Tech Spotlight

A video showcase of the latest trends

Sense will examine your electricity consumption

Sense is a bright orange box that sits in your electrical breaker box and gives in-depth insight into your home's entire power usage. The whole system is quite clever and—thankfully—free of any monthly charges. But it learns very slowly, and that's likely to frustrate you.

PCWorld

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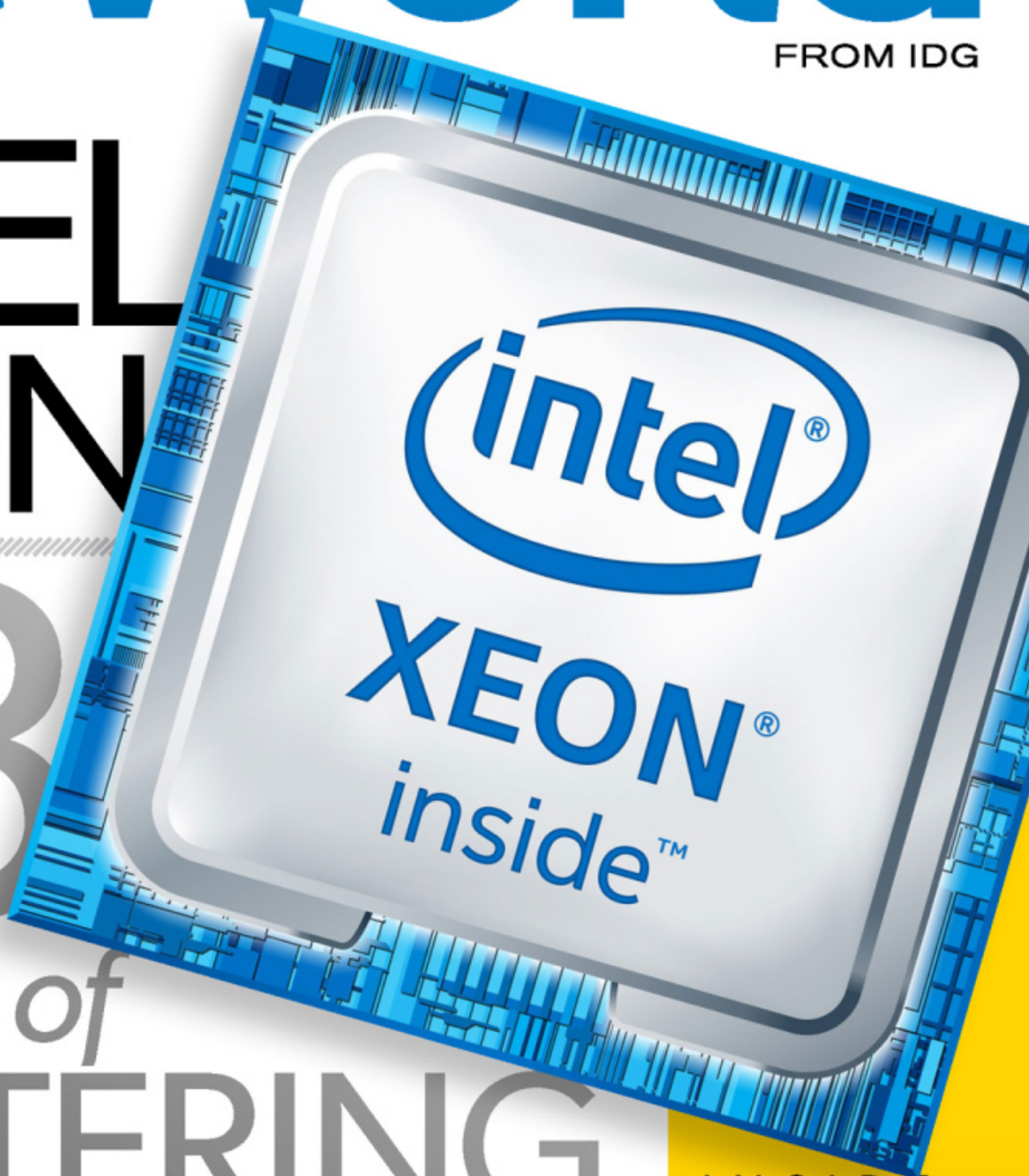

28 CORES of BLISTERING SPEED

INSIDE:

RADEON VII IS AMD'S RETURN TO ENTHUSIAST GAMING

ad COUNCIL

BECAUSE YOU WERE THERE FOR ME WHEN I HAD NO ONE, I STARTED LOVING MYSELF AGAIN.

Kailee M.

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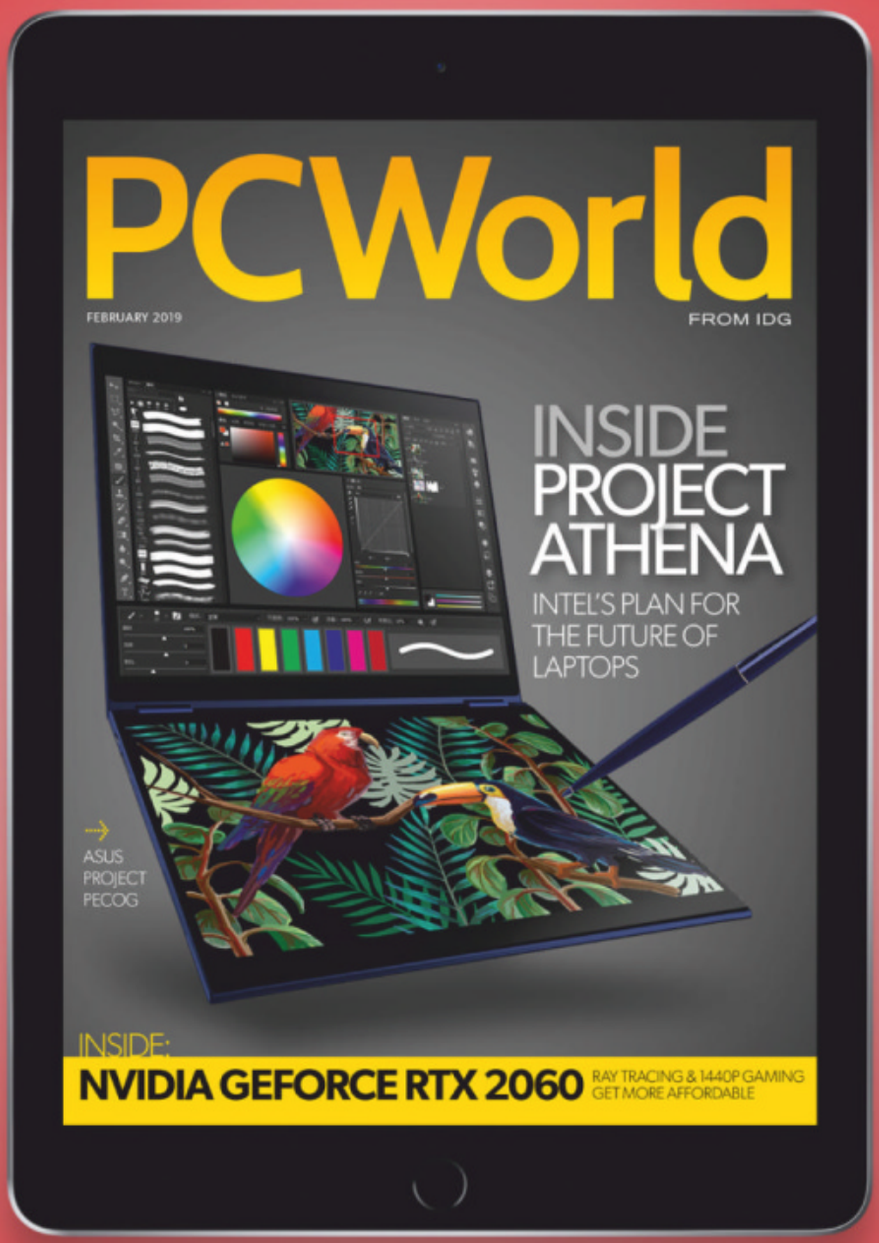

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For Windows 7 users, the glory days of Microsoft are ending in about a year

The Windows 7 transition will be a major pain point for Microsoft and its customers during 2019. **BY MARK HACHMAN**

For some, two of the best products Microsoft ever produced are Windows Mobile and Windows 7—and support for both are ending in about a year's time.

Earlier this week, Microsoft reminded customers that official support for Windows 7 ends on January 14, 2020, even posting an official reminder page (go.pcworld.com/7end) to encourage customers to hurry up and adopt Windows 10.

Now is also the time for Windows

IMAGE: DENNIS BUNTROCK

phones to finally accept their fate: Windows 10 Mobile, version 1709, will lose support (go.pcworld.com/lfaq) on December 10, 2019. At that time, Windows 10 Mobile users will no longer be eligible to receive new security updates, non-security hotfixes, free assisted support options, or online technical content updates from Microsoft for free, Microsoft says. In other words, no new patches. Backups, at least, will persist until March 10, 2020. It's even worse if you own a Microsoft Lumia or Lumia XL: June 11, 2019 will be the last date those devices are supported.

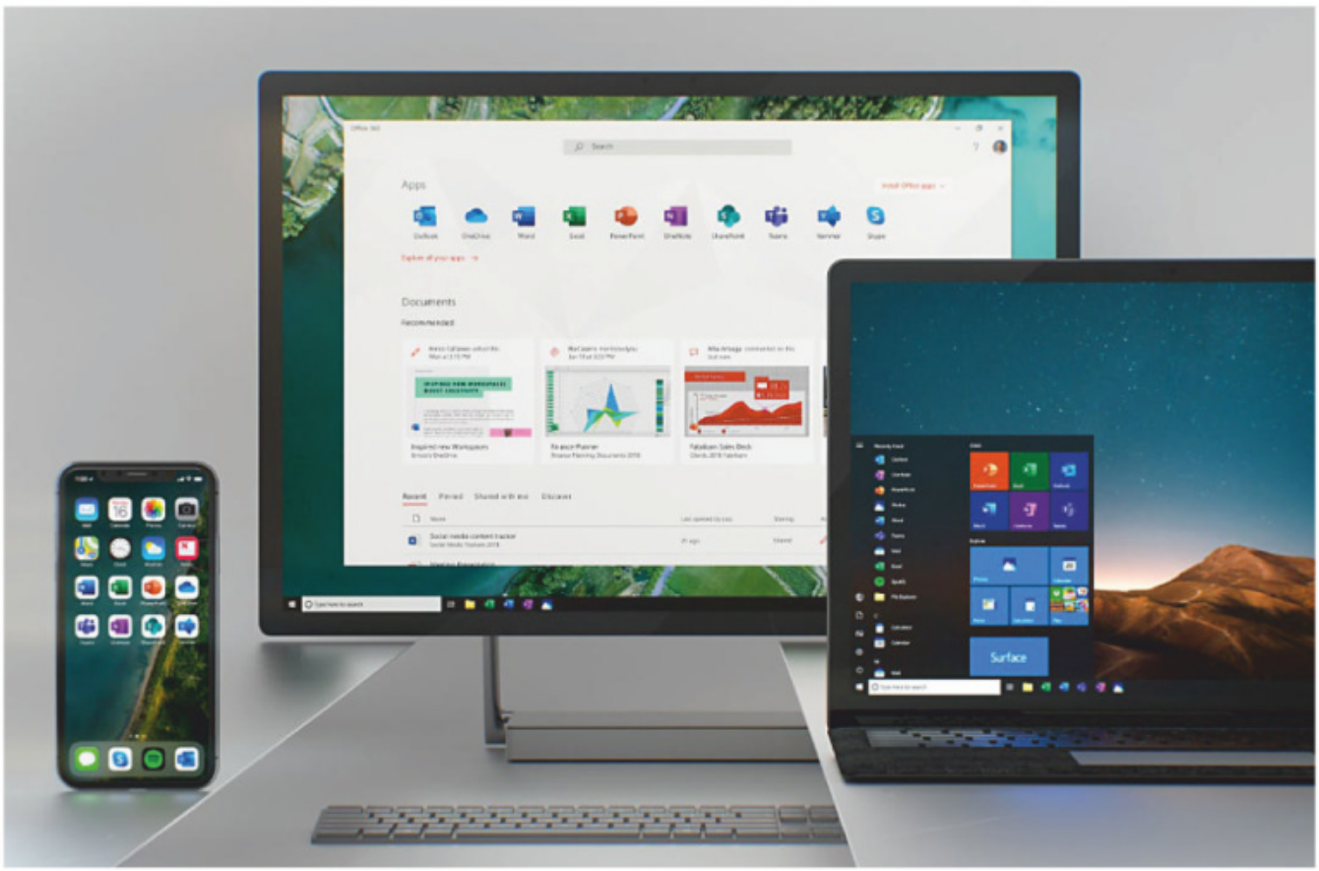
Because Microsoft has discontinued support for the Lumia family, the news is bleak for those who own and use a Lumia phone: "With the Windows 10 Mobile OS end of support, we recommend that customers move to a supported Android or iOS device," Microsoft says. "Microsoft's mission statement to empower every person and every organization on the planet to achieve more, compels us to support our Mobile apps on those platforms and devices."

The good news, if there is any, is that Windows Mobile market share was always tiny to begin with, and now is largely infinitesimal: 0.10 percent, according to NetMarketShare (go.pcworld.com/010p). (Two of the remaining few users are my wife and eldest son—can't play Fortnite if your phone doesn't support it, right?)

The more serious problem is the transition away from Windows 7. Microsoft's beloved Windows 7 is the most popular desktop PC operating system in the world, with over 40 percent market share (go.pcworld.com/40pc), again by NetMarketShare. Microsoft is encouraging businesses to make the transition before the deadline, and to ensure users also migrate away from legacy apps like Internet Explorer—which will die with Windows 7, too.

The upgrade path from Windows 7 is, naturally, to Windows 10—which isn't free. Microsoft's encouraging businesses to migrate to Microsoft 365—its package of Office 365 and Microsoft Windows support—which comes with a free upgrade from Windows 7, 8, or 8.1 Pro, but for $20 per user, per month. Consumers have no such option—you'll pay $139 to download Windows 10 Home (go.pcworld.com/by10), or a bit less if you opt for a system-builder option. Either way, the free upgrade window closed long ago.

What this means for you: If you own a Windows Mobile phone, you're going to have to migrate your phone's data onto an iOS or Android device, if you haven't already. As for Windows 7 owners, the problem is financial: Backing up your data to an external hard drive, then upgrading to Windows 10, requires an investment in time and money. Unfortunately, using Windows 7 after support expires is playing with fire.



Microsoft dismisses Office 2019 as old in videos promoting Office 365 subscriptions

Of course Microsoft would rather you pay them regularly for Office, just as you would for any other household utility. **BY MARK HACHMAN**

When Microsoft announced the standalone versions of Office last year, known as Office 2019, Microsoft's attitude seemed decidedly lukewarm (go.pcworld.com/half). We were wrong: Now it's downright hostile.

Microsoft released three videos (go.pcworld.com/3vid) recently to try and demonstrate that the AI-powered, always-updated version of Office 365 trounces the standalone Office 2019 in tasks ranging from automatically filling in geographic data in an Excel spreadsheet to automatically adding

IMAGE: MICROSOFT

relevant skills to a Word resume that can then be sent to a recruiter. In each of the "showdowns," Office 2019 forces the user to perform the tasks manually, while Office 365 either automatically performs the task or connects to the Internet to simplify it.

According to Jared Spataro, corporate vice president for Microsoft 365, Office 2019 is "frozen in time": "They [the Office 2019 apps] don't ever get updated with new features, and they're not cloud-connected," Spataro wrote. "Also, Office 2019 doesn't support real-time coauthoring across apps, and it doesn't have the amazing AI-powered capabilities that come with Office 365."

Microsoft has been busy adding intelligence to Office, with innovations like smarter search and Ideas (go.pcworld.com/nwsr) being added to simplify Office's deep feature set, to video transcription (go.pcworld.com/vdtr), to the Resume Assistant feature (go.pcworld.com/rsis) being shown off within the Word video. The message, so far, has been relatively understated: Office 365 enables these features, while Office 2019 does not. Now that positioning has become much more explicit.

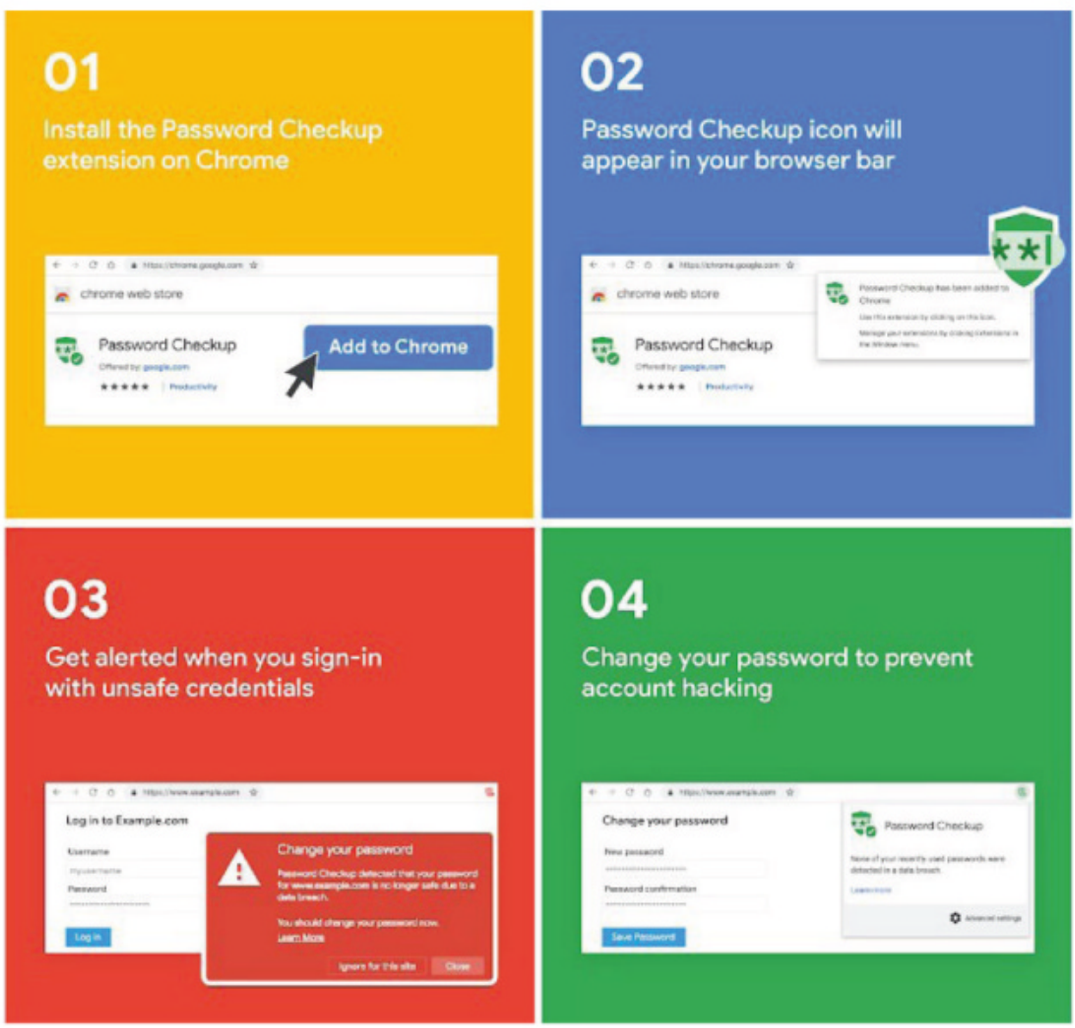
Office 2019—with what Microsoft calls a "perpetual license"—is $149.99 for Office Home & Student 2019 (go.pcworld.com/ofpr), which includes Word, Excel, and PowerPoint for a single PC. The Office 365 equivalent—Office 365 Personal (go.pcworld.com/365p), which includes Word, Excel, PowerPoint, Outlook, Publisher, Access, plus OneDrive and Skype—costs $69.99, though you'll have to renew every year to edit your documents and gain new features. Microsoft has historically encouraged users and businesses to budget for the ongoing costs of an Office subscription, just as you would for water and power utilities or property taxes.

What this means to you: For years, users questioned the value of upgrading to new versions of the standalone Office suite—a spell-checker was a spell-checker, after all. Microsoft would like you to accept that a connected Office suite provides not only up-to-the-minute access to a dynamic world of data, but also new services that you might not even imagine. What's interesting is that Microsoft now rather baldly considers its past versions of Office to be the competition: "Heads Up: Why Microsoft Doesn't Want Consumers to Buy Office 2019" was the subject of a Microsoft email announcing the new strategy.

Microsoft would like you to accept that a connected Office suite provides not only up-to-the-minute access to a dynamic world of data, but also new services that you might not even imagine.

Google's Password Checkup plug-in for Chrome can warn you if your password was stolen

It's another way of locking you into Chrome, but it's a useful tool. **BY MARK HACHMAN**



As data breaches become normalized, it's more and more likely that your personal information may be exposed. But how will you know? In February, Google published a Chrome plug-in that will report if the login info you use in say, Yahoo, has been stolen.

Google's Password Checkup plug-in (go.pcworld.com/4stp) won't do anything

IMAGE: GOOGLE

until it detects that you've logged in to a site whose data has been previously compromised. If a login and password have been found in the recent "Collections" leak (go.pcworld.com/colk) of more than 2 billion usernames and passwords, a message will pop up warning that your information has been compromised. All told, Google has archived over 4 billion credentials that it feels have been compromised.

Put another way, you can always manually check to see if your username and password has been leaked to the Web, using the Hasso Plattner Institute's Identity Leak Checker (go.pcworld.com/idlk), HaveIBeenPwned (go.pcworld.com/hvpw), or some other trusted database. Google is promising to perform this process automatically via Chrome, each time you visit a site.

If Chrome detects a credential has been stolen and published to the web, the Password Checkup pop-up will then ask you to change your password. (It's not necessary, but it's strongly advised.) Chrome already offers an automatic password generator, and will store that new password in a password credential file automatically, if you choose, and use it to log in to a site automatically in future visits.

CROSS ACCOUNT PROTECTION WORKS WITH PARTNER SITES

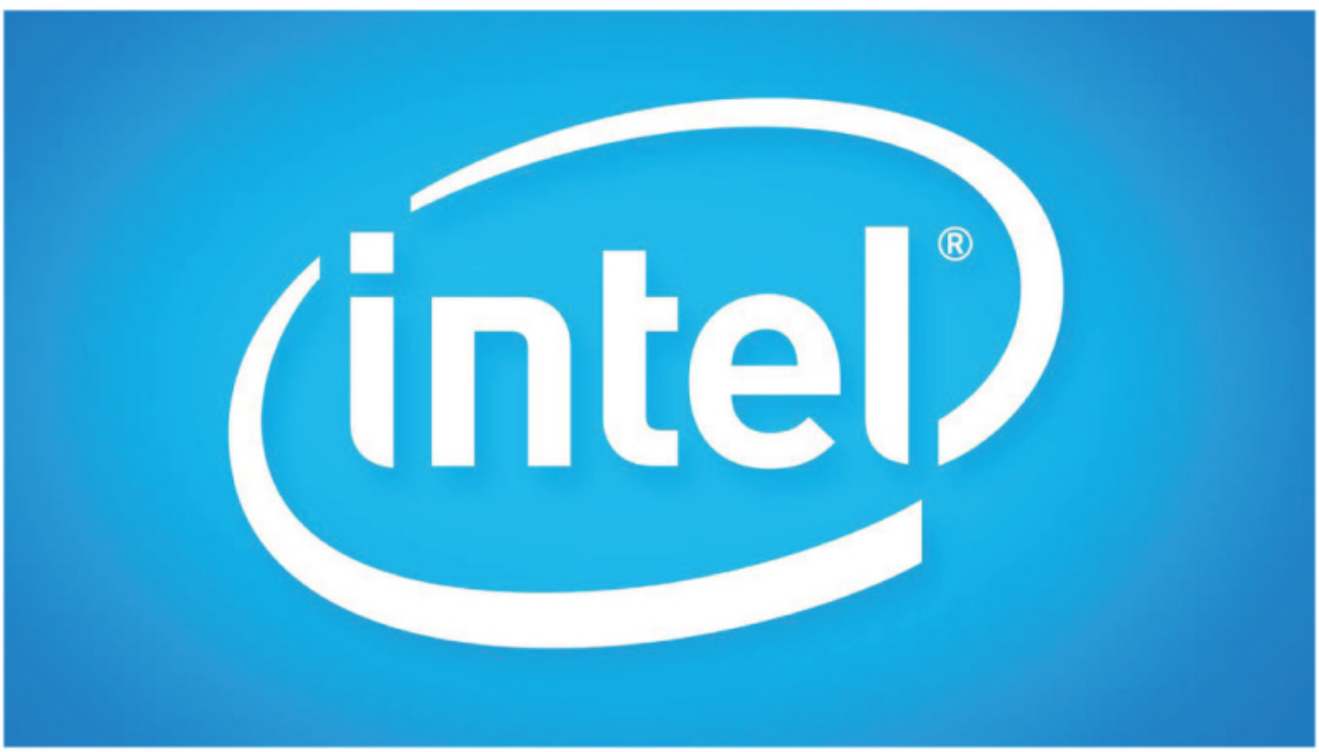
Google also marked Safer Internet Day today by rolling out a related technology, known as Cross Account Protection, to provide another line of defense to those third-party apps that use your Google account to log in. This isn't something that you can do anything about; Google said it's working with the Internet Engineering Task Force (IETF) and OpenID Foundation, as well as major technology companies like Adobe, to secure accounts using Cross Account Protection behind the scenes.

If Google knows of a hack where your Google account was compromised, it will quietly send information to those sites, letting them know that your account should be deemed suspicious for the time being. It's apparently up to those sites to determine whether they wish to continue allowing access for your compromised account while the situation's sorted out. Google said that it will share a minimum of information with those sites to protect your privacy.

What this means to you: At one point, Microsoft, Google, Mozilla, and others wanted you to become accustomed to using their own particular browser. Now, the incentive is for you to feel like you need to use a browser like Chrome. With additional features like a password locker, password generator, and now breach detector, Google's quietly building in value to convince you to stick with its browser rather than try alternatives.

Intel addresses processor shortages, CEO hunt after reporting disappointing fourth-quarter results

Intel heads into 2019 facing a number of challenges. **BY MARK HACHMAN**



Stealing a page from Apple's recent earnings warning, Intel blamed a lack of demand in China as one of the reasons for reporting healthy fourth-quarter profits that were nevertheless less than Wall Street expected.

Intel's fourth quarter, traditionally the company's strongest, capped what Intel said was a record-breaking year in terms of revenue. But Intel blamed China, weakness in cloud-computing customers, a weakened modem market, and an inability to manufacture enough processors as reasons the company's revenues did not meet expectations. Intel's manufacturing woes have been a source of questions since 2018, as has been when Intel will name a replacement for Brian Krzanich, Intel's former chief executive,

IMAGE: INTEL

who unexpectedly stepped down in June of 2018.

Interim CEO Bob Swan addressed both issues, at least in part. Swan predicted that Intel's manufacturing problems, which caused a shortage of its CPUs, would be fixed by the end of the second quarter. And as for a new CEO, Swan said the board would name a replacement "very soon."

Intel's first-quarter 2019 numbers aren't what analysts expected to see.

INTEL'S FOURTH QUARTER, BY THE NUMBERS

Intel disappointed Wall Street by reporting $5.2 billion in profits, compared to $18.7 billion in revenue. (Analysts polled by Yahoo Finance had expected earnings per share of $1.22 on revenues of $19.01 billion.) They also expected Intel to forecast $17.37 billion in revenue for the first fiscal quarter, ending in March. Instead, Intel said it expected to book $16.0 billion in first-quarter 2019 sales.

Intel blamed a number of factors, but China was a high-profile scapegoat. Apple had previously blamed for its own earnings warning (go.pcworld.com/ct19). For the current quarter, Intel sad that a slowdown in China, weaker sales to cloud customers, a weakening NAND flash market, and weaker modem demand contributed to the lower fourth-quarter sales. Looking forward, Intel said it sees trade and "macro" concerns intensifying, especially in China.

Intel's Client Computing Group saw strong demand for its higher-performance products, including gaming. Intel's PC-centric CCG grew 10 percent during the fourth quarter, to $9.8 billion overall. CCG still is Intel's largest business, though Intel's Data Center Group continues to climb: the unit reported $6.1 billion, up 9 percent year-over-year. PC volumes, though, fell by 2 percent, which Swan blamed on Intel's inability to manufacture enough chips. "We expected a stronger finish" to 2018, Swan said.

WHAT INTEL'S PROCESSOR SHORTAGES MEAN FOR YOU

Swan told analysts that part of Intel's inability to meet expectations has come as the company has struggled to transition to the 10nm manufacturing node. Intel spent the

recent CES in Las Vegas describing the company's wholesale switch to 10nm (go.pcworld.com/sw10), including Ice Lake, its next-generation processor, which is still on track to ship by the 2019 holiday season, Swan said.

The shortages were and are the most pronounced in the value end of the PC market, as Intel's strategy is to prioritize Xeon chips for servers—where there are "no shortages," Swan said—and so-called "big core" products at the high end of the PC market. "Big core" chips like the Core i9 will be prioritized over "small core," mid-range processors, followed by the cheapest "value" chips. Though he didn't say so explicitly, it appears that Intel's ceding the low end of the market to rivals such as AMD.

Swan said the total available PC market was essentially flat. The fact that Intel's PC sales fell by 2 percent, Swan said, was directly tied to the shortages.

In the meantime, Intel appears to be doubling down on its areas of strength—which, not coincidentally, are where it can turn high profits. Oddball chips like the Core i9-9990XE, which Intel will sell at auction (go.pcworld.com/9990)—yes, to the highest bidder—indicate that Intel will try and milk its high-end chips for all they're worth.

Intel's numbers also indicated two trends in the PC business. Though notebooks are selling well (up 8 percent year-over-year in revenue), they're not making much money per device (as average sale prices rose 6 percent). Buyers might be buying fewer

Intel is pinning its hopes on Ice Lake, its upcoming 10nm CPU.

desktops, as evidenced by the fact that desktop PC sales grew just 3 percent. But desktop PC prices soared 13 percent, indicating that gamers are investing in their desktop rigs.

Intel's latest Optane innovation combines Optane and flash memory on the same PCB.

FLASH WOES ARE GOOD NEWS FOR CONSUMERS

But what hurt Intel can benefit consumers. Intel cited a weakening market for NAND flash, and forecast that the trend will continue. That's good news for consumers planning to convert to or invest in SSDs, which should continue to decrease in price.

In the meantime, there's already been talk of SSD prices plunging throughout 2019, making great deals like this Samsung SSD (go.pcworld.com/86ev) more common. You're already seeing 500GB SSDs for about $60 (though some use the SATA interface, rather than the faster NVMe).

Swan said that Intel is "not too excited" about being in a commodity flash business, and that the company is seeking differentiated roles for flash memory and its Optane technology. A recent example of that strategy was the company's hybrid flash-Optane M.2 card (go.pcworld.com/0pm2) it showed off at CES.

As for Optane itself, Intel's message was that it won't be hampered by one-time partner Micron's decision to buy up the plant (go.pcworld.com/klop) that Intel and Micron used to manufacture Optane, more generically known as 3D XPoint. Swan said that a number of products were on tap to take advantage of Optane, though it's unclear what Intel's manufacturing strategy will be.

Intel executives concluded by saying that they didn't believe that conditions were that different than a few months ago, in October, when Intel predicted a slightly rosier outlook. This year, 2019, should be another record year of revenue, Swan said—its fourth in a row.

But 2019 should also be a challenge. That guidance includes Intel's prediction that it will successfully fight to protect its position in the face of increased competition, Swan said. Trade issues, a manufacturing conversion, and an aggressive AMD all mean that Intel will be fighting to keep its lead.

Intel makes Bob Swan its permanent CEO, maintaining a steady course away from the PC

Intel's choice is a surprise, as Swan reportedly didn't want the job. **BY MARK HACHMAN**

After searching more than half a year for a new chief executive, Intel decided the best candidate was the guy already running the company: Robert "Bob" Swan, the "acting" and now permanent CEO.

Technically, Intel promoted from within to hire Swan, who had served as the company's chief financial officer since 2016. But Swan's resume paints him as an outsider, with stints at fab tools maker Applied Materials, and nine years as the CFO at eBay. Swan has had CEO experience, but only running Webvan, an online grocery service that entered bankruptcy in 2001.

There's no question Swan comes as a

IMAGE: INTEL

surprise, as he was reported not to have wanted the job in the first place. "Swan told me that as he was in the interim CEO role, he started to like and enjoy it," analyst Pat Moorhead said in an email. "I do think Intel's strategy is the right one; the company needs to improve its execution, and bringing in an outsider without Intel experience didn't make sense."

As the chief financial officer, Swan's role within Intel was often behind the scenes. To many, then, he's a closed book. Intel's message in announcing Swan is of a guy determined to stay the course.

LITTLE TO SAY

Take, for example, Swan's letter (go.pcworld.com/swlt) to his employees, partners, and customers. We learn little: Swan's four key takeaways are that Intel will be "bold and fearless," that its strategy of transforming from a PC-centric to a data-centric company remains unchanged, that it must continue to execute, and that it must continue to evolve its culture—boldly.

Not a lot of insight there. In fact, Intel chairman Andy Bryant, himself a former CFO, arguably did a better job summing up where Intel is now than Swan did.

"As Intel continues to transform its business to capture more of a large and expanding opportunity that includes the data center, artificial intelligence and autonomous driving, while continuing to get value from the PC business, the board concluded after a thorough search that Bob is the right leader to drive Intel into its next era of growth," Bryant wrote. Not much, but it's something.

Really, though, what's always been in question at Intel was how firmly the company believed in its strategy. Processors, especially for the PC and data center, remain the company's lifeblood. Go too far astray, and Intel wanders into the embedded and IoT markets where the competition heats up. Intel's had an on-again, off-again relationship with communications, too. For the last few years, former chief executive Brian Krzanich's keynotes at the Consumer Electronics Show were a circus of drones and sensors. This month, at CES 2019, "IoT" wasn't mentioned once.

It does seem, however, that Swan seems committed to growing new businesses. "Our ambitions have never been greater and we have a relatively small share of the largest addressable market in Intel's history," Swan wrote to employees. "We must remain focused on playing offense and innovating for an increasingly data-centric world."

A HANDS-OFF APPROACH?

What Swan and Bryant seem to be signaling is that Swan will be a hands-off type of guy, more inclined to let Intel's business leaders set the direction as opposed to aggressively charting his own vision. It's not hard to imagine that he'll ask for a solid business case,

Intel's former CEO Brian Krzanich's.

too. "Leadership is a team sport and is about bringing together the team, setting the direction and letting the team be unencumbered – so they can achieve things nobody thought was possible," Swan wrote in his letter.

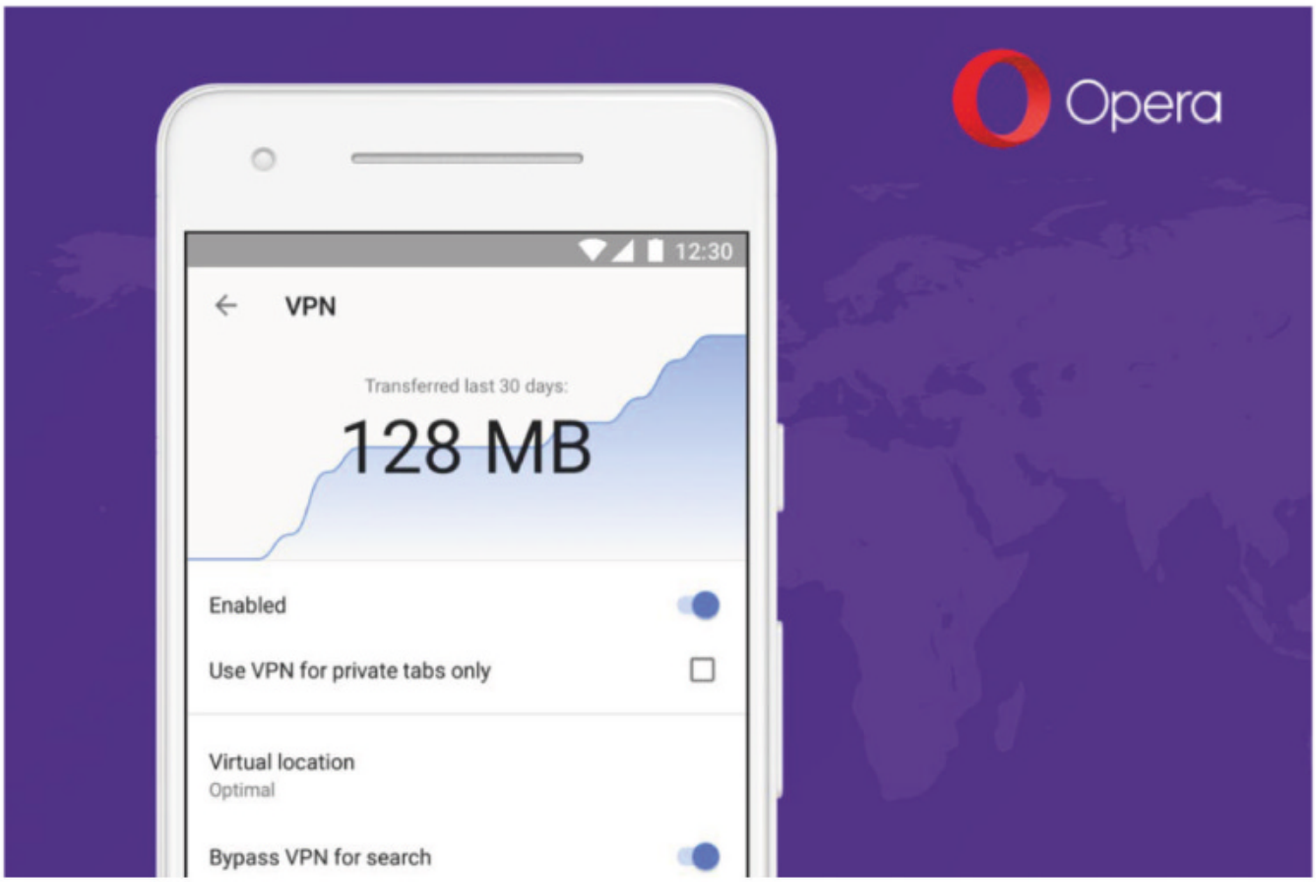
There's no question that Swan has succeeded in the months since former CEO Brian Krzanich unexpectedly stepped down last June (go.pcworld.com/krzn). But it's also unclear how Swan plans to proceed.

Take execution, for example. Intel has clearly struggled in its shift to 10nm processors, which are several years late and aren't expected to launch until the holiday season. But Intel's chief operating officer Kim Stevenson quit in 2017, without a direct replacement. While Intel would like you to believe that announcing "Ice Lake" and other 10nm chips at CES (go.pcworld.com/icel) means that its production woes have been solved, it still hasn't shipped those chips for revenue yet. There's still room for error.

If this theory is correct—and we won't know until more of Swan's moves are made public—Intel should continue tip-toeing into the IoT market, and continue pushing into "edge" computing with new investments in AI and related technologies. Intel has always recognized that data fuels the processors that are the engines of its own growth. Without enough data, those processors become less valuable. So if Intel's chips don't have enough data, it's Intel's job to enable more. At the same time, applying analysis to that data adds more value.

What does this mean for the PC market? Over the past few years, it's become damn difficult to continually push the envelope in processor innovation. Clock speeds have begun topping out between 4GHz to 5GHz, and the emphasis has shifted to additional cores—which software developers still struggle to fully use—and lower power, part of which is a component of processor technology.

For now, there's no suitable high-margin, high-revenue replacement available for the PC processor market. In a sense, then, Intel's future is already set: continue driving forward in the PC space, make gobs of money from the datacenter and Xeon chips, and continue investing in IoT to help further synergies in Intel's ecosystem. It's up to Swan to decide how quickly Intel evolves.



Surprise, Opera's free VPN is back! Here's how to get it on your Android phone.

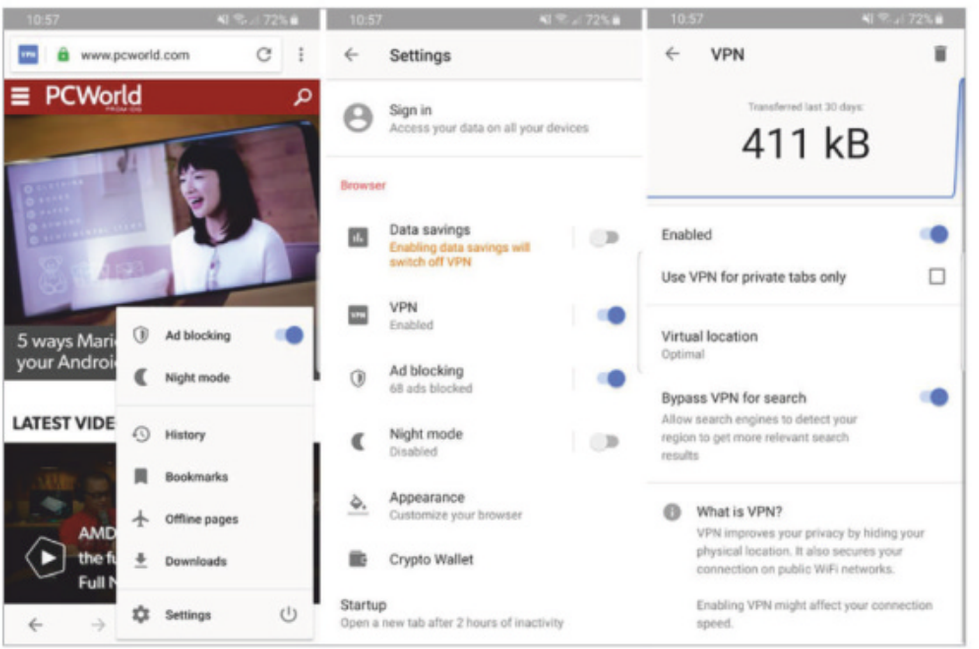
It's just as free and unlimited as before. **BY MICHAEL SIMON**

When Opera announced that it was shutting down its VPN app (go.pcworld.com/sdwn) for iOS and Android last year, it appeared as though it was gone forever. In fact, Opera directed users toward SurfEasy Total VPN with deep discounts on subscription plans. Apparently, Opera thought better of that idea, because it's bringing its VPN back (go.pcworld.com/adap).

There are a few caveats though. For one, it's still in beta mode. For another, it's only available within the full Opera browser (not

IMAGE: OPERA

Opera Mini) on Android phones. But otherwise, it's just as free, unlimited, and easy to use as the standalone app that was shuttered in April. And it's basically just like the desktop version except on your phone.



Enabling Opera's new in-browser VPN takes just three taps once the Opera browser beta is installed on your phone.

To try it out, you'll need to download the Opera browser beta (go.pcworld.com/brbt), which is separate from the Opera browser. Once you install it on your phone, tap the O icon in the bottom right corner of the screen, tap Settings, and flip the VPN toggle from Disabled to Enabled. Inside the VPN tab there are a couple of options for limiting VPN to private tabs, choosing a virtual location, and bypassing it for search engines, as well as a snapshot of how much data has been transferred, but mostly it offers automatic protection with virtually no fuss. You don't even need to sign in to an Opera account to start using it.

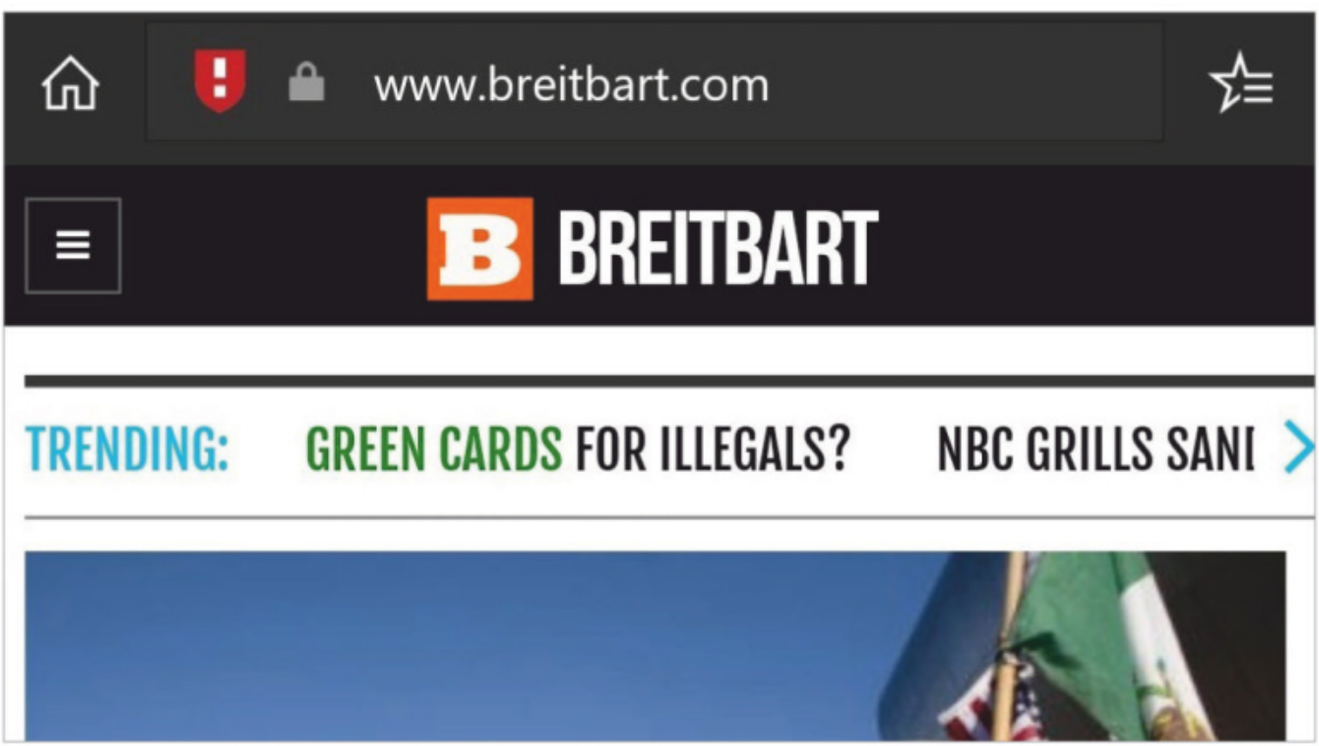
The VPN functions as expected. When enabled, it replaces your IP address with a virtual one to make it more difficult for websites to track you. It also is a "no-log service," Opera promises it won't collect any information routed through its servers.

It's unclear how long the VPN will stay in beta, but Opera says tests will continue "for some time." Also unclear is whether Opera will offer a paid subscription tier like before, which promised faster speeds and more regions.

Why this matters: In the age of data leaks and ad tracking, a VPN can be an excellent line of defense against bad actors and unscrupulous sites. Opera's VPN might not be as full-featured or versatile as some other VPN's, but it's hard to beat its simplicity and ease of use. Check out *PCWorld*'s roundup of the best VPNs for a deeper look at the category.

Microsoft fights fake news with NewsGuard integration in its mobile Edge browser

You'll need to dig into Edge's Settings to turn it on, though. **BY MARK HACHMAN**



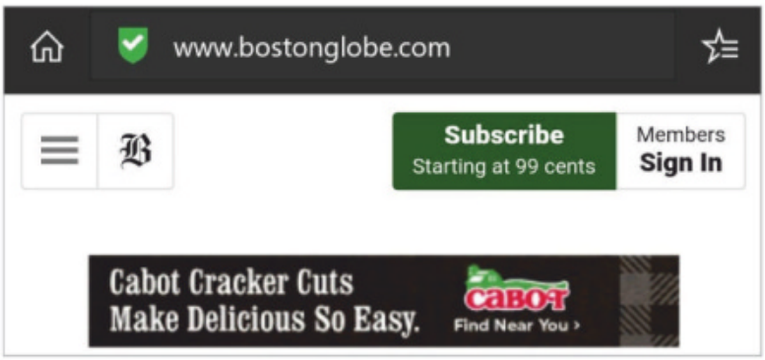
In a bid to fight fake news while on your phone, Microsoft's mobile Edge browser on Android and iOS now includes the NewsGuard extension.

The addition, noted (go.pcworld.com/fake) by *The Guardian*, needs to be toggled on within the Edge settings menu to be enabled. Once it is, Edge will display a small shield icon next to the site's URL in the search bar: a green shield with a checkmark for a trusted news site, and a red shield with an exclamation point inside of it for a site that NewsGuard believes isn't always accurate. (Some sites haven't been evaluated, and these will simply show a gray shield.)

NewsGuard isn't there to protect you from phishing or to alert you that the site may be hosting a bad ad that may infect your phone. Instead, it's there as a sort of

IMAGE: MARK HACHMAN

anti-malware for your mind. Clicking on the shield brings up a summary of how NewsGuard sees the site, from a responsible presenter of information, to correcting errors quickly, to clearly labeling ads. In certain cases, sites will be given a green shield but NewsGuard will flag problems that won't be revealed unless you click on the shield.

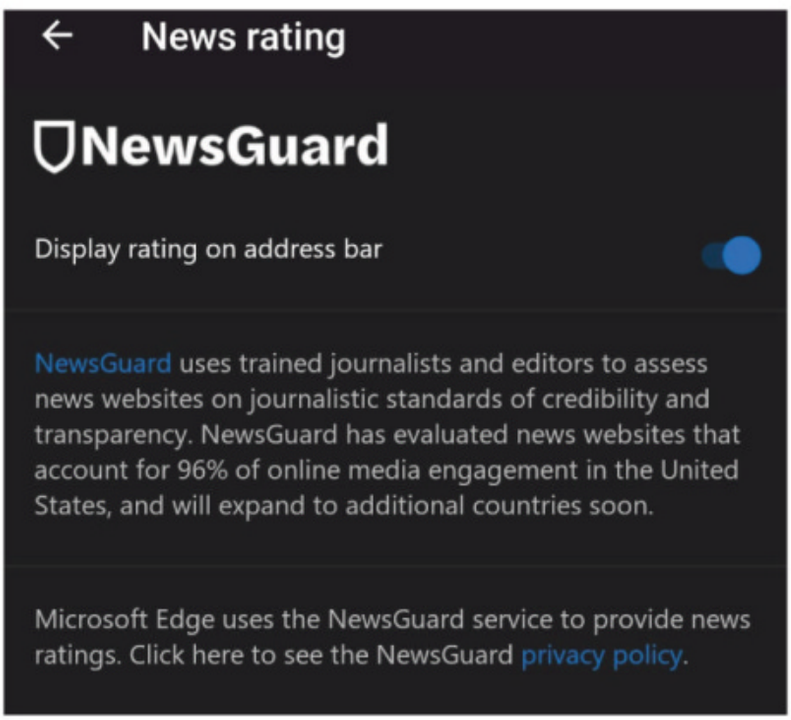


This site, according to NewsGuard, "generally maintains basic standards of accuracy and accountability."

It's a proactive move for Microsoft, which does not offer the same sort of integration within its desktop Edge browser. There, NewsGuard is merely an available extension. (To enable it, you'll need to access the ellipsis menu in the top right-hand corner, navigate to Extensions, then manually search for the NewsGuard plug-in.)

Within the mobile browser, though, NewsGuard is off by default. You'll need to go into the Settings menu, scroll down to News Rating, and then toggle on NewsGuard. Note that Edge also has a built-in relationship with Adblock Plus, which you can toggle on under Content Blockers.

What this means for you: The problem is that the only way to enable this on your phone is to download Edge manually, access the Settings, turn on the feature, and enable Edge as your default browser, rather than the default Chrome (or Safari) browser—which is what probably 99 percent of all users already have configured. That's a lot of steps to help stop your crazy uncle from forwarding the latest viral news story that Barack Obama was born on Venus. But every little bit counts, right?



You'll need to enter the Edge settings to toggle NewsGuard on.

New World preview: Amazon's debut video game is a sandbox MMO with faith in its players

Okay, it's technically Amazon's second game, but the company canceled its first game, Breakaway, so… **BY HAYDEN DINGMAN**

Amazon's foray into the games industry is proof nobody can shortcut their way to a hit. It's been fully five years since the online retailer, worth more than most (if not all) of the major video game publishers combined, announced it was going to start making video games. And it started so well! Amazon forked CryEngine into its own proprietary engine, Lumberyard. It hired Clint Hocking, hired Kim Swift—hired the sorts of people, in other words, that you'd want to see making games.

Then it uh…lost Clint Hocking, lost Kim Swift, and canceled the only Amazon game we'd seen in action, the MOBA-esque sports game *Breakaway* (go.pcworld.com/bway).

So what's left? Well, *New World*.

IMAGE: NEW WORLD

Announced at the same time as *Breakaway, New World* is an online sandbox set in the 17th century, a combination survival game, builder, and social sim. There's a lot going on here, for sure. The only problem? I'm not convinced the players will cooperate with Amazon's vision.

FREEDOM OF CHOICE

We had the chance to go hands-on with *New World* here in San Francisco. I'll be honest: Two hours? Not enough time to demo a game of this scope. To its credit, Amazon Game Studios tried its best by giving our entire play-session of around 20 people a "guided tour" through some of the major features.

But it's hard, because *New World* is very much a sandbox. When I think MMO, I still think of *World of Warcraft,* or more modern examples like *The Old Republic, Elder Scrolls Online, Final Fantasy XIV, Warframe,* and so on. These are all wildly different games, but stem from the same role-playing game influences. They all have heavy story components. There are missions, characters, shopkeepers, and so on.

All those games succumb to the same problem, as well. See, it's impossible for developers to produce content faster than players consume it. In the old days this led to a roller coaster, with large expansions seeing an influx of players for a few weeks or months, then a gradual falling off. Nowadays devs supplement those larger expansions with smaller missions or activities, generally every few weeks or months. Regardless, players are waiting on developers to provide the bulk of the entertainment.

New World puts that burden on the players. It's not a new idea. Hell, *EVE Online*'s done it this way for nearly two decades now. *EVE*'s story is generally not what keeps people playing, it's the complex and player-created political machinations. CCP gives you the tools, you use them to stab someone in the back. Easy.

And yet if it's so easy, why hasn't anyone else done it?

Two reasons, I think. One, you need

enough players to populate the game world and create these intricate factions. Two, and this is a related issue, is you need that back-and-forth to be interesting enough that players stick around, form ever-more-complex webs of alliances, build up items worth losing, and ultimately create a functioning society. Sure, it's a society in a bubble, but entire books have been written about *EVE Online*'s factions.

It's (relatively) easy to get people playing your game. It's much harder to lead them to create the kind of organic interactions you need to keep a sandbox game alive. The past decade's littered with games that tried and failed. *DayZ* had that magic for a year or two before succumbing to Early Access Hell. *Just Cause 2*'s multiplayer mode had a few months in the sun. *Sea of Thieves* tried, but its world felt empty and its loop too repetitive. *Fallout 76* quickly devolved into nonstop nuclear warfare or, worse, players just simply ignored each others' existence.

All this is to say, *New World* has an uphill battle ahead of it. The concept is unique enough. As I said, it's set in the 17th century, the tail end of the Age of Exploration. You and hundreds (or thousands) of strangers are sent to an uncharted island, one of the last in the world—uncharted because nobody's ever returned, not because nobody's tried. Surprise, there's something weird about this

island, remnants of an ancient civilization. Also, zombies.

But none of this is really "The Point" of *New World*. From what I can tell there are no missions in the game. Nobody's telling you, "hey, maybe go check out this weird ruin up north," or anything. I could be mistaken, but we didn't see any evidence of that in our demo at least.

Instead these elements exist as set dressing for the world, there for players to poke around in if they so choose. The focus is on building faux-societies, from scratch.

There's a major survival game element here. If you've already had your fill of chopping down trees and collecting rocks, *New World* is absolutely not going to sway you. It's…a lot of that. Collect sticks and flint, make an ax and a pick, collect more wood and stone, turn that into walls. I imagine people generally know what they're in for by now with one of these crafting games, and *New World* doesn't really break from the mold.

New World's island is peppered with claims, though: plots of land where players can group up and build larger strongholds. You can put up fortifications and gates, create better crafting tables, all the usual stuff—except as with *EVE,* this all happens in groups. Impromptu factions form, if only because you built a wall and it took you an hour to harvest enough stone to do it and you don't want somebody to break the thing down.

Or at least, that's how Amazon envisions *New World* working. That exact example, a player not wanting their wall broken, was cited multiple times during our demo. I can certainly see the intent. One of the most unique things Amazon's done is make building prohibitively expensive, from what little I saw of that system. Keep in mind we didn't do much building ourselves, but even basic fortifications seemed like they'd take a concerted effort to erect. Maybe it's enough to get people invested in their new society.

If it is, then the idea is factions will square off in large battles, trying to secure better territory. You have to actually declare war in *New World,* at which point the defending faction is given 24 hours to prepare. When

time's up the attackers storm the walls, use barrels of gunpowder to blow them up, slaughter the defenders, and take the remnants of the fort for themselves. Or they don't, and are turned away. (In our demo we did take over a lightly defended fort, though not much remained by the time we finished.)

BOTTOM LINE

What if people don't get invested? That's my real worry with *New World*. When Amazon Game Studios describes the game, it sounds neat—thousands of players all vying for control of this island, building forts and declaring war and jockeying for position. The non-combat roles sound interesting as well, with the developers telling us you could role-play an archaeologist or an engineer, or what-have-you.

With no structure, everything ultimately depends on how players react to *New World*. If they embrace it, Amazon's vision could become reality and *New World* could become a blueprint of sorts for future MMOs, or at least a bright spot in a tempestuous genre. If they don't? Well, we're in for another *Sea of Thieves*, another *Fallout 76*, another sandbox that sounds conceptually interesting but minute-to-minute boils down to the player feeling bored and trying to wring entertainment from a limited tool set.

It's hard to know which future is in store, and maybe that's the most surprising aspect—that Amazon, with all its resources, can't guarantee a hit game either.

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Intel Xeon W-3175X: 28 cores of blistering performance

Intel's 28-core Xeon W-3175X isn't quite the Threadripper killer, but damn, it gets close.

BY GORDON MAH UNG

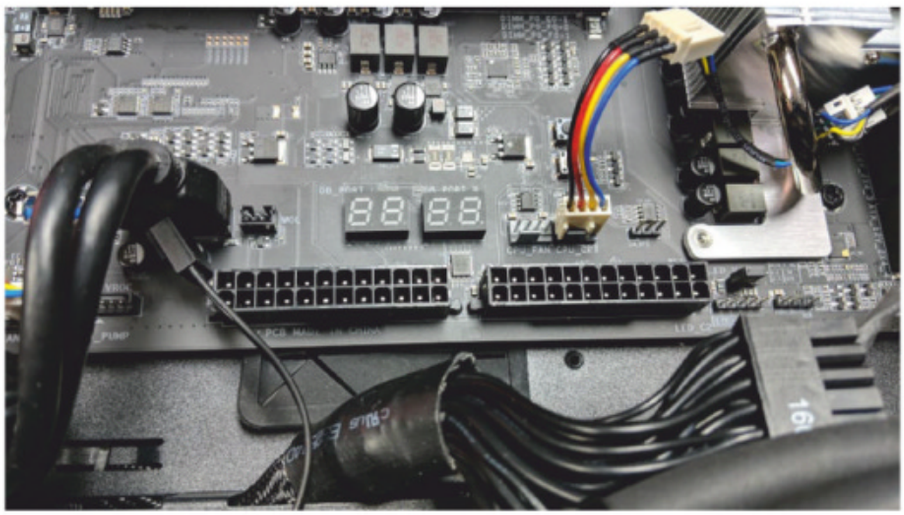
Intel's crazy-ass 28-core Xeon W-3175X isn't a CPU built for you, me, or most of us.

Sure, Intel pitches it as a high-end workhorse: "Built for handling heavily threaded applications and tasks, the Intel Xeon W-3175X delivers uncompromising single and all-core world class performance for the most advanced professional creators and their demanding workloads."

But make no mistake, the 28-core Xeon W-3175X is a chip made to do one thing:

IMAGE: GORDON MAH UNG

make waves and push back at an increasingly assertive AMD. And it delivers—for a pretty penny. Fasten your seat belts, because you're about to see some huge motherboards, a huger number of benchmarks, and the hugest desktop CPU price ever.



The Gigabyte AX1 motherboard for Intel's Xeon W-3175X can support two power supplies in case you somehow need more amps than a single 1600 watt power supply.

WHAT IS XEON W-3175X?

If you've read reviews (go.pcworld.com/ci9r) of Intel's previous 18-core Core i9-7980X or 18-core Core i9-9980X that replaced it, you already know something about the Xeon W-3175X. Like them, it's essentially a Skylake-SP aimed at a high-performance crowd. It's built on a 14nm process and has a stock TDP of 255 watts. To keep its cores fed, it features support for six channels of DDR4 memory in ECC or non-ECC trim.

Perhaps its most important feature may be its unlocked status. As always, Intel doesn't actually condone overclocking, the same way Lamborghini doesn't tell you to break local speed limit laws.

What's in the name? Why isn't this a Core i9? Or, maybe a Core i11? Intel didn't say why it chose to keep the Xeon name, but in the end it doesn't matter much. With a list

One of two current motherboards for the new 28-core Xeon W-3175X is the Asus Dominus Extreme—a 14x14-inch motherboard using the SSI EEB form factor.

price of $3,000, it's how it performs that matters.

CRAZY-POWERFUL MOTHERBOARDS

One look at the first two motherboards designed for Xeon, and you know this isn't for someone to run a SQL database to manage the inventory for a supermarket. Gigabyte's AX1 features nothing less than a 28-phase power circuit (go.pcworld.com/28ph) for the new Xeon W-3175X.

On the right is Intel's new 28-core Xeon W-3175X and on the left for a size comparison is AMD's Threadripper 2970WX.

Hell, the Asus Xeon W-3175X motherboard weighs 10 pounds alone. Like the AX1 it, has enough auxiliary power connectors to light up a small city.

You don't need two 1,600-watt power supplies to run a few virtual machines. No, the only time you'd need that amount of power is for over-the-top overclocking. Yes, it's benchmark time.

HOW WE TESTED

For our tests, we basically made quad-core and eight-core CPUs leave the building. What? Just 18 cores? Get out! No, for this slug fest we wanted to find out the eternal question of what would happen if The Hulk fought Superman. Yes, nerds, you want to only know what happens when 28-core Xeon W-3175X faces off against 32-core Ryzen Threadripper 2990WX.

For our tests, we used the same configuration as our original Ryzen Threadripper 2990WX review here (go.pcworld.com/290w). The only variance from the original review were updated motherboard drivers, updated GPU drivers and an updated BIOS and the latest version of Microsoft Windows 10 Pro RS5. While we used the same GPU, storage and OS for both, we did vary on memory and cooling.

The Threadripper 2990WX ran in quad-channel configuration with 32GB of dual-rank, DDR4/3200. The Xeon W-3175X, ran 48GB of ECC DDR4/2667in hexa-channel configuration.

For cooling, the Threadripper 2990WX used the same Enermax TR4 CLC cooler, while the Xeon W-3175X was cooled with an Asetek 690LX-PN.

The motherboard for the Xeon W-3175X was Gigabyte's soon-to-be-released AX1, ,while the Threadripper used the same MSI X399 MEG from the original review.

One last note before we get too far: Since our last review, AMD released its "Dynamic Local Mode," which helps keep threads on the most efficient cores in the CPU rather than let Windows randomly throw them at the wall. Normally DLM works really well, but there were moments when it slightly hurt performance. Because you have to enable DLM through Ryzen Master, we opted to run both DLM and the default configuration for our tests.

Finally, all of the tests were run at "stock clock" which oddly, means many things to many people these days. Basically, it's the default setting on both boards.

3D MODELLING PERFORMANCE

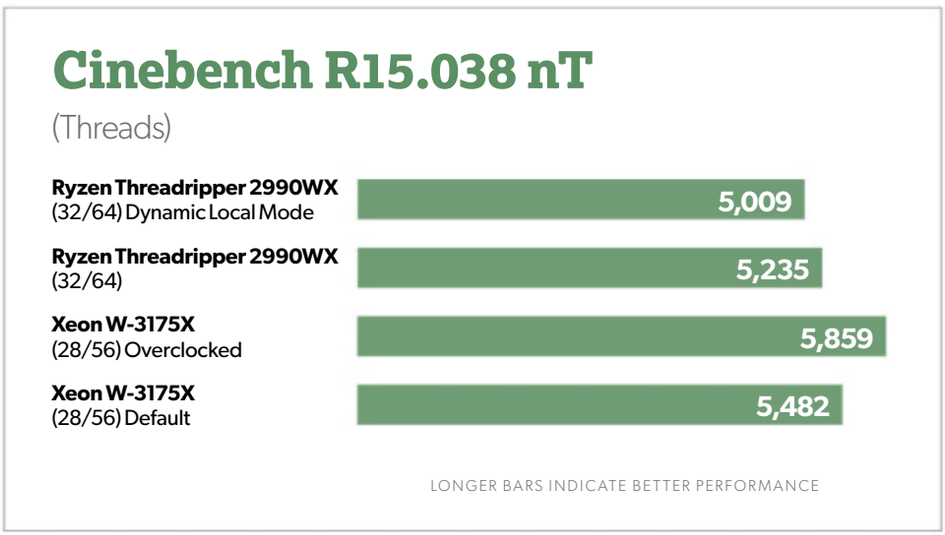
Sometimes we apologize for using 3D modelling tests for performance testing because it's not really what most people are doing. Well, if you buy a 28-core Xeon or a 32-core Threadripper 3D rendering is probably your jam.

The first result is from Maxon's Cinebench R15. Although it uses a somewhat older version of the engine than the one in its Cinema4D product, it scales with core count and thread count exceptionally well.

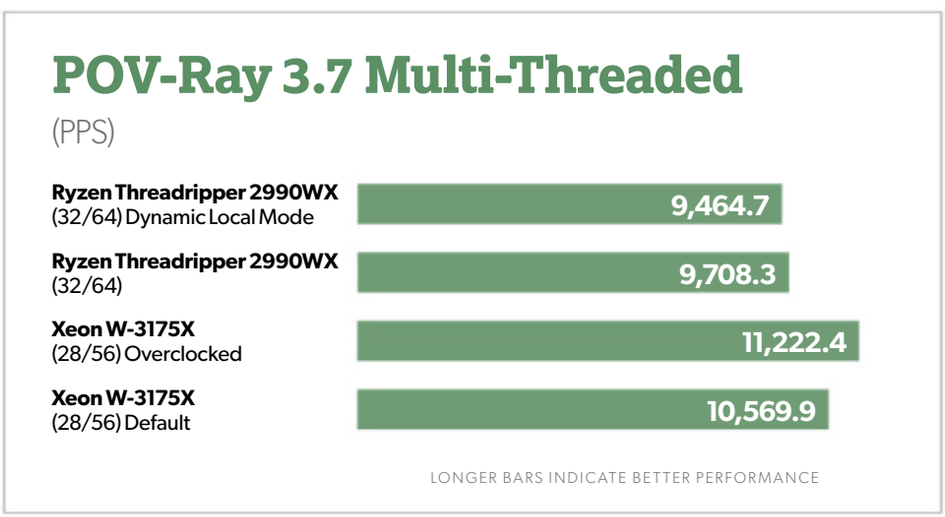
HEAVY HITTERS

MAKER	INTEL	AMD
Model	Intel Xeon W-3175X	Ryzen Threadripper 2990WX
Socket	LGA3647	Socket TR4
Memory Channels	6	4
Cores/Threads	28/56	32/64
Cache	38.5MB	80MB
CPU PCIe Lanes	44 Gen 3	64 Gen 3
TDP	255 Watts	250 Watts
Base Clock	3.1GHz	3GHz
Boost Clock	4.3GHz	4.2GHz
Process	14nm	12nm
Price	$2,999	$1,799
Release Date	Jan. 2019	Aug. 2018

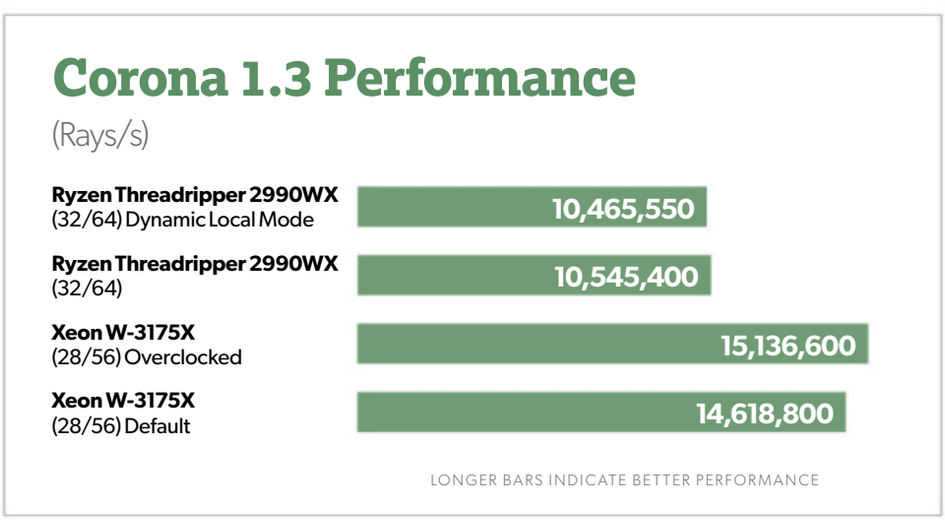
It's clear Intel and AMD are vying to see who can make the best Wendy's Baconator of burgers.



Despite having 8-more threads, the Threadripper 2990WX loses to the 28-core Xeon.



POV-Ray also puts the 28-core Xeon ahead of the 32-core Threadripper.



More cores typically mean more performance

The clear winner here is the Xeon W-3175X, which crosses the finish line about 10 percent ahead of the Threadripper 2990WX. Some will see the proximity of the AMD CPU (as you can see, turning on AMD's dynamic local mode slightly depresses performance) and think it's a tie—but you should remember that we are talking about 64 threads vs. 56 threads. We had expected the Threadripper 2990WX to take the win here

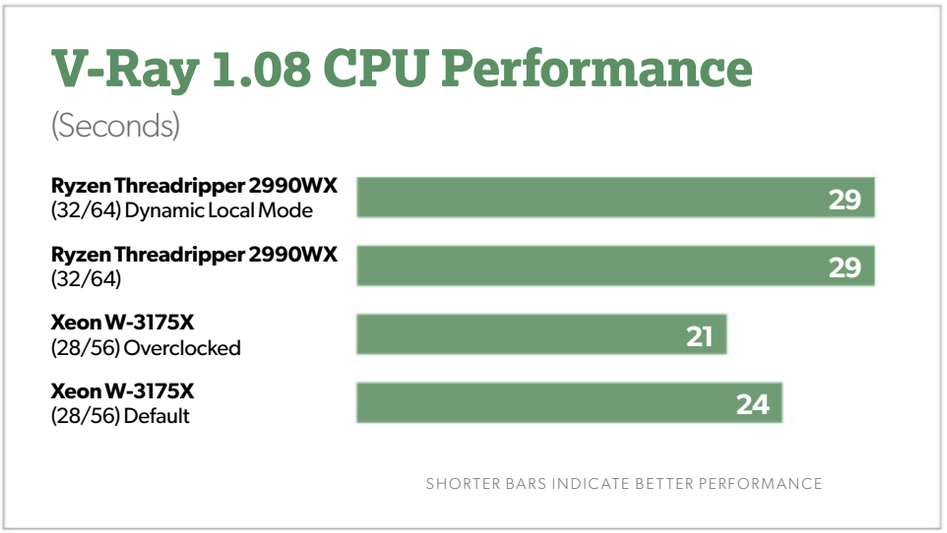
Corona puts the 28-core Xeon about 28 percent (coincidence?!) ahead of the 32-core Threadripper 2990WX.

instead of losing it.

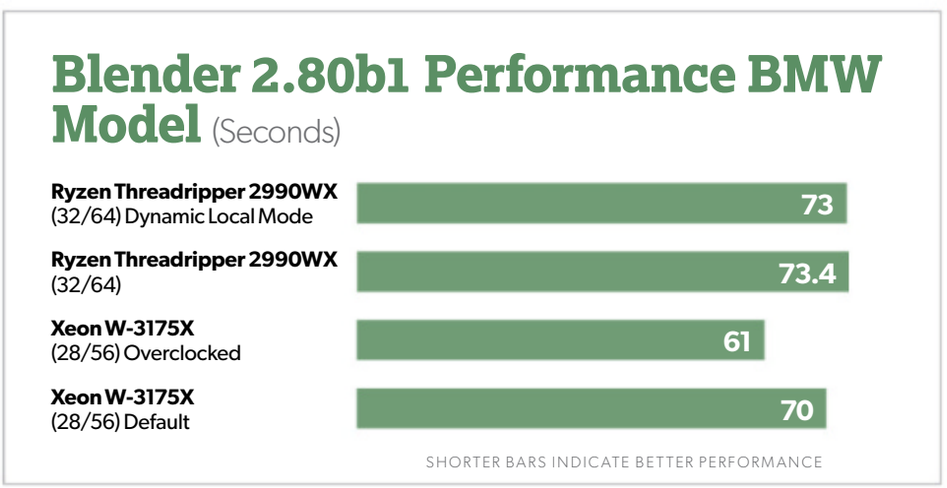
The Threadripper's loss to the Xeon isn't just in Cinebench. In the Persistence of Vision ray tracer, the 32-core chip loses to the 28-core chip by about 8 percent. Again, DLM slightly depresses its performance.

Where it gets particularly ugly for Threadripper is in the Corona 1.3 Render. The Corona Renderer is an "unbiased photo-bought realistic renderer."

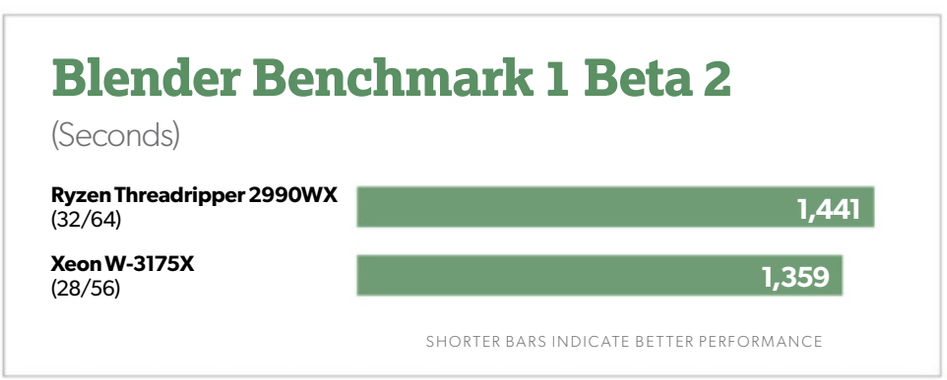
Unbiased" refers to its rendering technique—not an allusion to any hardware leanings. The test embraces multi-core CPUs, so we expected Threadripper would do better than Xeon. Nope: t to be similar to the Cinebench performance but the Xeon absolutely hammers the Threadripper to the tune of 28 percent.



V-Ray puts the Xeon ahead of the Threadripper by about 20 percent.



Blender 2.80 puts the two chips much closer, but despite its thread advantage, Threadripper loses



Blender's new Benchmark mashes multiple different tests together to give you a single score. Xeon wins again.

Next up is the Chaos Group's V-Ray renderer. Generally, the more cores you throw at it, the faster it gets. And yet the Xeon W-3175X again whups the Threadripper, despite the latter's advantage in thread count. Possible reasons include each CPU's particular micro-architecture design, the actual clock speeds each CPU runs at when loaded up, to the compiler used for each. We'll try to circle back to find out more.

All that is academic, though, if the only thing that matters to you is less waiting for your V-Ray or Corona-based render to finish.

Not everything is that ugly though. Using the latest beta version of Blender and Mike Pan's BMW model, the Xeon again wins, but by just 5 percent. It's close enough to be boring, unless, of course, you're wondering why the extra 8 threads in Threadripper aren't pulling their weight.

Our last multi-threaded rendering result is Blender's new benchmark. It smashes together multiple popular benchmark models, runs them against Blender, and spits out a final result based on how long it took. There's the option to run it against the GPU or the CPU, so we opted for the CPU test.

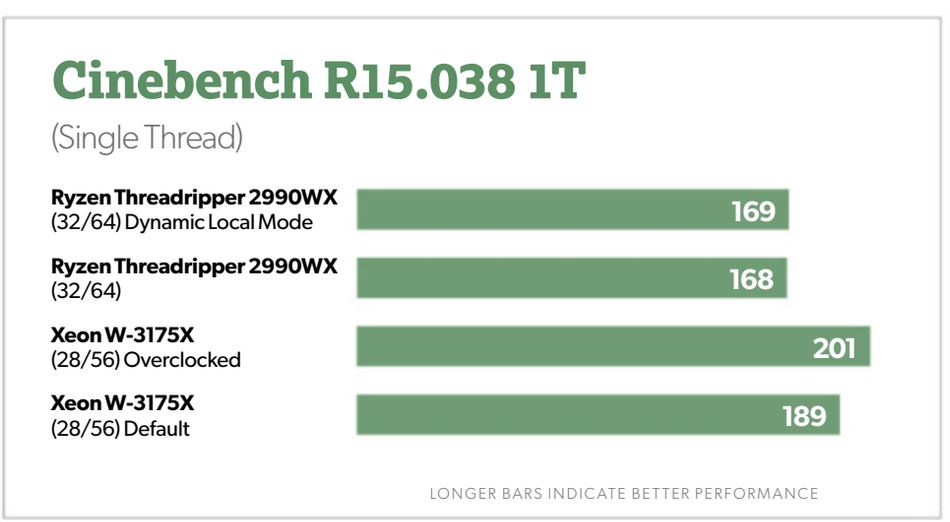
The result, again puts the 28-core Xeon on top by about 6 percent. Again, not a huge win, but it's doing it against a 32-core CPU.

SINGLE-THREADED PERFORMANCE

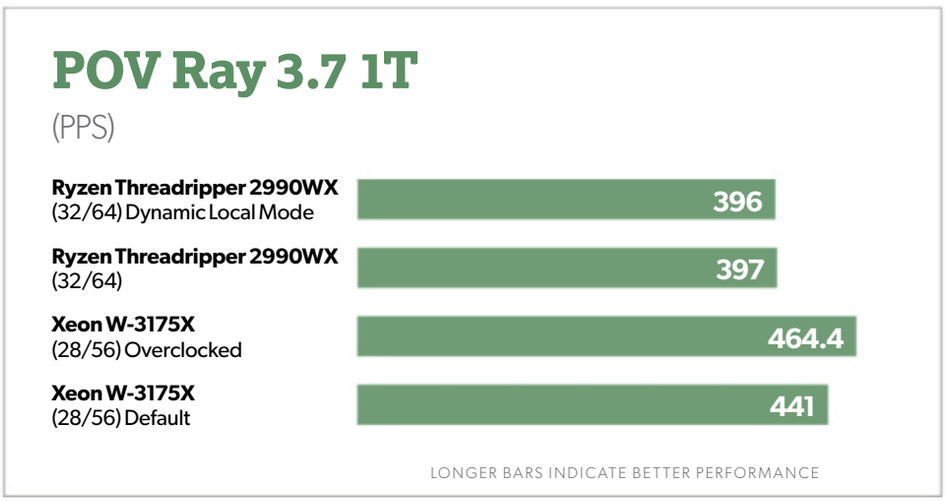
If you bought a very expensive CPU to run single-threaded tests, you overdid it. Still, there's value in seeing just how fast these particular chips are in much lighter loads. First up is Cinebench R15 where, no surprise, we see Intel's advantage in clock speeds show up: The Xeon comes in about 11 percent ahead of the Threadripper. Intel has long held the win for single-threaded performance.

If anything, we're actually surprised the Threadripper is as close as it is, so in some ways, it's a win for AMD too. We also see the Dynamic Local Mode actually help it slightly.

We an POV Ray using a single thread and, well, surprise, 10 percent.



In single-threaded performance the Xeon comes in about 10 percent to 11 percent faster, which is almost a win our book.



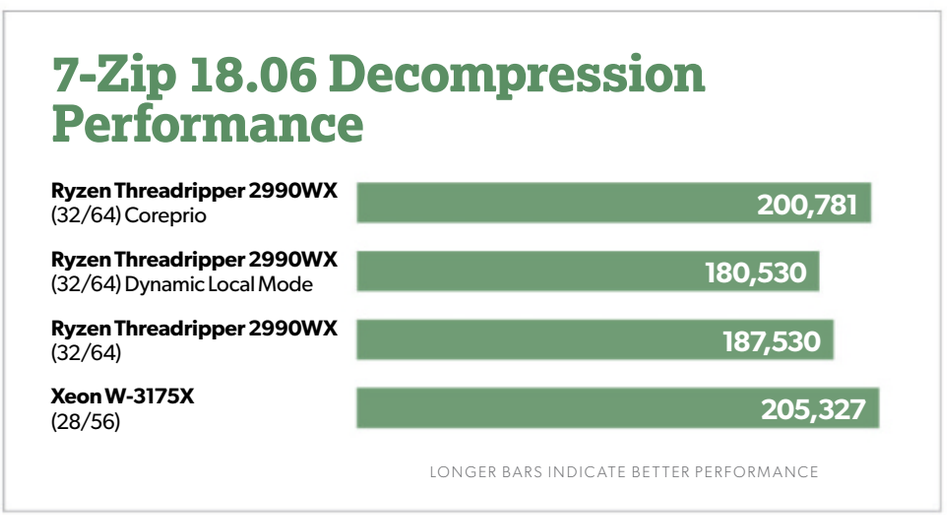
POV Ray puts the two chips about 10 percent apart on light single-threaded loads.

COMPRESSION PERFORMANCE

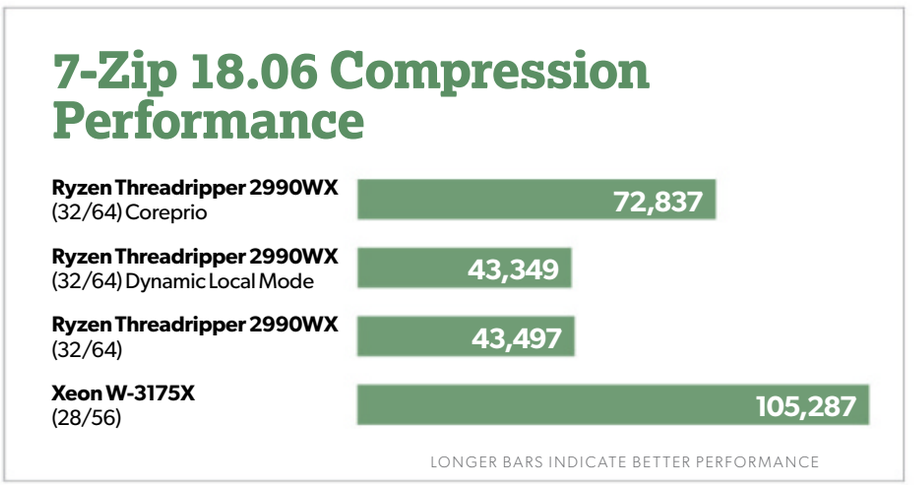
Next up is performance of the two chips in compression, starting with WinRAR. We've been running it long enough to know that Ryzen just doesn't like it. Besides testing AMD's DLM mode, we also tested BitSum's CorePrio free utility (go.pcworld.com/crpr), a DLM competitor that also fixes the mysterious problem in Windows that sees performance in some tests simply plummet. Most fingers point to problems with Microsoft Windows scheduler. CorePrio's NUMA Dissassociator feature implements work discovered by Level1Techs (go.pcworld.com/lvl1).

First up is the decompression portion of 7-Zip which is mostly heavy in integer performance. Without the CorePrio utility, The Xeon has and advantage by about 10 percent. With the utility though, it's mostly a tie. Intel fan, will of course point to 8-fewer threads means Xeon still wins right? But then, AMD fans will point to the dollar amount. So yeah.

Of more interest to us is the compression performance of 7-Zip. The developer has stated this portion of the test is particularly sensitive to memory bandwidth. As you know, the 32-core Threadripper has four channels of memory bandwidth spread among all of its cores.



BitSum's CorePrio utility is worth having on your Threadripper machine.



The new 28-core Xeon has six channels of memory bandwidth. This theoretically gives each core about 27 percent more memory bandwidth at the speeds we tested and you're likely seeing some of that here.

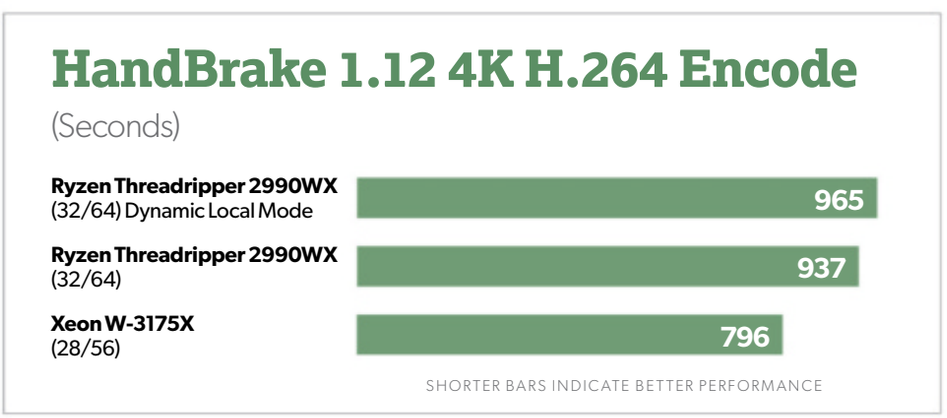
We're saying likely because the memory bandwidth issue in Threadripper may not be as dire as it looked some months ago when we wrote this. With the CorePrio NUMA Dissassocator running we saw the huge gap of 58 percent for the Xeon versus just AMD's DLM mode (red bar above) pull back to just 31 percent. Sure, 31 percent is still, umm painful when you consider it has more cores and this is a multi-threaded test, but it's better than 58 percent (green bar above). Expect more on this in the future hopefully. The short answer is: Xeon wins big still.

CONTENT CREATION PERFORMANCE

Not everyone who might buy these CPUs does only 3D modelling. There's a good chance they will also do content creation tests, which traditionally lean heavily on the CPU.

Our first test tasks the free and popular HandBrake utility with converting a 4K, 4GB file using the app's H.265 profile. HandBrake is multi-threaded but it typically won't use all of the threads of a 32-core, or even 28-core CPU.

The big winner here is the Xeon, which comes out on top by 17 percent when DLM is off. When DLM is on, the Xeon is actually 21 percent faster.



The Xeon wins big in our HandBrake transcode test.

What's up? Well, there's a good chance that where HandBrake maxes out is just in that zone where the Xeon is at its peak performance on clock speeds. Sure, there's that memory bandwidth thing, but we honestly have not seen memory bandwidth make that much of a difference in most encoding tasks.

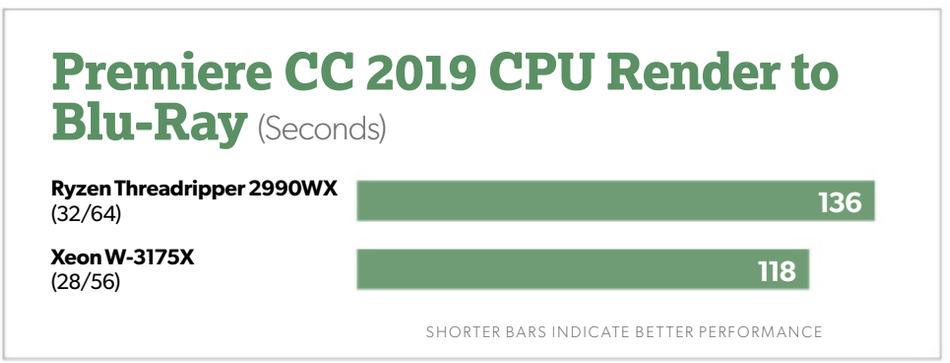
Our next test uses Adobe Premiere Creative Cloud 2019 to export a short video shot on a 4K Sony Alpha camera using the app's Blu-Ray preset for export. Because the resolution changes, we also check off the Maximum Render quality option, which improves visual quality when resizing.

Finally, we do the encoding on the CPU, which some video nerds claim gives you the highest possible quality over GPU encoding. The winner: Xeon by about 15 percent.

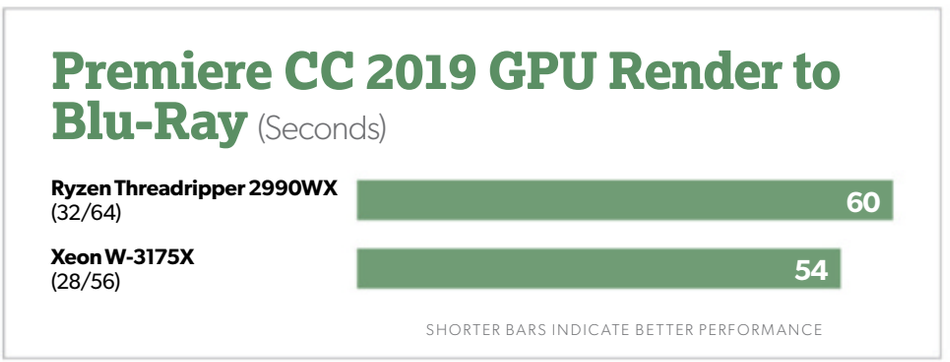
Those who actually use Premiere CC are probably slamming their fists on the table saying, "no one uses the CPU purely for a video encoding anymore!" So yes, we did also encode it out using the GeForce GTX 1080. The win still goes to the Xeon, but it closes to about 11 percent.

Our next test uses the recently released benchmark test by Puget Systems. The company is famous for its systems and also for its in-depth testing of workstation-level hardware. The test uses Adobe After Effects Creative Cloud 2019 to run through several popular tasks done in After Effects. If you have After Effects, you can download the benchmark here (go.pcworld.com/pget).

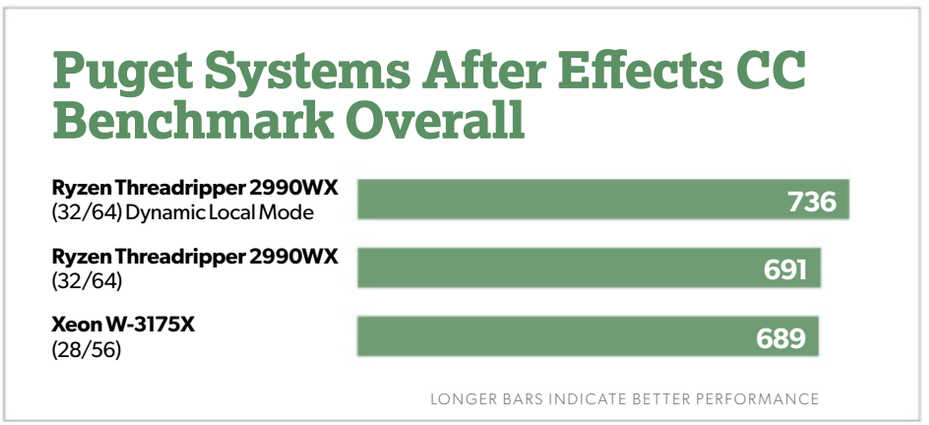
Running the AE test on the Xeon and Threadripper, it was basically a dead-even tie between the machines (although Threadripper performance dropped slightly with DLM on). In our book that's a win for AMD.



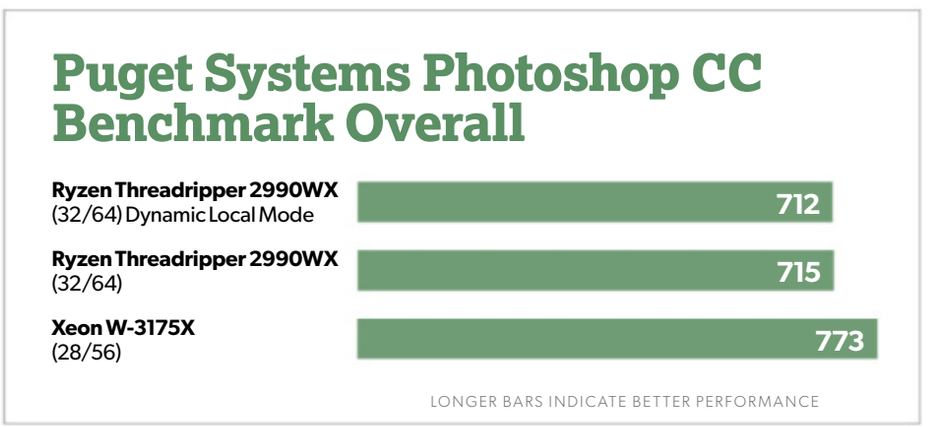
Our Premiere export puts the Xeon ahead by about 15 percent.



In a GPU encode, the Xeon still has the lead by about 11 percent.



The Threadripper 2990WX and Xeon W-3175X are dead even in Puget's After Effects benchmark.



The Xeon comes in about 8 percent faster than the Threadripper but you really don't need either if all you do is Photoshop.

Although Adobe Photoshop tends to be pretty easy for any modern computer to run, we did want to see which CPU had the advantage in Puget's Photoshop test (go.pcworld.com/phbn). Like the After Effects test, it's free to download from Puget Systems and again—we highly recommend you head over to Puget System's website if you are interested in this level of professional hardware. It's simply a treasure trove.

Photoshop rarely loads up the cores of a CPU so the chip with the higher clocks was probably always going to win this and no surprise, the Xeon comes out ahead by about 8 percent.

If you drive Photoshop exclusively, a machine with as many cores as a Threadripper or Xeon is probably way too much.

MULTI-TASKING PERFORMANCE

In the real world, few applications can use all of the threads in a 64- or 56-thread CPU, so we've been trying to measure performance when you do multiple things at once. We say *try* because multi-tasking can be inherently unreliable for performance.

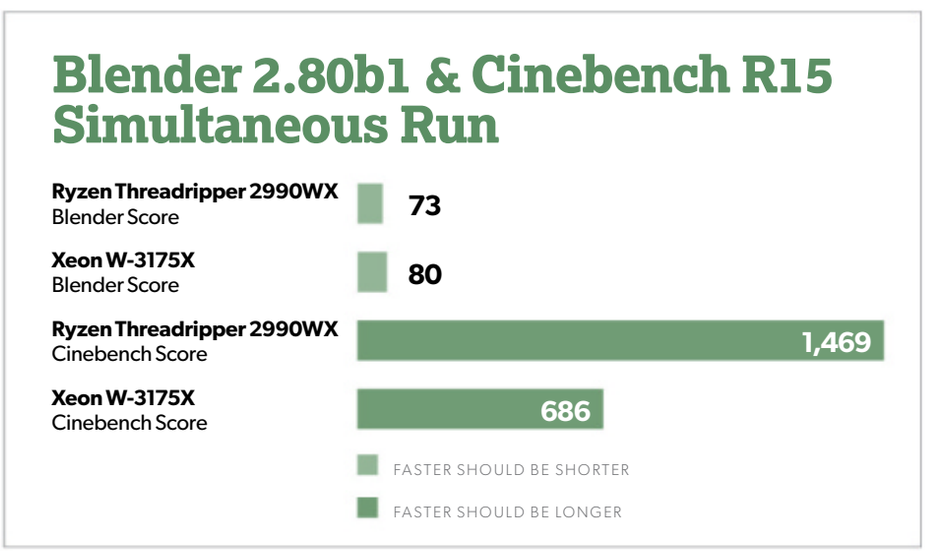
Still, we've done this particular test enough that we feel the results are reliably repeatable. We run Blender while also simultaneously running Cinebench. The result for Blender is almost a tie, but the big, big win for Threadripper is in Cinebench where it simply blows the Xeon away.

It's almost, hmm, like the 32-core Threadripper has an additional 8-threads of compute power sitting around to tap on

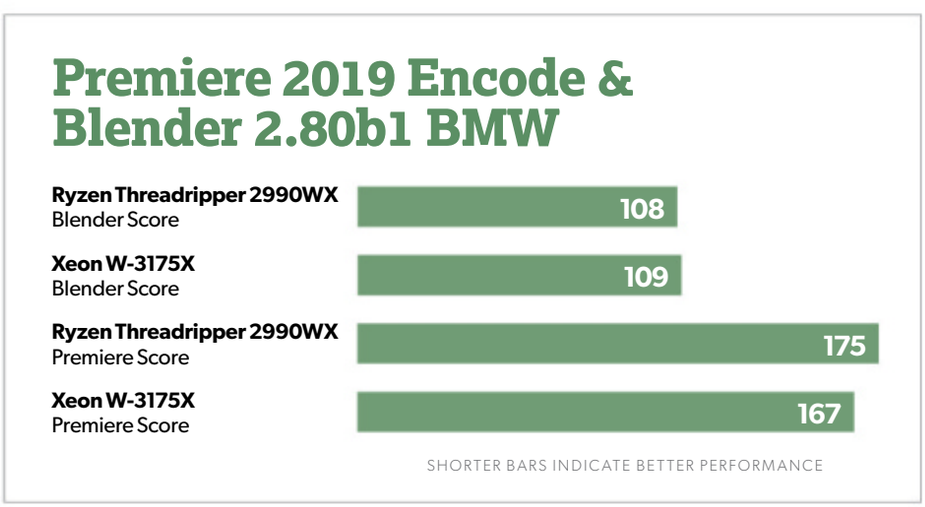
that the 28-core Xeon doesn't have. Win: Threadripper.

One thing about the above test: It's probably not that realistic for someone to do a Cinema4D render at the same time as a Blender render. So we also uses Premiere CC to encode a 4K video to the Blu-ray preset while also rendering out a scene in Blender. This may sound crazy to you, but if you're an indie movie maker, it's an entirely realistic workload.

For the most part it's a tie, but the Xeon ekes out a little more performance in the Premiere encode. Enough to call it a win? No, more like a draw.



When you run two heavily multi-threaded tasks, the Threadripper comes out smelling like roses.



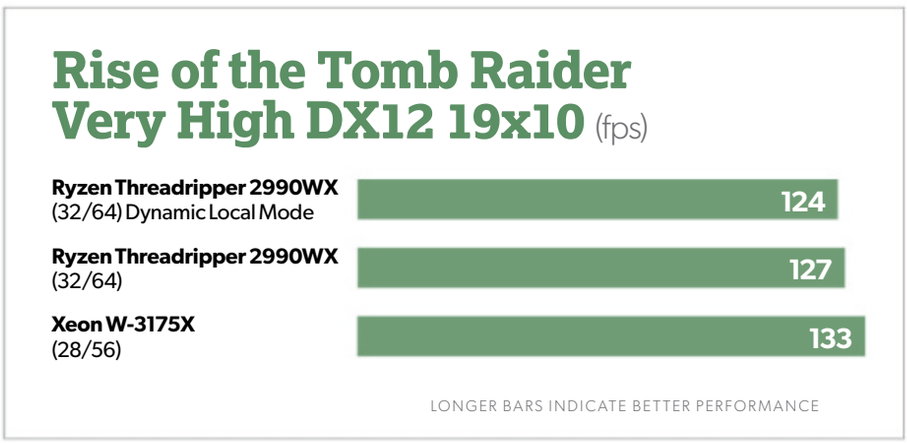
Running Premiere and Blender, the Xeon has a very slightly advantage over the Threadripper.

GAMING PERFORMANCE

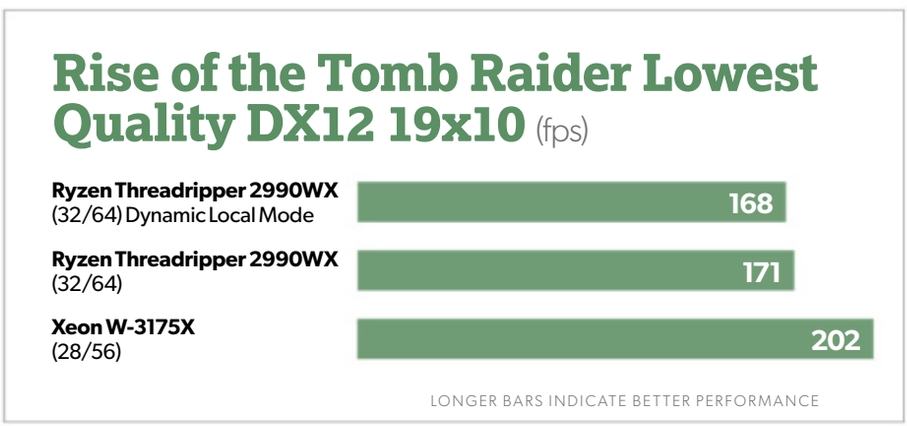
If you bought a $3,000 Xeon or a $1,800 Threadripper to play a game 90 percent of the time—you're doing it wrong. Still, you do want to know how it performs so we present abbreviated set of results culled from other gaming tests we ran.

The result is no surprise: At resolutions and game settings that make the graphics card power the bottleneck, it's nothing to write home about. The Xeon has about a 5- to 7-percent advantage in frame rates, but let's just call it a tie.

The gap that has haunted Ryzen since day one remains,



At resolutions and settings you would actually play at, it doesn't matter that much.



We see the familiar "Ryzen gap" when you remove the GPU as the bottleneck.

though. In fact, when you take the GPU out of the equation by lowering the graphics quality, we see the very familiar 15 to 17 percent advantage for the Intel CPU. If you are buying a big CPU and do plan to game with the fastest GPUs in the world and do 3D rendering, modelling and other content creation, the advantage will generally go to Intel. If you're just playing games sometimes, then it really doesn't matter that much.

OVERCLOCKING PERFORMANCE

The vast majority of our testing is based on baseline speed which is what most people will stick with. It is, after all, pretty scary to think about heavily overclocking a $3,000 CPU.

Still, it would honestly be a crime not to at least do some basic overclocking with Xeon W-3175X. It was snap to push the Xeon W-3175X to a 4GHz all-core boost just by goosing the multiplier. We pushed all cores up to 4.1GHz and then also set turbo ratios for higher clocks on lighter loads. The results of a casual hour netted significant performance dividends.

While an all-core of 4.1GHz sounds pretty weak, it's something many can aim for and not feel squeamish about. But all the indicators are there's a ton more headroom in the chip. Speaking with vendors planning to sell Xeon systems at CES, they suggested an all-core overclock to 5GHz wasn't far from reality, with the only limits being power and thermals.

That probably tells us why both of the

launch motherboards for the Xeon W-3175X feature dual power input.

To give you an idea of where that falls, the current HWBot record for a single 28-core Xeon 8180 Platinum is 5,010. We kicked out 5,859 without breaking a sweat.

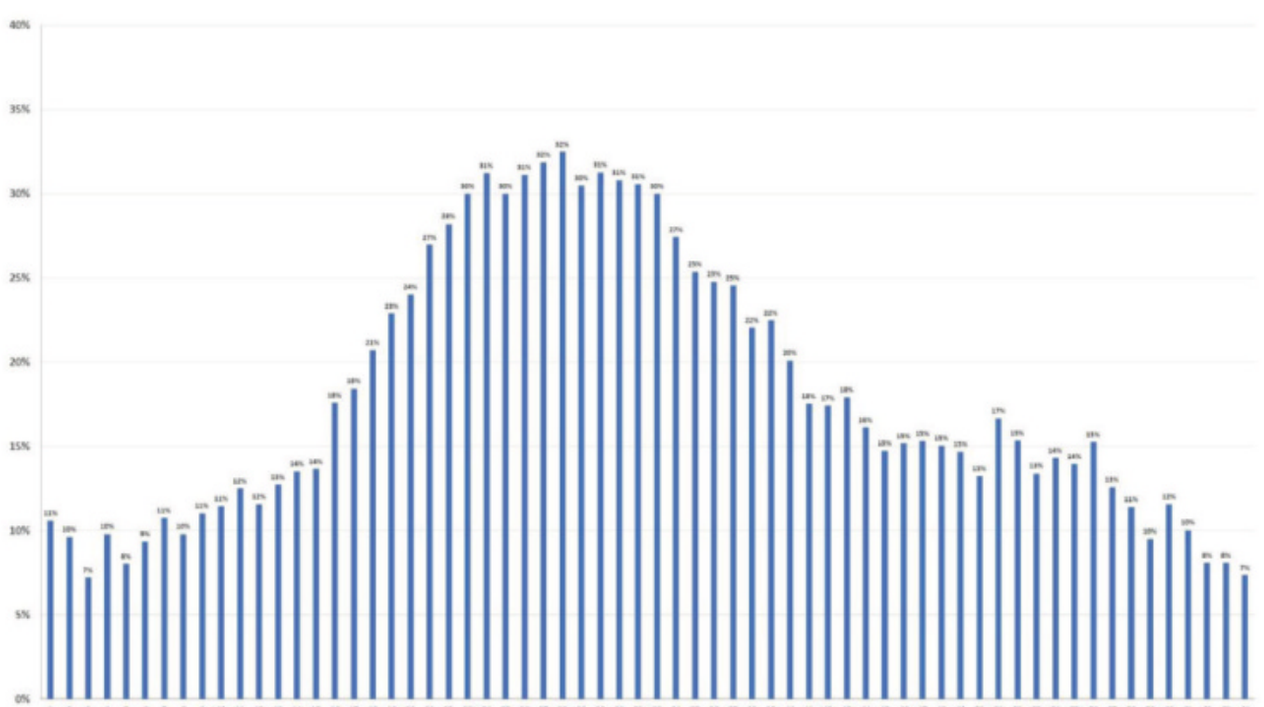
IT'S A POWER HOG

And yes, the Xeon W-3175X is a power hog. On stock, we saw it regularly pushing loads of 550 watts at the socket (we'd estimate 60 watts to be just the fans in the system). The Threadripper 2990WX system was far more 'green' down at 350 watts under full load. Overclocking our Xeon W-3175X to a mild 4.1GHz, we saw power climb up into the 700-watt range, too.

Mind you: That's with a single power supply. It's generally recommended that if you want to attempt to push all cores to 5GHz and up, you should run a second matched PSU to keep the power-hungry Xeon happy. After all, if you bought a muscle car with a 440-cubic-inch engine, you wouldn't complain about the gas mileage, would you?

Cinebench R15 performance advantage based on thread load

Xeon W-3175X vs. Threadripper 2990WX with Dynamic Local Mode On

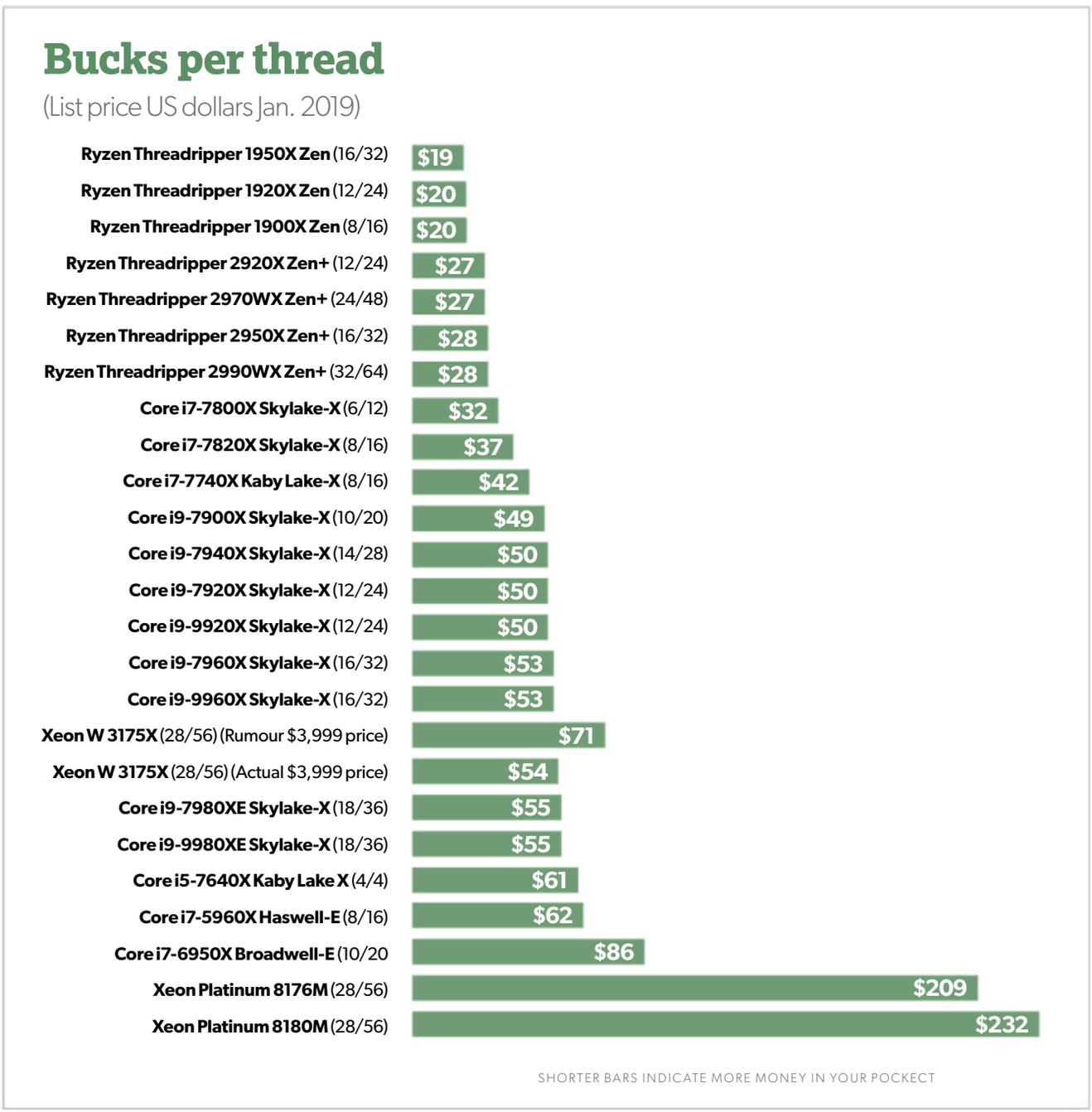


The Xeon W-3175X pretty much has the advantage across the board in performance.

THREAD SCALING

The last performance chart we want to leave you with shows how the Xeon W-3175X performs when you scale from 1 to 64 threads in Cinebench. Rather than the actual result we'll give you the performance advantage for the Xeon W-3175X over the Threadripper 2990WX.

With the original Core i9-7980X, the 18-core CPU would outpace the AMD chip on lighter loads but eventually get hammered



You know what's crazy? The 28-core Xeon W-3175X isn't a bad value—for Intel.

as the 32-core Threadripper 2990WX's advantage took over. Here, at stock speeds, the Xeon W-3175X has a huge performance advantage across the board, especially with applications that sit in that middle ground.

This doesn't necessarily mean all applications will follow suit, but we will note that our HandBrake test, which put the Xeon W-3175X ahead by 17 percent to 20 percent, typically only used about 28 threads.

The upshot, as the vast majority of our tests have shown, is that the 28-core Xeon W-3175X is faster most of the time over the 32-core Threadripper 2990WX.

AND THEN THERE'S THE COST

Our normal price guidance in the lofty echelons of high-performance chips is not to care about price or value. When you're shopping for a custom-built, custom-painted PC that costs at a minimum $12,000, caring about how much the CPU costs is like haggling to get the floor mats on a $300,000 car.

Still, we do have to look at the value of the $3,000 Xeon W-3175X per thread. We looked up the list prices of AMD and Intel's big socket chips and computed how much they cost per thread. The worst are the 28-core Xeon Platinum chips that go into servers, which is not a surprise.

Among the CPUs that might conceivably be used in a (very fancy) desktop, the $3,000 Xeon W-3175X is actually in line with most Intel CPUs. The best value still belongs to AMD, which is basically charging you half of what Intel charges per thread for its CPUs.

BOTTOM LINE

Here's a funny story: When we originally received the Xeon W-3175X for testing at what we thought was a price of $4,000 we actually thought Intel had actually created a CPU at a price designed to actually make AMD's Threadripper 2990WX look better. After all, with a 32-core Threadripper 2990WX going for $1,800, no amount of performance was going to really make it a product worth considering for anyone who doesn't fly around on a private jet.

With a price of $3,000 and an actual demonstrable performance advantage in a lot of areas though, it's actually a contender. It's not a knock out by any means but for those who do want it all and don't mind paying for it, it's going to be really hard to find a faster CPU out today than the Xeon W-3175X.

Intel Xeon W-3175X

PROS

- Easily the fastest CPU for multi-threaded tasks today.
- A crime not to overclock.
- Pretty much screams in most workloads.

CONS

- Requires crazy expensive and crazy huge motherboards.
- Sucks down electricity.
- Doesn't offer the value of AMD's Threadripper 2990WX.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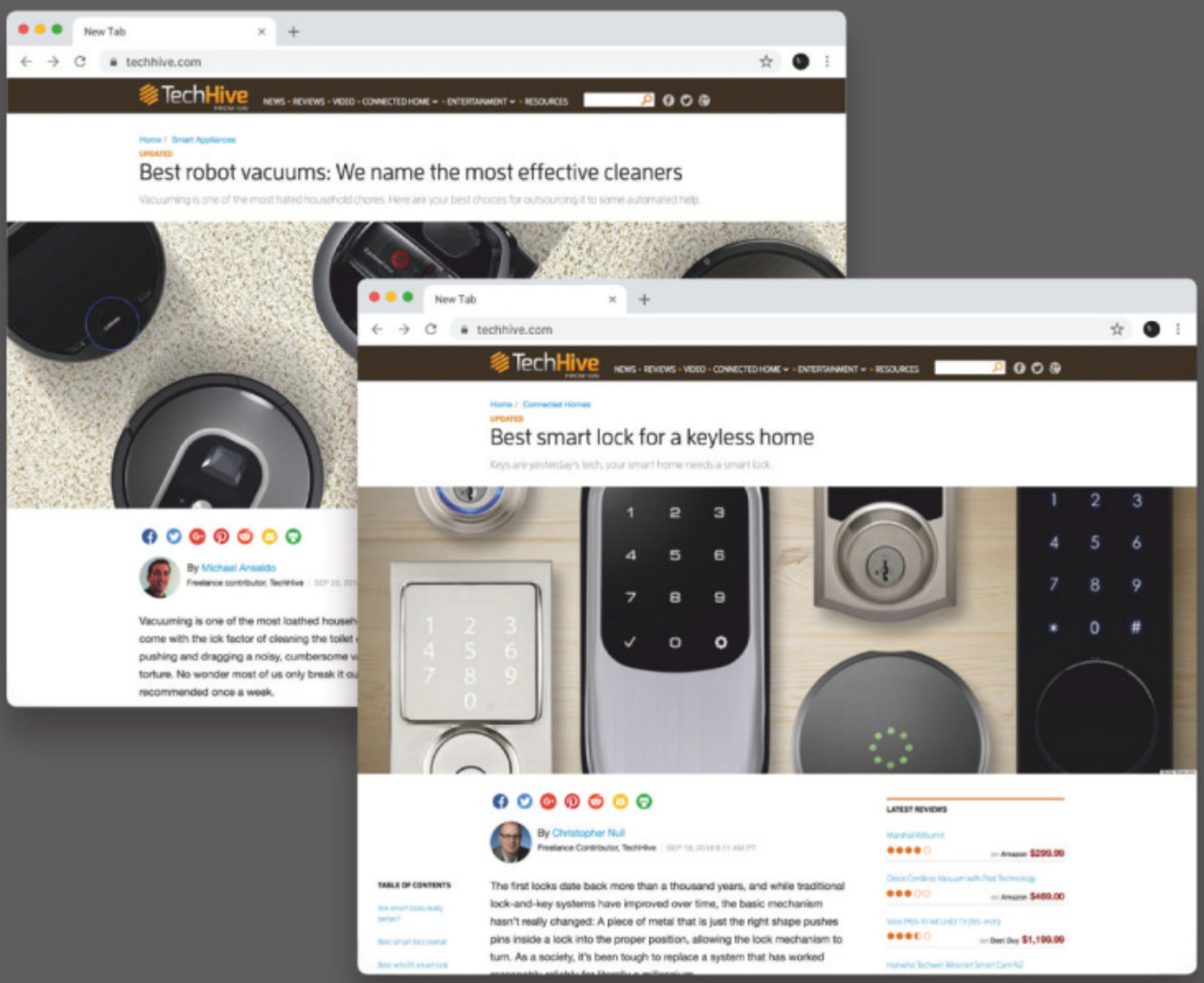

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Radeon VII: AMD's cutting-edge return to enthusiast gaming

Built for 4K, in gaming and content creation. **BY BRAD CHACOS AND GORDON MAH UNG**

Radeon VII breaks new ground for AMD, and for graphics cards in general. It's the company's first truly high-end 4K GPU, capable of surpassing 60 frames per second at High or Ultra settings. It's the first-ever consumer graphics card built using the next-gen 7nm manufacturing process, and the first to ship with a massive 16GB of ultra-fast high-bandwidth memory (HBM) (go.pcworld.com/hbdm). Radeon VII is even the first AMD graphics card that shifts away from reporting the GPU temperature alone to monitoring a more holistic array of 64 thermal sensors spread across the die. This is impressive hardware, the likes of which gamers haven't seen before.

It's no GeForce killer, though. The $700 Radeon VII (go.pcworld.com/rad7) trades performance blows with the similarly priced

IMAGE: GORDON MAH UNG

Nvidia GeForce RTX 2080 (go.pcworld.com/n208) and even the two-year-old GTX 1080 Ti. Nvidia's recent embrace of adaptive sync monitors (go.pcworld.com/fsyn) eliminates AMD's FreeSync monitor pricing advantage. And AMD's graphics card lacks the real-time ray tracing hardware offered by GeForce RTX GPUs, though very few games take advantage of those capabilities at this point.

But don't let those trade-offs deter you. Nvidia's offerings have plenty of their own limitations, and AMD's Radeon VII is a very competitive bleeding-edge beast of a graphics card. Let's dig into why.

SPECS AND FEATURES

AMD's name for this card contains several clever nods. Not only is the Radeon VII the first 7nm consumer graphics card, it's the second generation of the company's Vega architecture, following in the footsteps of the Radeon RX Vega 56 and 64 (go.pcworld.com/vg56). Here's how the three GPUs compare in raw under-the-hood specs:

Even though the Radeon VII harbors fewer streaming processors than Vega 64, it demolishes its predecessor in sheer performance, as you'll see in our benchmarks later. There are several reasons for that. First off, AMD tuned Radeon VII to run at much higher clock speeds than Vega, with maximum boost clocks roaring ahead by more than 200MHz—no small feat. (Note: The "peak engine clock" specification listed in the chart above refers to "the highest achievable frequency" in certain content creation workloads, while the traditional "boost clock" specification is for games.)

AMD also optimized the second-generation Vega architecture to provide lower latency, as well as more bandwidth to the render output units (ROPS). Those tweaks help improve gaming performance, while "increased floating point and integer accumulators" help boost results in compute workloads, a big focus for AMD with Radeon VII.

AMD also tweaked temperature monitoring significantly in Radeon VII. Traditionally, AMD graphics cards reported and adjusted performance based on a GPU temperature taken from a single sensor near a thermal diode. Modern GPUs, by contrast, come laden with temperature sensors: Radeon VII contains a whopping 64 spread across the chip—twice the number on the Vega 64.

AMD's graphics card takes advantage of all that hardware with a new "Junction Temperature" reading that handles thermal throttling and fan control using all the available data. AMD claims the switch offers more dependable throttling behavior and slightly increased performance in thermally limited scenarios, like many (but not all) gaming workloads.

You can have your cake and eat it too, though, as Radeon Software's Wattman

SPECIFICATIONS: RADEON VII, RX VEGA^{64}, RX VEGA^{56}

	RADEON VII	RADEON RX VEGA^{64}	RADEON RX VEGA^{56}
Architecture	Vegas 20	Vegas 10	Vegas 10
Manufacturing process	7nm	14nm	14nm
Transistor Count	13.2 billion	12.5 billion	12.5 billion
Die Size	331 mm^2	495 mm^2	486 mm^2
Next Gen Compute Units	60	64	56
Stream Processors	3840	4096	3584
Base GPU Clock	1400 MHz	1274 MHz	1156 MHz
Boost GPU Clock	1750 MHz	1546 MHz	1471 MHz
Peak Engine Clock	1800 MHz	1630 MHz	1590 MHz
Peak SP Performance	Up to 14.2 TFLOPS	Up to 12.7 TFLOPS	Up to 10.5 TFLOPS
Peak Half Precision Performance	Up to 28.1 TFLOPS	Up to 25.3 TFLOPS	Up to 21 TFLOPS
Peak Texture Fill-Rate	432.24 GT/s	Up to 395.8 GT/s	Up to 330 GT/s
ROPs	64	64	64
Peak Pixel Fill-Rate	115.26 GP/s	Up to 98.9 GP/s	Up to 94 GP/s
High Bandwidth Cache (HBM2)	16 GB	8 GB	8 GB
Memory Bandwidth	1 TB/s	483.8 GB/s	410 GB/s
Memory Interface	4096 bit	2048 bit	2048 bit
Board Power	300W	295W	210W

overclocking tool reports both the new Junction Temperature as well as the standard GPU temperature.

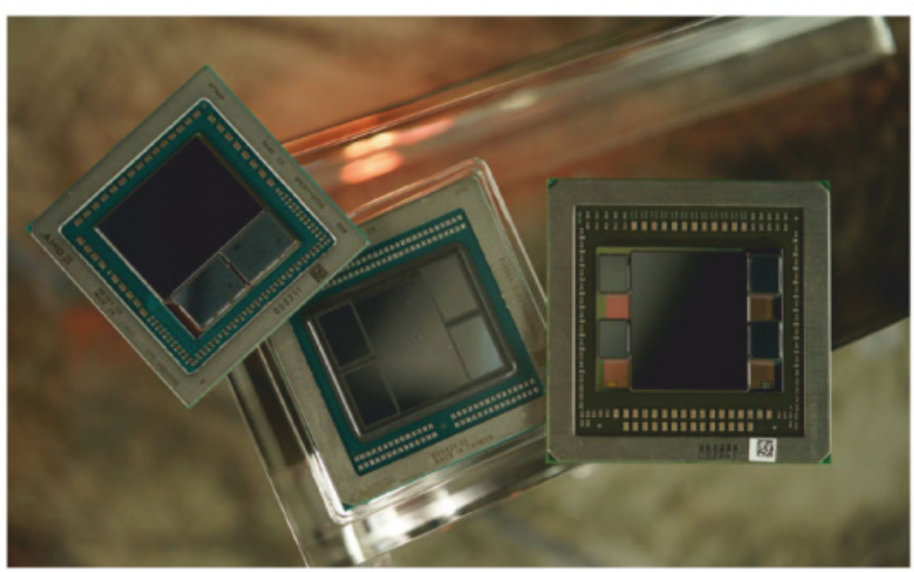
The shift from a 14nm to 7nm manufacturing process didn't just improve GPU performance. AMD managed to shrink

	MANAGED BY JUNCTION TEMP		MANAGED BY EDGE TEMP
Strange Brigade 4k Ultra DX12	74C Edge Temp 106C Junction Temp 93.28 fps	+2% performance	70C Edge Temp 101C Junction Temp 91.56 fps
Wolfenstein II – The New Colossus 4K "mein Leben" (Vulkan	74C Edge Temp 110C Junction Temp 94.69 fps	+2% performance	70C Edge Temp 101C Junction Temp 93.28 fps

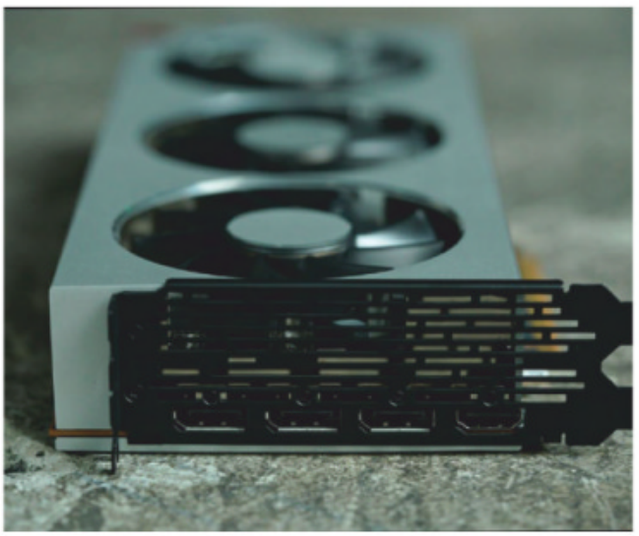
the GPU die from 495 square millimeters in Vega 64 to 331 in Radeon VII. As a result, the company crammed two more 4GB stacks of HBM memory onto the chip, bringing the total number of stacks up to four and the total memory capacity to 16GB. That's twice as much as you'll find in Nvidia's RTX 2080, and even 5GB more than you'll find in the lofty $1,200 GeForce RTX 2080 Ti.

Just as impressive: Radeon VII features a 4,096-bit memory interface, compared to Vega 64's 2,048-bit interface, giving the card as astonishing overall memory bandwidth of 1 terabyte per second. Sweet holy moly. By comparison, Vega 64 offers 484GBps of memory bandwidth; the GeForce RTX 2080 offers 448GBps; and the RTX 2080 Ti offers 616GBps.

Such lofty memory capabilities offer benefits to gamers and content creators alike. Radeon VII shines brightest as a 4K gaming GPU, and games that offer 4K textures will often gobble up all the memory you can throw at it. A 16GB frame buffer offers abundant future-proofing if memory demands continue to expand, and it could also prove advantageous today if a 4K game exceeds the 8GB buffer offered by the RTX 2080. When a game surpasses the onboard memory total of your video card, it needs to tap into your much slower overall system memory instead,



Left to right: The HBM-equipped chips found in Vega 64, Radeon VII, and the Fury X

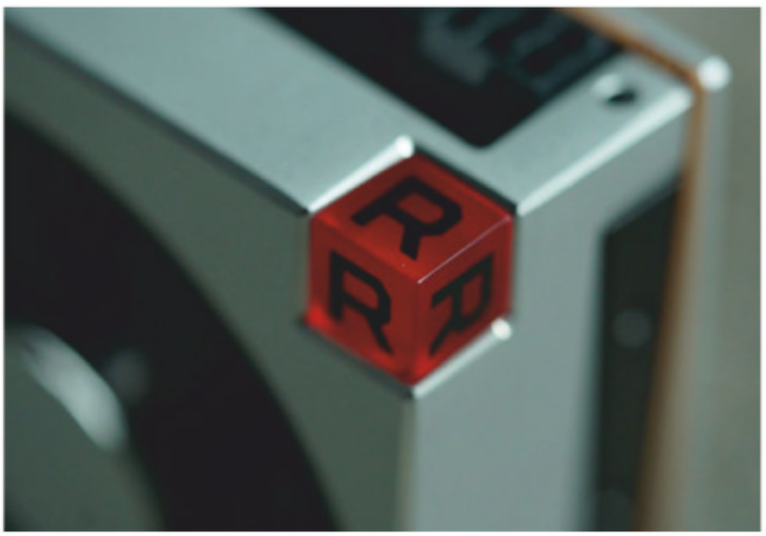


which can result in stutter-inducing frame time lag. For content creators, editing 4K or 8K videos can monopolize tremendous amounts of memory. Radeon VII can handle those workloads without breaking a sweat.

Radeon VII also comes loaded with connectivity options, in the form of an HDMI port and three DisplayPorts. It lacks the VirtualLink USB-C connector that debuted in Nvidia's RTX 20-series GPUs, but virtual reality headsets that support the newly created standard don't exist yet, anyway. The card requires a pair of 8-pin power connectors to supply the 300 watts of energy needed to fuel it—a mere 5W increase over the Vega 64, despite Radeon VII's significant performance uptick.

The card itself looks absolutely stunning from top to bottom, returning to the stark brushed aluminum design introduced in the woefully rare Radeon RX Vega 64 Limited Edition. One key difference: While the Vega 64 Limited Edition included a single blower-style fan on its shroud that helped expel air out of the back of your PC, the Radeon VII follows in the footsteps of Nvidia's GeForce RTX Founders Edition cards by switching to a more traditional multi-fan setup that pushes the heat dissipated by your GPU into your case instead. Three black fans adorn the shroud to assist in the endeavor.

A red cube with a "Radeon" R lights up the outer corner of the graphics card when it's running, an aesthetic matched by an illuminated red Radeon logo on the edge of the card. You can't change the color of the LEDs. Normally, that's not a big deal, but custom third-party Radeon VII graphics cards aren't expected to be available when the card launches on February 7, so RGB fiends probably won't be able to get their fix in the near-term.



The Radeon VII also supports FreeSync 2 HDR, virtual super resolution, the Radeon Overlay, per-game overclocking, and all the other nifty features baked into AMD's superb Radeon Software Adrenalin 2019 edition (go.pcworld.com/an19). For a limited time, AMD will also toss in three free games—The Division 2, Devil May Cry 5, and Resident Evil 2—when you buy the Radeon VI.

OUR TEST SYSTEM

Our dedicated graphics card test system is packed with some of the fastest complementary components available, to put any potential performance bottlenecks squarely on the GPU. Most of the hardware was provided by the manufacturers, but we purchased the cooler and storage ourselves.

- Intel Core i7-8700K processor ($360 on Amazon at go.pcworld.com/700k)
- EVGA CLC 240 closed-loop liquid cooler ($120 on Amazon at go.pcworld.com/c240)
- Asus Maximus X Hero motherboard ($260 on Amazon at go.pcworld.com/mxmc)
- 64GB HyperX Predator RGB DDR4/2933 ($416 for 32GB on Amazon at go.pcworld.com/hxpr)
- EVGA 1200W SuperNova P2 power supply ($180 on Amazon at go.pcworld.com/spnv)
- Corsair Crystal 570X RGB case, with front and top panels removed and an extra rear fan installed for improved airflow ($170 on Amazon at go.pcworld.com/crst)
- 2x 500GB Samsung 860 EVO SSDs ($100 on Amazon at go.pcworld.com/smev)

To see how the $700 Radeon VII stacks up against the current competition, we're comparing it to Nvidia's $500 GeForce RTX 2070, $800 GeForce RTX 2080, and $1,200 GeForce RTX 2080 Ti Founders Edition graphics cards. We're also including benchmarks for the $740 PNY GeForce GTX 1080 Ti and AMD's $500 Radeon RX Vega 64 reference card.

Each game is tested using its in-game benchmark at the highest possible graphics presets. We disable VSync, frame rate caps, and all GPU vendor-specific technologies—like AMD TressFX, Nvidia GameWorks options, and FreeSync/G-Sync, and we enable temporal anti-aliasing (TAA) to push these high-end cards to their limits. If any setting differs from that, we'll mention it.

GAMING BENCHMARKS

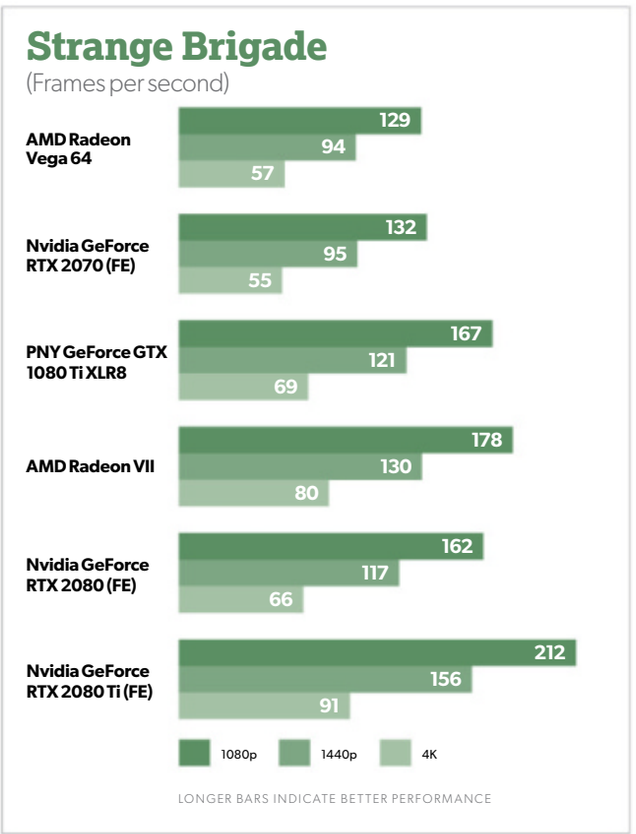
Strange Brigade

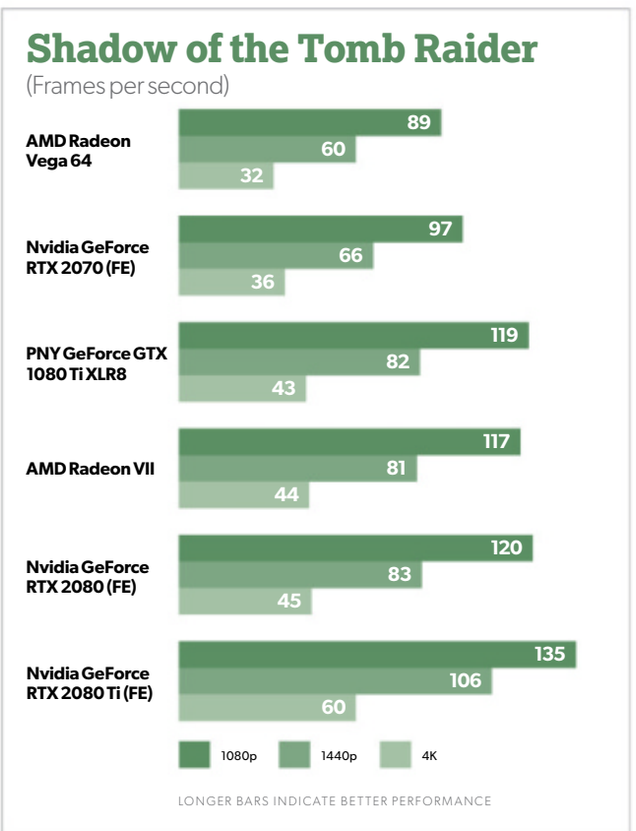
Let's kick things off with *Strange Brigade* ($50 on Humble at go.pcworld.com/bysb), a cooperative third-person shooter where a team of adventurers blasts through hordes of mythological enemies. It's a technological showcase, built around the next-gen Vulkan and DirectX 12 technologies and infused with features like HDR support and the ability to toggle asynchronous compute on and off. It uses Rebellion's custom Azure engine. We test with async compute off.

Spoiler alert: Radeon VII puts in its strongest performance by far here, easily outclassing both the PNY GTX 1080 Ti and the Nvidia RTX 2080 FE—two similarly priced graphics cards—by more than 10 frames per second across all resolutions, and toppling the older Radeon RX Vega 64 by over 40 percent at 4K resolution.

Shadow of the Tomb Raider

Shadow of the *Tomb Raider* ($60 on Humble at go.pcworld.com/shdw) concludes the reboot trilogy, and it's utterly gorgeous—even the state-of-the-art GeForce RTX 2080 Ti barely manages to average 60 fps with all the bells and whistles turned on at 4K resolution. Square Enix optimized this game for DX12, and recommends DX11 only if you're using older hardware or Windows 7, so we test with that. *Shadow of the Tomb Raider* uses an enhanced version of the





Foundation engine that also powered *Rise of the Tomb Raider*.

The three $700 graphics cards turn in virtually identical performances, including the Radeon VII. Again, the newer card outclasses Vega 64 by just shy of 40 percent.

Far Cry 5

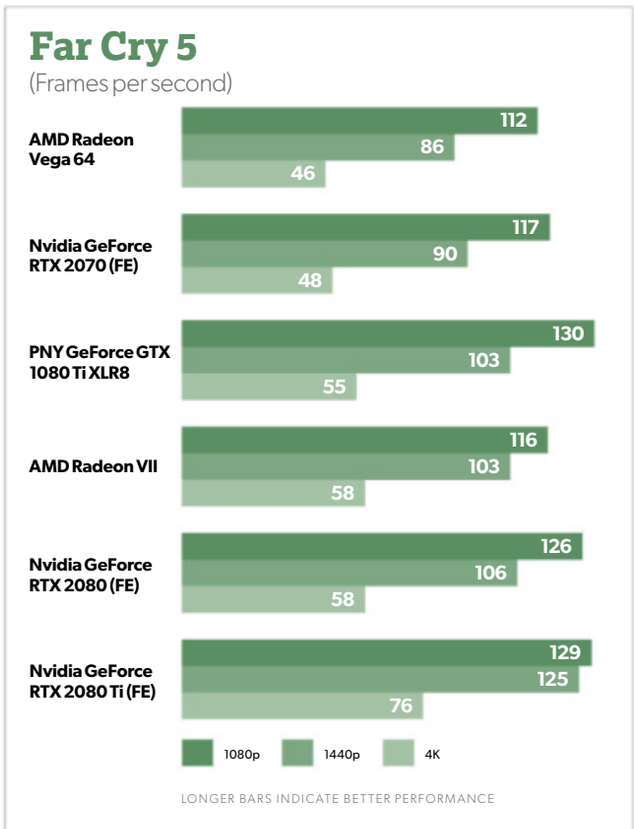
Finally, a DirectX 11 game! *Far Cry 5* ($60 on Humble at go.pcworld.com/fcr5) is powered by Ubisoft's long-established Dunia engine. It's just as gorgeous as its predecessors were, and even more fun.

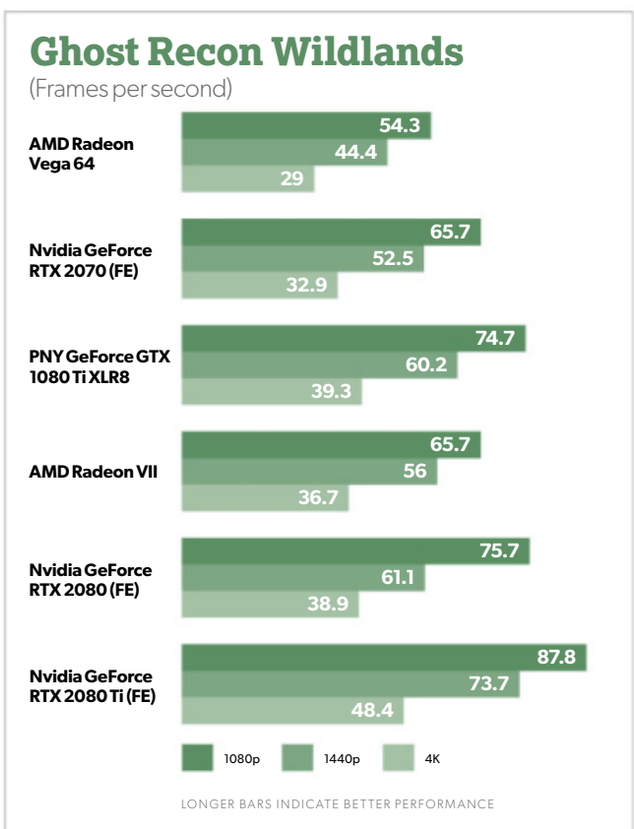
Radeon VII once again manages to hang tough with Nvidia's powerful pair of $700 GPUs, flirting with 60 frames per second even with everything cranked at 4K resolution. Its lead over Vega 64 greatly diminishes in this game though, at just over 26 percent faster.

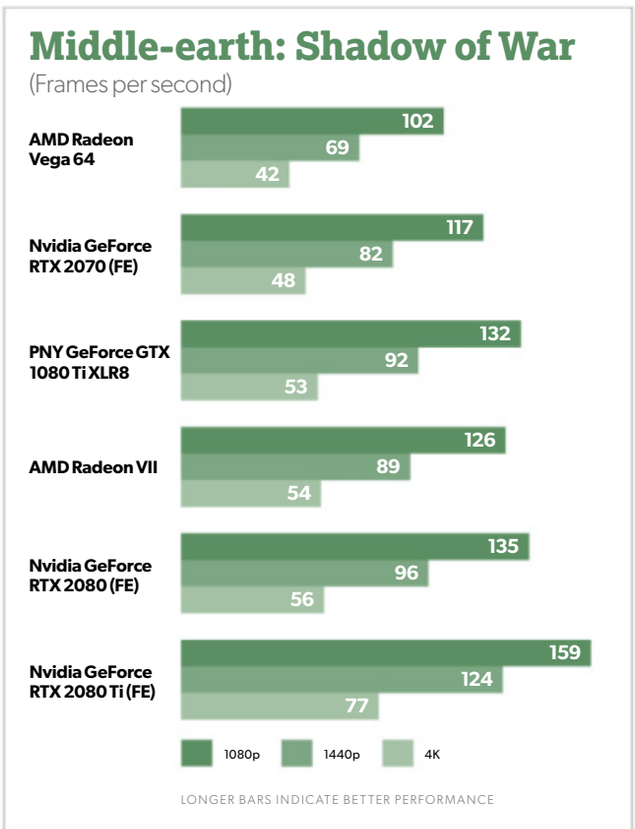
Ghost Recon Wildlands

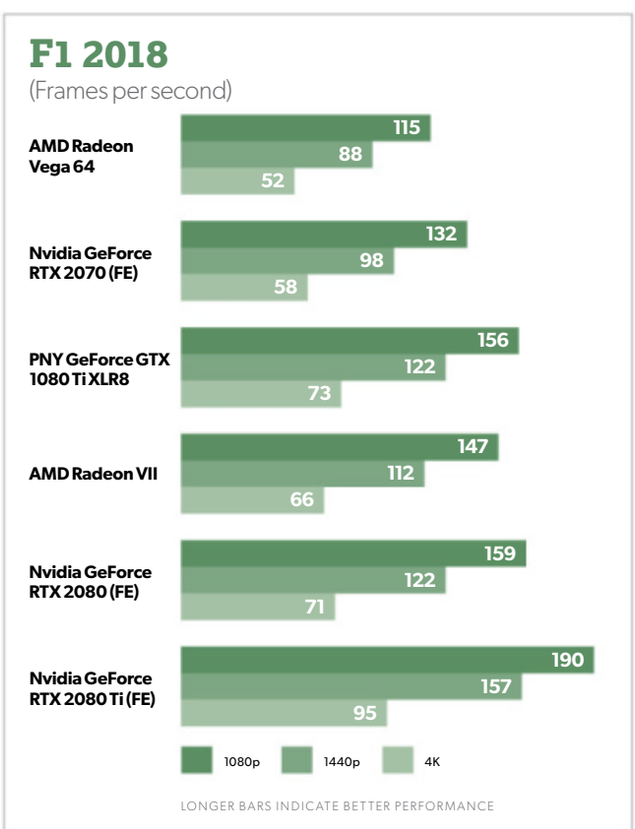
Move over, *Crysis*. If you crank all the graphics options up to 11, like we do for these tests, *Ghost Recon Wildlands* ($50 on Humble at go.pcworld.com/recn) and its AnvilNext 2.0 engine absolutely melts GPUs.

Ghost Recon Wildlands also prefers Nvidia's GPU architecture in general, putting AMD's new card very slightly behind the GTX 1080 Ti and RTX 2080 in raw frame rates. In terms of real-world experience it's effectively a dead heat, though. Radeon VII once again claims a roughly 26 percent victory over AMD's Vega 64.









Middle-earth: Shadow of War

Middle-earth: Shadow of War ($50 on Humble at go.pcworld.com/shwr) adds a strategic layer to the series' sublime core gameplay loop, adapting the Nemesis system to let you create an army of personalized Orc commanders. It plays like a champ on PC, too, thanks to Monolith's custom LithTech Firebird engine. We use the Ultra graphics preset but drop the Shadow and Texture Quality settings to High to avoid exceeding 8GB of VRAM usage in our testing scenario, because graphics cards that exceed 8GB of capacity are rare indeed. Radeon VII's 16GB frame buffer would easily let you crank those settings back up if you wanted, though.

Once again, while the Radeon VII technically falls behind Nvidia's similarly priced GPUs by a few frames per second, they offer virtually identical real-world experiences.

F1 2018

The latest in a long line of successful games, *F1 2018* ($60 on Humble at go.pcworld.com/f118) is a benchmarking gem, supplying a wide array of both graphical and benchmarking options—making it a much more reliable option that the *Forza* series. It's built on the fourth version of Codemasters' buttery-smooth Ego game engine. We test two laps on the Australia course, with clear skies.

The Radeon VII lags behind the GTX 1080 Ti and RTX 2080 by a more noticeable 7.5

and 10.6 percent, respectively, at 4K resolution. Nevertheless, AMD's card easily delivers buttery-smooth 4K gaming that surpasses the 60-fps gold standard.

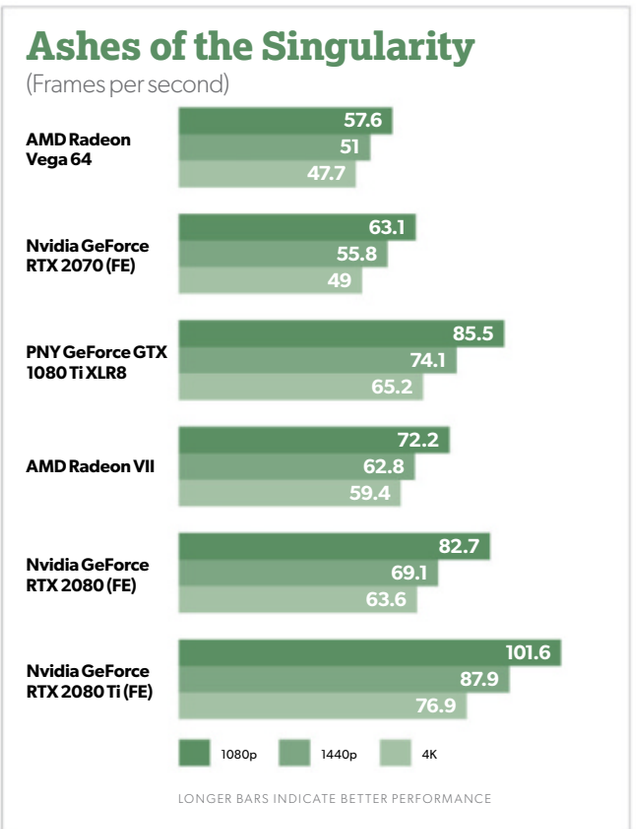
Ashes of the Singularity: Escalation

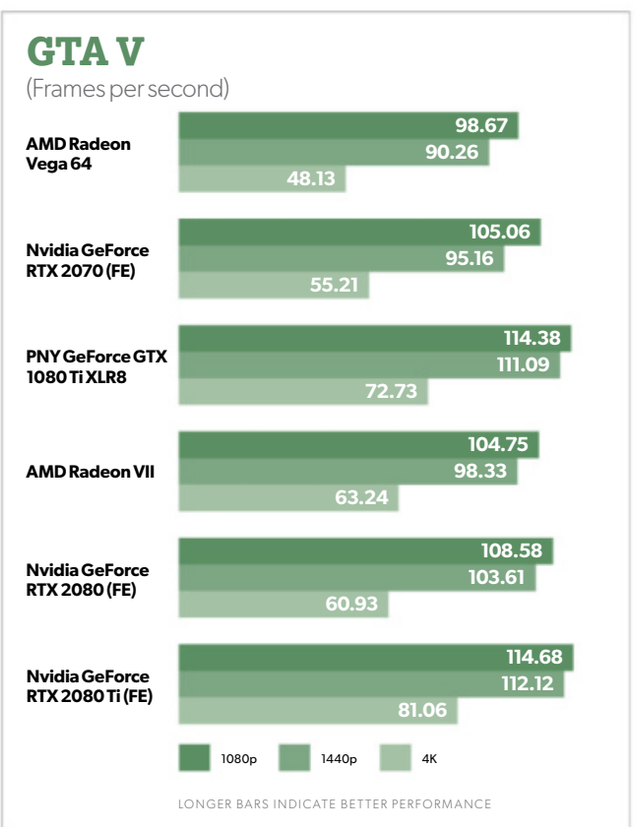
Ashes of the Singularity ($40 on Humble at go.pcworld.com/sing) was one of the very first DX12 games, and it remains a flagbearer for the technology to this day thanks to the extreme scalability of Oxide Games' next-gen Nitrous engine. With hundreds of units onscreen simultaneously and some serious graphics effects in play, the Crazy preset can make graphics cards sweat. *Ashes* runs in both DX11 and DX12, but we only test in DX12, as it delivers the best results for both Nvidia and AMD GPUs.

This is another game where the Radeon VII trails Nvidia's GPUs by 6 or 7 percent at 4K resolution. That shouldn't be very noticeable to the human eye, and AMD's card again has no problems hovering around 60 fps, even with all the eye candy cranked.

GTA V

We're going to wrap things up with a couple of older games that aren't really visual barn-burners, but still top the Steam charts day in and day out. These are games that a lot of people play. First up: *Grand Theft Auto V* ($30 on Humble at go.pcworld.com/gta5) with all options turned to Very High, all Advanced Graphics options except extended shadows





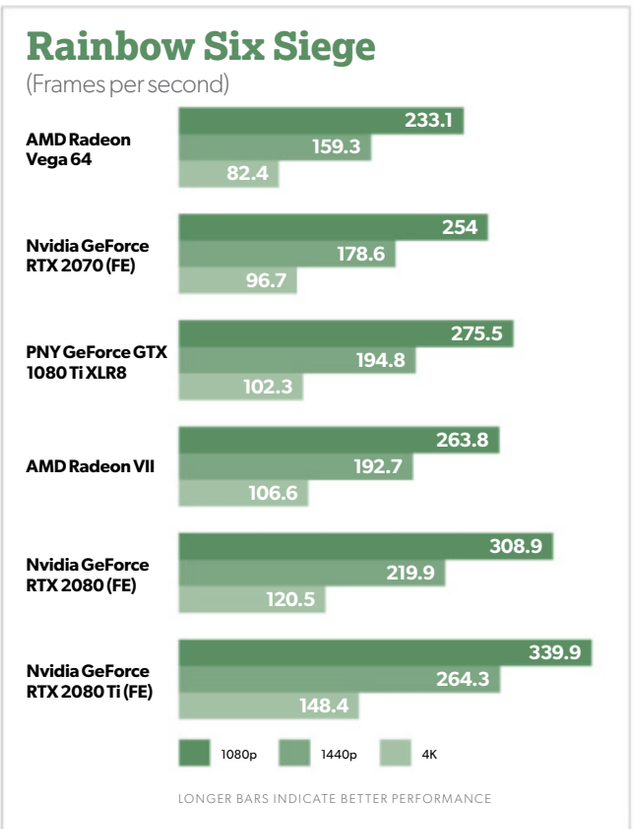
enabled, and FXAA enabled. *GTA V* runs on the RAGE engine and has received substantial updates since its initial launch.

This game tends to vastly prefer Nvidia GPUs, and the Radeon VII trails the older GTX 1080 Ti by a decent amount. But interestingly, thanks to tweaks in the GeForce RTX 2080's technological configuration, Radeon VII comes out ahead of it at 4K resolution. Nvidia's modern option takes back the lead if you shift the resolution down to 1440p or 1080p, though. Radeon VII is also 31 percent faster than Vega 64.

Rainbow Six Siege

Finally, let's take a peek at *Rainbow Six Siege* ($40 on Humble at go.pcworld.com/rnss), a game whose audience just keeps on growing, and one that still feels like the only truly next-gen shooter (go.pcworld.com/rain) after all these years. Like *Ghost Recon Wildlands*, this game runs on Ubisoft's AnvilNext 2.0 engine, but *Rainbow Six Siege* responds especially well to graphics cards that lean on async compute features.

Nvidia greatly enhanced the async compute capabilities of its graphics architecture in the new RTX 20-series lineup. As a result, the RTX 2080 opens up a huge lead over Radeon VII, even though AMD's new card performs fairly evenly with the older GTX 1080 Ti. If you're a Siege fan, you'll want to opt for RTX over RVII.



CONTENT CREATION BENCHMARKS

AMD wants to tout the Radeon VII's content creation chops, too. So for this review, my colleague Gordon Mah Ung ran additional tests focused on this use case.

Our Content Creation Testbed

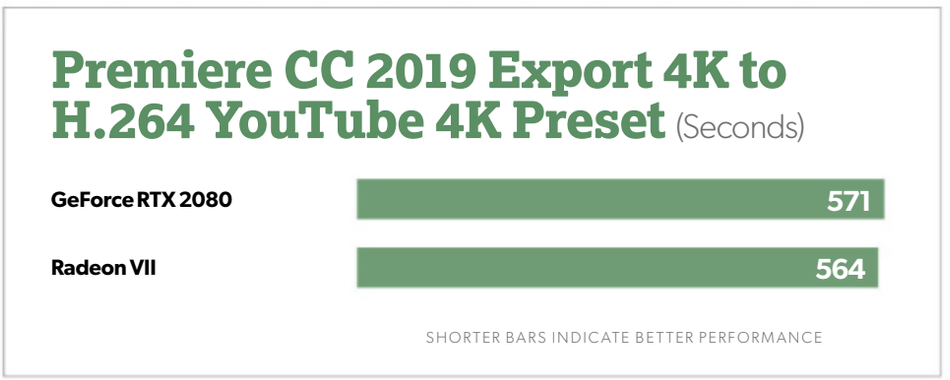
For content creation, we used a machine a little better suited to actual content creation artists: AMD's 32-core Threadripper 2990WX CPU in an MSI X399 MEG Creation motherboard. The build used Windows 10 RS5 and 32GB of DDR4/3200 in quad-channel configuration. The OS was installed on a HyperX SATA SSD with a Plextor M8Pe

SSD for workloads that might be disk-bound. We used the latest available drivers for the Radeon VII and the GeForce RTX 2080 Founders Edition card. OpenCL was used for the Radeon VII, while the GeForce ran on CUDA.

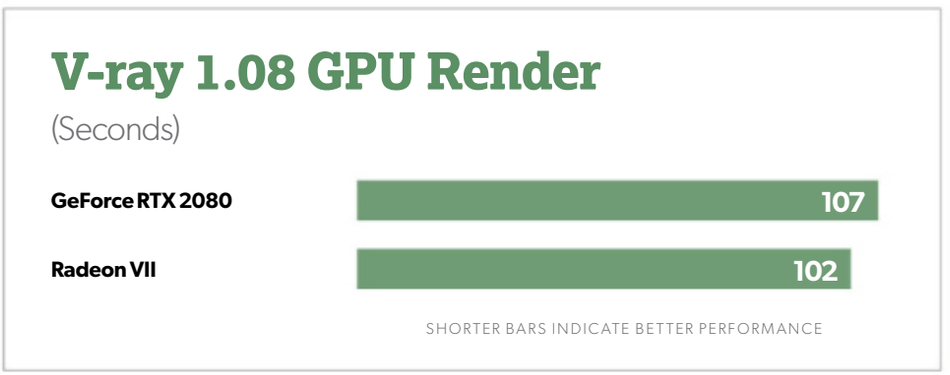
Our first test uses Adobe Premiere Creative Cloud 2019 to export a 4K video using the H.264 YouTube 4K preset and the max render quality option. The first portion of the video is mostly a straight encode, while the latter half layers on GPU-taxing graphics and B-roll. The entire clip is also color corrected.

The results gave the Radeon VII a very small lead, but let's call it a tie. For the most part, these results match performance data from AMD for 4K content where the two cards are nearly even. We should note that AMD says using 8K resolution video actually opens the gap more.

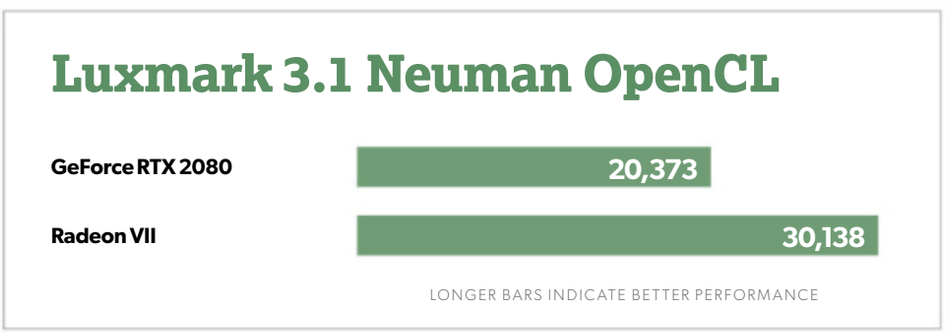
Our next test used the Chaos Group's V-ray benchmark to measure performance when rendering a ray-traced scene on the GPU. The Radeon again has a small lead of about five percent.



Using Adobe Premiere CC 2019 to export a 4K resolution file with color correction and graphics overlays.



The Chronos Group's V-Ray GPU test measures performance of a GPU when used for rendering ray traced images. The Radeon VII has a slight edge over the GeForce RTX 2080 here.



One area where the Radeon VII flexes its muscles is in LuxMark's OpenCL test. We found the Radeon VII outperformed the GeForce RTX 2080 from 11 percent to 38 percent in the three available workloads.

The elephant in the room are those two words: ray traced. While the current V-ray benchmark does not support Microsoft's DirectX Ray and by extension, Nvidia's RTX, it will (go.pcworld.com/prlv). And once that happens, you can expect the performance win to shift in a big way to Nvidia. One could argue, however, that straight up OpenCL performance matters more in the here and now. To measure OpenCL performance we used LuxMark 3.1 (available at go.pcworld.com/lxmk) to gauge performance of both the Radeon VII and the GeForce RTX 2080.

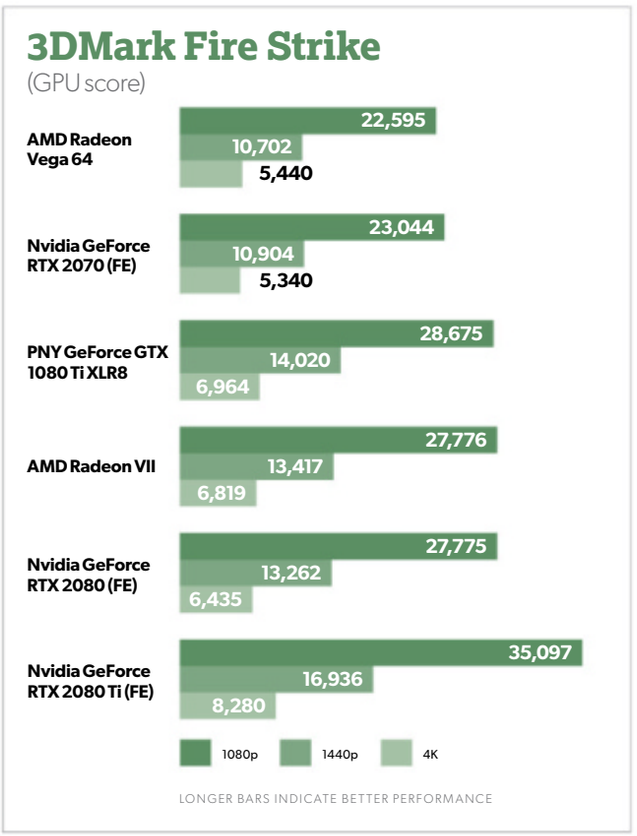
The winner: Radeon VII in a big way. LuxMark (based on LuxRender) gave the Radeon VII everything from as little as 10 percent to 38 percent advantage over the GeForce RTX 2080.

Radeon VII Content Creation Conclusion

For the most part, we'd say the Radeon VII pretty much equals or exceeds the RTX 2080 in several content creation tasks. But the answer is never that simple. Like games, content creation engines tend to be fairly specialized. Rather than simply saying one is the winner, you should focus on which is the winner for what you do. —Gordon Mah Ung

POWER DRAW, THERMALS, AND NOISE

We also tested Radeon VII using 3DMark's highly respected Fire Strike synthetic benchmark. Fire Strike runs at 1080p, Fire Strike Extreme runs at 1440p, and Fire Strike Ultra runs at 4K resolution. All render the same scene, but with more intense graphical effects as you move up the scale, so that Extreme and Ultra flavors stress GPUs even more. We record the graphics score to eliminate variance from the CPU.



Yep, everything falls about where you'd expect after observing the gaming benchmarks, which is always the case with Fire Strike. It's a good "sanity check" tool.

We test power draw by looping the F1 2018 benchmark for about 20 minutes after we've benchmarked everything else, and noting the highest reading on our Watts Up

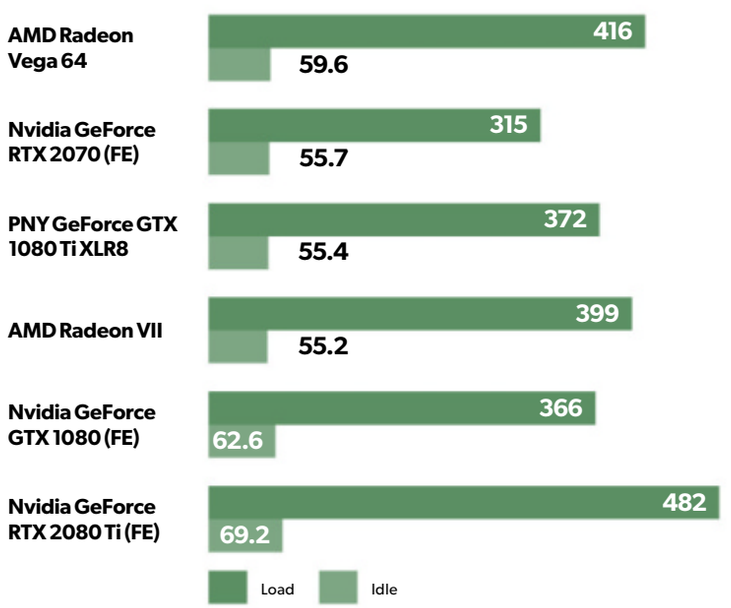
Pro meter. The initial part of the race, where all competing cars are onscreen simultaneously, tends to be the most demanding portion.

Moving to the 7nm process has done wonders for Vega's power efficiency. It's still not quite on a par with Nvidia's results, but it's a close enough that efficiency can't be considered an AMD drawback anymore. It's a colossal improvement over the hot, hungry Vega 64.

We typically test thermals by leaving HWInfo's sensor monitoring tool open during the F1 2018 5-lap power draw test, noting the highest maximum temperature at the end. But third-party monitoring software like HWInfo and SpeedFan haven't been adjusted to handle the way AMD tweaked Radeon VII's temperature monitoring, and display the newer (and much higher) Junction Temperature rather than the traditional GPU temperature reading. Because all other graphics cards list the GPU temperature, we need to test that to properly compare performance. As such, we deviated from using HWInfo on the Radeon VII and measured the GPU temperature using AMD's Wattman tool instead.

Assuming Wattman's readings are accurate—and they've always tracked with HWInfo and SpeedFan in the past—then

Whole system power consumption (Watts)



SHORTER BARS INDICATE BETTER PERFORMANCE

Maximum GPU temperature under load (Celsius)

SHORTER BARS INDICATE BETTER PERFORMANCE

Radeon VII once again crushes its hot-blooded predecessor, Vega 64. Topping out at 78 degrees Celsius (172.4 degrees Fahrenheit) under load, AMD's fan-laden 7nm GPU runs at a perfectly acceptable temperature. Heck, it's chillier than the PNY GTX 1080 Ti's customized cooler. No complaints here.

You can definitely hear the Radeon VII working when it's under full load, but not enough to be distracting. Once again, it's a huge improvement over the Vega 64's banshee-like screaming, though the GeForce RTX 2080 Founders Edition runs noticeably quieter.

BOTTOM LINE

If you're hunting for a high-performing graphics card capable of playing games with few visual compromises at 4K resolution, or ultra-fast 1440p, then you should definitely consider the Radeon VII—especially if the sky-high $1,200 price tag for Nvidia's GeForce RTX 2080 Ti scares you off. Don't bother upgrading to this card if you already have a GTX 1080 Ti, though.

The GeForce RTX 2080 and Radeon VII each cost $700 (though the overclocked Founders Edition we tested costs $800) and deliver similar real-world performance, though the Radeon VII lags slightly behind overall, and the frame rate differences are extreme in some games. Radeon VII pounds the RTX 2080 Founders Edition in Strange Brigade, and the RTX 2080 pounds AMD's card in Rainbow Six Siege and Ashes of the Singularity. Performance is a wash in most games, but the RTX 2080's lead expands if you drop all the way down to an ultra-fast 1080p monitor. Nvidia's GPU holds a small advantage in power efficiency and thermals as well, but the differences between the two cards are once again negligible.

Nvidia's GeForce RTX 2080 vs. AMD's Radeon VII.

So what about the standout features of each?

Nvidia's recent FreeSync adoption eliminated a compelling reason to opt for Radeon cards over GeForce. Still, AMD loaded Radeon VII with some eye-catching extras. Radeon VII holds a small-to-large performance advantage over the RTX 2080 in the content creation benchmarks we tested—as expected, given how strong Radeon architectures have typically performed in compute workloads. One thing to consider though: Nvidia's CUDA

is much more popular for compute workloads than the OpenCL tools AMD relies on, and if you need to perform ray tracing, the RTX 2080's dedicated RT cores could give that card a boost in ray tracing tasks.

The massive 16GB of HBM2 blazing along at 1TBps is another huge win for Radeon VII, doubling up the RTX 2080 in both capacity and overall bandwidth. Such a potent memory configuration provides the Radeon VII with plenty of future-proofing in case 4K textures keep growing in size (as they likely will), and could give AMD's cutting-edge GPU a leg up if you're planning to edit videos at ultra-high resolutions, like 4K or 8K.

Nvidia opted to push gaming into the future with its RTX graphics cards. Rather than loading them down with extra memory, Nvidia equipped the GeForce RTX 2080 and its brethren with dedicated RT and tensor core hardware than unlock real-time ray tracing and AI-enhanced gaming capabilities that the Radeon VII simply can't match. Then again, developers haven't rushed to roll out RTX technology. While more than 20 games (go.pcworld.com/20gm) have pledged to support real-time ray tracing or Nvidia's Deep Learning Super Sampling, you can count the number of games that actually do right now on one hand.

The GeForce RTX 2080 Founders Edition also runs significantly quieter than the Radeon VII.

If you create high-resolution videos when you're not gaming, you might want to opt for the Radeon VII over the GeForce RTX 2080. If you're simply a gamer looking for a killer 4K or 1440p gaming experience, your choice boils down to which graphics card offers the better future-proofing option: the Radeon VII's 16GB of ultra-fast memory, or the GeForce RTX 2080's nascent ray-tracing and AI hardware? Pick your poison, but don't sweat it too much, because you can't go wrong with either of these cards. The Radeon VII is a winner, even if it isn't an outright GeForce killer.

That said, it is a bummer that two long years after the GTX 1080 Ti's release, the modern successors from Nvidia and AMD each deliver comparable performance at the exact same price. Each comes loaded with cutting-edge hardware to justify the cost, but fingers crossed graphics card pricing returns to sanity sooner rather than later.

AMD Radeon VII

★★★★☆

PROS

- Excellent 4K/60 gaming.
- Beautiful design.
- 16GB of high-bandwidth memory.
- Greatly improved power efficiency and thermals.

CONS

- Comparable performance to 2-year-old GTX 1080 Ti.
- No dedicated ray tracing hardware.

BOTTOM LINE

AMD's Radeon VII is a fast, memory-rich graphics card loaded down with the latest technologies. It trades blows with Nvidia's GeForce RTX 2080 in 4K gaming.

$699

ad COUNCIL

~~In a disaster,~~ we come together.

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Dell XPS 13 9380: The best little laptop fixes its biggest problem

Dell's new Whiskey Lake U-based XPS 13 is faster and finally puts the camera on top.

BY GORDON MAH UNG

PCWorld EDITORS' CHOICE

When the news surrounding the latest version of the Dell XPS 13 is its camera position, that's both good and bad.

It's good because the camera's one "feature" that some customers (and competitors) have used to batter what has otherwise been the most trend-setting laptop of recent memory.

If you recall, the original Dell XPS 13 9343 (go.pcworld.com/9343) from 2014 crammed a 13.3-inch laptop into the space an 11-inch laptop would normally occupy. Dell relied on "InfinityEdge" bezels to shrink the foot print of the XPS 13 to unbelievable levels. Just about every laptop maker now offers their own narrow bezel designs.

But Dell's implementation compromised convenience for slimness, moving the camera around the bottom bezel. No more.

IMAGE: GORDON MAH UNG

After years of mocking, Dell's thrown in the towel and moved the camera above the screen, though in doing so the XPS 13 9380 lost the ability to use your face to sign into Windows Hello.

The bad news? The camera's movement overshadows other upgrades in the Dell XPS 13 9380. You'd hardly know the XPS 13 packs Intel's newest ultra-low power consumption Core i7-8565U, for instance—the first laptop we've tested with this "Whiskey Lake U" chip. Beyond a fair performance bump, other changes in the CPU include native support for USB 3.1 10Gbps and integrated Wi-Fi support (except for the radio).

If you're thinking "that's it?" then, well, you can understand all the excitement over moving the Dell XPS 13's camera to the top bezel. So let's start there.

CAMERA: MAYBE YOU WERE RIGHT

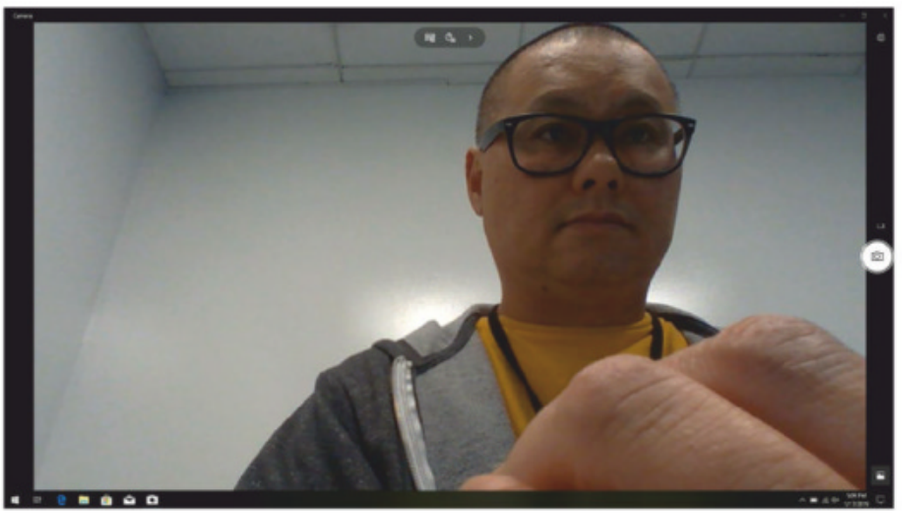
Dell wasn't about to give up the narrow bezels to fit the camera in, so it opted for a 2.25mm diameter camera using four elements, compared to typical three element cams. The camera is also built using the same precision usually reserved for higher-end smart phones, the company says, and sharper in corners than previous designs.

The older Dell XPS 13 9360's often-mocked webcam.

Dell caved and moved the camera to top bezel on the new XPS 13 9380.

We compared the new XPS 13 9380's camera against the XPS 13 9370, which positioned it's camera in the middle of the bottom bezel, and also against the XPS 13 9360, which put its camera in the lower-left corner.

For the tests, we



The XPS 13 9370 put the camera in the middle of the bottom bezel.

The newest XPS 13 9380 finally moves the camera to the top bezel.

positioned all of the laptop screens at similar angles, with our hands on the keyboard. Our eyes were on the same spot on the screen: Dead center, where you'd be looking in a video conference.

The first image is from the XPS 13 9360's lower-left corner camera. It's pretty wacky because it looks like we're not paying attention to our three bosses drone on about TPS reports.

It gets somewhat better with the XPS 13 9370 and its low-center-mounted camera, but then you can see when someone needs a manicure and some industrial hand lotion. If you don't mind your co-workers snickering that you must be working as a dish washer on the side, then this positioning is OK, though you also get a good amount of "turkey neck" or neck waddle at this angle.

Finally, we have the new Dell XPS 13 9380's conventional top-mounted

camera. While we actually prefer the exposure of the previous images, the new camera's position is a vast improvement because it looks like we're paying attention to our three bosses. It also minimizes turkey neck and doesn't let coworkers gawk at your chapped hands.

As we mentioned, the new XPS 13 9380 ditches infrared support for Windows Hello, but Dell does offer a finger-print reader integrated into the power button as an option.

WHISKEY LAKE U PERFORMANCE

There's one more very important thing inside the XPS 13 9380 that nerds care about: performance.

The XPS 13 9380 is the first laptop we've reviewed with Intel's Whiskey Lake U Core i7-8565U. The 14nm chip is essentially an improved version of the 14nm Kaby Lake R used in other 8th-generation CPUs. The performance bump mostly comes from higher clock speeds. Thanks to whatever magic Intel has mustered, Whiskey Lake U can run up to 500MHz faster than its predecessor.

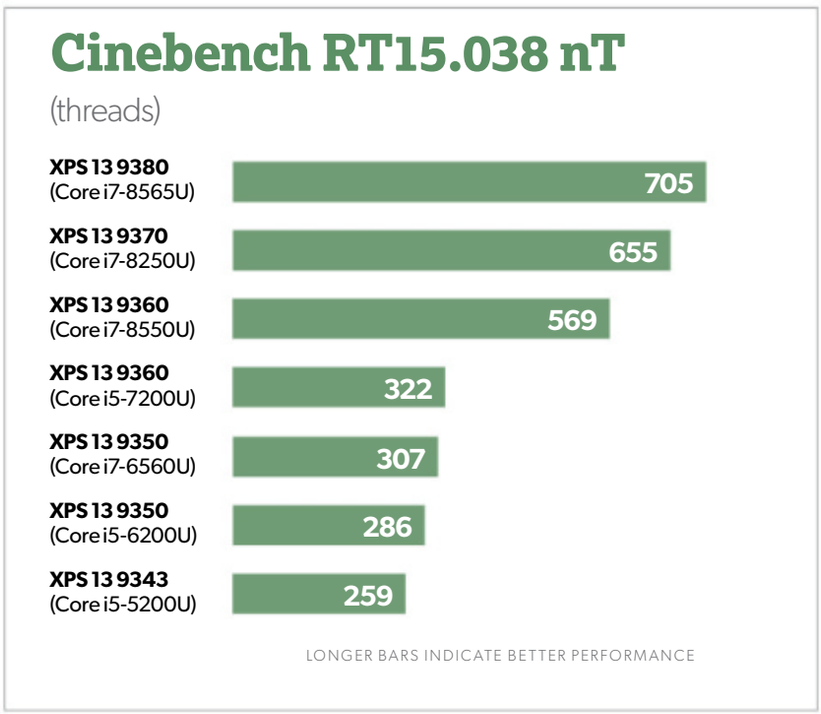
The other change is actual hardware mitigation against the Meltdown exploits (go.pcworld.com/mldn) that boiled over last year. Intel's previous laptop CPUs featured security updates applied through firmware only. Whiskey Lake implements changes in hardware against Meltdown Variant 3 and Variant 5. But the biggest hit to performance, Spectre Variant 2 fixes, won't change much.

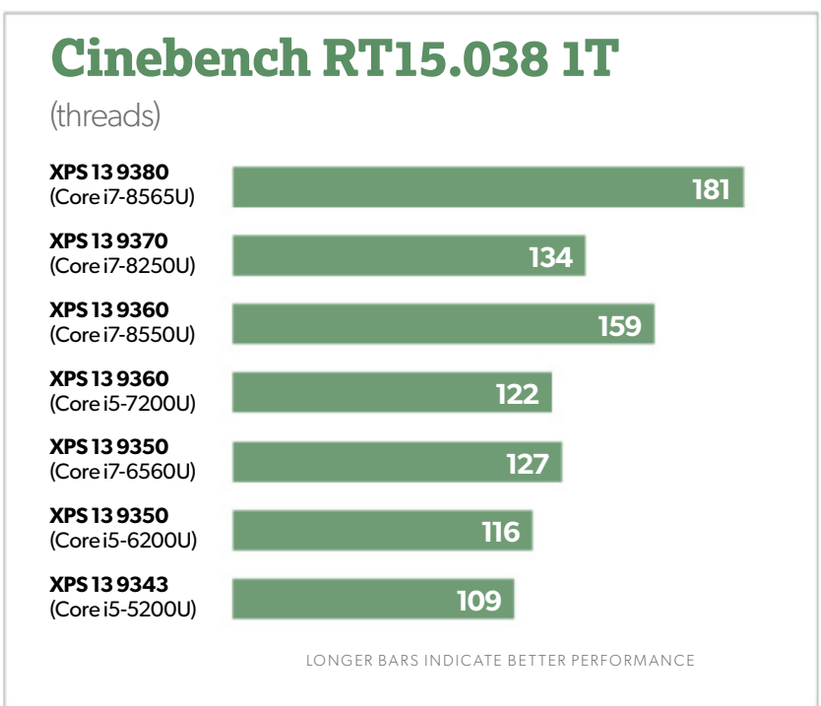
Our first test is Maxon's Cinebench R15. It's a free benchmark based on Maxon's older Cinema4D rendering engine. The test is multi-threaded and probably isn't what most XPS 13 9380 users will run, but it's still a fair representation of what you're likely to see from the

The Dell XPS 13 9380 shows just how much smaller you can make a 13-inch laptop over a much older and definitely unfashionable 13-inch laptop with wide bezels.

laptop and CPU in shorter multi-threaded workloads. Those occasional multi-threaded tasks in Excel or that rare multi-threaded Adobe Photoshop filter would likely see similar performance bumps.

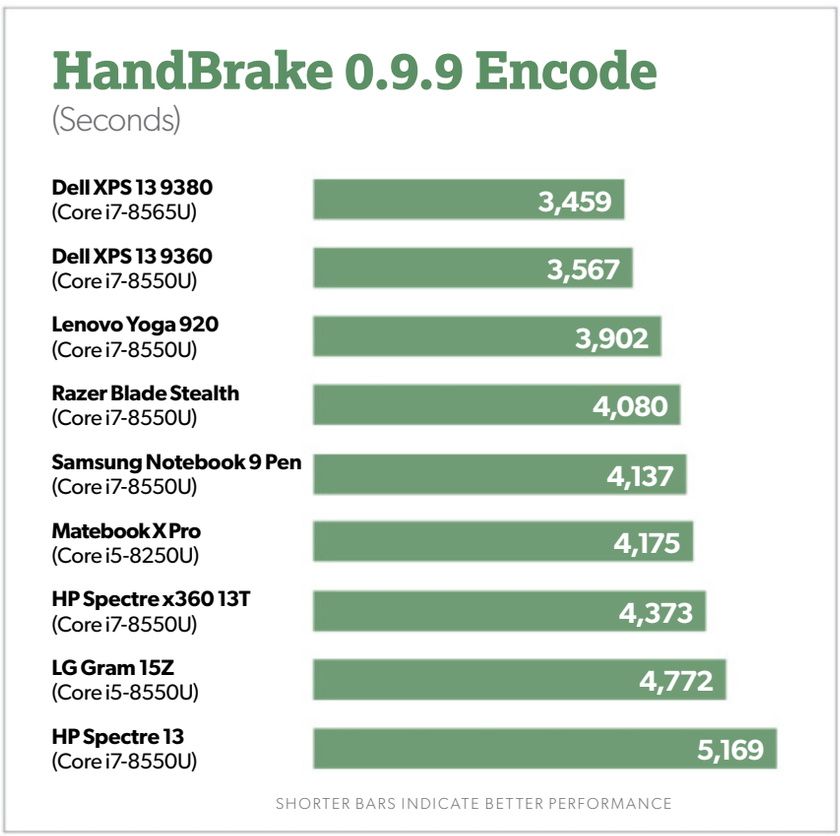
For comparison, I rounded up Cinebench scores from eight Kaby Lake R, Core i7-8550U laptops of varying sizes and shapes. As you can see, the new Dell XPS 13 9380 has about a 20 percent multi-threaded performance advantage. We can attribute some of that to the new Dell XPS 13 9380 design's upgraded cooling—more cooling usually means more performance—and some to the higher clocks that the Whiskey Lake U chip can run at.





But Cinebench R15's view of multi-threaded performance probably doesn't reflect much real-world usage. The vast majority of software and games that people use relay a single-thread or two—especially on a 13-inch laptop. To get a better gauge of how Google Chrome or Microsoft Word will respond, we again rely on Cinebench, but measure performance on a single-thread.

Here, the performance gap closes between the 8th-gen Kaby Lake R laptops and the 8th-gen Whiskey Lake U in the XPS 13. The Kaby Lake R Core i7 is only about 13 percent slower



on paper than the Whiskey Lake U. A win is a win though, and the XPS 13 9380 still tops the chart.

Both of the previous loads test fairly short runs. Since laptops have limited ability to dissipate heat, their CPUs have to run at slower clocks when they're under a sustained load. To test a longer task, we use Handbrake 0.9.9 and transcode a 30GB 1080P MKV file using the built-in Android Tablet preset. The workload takes around an hour or more for laptops to complete.

Besides measuring CPU performance, this test also lets us gauge how well laptops deal with heat. Some laptop makers decide to crank up fan speeds or crank down clock speeds. Others decide to actually let the shell of the laptop heat up too. Dell tends to swing for the fences in performance and you see that reflected here.

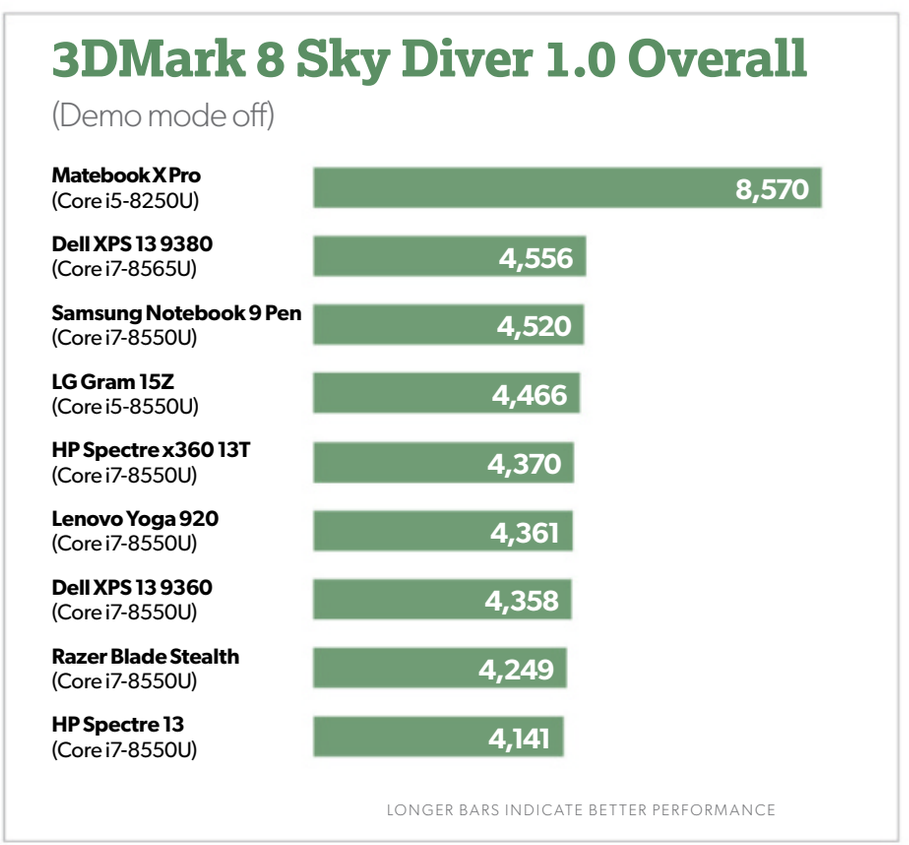
The Dell XPS 13 9380 and its Whiskey Lake U come in first place, but the older XPS 13 9360 with its Kaby Lake R chip isn't that far behind. The larger 14-inch Lenovo Yoga 920 is about 12 percent slower than the new XPS 13 9380, and the Razer Blade Stealth is 16 percent slower. Again, much of what you see here is represented by the available cooling, how much space there is for that cooling, and what the laptop maker opts to prioritize.

The last to cross the line is the HP Spectre 13, which finishes a whopping 39 percent slower than the new XPS 13 9380. The reason is simple: HP touted the Spectre 13 as the "thinnest laptop" in the world at just over 10mm thick. Well, you don't get there without compromises. In fact, the Spectre 13 isn't the thinnest in the world anymore as Acer's Swift 7 (go.pcworld.com/swf7) now claims that at 8.98mm thick, and with its Core i7-7Y75 CPU it's even slower than the Spectre 13.

GRAPHICS PERFORMANCE

While Dell's new XPS 13 9380 is technically faster than its predecessors in overall 3DMark Sky Diver performance, it's really a tie, isn't it? As you can see, they're almost all the same except for small differences due to thermals and run-to-run variances. The fastest is Huawei's Matebook X Pro but it features a discrete GeForce MX150 GPU.

But can you game on the Dell XPS 13 9380? Soft of. Intel's integrated graphics have gotten steadily better over the years, but to play games you'll need to play at 720p resolution at Low graphics settings, or possibly Medium settings in older games. To really get your game on with the XPS 13 9380, we recommend picking up an external Thunderbolt 3 graphics box.



Yawn. Just how boring has the performance curve of Intel's integrated graphics been? You can see that one UHD 620 laptop is essentially the same as all the others.

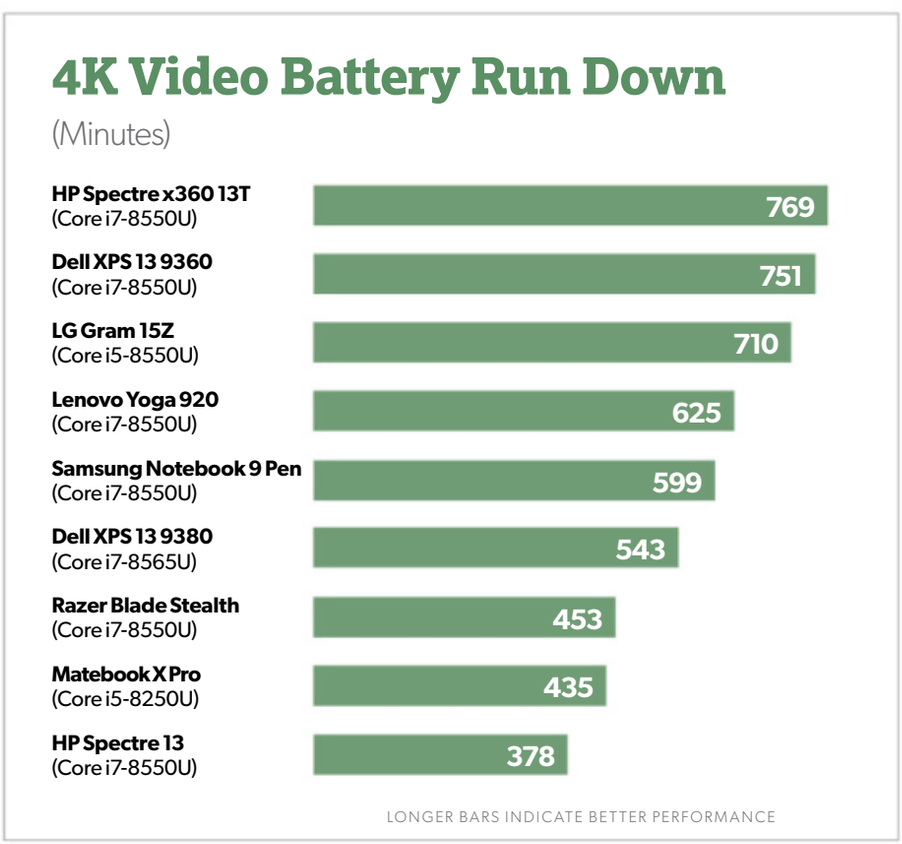
BATTERY LIFE

Our final cross-vendor platform test looks at one of the most important categories for laptops: Battery life. We set the screen at a relatively bright 250 to 260 nits and then loop a 4K video on airplane mode until it dies. For audio, we use a pair of analog earbuds to minimize differences from the speakers. It basically mimics what you'd get trying to watch a movie in a well-lit office building.

Among all of the tests we ran, this is the only one where the XPS 13 9380 loses, but you shouldn't be surprised. There's a battery penalty to be paid for having a high-resolution 4K touch screen. In fact, if you look at the results closely, you'll see that most of the laptops on the bottom of this list feature higher-resolution panels. The XPS 13 9380's screen contains about 8.3 megapixels, the Razer Blade Stealth is about 5.7 megapixels, and the

Matebook X Pro packs 6 megapixels. Generally, the more pixels, the more work it takes to achieve the same brightness as a lower-resolution screen, so a typical 1920 x 1080 panel and its mere 2 megapixels can be a huge power advantage.

Dell's XPS 13 9380 actually does pretty well at about nine hours of playback. With its pixel density that's really not as bad as were expected. (It gets bright, too, at 400 nits maximum.) Still, compare that to 12 hour-plus endurance of the HP Spectre x360 13T and Dell XPS 13 9360 and you really wonder if the 4K panel is worth the trouble.



The battery life of the new XPS 13 9380 is decent for a 4K laptop, but you'd probably get another few hours of run time for opting for a lower-resolution XPS 13 9380 with the 1920x1080 or FHD screen instead.

We generally don't recommend the 4K option for small laptops but consumers like the "sound" of 4K so it's there. We suspect that if you opted for the 1080p version, you'd definitely add another few hours of playback, and won't likely be disappointed by the lower resolution.

COIL WHINE

While we've long loved the XPS 13 series, there have been off and on reports of "coil whine." Coil whine is essentially electrical noise that's audible to your ears. Most high-performance video cards and other computer equipment can have coil whine.

The XPS 13 (and the XPS 15 in particular) have been often dinged for "excessive" whine. One problem with judging coil whine is that it's often not always the same from laptop-to-laptop—some units might have it, while others won't. It doesn't help gauging the problem when some people can hear it and some can't, either.

The XPS 13s that we've tested over the years haven't exhibited coil whine—until now. The Dell

Like the previous model, the XPS 13 9380 includes a 45-watt USB-C charger.

XPS 13 9380 emitted a coil whine perceptible in a quiet room. The whine seemed to emanate from the left side of the unit, but we should note that it was intermittent and in an office environment. We had to put our head almost on the keyboard to hear it.

Is it something we think you should be concerned about? Probably not, but we'd be remiss if we didn't mention it.

BOTTOM LINE

Most will dismiss the Dell XPS 13 9380 as a "meh" update. We'd tend to agree, as the CPU update offers a fairly small (albeit real) performance bump. The problem with that narrative is it ignores the position of the strength the XPS 13 comes from. The previous model reigned as most everyone's top ultrathin laptop, including our own (go.pcworld.com/tplp)—until you got to the webcam placement. By taking that criticism away, the already-great Dell XPS 13 9380 is a better laptop.

While the version we're reviewing today is over the top with its 4K panel, 16GB of RAM, 1TB SSD, Core i7-8565U, and Windows Pro, you can expect similar performance in versions with smaller SSDs and lower-resolution displays. In fact, we'd probably recommend those first unless you absolutely are set on the 4K panel.

Dell XPS 13 9380

★★★★☆

PROS

- Camera finally back on top and no more turkey waddle neck.
- Intel's Whiskey Lake U offers a decent but marginal performance bump.

CONS

- Doesn't support Windows Hello facial login.
- 1080P version lacks touch screen support option.

BOTTOM LINE

A rejiggered camera position and Intel's new Whiskey Lake U processor makes the best thin-and-light laptop even better.

$2,470

Creative Super X-Fi: A 'holographic audio' eargasm

Has Creative created the holy grail of headphone audio on phones, laptops, and PCs?

BY GORDON MAH UNG AND ADAM PATRICK MURRAY

PCWorld EDITORS' CHOICE

Few things in technology are guaranteed to bring you actual joy, but Creative's Super X-Fi just might qualify for that list.

In short, the Super X-Fi distills decades of audio work into a tiny, portable dongle no bigger than a USB thumbdrive that transforms smartphone, laptop, or PC audio with "holographic audio," according the company.

While that sounds like a lot of superfluous ad copy, we have to admit that after weeks of using the Super X-Fi, the company is on to something. We'd almost believe Creative's claim that it has found the "holy grail" of audio, but we're disinclined to recall the Quest Knights just yet.

IMAGE: GORDON MAH UNG

GETTING STARTED

The Super X-Fi features a USB-C port on one end, a standard 3.5mm analog jack on the other, and features volume, shuffle, and a single control button on its surface. A tiny LED changes state from green to orange to let you know if it's at work or not.

To get started with the Super X-Fi, you first download an Android app through the GooglePlay store. You then take pictures of your head which is analyzed by Creative to pick the perfect audio profile for your particular head shape.

This is necessary because so much of how we hear sound is determined by the timing differences of audio arriving in our ears, and the shape of our head and earlobes plays a large part of it.

Besides profiling for your head, you also pick from a set of listed approved headphones in the app, or set it to "generic" for either headphone or in-ear. The headphone profiles are fine-tuned by Creative to make the most of each pair's sonic characteristics and fit style.

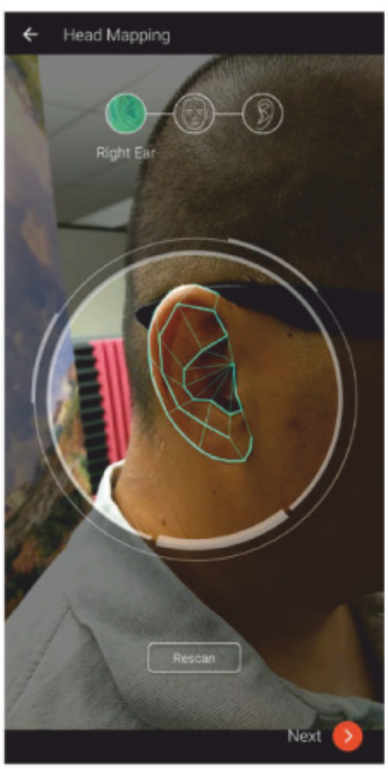
Creative actually has an even more optimized approach for mapping that uses in-ear microphones to precisely model audio for your head while frequency sweeps are run on a surround system. Obviously, this isn't something that's currently feasible for your average consumer. But we can say that in demonstrations of the Super X-Fi mapped using the in-ear microphones, we had a tough time distinguishing the Super X-Fi from a decently high-end Dolby Atmos system.

For now, the head scans using a phone camera are the next best thing.

Having that extra information is how Creative distinguishes the Super X-Fi from all other spatialized audio solutions. Creative expects its algorithms to get even better still as it adds more scans to its growing database.

INSIDE THE SUPER X-FI

Crack open the Super X-Fi and you'll find an AK4377. That's a 32-bit, 768KHz digital analog converter from acclaimed audio company Asahi Kasei Microdevices. The other chip is Creative's Super X-Fi chip. The company is pretty secretive about what the Super X-Fi does exactly but we'd guess it relies on such technologies as Creative's



The Super X-Fi app scans your head to determine what is optimal for you.

On one end is a USB-C port, and on the other is a 3.5mm jack, which many companies have banned from phones.

Crystalizer, CMSS, and dozens of other audio patents the company has in its war chest.

Yes, true audiophiles who pursue the highest-resolution FLAC or DSD files will scoff at Creative's bag of audio techniques as gimmicks or magic tricks, but in our listening experience, the Super X-Fi was nothing short of phenomenal.

SUPER X-FI AND MUSIC

With stereo content over a good set of headphones or in-ear earphones, most music is rendered as if a singer or band is inside your skull. In fact, we're so accustomed to this John Malkovich feeling that switching on the Super X-Fi may throw you off for a second or three.

If you keep listening though, you'll eventually realize you're just not used to the sound of a band in front of your head, where they would be if they were performing for you.

If we were writing Creative marketing lines, it would be easy to say that the Super X-Fi is like having a personal audition by musicians.

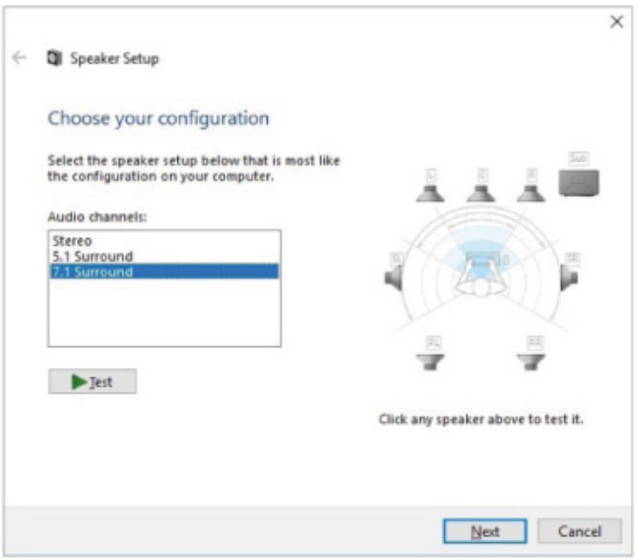
Using whatever wizardry Creative has summoned from its library, there were times when the difference was stunning. It had us combing through our collection for more music to re-experience.

SUPER X-FI AND GAMES

Want to feel like you have an advantage in a multiplayer shooter? Want to be further immersed further in an open world? Plug that Super X-Fi into your PC and enjoy a 5.1 setup at the comfort of your desk with no pesky speakers or wires to worry about.

Online games like *Destiny 2, Battlefield V,* and *Call of Duty: Black Ops 4* worked like a dream and provided a level of feedback that made us feel as if we were cheating. When you can accurately place a sound without any visual feedback and respond to it, it becomes a game changer. Did it make us a better player? No, it's not magic. But it did give us a deeper sense of our surroundings than we'd experienced before. The Super X-Fi will also pass microphone data as well, for when you are teaming up with your buddies.

The spatialized sound even increased the immersiveness of single-player games like *The Evil Within 2, DOOM,* and *Red*



With the Super X-Fi in Windows, you set the OS to output as discrete 7.1 audio, which the dongle then reassembles positional audio from.

Dead Redemption 2 (gasp—a console game). Yes, the Super X-Fi also works with the PlayStation 4 and Nintendo Switch, but not on the Xbox One due to current restrictions from Microsoft.

We've been using the Super X-Fi primarily to play games for two months and it's become a must-have. In situations where a dedicated 5.1 sound system isn't an option, the Super X-Fi is the next-best thing whether you're playing on a TV or PC.

And for those who are worried about Creative drivers, have no fear, this is plug-and-play—meaning you can't blame the company anymore if your build locks up mid-match!

SUPER X-FI ISN'T PERFECT

Be forewarned, the Super X-Fi is not perfect by any stretch. As we said, there will be times when you'll be floored by just how good the Super X-Fi sounds. But there will also be times when it's just meh, or even just wrong. Maybe a pinch too much reverb, maybe the vocals are processed out as a little too thin. Android users will also be annoyed by the device asking for permission to access the Super X-Fi (Creative says it's a security limitation imposed by the OS).

There also isn't much customization in how much depth you can add to the spatialization. In future iterations we'd love to see the ability to push the "speakers" out further, or adjust how much reverb is in the space with you. Fine-tuning like this can further trick the brain to accept you are indeed listening to speakers in the space with you.

Fortunately, in situations where the Super X-Fi's processing isn't working for you, you can click a button on the device to switch it off. You'll still get the benefits of a 120dB SNR, 32-bit AKM DAC, which is likely a big improvement on anything built into your phone or laptop, or the generic dongle that came with your phone.

SUPER X-FI WORKS BEST WITH UNSPOILED SOURCES

In our experience, the Super X-Fi seemed to tickle us most with older, unspoiled music. The older the better. Mono recording? Even better.

For example, an Amazon-downloaded

Hank Williams' Jr. MP3 of "Angels Are Hard to Find" (recorded in 1974) sprang to life with Super X-Fi, where the only thing that could possibly make it better was a hay bale and ice cold Lone Star beer.

When it comes to gaming, your experience is likely to be better with games from studios that put a ton of resources into their sound teams, such as DICE and Blizzard—we found the Super X-Fi to shine bright here.

We found that the Super X-Fi typically used just a little less than half a watt of power under load, which didn't seem to hit the phone's battery life much. That's not bad, but the Google USB-C audio dongle is even less at a 10th of a watt, so there's a power cost.

SUPER X-FI IMPROVES BAD MP3S

If you saw "MP3" and did a needle-scratch, stop. Yes, most audio snobs will turn up their noses at MP3s the same way a coffee enthusiast recoils at the mention of Folgers, and that condescension is warranted. MP3s are inherently compromised.

Interestingly, we found this to be one of the areas where the Super X-Fi really shows its stuff. For the vast majority of average folks who have boxes of MP3 files they collected in college from that corner store called Napster, the Super X-Fi can, and will, make many of those files sound better.

Obviously, your mileage will vary depending on the MP3 and how processed it was from the studio, but by and large, it improved most of the music we listened to.

That's not to say the Super X-Fi won't make FLAC files also sound better. A 24-bit, 96KHz recording of the Eagles singing "Hotel California" sounded so much improved, that even Jeffrey Lebowski would likely approve.

HEADPHONES MATTER TOO

As we mentioned earlier, in addition to profiling your head shape, the Super X-Fi's app also uses a profile for your specific headphones. The list includes several major brands in addition to Creative's own models, such as AKG, Apple, Audio Technica, Beyerdynamic, Bose, HIFIMAN, Jaybird, Koss, Massdrop, Oppo, Sennheiser, Shure, Skullcandy, Sony, V-Moda, and Venture Electronics plus its own Creative and E-Mu

models. All told, there were 43 headphone models supported at the time of our review, with more to come. (Generic profiles exist for models not on the list.) For our testing, we used Creative's $850 E-Mu Teaks, $150 Aurvana Trios, and a set of Aurvana SE's that go $59. All had Super X-Fi profiles but we also used a pair of unprofiled Mionix Nash 20 gaming headphones as well as a set of Polk headphones and Sennheiser HD700s. The Nash 20 and Polk's used the generic profile while the Sennheiser HD700s used the very similar Sennheiser HD800 profile in the app.

Does the headphone quality matter? Yes, definitely.

While there is some overall "enhancement," don't expect the Super X-Fi to make your lousy headphones sound great. Still, we were pretty happy with the results from the Aurvana SE's that sell for $60. And a generic profile shouldn't be a deal-breaker. In fact, the Sennheisser HD700's sounded great. Just don't expect a magical transformation from subpar cans.

The large round button on the Super X-Fi lets you turn off any processing, making the dongle a standard USB Audio DAC. The LED turns green when processing is on and orange when it's off.

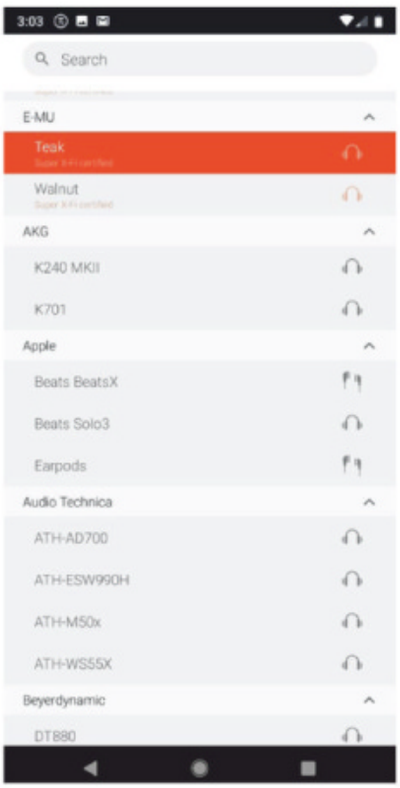
SUPER X-FI'S POSITIONAL AUDIO IS EXCELLENT TOO

All of the above pertains to the Super X-Fi's ability to improve stereo content, but the other big selling point is positional audio, which is marketed as being comparable from a Dolby Atmos setup. Really? Well, yes and no. While in a controlled environment set up by Creative, we found it hard to tell the difference…at times. But honestly, few who actually have a true surround sound system are likely to ditch it for the Super X-Fi.

Still, if you want "Dolby Atmos" (hyperbole aside) in your ear, it's going to be hard to beat the Super X-Fi right now.

For our close-listening tests, we used the Super X-Fi's profile generated by taking pictures of our head and ears combined with the profiles for the in-air Aurvana Trio and E-Mu Teak headphones, respectively. What's cool about the Super X-Fi is that it functions as a basic USB Audio 2.0 device. That means anything that supports USB Audio 2.0 should technically work with the Super X-Fi.

On the PC there's one more trick you perform. Rather than let it default to a standard two



Creative has added 43 different profiles (at last count) that the Super X-Fi supports. You can also use generic profiles too.

channel audio device, you set it to 7.1 audio in the control panel. This lets Windows spit out eight discrete channels over USB, which the Super X-Fi then processes back into surround audio.

In our close-listening tests we used the oldie-but-goodie RightMark 3D Sound, which lets you carefully position an audio source around you.

The problem with using just RightMark 3D to judge the Super X-Fi is that the antiseptic feel detracts from the surround audio. So rather than rely on just moving an object around in DiretSound3D, we also relied on what people might actually use the Super X-Fi on the PC for: watching videos—on YouTube (yes, audio and cinema snobs, recoil in horror again.)

To replicate our RightMark 3D audio test, but with some control, we first used a 360-degree recording with an integrated 5.1 audio track using the Google Chrome browser. For the video, which you can see here (go.pcworld.com/m4tk), a 360-degree camera was mounted on the turret of an M4 Sherman tank at the Thunder Over Michigan 2017 show. Besides the thunder of machine guns and tumble of the Detroit motors, the audio includes several passes by a P-51 Mustang. That let us rewind the video and repeat the P-51 pass using the Super X-Fi on and off, with the ability to "move" our virtual heads in the video. The result? Far better positional and far better immersive audio. Would we say we felt like we were a GI on the front of a Sherman? No, but it certainly sounded more like it than pure stereo output.

This, again, seems to be the strength of the Super-Fi: to render what would be pretty mundane audio into far more immersive audio. Another video we used for listening tests featured the repeated flybys of a Huey UH-1 helicopter (which you can see here [go.pcworld.com/huey]). Switching off the Super X-Fi made that large rotor whop-whop-whop of the Huey sound dull and lifeless. Turn it on though, and the device adds just the right amount of reverb and touches to, well, make it feel like you are about to land in a hot LZ along with Four Leaf Tayback and Sgt. Lincoln Osiris during the Wet Offensive.

One end, of course, features a standard 3.5mm "courage" jack that's been banned by most phone companies.

It's not just YouTube videos, of course. We also used CyberLink PowerDVD to closely listen to James Cameron's *Avatar* on Blu-ray. Say what you will about the movie, the audio mastering is well executed. We used one particular Na'vi scene where the characters fly past waterfalls and we could clearly hear—or at least we believed we heard—the waterfalls behind us.

And that's the thing. Over the years, we've wondered if positional audio isn't more the power of suggestion than the power of HRTFs, reverb, and other audio filtering. You are, after all, using two channels to fool your brain into thinking something is behind you, or above you. We'll let the audio nerds argue that in forums, but what we can say is the Super X-Fi really does a damned-good job at making you believe it and that is really all that matters in the end.

BOTTOM LINE

As good as the Super X-Fi is, convincing consumers this is something they need is still an uphill battle. Again, we believe that most of the time, you'll find the rendering of the content that you listen to vastly improved. That runs the gamut from your FLAC files to MP3s and, yes, YouTube videos of WWII-vintage warbirds taking off (go.pcworld.com/vntg).

But do you care enough about the audio from your laptop, phone, or desktop to invest $150, along with purchasing a decent pair of headphones, and then deal with wires too?

The truth is, we know few will do that, instead favoring Bluetooth. And that's a real shame because we can honestly, and unabashedly, say your ears are missing out without the Super X-Fi.

Creative Super X-Fi

★★★★½

PROS

- Can truly transform audio.
- Can turn some meh audio into wow.

CONS

- Wires, man, wires.
- Really needs profiled headphones for the best experience.

$149

Kaspersky Total Security vs. Norton Security Premium

Kaspersky is a fan favorite in the AV world, while Norton is a longtime brand that's not nearly as beloved. Who wins when these two suites mix it up? **BY IAN PAUL**

If there's one antivirus suite that gets people excited it has to be Kaspersky (go.pcworld.com/ks19). The popular suite from Russia-based company Kaspersky Labs is a favorite among tech types, and that's despite the controversy from 2017 where the company was accused of being a tool of Russian intelligence (go.pcworld.com/hkav).

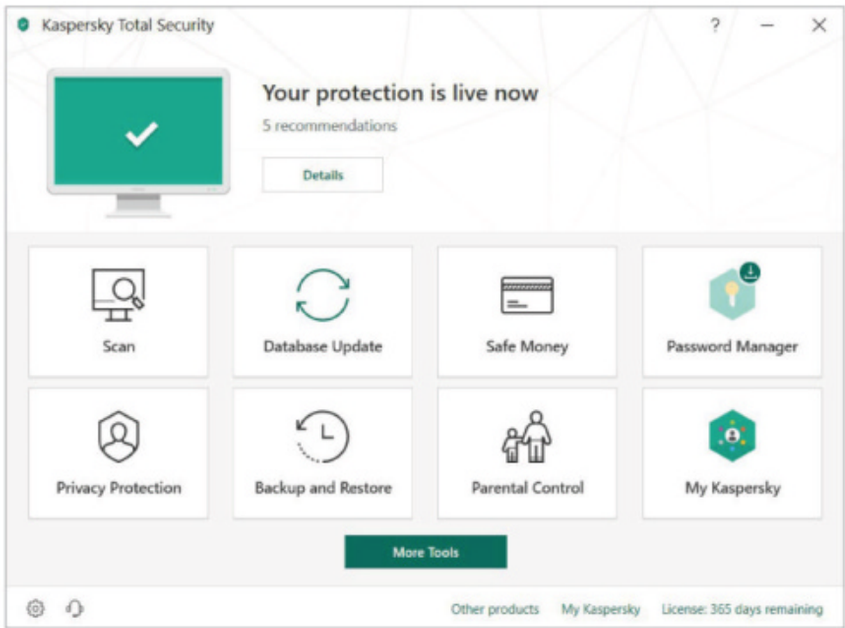
Then there's Symantec's Norton Premium Security (go.pcworld.com/nr19), a go-to security solution for many years that's still a great choice—and our current favorite antivirus suite (go.pcworld.com/avrs).

Both are popular choices for protecting your PC. Let's take a look at how they

compare in key categories in this head-to-head matchup.

APP DESIGN

The desktop apps for Norton and Kaspersky both offer an easy-to-understand interface employing mobile-style tiles. With Kaspersky, the primary screen has eight tiles representing various "modules" in addition to a More Tools button that leads to more options. Norton, meanwhile, uses five category tiles that let you jump into the app's features from there.



Kaspersky Total Security.

Kaspersky's approach means you have to take fewer steps to get key features such as security scans, updates, and parental controls. The trade-off is that you have more options to sort through from the primary dashboard.

Norton, meanwhile, requires an extra click to get to key features, but the starting dashboard is simpler with just a few categories.

Both applications are easy to use and it really comes down to which approach you prefer. In our opinion, Norton is just a little bit easier to use than Kaspersky, but it would be totally reasonable to go the other way.

Winner: Norton

PERFORMANCE

Both Norton and Kaspersky showed little to no impact on performance when we ran PC Mark 8's Work Conventional test after a full system scan. With Norton the PC's performance improved slightly, while with Kaspersky performance remained more or less the same before and after installation.

The file-conversion test using HandBrake yielded a similar result. Norton improved performance slightly, while things stayed more or less the same with Kaspersky.

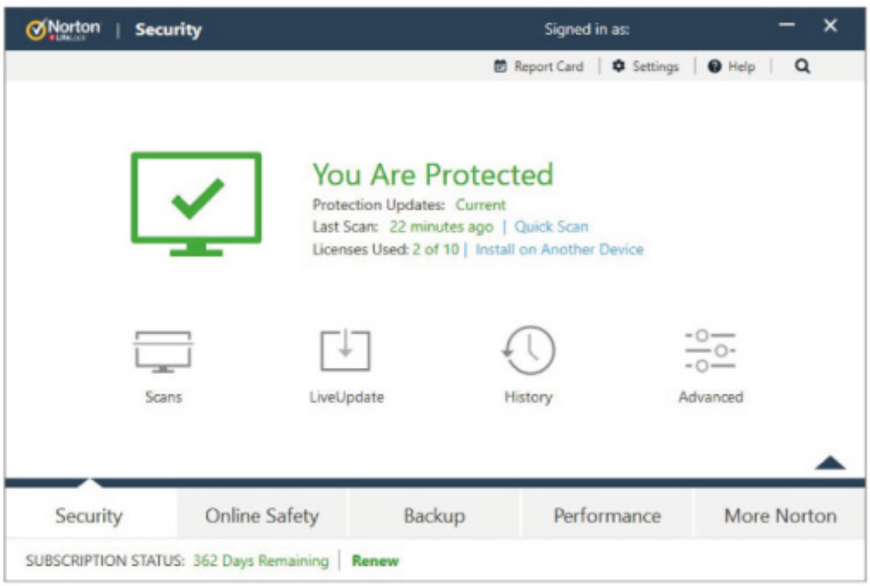
Winner: Norton

PRICE

Norton Security Premium costs $55 per year for new users, and the standard price is $110 for protection of 10 devices. Kaspersky Total

Security is $50 per year for a new user, and the standard price is $100 for five devices. The price-per-device makes Kaspersky one of the more expensive A/V suites.

Winner: Norton



Norton Security Premium.

EXTRA FEATURES

Kaspersky Total Security has a lot to offer when it comes to extra and non-standard features. It has a password manager, a sandboxed browser to protect financial transactions, a tool for blocking unauthorized access to webcams, a network monitor, PC cleaner, and a software updater.

Norton has some similar features such as the password manager, PC cleaner, and PC optimization tools, but Kaspersky offers a lot more extras and they're all fairly useful.

Winner: Kaspersky

PROTECTION

In the most recent results from A-V Test (go.pcworld.com/avts), both Kaspersky and Norton scored 100 percent in September and October for the zero-day and widespread malware tests. Over at AV-Comparatives (go.pcworld.com/avcm) both suites scored very highly in the Real-World Protection and Malware Protection tests. In the Malware Protection test's offline detection rate, however, Norton scored much lower than Kaspersky—81.5 percent versus Kaspersky's 99.2 percent.

Finally, at SE Labs (go.pcworld.com/selb) both Norton and Kaspersky received a AAA ranking.

Winner: Tie

BOTTOM LINE

The bottom line is that both Norton and Kaspersky are excellent antivirus suites, but when you consider price, app design, performance, and protection we're putting Norton ahead of Kaspersky. The latter is great for extra features, and protection is equal to Norton, but the price makes it less of a value.

Hands on: The Kensington SD7000 dock turns a Surface tablet into a Surface Studio

Unfortunately, Kensington's SD7000 dock takes a page from Microsoft and charges a premium price. **BY MARK HACHMAN**

For years, Microsoft Surface fans have wondered two things: First, would Microsoft ever sell a standalone version of its massive Surface Studio display (go.pcworld.com/sfs2)? And second, when would the company update its Surface Dock (go.pcworld.com/sfdk)? The Kensington SD7000 Surface Pro Docking Station answers both questions…sort of.

Put simply, Kensington's SD7000 features

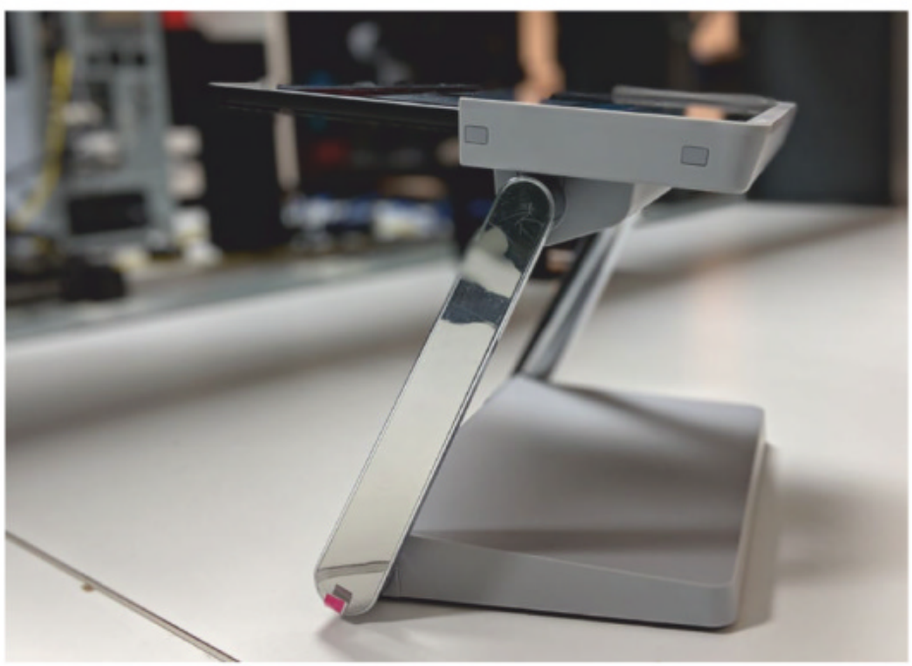
IMAGE: MARK HACHMAN

the "zero-gravity hinge" construction of the Surface Studio, but instead of a massive 25-inch, 4.5K screen, there's a partial frame which can hold a Surface Pro 4, Surface Pro (2017), or Surface Pro 6. We'd call the SD7000 a sort-of hybrid between a tablet stand and a dock, which can also serve as an inking surface should you need that.

In some ways, the Kensington SD7000 reminds me of the first generation of Surface Pro docks, which "grabbed" each side of the tablet and featured a port extender at the Surface Connector slot. To use the SD7000, you slide the Surface Pro tablet into the SD7000's frame, then hold the device in place by snapping a side handle closed. Naturally, you'll immediately discover one limitation: You have to remove the Type Cover.

Meanwhile, on the rear of the SD7000's base, there's an array of ports: four USB 3.0 ports, an ethernet jack, a full-sized DisplayPort++ 1.2 port, HDMI, a Kensington lock (naturally), and a headphone jack. Finally, there's also a USB-C port, though it's data only. (USB-C is a feature of the Surface Studio 2, though not the Surface tablets.)

In all, it's a solid idea, executed solidly—until you factor price into the equation. The



This is about as high as the SD7000's arms can raise the tablet…

…and here the SD7000 is in "easel mode." It doesn't recline as far as the Surface Pro 6 kickstand allows, but it provides a sturdier surface.

Kensington SD7000 docking station costs $399.99 (go.pcworld.com/k629)—which sounds exorbitant, and it is. The one saving grace is that Microsoft already charges, $199 for the Surface Dock, though prices are lower elsewhere (go.pcworld.com/msfd).

STURDY AND USEFUL

Though the Surface Pro is a mobile device, the SD7000 decidedly isn't: At 7.28 pounds, the SD7000 is weighted to hold the Surface Pro firmly. Though the SD7000's construction is plastic, a large metal hinge and arms smoothly moves the tablet receptacle flat upwards through 65 degrees or so. A secondary hinge also rotates the receptacle itself by about 90 degrees.

Both hinges allow you to adjust the tablet through a wide range of positions. At its highest point, the tablet can't get quite vertical, though the slight angle is actually more ergonomic. At its lowest point, the tablet reclines to about 30 degrees. Unfortunately, the hinge isn't quite strong enough to support the full weight of the tablet if you lower it close to the desktop, so it sags until the tablet's weight is supported by the flat surface. On the other hand, the SD7000's construction also allows you to place the dock on a desk, then drop it down to where it's hanging off the edge, onto a keyboard drawer.

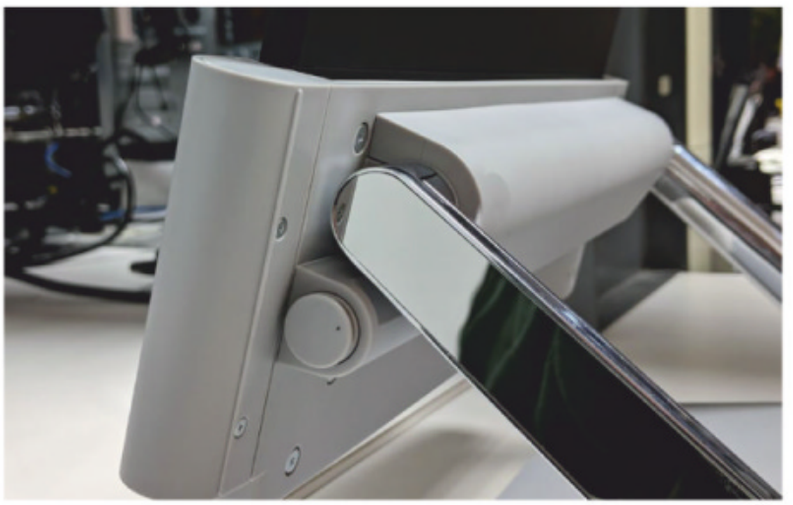
A retaining handle snaps in and out, connecting power and I/O to the Surface tablet and holding it in place.

VIDEO: **DOCKING STATION TURNS THE SURFACE PRO INTO A SURFACE STUDIO**
Watch now at go.pcworld.com/dkst

The SD7000's inability to support the tablet's weight is annoying if you're planning on using it as a monitor; as an inking surface, the sag is perfectly acceptable. Keep in mind that the built-in kickstand of the Surface lineup allows you to recline the tablet further than the SD7000, though with a bit of unwanted springiness that isn't present in the SD7000. The frame goes just partway up the Surface tablet, providing plenty of area for the tablet to cool itself under load.

Unfortunately, as a dock, the SD7000 is hampered by the limitations of the Surface

Connector—though the dock can support more than one physical display, only a single 4K display can be run at 60Hz. If two are connected, the display bandwidth must be split into two 4K connections at a sub-standard 30Hz—a limitation of the Surface, however, and not the SD7000.



A closer look at the hinges that allow the SD7000 to raise, lower, and swivel the Surface tablet.

Unfortunately, Kensington followed Microsoft's cue with the Surface Studio and placed the SD7000's ports on the rear. It might be a strong choice aesthetically, but functionally it isn't: You'll be rotating the entire contraption around to insert any new cable or device. But the SD7000 also receives power through its power cord, which it passes along to the tablet. The sleeve construction also keeps accessible the USB Type A and miniDP ports already on the Surface Pro. (If you already own a Surface Pro tablet, chances are you already own a miniDP-to-HDMI cable anyway, making the full-sized DisplayPort and HDMI connectors on the SD7000 somewhat irrelevant.)

Kensington's SD7000 plays into the odd little ecosystem of devices that can control more than one PC at a time, enabled by apps like Microsoft's own Mouse without Borders app (go.pcworld.com/mswb), as well as the Logitech MX Master 2S (go.pcworld.com/ms2s) and its Logitech Flow technology. It's up to you whether you'll want to use the Surface Pro tablet as your primary device, or just use the SD7000 to put it in a convenient position as a secondary display.

Either way, convenience is a pricey proposition for the SD7000. But without Microsoft stepping in to provide its own docking alternative, who can blame Kensington for cashing in?

The ports on the rear of the Kensington SD7000. Don't forget the Kensington lock to the far right!


END
FAMILY
FIRE
8 kids a day are accidentally killed
or injured by **FAMILY FIRE.**
FAMILY FIRE is a shooting involving an
improperly stored gun, often found in the home.
ENDFAMILYFIRE.org
Ad
Council

HOW TO BUY THE SD CARD FOR YO PHONE, TABLET

IMAGE: GETTY IMAGES

E BEST UR CAMERA,

MEMORY CARD SPEED, CLASS, AND CAPACITY DIFFERENCES EXPLAINED. **BY GORDON MAH UNG**

You just want to buy an SD (secure digital) card or microSD card for your DSLR, dash cam, drone, smartphone, or tablet. But one size doesn't fit all. If the confusing array of memory card logos and specs has you pounding your head against a wall, we understand.

We'll give you the quick answers for the most common memory card uses. (Pro tip: Check your device's manual for memory card recommendations.) If your needs are very particular, we've also delved deep into SD card standards to help you understand the difference between Class 10, V30, UHS-I, A1, and U3, so you can make the right choice for any device or purpose.

SECURE DIGITAL (SD) CARD CHEAT SHEET

Here are the short answers to determine which SD card to buy for certain purposes:

Best SD card for video use: Concentrate on the Speed Class rating given for your device. Generally, a Class 10 card works for 4K video at 30fps. For anything higher, it's recommended to invest in V30 and up. See page 96 for more details.

Best SD card for a GoPro Hero: For Hero 4 Black and older, a Class 10-rated card is generally fine but newer cameras such as the Hero 7 Black should be fed with U3- or V30-rated cards. See page 97 for more details.

Best SD card for a DSLR: Choose a card based on its maximum write speed. While there's no logo for that (thank god), 40MBps to 50MBps is typically good enough for most consumer and even some prosumer DSLRs. See page 97 for more details.

Best SD card for an Android phone or tablet: Because of limitations in how these devices handle SD storage, storing apps on a card may frustrate you—though an A1-rated card may help a little. For storing photos or video, pay attention to the stated write speed. See page 100 for more details.

Best SD card for a Nintendo Switch: For the best deal, skip the "official" card and buy a high-capacity card that works for your budget. See page 102 for more details.

Best SD card for a dash cam or nanny cam: Ignore the write speeds and X-ratings and go for one that touts "High Endurance." See page 104 for more details.

SD SPEED CLASS MARKS EXPLAINED

One of the most confusing specs on SD and microSD cards is the dreaded "speed class" mark. For the most part, it's pertinent only to recording video. Let's say that again: It's mostly intended for video.

Unlike with still photography or file storage, an occasional pause in data writes isn't a big deal, as the camera or device should just pause and pick up where it left off. Video, however, requires undisturbed writes, because the stream can't be easily paused on

most consumer hardware.

The most familiar of these speed class designations is the basic numeric code of 2, 4, 6, and 10 that have been around since the mid-2000s. The number denotes the minimum write speed without a fatal (for video) disruption. A Class 4 card will write at 4MBps, for instance, and a Class 10 at 10MBps.

This was fairly straightforward until the U1 and U3 UHS Speed Class marks were introduced in 2010 and 2013, respectively. U1 and U3 indicate a respective minimum of 10MBps or 30MBps write speeds. Both also support a faster ultra-high-speed (UHS) bus.

To help muddy things even more, in 2016, a new Video Speed Class mark was introduced to increase speeds for even higher-resolution cameras and devices. Video Speed Class includes: V6, V10, V30, V60, and V90. As you can guess, the number denotes the guaranteed write speed in MBps (which in some cases can be lower than a card's maximum write speed.)

There are actually deeper technical reasons for why you might prefer a Class 10 card (or an even slower Class 6 card) instead of a V90 card for standard-definition video (think 1990s' era 640x480), but generally, if the card maker did its job, writing even standard-definition video won't be an issue.

The part that drives consumers batty is that all three speed class ratings are still in active use on memory cards today. Many cards carry multiple speed class markings.

Confused? This Toshiba microSD card carries speed markings for V30, U3, and Class 10.

Even more confusing are cards like the Toshiba pictured here: If V30 is rated at 30MBps writes, why does it only have a Class 10 rating, which indicates a 10MBps write speed?

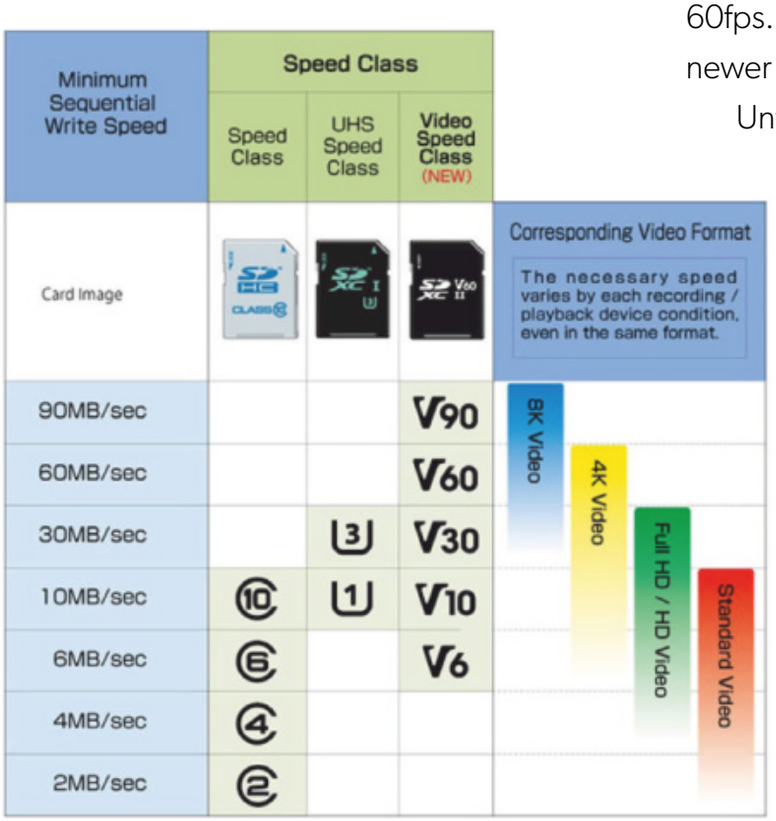
WHICH SD SPEED MARKING IS THE 'BEST'?

Believe it or not, the markings on the card and package aren't there to confuse you, but to help you. Ideally, you'd look at your action cam or nanny cam's manual, and see that the maker recommends a Class 6, Class 10, V10, or U3 card, and buy a card with that marking.

In fact, that's the best way to use the speed-class markings properly. The problem is you probably don't know what your camera or doohickey recommends, so you end up trying to find out what C10, V30, and U1 mean from a browser on your phone while two kids tug on you to go to the toy section.

The only real pitfall to watch for is paying (probably overpaying) for something you don't need or can't even use. For example, putting a V30 card in a device that requires Class 10 is about as wasteful as filling up a minivan's tank with high-octane gas instead of plain, old unleaded.

Seen in that light, the chart below from the SD Association actually starts to make more sense. If you don't know what your device recommends, you should probably look at the video standard it records at on the right of the chart below, and buy the cheapest name-brand card that corresponds with the speed class. For example, say you have no-name action cam that records at 4K 30fps. Based on the chart below, a Class 10 card should work, with a V10 card being mostly interchangeable. If you have a creepy nanny-cam in your kid's bedroom that records grainy 1080p 30fps video in night mode, a Class 6 should work just fine.



If you're buying solely for video in an action cam or similar device, the most important marking is the Speed Class. Match the bars on the right to the specs in the columns on the left to determine which specs work for your device.

WHAT'S THE BEST SD CARD FOR A 4K VIDEO CAMERA OR A DRONE?

The guidance above, however, assumes fairly low frame rates of 4K at 30fps, or 1080p at 60fps. It doesn't actually take into account newer cameras that record at 120fps.

Unfortunately, there's no general guideline, so the fallback is always to refer to the manual or manufacturer's website. If you don't know, it's safest to opt for more speed. For 4K at 60fps, for example, you might want to reach for a faster V30 or U3 card. If you're recording 8K, surround video, or multiple data streams at once (GPS data for example), you should opt for a V60 or V90 card.

But again, always check what the manufacturer recommends. You may be surprised at what works. Mavic's Phantom 4 Pro V2.0 drone, for example, can record at up to 4K and 60fps on a Class 10 card (go.pcworld.com/cl10)—but it must be

rated at 15MBps write speeds. So something like Transcend's High Speed card (go.pcworld.com/ts63) would work.

WHAT'S THE BEST SD CARD FOR A GOPRO?

As our guidance goes for all devices: Read the manual (go.pcworld.com/frmn) for what's recommended for the camera before you go out and buy a memory card. This can save you from buying a card too slow (potentially losing video) or from spending too much money on a card your camera can't fully exploit.

In the case of GoPro's popular Hero cameras, much of what is recommended will depend on the vintage of your camera. The very old Hero 3 cameras, for example, don't support more than 64GB capacity, and with their maximum of 4K video at 15fps, a Class 10-rated card, such as the SanDisk Extreme

Higher performance cameras such as the GoPro 7 Hero Black need to be fed with U3 or V30-rated memory cards when recording at the highest bit rate and resolution. For older cameras, though? Reach for the cheap Class 10 stuff.

microSDXC UHS-1 (go.pcworld.com/sdet) should work just fine.

Step up to the newest Hero 7 Black, which can record 4K video at 60fps, or 1080p at 240fps, and you'll need a U3- or V30-rated memory card memory card like the Samsung 128GB EVO Select (go.pcworld.com/smsd).

GoPro's manual nicely lists cards that it has vetted for each camera going back to the original Hero.

WHAT'S THE BEST SD CARD FOR A DSLR?

There's a very important thing to remember: The Speed Class discussions above are mostly pertinent to video use, where you cannot ever have the card stall while writing video. Modern digital cameras aren't so sensitive. If there's a slowdown while writing 40 images, the camera's internal memory buffer can hold the pictures just a bit longer while they're written to the memory card. So, for the most part, even super-budget SD and microSD cards will yield good results for the average photographer.

The only real problem is when that buffer is full from taking, say, 75 images of the kids blowing out the candle. Once that happens, the camera won't take pictures until the buffer is clear. Sometimes, the camera will actually slow down the picture-taking from 4fps to 1fps while clearing the buffer.

For these photographers, you'll want to pay attention to the explicit write speed of the

For 4K-and-up video, the V30 or U3 rating on this SanDisk Extreme Pro matter for its minimum write speeds, while photographers will care about the max write speed of 95MBps.

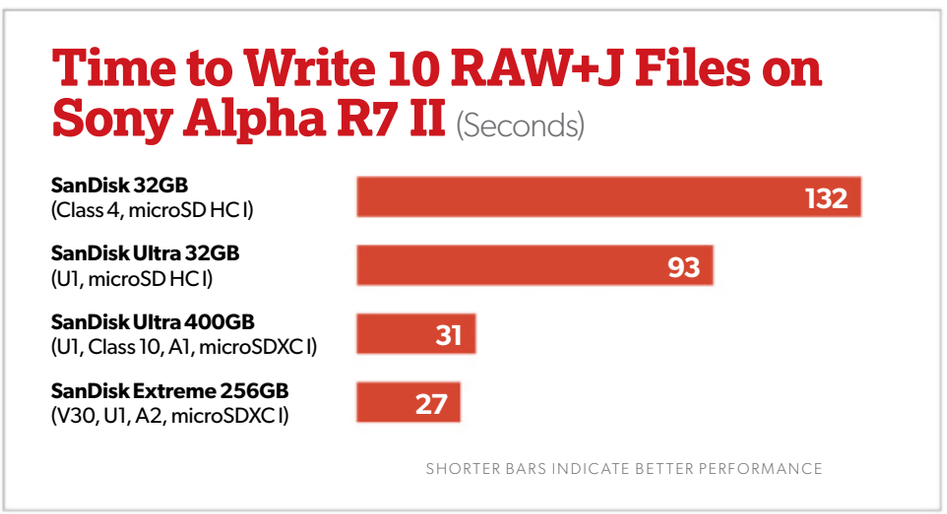
card. The SanDisk Extreme Pro (go.pcworld.com/sdpr) pictured here, for example, can write at 95MBps. There is no industry logo or marking for write speed, but we've found that most cards that state the write speed are bragging (sincerely) about a tested capability.

If you're choosing between cards for photography and you have a choice of V30, or V10 (or Class 10), the V30 will likely outperform the Class 10, at least by the specs.

Some card makers will actually express the maximum write speeds as an "X-rating," such as 400X. This is the write speed of the card expressed by CD-ROM speeds. Every 100X denotes 15MBps. For still use, you'll want a higher X-rating if you like to take a lot of pictures in a row.

TESTED: SD PERFORMANCE IN A DSLR

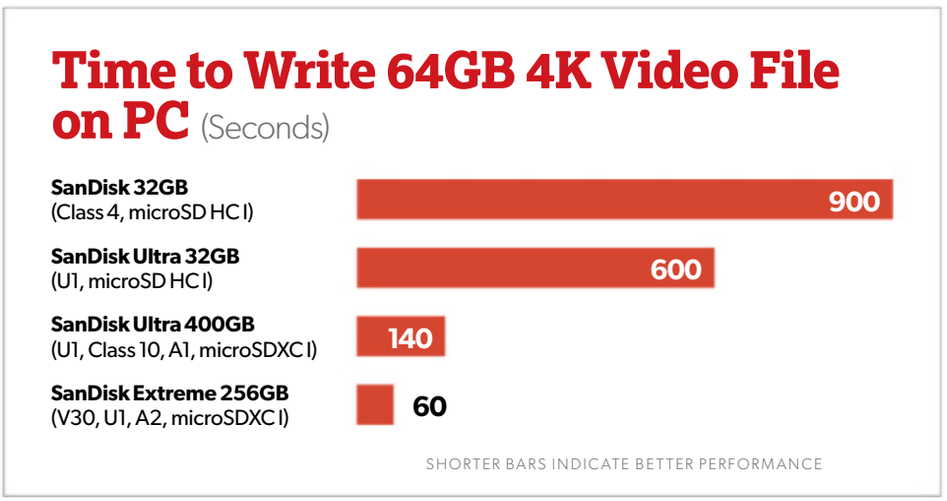
How much does the write speed matter in actual use? We did some quick tests with four grades of SanDisk microSD cards in a Sony Alpha A7R II camera. We timed how long it took the camera to write 10 RAW+JPEG files, each about 42MB. For this test we used a 256GB SanDisk Extreme (go.pcworld.com/256x), a recent-production 400GB SanDisk Ultra card (go.pcworld.com/400u), a 3-year-old 32GB SanDisk Ultra card (go.pcworld.com/32ul), and a nearly generic, basic black 32GB SanDisk card (go.pcworld.com/32cd). Each card's markings are noted on the chart below. Only the SanDisk Extreme



We timed how long it took four SanDisk microSD cards writing 10 RAW+JPEG images from a Sony Alpha R7 II.

had a rated write speed of 90MBps. Each card was formatted in camera prior to testing.

There are three takeaways from the results you see. The most obvious is that there is a world of difference between the generic 32GB SanDisk card with no markings and the older 32GB SanDisk Ultra card. There's also a galaxy of difference between the older 32GB SanDisk Ultra card and the new 400GB SanDisk Ultra card. While some of that is the newer memory chips in the 400GB card, some of it is also the capacity. Memory cards today are very similar to SSDs, where some of the capacity is set to cache reads and writes. What that means is a 400GB SSD or memory card, is generally going to be faster than a lower-capacity version of the same model. As the large card reaches full capacity, cache gets smaller as it's turned into storage, and performance will drop.



We timed how long it took to write a single 6GB file to each microSD card from a PC.

Finally, the test revealed yet another factor that comes into play with SD media: the memory bus of your device. We expected the 90MBps 256GB SanDisk Extreme to blow away the 400GB SanDisk Ultra, which while not specifying its maximum speed rating, is but a U1 card. The fact that the two performed so closely has less to do with the SD and more to do with its host—the camera. The 2015-vintage Sony Alpha R7 II apparently uses a very old USB 2.0 bus coupled with a large buffer, so it can basically never exceed about 35MBps writes. We know this from extensive testing Alik Griffin (go.pcworld.com/alik) has done on the Alpha R7 II. Paying extra for 90MBps would be a waste.

Granted, having a faster card does mean you can move the pictures to your computer much faster, but that's probably not as important as write speeds in the camera itself.

To confirm our hypothesis about the camera bottleneck, we used a SanDisk UHS-I USB adapter to write a single 6GB 4K video file to each of the cards from a laptop. The 256GB SanDisk Extreme was at or around its rated 90MBps write speed, while the 400MB SanDisk Ultra wrote at about 40MBps. The two remaining SanDisk cards were obviously much, much slower, with writes at 10MBps or

less. Each card was formatted prior to testing, using the exFAT file system.

The upshot for DSLR photographers focused on still photos is to pay for a card that can write at close to the maximum write speed of your camera. The 3-year-old Sony camera obviously has a serious limitation, but a camera produced in 2018 or 2019 is unlikely to be as hindered. Look for the rated write speed of the card. You won't always find one, but the good news is, cards that can hit high write speeds usually like to brag about it on their packaging.

Application Performance Class Specification Table

Application Performance Class	Pictograph	Minimum Random Read	Minimum Random Write	Minimum Sustained Sequential Write
Class 1 (A1)*	A1 APP PERFORMANCE	1500 IOPS	500 IOPS	10MBytes/sec
Class 2 (A2)**	A2 APP PERFORMANCE	4000 IOPS	2000 IOPS	10MBytes/sec

*The detailed preconditions and test are defined in SD 5.1 Part 1 Physical specification.
**The detailed preconditions and test are defined in SD 6.0 Part 1 Physical specification.

For tablet or phone use, better random read and random write speed is more important if you intend to run an app from the card.

WHAT'S THE BEST SD CARD FOR AN ANDROID PHONE OR TABLET?

When it comes to an Android phone or tablet, you can pretty much give up on using speed class or write speeds to choose a memory card. While video cares about uninterrupted minimum speeds and still photography cares about maximum write speed, the designation that concerns running applications from a card is "Application Performance Class," expressed as Class 1 (A1) and Class 2 (A2) markings.

These specs ratify a minimum sustained sequential write speed of 10MBps, and more importantly for application use, a minimum random read and minimum random write performance.

This is typically measured in IOPS (input/output operations per second) and indicates how fast a card can read and write bits from different areas of the memory card.

Unlike video and photo reads and writes, which are mostly sequential, application use from a card tends to jump around. Higher IOPS improves app performance.

TESTED: WHY A1 AND A2 PROBABLY DON'T EVEN MATTER

While memory cards are typically tested in a PC with Windows-based storage tools, we wanted to see if we could detect a difference

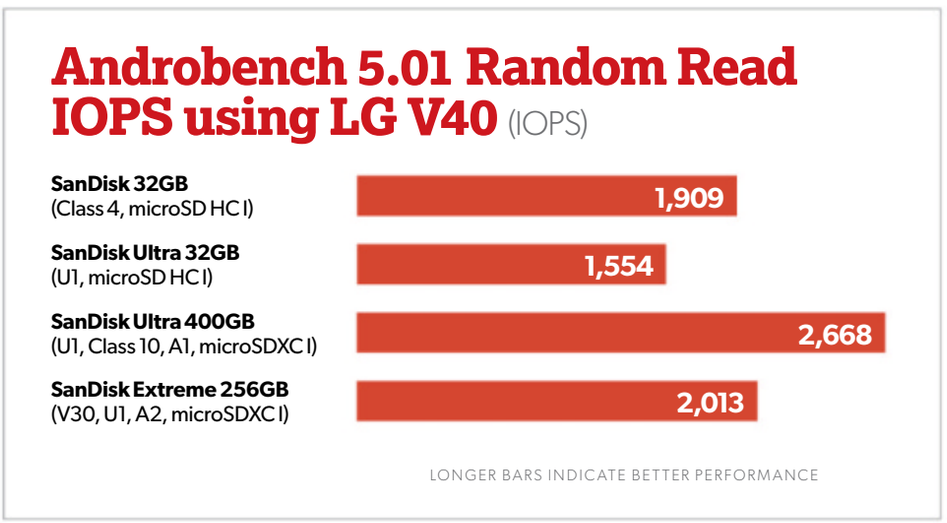
in the place the cards would be used: a phone. We used an LG V40 ThinQ phone with the Qualcomm SnapDragon 845 SoC running Android Oreo, and AndroBench 5.01 to measure the performance of each of the cards—an A1 card, an A2 card, and two cards that lack any such class marking (as noted in the chart on the previous page).

We did not test the cards using Android's Adoptable Storage (go.pcworld.com/adpt), as the V40 doesn't offer the option, nor would it allow AndroBench to run its tests. Each of the cards was formatted in the phone prior to use.

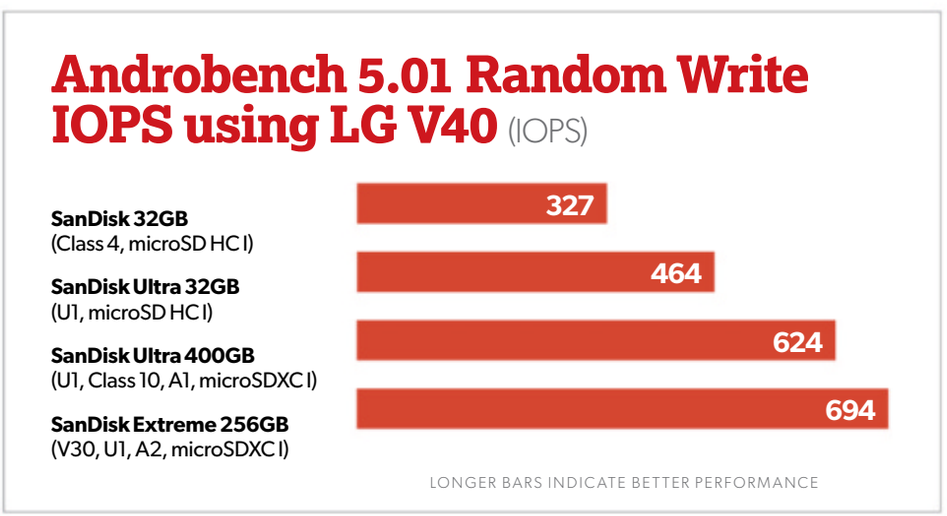
The results between the A1 and A2 cards were mixed. In random reads, the A1-rated SanDisk Ultra 400GB came out in front by about 30 percent. In the perhaps more critical random write performance, the A2-rated SanDisk Extreme performed best.

But even there, the Extreme card's performance was underwhelming. That's due to the same issue we had in our DSLR tests earlier: the hardware.

Technically, the SanDisk Extreme is rated for almost four times the random-write speed as the SanDisk Ultra, but to achieve that, you need hardware and firmware that fully supports the newer A2 specification.



Random reads saw the A1-rated SanDisk Ultra 400GB ahead of the pack. The underwhelming performance of the SanDisk Extreme 256GB is a surprise.



Random writes were better on the faster SanDisk Extreme, but nothing to write home about.

Today, there are no known Android phones or tablets that support the 2016-era SD 5.01 specification. Even worse for those hoping to use a 400GB microSD card to host apps—today's phones don't even support A1 yet.

In fact, the Qualcomm SnapDragon 845 SoC inside the V40 and other premium phones only supports SD version 3.01, which was passed in 2010. The App Performance specs for A1 and A2 were passed in 2016 with version 5.1.

Even worse: We ran AndroBench on the V40's 64GB of Flash storage and saw about 15 times the performance of the SanDisk Extreme in random reads, and about nine times that card in random writes.

The practical upshot is that if you want to store apps on your microSD card and get more performance, an A1 card can't hurt. It's likely to have higher random performance than one without a rating, though your phone's limitations may not allow it to reach its full potential. And yeah, it's just not worth paying a premium for an A2 card just yet.

The two caveats here are if you want to use the card primarily for storing media for consumption, or for capturing your own videos. If you want to, say, copy 128GB of MP3 and video files to the SD card to watch or listen to, you may want to pay for a card with faster write speeds, such as this 100MBps SanDisk Ultra (go.pcworld.com/sand). This will greatly cut down how long it takes to copy the media to the card on your PC or your mobile device. If you plan to use your device for capturing video on a regular basis, you should probably follow the same guidelines from the video section earlier—a Class 10 works in most cases, such as this Kingston Canvas Select (go.pcworld.com/kcan).

WHAT'S THE BEST SD CARD FOR A NINTENDO SWITCH?

Nintendo's own guidance (go.pcworld.com/nngd) is to use a UHS-I card with a "transfer speed" of 60MBps to 95MBps (UHS-I is not to be confused with the U1 or U3 Speed Class markings, which just mean minimum write speeds of 10MBps and 30MBps, respectively). Nintendo also says that "the higher the transfer speed, the better gameplay experience on Nintendo Switch."

That's likely meant to lower the load time

SanDisk's officially licensed memory card for the Nintendo Switch isn't worth it as comparable cards can be had at a lower price.

of games, which can be fairly large (Take-Two's NBA 2K19, for example, is 31.5GB), although the average Nintendo Switch game is under 3GB in size.

Nevertheless, the UHS-I bus supports multiple maximum performance modes: 12.5MBps, 25MBps, 50MBps, or 104MBps—and it's unclear which mode the Tegra X1 in the Switch uses. In our tests below, we found very little difference between a SanDisk Extreme with a 160MBps maximum read speed and our basic SanDisk card with a 45MBps maximum.

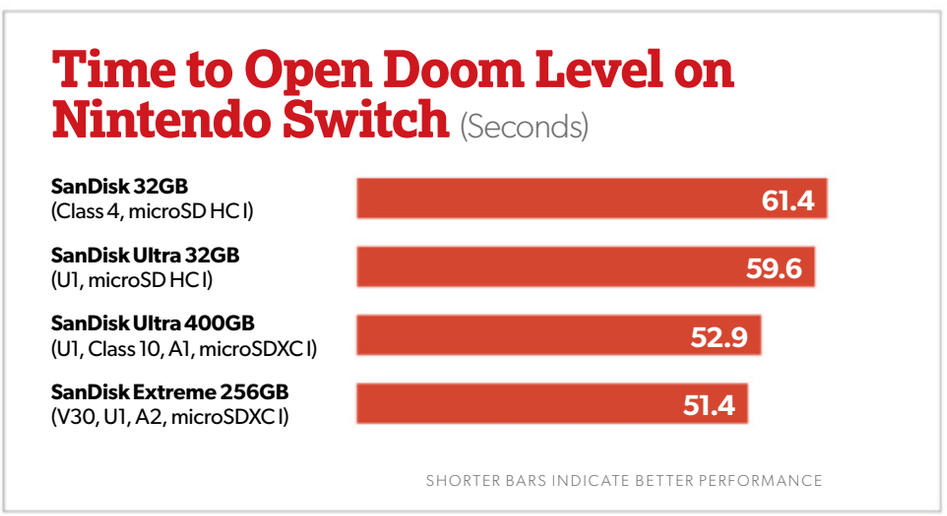
For most gamers, we think it boils down to capacity first with explicitly stated read performance a very close second for the best experience on the Switch. Note: Cards often don't state their read performance unless it's worth touting, so if you want to ensure your card doesn't fall below the maximum potential, you'll probably end up with something a little overkill in this department.

Since the card is not primarily for video, the Class, U-, and V-ratings don't matter much. And since Tegra X1 is likely limited to version 3.01 of the SD specification, A1 and A2 ratings aren't relevant, either.

If you're a serious Safety Sally, you can go ahead and buy an "official" memory card, such as the 128GB SanDisk Nintendo Switch (go.pcworld.com/128s). It's rated for 100MB/s read and 90MB/s write speeds and carries U3 and V30 markings. But it can cost as much as $35 on Amazon. Alternatively, you could save some money by opting for a 128GB SanDisk Ultra card with a 100MBps read speed—you'd save about $15 and probably never notice a difference.

TESTED: MEMORY CARD PERFORMANCE IN THE NINTENDO SWITCH

Rather than go off our gut instincts we decided to look at one aspect of game experience: level loads. We installed the 21GB game *Doom* on each of the memory cards used in our previous tests and then timed how long it took to open the level Resource Operations.



What's the best memory card for a Nintendo Switch? The cheapest and largest probably.

We averaged three level loads and restarted the Switch between runs. The results, as you can see, are pretty underwhelming. The four cards used in the tests range from yuck to yum, but the Switch doesn't care all that much what it eats.

The reason? Level loads for a game aren't always about sheer read performance. They can often be CPU-intensive as texture assets and sound assets are decompressed before gameplay can begin.

The basic upshot is that a faster memory card can indeed lower the level loads and game starts, but probably not by much.

WHAT'S THE BEST SD CARD FOR A DASH CAM OR NANNY CAM?

If you just bought a dash cam and are eyeing a card that simply offers the most capacity for the price, you might be making a huge mistake. That's because memory cards actually have a limited lifespan. While DSLR or action-cam usage is unlikely to hit that limit, a surveillance or dash cam is a different story.

Take your average cheap Black Friday-special card and drop it in a dash cam and it just might quit in a few months. In a crash cam or surveillance cam, that's a disaster.

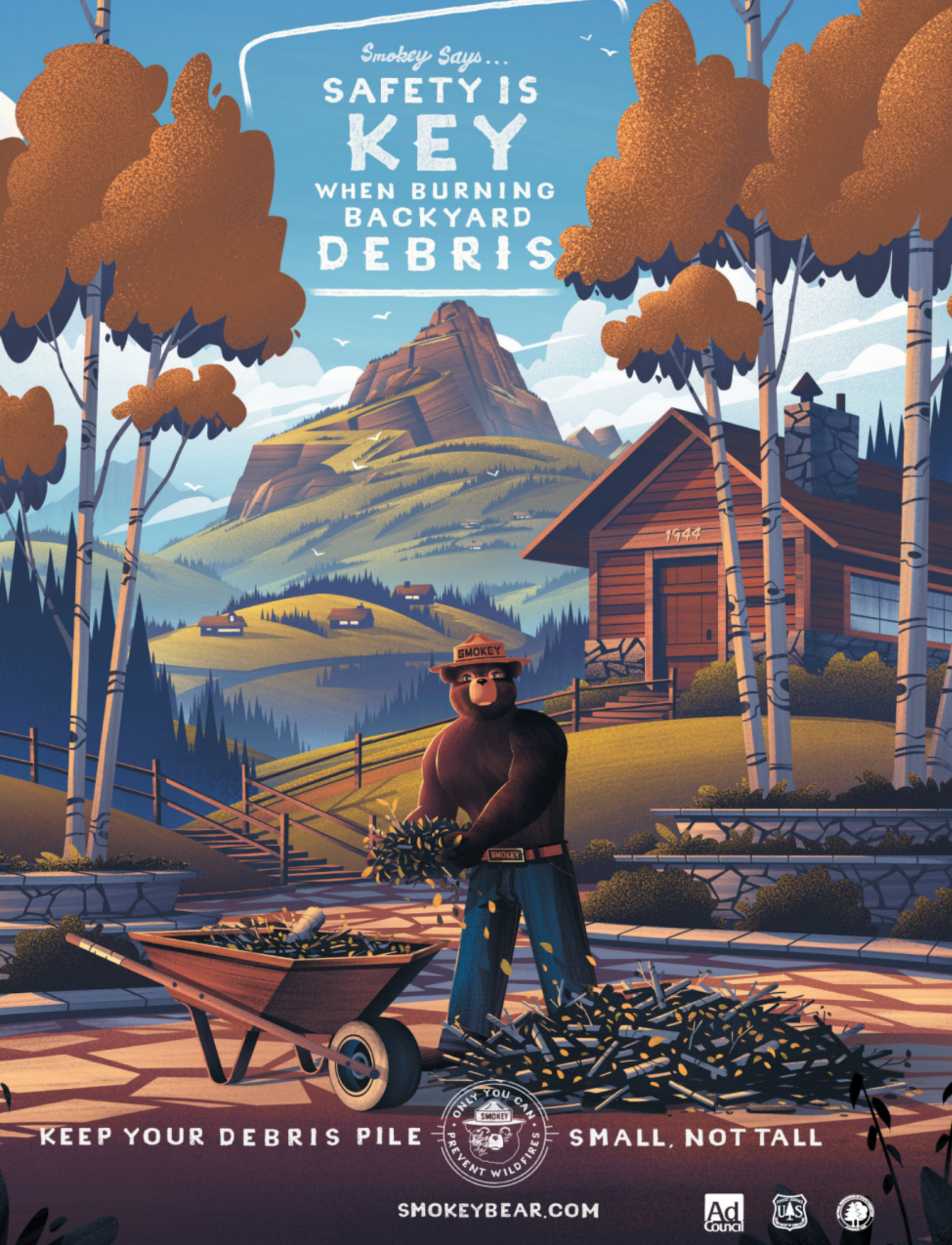
The answer is a "High Endurance" card, which is purpose-built for heavy use and harsh environmental conditions.

The 32GB Transcend High Endurance card (go.pcworld.com/32tr), for example, is

If you're buying a microSD card for a dash cam or surveillance, it's recommended that you opt for one rated for "high endurance," to keep it from dying at a critical moment.

rated for 6,000 hours of 1080p video before possibly quitting. Endurance on these cards usually increases with capacity, so the same Transcend card at 16GB is rated for 3,000 hours, while the 64GB version is rated for 12,000 hours.

Transcend attributes the lifespan to its use of higher-performance MLC NAND, which is a less data-dense version of memory. Competitors such as SanDisk say MLC isn't the only answer—firmware and controller NAND matter too. Although SanDisk doesn't disclose its memory type (we believe it to be 3D TLC) the company's own 64GB High Endurance memory card (go.pcworld.com/65en) is rated to live for 10,000 hours, and 5,000 for the 32GB version. Again, the recommended course of action is to buy what your dash-cam maker recommends. If you don't know, a high-endurance memory card makes the most sense.


Smokey Says...
SAFETY IS KEY WHEN BURNING BACKYARD DEBRIS
1944
SMOKEY
SMOKEY
KEEP YOUR DEBRIS PILE
ONLY YOU CAN PREVENT WILDFIRES
SMALL, NOT TALL
SMOKEYBEAR.COM
Ad Council


HE HAS TWO JOBS
BUT ONLY GETS PAID
FOR ONE.
Caregiving is tougher than tough.
Find the care guides you need at AARP.org/caregiving
Ad Council
AARP
Real Possibilities

ANDROID CONFIDENTIAL

3 RADICAL CHANGES

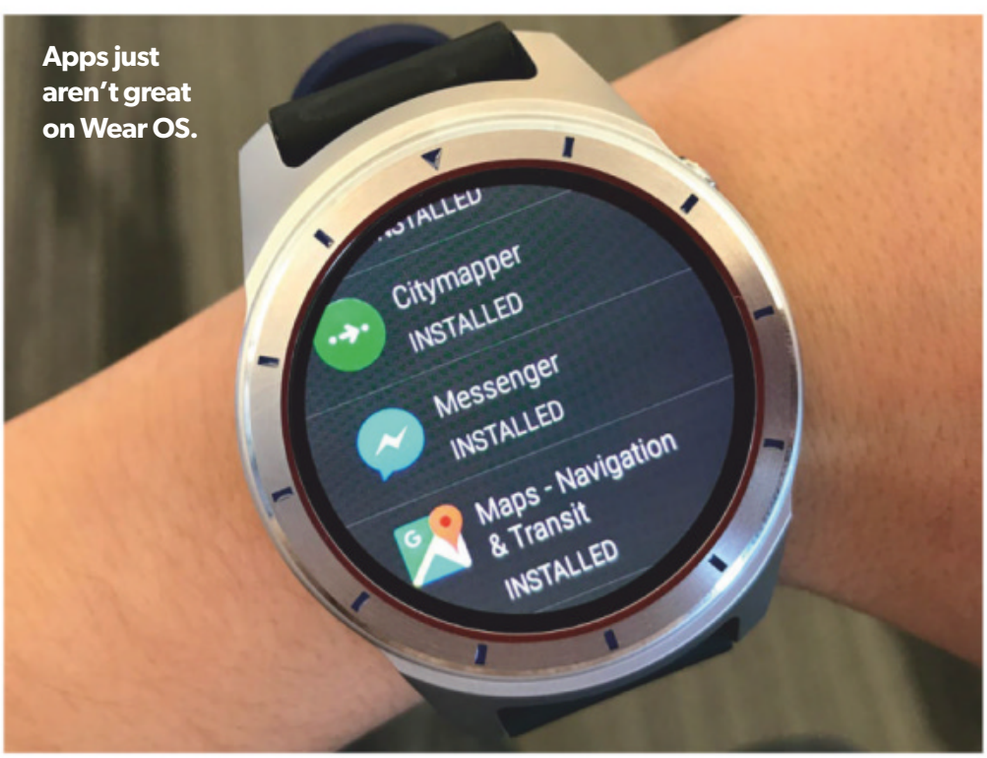
I WANT TO SEE GOOGLE BRING TO **WEAR OS**

FEWER APPS, MORE ASSISTANT. BY MICHAEL SIMON

IMAGE: GOOGLE

It's 2019, and we're still waiting for a proper Wear OS watch that can take on the Apple Watch. Not since the original Huawei Watch has there been an Android wearable truly worth getting excited about. If anything, they seem to be getting worse. The latest Wear OS watches are thicker, clunkier, and slower they they've ever been, and most of them still barely last a day.

So maybe it's time for a change. A big change. Instead of trying to chase Apple and offer an inferior version of its watch, Google should rethink not just Wear OS, but the whole idea of a smartwatch. In the latest episode of Android Confidential I propose three radical ideas for not just fixing Wear OS, but turning it into something completely new:



Apps just aren't great on Wear OS.

DUMP THE APPS

That's right, I want Google to abandon the Play Store completely in Wear OS. I'll admit it was cool back in 2017, when I could browse apps on my wrist while my Apple Watch–using friends had to use their phones to install Uber and Twitter. But it's been two years, and apps aren't any better on our wrist. There may be a few that are worth downloading, but for the most part, the functionality they provide could just as easily be incorporated into a watch face.

That goes for Google's apps, too. Instead of apps that I need to download, install, and scroll through, I'd rather see better complications and a tighter integration with my phone. My watch should be something that anticipates what I need. When I ask for directions or request an Uber on my phone, my watch should respond rather than make me tap away at a tiny screen to get things done.

OFFER A WATCH MODE

Battery life is the biggest issue with smartwatches, with most lasting the better part of a day. Google already

Assistant has a starring role on the new redesigned Wear OS, but I'd like it to do more.

offers a battery saver that ekes out a couple more hours of life by turning off things like notifications and haptics, but I'd rather Google implemented a Watch Mode that lasted a week, let me turn it on with a toggle, and focused on the features that matter. There are times when I just want my smartwatch to tell time, get notifications, and count steps. I don't need every battery-sucking sensor, feature, and app turned on to do it. I don't even want the ability to respond to texts. We've seen various modes on Wear OS watches that extend battery life, but I'd like to see a Watch Mode built into Wear OS, so any model I choose can last more than a day.

LET ASSISTANT TAKE OVER

With the switch from Android Wear to Wear OS, Google added an Assistant feed screen to the left of the watch face that keeps you up-to-date on weather, appointments, alarms, and the like. It's a neat feature, but it's unnecessarily hidden. Why should I have to swipe or otherwise activate Assistant on my watch? I want Assistant on my watch to be like Assistant on my Home Hub: always ready, always thinking. When I'm in a dark room or a movie, turn off raise-to-wake. When I'm sleeping, don't buzz my wrist for anything other than an alarm. When I'm working out, automatically record it, no matter what I'm doing. And if I clear a notification on my phone, delete it from my watch. Talking to Google Assistant is one thing, but I'd rather Assistant did the heavy lifting behind the scenes without my having to think about it.

Google doesn't need to reinvent the wheel, but it does need to rethink how it rolls. Wear OS has been stagnant for far too long. It needs more than simple UI tweaks to bolster the experience, and I think it's time to shake things up.


Smokey Says...
DON'T KEEP IT
LIT,
EXTINGUISH
IT
SMOKEY
FOLLOW THE RULE, STAY
ONLY YOU CAN
SMOKEY
PREVENT WILDFIRES
UNTIL ASHES ARE COOL
SMOKEYBEAR.COM
Ad Council

5 ways to tidy up your Android phone, inspired by Marie Kondo

The cleaning guru's home-tidying tips can also work on your phone. **BY MICHAEL SIMON**

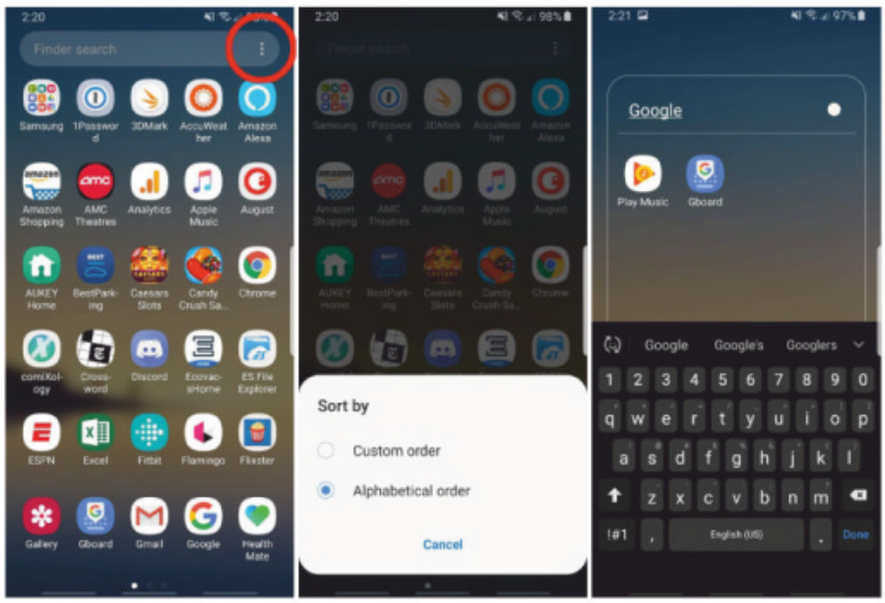
If you've been watching Marie Kondo's Netflix show, *Tidying Up*, you've no doubt caught the cleaning bug. Kondo's organization method breaks down your clutter into five key areas: clothing, books, paper, *komono* (miscellaneous things), and sentimental items. Her mission is to "spark joy in the world through cleaning," by throwing out anything that doesn't make you happy.

But while Kondo's method may help keep your closets and cupboards clean, what about your phone? With six-inch screens and storage both on and off your device, it's easy to fill up every digital nook and cranny with things you don't need, don't use, and just plain don't remember.

If you transfer Kondo's concepts to an Android phone and think of clothing as apps, books as downloaded videos and songs, and

IMAGE: MICHAEL SIMON

so on, you can begin to apply her wisdom to your mobile life. Here's how we think Marie Kondo would clean a smartphone. (For more tips, check out our earlier story on "10 quick ways to clear space on an overstuffed Android Phone" at go.pcworld.com/10qk).



The apps inside your drawer can be shown and organized in any number of ways, depending on your phone.

1. APPS (CLOTHING)

Just like it's easy to fill your closets and drawers with shirts dating back to the grunge era, it's easy to fill up our phones with apps we haven't opened in years. Some might not even work anymore—backups can bring over apps that we downloaded years ago for phones that are long gone.

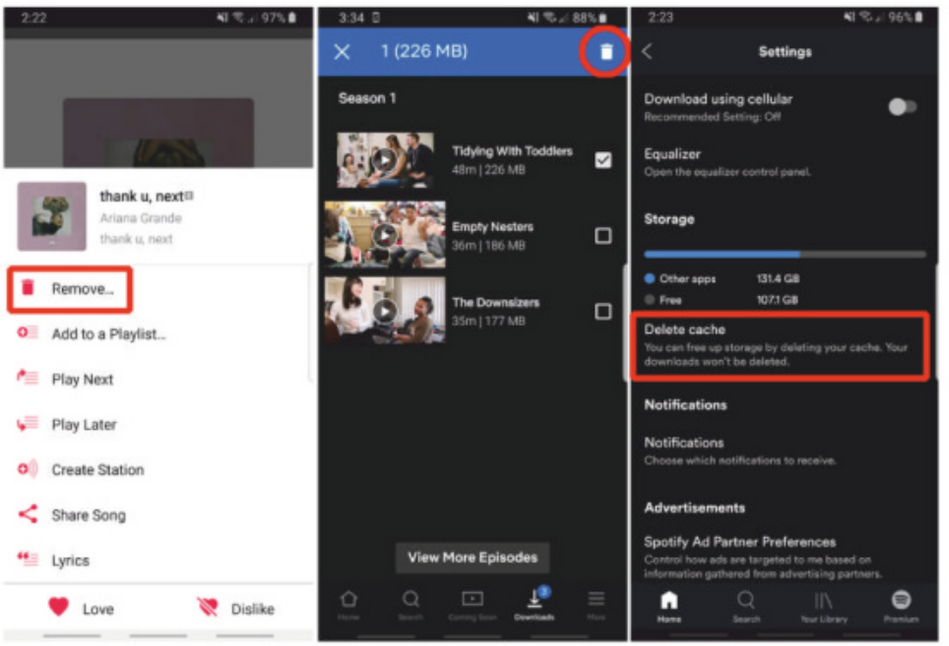
Take some time to go through your app drawer. Deleting ancient and unused apps is a good start, but equally important is organizing the apps you have so you can find them easily. Most phones let you sort by name or another method of your choosing, and some let you sort by date installed. Try tapping the menu button next to the search bar to see which options you have.

Folders are also important. Nearly every phone lets you create folders within your app drawer, so you can group similar apps for easy reference. Even just creating a "Google" folder will cut down on your clutter, as you probably have a dozen or so apps from that company in your drawer. It's easy: Just tap and hold an app and drag it on top of another app in your drawer to create a new folder. Then name it and add as many as you'd like to it.

2. MEDIA (BOOKS)

Next to apps, the most cluttersome items on our phones are media files: books, movies, songs, videos, and the like. Not only do they take up the most space, but they can also be the hardest to mind, as they're often tucked away inside hidden folders that you can't access outside of their respective apps.

Start by checking inside any apps that might have allowed downloads, such as Spotify, Netflix, and Google Play Movies.



Downloaded media files can be tricky to find.

Depending on the app, you may have to delete each file individually or clear the cache inside Settings. Then check the places where large downloads are most likely to live: your external SD card, and your cloud drives. There's a reason why Google and Dropbox offer so much storage, because it's easy to upload something and forget about it. A little digital cleaning will help—and it might even save you some money in the process.

While you won't be able to organize your TV and movie collections into folders—an unfortunate limitation of digital media libraries—most services let you hide content that you've purchases to streamline your catalog. (In Google Play Movies, you'll need to select a movie, then tap the menu at the top right and choose Remove from device.)

Do the same with your music library. With unlimited streaming we have a tendency to add things that we listen to only once, so keep only the songs you still want.

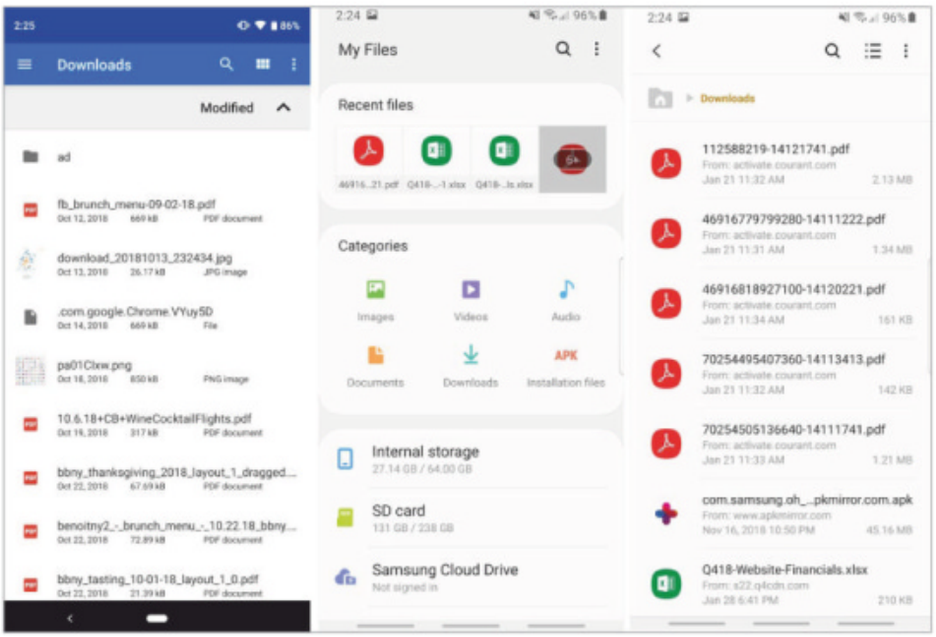
3. FILES (PAPER)

While they won't pile up like they would on a PC, your Android phone can be home to tons of files that aren't doing anything other than collecting digital dust.

The first place to look is your documents app, which may be called Files, My Files, Downloads, or something similar, depending on your phone and the version of Android you're using. What's inside will be the same: any attachments, Chrome files, or other downloads you've collected since you started using your phone. You can probably delete most of them.

It's easy to get rid of them: Just tap and hold on a file, and tap the trash can icon. If there are any that you want to keep, create a new folder for them, where you can also stash future downloads.

You can extend your digital tidying to any online services you have. It's easy to lose sight of just how much stuff is in there. Check out your Dropbox, Google Drive, and any



Files can accumulate on your phone without even realizing it.

other storage lockers and see what can be saved and tossed.

4. HOME SCREEN ('KOMONO')

You might not think of your home screen as a place for clutter, but you'll be surprised at how much opportunity there is for tidying up. First take a look at how many home screens you have. Some Android phones add newly downloaded apps to your home screen by default, so swipe left to check for strange apps hiding to the right of your main screen.

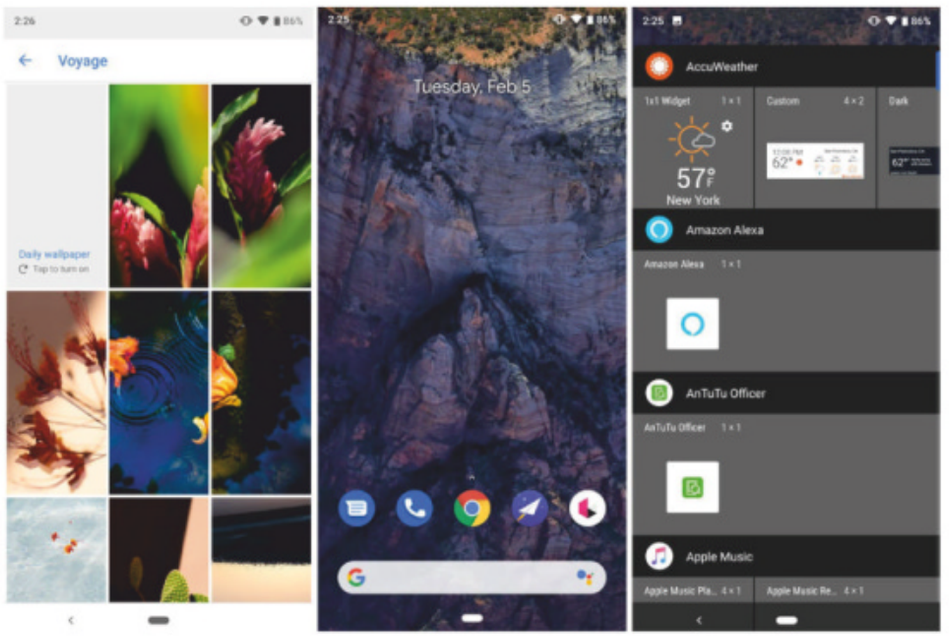
But even if you've already boiled down your apps to a single home screen, Kondo would probably tell you that your home screen should be limited to the apps that you open multiple times a day. Make a list of your 10 most essential apps, then rank them in order of importance. Take your top five and put them in the bottom row of your home screen.

Chances are you'll have a hard time naming more than 10 apps that you need to use every day, but if you do, try not to litter your home screen with them. At the most, add a second row and group the remaining apps into folders.

With so much space available, now you can rethink your home screen wallpaper as well as any widgets you have. Pick an image that's relaxing and doesn't extend too far into your icon rows. That'll act as a visual barrier to prevent you from re-cluttering. Try to limit widgets to things you actually use, like a weather widget or maybe a search bar.

5. PHOTOS (SENTIMENTAL ITEMS)

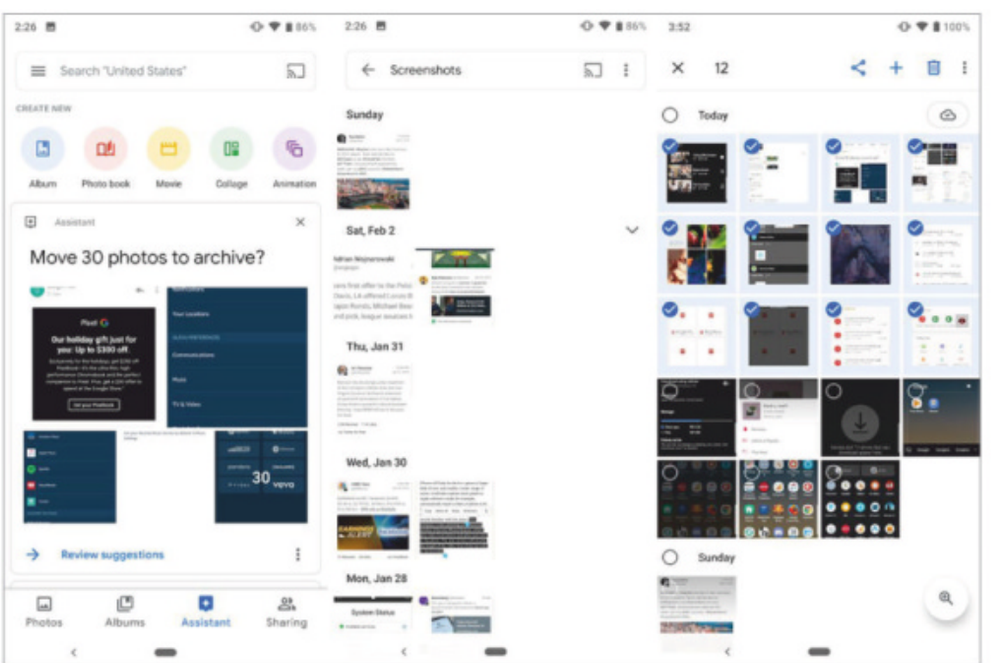
As Kondo says, the hardest thing to clean out are the things that mean the most, and on our phones, that means one thing: photos. Just like the shoeboxes your grandparents kept, your library keeps getting bigger and bigger. Even if they aren't taking up physical space on your phone, they're still adding to the clutter.



With a little work, your home screen can be a calming, clutter-free space.

So start with the easy things. More than likely there are hundreds of screenshots, miscellaneous shots, and saved memes that can be trashed. You don't even have to search your entire library manually—just tap on the Assistant tab in Google Photos, and it'll suggest recent photos that you can archive. You can also type the word **`screenshots`** into the search bar, and Assistant will filter them for deletion in one fell swoop.

Then you can go through your actual photos. This will take a while, so start with your oldest pictures and work forward. Duplicate, out-of-focus, and unmemorable shots can go. Just tap and hold on an image until a check appears, then select any additional photos and tap the trash can icon in the top right. You'll find that a smaller library with only the pics that matter most will actually be more sentimental than thousands of photos that are too overwhelming to browse.



Downloaded media files can be tricky to find.

How to change the Google Assistant voice

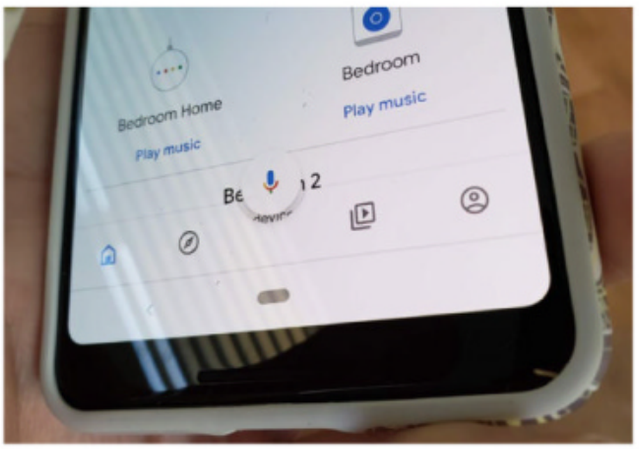
Mix it up a bit to make Google Assistant your own. **BY MARTYN WILLIAMS**

If you don't like the default voice of your Google Assistant, don't fret, as it's quite easy to change. There are 10 Assistant voices available—five male and five female—and here's all you need to do to give it a new sound, or even accent.

METHOD 1: USE THE GOOGLE HOME APP

First, find the Google Home app on your device, and open it. Next, look in the bottom right corner for the circular icon with a face inside it, and tap it.

IMAGE: ISTOCK



Look in the bottom right corner for the circular icon with a face inside it, and tap it.

This brings up your account preferences. Tap Settings, and then on the next page tap Assistant along the top row.

You should now see an option for Assistant Voice.

Tap that option and you'll land on a selector tool where you can choose between any of the voices on offer. Listen to them all, and pick the one you like.

VIDEO: **HOW TO CHANGE THE VOICE OF GOOGLE ASSISTANT**
Watch now at go.pcworld.com/936

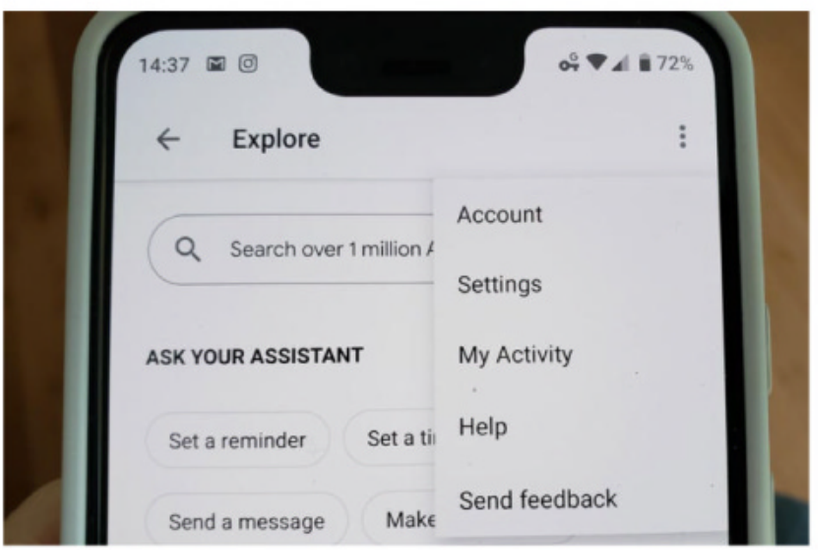
Then you'll be through to the settings page details mentioned earlier. From there, the steps are the same: Choose Assistant from the four options at the top, tap Assistant Voice, and then pick a voice.

The ability to change voices is available universally. Google is rolling it out slowly so if you don't yet see it, you can assume it probably hasn't come to your account language or region yet.

Please note: The setting won't just change the way your phone speaks to you. It also carries through to any other Google Assistant devices on your account, such as Google Home speakers.

METHOD 2: JUST 'OK GOOGLE'

There is a second way to get to the same screen. Fire up Google Assistant by saying "OK Google" and look for the compass icon in the bottom right corner of the screen. Tap it and you'll land on a Google Assistant preferences page. Tap the three vertical dots in the top right and choose Settings.



Tap the three vertical dots in the top right and choose Settings.

How to use Microsoft Word's Resume Assistant to look for a new job…on LinkedIn

Resumes are so passé. How about a LinkedIn profile instead? **BY MARK HACHMAN**

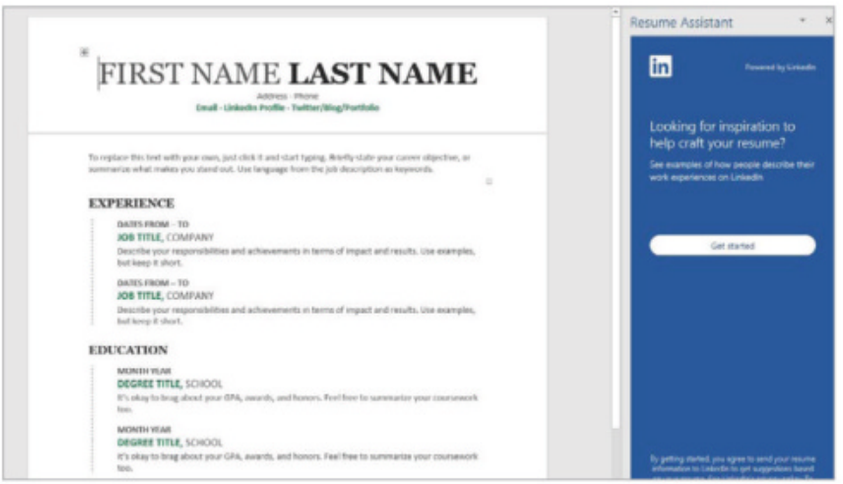
While polishing your resume is still as much about relevant experience and skills as ever, finding a job now involves targeting the right keywords and SEO, too. That's how Microsoft Word's Resume Assistant can help: tapping LinkedIn to assist your work experience.

Resume Assistant is now part of Microsoft Word, assuming you have an Office 365 subscription and subscribe to LinkedIn. It's part of Microsoft's combination of apps and services, and a key part of justifying Microsoft's $26 billion purchase of the business networking service (go.pcworld.com/26bn).

It's important to note that Resume

Assistant doesn't actually alter or correct your resume; it merely suggests ways to improve it. Resume Assistant can tap into other LinkedIn profiles and mine them for what made them successful.

Be aware that there's far more assistance further down the Resume Assistant column. Scroll down to see suggested skills, helpful articles to assist your resume writing, and a list of open jobs near you in that specific field. Finally, there's a link to LinkedIn to submit your resume, and let the world know that you're looking for a job.



Resume Assistant is the big, blue sidebar—you can't miss it.

If that seems like a lot of LinkedIn references to a feature within Word—well, you're right. It's probably fair to say that Word's Resume Assistant ("powered by LinkedIn") is geared more toward uploading your profile to LinkedIn than to helping you ship your resume around the web…and away from Microsoft's services.

HOW TO GET STARTED WITH RESUME ASSISTANT

Though you can manually turn on Resume Assistant within Word, the easiest way is to launch Word, then select an existing resume template. Resume Assistant should launch in a sidebar to the right. If you have an existing resume, you can also open it within Word. If Resume Assistant doesn't open automatically, you may launch it manually via the "Tell me what you want to do" search box, where you can type in Resume Assistant. Also, make sure you've enabled LinkedIn integration via File > Options > General > Show LinkedIn features in my Office apps).

When you're ready to move on, click the Get Started button in the blue Resume Assistant pane to the right. It's here that LinkedIn will begin suggesting ways to frame your work experience.

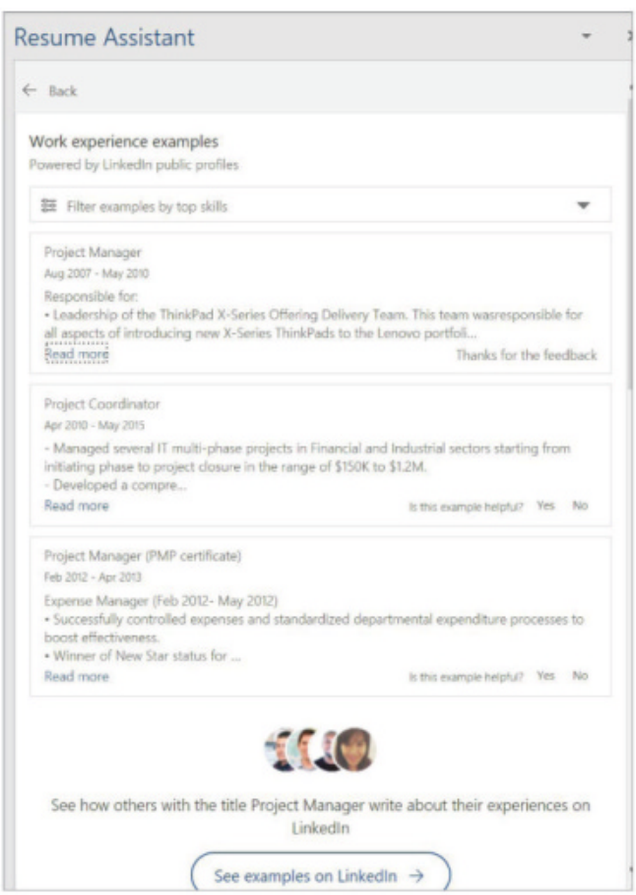
LinkedIn will autofill your most recent position as a way to start hunting down relevant information, but you can select whatever title and industry you'd like. (If you don't identify one on the list, though, LinkedIn won't be able to suggest any examples.) Click the Read More link for the full listing.

What Resume Assistant first does for you is anonymously suggest language to help you write your own resume, specifically work

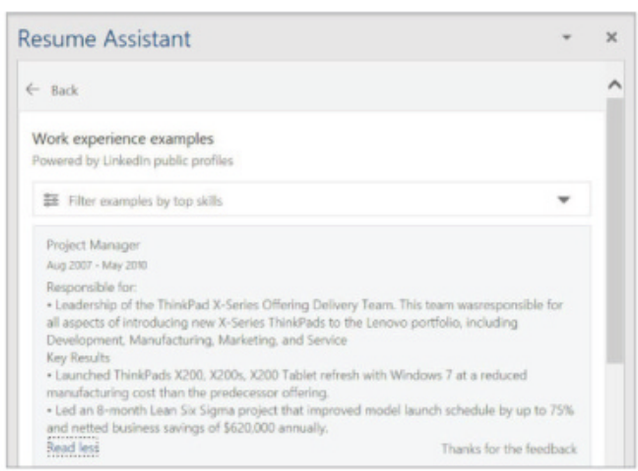
experience. For example, in this snippet, the employee responsible for leading the ThinkPad X-series delivery team lists their accomplishments. The idea isn't for you to copy them, but to think about using similar language in describing your own skills.

Directly below the work experience examples are a suggested list of relevant skills. This is all about SEO: Not only are you telling a prospective employer that you can perform as expected, but these are also the search terms that prospective employers may be using. From there, Resume Assistant and LinkedIn jump into the good stuff: available jobs, and how to apply for them.

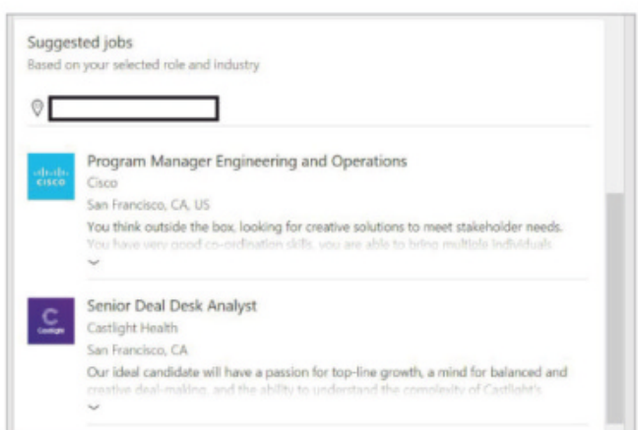
Based on your stated position and location, Resume Assistant will tap LinkedIn to suggest nearby jobs that may be a good fit. You can then click on the job position to open a LinkedIn page, where you can do everything that LinkedIn allows you to do: read more information about the position, and even apply—where you'll share your information that you've already stored within LinkedIn.



Resume Assistant provides real-world job experience descriptions from people with similar positions, as a guide to assist you with your own language.

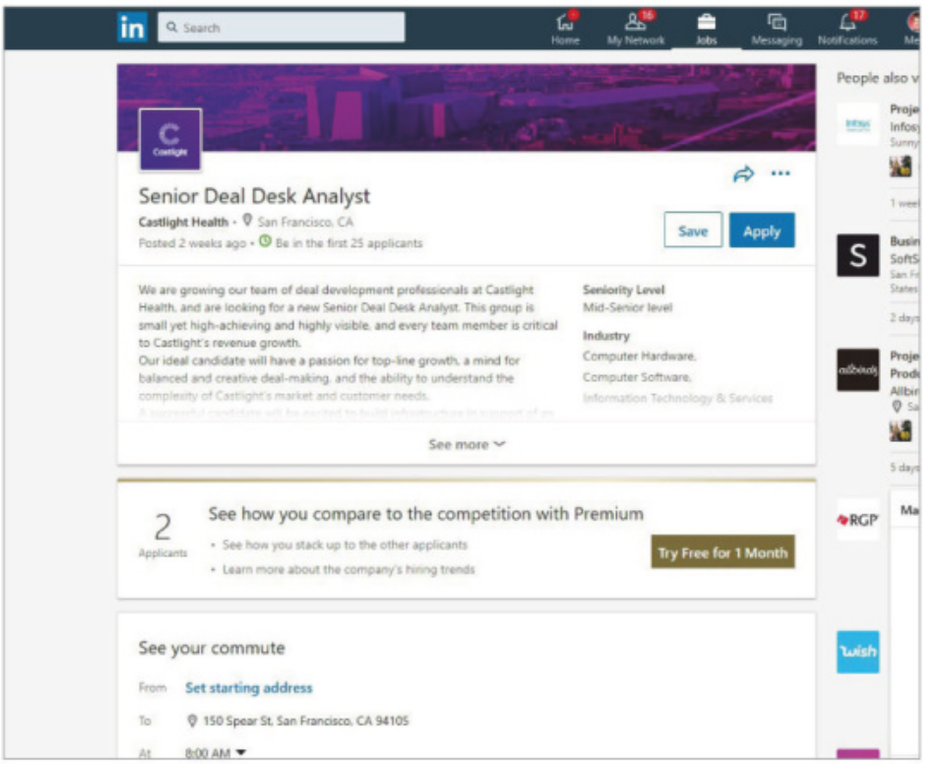


Click on each one to get the full description.

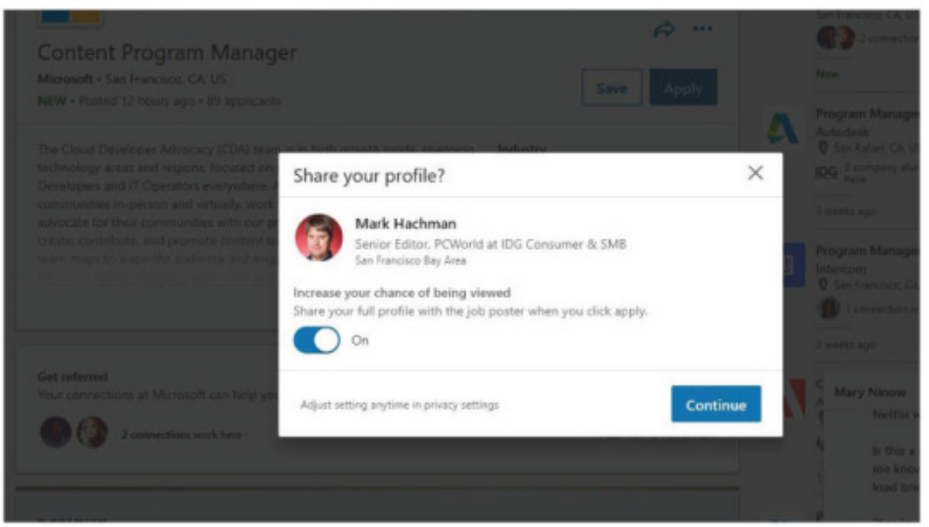


Resume Assistant will tap LinkedIn for a list of jobs close by.

Finally, at the very bottom of the Resume Assistant column, you can also click into LinkedIn, to a separate page that signals your interest to allow recruiters to contact you.



Clicking on an available position will take you right to a LinkedIn page…



…where you can apply and share your "profile"—which is essentially your resume.

At this point, you may wonder: What good is my resume, exactly? You know, the whole reason I began the process? That's an excellent question. In fact, Resume Assistant doesn't really facilitate the formatting or uploading of a resume anywhere in the process that I could see.

Instead, you're tacitly encouraged to take your newfound knowledge and apply it to your LinkedIn profile—what you might call a traditional resume in LinkedIn's lingo. "Applying" for a position within LinkedIn simply signals the prospective employer that you'd like to be considered as a candidate, and makes your profile available to the recruiter.

Sure, you may submit a resume at some point in the process, and perhaps to an employer who doesn't use LinkedIn's network. But the implicit suggestion is: Why would you want to work there?

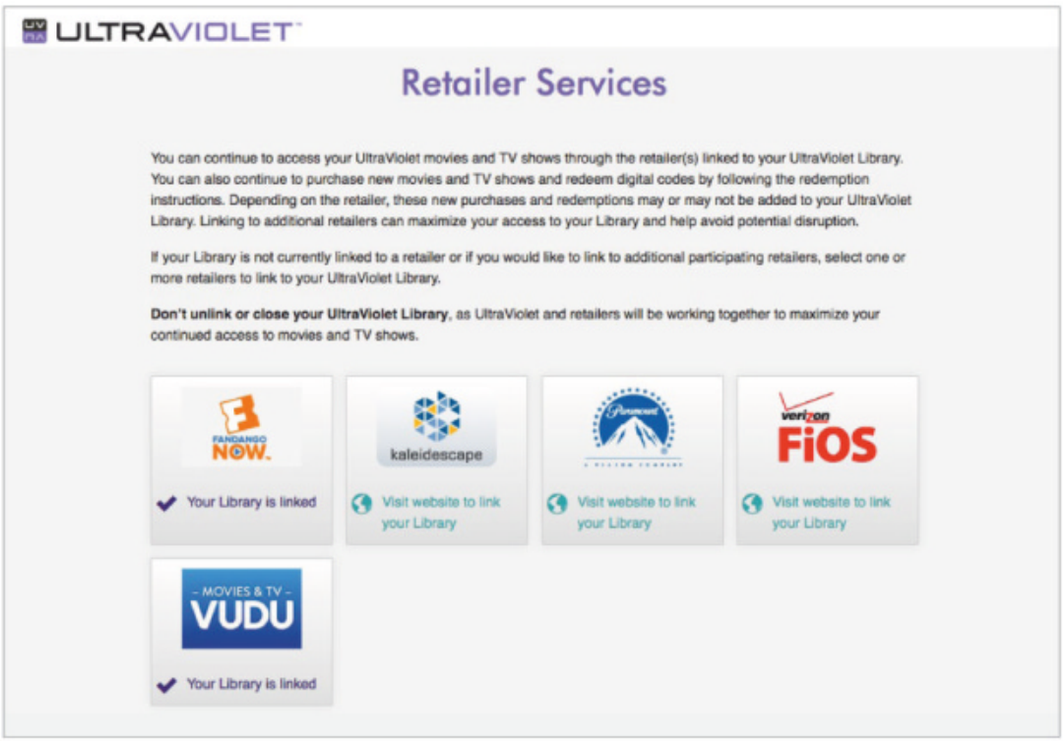
How to rescue your movies and TV shows from Ultraviolet before it shuts down on July 31

It's easy and free. **BY MICHAEL SIMON**

If you've bought a Blu-ray movie over the past decade and redeemed the digital download code, there's a good chance it ended up in your Ultraviolet library (go.pcworld.com/ultr). There's an equally good chance that you've forgotten about it. The service has announced it will be shutting down on July 31, but you still have about five months to rescue them before they end up in digital oblivion.

The first thing you need to do is log in to your Ultraviolet account. If you've ever redeemed an Ultraviolet code, you had to sign up for an account, so if you don't remember it, try the Forgot Username Or Password link. Ultraviolet has been around

IMAGE: ULTRAVIOLET



You can link your Ultraviolet movie collection to other services to ensure they don't disappear forever.

since the release of *Horrible Bosses* in 2011, so it goes back a while.

Once you've logged in, you can check your library to see what's in there. If there's something you want to save, head over to Settings and click Linked Services to see the services you've previously connected. If there are any, you should already see your Ultraviolet movies in those libraries, though whether they show up depends on the studio, so it's best to link to a couple of different sites to ensure your titles end up somewhere once Ultraviolet goes away.

To see the available partners, click on Retailer Services. From there, you'll be able to link your library to an external resource, which will essentially copy your library into their store. There are five services available, but we recommend Vudu (go.pcworld.com/vudu) above all others. Vudu is Walmart's service and it includes every major studio, so your entire library will transfer over without a hitch. You'll need to sign up for a Vudu account if you don't already have one and then link your Ultraviolet library, but the whole process doesn't take more than a couple minutes.

With your Ultraviolet library linked to Vudu, you can then link your Vudu library to Movies Anywhere (go.pcworld.com/mvan) so you can merge your iTunes, Google Play, and Amazon libraries into one. Vudu will also link any TV shows in your Ultraviolet library, but they won't appear in Movies Anywhere, nor will Paramount, MGM, or Lionsgate movies.