for control and interaction, but it's understandable that the much cheaper Quest 3 relies on controllers and hand tracking instead.

The other main use of eye tracking is for foveated rendering: making only the portion of the image you're looking at look really good and rendering less detail in other areas. However, as I've already said, I have no complaints about the Quest 3's graphics quality.

Ultimately, it's still early days for VR and mixed reality, and even the Quest 3 is a long way from how good this tech will become. Right now, with current technology being what it is, the Quest 3 is still pretty remarkable for the money. If you can afford it, you should buy one right now.

Meta Quest 3

★★★★½

PROS

- Mixed reality is great fun.
- Big step up in graphics quality.
- Much cheaper than the Apple Vision Pro.

CONS

- Not many mixed reality titles…yet.
- Not as affordable as the Quest 2.
- Video passthrough could be better.

BOTTOM LINE

With night-and-day graphics upgrades and the addition of mixed reality, the Quest 3 justifies its higher price. There's enough here to even recommend that Quest 2 owners upgrade.

$499

Samsung T9 portable SSD: Rugged outside, fast inside

With its highly grippable sleeve, the T9 is a luxe-feeling portable SSD drive that will never slip out of your hand. **BY JON JACOBI**

PCWorld EDITORS' CHOICE

The latest in a series of excellent portable SSDs that started around eight years ago with the T1, Samsung's T9 is the first to bring SuperSpeed USB 20Gbps performance to the table. If you're blessed with such a port (nee USB 3.2 2×2), it will nearly double the sustained throughput of the older T7. (Only odd numbers are used in Samsung's numbering for the series.)

Alas, compared to other 20Gbps drives, the T9 is merely a middle-of-the-pack

IMAGE: SAMSUNG

Samsung's SSD utility provides information on the drive status as well as the ability to enable or disable password protection.

performer. But it also provides the most luxe tactile experience of the pack with its textured surface and sculpted lines.

FEATURES

The Samsung T9 is a 20Gbps USB SSD that uses NVMe internals and sports a USB Type C port for connectivity. Samsung provides both Type-A to Type-C and Type-C to Type-C cables.

The SSD measures 3.46 inches long by 2.36 inches wide and 0.55 inches thick. It weighs in at a mere 4.3 ounces. The internals are definitely NVMe-based as SATA could never surpass 550MBps, let alone achieve the nearly 2GBps the T9 is capable of.

Samsung was mum about the controller and actual drive inside, but if I had to guess, I'd go with a 970 Evo Plus or an update on that given the price and performance, which you can read about below.

A cross-platform utility is provided by the company to turn password security on and off. The utility is required to access the drive when the password protection feature is enabled.

As for the T9's textured, sculpted countenance (see the lead photo), it makes the drive feel very nice and provides a sure grip both in the hand and while it's rested on a smooth surface. The downside to the texturing, however, is that the drive

The retail box for the 2TB T9 we tested.

collects dust, lint, and other schmutz at a near-record pace. Tidying it up for the photos was a bit of a chore.

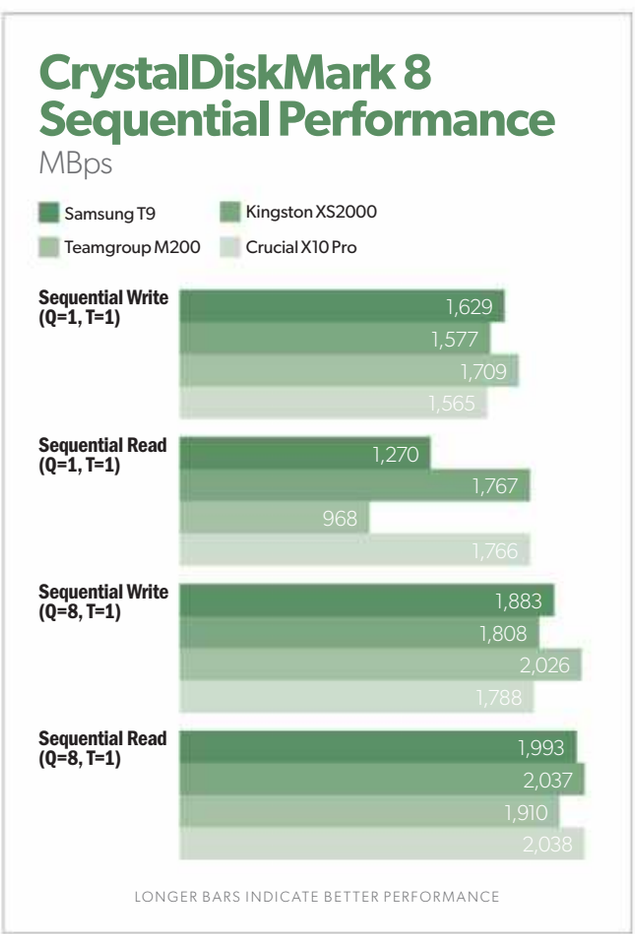
The T9 is warrantied for five years, though no TBW ratings (terabytes that may be written) were provided. In our experience, given reasonable usage, vendors will honor the warranty time period regardless.

PRICE

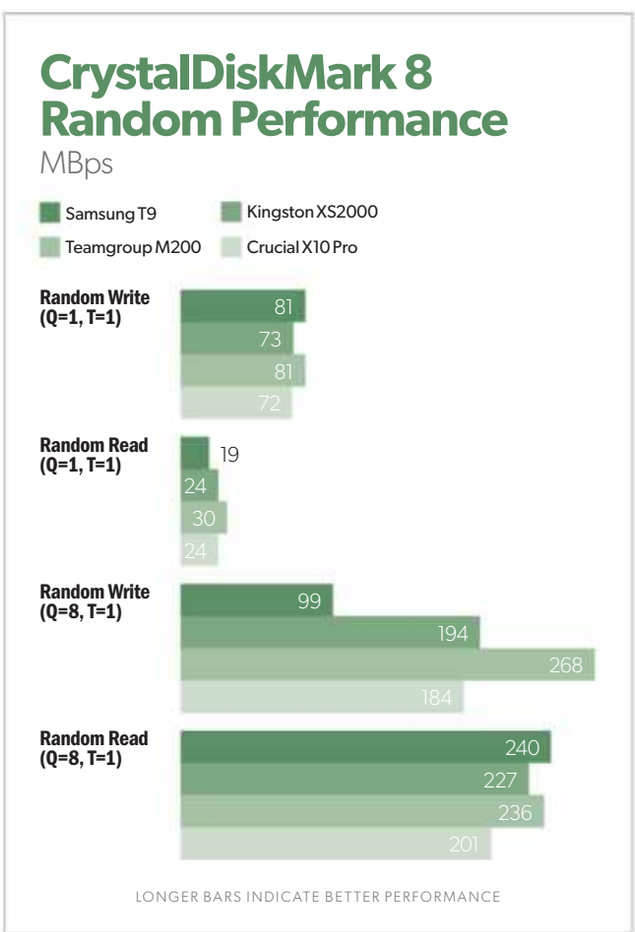
The T9 will be available in 1TB, 2TB, and 4TB capacities for $140, $240, and $440, respectively, at the time of this writing. Those are the MSRPs provided by the company. You may see different prices online. Note that some unscrupulous online sellers will try to charge considerably more when drives are brand new and in demand.

PERFORMANCE

The T9 is a performance leap beyond the 10Gbps T7 Touch (fave.co/3wx2D1J) and T7 Shield (fave.co/3S10p6P) we've reviewed. But it's not close to the fastest 20Gbps SSD we've tested. That would be the mighty Crucial X10 Pro (fave.co/48mS7fC).



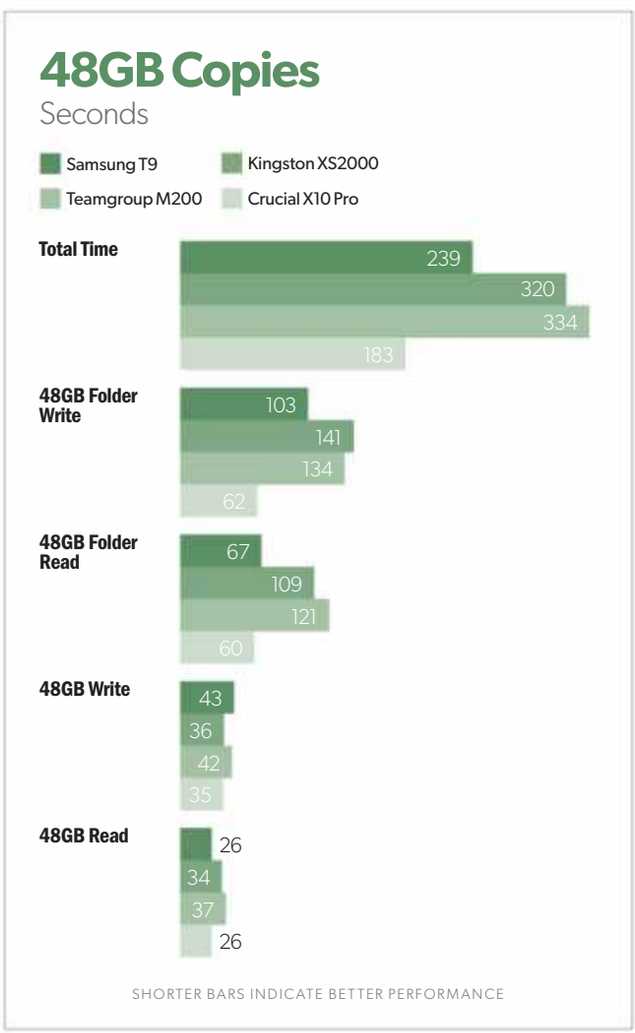
The Samsung T9 was up and down in these tests, but good overall.



Again, the T9 was fast in two 4K tests and off the pace in two others.

As you can see below, the 2TB T9 we tested turned in good, if not stellar, CrystalDiskMark 8 scores. Sequential performance was a bit up and down, but quite good overall.

The T9 was again a mixed bag with CrystalDiskMark 8 4K performance. It was aces at the 32-queue read, but the single-queue read and 32-queue write were noticeably lacking in oomph.



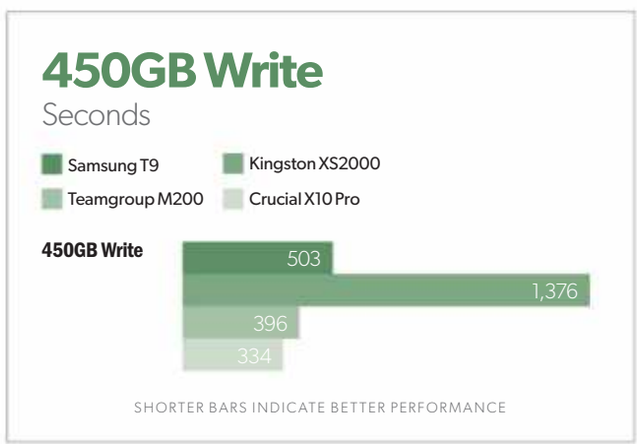
When it came to real-world 48GB transfers, the T9 was only slower than the Crucial X10 Pro.

Where the T9 dominated over the Kingston XS2000 and Teamgroup M200 was in our 48GB transfers. It shaved almost 100 seconds off those drives' times in the aggregate.

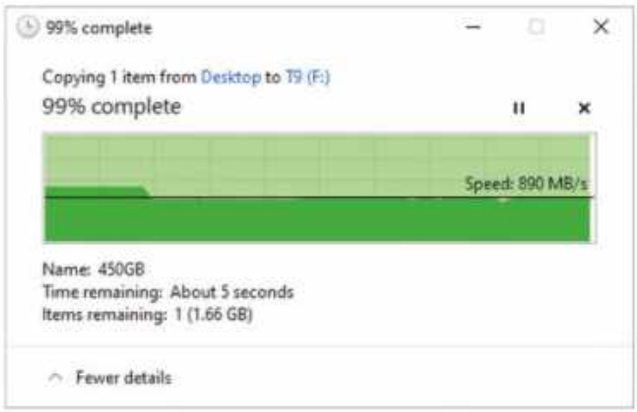
The T9 took third place among the 20Gbps drives in the 450GB write. While its time of 8 minutes and 23 seconds wasn't great, it wasn't as tragic an outcome as the Kingston XS2000's lowly performance. The T9 turned in a decent enough score, reflecting an overall write rate of around 900MBps.

Although it was not the fastest external USB SSD out there, the T9 is no slouch, and we really like its 48GB transfer times.

Samsung touts the T9's low power usage and thermal output. While the drive was warm after our testing, it was in no way uncomfortable to touch—another plus for the silicon sleeve.



This isn't a fantastic 450GB write time, but we've seen much worse, as with the Kingston XS2000, which absolutely tanks in this test.



Once secondary cache was exhausted, the T9 still maintained a decent transfer pace for our 450GB write of nearly 900MBps.

BOTTOM LINE

We appreciate Samsung's history of delivering fast, reliable external USB SSDs. We've come to regard these drives as something of a standard. However, at the time of this writing, Crucial's 4TB X10 Pro is only $290 (fave.co/3PWqmSw), making the T9 seem overpriced. This may change rapidly. Regardless, if you opt for the T9, it will get the job done, and in luxe fashion.

HOW WE TEST

Drive tests currently utilize Windows 11 (22H2) 64-bit running on an X790 (PCIe 5.0) motherboard/i5-12400 CPU combo with two Kingston Fury 32GB DDR5 modules (64GB of memory total). Intel integrated graphics are used. The 48GB transfer tests utilize an ImDisk RAM disk taking up 58GB of the 64GB total memory. The 450GB file is transferred from a Samsung 990 Pro 2TB, which also contains the operating system. For external drives, the motherboard's dedicated Thunderbolt 4 and 20Gbps USB ports on the rear panel are used. Each test is performed on a newly formatted and TRIM'd drive so the results are optimal. Note that as any drive fills up, performance will decrease due to less NAND for secondary caching, and other factors.

The performance numbers shown apply only to the drive we were shipped as well as the capacity tested. SSD performance can vary by capacity due to more or fewer chips to read/write across and the amount of NAND available for secondary caching (writing TLC/QLC as SLC). Vendors also occasionally swap components.

If you ever notice a large discrepancy between the performance you experience and what we report (systems being roughly equal), by all means let us know.

Samsung T9

★★★★½

PROS

- Good performance.
- Textured, sculpted surface provides a good grip.
- 5-year warranty.

CONS

- Pricey.
- Surface tends to grab dust and detritus.

BOTTOM LINE

Once the price drops a bit, this high-quality, luxurious-feeling, high-performing external 20Gbps USB SSD will no doubt be one of our favorites.

From $140

Asus Chromebook Plus CX34: The future of Chromebooks?

The Asus Chromebook Plus CX32 makes quite the impression with its minimalist design, strong performance, and 1080p webcam. **BY ASHLEY BIANCUZZO**

Back in the day, Chromebooks were nothing more than low-powered machines that ran a web browser as your operating system, an extension of Google Chrome if you will. They were durable and largely virus-free, making them a popular choice in the educational market. Nowadays, they're capable of cloud gaming, which I never thought I'd see. Well, Google gave us whiplash once again with the new Chromebook Plus (fave.co/3QevGBY) line of laptops. These devices promise better performance, 1080p webcams, AI-powered apps, and more. That's where the Asus Chromebook Plus CX34 comes in. It's a real game changer as far as cloud-based machines go.

IMAGE: ASUS

The Asus Chromebook Plus CX34 puts a lot on the table. The hardware is more powerful than your typical standard fare, the screen is bright, and the color scheme is to die for.

It has all the markers of an expensive machine without actually being one. In fact, it has a starting price of $399.99, making it more accessible to people with varying budgets. Not everybody (hi) can shell out a thousand dollars for an everyday laptop that both performs well and looks good. Read on to learn more.

SPECIFICATIONS

The Asus Chromebook Plus CX34 is available in a number of different configurations. Our review unit comes equipped with an Intel Core i3-1215U CPU, 8GB of RAM, and 128GB of SSD storage. It's a modest amount of power, but great for a Chromebook, and it's designed with everyday tasks in mind.

CPU: Intel Core i3-1215U

Memory: 8GB RAM

Display: 14-inch 1920×1080, nontouch

Storage: 128GB SSD

Webcam: 1080p

Connectivity: 2×USB 3.2 Gen 1 Type-C, 2×USB 3.2 Gen 1 Type-A, 1×HDMI 1.4, 1 mm×3.5 mm audio combo jack

Battery capacity: 50 Wh

Dimensions: 32.64 cm×21.44 cm×1.87 cm

Weight: 3.17 lbs

Price: $399.99

AI CAPABILITIES

Generally speaking, I'm semi-resistant to using AI, as I'm troubled by the ethical problems with AI-generated artwork. That said, the one AI feature I wanted to try for the sake of this review is not available yet, and that's the AI wallpaper generator. Already available on Google's Pixel 8 devices, all you have to do is select a category and then type whatever you want into the text fields to get the specific result you're looking for. It's definitely interesting, but I wasn't able to test-drive it for this review.

DESIGN

When I removed the Asus Chromebook Plus CX43 from its snow-white box, I found myself repeatedly running my hands over

The pearl-white color scheme is chic and minimalist.

the glossy lid, oohing and aahing at the silky smoothness of it. It definitely feels more expensive than it really is. The 180 degree hinge that connects the display to the keyboard feels tight and secure, even when adjusting it a click or two. No floppy displays here! The keyboard deck is solid as well. I pressed down hard on the deck with both hands and noticed zero creaking, which is always a sign of a well-made machine.

Let's talk for a second about the pearl-white color scheme, which I absolutely adore. It's definitely chic and minimalist, but it's not so over the top that it'll draw much attention. In fact, I'd say it's the perfect look for an office environment, as it's really sophisticated. The dark-gray keys also nicely balance the white chassis.

We were impressed by the display's rich colors.

The vent placement adds an interesting touch to the overall design, too. Unless you turn the laptop upside down, you'll probably miss it, but there are three vents of varying lengths on the bottom of the machine. It's cool and stylish, but likely practical too.

DISPLAY, WEBCAM, AUDIO

The first thing I noticed about the Plus CX34's 1080p display is the brightness level. Normally, I like to bump the brightness up on laptops because I'm a goblin in a human suit and I like to operate in darker environments. However, the display on this particular machine is very bright, even when it's at 50 percent. It definitely seems brighter than Asus' reported 250 nits. It's not ideal for outdoor use, but that's not really a deal-breaker for me. As for colors, they're surprisingly rich! When I watched the final episode of *Ahsoka*, the crimson cloaks the night sisters were wearing were both deep and luscious.

The Asus Chromebook Plus CX34 comes with a 1080p webcam, which excites me to no end. All of the new Chromebook Plus laptops have 1080p webcams. I'm so over 720p webcams, as they're just not sharp enough for

The Asus has a good selection of ports.

remote or hybrid workers. As for image and video quality, it's relatively color accurate and I didn't appear washed out or overexposed. I work from home on a regular basis, so having a webcam that can capture clear video is important, especially when I have to hop on a work call.

The audio, however, left me wanting more. The Asus Chromebook Plus CX34 has downward-firing speakers, which means the sound is going into either the table or your lap (depending on where you're using the machine). It's fine if you're watching YouTube or a show on Netflix, but for listening to music, in which there's a lot of highs and mids, it's just okay. I could hear most things when the volume was turned up to 50 percent.

That said, I'm not too picky when it comes to laptop audio. If I can hear the show I'm watching without having to turn the volume up all the way, I'm good. The Asus Chromebook Plus CX34 is sufficient in this regard.

CONNECTIVITY

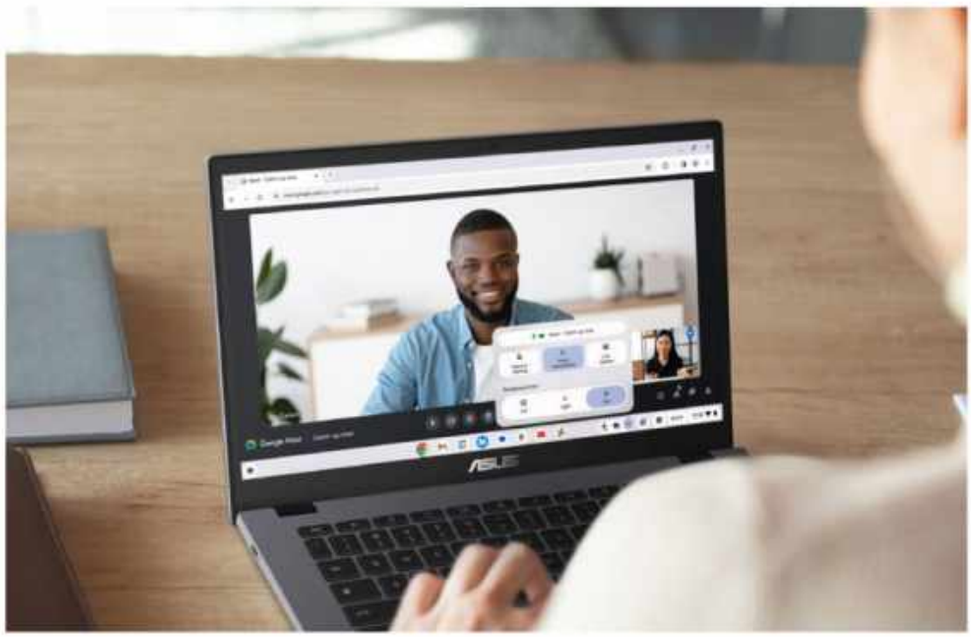
The Asus Chromebook Plus CX34 features two USB 3.2 Gen 1 Type-C ports, two USB 3.2 Gen 1 Type-A, one HDMI 1.4, and one 3.5 mm audio combo jack. That's a good selection right there, especially if you're looking to hook up to an external mouse and display. You probably won't need to tote around an adapter, either. It has enough connectivity options for most people.

KEYBOARD, TRACKPAD

All I have to say about the typing experience is…wow! I've never acclimated to a new

All I have to say about the typing experience is…wow!

keyboard so fast, which is really saying something. I'm a blazing-fast typist. That's not a flex, as I tend to make a number of typing mistakes, especially when I'm excitedly blabbering away with coworkers on Slack or with my husband on Discord. I don't adjust to new keyboards well, but that's not the case with the Asus Chromebook Plus CX34. The keys feel nice and springy underneath my fingertips. There's 1.4 mm of key travel and anti-ghosting, which means you can press multiple keys at once and they'll all register. Honestly, the keyboard felt like home to my fingers.



The Chromebook Plus CX34 is a powerful, reasonably priced laptop.

The touchpad is easy to use as well. It measures a roomy 5.7 inches and is centered in the middle of the keyboard deck, which I prefer over the asymmetrical variety. There's nothing more aggravating to me than an off-center touchpad (I'm looking at you, gaming laptops!). I didn't notice many misfires, as my palms didn't seem to drift over to the corners of the touchpad all that much. This is a problem I regularly have with those pesky off-center touchpads. The surface on the Asus Chromebook Plus CX34's touchpad feels smooth as glass, and it registers both multi-touch swipes and clicks just fine.

PERFORMANCE

The Asus Chromebook Plus CX34 offers reliable performance, especially if you're using it for day-to-day tasks like checking e-mail and watching Netflix. In real-world use, I found it to be very snappy overall. Whenever I booted up the machine or jumped from tab to tab in Google Chrome, it only took a few seconds (if that). That's likely due to the Intel Core i3-1215U processor, which has six cores and eight threads as well as a maximum turbo frequency of 4.40 GHz. An Intel Core i5 or higher will be even faster, but it's still fast and better than the lower-end processors found in standard Chromebooks.

Here's how the Asus Chromebook Plus CX34 fared in the five browser-based benchmarks.

CrXPRT 2: 181

Speedometer: 114

Basemark Web 3.0: 1111.74

Kraken: 466.5ms

Jetstream 2: 250.141

The Asus Chromebook Plus CX34 smoked the comparable Asus Chromebook CM34 Flip (fave.co/3rS464e), which has an AMD Ryzen 3 7320C CPU. In the Speedometer benchmark, which measures the responsiveness of web applications, the Plus CX34 earned a score of 114, beating out the CM34 Flip's score of 73.3. The Plus CX34 also earned a higher performance score of 181 in CrXPRT 2, which measures how well the Chromebook handles everyday tasks like watching movies or doing homework. Overall, it's speedier and more responsive than the CM34 Flip.

BATTERY LIFE

The CX34 lasted just over 12 hours during the web-based battery benchmark, a modest result. While it's not as record-breaking as the Acer Chromebook CM34 Flip's 19 hours of battery life, it's still quite good, especially if you travel often or (if you're a student) like to take your laptop to class with you. You don't have to worry about the Asus Chromebook Plus CX34 losing juice anytime soon,. You could probably squeeze more hours out of it if you turn down the brightness.

BOTTOM LINE

Should you buy it? Definitely! What it boils down to is this: The Chromebook Plus CX34 is a powerful, reasonably priced everyday laptop. The pearl white minimalist chassis is beautiful and sophisticated, and the 1080p display is lovely to binge watch your favorite shows on. The keyboard is effortlessly easy to get used to, and the 1080p webcam will make you look good on work calls. Plus, battery life is just over 12 hours, and performance is both zippy and reliable. While the audio could definitely be better, a criticism I have of most laptops, it wouldn't dissuade me personally from buying this laptop.

The Asus Chromebook Plus CX34 is an exciting debut for the new Chromebook Plus concept—and it shows that even with all these extra bells and whistles, a very nice Chromebook doesn't need to break the bank.

Asus Chromebook Plus CX34

★★★★☆

PROS

- Beautiful design and color scheme.
- Reliable performance.
- 1080p webcam.

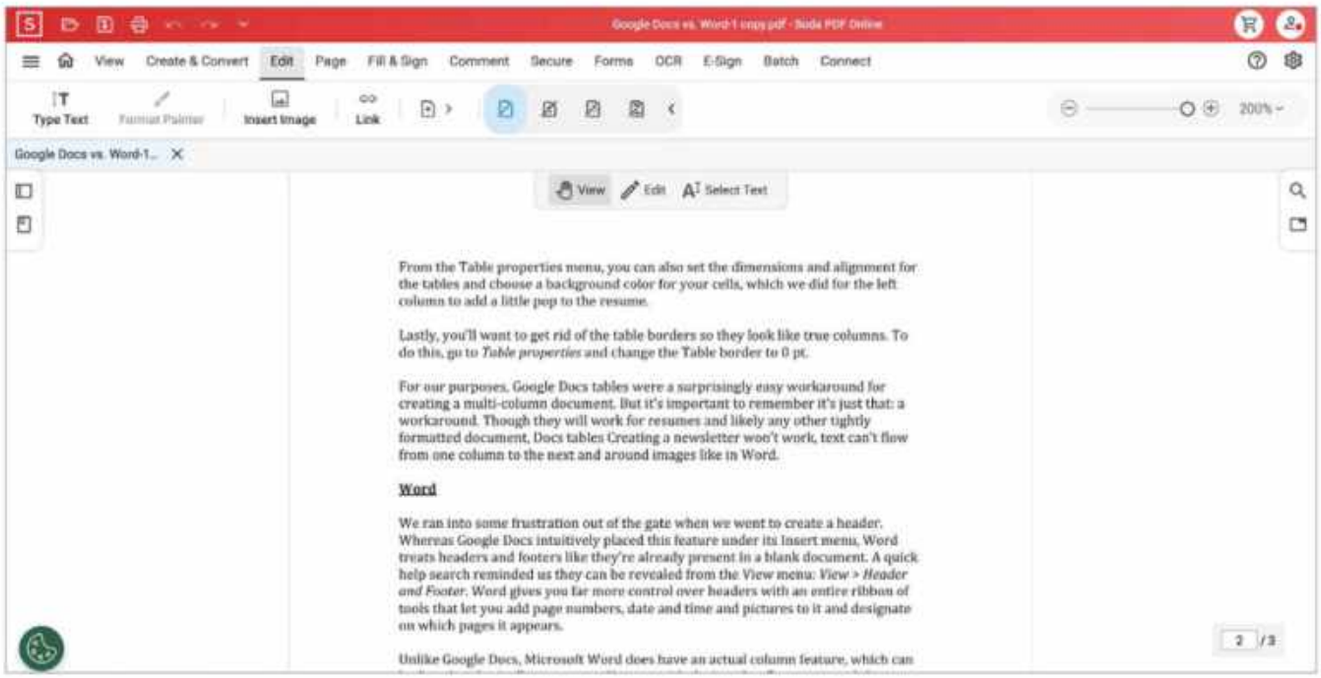
CONS

- Weak audio
- Average battery life for a Chromebook.

BOTTOM LINE

The Asus Chromebook Plus CX34 offers reliable performance, a 1080p webcam, and a stunning design at a reasonable price point. What more could you ask for?

$399



Soda PDF Online review: A PDF editor for any device

The web-based editor allows you to work with PDF documents on PCs, Macs, tablets, and smartphones. **BY MICHAEL ANSALDO**

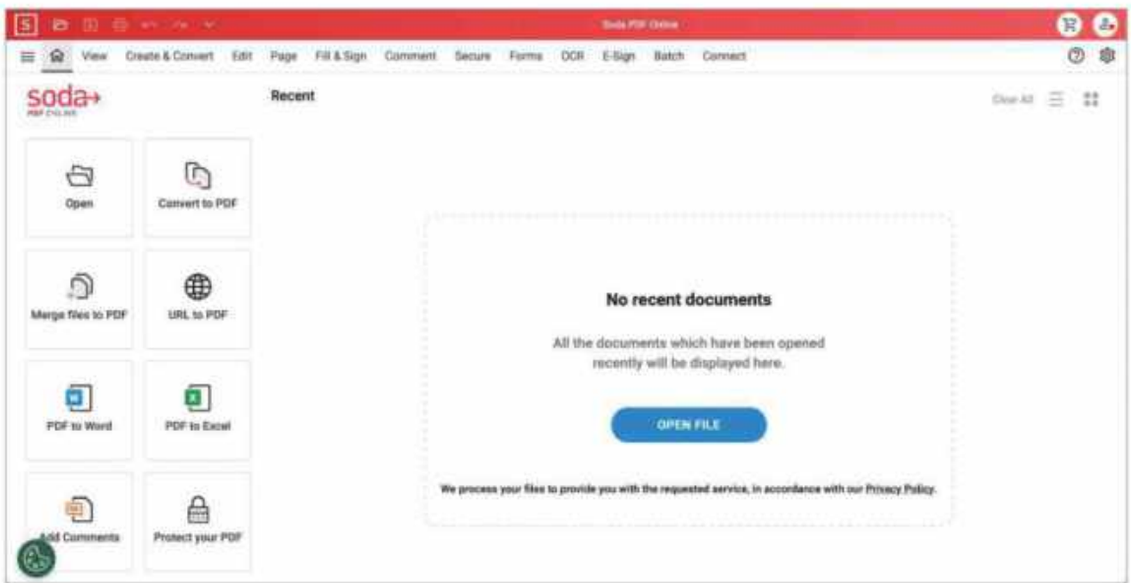
PCWorld EDITORS' CHOICE

Although we live and work in a multiplatform world, PDF editors still tend to be Windows-only affairs likely due to the software's origins as a "business" tool. Online PDF editors can often fill in the gaps for Mac users and those who work with PDFs on the fly via mobile devices. Soda PDF Online is one of the best of these, offering a complete suite of PDF tools in a user-friendly, platform-agnostic package.

Soda PDF Online is a subscription service (fave.co/3tFzOC9) offered in two basic tiers. A Standard license provides the essential tools for viewing, creating, converting, and editing PDF documents for $12 a month or $84 a year. The Pro tier adds OCR searching, e-sign software, form and commenting capabilities, and batch processing options for $15 a month or $87 a year. A third Business tier adds phone support, flexible deployment options, and self-serve plan management for $20 a month or $198 per year. Soda offers a free 14-day trial with all features enabled.

To get started, you just have to point your preferred browser to fave.co/46v9qd3 and

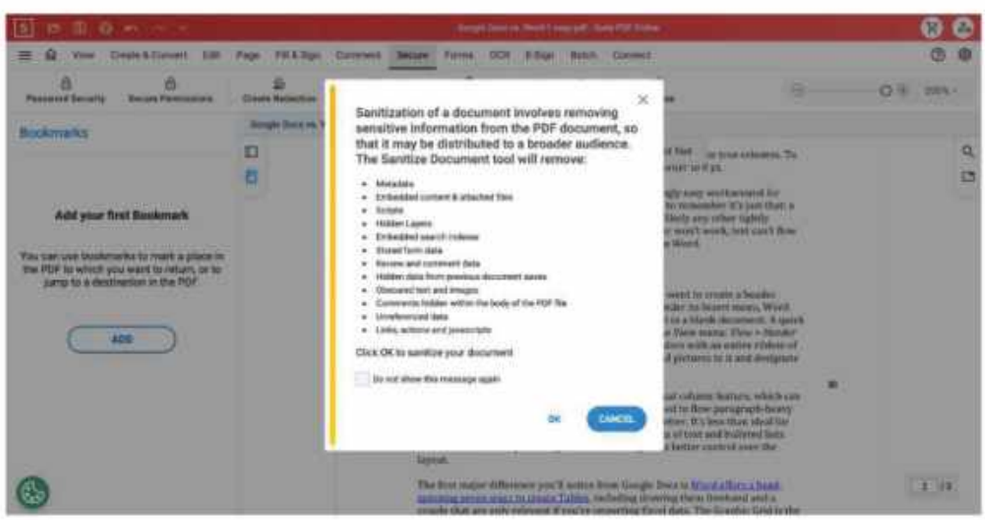
IMAGE: FOUNDRY



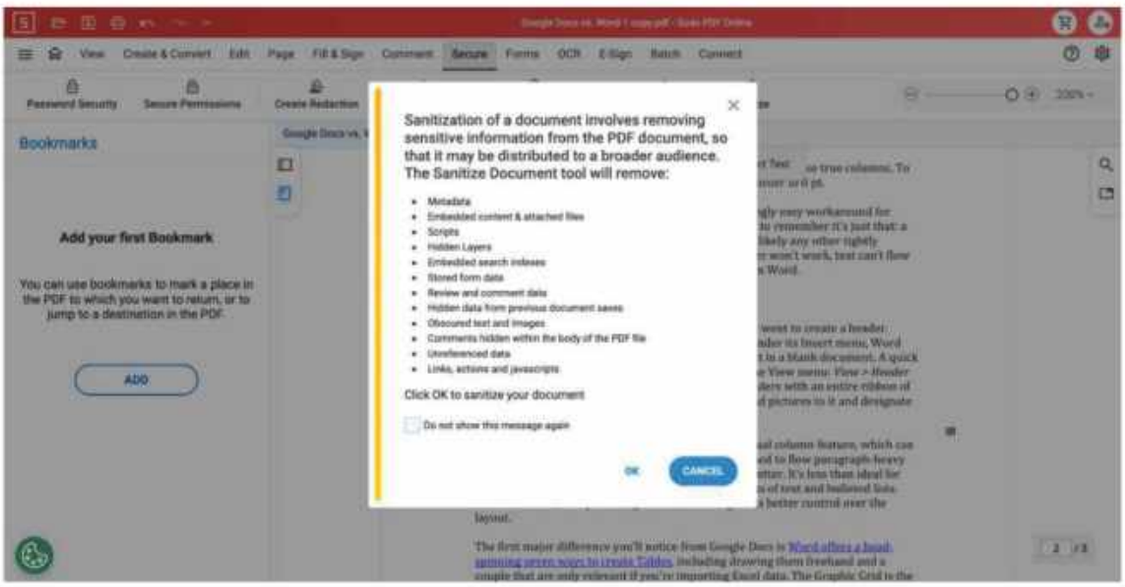
You can perform a selection of quick tasks from Soda PDF Online's home page.

select Start Free Trial, which launches you directly to Soda PDF's Home page. Down the left side of the page are two vertical rows of tiles that let you perform quick tasks such as securing a PDF file or converting one to a Microsoft Office format. Along the top, an Office-style ribbon interface groups tools across a dozen tabs that are labeled to indicate their various functions—View, Create & Convert, Edit, and so on. Clicking on a tab opens a submenu of corresponding tools. The interface looks similar on both tablets and smartphones, with some slight modifications to fit the smaller screens.

Opening a document in Soda PDF is as simple as locating the file on your hard drive or in a connected cloud folder via a provider like Google Drive or DropBox. Once the file opens a second smaller toolbar with three buttons—View, Edit, and Select Text—appears at the top of the document pane. Essentially, it surfaces these common tasks separately from the main toolbar to allow you to make quick



Soda PDF Online offers a full set of annotation tools, including sticky notes.



The sanitization option removes all sensitive information from your PDF document with a single click.

changes without having to toggle between multiple tabs and submenus.

To make more extensive changes to a PDF, you'll need to dig into the Edit tab. From here you can add text, images, and links to your document; insert page numbers; and add headers, footers, and watermarks.

Soda PDF Online lets you do more than just manipulate the content of your PDFs, though. It offers a full set of annotation tools, including the ability to highlight text, add shapes and stamps, and comment in the form of sticky notes. It can be used to design and fill in forms. You can secure sensitive documents through password protection, text redaction, and "sanitization," a one-click function that removes all sensitive information from the document, including annotations, links, metadata, and more. And naturally, you can convert existing documents to PDFs and create PDFs from scratch.

Overall, I was impressed with Soda PDF Online's extensive tools and intuitive interface, and I like that its tiered pricing takes into account that not every user will need every capability it offers. If you work a lot with PDFs on a variety of devices, a Soda PDF subscription is well worth the money.

Soda PDF Online

★★★★½

PROS

- Compatible with any device and platform.
- Well organized with extensive tools.
- Affordable subscriptions.

CONS

- Requires Pro subscription for some tools.
- Only zooms to 200%, which may not be enough for some documents.

BOTTOM LINE

Soda PDF Online is a well-designed web-based editor with everything you need to work on PDFs from any device.

From $12 per month

Ugreen 9-in-1 USB-C dock: Terrific value, but BYO power supply

You'll be impressed by this affordably priced DisplayLink dock. **BY MARK HACHMAN**

PCWorld EDITORS' CHOICE

Ugreen's 9-in-1 USB-C docking station (fave.co/45wZDIk) is typical of the brand: quality design and manufacture, obtuse naming, and pricing that seems to vary from one vendor to the next. Oh, and nowhere on this DisplayLink dock is any indication that it uses DisplayLink, either.

If you found the dock on Ugreen, the company calls it the "Ugreen 9-in-1 4k HDMI Fast Charge Universal Docking Station" and refers to its product number, 90912. On the box, the dock is called the "9-in-1 USB-C Docking Station (CM615)." Amazon calls it the "Revodok Pro." eBay sellers, naturally, refer to it as something completely different. They're all the same dock, and it's worth hunting it down.

Ugreen's dock is a DisplayLink dock (fave.co/3EJLvuc), which falls between the raw power of a Thunderbolt dock and the budget price of a USB-C dongle or hub. We consider them to be "tweener" devices, straddling both categories, and so our DisplayLink reviews tend to fall in both our list of the best Thunderbolt docks (fave.co/3vtA0BE) and

IMAGE: UGREEN

the best USB-C dongles and hubs (fave.co/30z4JBG). (Ugreen seems to want to position this dock as a USB-C device.) Put simply, a DisplayLink USB-C dock usually delivers the capabilities of a Thunderbolt dock—or support for two displays at 4K resolutions—at a lower price.

What Ugreen doesn't really tell you on the box is that it's a DisplayLink dock, and a software driver is mandatory for the product to work. For that, you'll need to read the manual carefully and download the driver from Synaptics, the manufacturer whose silicon powers the Ugreen dock itself. The documentation is there, but it's poorly spelled out.

In this case, Ugreen's dock compares favorably to one of our favorites, the Plugable UD-6950PDH (fave.co/3PW75Rm), with slightly fewer ports but your choice of either a DisplayPort or HDMI connection. Put another way, the dock allows two displays to be connected to it, and for each display you have the option of using either display connection. It's extremely handy, and avoids the need to buy additional display cables.

On the front of Ugreen's 9-in-1 USB-C dock are two 10Gbps USB-A ports and a USB-C port, too.

On the front of the dock is both a legacy USB-A port as well as a USB-C port, both 10Gbps. A small power button lights when the dock is powered on, and connected—and a key omission is a power brick. You'll need to supply a USB-C charger yourself, probably one that your laptop uses already. The dock can accept up to 100W from the charger, but uses some itself. The result is that your laptop may complain it's not getting enough power. (Under our tests, the dock passed about 76 watts to the laptop from a 100W charger.)

Don't expect the dock to power a phone, either; the front USB-A port delivered no power at all, and the front USB-C port delivered a relatively paltry 2.5W or so. That will charge a phone, albeit slowly.

On the back of Ugreen's dock is a gigabit Ethernet port, the four display ports (one DisplayPort and one HDMI port per display), plus a 10Gbps USB-C cable connecting the dock to your laptop. The other USB-C port is for charging only. The USB-C cable between the dock and your laptop is about three feet, which was just fine for my purposes.

The dock is constructed from aluminum, measures 7.9×4.5×2.1 inches, and weighs just over a pound. The dock does get quite warm under

You'll appreciate the flexibility Ugreen's 9-in-1 dock offers. On the rear you have a choice of HDMI or DisplayPort, plus Ethernet and connections for power and the USB-C cable.

load—even hot—though it didn't have any problems maintaining a connection. There is passive venting on either side of the dock to help with cooling.

PERFORMANCE

DisplayLink docks are usually exceptionally stable, with no flickering or unexpected detachments from connected displays. Ugreen's dock proved to be the same.

The issue with DisplayLink docks is that only so much data can pass over a 10Gbps connection to and from the dock at any one time. We perform several tests to see how the dock performs under load.

For some reason, the dock performed poorly when we first streamed a 4K video across Ethernet, dropping 671 frames out of 10,000. But the performance improved dramatically to just 62 frames dropped when we ran PCMark's storage benchmark on an external SSD we attached—performing comparably when we tried several other streams just in case a caching issue had improved the results. Storage performance was quite good, though, with the benchmark reporting 141Mbps and a score of 917. (The SSD, when directly connected to the laptop, produced 161Mbps and a score of 1,042.)

You can "break" the dock by pushing more and more over the connection. Playing back two 4K60 streams on either display while copying files from the SSD to the laptop caused noticeable stuttering, but overall the dock handled itself well. We wouldn't expect that you would perform those tasks in real life.

Consider the fact the Ugreen dock is priced at between $129 and $139, and Plugable's very comparable dock costs $199. Provided you can find one, Ugreen's 9-in-1 dock is a solid investment.

Ugreen 9-in-1 USB-C Dock

★★★★½

PROS

- Terrific price and value.
- Excellent stability.
- Great display port flexibility.

CONS

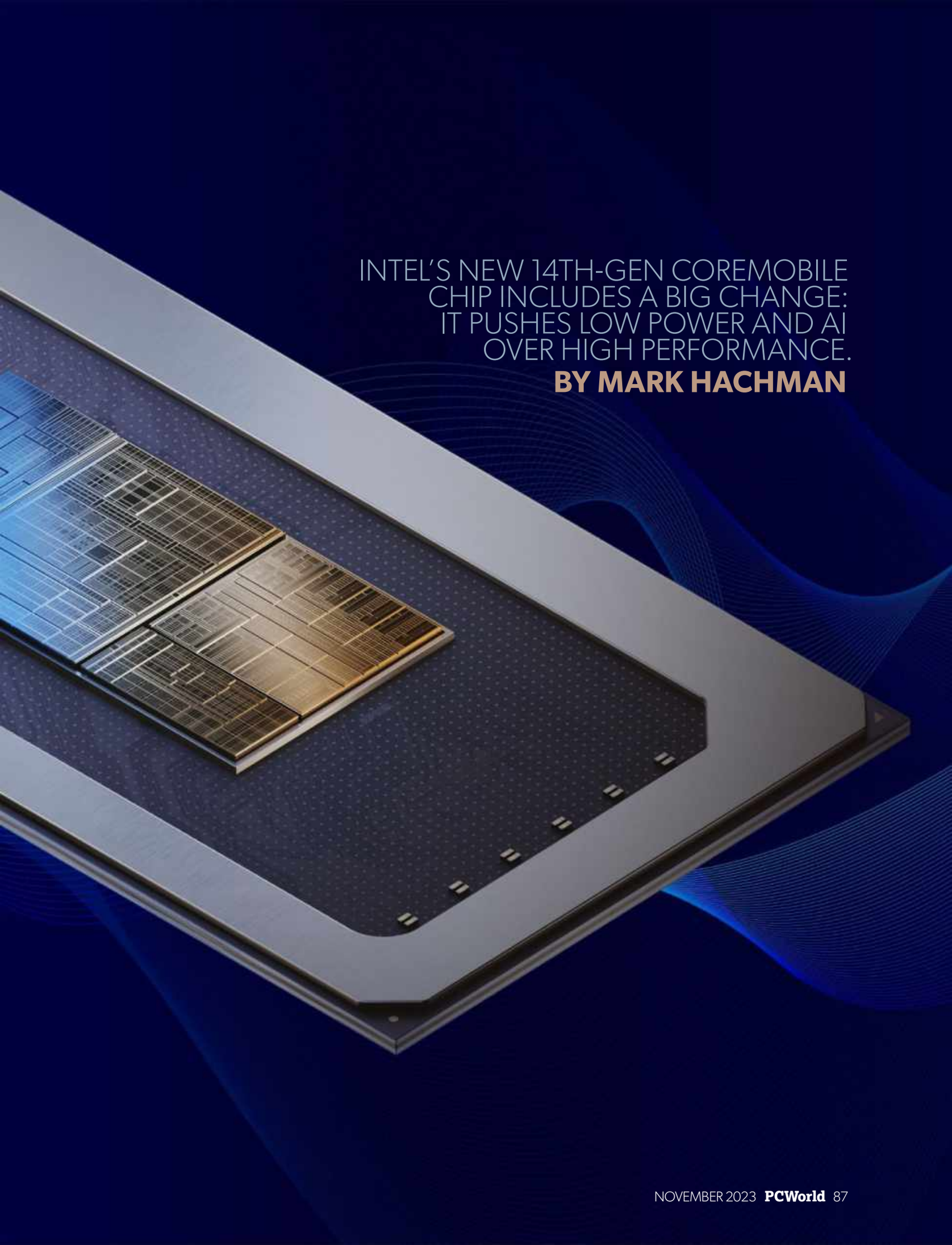
- You have to provide your own power supply.
- Can warm to somewhat alarming temperatures.
- Mandatory software driver.

BOTTOM LINE

You many have a hard time finding Ugreen's 9-in-1 USB-C docking station, but if you do, we'd recommend buying this affordably priced DisplayLink dock.

$129

INSIDE METEOR LAKE: INTEL'S RADICAL NEW CORE CHIP IS OPTIMIZED FOR THE FUTURE



INTEL'S NEW 14TH-GEN COREMOBILE CHIP INCLUDES A BIG CHANGE: IT PUSHES LOW POWER AND AI OVER HIGH PERFORMANCE.

BY MARK HACHMAN

Intel's new 14th-gen Core chip, Meteor Lake, is designed as much for Intel as it is for you. A new disaggregation scheme separates the "processor" into four tiles, cutting power and increasing yields. But a doubling of graphics performance and a new AI engine cater to consumers seeking new features.

Let's be clear, though: Meteor Lake was not designed with CPU performance in mind. Intel executives describe Meteor Lake as offering the performance of the current 13th-gen chip, Raptor Lake, but at half the power—aided by low-voltage efficiency cores (E-cores) that are new to the platform. Even the way Intel assigns CPU tasks has been flipped on its head, pushing them first toward the *lowest-power* E-cores, then migrating them to the more power-hungry performance cores if need be.

Intel unveiled its new Meteor Lake platform in an offsite press event in Penang, Malaysia. At Intel's Intel Innovation conference in San Jose, California. Intel chief executive Pat Gelsinger added two more details: that Meteor Lake will launch on Dec. 14, and that it will be branded as the Core Ultra. Acer appeared on stage to show off its own Meteor Lake laptop, and Intel used MSI-branded laptops in Malaysia.

Intel typically unveils a new chip in two parts: It starts with a general architectural overview, explaining how everything works; and then it provides the information that helps influence buying decisions, such as the model numbers, speeds, prices (where applicable), and so on. For now, Intel is only explaining what's inside its new Core chip. The chip maker isn't saying when it will ship Meteor Lake, but our guess is that the first chips will go out the door this fall, with January's 2024 CES show in Las Vegas serving as a venue to launch the chip into mainstream notebooks.

The first Meteor Lake chips should ship this fall.

As you might expect, Intel's new Meteor Lake is quite complicated. Breaking it down into its component parts, however, seems to make the most sense. Intel's Meteor Lake has four tiles: one each for the CPU, the SOC, graphics, and I/O. We'll explain each in turn, digressing where necessary to explain how Meteor Lake all fits together.

THE ROAD TO METEOR LAKE

Intel's pushing hard in manufacturing, with an eye toward transitioning away from Meteor Lake's Intel 4 process to the Intel 3 process used by future processors.

Traditionally, an Intel CPU has been divided into two main parts, packaged together: the CPU and the Platform Control Hub, or PCH. A Direct Media Interface (DMI) bus connected the two. In this scheme, it's easy to think of the arrangement as the CPU, plus everything else: I/O, memory, and so on. (It's not that clear-cut, but you get the idea.)

Intel's new tiled arrangement solves several problems. For one, each tile can be worked upon separately, on its own road map, and manufactured on the manufacturing process it demands. Intel uses its Foveros technology (fave.co/3Uuo7HC) to connect and stack them all together.

After stalling out on a 14nm manufacturing process (fave.co/3FfNKW9) for years, Intel's new plan is to regain manufacturing leadership by striding through five new manufacturing process technologies in four years, faster than it ever has before. But one of the selling points of Meteor Lake—that it's an "Intel 4" chip (fave.co/3PI6UKt)—is a trifle deceptive. Only the CPU tile is manufactured on Intel 4. In fact, the graphics tile and SOC tiles are fabricated at manufacturing rival TSMC.

Intel's new tiles also mean its logic can be intelligently separated, saving power. Each tile is connected by a fabric that offers approximately 128GB/s of bandwidth.

Intel's chief executive, Pat Gelsinger, has referred to Meteor Lake as the company's "Centrino moment," hearkening back to 20 years ago when Intel launched the Centrino brand (fave.co/3rHxOZP).

Centrino was the first time that Intel had bundled a CPU, chipset, and Wi-Fi chip together, but most forget that it was also Intel's reaction to Transmeta, a failed CPU startup that offered drastically lower power options for laptops. Intel's legacy CPU-PCH design meant that virtually all tasks touched both chips, powering them up into an active state. Even though Intel then tried to return the CPU and PCH to a low-power sleep state as soon as possible, it still was an inefficient

use of power, Intel executives said. By separating Meteor Lake into tiles, Intel can leave the unused tiles in a power-saving deep sleep mode.

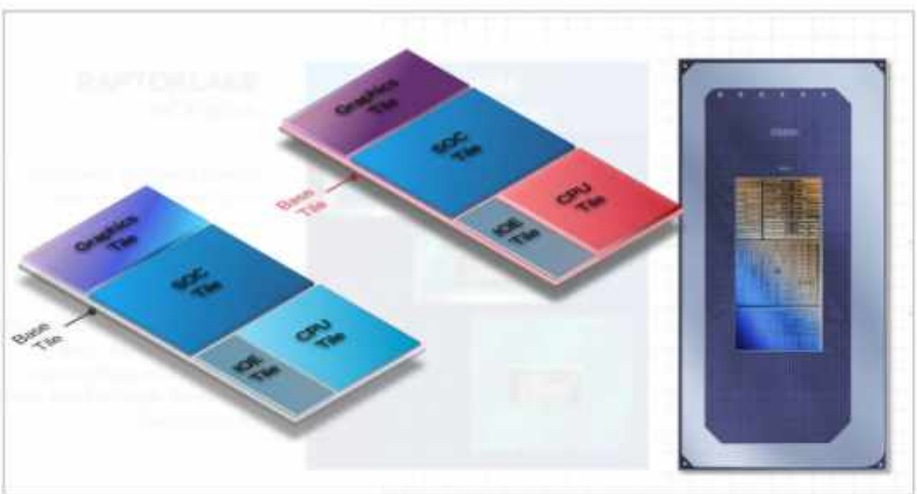
According to Michelle Johnston Holthaus, executive vice president and general manager of Intel's Client Computing Group, customers asked for better power savings. Meteor Lake will deliver the performance of Raptor Lake (or a little more) at roughly half the power, she said.

"'We love the performance that Intel delivers, but we want it in a more efficient power envelope and we want a more balanced platform,'" Holthaus told PCWorld in an interview, referring to what she said customers have told Intel. "This delivers all that."

But there's also a huge secondary bonus, too: manufacturability. Intel's Intel 4 process is the first to use Extreme Ultra Violet (EUV) lithography, a technology that solves a fundamental problem: The transistors that Intel carves out of its photoresistive silicon wafers are smaller than the wavelengths of light used in the etching process. EUV (which requires a hard vacuum inside the equipment) is seen as the way forward to Intel 4 and beyond.

Intel doesn't even manufacture all of its tiles itself. Intel's Meteor Lake GPU tiles are made by TSMC in its 5nm N5 process. The SOC tiles are made by TSMC in its 6nm N6 process, while the CPU tile is made by Intel on its Intel 4 process. (Intel didn't say who makes its I/O tile.)

Intel has pledged to roll out five process technologies in four years (fave.co/46OS0rr), believed to have begun with the Intel 7 process used by the 12th-gen Alder Lake chips. The Intel 4 process also uses an alloy called enhanced copper, a combination of copper and cobalt for superior conductivity, said Bill Grimm, a vice president in Intel's Logic Technology Development group.



The four tiles of Meteor Lake: the CPU tile, SOC tile, graphics tile, and I/O tile. The point Intel is making here is that each tile can be developed separately and packaged with others to meet the needs of a customer.

Even better, Grimm told attendees that the smaller tiles also mean they're easier to actually produce. Small errors in the manufacturing

This demonstrates a surprising amount of confidence in a new chip on a new process technology, something Intel was once extremely reluctant to commit to.

process can make a chip too flawed to ship (a problem that the iGPU-less Intel "KF" series was designed to solve). Smaller tiles also mean that more chips can be placed on a wafer.

According to Grimm, Meteor Lake will be "the best-yielding product at time zero [launch] in more than a decade." Intel expects that Meteor Lake will see better yields than either any 14nm or 10nm chips, he said. That's probably good news for the availability and price at which Intel sells Meteor Lake to laptop makers.

METEOR LAKE'S CPU TILE

As with the 13th-gen Raptor Lake, Intel's 14th-gen CPU tiles consists of two major parts: the performance cores (P-cores), now known as Redwood Cove, and the new efficiency cores (E-cores,) code-named Crestmont.

We really don't know that much about what differences there are between Raptor Lake's P-cores and E-cores and those found in Meteor Lake. Redwood Cove, however, does offer both improved performance efficiency and improved bandwidth, with a larger (though undisclosed) level-2 cache.

Intel also did not disclose anything about Redwood Cove's performance improvements. Rajshree Chabukswar, an Intel fellow in its client systems and software division, however, said that Crestmont's performance improvements are between 4 to 6 percent faster in terms of instructions per

Intel's new performance core (P-core), Redwood Cove.

Intel's new efficiency core (E-core), code-named Crestmont.

clock versus Raptor Lake. (An IPC improvement means that if Raptor Lake and Meteor Lake were to run at the same speed, Meteor Lake's Crestmont E-cores would run 4 to 6 percent faster.)

Intel isn't revealing the various Meteor Lake configurations, but it did show off one during its Tech Day presentation.

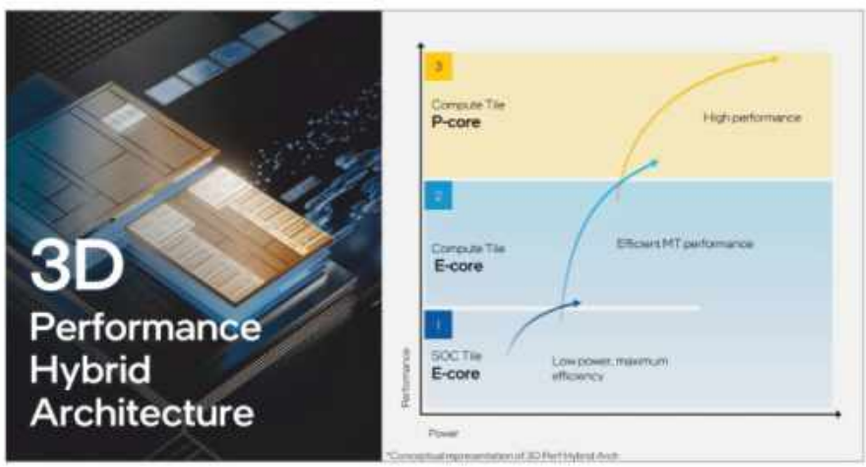
"For demonstration purposes during our Tech Day presentation, we showed a 6 [P-cores] +8 [E-cores] configuration," an Intel spokesman confirmed in an email. "However, we'll be sharing additional product details closer to launch—including specifications, features, configurations, and performance data."

To be fair, we don't even officially know if Intel will ship a desktop version of Meteor Lake, which some call Meteor Lake-S. As for a rumored desktop "Raptor Lake Refresh" chip, Intel didn't disclose that chip's existence, either.

METEOR LAKE'S SOC TILE: WHAT LOW-POWER E-CORES MEAN TO YOU

One feature that's not on the CPU tile is Meteor Lake's new low-power E-Cores, and that was a deliberate choice.

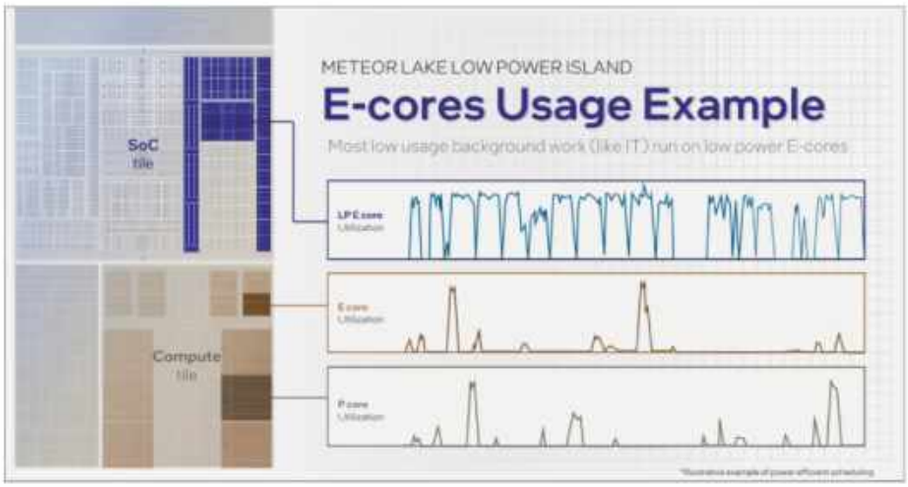
Meteor Lake's two new low-power E-cores are contained within the SOC tile, Meteor Lake's most complex in terms of its array of functions. While the CPU tile contains the CPU cores, the SOC tile is essentially the old PCH, housing the vast majority of Meteor Lake's secondary functions. Here, you'll find the low-power E-cores, the new NPU AI



How Intel is thinking of its low-power E-cores: as a starting point.

engine, as well as the display engine, PCI Express, and more.

Why put low-power E-cores here? Again, that's part of Intel's low-power plan: By separating the low-power E-cores from the CPU tile, that means only the SOC tile (or a specific portion of it) needs to be awoken into an active power state. That saves power, extending the laptop's battery life.



This slide is a subtle but powerful message: In Meteor Lake, expect the bulk of your PC's tasks to work on the low-power E-cores.

So what is a low-power E-core? Perhaps a little lamely, it's a "new" E-core, a different version of the Gracemont architecture. Recall that E-cores were originally designed for low-power tasks. The new low-power E-cores are designed for what executives referred to as background "IT tasks," and it's not entirely clear what those are. Nor do we know how "low power" these new cores are.

One rather shocking example of what those "IT tasks" entail, however, was when Intel executives used a low-power E-core to play back *Tears of Steel*, the open-source video file that we use to measure a laptop's battery life. That's impressive!

Historically, playing back video demanded the attention of the entire CPU up until about 2017. Then, in Lakefield and Alder Lake, Intel began assigning that task to E-cores and P-cores. Now, video playback has migrated to a tiny portion of Meteor Lake. Imagine how often you play back video. The battery life of laptops should increase dramatically just based upon this task alone.

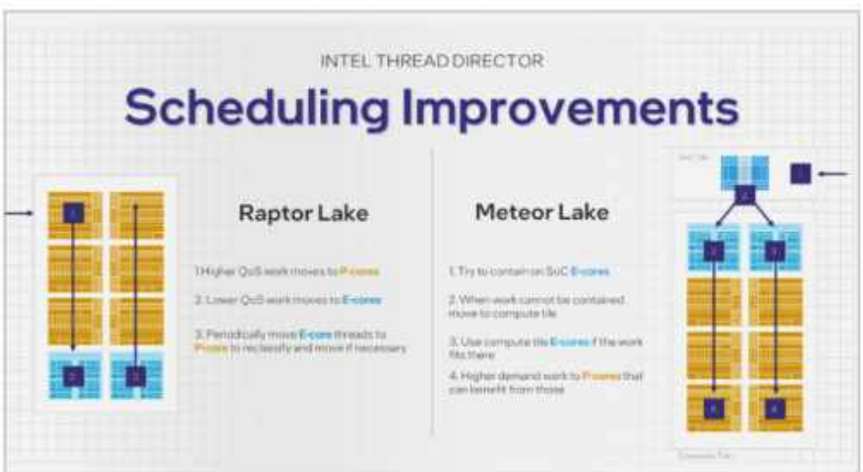
METEOR LAKE'S THREAD DIRECTOR MAKES POWER, NOT PERFORMANCE, THE PRIORITY

Intel has also massively altered Thread Director, the mechanism by which threads or workloads are shunted between cores, within Meteor Lake. Windows or Linux understands what needs to be done and instructs the CPU to take over. That job is then handed to Thread Director. In Thread Director 2 (fave.co/3PNieUo), running on the Core

i9-13900K, tasks were routed to the performance cores first, then shunted to the E-cores if needed.

In Meteor Lake, the *opposite* is the case: Threads are first assigned to the low-power E-cores, then the full-power E-cores, and lastly to the P-cores. Thread Director assigns tasks different priorities and then assigns the tasks accordingly. (The tasks are rated not on their performance, but by other characteristics: "0" is "idle," "2" is "sustained," and "3" is "bursty.")

And Intel is serious about this: If a low-power E-core finishes a task and is freed up, an available thread will be pushed to it, even if a P-core is available, Chabukswar said. Even in a situation where a P-core is free, and Intel's Thread Director is optimized for performance (perhaps via the Windows power slider, fave.co/3DOnyiE), tasks will be assigned to the E-cores first, she said.



This is a big change, so Intel just explicitly spelled it out: It doesn't matter what job Windows assigns Thread Director to do; it will begin on the low-power E-cores.

We've gone down this road before. Though Intel appears to be able to adjust Thread Director as a policy, we don't know whether it will. Could a gaming-optimized laptop feature predominantly P-cores, with Thread Director routing threads to the P-cores first?

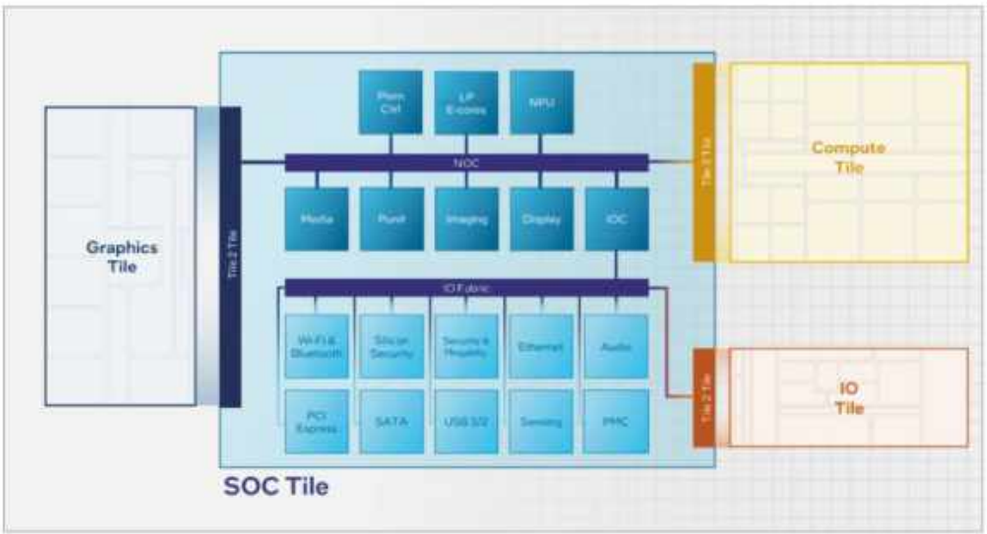
Chabukswar agreed that Thread Director could be adjusted for the needs of gaming. What isn't entirely clear is whether there will be a performance penalty for starting a gaming thread, for example, on a low-power E-core, then stepping it through to an E-core and then to a P-core—rather than recognizing that it needed a P-core to begin with.

Intel has disclosed some of its power-management plans. At the Hot Chips conference in August, Intel stated that it would use "AI" on Meteor Lake (fave.co/3LZj8Ms) to determine how a user interacts with a common task such as opening a webpage.

By quickly shifting threads to the right cores and then dropping into an idle state, Intel believed it could save 10 to 20 percent in energy without impacting the user experience. But Meteor Lake won't learn from you: Instead, Intel is taking an average of sorts from what the

machine-learning algorithm has learned from its test users.

Intel executives also disclosed that they're working closely with Microsoft, so that basic Windows functions can be assigned to the right cores.



A block diagram of Meteor Lake's SOC tile. Notice all of the (separate) I/O on the bottom, and the AI NPU, low-power E-cores, and display on the top.

METEOR LAKE'S SOC TILE: AI ARRIVES ON YOUR PC VIA THE NPU

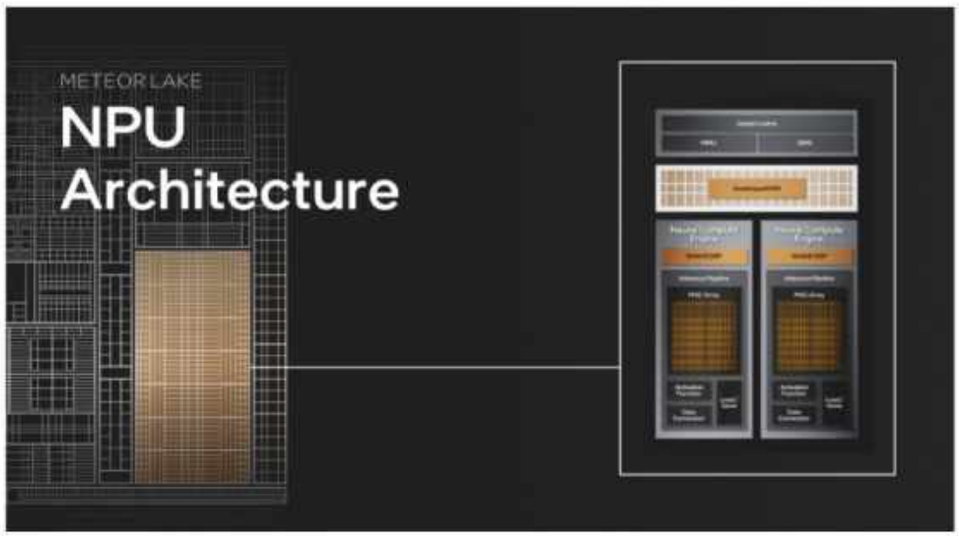
The SOC tile is also home to what Intel calls the NPU, or AI block. In 2022, Intel CEO Gelsinger confirmed that AI was coming to Meteor Lake, launching the "AI PC era (fave.co/3PI7gkh)." According to Holthaus, Intel will ship "millions" of these AI PCs. Incidentally, this NPU will be on all versions of Meteor Lake, Intel confirmed.

Intel is actually on its third generation of AI: The first generation it bought from Movidius in 2016 (fave.co/3PWCYcd), later building discrete cards into some PCs like the Samsung Galaxy Book3 Ultra (fave.co/3XOG7yE) that enable those PCs to do background blurring and noise filtering via what's known as Windows Studio Effects. (While Windows Studio Effects use the Movidius technology, Zoom, Teams, Google Meet, and others simply use your PC's CPU or GPU instead.)

What Intel is trying to do is position the PC for future AI applications, even if it doesn't know exactly what they'll be. Tom Petersen, an Intel fellow, showed off Stable Diffusion (fave.co/3kzk7rZ), an AI art generator. He also demonstrated a plugin for audio editor Audacity that not only separated the vocals from the backing instruments, but later altered that instrumental style using a text prompt. Intel's goal appears to be becoming the tide that lifts all boats, accelerating AI APIs like WinML, DirectML, and its own OpenVINO inference engine.

"Our goal is to democratize AI," said Tim Olson, general manager of SOC design for Intel, in a separate presentation.

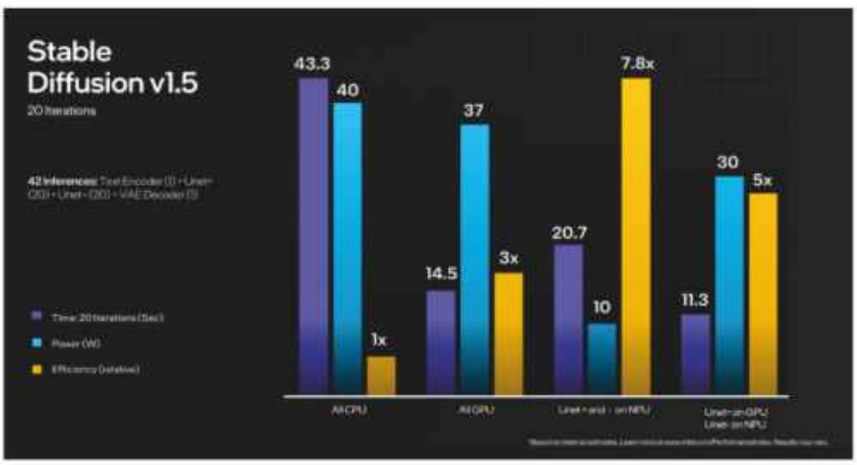
The NPU is one part of that. Intel's NPU includes a pair of neural compute engines, each with two VLIW Shade DSPs inside, with inference engines capable of up to eight instructions per cycle. Even for consumers used to parsing the number of cores per chip, base clocks, and turbo clocks, this won't make a lot of sense. What Intel is trying to convey is that AI requires a ton of multiply-accumulate (MAC) instructions per cycle, and that those engines can perform 2,048 MAC calculations each.



Intel's NPU architecture, or its AI engine.

Is that good? Is that bad? We really don't know. We don't really have a general point of reference for what makes for "good" AI, in terms of specs or benchmarks, and Intel executives gave us the idea that they're trying to work that out, too.

Intel's secret sauce, though, isn't just the AI NPU, but how the CPU, GPU, and NPU can all assist each other. Consider the following example: Running 20 iterations of Stable Diffusion, Intel tried various combinations: performing all of the calculations on the CPU, all on the GPU, all on the NPU, and a combination of all three. Performing them all on the NPU took 20.7 seconds and 10 total watts, the most efficient use. But performing them all on the GPU *and* NPU finished the task in 11.3 seconds, consuming 30W. Which solution is better? Ideally, the user and/or Windows will make that



Intel isn't just banking on its NPU for AI processing — it wants to establish a cross-platform AI scheme.

decision. But it's not a straightforward, simple calculation.

Intel is also integrating what it calls the DP4A instruction into the GPU, a GPU instruction specifically designed to accelerate AI.

METEOR LAKE? TRY MEDIA LAKE

Remember, Intel's not disclosing all of what Meteor Lake hides. We know, for example, that PCI Express Gen 5 (PCIe 5) will be supported, but not how many lanes. Ditto for what flavor of Ethernet the chip will support, or the number of USB bus connections. It appears, though, that the chip will support Thunderbolt 4, but not the upcoming 80Gbps version, Thunderbolt 5 (fave.co/3txpsEA).

Intel executives also said that the chip would support DDR5 and LPDDR5, but we don't know for certain if that excludes DDR4 or LPDDR4. Intel has confirmed that both Wi-Fi 6e and Wi-Fi 7 (fave.co/3rPd820) will be supported, however, giving gobs of headroom for persistent wireless connectivity.

Intel essentially separated the SOC tile into two halves, with an I/O fabric connecting all of the I/O (Ethernet, Wi-Fi, and so on) to the I/O tile. A separate NOC fabric connects the low-power E-cores, NPU, and display controller. (A small I/O controller connects both halves.) Again, this was done to minimize power consumption, as each half can work as independently as possible.

Intel's imaging and display blocks support HDMI 2.1, DisplayPort 2.1, and embedded DisplayPort 1.4. One important feature that Intel *is* disclosing is how many displays Meteor Lake will support: up to a single 8K60 display (with HDR), or *four* 4K60 displays, again with HDR. And if you're a gamer, Meteor Lake will support a single 1080p or 1440p display at 360Hz. That's a big deal.

The media engine will support 8K60 10-bit HDR decode and encode, with support for various codecs. Among them is the open-source AV1 codec, which has already demonstrated impressive encoding results

Streaming and decoding continue to be priorities for Intel and Meteor Lake.

18+

WHAT IS AVAXHOME?

running under Intel's standalone Arc chip (fave.co/3eBsbpj).

Intel also put a small twist in its display engine to save power: If the same frame happens to repeat, Meteor Lake is smart enough that it can leave the frame off entirely. Two of its four display pipelines are also optimized for low power, which Petersen highlighted as a potential solution for a virtual keyboard on a foldable device.

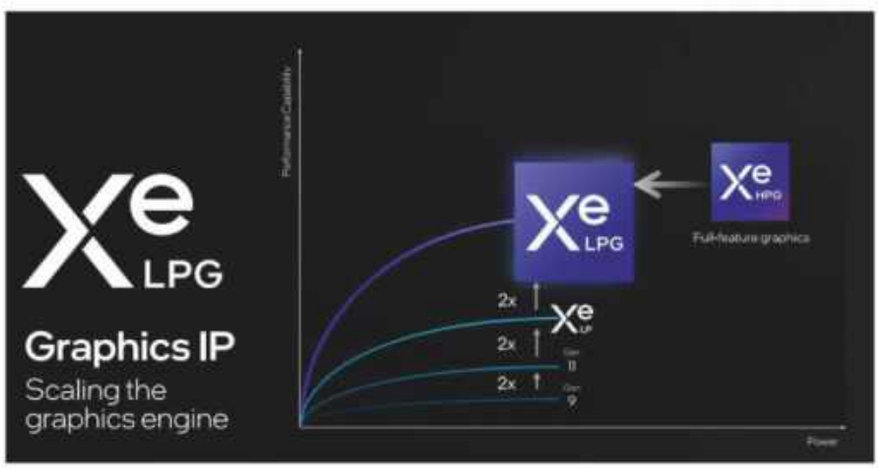
METEOR LAKE'S GRAPHICS TILE: RAY TRACING IN AN INTEGRATED GPU?

While Intel's debut in the PC graphics space (fave.co/3QiAgzr) provided a welcome third competitor, the company's efforts in both the integrated and discrete graphics market (fave.co/45pDHbO) have had their issues. Meteor Lake and what Intel calls its XeLPG graphics block combine elements of both markets, updating the Xe (or XeLP) integrated GPU that has been inside Core processors for the last few years. Essentially, Intel is taking as much as it can from its standalone Arc GPUs and putting it inside the integrated Meteor Lake GPU.

"We've taken all the goodness from our XeHPG architecture and put it into our XeLPG architecture," Petersen said. Even better, by placing graphics on a separate tile, Intel can mix and match graphics performance for the market it's pursuing, Petersen added.

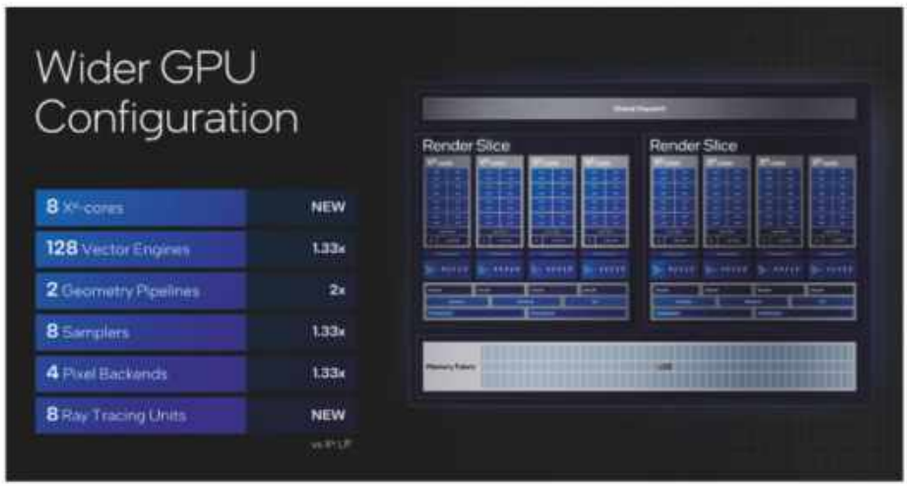
According to Intel's Petersen, Intel is targeting twice the performance of the earlier Xe core, and twice the performance per watt, too. Intel is increasing the XeLPG's clock speeds, dedicating more silicon to it, and making it more efficient.

Finally, Intel is bringing in the eight Xe cores from the Arc A770 as well as eight ray-tracing units into Meteor Lake. Yes, that means ray tracing is now part of the basic integrated GPU, and not just a discrete chip. Petersen did admit, however, that it would be up to software developers to take advantage of this change.



Intel's XeLPG graphics block combines elements of both the integrated and the discrete graphics market.

Put simply, compare our earlier deep dive into the XeHPG architecture (fave.co/45pDHbO) and it all looks extremely similar: Inside each "slice" of the XeLPG core are four Xe cores, with 16 256-bit vector



The specs of the Intel XeLPG core inside Meteor Lake. They look very similar to Intel's Arc GPUs.

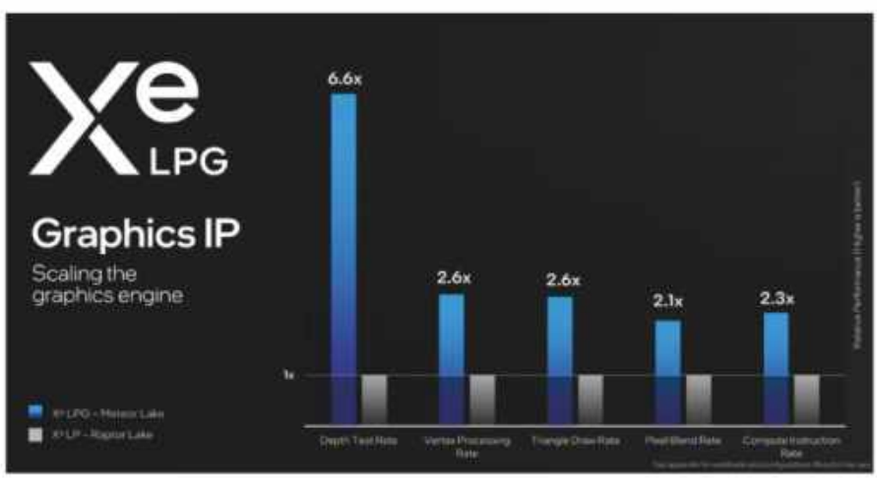
engines and 192KB shared L1/SLM cache. Intel supports DirectX 12 Ultimate natively.

There are new bits, too. The new architecture supports FP64 instructions—Arc doesn't—plus out-of-order sampling, and Intel's software partners told Intel that including FP64 would do wonders for software compatibility, Petersen said.

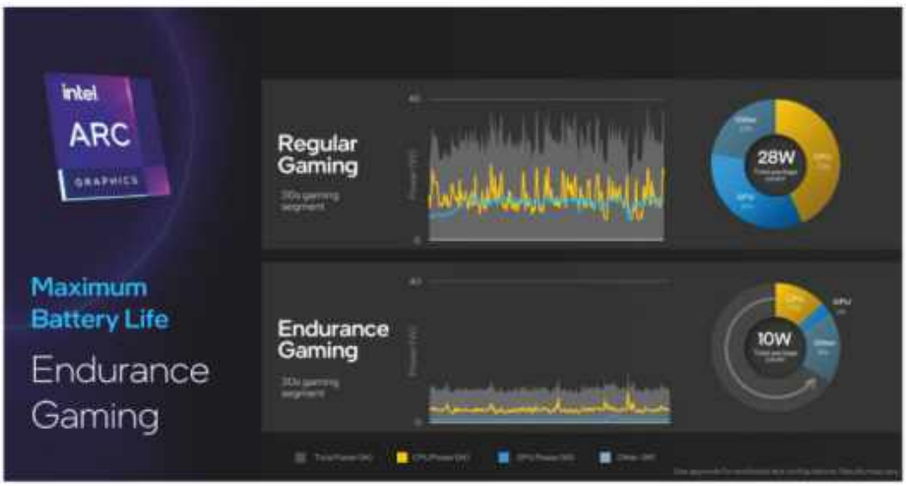
While Intel declined to share actual game performance data, Petersen did agree to share some of its "micros," or internal abstract performance tests. Measurements ranging from triangle draw rate (2.6 times over the XeLP found in Raptor Lake) to depth test rate (6.6 times Raptor Lake) are one indication that Intel believes that its new Xe cores are head and shoulders above its older technology. Intel also showed off *Forza Horizon 5* running on the Meteor Lake hardware, but didn't disclose the resolution or graphics settings.

Meteor Lake's XeLPG also supports XeSS, Intel's answer to Nvidia's DLSS. Intel's technology renders the frame at a lower resolution, then supersamples it up to a high-res image.

According to Petersen, this saves energy as well as improving the image; applying XeSS lowers the energy consumed to 526 millijoules as opposed to 863 millijoules. Meanwhile, Peterson showed off frame rates that increased to 1.69 times or so when XeSS was turned on.



This is the closest thing we have to performance metrics for Meteor Lake's XeLPG core at the moment.



Meteor Lake introduces what Intel calls Endurance Gaming, which will use the Intel Arc Control application for power management.

Finally, Meteor Lake introduces what Intel calls Endurance Gaming, which will use the Intel Arc Control application for power management. The app talks directly to Intel's mobile drivers, moderating performance and improving efficiency; in a "regular gaming" mode, Arc Control, could allocate 28W to the entire system, including the CPU and GPU. In Endurance Gaming, that could be cut to a total of 10W, giving just 1W to the CPU. Intel's Petersen said that the game *Rocket League* could be run at 30 frames per second at less than 1W of power.

APPENDIX: METEOR LAKE'S I/O TILE

We're not going to talk about the fourth I/O tile, precisely because Intel barely touched upon it. With most of the "I/O" functions actually contained within the SOC tile, some of the additional, market-specific functionality may live here. What that will be, and what it will look like, isn't really known.

Intel confirmed that Meteor Lake will have Thunderbolt 4, not 5, connectivity to external Thunderbolt docks (fave.co/3vtA0BE), as well as external USB functionality—no surprises there. But Intel fellow Mikal Hunsaker also indicated that the I/O tile could also be reworked to meet the needs of the market.

One question that leaves us with: How quickly will each of these tiles be overhauled? We can't help but think a little of how Windows apps like Photos are now on their own development cycle, and not tied to any particular Windows release. It seems like Intel may adopt a similar approach.

INTEL'S SYSTEM-LEVEL TECHNOLOGIES

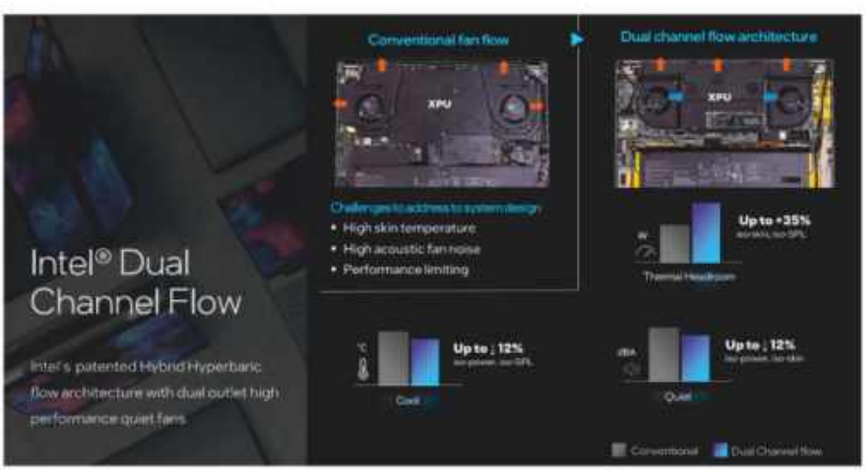
Intel, naturally, doesn't just manufacture PC silicon—its Arc software is proof of that. But Intel also outlined some of the system-level initiatives it would focus on with Meteor Lake platforms, too:

Wi-Fi 7: Intel's BE200 radio chip (aka Gale Peak 2) will be used alongside Meteor Lake platforms. It supports Bluetooth LE with lower power and latency, plus Wi-Fi 7—with speeds of

up to 5.76Gbps, it's theoretically faster than most implementations of wired Ethernet.

Intel Unison: Intel's Unison software is like Windows' own Your Phone, but it's the most effective way to get the iPhone's iMessage communication on your PC. It's much more powerful with Android, though, and the updated Unison software will support extending your laptop's screen onto a tablet (Android), as well as more effective wireless communication that can take advantage of multiple wireless connections.

Intel Cool, Quiet, Performant: Part of Intel's Evo program (fave.co/3ZWb4BP) is working with PC makers to co-engineer their notebooks and desktops. Intel showed off its dual-channel hyberbaric flow design that it patented, which can be used with laptops. It also developed an ultrathin vapor channel, also patented, that it can supply to notebook makers. Specific software to optimize fan speed and analyze workloads to shift performance up and down are also options.



Intel's engineering goes beyond the chip level.

The fan speed controls were designed with acoustics in mind, so they'll scale up just under the point where you'll find the fan noise annoying. The workload analysis software appears to be, or be related to, the AI-powered power-management techniques (fave.co/3LZj8Ms) Intel showed off previously at Hot Chips.

BOTTOM LINE

Intel may have presented us a massive amount of information about its Meteor Lake chip, but we still don't know that much about the 14th-gen Core: when exactly it will ship, its clock speeds, how it will be configured for its various markets, and so on. Interestingly, Intel has splintered its Xeon server chip road map into two different forks: Sierra Forest, made up of all E-cores, and Granite Rapids, consisting of all P-cores. Intel's tiled architecture should allow it some of these options, if it so chooses.

We await AMD's response in the notebook space, and even Qualcomm's answer with its Oryon (Nuvia) technology (fave.co/3Fn0zxP). But Intel still ships the vast majority of all laptop CPUs, making it the dominant player in the space. You've likely just read the specific details of your next laptop's microprocessor.

22 AWESOME **OPEN-SOURCE PROGRAMS** THAT DO EVERYTHING YOU NEED

OPEN-SOURCE SOFTWARE IS AVAILABLE FREE OF CHARGE ON THE INTERNET. FOR ALMOST EVERY FIELD OF APPLICATION, THERE ARE SOLUTIONS WITH WHICH YOU CAN WORK COMFORTABLY.

BY JÖRN-ERIK BURKERT

IMAGE: PATRICK/UNSPLASH

Good software is the basis of all PC use, but many professional programs are too expensive for private use. This is where free software-based applications step in. These apps, including their source code, are available for no charge on the internet.

Regarding the question of quality and functionality, there's no need to worry—much open-source software offers real competition to professional products on both counts.

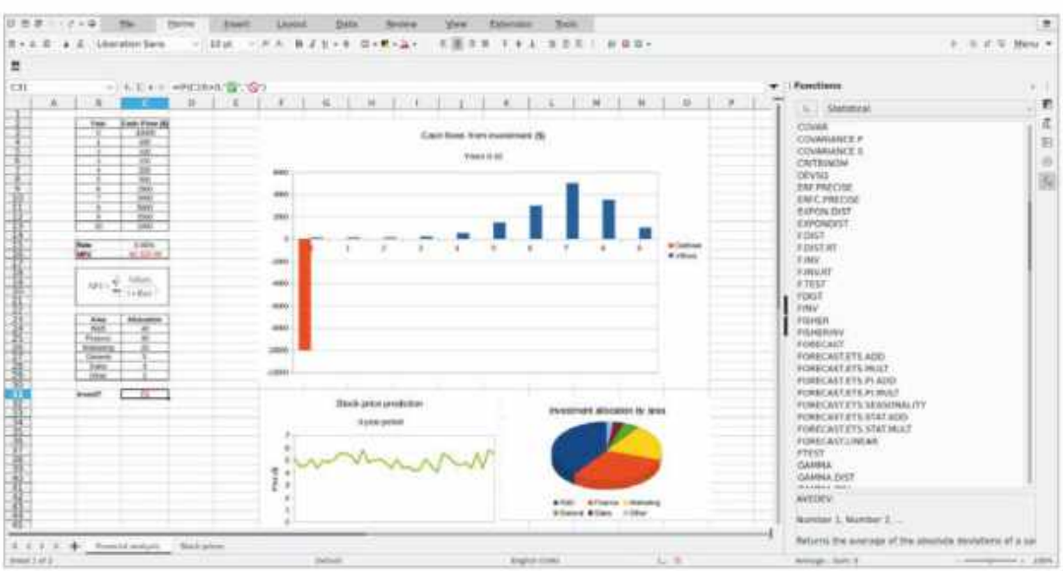
In this guide, we present the best open-source tools for typical areas of application—from Office, to media editing, to file management and backup.

OFFICE, PDF, AND CONFERENCE TOOLS

Editing documents is part of everyday computer life. With LibreOffice (fave.co/3QdPIN8), you get a comprehensive office package for creating texts, spreadsheets, and presentations. The program is an offshoot of Open Office, whose source code was released back in 2000. The project is now being continued as Apache Open Office. The more frequent updates for LibreOffice offer advantages over Apache Open Office (fave.co/3QffMHx).

The current version, 7.5, brings improvements to the editing of text documents in Writer, including better formatting control of headings and easier insertion of tables. Colored bookmarks make navigation and finding sections easier. In the spreadsheet, Calc, the extended assistant for formulas and the new functions for diagrams catch the eye. In Draw and Impress, you can design tables more easily and import EMF graphics more quickly. There is also a dark mode with a dark user interface.

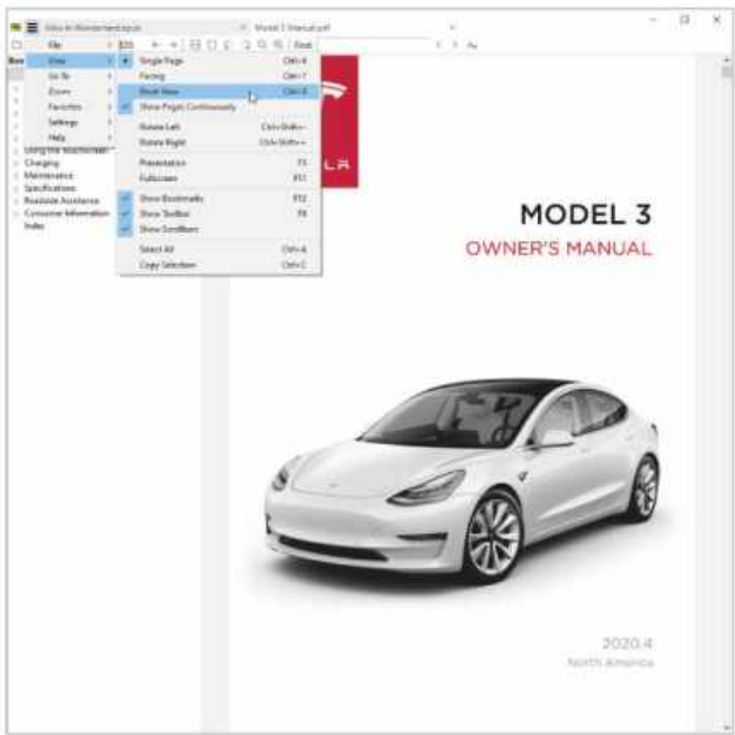
The PDF format is used for cross-device document exchange: The display does not change even in different operating systems



LibreOffice: Use this free office suite to create and edit documents and presentations. The spreadsheet works like Excel and also analyzes data.

and in mobile apps. You can use additional functions such as markings or notes to quickly document notes or change requests. These features also work for group editing.

Many users use the free Adobe Acrobat Reader (fave.co/46PXimq). For the quick display of PDF files, there is the program Sumatra PDF (fave.co/33TMoBt) in the open-source area. The range of functions includes links to translations via Google Translate and DeepL as well as the insertion of markers with annotations.



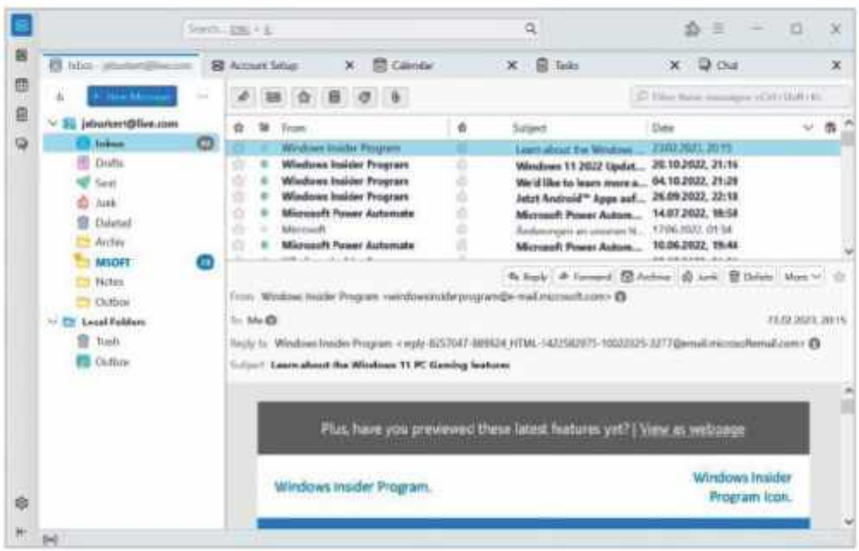
Sumatra PDF: This small, fast program displays PDF documents immediately, offers online translations, and supports page printing.

Cooperation in teams has changed fundamentally, especially during the Covid-19 era; online videoconferences are now commonplace. This has many advantages: You don't need meeting rooms, there's no need to travel, and staff can join in on the go. Open Talk (fave.co/3tzcFS3) is available as a free alternative to Zoom (fave.co/46skrMc) or Microsoft Teams (fave.co/45ttjQf). The system works in the cloud and can be used directly via the website. One finds similar functions to those of the commercial competitors, such as telephone dial-in, screen sharing, voting, and recording meetings.

Many companies have already implemented digital management of work groups. Mattermost (fave.co/46wixKo) is a system for desktop, mobile, and online with, among other things, group chats, project management, and the option to share the screen, including sound. These options are available for use with a free account on the Mattermost website (fave.co/46wixKo). Integration into the company IT requires the software, and Mattermost charges for support and IT integration.

INTERNET: BROWSER AND EMAIL

Messaging, online shopping, and internet banking have become indispensable to many people. A web browser is needed to access such sites. Google Chrome (fave.co/3txvR2A) is the favorite of many users, but it has privacy problems. Google's



Thunderbird: This powerful mail client with a wide range of functions handles the receipt and sending of electronic mail and offers an extensive calendar for managing appointments.

data-collecting frenzy is not limited to internet searches. Ungoogled Chromium (fave.co/3Prqc5l) offers a solution. This is an open-source version of the web browser in which all access by the search engine giant is disconnected. There are no functional restrictions when surfing, and extensions from the Chrome Web Store also work.

Emails are also part of everyday PC activity. They transmit messages fast and are also suitable for sending photos, documents, and data of all kinds. Thunderbird (fave.co/46PRABk) is a free mail program with many functions. These include support for multiple mailboxes, different transfer protocols, address book, calendars, and more. For Thunderbird's 20th birthday this year, the development team has planned a comprehensive modernization.

PHOTO, VIDEO, DTP, AND DESIGNS

Digital photos are more popular than ever. Editing them is easy with Gimp (fave.co/33TKn8n). You can use it to crop motifs, adjust contrast and brightness, and sharpen images. Layers, masks, and other tools for image montage have long been standard in the app. Since version 2.10, there have been tools for cropping and selecting

Gimp: This free photo editor comes with many sophisticated functions for enhancing and mounting pictures.

areas, including one for removing the background.

Digikam Photo Manager (fave.co/3Qfgswz) provides an overview of your photo collection. The program offers sorting by keywords, ratings, and colored markers. In addition, it evaluates metadata and can identify the location of the photo. It also offers editing functions and tools for RAW images.

Inkscape: Create designs with this vector-based graphics program. Thanks to the Import feature, you can import free clip art from Freepik, among other options, and adapt it for your own use.

You will find even more RAW options in RAW Therapee (fave.co/3PR0NIX), including a management tool for viewing images and numerous tools for developing RAW photos.

For document design with desktop publishing (DTP), the combination of Inkscape (fave.co/3tDOPEz) and Scribus (fave.co/46OHzUU) does the trick. You can design detailed illustrations with Inkscape. All important functions for creating curves, objects, or texts are available, along with other tools for aligning elements, color fills, gradients, combining graphics, and more. The program quickly creates scalable logos, infographics, and other designs.

You can use all of this for page design in Scribus. You can create not only simple flyers or menus, but also extensive layouts for newspapers or magazines using sample pages and self-designed standard elements. You can get professional printing results via output in PDF format. Inkscape and Scribus import numerous graphic formats such as JPG, TIF, PNG, and SVG.

Krita: Digital painting

Artists are increasingly using the computer for painting, sketching, and coloring. The illustrations, paintings, or conceptual designs are then available digitally and can be processed immediately without scanning. With special graphics programs, users can bring their ideas to the screen. Krita (fave.co/3LZCpxa) supports this process with special brush tips, layers, effects, and masks. Animation options can bring animated films to life. In combination with a graphics tablet, the software analyzes the pressure and inclination of the digital pen. The program adopts these values and simulates digital

Krita: This digital easel contains many drawing tools for artists who want to work creatively on the computer.

brush strokes or pencil strokes.

The 3D application Blender (fave.co/3RYG0iW) has been around for almost 30 years. At first, the software was only used internally in film studios. In 2002, Blender became open source, and it has since undergone rapid development. In addition to offering sophisticated modeling and texturing modules, it has functions for animation, compositing, and video editing. Via a plug-in interface and scripting, the program can be extended and adapted to the user's requirements.

The variety of functions has paved the way for open-source solutions in many areas of image editing. Blender is even used in Hollywood film production: for example, in the films *Spider Man 2* and *Wonder Woman*. NASA even used Blender to create its interactive web application, Experience Curiosity.

When it comes to video, the VLC media player (fave.co/3rHaCuN) is unbeatable: There is hardly a format that you cannot play with VLC. The palette ranges from videos from old mobile phones to new high-resolution 4K clips. The abilities to work with playlists, retrieve

Blender: This graphics package has a comprehensive set of tools for the production of 3D scenes, special effects, and animations.

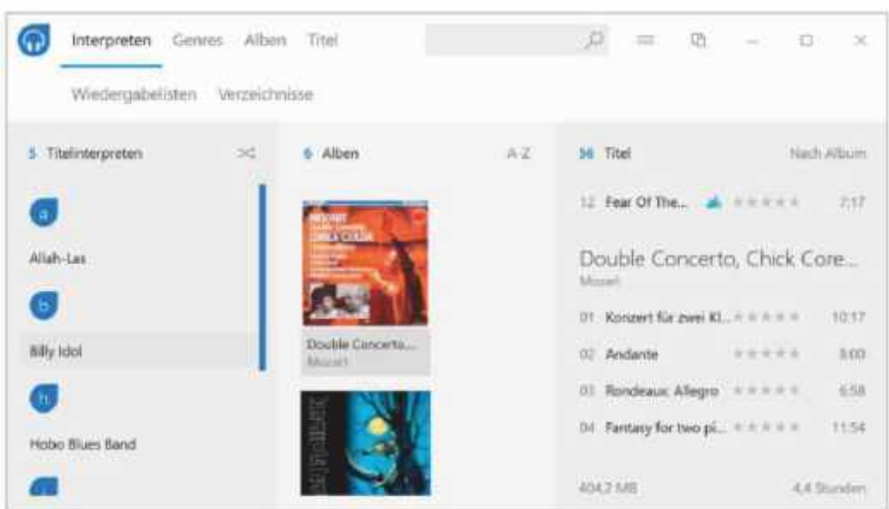
VLC media player: This free program is an all-rounder for playing videos and music. It supports many formats and also streams over the net.

online videos and podcasts, and stream on the home network make the software universally applicable. The somewhat hidden functions for converting video are a welcome bonus.

Finally, ShotCut (fave.co/46PXSR8) helps with video editing. The software is used for viewing recordings as well as for cutting and arranging. It also comes with a flexible timeline for mixing video, audio, transitions, and effects. Through the integration of the FFmeg framework (fave.co/3FAaTmB), you can import and export a wide variety of video formats.

Dopamine: Manage and play music

Many users use Microsoft's media player to manage their own music collection. Although it allows digitalization, playback, and streaming to other devices, the software ties up a lot of system resources. One open-source alternative, Dopamine (fave.co/46NuJWP), is much leaner and offers many management functions, playlists, and an integrated equalizer. In addition, you can call up song lyrics online and integrate Last.fm and Discord. The portable version is particularly interesting: It is installed on a USB stick, which



Dopamine music player: This app quickly finds the right songs in a music collection and allows you to play them with a single click.

also contains the music. You can then use the program on different computers, and the song database always remains up to date. This also works in a local network.

BACKING UP DATA AND SYSTEM

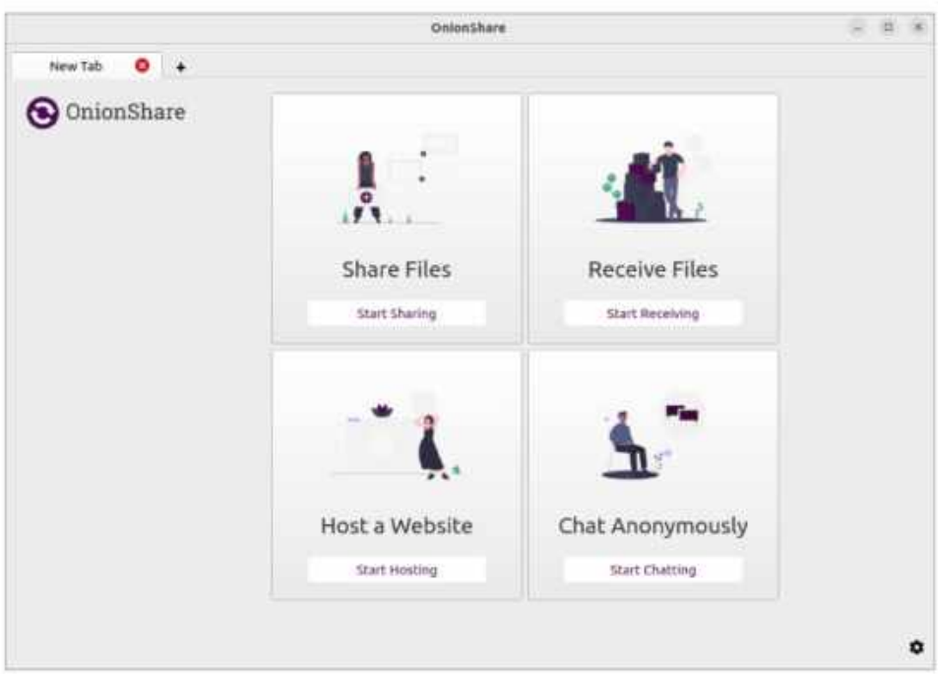
Regularly saving important data and the system partition is a must. You can handle the backup of documents, photos, or music with Duplicati (fave.co/3PgOa3e). After installation and startup, the tool works in the background; you manage the configuration of data selection, schedule, and so on via an interface in the browser.

You can define hard disks, network drives, USB storage devices, or servers on the internet as the target medium. In addition to well-known transfer protocols such as FTP or WebDAV, the program also supports access to cloud services such as Dropbox, Amazon, or Google. Duplicati compresses the stored data and encrypts it with AES-256 if desired.

Clonezilla (fave.co/3QdWEtG) is recommended for backing up a complete partition or hard drive. First, you create a bootable rescue system on CD or USB stick. You then use it to create an image of the hard disk or individual partitions. In the event of a hardware failure, restart the system with the help of Clonezilla and restore the image data. To store the backups, use a local storage device or a drive in the network. In addition, Clonezilla can establish connections via NFS or WebDAV to back up the data to a server on the internet.

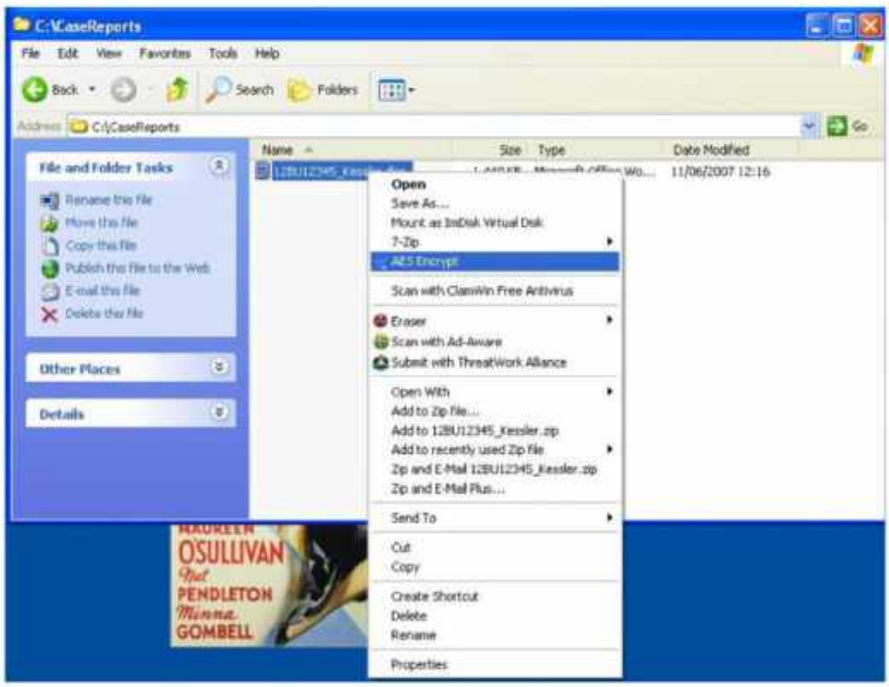
Onionshare: Send data securely

There are many ways to file-share documents or photos: Exchanging via the cloud or by email often involves security risks; for sensitive data, encrypted connections are better. Onionshare (fave.co/3ZVwA9V) enables the secure exchange of data with the help of Onion



Onionshare: Secure file sharing works via the Tor network and encryption.

technology. You use this in the Tor browser and it anonymizes user information. For transmission, the tool generates an Onion address for retrieval by the recipient; the encryption of the data itself creates additional security. The sender defines a private key with which the recipient can unlock the transfers. In addition to providing file-sharing functions, Onionshare has a chat option and a web server that securely delivers the website via the Tor network.



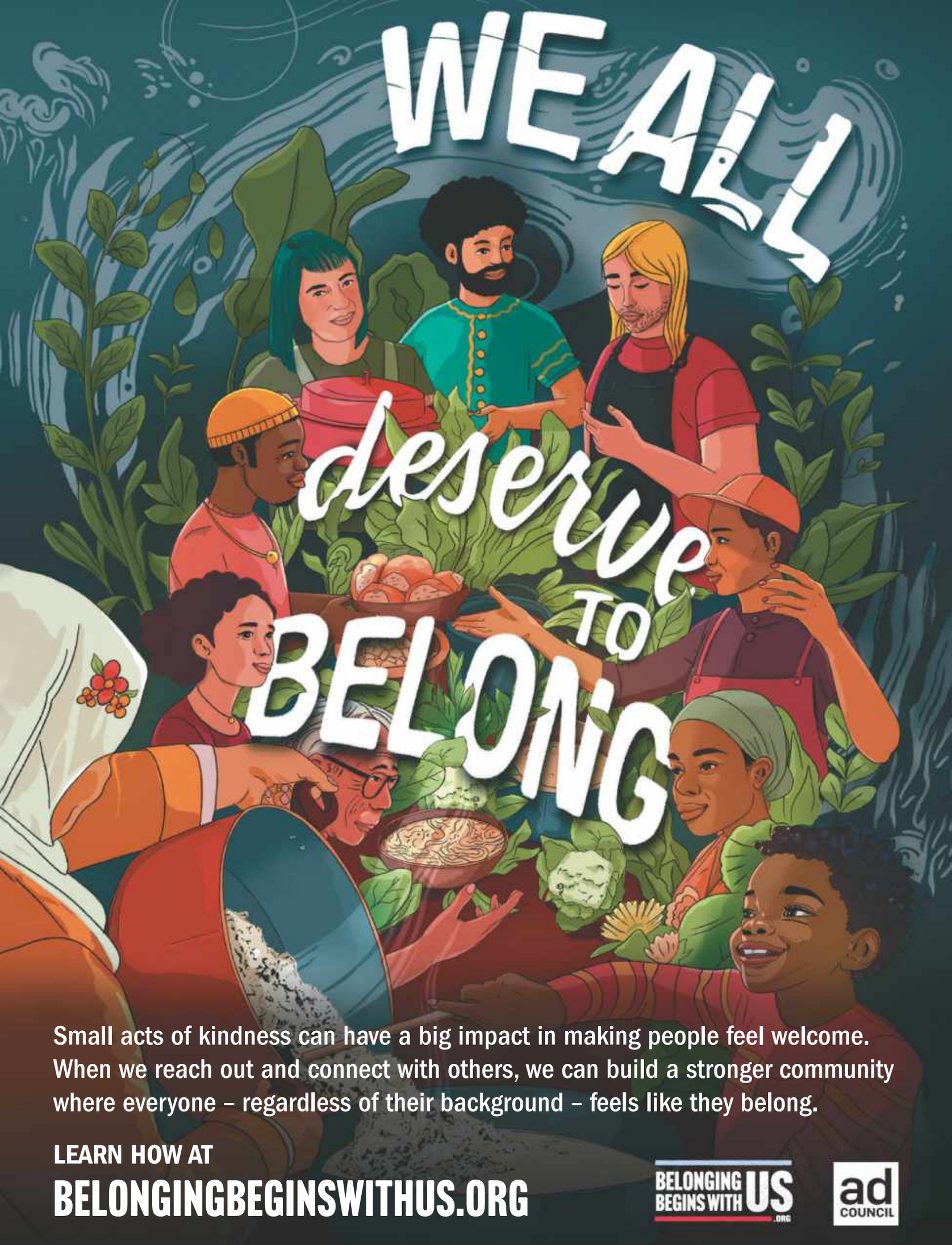
AES Crypt: This tool adds a convenient encryption option to Windows Explorer. Files are protected by AES algorithm and password.

OTHER LITTLE HELPERS

The ZIP format combines several files in one package and compresses the data, speeding up transfer by mail or via the cloud. 7-Zip (fave.co/46wjfaw) has a wide range of functions: It opens and creates ZIP archives and allows you to add or remove files. If desired, the program integrates itself into the context menu of Windows Explorer. This allows you to quickly call up the operations for opening and creating ZIPs. 7-Zip not only supports ZIP files, but also reads formats such as RAR, TAR, BZIP2, GZ, ARJ, LHA, LZH, and many more.

You can encrypt files with sensitive data very easily using AES Crypt (fave.co/46t1SaF). This means you stay on the safe side when you're sending files over the internet. After installation, you will find a new entry in the context menu of Windows Explorer. To encrypt, click on one or more files with the right mouse button and continue with AES Crypt in the context menu. In the following window, enter and confirm a password.

The program creates a new file with 256-bit protection that only allows access to the data via a password. To decrypt and open such files, click the right mouse button again, select the AES Crypt entry, and unlock the data with the password.



Small acts of kindness can have a big impact in making people feel welcome. When we reach out and connect with others, we can build a stronger community where everyone – regardless of their background – feels like they belong.

LEARN HOW AT

BELONGINGBEGINSWITHUS.ORG

BELONGING BEGINS WITH US .ORG

ad COUNCIL

The 5 most dangerous Wi-Fi attacks, and how to fight them

Your router is a popular target for hackers. But if you know how such an attack works, you can take protective measures. **BY THOMAS RAU**

An attack on your Wi-Fi network is not like a bank robbery: Instead of masked robbers blowing open the vault with a loud noise, a hacker inconspicuously approaches the router, searches for weak points, and tries out several attack paths. Or he exploits a known security hole by unleashing an attack on the router that's been prepared for this purpose.

Because you never know when and where your router will become a target, you should always ensure that the device is protected against hacker attacks: Increase the protection level of the router with suitable settings so an attack is too costly for the hacker. And keep yourself regularly informed about security gaps so you can plug them with firmware updates.

We show you how the most dangerous Wi-Fi network attacks work and how you can

IMAGE: ALEXANDER SUPERTRAMP/SHUTTERSTOCK

protect yourself against them: This means you immediately have the right answer to hacker attacks at hand and can secure your router and home network in just a few simple steps.

WHY HACKERS ATTACK YOUR WI-FI NETWORK

To attack a Wi-Fi network, hackers either attack the Wi-Fi connection between client and router or they attack the router directly.

With the first strategy, the attackers want to record data that the devices exchange via Wi-Fi: This enables them to first guess the Wi-Fi key in order to then connect to the connection or redirect it. In this way, they gain access to sensitive information such as passwords for online banking or online accounts. They can then use these themselves or sell them to other hackers.

In addition, attackers can go online via your internet access to download copyrighted material, for example, or to carry out other criminal acts that cannot be traced back to the hacker but only to you.

If attackers take over the router, all devices in the network are open to them: They can, for example, manipulate smart home devices that control lights, heating, or the alarm system. In addition, they can reach data on computers or NAS devices in this way, which they encrypt via ransomware in order to extort a ransom.

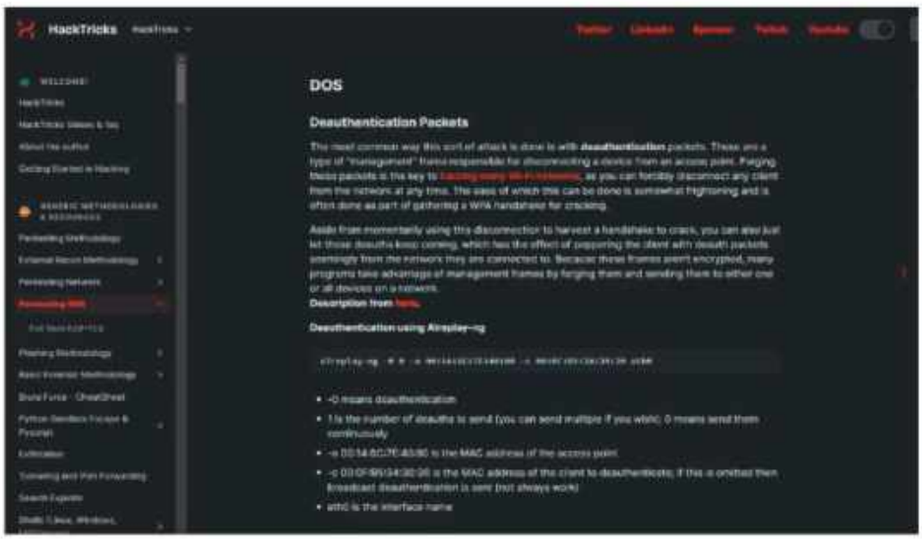
In most cases, a hijacked router becomes part of a botnet that hackers use to attack other targets, such as internal networks of government agencies or companies. But even if an attack has less ambitious goals, it can be annoying: For example, a neighbor may think it's fun to disrupt your network and online connections with a Wi-Fi attack. Or family members may hope to override parental control settings or website filters by gaining unauthorized access to the router.

DEAUTHENTIFICATION: THE FIRST ATTACK ON THE WI-FI NETWORK

This is how the attack works: With a deauthentication, the hacker interrupts the connection between the router and a client. This logoff process is a common and standardized procedure in WLAN: A router, for example, sends a deauthentication message to a client that has not been active in the Wi-Fi network for some time, so that it does not have to maintain this connection unnecessarily.

With band steering or AP steering, the router can also forcibly deauthenticate a client so that it subsequently connects via a faster Wi-Fi frequency or with a repeater that provides it with a better Wi-Fi signal.

In the case of the deauthentication attack, the request to log off comes not from the router but from the hacker. To do this, they manipulate a corresponding data packet: It contains the MAC address of the router and a client. In addition, the attacker must know the



Deauthentification is one of the standard attacks against the Wi-Fi network. How and with which tools hackers proceed is described in detail on numerous websites.

SSID of the attacked Wi-Fi network. If they also find out the radio channel, the attack is even more targeted.

This is what the hacker wants to achieve: Deauthentication is the basis for most Wi-Fi network attacks. The attacker can, for example, interpose themself when the client wants to reconnect to the router after the forced logoff. The two devices exchange messages with which they confirm to each other that they know the agreed WLAN password without transmitting it directly. Then they define the keys with which the following data transfer is secured (four-way handshake).

With a suitable tool, the attacker intercepts the data traffic during the login, with which they try to guess the Wi-Fi password. You can read more about how this is done in the section "Brute force attack" below. The Evil Twin attack also starts with a deauthentication attack.

However, the hacker can also permanently interrupt the connection between a client and the router (DoS, Denial-of-Service): To do this, they continuously send deauthentication packets to the client, which therefore cannot reach the router. In a private network, smart home devices such as alarm systems or surveillance cameras can be paralyzed in this way.

How to fend off the attack: The deauthentication packets are not encrypted, so the attacker does not need a Wi-Fi or network password to send them, but only the Mac addresses and the WLAN SSID, which are easy to find out on a network.

You can prevent this by activating the Protected Management Frames (PMF) function: The easiest way to do this is with WPA3. PMF is a mandatory part of the current security standard. If you switch it on in the router, it also transmits the deauthentication packets with a common key so that the client knows they actually are coming from the router it knows.

However, if the client does not support WPA3, this measure will not help you. But

PMF can also be used together with WPA2 on many routers: With the Fritzbox, for example, you can additionally activate PMF if you select the option "Activate support for protected logins of WLAN devices (PMF)" in the menu under WLAN > Security.

BRUTE FORCE ATTACK: HOW HACKERS CRACK YOUR WI-FI PASSWORD

This is how the attack works: All encryption in the Wi-Fi network derives the devices involved in a connection from the WLAN password they know. If, for example, after a deauthentication attack, the attacker cuts the data transfer to reestablish the connection, they can use it to deduce the password.

Usually, this does not happen directly after the interception, but the attacker unleashes a powerful computer with a strong CPU and GPU on the recording, which tries out different passwords in quick succession that could match it. They can speed up this process via an online service that uses several servers for this purpose. Dictionaries, databases with popular passwords, and character combinations serve as the basis for this attack.

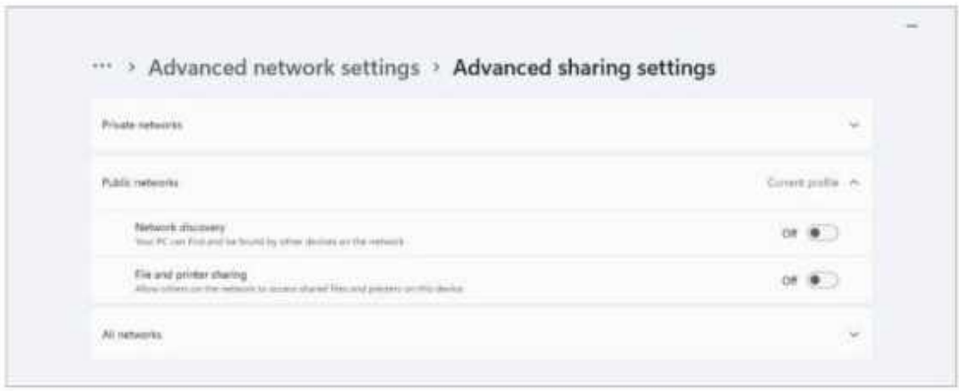
In a masked attack, the attacker sets certain defaults that they believe match the Wi-Fi key—for example, that the first letter in the password is written in capital letters or that half of the password consists of numbers. This considerably reduces the effort required to crack the password: For example, guessing a nine-digit password in the form *Anton1970* would take several years if the attacker had to try out all possible combinations of letters and numbers. If they speculate that the password consists of a name and a year, they will succeed in less than an hour.

This is what the hacker wants to achieve: If the attacker knows the Wi-Fi password, all doors in the home network are open to them. For example, they can infiltrate their own clients to gain access to other home network devices and shares. In addition, the entire data traffic can then be recorded without encryption.

A strong Wi-Fi password makes brute-force attacks more difficult because the hacker needs too much time or too many computing resources to figure it out. Many routers will alert you to a password that is too weak.

How to fend off the attack: The above example clearly shows that the longer and more complicated a password is, the more

difficult it is to crack. Therefore, you should definitely avoid predictable words or numbers such as name, address, year of birth, and so on in your Wi-Fi password. Special characters also increase the complexity of the password. In this case, a shorter password with eight to 12 characters is sufficient, but its components of uppercase and lowercase letters, numbers, and special characters are chosen completely randomly—for example, z9!qO6+B§.



Deactivate the automatic Wi-Fi login on a Windows notebook when you are in a public hot spot. This increases protection against an Evil Twin attack.

Also important: Do not use the password for another login—for example, to an online account: If the provider of the account is hacked, the stolen passwords usually turn up quickly on the internet, and a network attacker can then use them for a brute force attack.

EVIL TWIN: IF THE HACKER PLACES A FALSE ACCESS POINT

This is how the attack works: You are particularly at risk for this attack in a public Wi-Fi network. But this attack is also possible at home. The hacker sets up a router or access point that uses the same SSID as the regular router. This can easily be found out via a network scan. An attacker can proceed in a similar way with a honeypot attack: To do this, they offer WLAN in a place that has no internet access, but where this is not immediately noticeable: For example, they could set up a fake access point with the SSID "Pizzeria" in an Italian restaurant.

Both attacks can easily be carried out with a notebook or smartphone, as long as the client that connects can also access the internet via it. The attacker increases the chances of success if they place the false access point in such a way that it offers a better signal strength than the real one. They can also use a deauthentication attack to get clients to log off from the real access point and then connect to the fake one. With an unsecured Wi-Fi network, the hacker does not have to do anything else. If there is a Wi-Fi password, the attacker could present the client with a manipulated login webpage when trying to connect in order to retrieve the password.

This is what the hacker wants to achieve: With the Evil Twin, the hacker can monitor the client's entire data traffic—for example, the entry of passwords for online banking or shopping. Since this attack is usually not noticed immediately, the hacker has enough time to record enough data. In addition, they gain access to the client to search for sensitive files or to install malware that gives them more possibilities to control the device.

This is how you can protect yourself: In principle, you should not do anything on a public Wi-Fi network that requires you to enter an important password. If this is necessary, you must make absolutely sure that you establish an encrypted connection to the corresponding site: You can recognize this by the fact that the web address begins with https://.

The best protection against attacks in a public Wi-Fi network is a VPN that connects you to your router at home. This encrypts all data you send via the public WLAN.

You should also avoid using Wi-Fi networks that do not require a password. It is also best to switch off the client so that it automatically connects to known WLANs: Otherwise, it will automatically contact every access point within range that uses a known SSID—even if it is a false one. Deactivate the automatic WLAN registration on a Windows notebook if you are in a public hot spot. This increases protection against an Evil Twin attack.

ROUTER ATTACK: HOW HACKERS EXPLOIT SECURITY GAPS

This is how the attack works: The router is the most important device in your Wi-Fi network and therefore is an attractive target for hackers. Many models facilitate these attacks through security gaps in the firmware: In most cases, it is based on Linux, which is why router manufacturers do not program all the functions themselves, but also rely on numerous open-source programs that may contain bugs.

In addition, some manufacturers fail to replace or remove from the firmware outdated firmware modules that are no longer maintained by programmers. These gaps allow attackers, for example, to have program commands executed on the router, as it does not check or filter these manipulated inputs. This can instruct the router to execute prepared scripts that give the attacker comprehensive control. Depending on the firmware gap, an attacker must be connected to the router via Wi-Fi or remote access to do this.

This is what the hacker wants to achieve: By means of a security hole, the attacker can completely take over the router in order to change settings or switch off security functions. In many cases, this serves to ensure permanent but unnoticed access to the router menu. The attacker can make the hijacked router part of a botnet with which

It's important to keep your router firmware up to date. Some routers even offer a setting to automatically upgrade firmware.

they attack other networks, for example, via a DoS attack or to send spam messages.

How to protect yourself: Regularly check whether new firmware is available for your router. It is also a good idea to regularly check important security websites that report on router vulnerabilities and to visit the support pages for your router model.

REMOTE ATTACK: ACCESS TO THE ROUTER VIA THE INTERNET

This is how the attack works: Many users have set their router so that its settings can also be accessed from the internet. Therefore, hackers can also find these routers with a network scan, because remote access usually takes place via standard ports, such as port 443. Similar to cracking the Wi-Fi password, the attacker then tries to find out the access information—for example, via a brute force attack.

This is what the hacker wants to achieve: In the menu, the hacker changes settings that give them control over the router. In this way, they can integrate it into a botnet or redirect the online access of Wi-Fi clients to a manipulated server, for example, by storing corresponding DNS settings: Passwords can be tapped or malware can be infiltrated into the home network.

How to protect yourself: It is best to activate remote access to the router only when you absolutely need it. It is absolutely crucial to have a strong password for logging into the router menu. The router should also be able to offer to set up a user account for remote access that is different from the one for local access.

For additional security, you can often define an IP address range: Only devices with a matching IP address can then access the router menu remotely at all. Many routers also lock the menu after a certain number of failed logins or extend the time period after each failed attempt until someone is allowed to log in again.

Customize Windows Update and seize true control of your PC

Windows Update is the tool that keeps your computer up to date, and in Windows 11 there are many opportunities to customize the service to your needs. **BY MARTIN APPEL**

Updating is one of the most important things you can do to avoid problems in your digital life. New threats and problems are constantly emerging, and manufacturers are doing everything they can to find ways to protect against them. Updating also ensures that you always have access to the latest features that are regularly released.

In the Windows world, updates are managed by Windows Update. Most are automatic—as long as you restart your computer regularly. But you can also customize the updates to work the way you want them to.

NEW FEATURE

Recently, an option was added to download the latest updates as soon as they are available. Important security updates, which protect your computer from serious threats, are not affected by this. Instead, these are updates that simply add new features.

IMAGE: MICROSOFT

1. OPEN

To open Windows Update, press the Start button and select Settings, or press the keyboard command **Windows+I**. Go to Windows Update at the bottom left. Click on "Check for updates" to update your computer manually.

2. FASTER UPDATES

Windows Update gives you important security updates immediately, but you can also get regular updates as soon as they're ready. To do so, turn on the option that's named "Get the latest updates as soon as they're available."

The advantage of activating it is that you get news earlier than others, which many people find appealing. The disadvantage is that those who are early also take a greater risk. If a new function works poorly, it will of course affect all those who are early adopters. Waiting to install an update increases the chance that the problems will have been solved by the time it arrives on your computer.

As you can see, a large part of the settings decisions you make in Windows Update are about choosing how quickly you want your updates. For example, you can choose to pause updates when you're traveling or working on something important and don't want to be interrupted. You can also choose the timing of the updates so that they disturb you as little as possible. Here's how to do it, step by step:

3. CHECKING NEWS

To see what updates you've made and what news is contained in those updates, you can click on "Update history." In the chronological list, the updates are displayed and you can tap on "See what's new" or "More information."

4. USE PAUSE...

You can pause the updates with Pause for 1 week. One more tap will extend the pause by one week. You can also tap the arrow on the right to determine the length of the pause. The duration of the pause is shown at the top—and you can cancel with "Resume updates."

5. ...AND ACTIVE HOURS

You can specify when you don't want updates to disturb you. The feature, "Active hours," is controlled with "Advanced options > Active hours." Select Automatically to let the computer decide or press Manual and enter a time.

5.

6.

4.

6. CUSTOMIZE

Via Advanced options you can customize Windows Update. For example, you can choose "Update me" to restart your computer as quickly as possible, and you can decide how you want to receive restart notifications. You don't need to change anything here.

7. UPDATE WORD...

Windows Update can also update Office and other Microsoft products. Open Settings > Windows Update > Advanced options and enable the feature Get updates for other Microsoft products.

8. ...AND DRIVERS

In the same place you can also select Optional updates to update drivers and more. This is something you only need to do if you have a problem with a gadget or component. If everything is working properly, you can skip these updates.

6 printer tricks that solve problems and save energy

There are two areas that often cause printer trouble: Windows and high consumption costs. You can achieve a great effect with targeted tricks. **BY INES WALKE-CHOMJAKOV**

The printer always goes on strike when you need a printout very quickly. You probably first focus on the hardware to troubleshoot. But often your printer or multifunctional device is not responsible for the problem. Rather, the last Windows update turns out to be the cause. It can destroy the printer driver, change the basic settings of the Office software, or add driver versions to the system without your active intervention, which can then lead to unforeseeable printing problems.

Apart from Windows, consumption costs are a perennial issue with printers—at least if you have an output device that is supplied with cartridge ink or standard toner cartridges. But here, too, there are solutions with which you can noticeably reduce the follow-up costs right down to the paper. You do not need any additional software or a specific printer model. A little tuning is all it takes.

With the following tricks, the system will no longer interfere with your printing. At the

IMAGE: NEW AFRICA/SHUTTERSTOCK

Multiple entries under Printers & Scanners can make it confusing to figure out a printing problem.

same time, you are in control of how much of the ink goes on how many sheets.

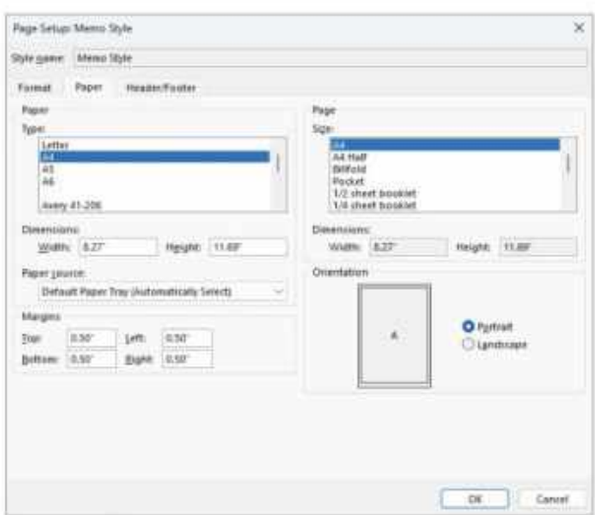
SOLVE PRINTER PROBLEMS AFTER WINDOWS UPDATES

No matter whether you're using Windows 10 or 11, updates to the operating system often result in printer problems. Suddenly, an email can only be printed with gaps. Or the printer disappears from the home network for some unknown reason. Or vice versa: The device appears with several entries in the Windows control panel.

Adjust the print format in Outlook

Especially with Microsoft Outlook, Windows updates often have a negative effect. A common printer error is missing text blocks when you print out a long email. The text parts are usually lost at page changes, although they are visible in the print preview.

This is how to proceed: To get the entire mail message on paper, you must redefine the print format. To do this, double-click on the mail in Outlook that you want to print. In the window that opens, go to File > Print. Click on Print options under the standard printer. Outlook uses the Memo Style for printing emails. You can see it under Print format. To check the memo style defaults, click on Page Setup. In the next window, select the Paper tab. A4 should be selected under both Type and Size. After Windows updates, other formats may be here—such as Letter or A3. Since they do not fit your standard printer, they cause misprints with omitted areas in mails. Finally, check under Orientation whether portrait format is set up. If not, change the setting accordingly and confirm your entries with OK.



Outlook's print settings can get out of whack after a Windows update.

Advantage: The print settings you have made now apply not only to the selected mail but to all Outlook mails—at least until the next Windows update interferes again.

Undo an update that paralyzes printer

Suddenly you can no longer control your WLAN printer. When you send a print job, it simply goes nowhere.

This is how to proceed: In most cases, the last Windows update turns out to be the cause when the network printer is no longer accessible. The first step is to verify this suspicion by searching for the last update in the Settings app of Windows 10 or 11 and clarify the situation by searching the internet.

You can find the installed updates for Windows 10 under "Update & Security > Windows Update > View update history." For Windows 11, go directly to Windows Update > Update History. Note the update identifier, which begins with the letters "KB" and is followed by a sequence of numbers. After that, search Google for "printer problem Windows Update."

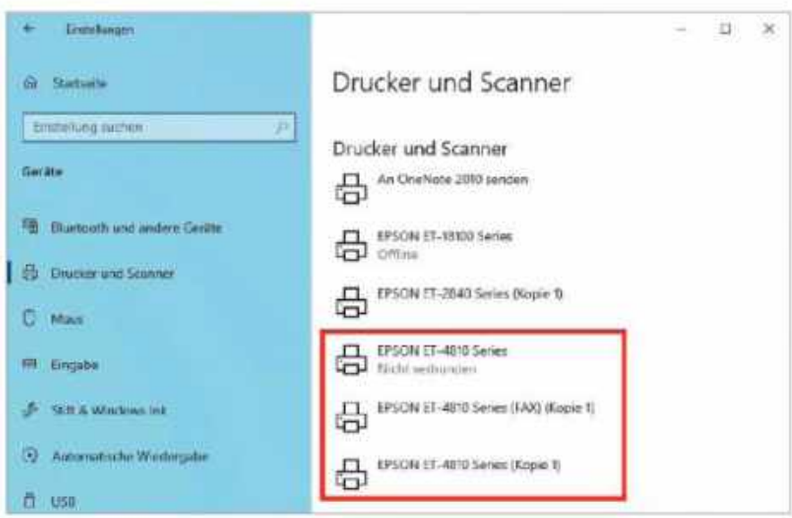
If it is confirmed that the system update is causing printer problems, uninstall the update. You can do this directly in the Update history under "Uninstall updates." Make sure you select the correct Windows update—again, the update identifier is decisive.

After a restart, the network printer should be accessible again. For a test, go to Devices > Printers and scanners in the settings for Windows 10, select your printer, and click on Manage. Print a test printout via "Print test page." On a Windows 11 system, navigate to your printer via "Bluetooth and devices > Printers and scanners."

Microsoft often provides a new update shortly after an update that has caused printer problems. You can install it even if you have deleted the previous update. This is recommended for security reasons.

Address multiple printer entries in Windows

All of a sudden your printer or multifunctional device appears twice or even more in the Windows operating system. The duplicates can be caused by an operating system



If your printer model is found several times in Windows, this may be due to different connections and functions, or to driver duplicates that do not work correctly.

update, among other things. They make it difficult to choose the right driver.

This is how to proceed: To delete multiple printer entries, go to "Devices > Printers and scanners" in the Settings app for Windows 10, and to "Bluetooth and devices > Printers and scanners" for Windows 11.

Duplicate printer entries usually consist of the printer name—for example, Epson ET-2840—with or without an addition. It either describes another function of your device—for example, FAX for the PC fax function. Or it indicates that the driver has been installed several times. Then you will see the description USB for the USB port or (Copy 1) next to the printer name. Only the latter is actually a duplicate entry.

With multifunction printers, additional Windows drivers for scanner and fax are fine. Multiple entries for the print function, on the other hand, cause confusion.

Before deleting it, use the printer driver to check that it is not the network driver. If this is not the case, click on it and delete the entry via "Remove device" in Windows 10 or simply "Remove" in Windows 11.

To avoid future confusion, set the desired driver as the default. To do this, click on the relevant entry in Windows 10, select "Manage," and then "Set as default." With Windows 11, you may first have to get the system out of the habit of managing the default printer. To do this, scroll down in the window and deactivate the checkbox labeled "Windows manages the default printer." Then click on the entry and on "Set as default." In both cases, this driver will now take effect when you trigger the print command in an application.

If you're not sure which driver variant you should define as the default printer, print a test page on each of the entries in question. As a rule, only one device driver works correctly. Select this one.

SAVE INK, TONER, AND PAPER

Printing always costs money, because ink or toner as well as paper all cost money.

Naturally, you want to keep these costs as low as possible. This also has the positive side effect of being less wasteful.

Save by using print preview

The print command is quickly given, but the result is not at all what you imagined. The result: The printouts are for the wastepaper basket and have to be repeated. You can avoid expensive misprints by using the print preview.

This is how to proceed: Especially with longer texts and extensive tables, it is worthwhile to use the print preview, even if it means an intermediate step before reaching the finished printout. Check the margins of the document and correct them so as much content as possible fits on as few pages as possible. With tables, it is worth checking the columns. For example, Excel often automatically moves wide columns to the next page, which can quickly waste sheets of paper.

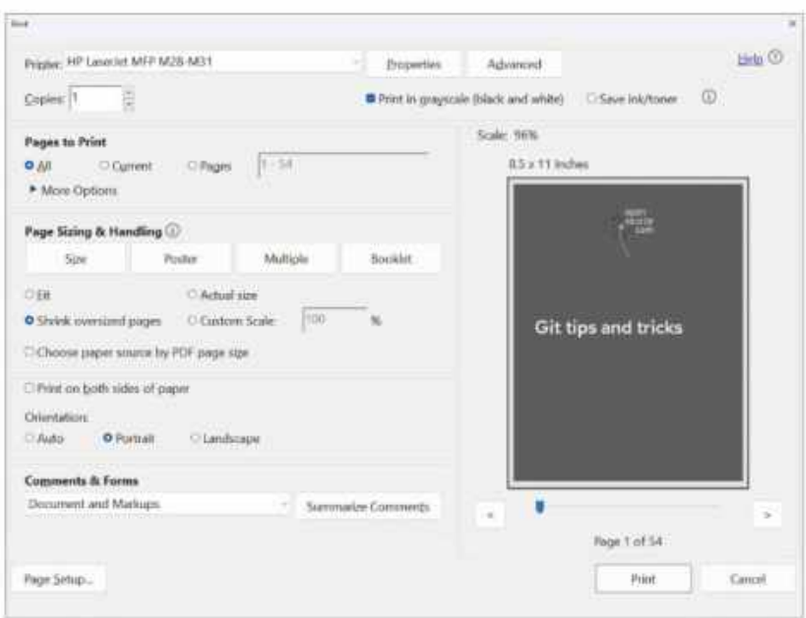
When printing photos, it is also worth taking a look at the print preview. It shows whether the photo is centered if you want to print it with margins. The preview can also save you from annoying misprints on expensive photo paper. You will see immediately if the picture is incorrectly aligned—that is, in portrait instead of landscape format or vice versa.

Save with grayscale

Most printer models use all colors in the basic settings and if in doubt use them even if a printout should only contain grayscale. This lowers the ink and toner levels of blue, red, and yellow, even though you actually only want to use black. You can switch off this effect on some printers and at least reduce it on others, thus actively reducing ink and toner consumption.

This is how to proceed: If you want to use only the black cartridge for a printout, several steps are usually necessary before printing. First, set the grayscale mode in the printer driver.

As the setting is usually not to be used generally, but only for a specific document, you do this from within the program—usually under File > Print.



In some programs, such as Acrobat Reader, you can explicitly set the grayscale mode before printing.

In the new window, look for Properties to open the printer driver. Here you often select the option "grayscale" directly in the main settings. Search the driver for further options for monochrome printing. Some printers also offer the option of printing only with the black cartridge under Extras or Further options. Confirm the entries with OK.

Before you execute the print command, take a look at the print options of the program from which you are printing. In many cases you can additionally set monochrome printing here. In Acrobat, for example, you will find the option "Print in grayscale (black and white)." If you tick this option, the program converts a color PDF document into grayscale. You can see the result in the preview window. Only now click on Print.

Special-case photo printing: As a rule, these measures help with all grayscale prints on normal paper. In photo printing on special photo paper, however, most four-color printers continue to use colored dots. They help to smooth edges and show shading better. As a side effect, however, they create color casts. Grayscale then appears too green, too blue, or too red.

To eliminate the color distortions, you have to trick your printer: To do this, select the best print medium in the printer driver that the printer accepts as normal paper—such as Brother inkjet paper, Canon high resolution paper, Epson photo quality inkjet paper, or HP presentation paper. Set the highest possible resolution.

If your printer complains that the settings in the driver and device differ, you must also assign the inkjet paper to the appropriate paper tray directly on the printer's control panel. Often you can also define the black coverage either in the driver or in the image-editing program. This way the photo is printed lighter or darker.

Make test prints on normal paper. Only when the result is satisfactory should you replace the plain paper with high-quality photo paper. The finished printout will not reach the printer's highest resolution, but it will not show any annoying color casts.

Exploit the savings potential in the driver

Every printer can be economical with paper and ink or toner. However, it depends on the printer model how many settings are available for this. The more finely you can tune the output device via the driver, the more you will exploit the potential for saving ink and paper.

This is how to proceed: A good efficiency measure is the draft or toner-saving mode. You will find it in the printer driver in the Main settings, usually under Quality. The mode reduces the ink application of all colors. Since many printer models put a lot of ink on the paper at standard resolution, the economy setting is often worthwhile for everyday printing. You should be able to read all text.

If your printer model does not provide a special draft mode, look for manual settings in the driver to reduce the coverage. You will usually find what you are looking for under "More options." The print colors can often be influenced via sliders. In many cases, it is enough to increase the brightness of the printout to reduce ink coverage and thus save ink or toner.

Even many multifunction devices for home use, such as the HP Envy Inspire 7220e, are equipped with duplex units that can automatically print on the front and back sides of a sheet.

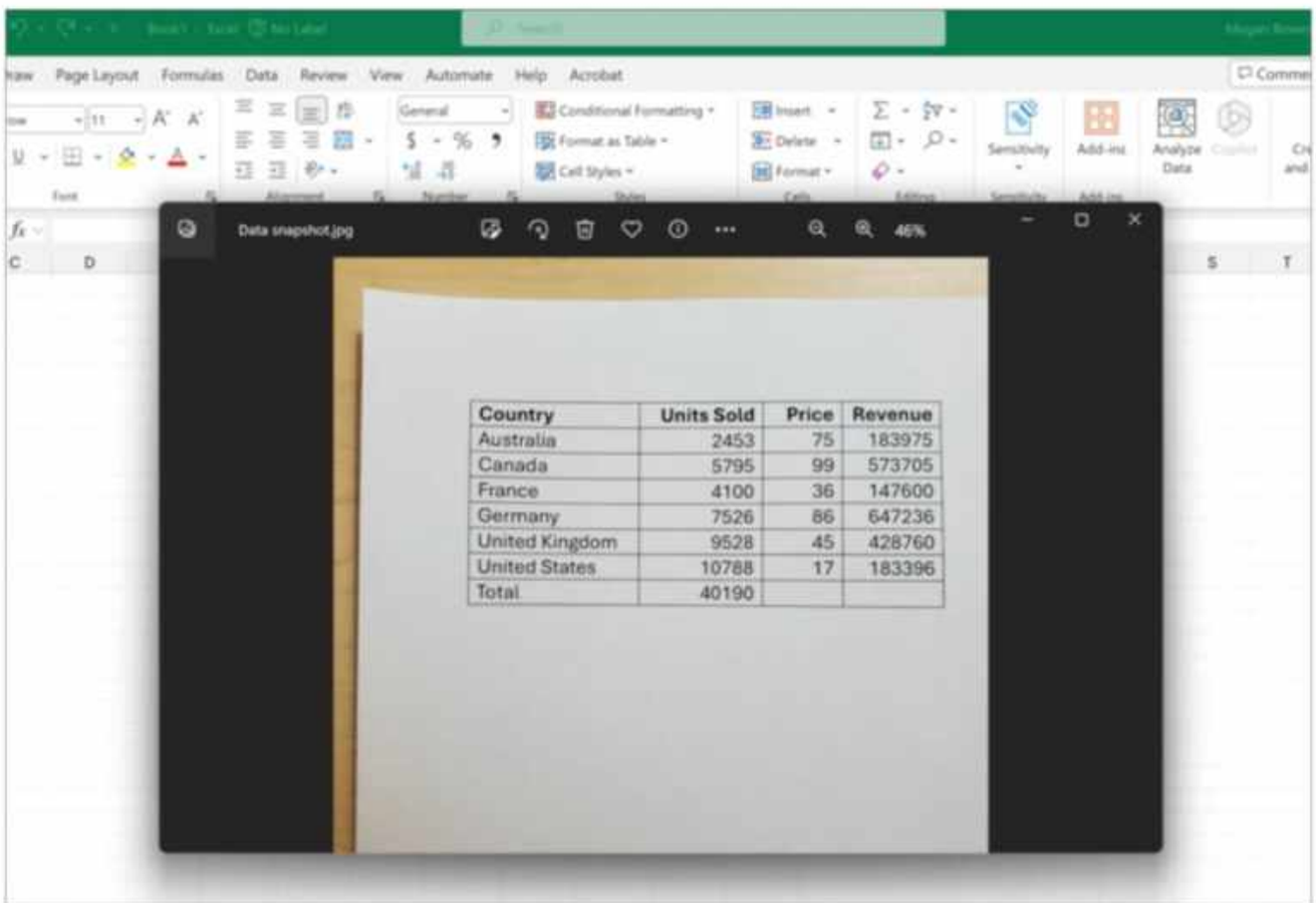
Duplex printing helps save paper. If your printer can automatically print on the front and back of a sheet, you usually activate the function directly in the main settings in the driver. You still have to control whether the sheet is turned over the short or the long edge of the paper. Duplex printing is only possible manually, mainly with entry-level devices. Once it is activated, a wizard shows you when and how to turn the sheets to print on the front and back. This feature is also worthwhile to keep paper consumption in check for longer documents.

The multipage mode allows you to place several pages on one printout. For this purpose, they are displayed in a reduced size but remain easily legible. You can usually find this function in the Layout area or directly in the main settings. In addition to the number of pages on a sheet, you can also determine the arrangement. Whether you place the pages next to each other or on top of each other depends on the document. The same applies to the number of pages that make sense on a printout. Economy foxes combine duplex printing with multipage mode for maximum paper savings.

If you have a multifunction printer with automatic duplex printing, it is also worth taking a closer look at the settings on the control panel, because your printer can also make copies on both sides, thus limiting paper consumption.

How to import data from paper into Microsoft Excel

This is a superhelpful, little-known feature. **BY ARNE ARNOLD**



You have a table on paper but you need the data listed in Excel? Fortunately, there's a simple trick for importing data on physical papers (or any other images) into Excel spreadsheets.

Take your smartphone and take a photo of the data, then send the photo to your PC via email, OneDrive, flash drive, or in any other manner. Once the picture is on your PC, open Excel, select the Data tab, and then choose the command From Picture > Picture from File from the "Retrieve and Transform Data" area.

Excel carries out text recognition and displays the data found on the right side of your spreadsheet. There you can check the data or insert it directly into the spreadsheet.

IMAGE: MICROSOFT

AMERICA'S DEADLIEST SHOOTINGS ARE ONES WE DON'T TALK ABOUT

On any given day in America, an average of 67 of our mothers, brothers, partners, and friends are taken from us by gun suicide. But tomorrow's deaths could be prevented. Store your guns safely: locked, unloaded, and away from ammo.

END FAMILY FIRE

EndFamilyFire.org

BRADY
UNITED AGAINST GUN VIOLENCE

ad COUNCIL

Tech Spotlight

A video showcase of the latest trends

Intel & The AI PC, NPU Performance, Developer Support & More

Join The Full Nerd gang as they talk about the latest PC hardware topics. In this episode the gang is joined by special guest Robert Hallock, Senior Director of Technical Marketing at Intel, to talk about all things AI, including Meteor Lake, NPU performance expectations, how developers will get involved, and more.