

Tech Spotlight

A video showcase
of the latest trends



Dive into retro gaming with an emulator

➡ Over 2019, we played on a lot of retro gaming

devices. With so many options available (including, of course, playing on a PC!), we decided to sit down and chat about the best of the bunch and who should buy them.

WINDOWS 10X: FIRST LOOK AT ITS NEW FEATURES

PCWorld

MARCH 2020

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SAMSUNG GALAXY S20 ULTRA

THE MOST
LAVISH
SMARTPHONE
EVER

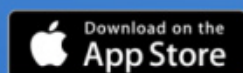


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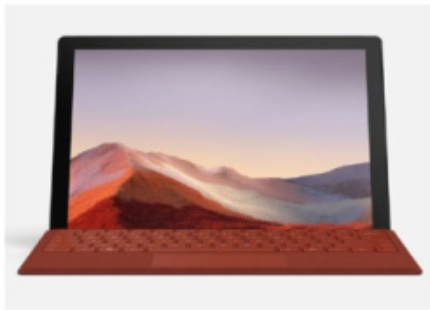
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#DanceLikeaDad



fatherhood.gov

Galaxy S20 Ultra hands-on: Samsung's pro phone is a monument to excess

It's got everything (except a headphone jack). **BY MICHAEL SIMON**

The Galaxy S20 Ultra is the most phone I've ever held in my hand. I'm not just referring to the screen size—a hair under 7 inches—or even the weight, which tips the scales at 220 grams. It's the whole package, which oozes luxury and excess in a way no Galaxy phone

has ever before.

At a quick glance, the S20 Ultra doesn't seem all that different from the S20 or S20+: You get the same basic features in increasingly larger displays (6.2, 6.7, and 6.9 inches, respectively, as you step up the line). But as soon as you pick up the Ultra, you can



feel the difference. It feels more substantial than any other I've ever used, including the iPhone 11 Pro Max. It's hefty without being too heavy, and gigantic without being cumbersome. That's with a display that's even bigger than Samsung's recent 6.7-inch behemoths.

Even though the S20 Ultra is the thickest Galaxy phone since the S5 (and that thickness doesn't even include its bulbous camera bump), the girth complements its tremendous size surprisingly well. The rounded corners and slimmer bezels give it a sleeker look than the Note 10. The taller aspect ratio makes it feel smaller and gives it a surprising holdability.

Samsung's color options, which are limited to somewhat staid black and gray, also give the phone a slimming appearance. That said, the extra millimeter of thickness that the Ultra has on the S20 and S20+ is palatable, and you'll notice it, even if the phone you're coming from is several years old.

While you'll find a ton of power inside the Ultra's chunky frame, you won't be able to plug in your wired headphone



Like everything else, the Galaxy S20 Ultra's camera bump is significantly bigger than the one on the S20+.

without an adapter. This was to be expected after the Note 10+ dumped the headphone jack last year, but it still stings given the S20 Ultra's otherwise maxed-out spec sheet.

You get most of the same performance features across the S20 lineup, but the Ultra packs a few more pixels into its Quad HD+



Next to the Galaxy S10+ (right), the S20 Ultra is a beast.

Infinity-O display. Samsung has finally brought a high refresh rate (120Hz) to a Galaxy phone, and it feels luxurious, like my fingers were running through water rather than mud. However, you'll need to keep the Ultra locked to Full HD if you want to use that refresh rate, which is a major bummer.

The S20 Ultra is powered by the same top-of-the-line Snapdragon 865 processor and 12GB of LPDDR5 RAM as the S20, and includes 128GB of base storage, a 5G modem, and an ultrasonic in-display fingerprint sensor. I'd much rather have 3D facial recognition on a phone this big, but Samsung is still using the less-secure selfie camera for face unlock. Nonetheless, during my hands-on I did see an improvement in the accuracy of the sensor compared to the one on the S10+, especially when using my thumb. I attribute this largely to the sensor's new position, higher on the screen.

The S20 Ultra is extra-thick because it includes the largest battery Samsung has ever shipped in a phone: a whopping 5,000mAh cell. That's a healthy boost from the S10 5G's 4,500mAh capacity, and I'd be lying if I said the Note 7's exploding battery wasn't in the



Samsung has moved the position of the fingerprint sensor on the S20, and it's much easier to hit now.

back of my mind while holding it. But with a 5G modem and a 120Hz 6.9-inch display, the Ultra is going to need every ounce of juice it can get.

ZOOM TO THE MOON

While the super-sized display and battery certainly set the Ultra apart from its S20 siblings, the main reason to drop \$1,400 on it (or \$1,600 if you opt for an insane 16GB of RAM) is the camera. And for that sky-high price, you also get a bit of unsightly "Space Zoom" branding on top of an already unappealing camera bump.

While it has the same 12MP, f/2.2, 120-degree ultrawide camera as the S20 and S20+, the wide and telephoto cameras are quite a bit different. Dig the specs:



In case you couldn't tell, the Ultra has the bigger bump.

Galaxy S20/S20+

Wide (main): 12MP, f/1.8

Telephoto: 64MP, f/2.0

Galaxy S20 Ultra

Wide: 108MP, f/1.8

Telephoto: 48MP, f/3.5

That's not a typo. The S20 Ultra has a ridiculous 108MP sensor, which is a bit of marketing bluster. Any photographer will tell you that megapixels don't make a great camera, but Samsung has done some pretty cool and innovative things with the sensor. Using a process called *nona binning*, the S20 Ultra's main camera merges nine pixels into one to create a 12MP image using the entire 108MP sensor.

In real-life results, that means the S20 Ultra's pictures will have more detail in full

light and less noise in low light. Samsung says the Ultra's camera will dynamically switch between the full 108MP and 12MP modes to bring in three times more light than the S10+ (which has always been a bit disappointing when it comes to nighttime shots).

During my hands-on demo, I didn't get a chance to test the camera in low

light, but I did get to test the S20 Ultra's other over-the-top camera feature: 100X Space Zoom (also not a typo). Like the Huawei P30 Pro and other long-zoom phones with periscope lenses, the S20 Ultra's telephoto camera sits sideways in the device and refracts the light through a prism at a 90-degree angle.

Samsung says this proprietary hybrid optical and AI-powered digital zoom solution is able to achieve 10X lossless zoom and 100X max zoom, both of which are impressive claims. I was in a pretty small room (and I got yelled at when I tried to shoot out the window), but the Ultra was able to zoom way further than any other phone I used. Without OIS, it was extremely hard to control at even 30X and nearly impossible to keep steady at 100X, but a mini zoomed-out viewfinder in the corner of the screen did help maintain some semblance of position. The photos I



We might be a little sad that Samsung dumped the headphone jack on the Galaxy S20, but we can't fault the beautiful curves and contours of the overall design.

snapped, while extremely noisy and hazy, were surprisingly legible.

Space Zoom may very well be the thing that compels a few fence-sitters to take the \$1,400 plunge, but it's the smaller camera advancements that will make or break the S20 Ultra. These include enhanced low-light mode and nighttime hyperlapse; 8K video recording; improved Super Steady; and a cool innovation called Single Take mode, which was the smartest S20 camera trick I tried. Instead of fussing with modes and cameras, you need only take a 10-second video of the scene in front of you, and the S20 will use AI to decide which pics and video clips best capture the moment.



The Galaxy S20 Ultra (bottom) is about 10 percent thicker than the S20.

ULTRA EXCESS

The Galaxy S20 Ultra is probably too much phone for most people, but never have I held a phone that felt so consequential. Granted, you're going to pay dearly—a \$1,400

starting price makes the iPhone 11 Pro Max seem like a bargain—but switching between the S20+ and S20 Ultra felt more dramatic than going from the S10 to the S10+.

Even more than the Note 10+ 5G, the S20 Ultra is absolutely the biggest and best phone Samsung can build right now (except for that pesky missing headphone jack). Is it excessive? Unapologetically so. But I'll take it over the Galaxy Z flip any day. 🔌



Samsung Galaxy S20 v S20+: How do the non-Ultra phones stack up?

To+ or not to +? **BY MICHAEL SIMON**

If you've got your eye on a new Galaxy S20, chances are the Ultra is just too much phone for you. It's huge, powerful, and, most importantly, crazy-expensive, so most people are going to be choosing between the classics: S20 and S20+. But just because they don't have Ultra branding, doesn't mean you're getting a subpar handset:

DESIGN

No matter which S20 you buy, you're getting a gorgeous phone, with extremely slim bezels, a stunning screen, and a striking camera array. Samsung isn't straying too far from its tried-and-true formula, but the S20 definitely has a character all its own.

However, while anyone will be able to pick the S20 out of a lineup of S10's, there

isn't too much of a size difference between the new phone and the old ones:

S20: 151.7 x 69.1 x 7.9 mm

S20+: 161.9 x 73.7 x 7.8 mm

S10: 149.9 x 70.4 x 7.8 mm

S10+: 157.6 x 74.1 x 7.8 mm

Samsung has taken a page from Google's and Apple's book for the S20's rear camera array, opting for a big rectangular camera bump rather than the S10's horizontal array. With a trio of cameras inside, it's a good deal deeper than the one on both the Pixel 4 and iPhone 11 (but not as gigantic as the Ultra).

While the rear camera will get all of the attention, the front camera has changed too. Samsung has corrected the S10's biggest blunder—the off-center selfie cam—by centering the hole and reducing the size beyond even what the Note 10 brings. Consequently, the Plus model loses its second front lens, and we're that much further away from 3D facial unlock (which requires an IR camera, flood illuminator, and a dot projector). It's a small price to pay for sweet, sweet symmetry. However, you can look all you want, but you won't find a headphone jack anywhere—it's gone for good.

DISPLAY

Samsung likes to go bigger whenever it launches a new Galaxy S phone, and the S20 follows suit. Where the S10 and S10+ were relatively small at 6.1 and 6.4 inches (and the S10e was downright tiny at 5.8 inches),

respectively, the S20 clocks in at 6.2 inches and the S20+ at a whopping 6.7 inches.

The Dynamic AMOLED Infinity-O display is basically the same save one big, new feature: 120Hz high-refresh support, a feature Samsung fans have been clamoring for after the Pixel 4, OnePlus 6T, and other phones gained it last year. That means the display is twice as fast as the S10's 60Hz screen, so scrolling and animation will simply fly.

There's just one problem: You can't use it at full resolution. Samsung has limited 120Hz refresh to 1080p, so you'll need to make a choice between the clearest or the fastest version of the screen.

BIOMETRICS

Samsung introduced the ultrasonic in-display fingerprint sensor with the S10, and it's sticking with it for the S20. However, there are a couple of changes. For one, the sensor is larger, so your finger should be able to find it quicker, and it's also been moved higher on the phone so you shouldn't need to adjust your grip. We'd much rather see 3D facial recognition on such large phones, but until Samsung can come up with a bezel- or notch-less solution, this is as good as it's going to get.

PROCESSOR, RAM, AND STORAGE

The latest Galaxy S always runs the newest Qualcomm processor. This year, it's the

Snapdragon 865, which should bring a nice speed and graphics boost over last year's 855.

Far more intriguing is the RAM. Samsung has switched to LPDDR5 RAM for the S20, which is reportedly 1.3 times faster than the S10 5G's LPDDR4X. You're also getting a lot more of it: Samsung has bumped the base RAM to 12GB in all models this year, a 50-percent increase over last year's 8GB. (If you wanted 12GB of RAM in the S10+, you needed to upgrade to the 1TB Performance Edition ceramic model for \$1,600.)

As far as storage goes, both phones offer 128GB of internal storage with support for a 1TB MicroSD card. The S20+ also has a 512GB option.

5G

The S20 isn't Samsung's first 5G phone—the S10 5G and Note 10+ 5G both arrived last

year—but it's the first Galaxy phone that's exclusively 5G. That's because Qualcomm is requiring the Snapdragon 865 processor to be paired with the X55 5G modem.

However, you're not getting an equal 5G experience on both phones. While the S20+ supports both the sub-6GHz spectrum and mmWave, the S20 supports only sub-6GHz. That means Verizon customers are going to be out of luck with the S20, because the carrier is building out its mmWave network first. However, Verizon will be selling its own model of S20 that does support mmWave at some point, we just don't know when or how much it'll cost. T-Mobile subscribers, on the other hand, will be able to use the company's 5G network on either phone.

BATTERY

With lots of pixels, 120Hz refresh, and a 5G modem, the S20 is going to need lots of battery capacity. The S20 has a 4,000mAh battery, while the S20+ gets a 4,500mAh one, a nice boost from the 3,400mAh and 4,100mAh batteries in the S10 and S10+.

The phones are also equipped with Wireless PowerShare (for charging your Galaxy Buds+ or a buddy's phone), 10W Fast



Sorry audiophiles, there's no headphone jack on any model of S20.

Wireless Charging 2.0, and a 25W charger in the box.

CAMERA

Now for the most important section: the camera. While the S20 has a completely new camera architecture as compared to the S10, Samsung isn't offering much in the way of upgrades between the two models:

Galaxy S20/S20+

Camera 1: 12MP wide, f/1.8

Camera 2: 12MP ultra wide, f/2.2

Camera 3: 64MP telephoto, f/2.0

Camera 4 (S10+): Time-of-flight (depth)

Galaxy S10/S10+

Camera 1: 12MP wide, f/1.5

Camera 2: 12MP ultra wide, f/2.2

Camera 3: 1264MP telephoto, f/2.4

While you're getting the same basic capabilities as the S10, Samsung has significantly upped the camera's abilities. The new telephoto lens is capable of 3X lossless zoom and 30X Space Zoom, while the sensor is 1.6X bigger than the one in the S10, which will allow for greater detail and better low-light photos, as well as 8K video recording.



The Galaxy S20 has a camera bump that's bigger and bulkier than the S10.

Around the front, both phones have a single 10MP camera, a bit of a downgrade from the S10+, which features a dual selfie cam.

COLORS

The Galaxy S20 comes in a variety of colors, but the one you like might—ahem—color your decision:

Galaxy S20: Cosmic Gray, Cloud Blue, Cloud Pink

Galaxy S20+: Cosmic Gray, Cloud Blue, Cosmic Black

PRICE

With 5G and bigger screens, the Galaxy S20 is more expensive than ever, and you're looking at a grand just to get in the door.

S20 (128GB): \$1,000

S20+ (128GB/512GB): \$1,200/\$1,350 🔌



Samsung Galaxy Z Flip: 6 features and facts to know before buying

Only \$1,380? We'll take two. **BY MICHAEL SIMON**

Samsung wasted little time in getting to the good stuff at its first Unpacked event of 2020. Right off the bat, it took the wraps off the Galaxy Z Flip (go.pcworld.com/zflip), its second folding phone and the first one that's actually kind of affordable. Seriously, it's cheaper than the Galaxy S20 Ultra (which has a starting price of \$1,400; see page 7).

As far as the specs go, the Z Flip isn't a

midrange device like the Motorola razr (go.pcworld.com/mrzt). Along with the Flip's 6.7-inch 1080p display, the Flip has a very speedy processor. I'm not sure exactly which chip it is, but the specs say it's a 7nm, 64-bit Octa-Core Processor with a max speed of 2.95GHz, which is actually faster than the S20. It also boasts 256GB of storage and 8GB of RAM. Its 3,300mAh battery seems small, however.

But if you're wondering whether to rush to drop \$1,380 on it (it started shipping on Valentine's Day, February 14), here are six features and facts you need to know first:

1. THE HINGE HAS VASTLY IMPROVED

After last year's Galaxy Fold debacle, Samsung had to work on the hinge for the Galaxy Z Flip. It remains to be seen whether Samsung's claims are believable, but this new model sports a Hideaway Hinge that uses a fibrous shield to protect the phone from the dust, dirt, and debris that brought down the first round of Galaxy Folds. Samsung says the Flip can be folded and unfolded more than 200,000 times, which is a thinly veiled shot at the Motorola razr and its own folding issues.

2. YOU CAN TAKE SELFIES WITHOUT OPENING IT

The outside of the Galaxy Z Flip has an extremely small, 1.1-inch Cover Display. That's good for checking the time and date or getting a glance at incoming texts, calls, and other notifications, but it's also hiding another trick: You can use the tiny screen to take a full-sized selfie with the rear camera. It's not entirely clear how that would work—whether



The Galaxy Z Flip opens up to a tall 6.7-inch OLED display.

it's voice-controlled or accessible via a hardware shortcut—but you won't need to open your Flip to snap a quick selfie.

3. THE SCREEN IS MADE OF GLASS

The Infinity Flex screen on last year's Galaxy Fold felt weird. That's because it's not made of glass. Rather, it was bonded with thin layers of innovative materials crafted into a polymer that felt just like plastic. Compared to the glass of the Galaxy S10, it wasn't great, so Samsung went to work. You can see the results of its efforts in the Galaxy Z Flip's Ultra Thin Glass display. That's right: It's actually made of glass, so it should feel just like a smartphone when you run your fingers over it.

4. YOU CAN USE IT AS A MINI LAPTOP

The Galaxy Z Flip's design is a major departure



The screen on the Galaxy Z Flip is made of glass, not plastic.

from the Galaxy Fold. It's not just that it flips open rather than folds, it's also that you can use it without fully opening it. It's called Flex mode, and Samsung describes it as having a viewing area and an interaction area, kind of like a very tiny laptop. When opened halfway, certain apps (camera, YouTube, Duo, Gallery, etc.) will split into two parts, with images at the top and controls at the bottom, whether that is a keyboard, trackpad, or buttons. It's a neat trick that transforms the Flip's somewhat cumbersome 6.7-inch screen into something much more usable. And even when you need to open it all the way, Multi Active Window lets you stack apps, so multitasking is just as easy as it is on your PC.

5. YOU GET A YOUTUBE PREMIUM SUBSCRIPTION FOR FREE

Google played a surprisingly big role during

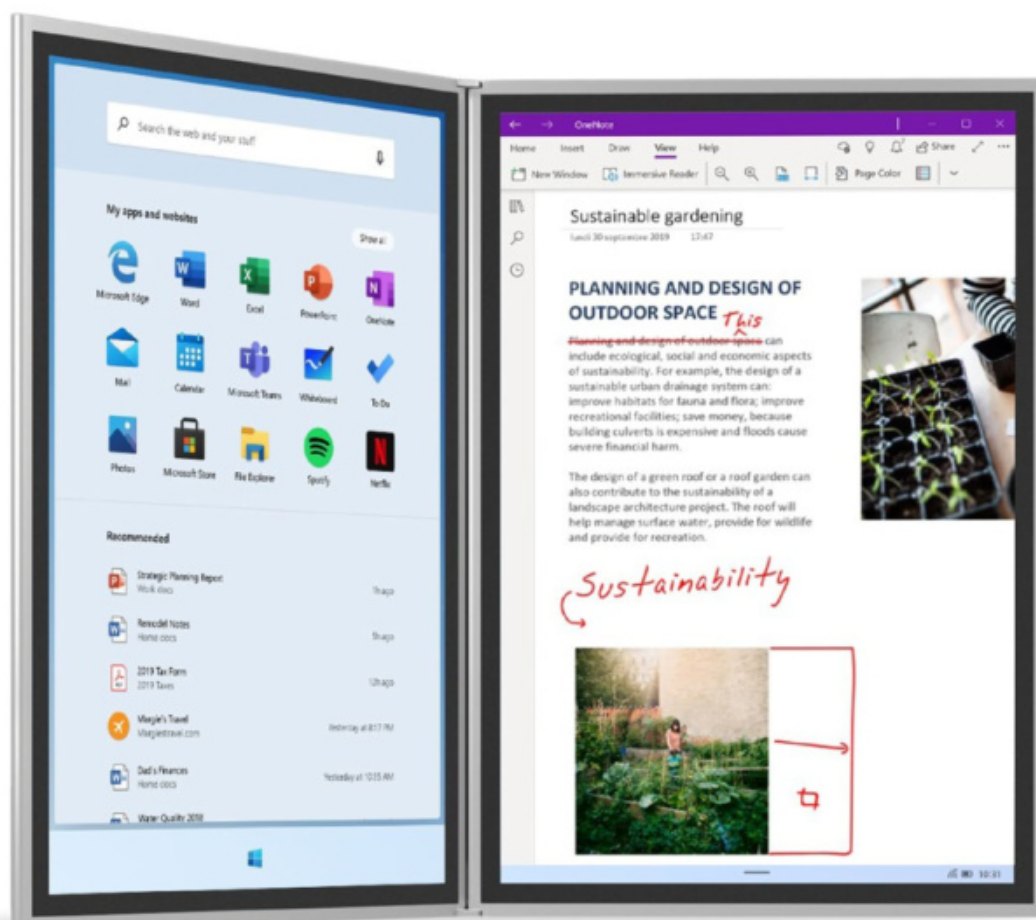
Unpacked this year, unveiling deep Duo integration that lets you video chat as easily on your S20 as you do on the Pixel. But the coolest announcement was the free YouTube Premium subscription you get with your Galaxy Flip purchase. Unless the subscription is open-ended, the benefit seems to be tied to the Flip itself, because Samsung didn't put a cap on the offer. But even if you need to use the Flip to enjoy the subscription, that's still a great deal for a service that normally costs \$12 a month.

6. IT DOESN'T HAVE 5G

Samsung talked a lot about 5G during Unpacked, so it's surprising that the new Galaxy Z Flip doesn't support it. There are any number of reasons why—heat, cost, battery—but if you're hoping for blazing download speed on your Flip, you'll have to wait 'til the Flip 2. 🔋

Microsoft's Windows 10X: A dozen ways it's cooler than just two screens

There's a lot more under the hood than we expected. **BY MARK HACHMAN**



Before a recent developer event, all we really knew about Windows 10X was that it would be some flavor of Windows 10, optimized for dual-screen devices such as Microsoft's own Surface Neo (go.pcworld.com/mneo) and an unknown number of third-party competitors by holiday 2020. Now we know

much more, including what's under the hood.

At the event, the company made a Windows 10X emulator available (go.pcworld.com/10xm)—though you'll need to assign a fairly powerful PC to the task, and dedicate it to the Windows Insider program. Microsoft revealed several intriguing characteristics of the new OS as well,

including lightning-fast updates, a special way of handling Win32 apps, and no apparent need for anti-malware apps.

Some have characterized Windows 10X as a new Windows 10 “experience,” in much the same way a movie might be re-released in a special director’s cut, with extras and in additional formats. But it’s more than that, as it will interact with files and other applications differently than Windows 10 does. Microsoft’s published enough separate documentation for us to start piecing together how Windows 10X will work. Here are a dozen intriguing features we’ve already learned about.

A SIMPLIFIED, PRETTIER WINDOWS SHELL

Windows 10X looks different. Most of what you expect about Windows still works—various inputs, drag and drop, the Clipboard, and more. But in Windows 10X, there’s a small dock that incorporates elements of the

traditional Windows taskbar, as well as the “app drawer” on smartphones. The Windows Start launcher moves from the bottom lefthand corner of the screen toward the center. The way app icons are aligned on the screen looks more like what you’d see on a traditional tablet or phone than the Windows desktop. Even apps are moved from one screen to the other via touch points on the bottom of the window, not the top.

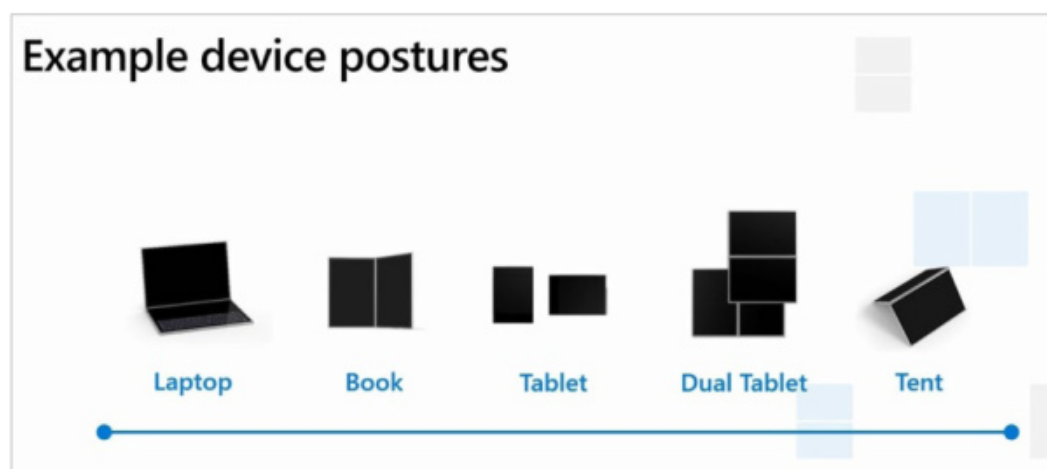
Windows 10’s tiled Start interface? That’s gone, too. Everything within Windows 10X looks simple and clean.

WINDOWS 10X UNDERSTANDS WHAT THE HARDWARE IS DOING

Microsoft expended quite a lot of effort hammering home why dual-screen devices are cool, both from a developer and user perspective. Two displays—though separated by a physical hinge—offer a variety of ways of

communicating information. But there’s two separate aspects, including the hardware and the software.

Microsoft envisions five separate hardware modes: laptop,



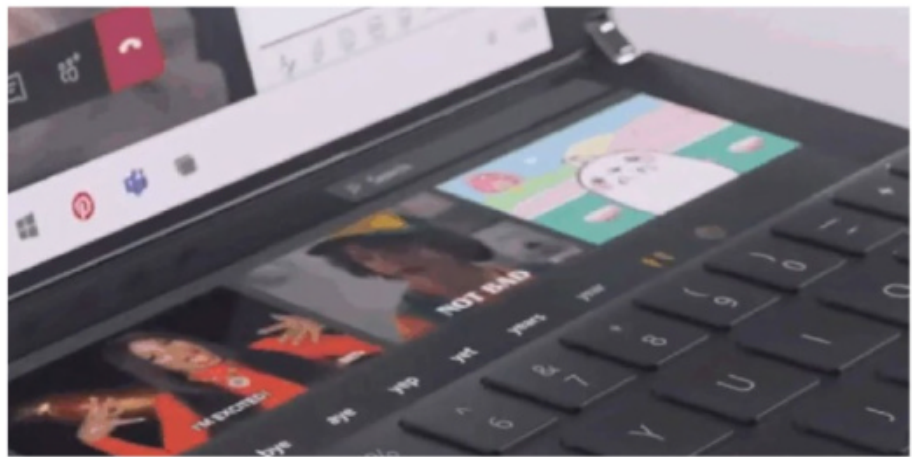
The different hardware “postures” for Microsoft’s Windows 10X, specifically the Surface Neo.

book, tablet, dual tablet, and tent. The three most interesting include tablet mode, where the rear display folds back out of sight and shuts off, to save on power and mistaken input. Tent mode, as with currently available 360-degree convertible laptops, is optimized for presentations. Last but not least, the Surface Neo's keyboard flops up to cover part of the screen, creating what Microsoft calls...

THE WONDER BAR: A TOUCH BAR THAT MAKES SENSE

When the Surface Neo's keyboard is attached to the device, a small strip of space is left uncovered. That's what Microsoft calls the Wonder Bar, a space for additional content, suggested emoticons or GIFs, or whatever.

Looks like the MacBook Pro's Touch Bar, you might sniff. But the Wonder Bar is inarguably better: bigger, so it can show more, and it also does more. In this picture, posted during Microsoft's Windows 10X developer presentations, you can see Microsoft's keyboard suggestions—a fantastic use of the technology. Auto-completing text suggestions are an integral part of



Microsoft's Wonder Bar and Windows 10X makes good use of the extra space when the Surface Neo's keyboard is folded over.

smartphones, but they feel useless in Windows. (Try them yourself in *Settings > Devices > Typing > Show Text Suggestions As I Type*.) By placing them right above the keyboard, you can quickly reach out and tap them, then return to typing.

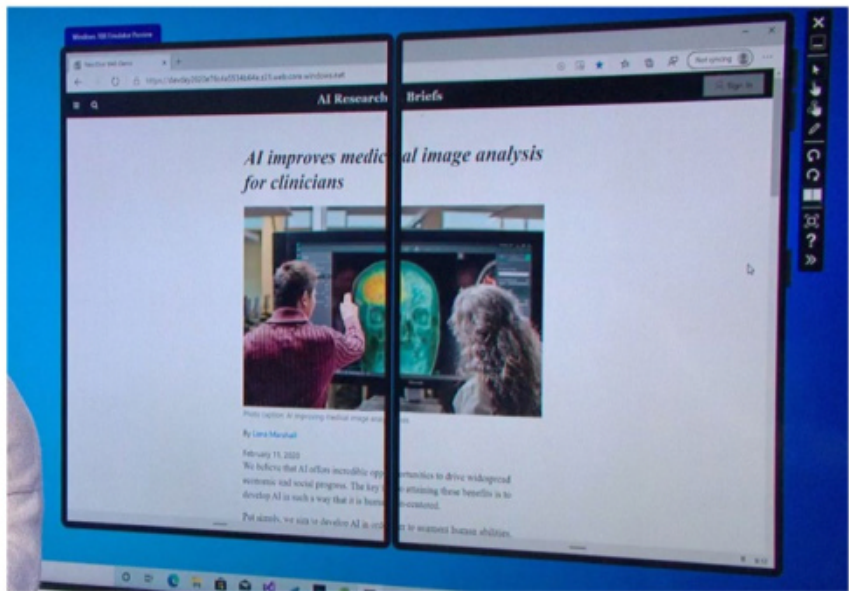
SMART SOFTWARE SPREADS CONTENT ACROSS SCREENS

Anyone who's worked with multiple displays understands the benefits of seeing more information at any given time. Windows 10X does this in three ways: allowing apps to open in what's known as "expansive workspaces," spanning apps across dual screens; "focused screens," which puts separate apps on each individual screen, and "connected apps," which puts separate apps on either screen but lets them talk with one another.

There already appear to be pluses and

minuses to this approach. Spanning a webpage across both screens—with a gap in the middle—looks a bit awkward when the gap splits a page vertically. But Microsoft's right in suggesting that if we're reading email on one pane, we might want to open a Calendar app in a second pane.

According to Kevin Gallo, corporate vice president of the Windows Developer Platform, apps will open in a single display by default. Searching for a restaurant in Edge, for example, will open the browser in one pane. Tapping a map of the area will open the Maps app in a second pane, while leaving the first open. This makes sense.



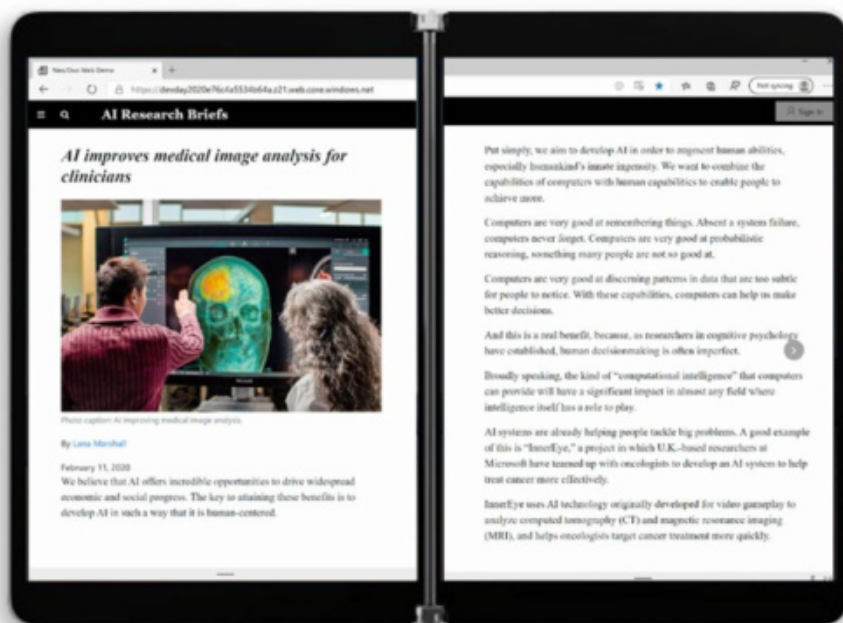
Spanning content within Windows 10X doesn't look that hot...

WINDOWS 10X IS READ-ONLY

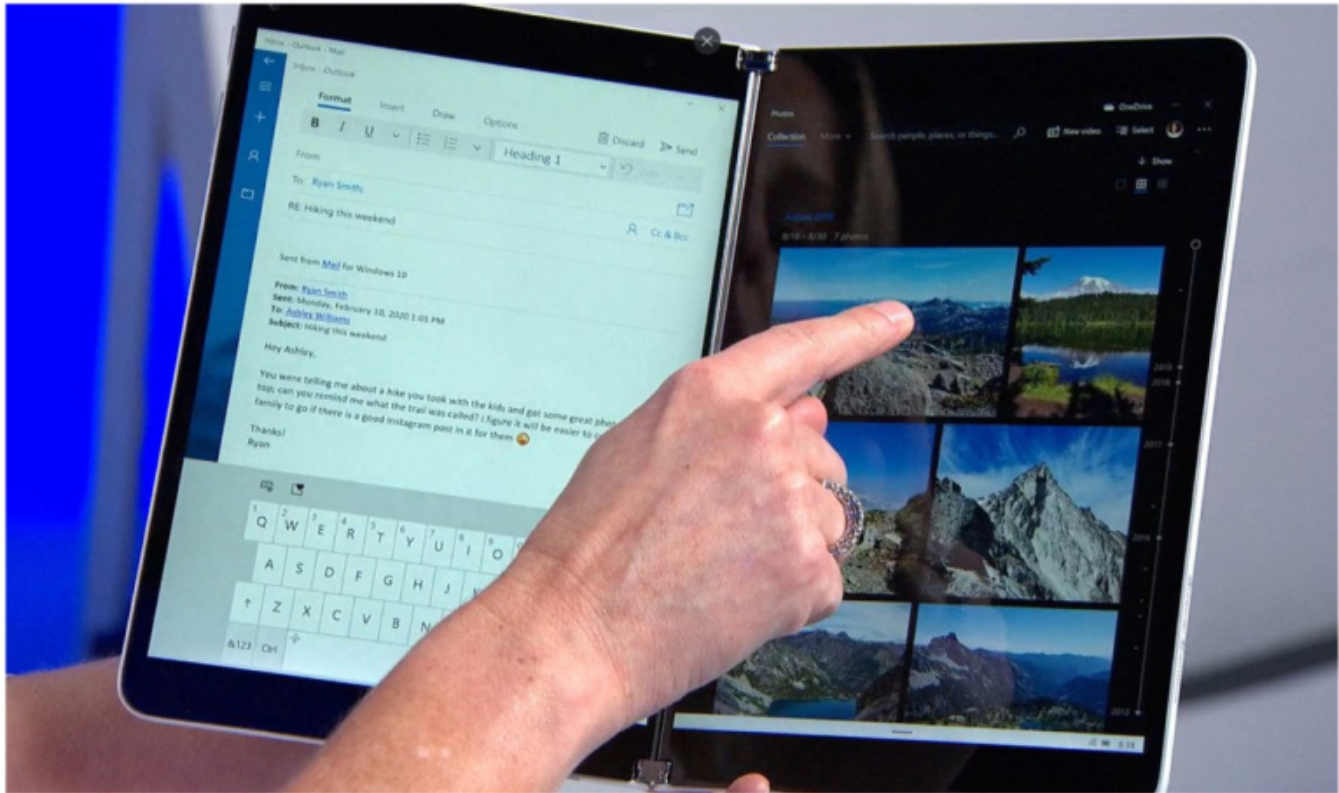
The core Windows 10X operating system is designed in a locked-down mode, so that only trusted apps are able to run in the operating system. You've heard this before—

that's the same model for Windows 10 S. (But wait! Legacy Win32 apps are supported, and we'll explain how in a bit.) What's different is that Windows 10X also runs signed code and apps with a "good reputation," including those published in the MSIX container, widening the available apps beyond just the traditional UWP apps, such as Mail and Calendar.

That doesn't mean that apps will have to be downloaded



...but it makes a bit more sense like this.



Windows apps like Photos will be the most commonly used within Windows 10X, certainly.

from the Microsoft Store app, either. As long as the app is trusted, it can be downloaded from a website, USB key, or another location. That's a big change from Windows 10 S.

All this is going to have interesting follow-on effects, including:

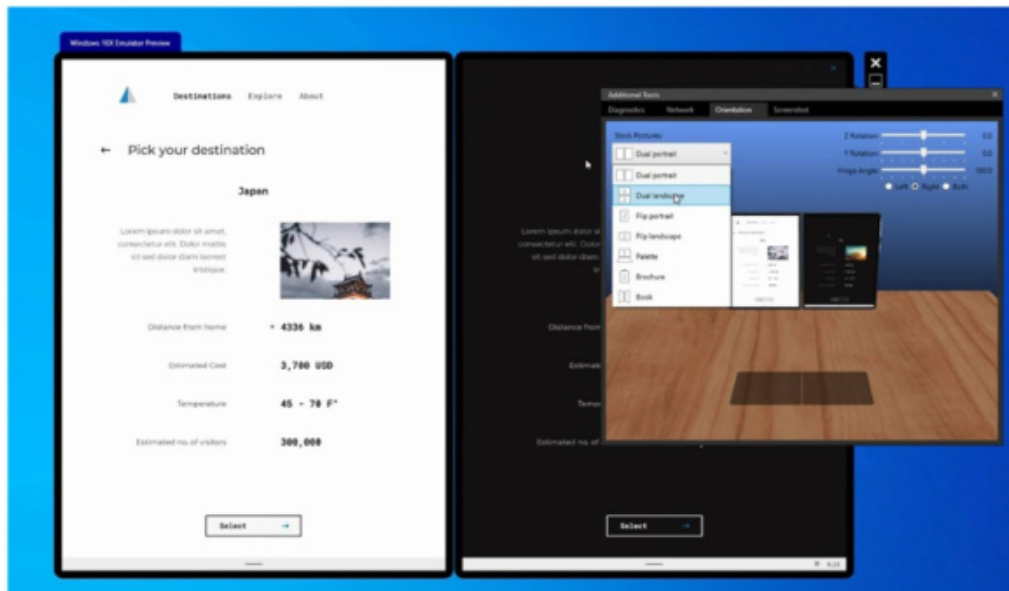
WINDOWS 10X WON'T REQUIRE ANTI-MALWARE

As with Windows 10 S, Microsoft believes that relying on signed and trusted applications will remove the need for anti-malware applications, even possibly including Windows Defender. That means the performance overhead that anti-malware requires can be re-allocated to other areas

within the OS, Microsoft executives said.

WINDOWS UPDATES WILL TAKE 90 SECONDS

According to Andrew Clinick, a Microsoft partner group program manager, Windows 10X won't require more than 90 seconds to update your PC. How? For one, they'll take place in the background. Clinick also said that Windows 10X will operate a bit differently than Windows 10, in that the operating system will be downloaded as a separate state, presumably as a patched copy of the OS that will exist entirely separate from the unpatched OS. You'll apparently have one version of Windows 10X running in the



Developers will be able to try out this Windows 10X emulator from Microsoft.

foreground, another one downloading in the background, and the reboot will simply swap between the two.

APP UPDATES WILL BE INCREMENTAL

You'll see some improvements in app updates, too. John Vintzel, the program manager lead for Microsoft, said that one advantage of a new MSIX app packaging container will be that all of the app's resources will be contained within it, each with its own unique software hash. In fact, there will be three containers: native containers for UWP apps, which will offer the best performance as well as battery life; the MSIX containers, which will offer high compatibility with existing apps and a robust installation / uninstallation procedure; and the new Win32 container, which we'll discuss in a bit.

When a new app is downloaded, the hashes of each of the components will be compared against the update. If a particular component (say the app icon) is left unchanged, it won't be downloaded and updated, saving bandwidth. But even if a

component is downloaded, it will be divided up into blocks, and only those blocks that have been changed will be downloaded. Even better, those blocks can be downloaded and then merged with the app later on, taking care of the process in the background.

It sounds like this same approach will be used to patch the Windows 10X OS, too. The secondary patched OS will be constructed from just what's new, saving you from re-downloading the entire OS every time a patch is released.

FAREWELL, REGISTRY CLEANERS

The UWP apps within Windows 10X, incidentally, will only be able to access certain libraries. Photos would just be able to access your Photo library, for instance, just as UWP apps behave within Windows 10. "Apps can interact with the OS, but only via a clear set of

APIs,” Clinick said.

“No more registry fiddling to optimize the OS,” Clinick added. “And my personal favorite, no more registry cleaners.”

SAY GOODBYE (AGAIN) TO “BIT ROT”

Microsoft promised this with Windows 10 S, and it’s making the same pledge again with Windows 10X: Because the initial code and subsequent OS and app updates will be clean and tidy, you shouldn’t see “bit rot,” the degradation of performance that often accompanies a PC over years of operation.

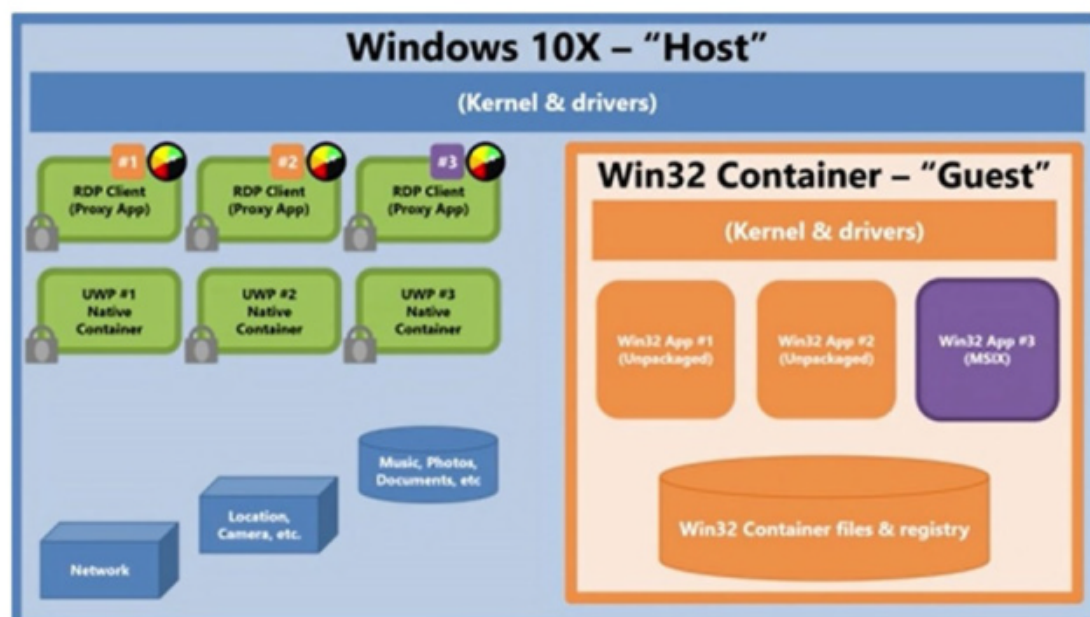
“We’re going to have sustained performance, ensuring the performance you see on day one stays with you for the lifetime of the machine,” Clinick added. “That’s so important. Because last time I checked processes don’t get slower, the more you use them.”

THE WIN32 CONTAINER: HOW LEGACY APPS ARE SUPPORTED IN WINDOWS 10X

How Windows 10X deals with legacy Win32 apps is one of the most fascinating parts of Windows 10X, and it builds upon a number of the other components we’ve already mentioned. Basically, Windows 10X will support most legacy Win32 apps, and it will do so by stealing a few tricks from Microsoft’s secret sauce: virtualization (go.pcworld.com/scsc).

Every app within Windows 10X runs within its own container—intended to protect the OS from potential malware. But the Win32 Container exists separately, as a large vault of sorts for legacy Win32 code. (MSIX Containers will run inside the Win32 Container—yes, as a container inside a container, too.) Inside the Win32 Container

runs all of the legacy Win32 apps that you may want to keep around: system utilities, old games, and the like. There’s even a traditional Windows directory tree, and its own



A diagram of what the Win32 container looks like inside the Windows 10X host.

kernel, drivers, and registry.

The Win32 Container is essentially a virtual machine, though with higher integration, much lower latency, and with access to more resources on the host Windows 10X than a VM has. Together, it all offers greater overall performance, according to Peter Torr, a principal program manager at Microsoft. Oh, and if there are no Win32 apps running? The whole thing shuts down. Even inactive Win32 apps are “tombstoned,” essentially left in a very low-power state to preserve battery.

But opening the Win32 app within Windows 10X doesn't actually launch it directly. Instead, what Windows 10X does is create “proxy” apps within the Windows 10X host operating system—essentially, using a Remote Desktop-like interface to access the secured Win32 app within the Win32 Container. Microsoft promises you'll have near-native performance of these apps, but some sort of slowdown would seem likely.

Shell experiences in the Win32 Container.

- **Windows 10X has a new, simplified shell.**
 - Most of what you expect from Windows just works.
 - Start, windowing, input, graphics, drag & drop, clipboard...
- **Some Desktop shell features aren't present in Windows 10X.**
 - System tray applets.
 - File Explorer add-ins, namespace extensions, etc.
 - Mouse, keyboard, or window hooks.
- **The APIs / Registry entries still exist, they simply no-op on 10X.**

Some of the limitations of Win32 apps within Windows 10X.

PRIVACY WITHIN WIN32 APPS

There will be a few bumps along the way. While all “typical” PC hardware—mice, keyboards, pens, touchscreen, printers, networking devices—should work as expected within Windows 10X, there will be limitations on “non-standard hardware” and “app-installed drivers,” Microsoft says. Microsoft's also putting some broad limitations on what it's calling “privacy-sensitive hardware,” such as the camera and microphone. In this case, all Win32 apps will have access to the mic, or none will; there are no per-app permissions, Torr explained.

Torr listed other limitations to Win32 apps in Windows 10X: No system tray applets will be allowed, and you won't be able to use File Explorer add-ins or namespace extensions, for example. If there's an app or utility that you interact with via the system tray, it'll have to move

elsewhere within Windows 10.

There's a lot here already, and it's still early in the year. Expect to hear more about Windows 10X as 2020 progresses, including at Microsoft's Build 2020 conference in late May (go.pcworld.com/mb20). 



Threadripper 3990X review roundup: AMD's 64-core CPU can play Crysis, but it's not for everyone

Its performance is in a class by itself, but it has some distinct limitations. **BY GORDON MAH UNG**

AMD's 64-core CPU has officially gone on sale, and early reviews of AMD's flagship high-end desktop processor give the chip very high marks—assuming you can make use of it.

And provided you can afford it! Newegg is selling the new Threadripper 3990X for \$3,989.99, which is a penny below its MSRP of \$3,990 (go.pcworld.com/thdr). Anything below MSRP on a new CPU launch is rare for

Newegg. If you'd rather get that brick-and-mortar experience, Microcenter has it in stores and online at the chip's \$3,990 list price (go.pcworld.com/mctr).

Before you break out that roll of hundert-dollar bills though, you should ask yourself: Is it worth it?



**VIDEO: THREADRIPPER
3990X ROUNDUP**

Watch now at go.pcworld.com/39x

Most reviewers are saying: “It depends.” Here are the highlights from major sites and some other interesting places that tested it.

ANANDTECH SAYS THREADRIPPER 3990X IS A “NO BRAINER” (BUT...)

Kicking off the review roundup are Anandtech.com’s Dr. Ian Cutress and Gavin Bonshor, whose views don’t fit into sound bites (go.pcworld.com/nrev).

Cutress and Bonshor say the consumer/prosumer chip is stunningly fast in some workloads, but many times it has issues outrunning the 32-core Threadripper 3970X

at half its price:

“For the first stage, the consumer/prosumer level, our conclusion is that the usefulness of the 3990X is limited. Aside from a few select instances (as mentioned, Corona, Blender, NAMD) the 32-core Threadripper for half the price performed on par or with margin. For this market, saving that \$2,000 between the 64-core and the 32-core can easily net another RTX 2080 Ti for GPU acceleration, and this would probably be the preferred option. Unless you run those specific tests (or ones like it), then go for the 32 core and spend the money elsewhere. Aside from the core count there is little to

differentiate the two parts.”

As anticipated, Anandtech’s review shows the single-chip Threadripper 3990X outpacing \$20,000 dual-socket Xeon chips, which makes it an easy win.

“The second stage, the enterprise level, it becomes a no brainer to consolidate a dual socket system into a single AMD CPU—the initial outlay cost is substantially lower, and the long term power costs also come into play. This is what the enterprise likes to combine into ‘Total Cost of Ownership’, or TCO. The TCO and performance advantage of AMD here is plain to see in the benchmarks and the pricing.”



Anandtech.com showed one of the challenges for Threadripper is out of its control: Which version of Windows you use matters.

Anandtech's review interestingly digs deep into one of the biggest challenges for AMD's 64-core, 128-thread chip: Windows itself.

Cutress and Bonshor ran the Threadripper 3990X through different flavors of Windows to show off the issues in how the OS handles not just 64-core processor pools, but also how some versions of it treat the new CPU as a dual-socket system even though the Threadripper is a single chip. As part of their testing, Cutress and Bonshor found disabling SMT in the CPU in Windows 10 Pro yielded better performance in some workloads, while Windows 10 Enterprise performed far better. .

TOM'S HARDWARE SAID MORE IS YET TO COME AFTER THREADRIPPER 3990X

Paul Alcorn of Tom's Hardware, who also showed the Threadripper 3990X outpacing Intel's dual socket Xeon chips was a bit less on the fence on the 64-core part saying (go.pcworld.com/alcn): "The Threadripper 3990X is pretty much exactly what AMD says it is: A highly specialized processor that provides incredible performance in a narrow cross-section of workloads, but at an extremely attractive price point given its capabilities."

Yet, like Anandtech.com, Alcorn said there are clearly limitations—not all of them within AMD's control. "We've done our best to show you the best of the Threadripper

3990X's performance, but we can't tell the whole performance story due to spotty software support for a processor of this class," Alcorn writes. "Outside of AMD's targeted workloads, most software can't extract the best performance from this processor."

Still, Alcorn notes in his review: "...the Threadripper 3990X is an incredibly impressive chip. Just three years ago, an eight-core \$1,000 chip represented the best the industry had to offer on an HEDT platform, but now we have up to 64 cores and 128 threads at our disposal, and AMD says it won't slow down as it shrinks to smaller process nodes. As crazy as it sounds, we'll see higher core counts in the future. Hopefully the software and operating system ecosystems respond with performance-boosting optimizations so this kind of incredible performance benefits more types of workloads." Amen, Paul.

HOTHARDWARE'S TAKE ON THREADRIPPER 3990X

Marco Chiappetta of Hothardware.com described Threadripper 3990X as a "beast" (go.pcworld.com/hthd) though with the same "under the right conditions" qualifier as other reviews.

Chiappetta continues: "The AMD Ryzen Threadripper 3990X isn't perfect and it's meant to appease a specific sub-set of users, obviously. Even still, we must commend AMD for continually and aggressively pushing the

envelope since the introduction of its first-gen Ryzen architecture. AMD's efforts that [sic] last few years have re-shaped the enthusiast computing landscape and injected some real excitement. If AMD continues on this trajectory with Zen 3 and beyond, we can't wait to see what the company has in store for us all next year."

PUGET SYSTEMS ON THREADRIPPER 3990X FOR PREMIERE

It wasn't just YouTubers and hardware sites who got first dibs on Threadripper 3990X. PC workstation maker Puget Systems put the new chip through its Adobe Premiere CC benchmark (go.pcworld.com/psys) and answers the singular question of "Is the AMD Threadripper 3990X good for Premiere Pro?"

The answer isn't likely to shock anyone: No.

"While there may be some niche uses for the AMD Threadripper 3990X 64 Core within the greater video editing industry, the 3990X is underwhelming for Premiere Pro. It is certainly no slouch, but only performs roughly on par with the Threadripper 3960X 24 Core for both live playback and exporting," Puget's Matt Bach writes.

TWEAKTOWN SAYS YOU'LL WANT A BIG PSU FOR THREADRIPPER 3990X

Many reviewers looked at power consumption of the new chip, but Steven



Tweaktown said the Threadripper 3990X consumes up to 800 watts and more by flipping on PBOC and XMP profiles.

Bassiri of TweakTown.com (go.pcworld.com/twkt) might have had the most fun, noting:

"The Ryzen Threadripper 3990X eats up power, but not nearly as much as we expected, at least at stock. We saw total system power go to around 370W, with the CPU pulling about 300W. We noticed that AMD achieved this by greatly reducing the core voltage, so we were pulling a bit over 300A at less than 1v. HOWEVER, look below to see what happens when we enable PBOC; hint, the system power went over 1000W."

Bassiri said he believes Threadripper 3990X itself was likely consuming about 800 watts.

Yup. Throw in a GeForce RTX 2080 Ti and custom liquid cooling, and the days of a 1,500-watt PSU just might be back.

LINUS TECH TIPS RUNS CRYISIS ON THREADRIPPER 3990X

But can it run Crysis?! Glad you asked. Besides showing the chip easily ripping through rendering tests, Linus Sebastian of Linus Tech Tips shows the CPU is actually capable of running Crysis (go.pcworld.com/Inst). And no, we don't mean running Crysis on a GPU in the system with Threadripper 3990X, we mean, actually running Crysis rendered in software mode ON THE CPU. It's an amazing feat worth watching.

Sebastian does point out the odd position AMD occupies at the moment. Yes, Threadripper 3990X eats Xeon for breakfast in compute, but he notes that AMD is now at the point where it has put artificial limitations on the 3990X so as not to compete with its own Epyc server chips, which support much higher RAM capacities than Threadripper does. In Sebastian's eyes, the new chip is a "\$4,000 deadend" due to its "low" memory limit of

256GB. That's a mere quarter of what Intel's Xeon W-3175X can take, he points out.

PHORONIX: WHAT ABOUT LINUX ON THREADRIPPER 3990X?

We'll close off our review roundup by satiating Linux fans, who are all screaming, "It's Windows' fault!"

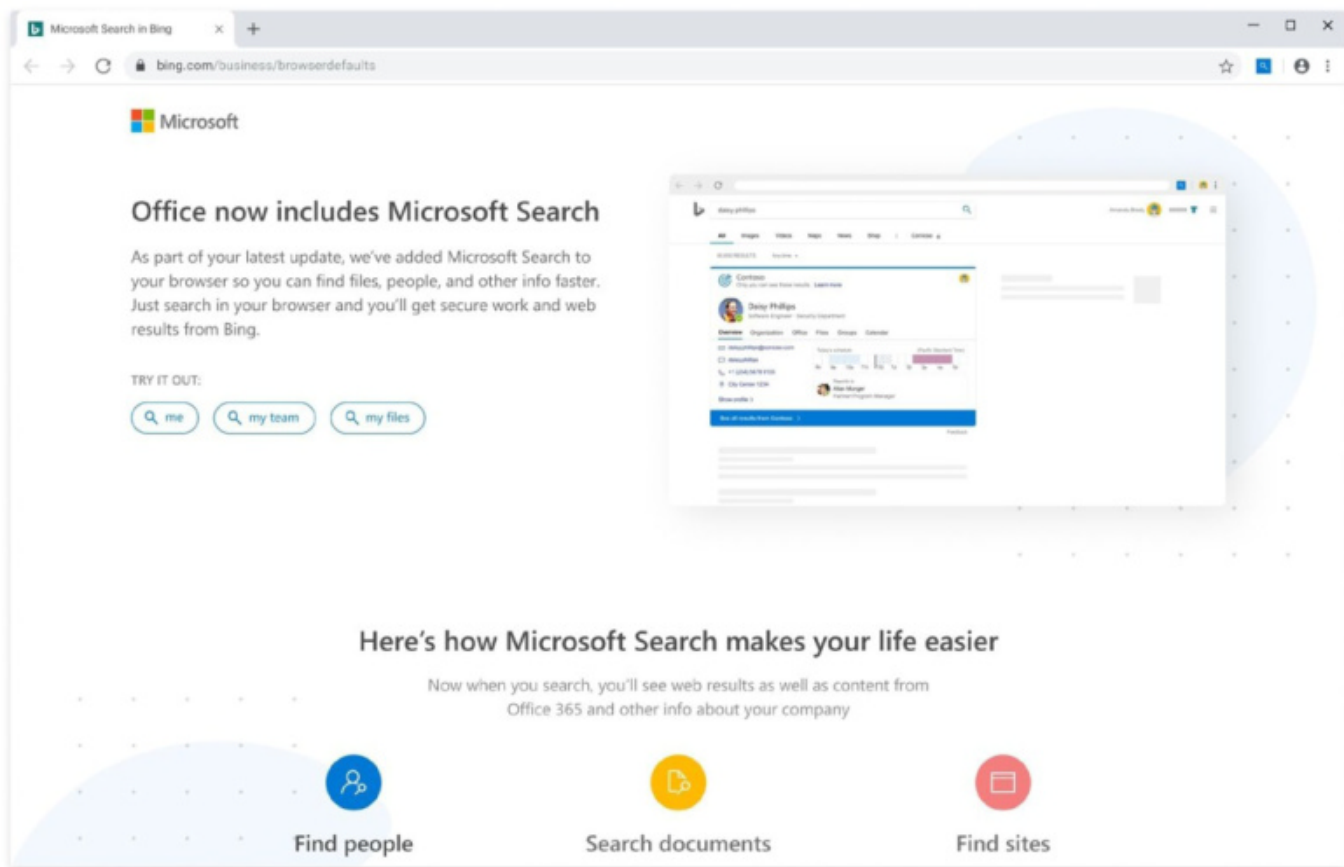
Phoronix's Michael Larabel (go.pcworld.com/phrn) writes that the "AMD Ryzen Threadripper 3990X Offers Incredible Linux Performance."

Larabel continued: "When taking the geometric mean of the benchmarks for this article today, The Threadripper 3990X came out overall 26% faster than the dual Xeon Platinum 8280, which is a very nice accomplishment since such a configuration currently retails for \$20,000 USD worth of processors alone. For those doing serious content creation work like Blender or other CPU-based renderers/

modeling, engaging in heavy multi-threaded workloads that aren't memory intensive (where instead you'd be better off with the EPYC 7002 CPUs with eight-channel memory), or code compilation of large software projects, the AMD Ryzen Threadripper 3990X is a mighty impressive competitor." 



Can it run Crysis?! Yes, in fact Linus Tech Tips used the 64-core Threadripper 3990X to do just that. And no, not on the GPU: The game ran rendered in software on Threadripper.



Microsoft walks back plans to switch Chrome search to Bing for Office 365 customers

Microsoft may think it's helping, but really, what gives them the right? **BY MARK HACHMAN**

In what seems like a broad case of overreaching, an upcoming version of Microsoft's Office 365 for enterprises will automatically switch Google Chrome's search engine to Bing. And Firefox is next on the list.

Yes, Google Chrome. Yes, Bing. Microsoft says it's doing so to enable Microsoft Search (go.pcworld.com/mssr), which essentially

evolves the Bing search engine into a way to delve through your corporate files and other information. But still, altering another company's search engine to do so? (We reached out to Google for comment, but the company hadn't responded by press time.)

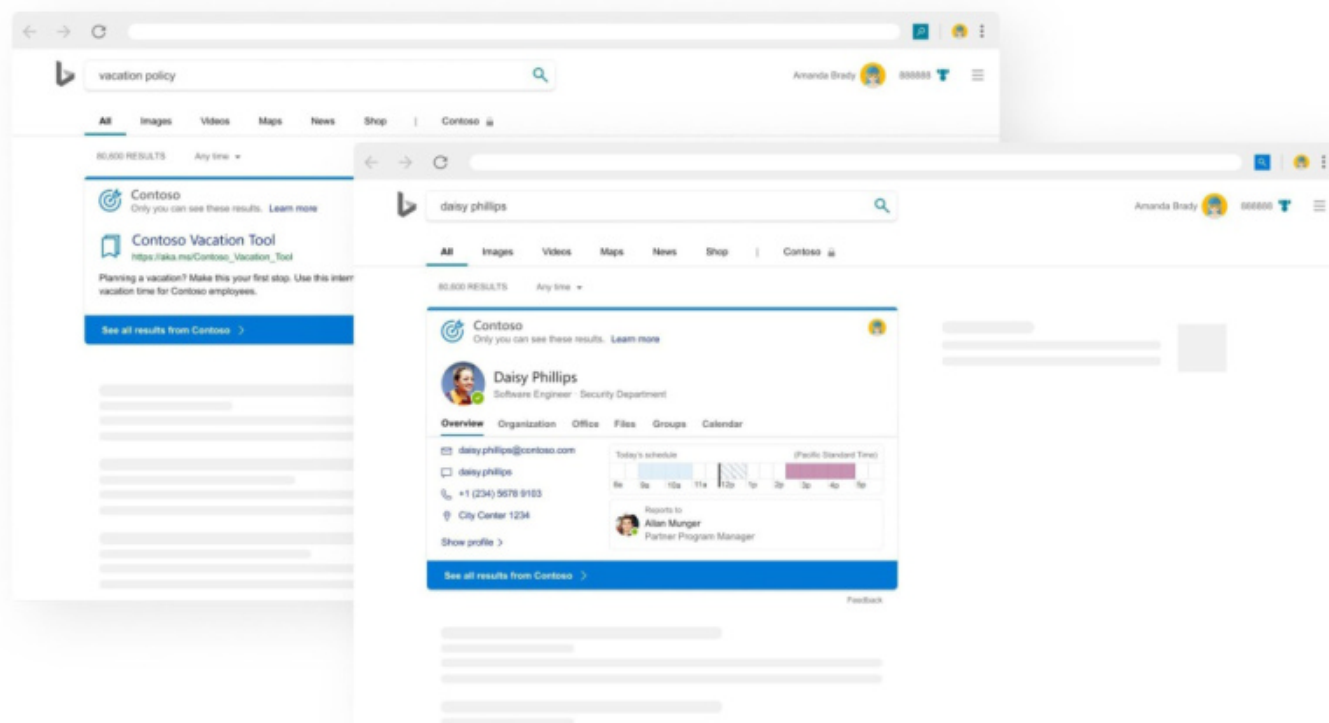
Microsoft laid out its plans in a support document (go.pcworld.com/mpln) that

surfaced recently, in part due to a report by Thurrott.com (go.pcworld.com/thur). Specifically, the change will be made to Office 365 ProPlus, a version of Office specific to enterprises. The change will be deployed as early as February for “targeted” users who receive monthly channel updates, and at a later date for others. Users in the United States and the United Kingdom will be affected, as well as those in some other regions, Microsoft said.

Microsoft refers to the changes made to Chrome as an extension: specifically, adding the Microsoft Search in Bing extension to Office 365 Pro Plus. Here’s how Microsoft explains what it is and what it does: “Microsoft Search in Bing provides a familiar

web interface to help your users find workplace information more easily, including files and documents, internal sites and business tools, people and org charts, building information, and other relevant information from within your organization,” it says. “Microsoft Search accesses files, SharePoint sites, OneDrive content, Teams and Yammer conversations, and other shared data sources in your organization, as well as the internet.”

What’s not exactly clear is how Microsoft can sink its hooks into Chrome to do this. The Twitter security handle SwiftonSecurity noted (go.pcworld.com/swsc) that it actually violates Windows Defender’s prohibition against installing software without your



An example of what users would see searching with Microsoft Search using Google Chrome.

consent. The support document also makes the greater intent clear: Microsoft's adding the tweaks to Chrome first, but "support for the Firefox web browser is planned for a later date," it says.

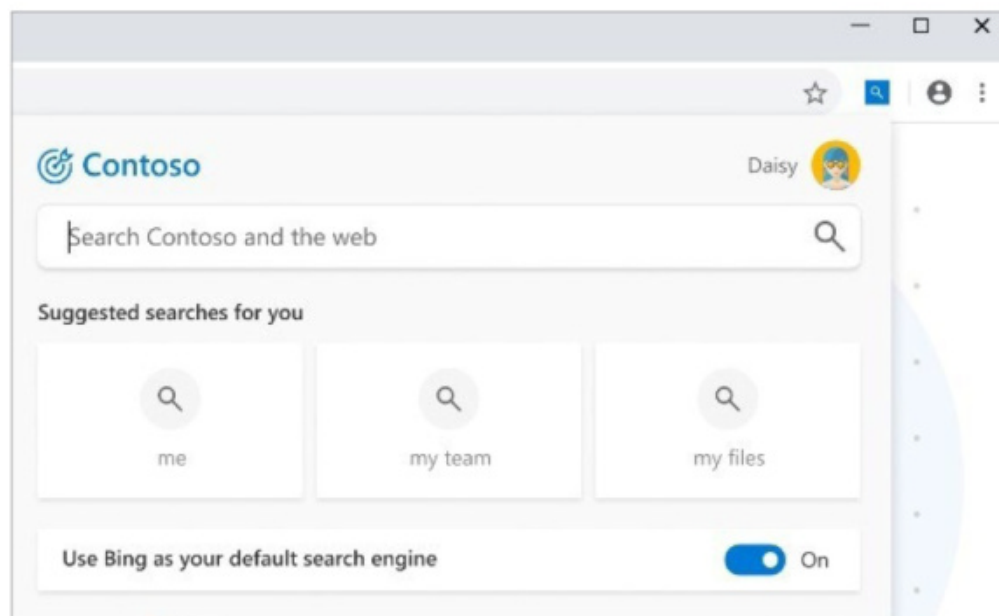
HOW TO BLOCK MICROSOFT FROM CHANGING CHROME'S SEARCH ENGINE IN OFFICE 365

IT admins who don't want the extension installed have a way around it. Enterprises can use either the Office Deployment Tool or Group Policy to prevent it, but it has to be done before the extension itself is installed. If an admin waits too long, they'll have to run a command (go.pcworld.com/rncm) to remove it.

Fortunately, it sounds like individual users will have the option of disabling Microsoft Search as well—though it's not

clear whether admins can lock this down. To disable Microsoft Search and restore Google as your search engine, users should be able to click the magnifying glass search icon next to the address bar in Chrome, and then toggle off the Use Bing As Your Default Search Engine selection.

Unfortunately, Microsoft's efforts to "help" users with Microsoft Search could easily be seen as just another example of the company's heavy-handed approaches to, say, upgrading users to Windows 10 (go.pcworld.com/nw10). The next natural question to ask is: Could Microsoft do this to consumers, too? Here's something to think about: In the new, Chromium-based Edge, Microsoft hasn't touched Chrome's choice of search engine. But it has buried Edge's search-engine options (go.pcworld.com/bury) in a deep level where they're difficult to find, and made Bing the default. 



Users can click the magnifying glass search icon to switch out of Microsoft Bing.

How 'Warcraft III' became a great 'Lord of the Rings' game

It doesn't get discussed as much as 'Defense of the Ancients,' but 'Warcraft III' had a surprising symbiosis with 'The Lord of the Rings'—one that's worth revisiting. **BY HAYDEN DINGMAN**



Warcraft III: Reforged has been released. We may never get a Warcraft IV, but at least III and its expansion *The Frozen Throne* are finally getting some love: A refined user interface, more detailed units and buildings, native 4K support, and so on. It's been a while since I've played either campaign, and I'm looking forward to revisiting it. Arthas's downfall is still one of Blizzard's best story lines, and I'm excited to see it fully redone.

Blizzard's authored story is the smallest portion of my love for *Warcraft III* though. I played it for years, and what kept me coming back is an element that was incredibly important at the time, but rarely discussed now: *Warcraft III* was one of the best *Lord of the Rings* games. Maybe the best.

And it happened by accident.

YOU BOW TO NO ONE

Warcraft III shipped in 2002 with a robust set of mapmaking tools. To younger folks that

might sound weird now. “Mapmaking tools?” But once upon a time it was normal. In the ‘90s and early ‘00s, most multiplayer games shipped with official tools for creating custom maps or scenarios. I imagine a number of today’s developers grew up making maps for *Unreal Tournament*, *Quake*, *Counter-Strike*, *Age of Empires II*, and yes, *Warcraft III*.

People tend to remember *Warcraft III*’s custom scene because of *Defense of the Ancients*, which makes sense. There’s a “student becomes the master” aspect to it, with the fairly rough *Defense of the Ancients* mod eventually spawning two of the biggest games in the world, *Dota 2*, and *League of Legends*.

For me it’s always *Lord of the Rings*, though. Peter Jackson’s *The Fellowship of the*

Ring released in December of 2001, a mere six months before *Warcraft III: The Two Towers* released six months after, in December of 2002. Then you get *Warcraft III: The Frozen Throne* in the summer of 2003, and *The Return of the King* in December 2003.

Both took place in fantasy realms populated by humans, elves, dwarves, and orcs. Better yet, *Warcraft III* introduced “Hero” characters, bigger and more powerful units that gave modders a perfect way to separate rank-and-file armies from named characters like Gimli, Legolas, and Aragorn.

The timing was perfect. You had these enormously popular films, a cultural zeitgeist that raked in awards, completely changed the “acceptable” length of a movie for over a

decade, sold goblets at Burger King, etcetera. Then on the gaming side you had a hit strategy game that drew from the same ur-fantasy source material, primed for custom content. The two became weirdly intertwined.

Not officially, of course. EA made the “real” *Lord of*



Warcraft III: The Frozen Throne.

the *Rings* games, serviceable hack-and-slashes that attempted to capture the scope of the films on PlayStation 2-era hardware—and did an okay job, by 2002 standards.

Warcraft III felt more grandiose though. It had the eye-in-the-sky viewpoint

that only a strategy game could give. The armies were larger, the battles more chaotic and unpredictable.

The Battle of Helm's Deep became a particular favorite, and for good reason. There are so many unique elements. There's the curved bridge leading up to the walls, archers peppering the oncoming orcs with arrows. Behind the door, elven swords arrayed a dozen ranks deep defending a narrow chokepoint. Gimli and Legolas competing for kills.

And of course, the two pivotal moments: The Uruk-hai blasting a hole through the fortress walls and streaming into the courtyard, and then the last-minute rescue by Gandalf and the Rohirrim at dawn.



The Lord of the Rings: The Two Towers.

Those touchstones made Helm's Deep a perfect fit for modders. They gave the conflict a structure: An asymmetrical hold-out mission, with a fixed number of defenders fighting back an unlimited orc army. The battle evolved—first a fortress siege, then a chaotic scrum after the walls are breached, and then a desperate final stand in the keep itself. A timer counted down the minutes to Gandalf's arrival, forcing the orcs to play aggressively and giving the defenders some small measure of hope.

It felt...well, maybe not real, but cinematic. Dynamic, in a way that most *Warcraft III* maps were not. Modders competed, creating ever-larger and more sophisticated simulations of the battle. I

must've played dozens of different iterations back in the day. Hell, I think I even tried to create one.

There were other *Lord of the Rings* maps as well, though none quite as successful as Helm's Deep. The Mines of Moria had a few different adaptations, wending through Balin's tomb and down all those rickety staircases and across the bridge where Gandalf faced off against the Balrog. Again, instantly recognizable locations—though it tended to be better for solo play than the big multiplayer battles.

With the release of the *Return of the King*, the Battle of the Pelennor Fields also became popular. This one was harder to simulate than Helm's Deep though, as Minas Tirith's

seven-tiered city didn't translate well to *Warcraft III*'s landscape tools and overhead camera, nor were there as many hooks for scripting.

Many of the late-era maps opted to cover the entirety of Middle Earth instead. These went by various names, including "The Ring Wars," "War of the Ring," and "The Third Age," but essentially you'd play a standard RTS battle out across a scale map of Middle Earth. One person would play Gondor, one Rohan, one Mordor, and so on.

It was the closest you could get to a full retelling of *Lord of the Rings* in *Warcraft III*, but again lacked the storytelling and the immediacy of Helm's Deep. It was more like playing *Risk*, less like watching the films.

So maybe it's just that *Warcraft III* was a great Helm's Deep game, and only a passable *Lord of the Rings* game. Still, I find it fascinating. You have this perfect right-place-right-time crossover, and it happened naturally. These days, something like *Fortnite*'s recent *Star Wars* event is a co-marketing deal



The Lord of the Rings: The Return of the King.



Warcraft III: Reforged.

months in the making. It's two corporations coming together to sell more of their respective products.

Warcraft III became a *Lord of the Rings* vehicle out of happenstance though. Blizzard released a popular (and modular) fantasy game just as Peter Jackson turned fantasy into a box office juggernaut. Then bystanders said "Wouldn't these be great together?"

And they were.

BOTTOM LINE

As I prepare to dip into *Warcraft III: Reforged*, I find myself hoping I can find a few people playing Helm's Deep again. I'm sure it won't live up to my memories, because it can't. Even the films don't entirely hold up for me,

almost twenty years later. A bunch of *Warcraft III* maps built with 2002's finest map-making tools probably won't cut it.

I can't imagine *Warcraft III* without *Lord of the Rings*, though. It wouldn't have been the same game, for me and (I imagine) so many others. And sure, I could say the same of *Dota* and tower defense—but those already get plenty of credit when people discuss *Warcraft III*'s legacy. The *Lord of the Rings*? Not so much. It was very much of that time and place, two of 2002's brightest stars overlapping by mere coincidence and then largely forgotten after pop culture moved on, the only record being the dozens of Helm's Deep maps that come up when you search for "Lord of the Rings Warcraft III" on Google. 🔌



Activision Blizzard just pulled its games from Nvidia's GeForce Now, and that sucks

Game over man, game over. **BY BRAD CHACOS**

Nvidia and Activision Blizzard seem like close partners. *Call of Duty: Modern Warfare* is one of the biggest games to take advantage of the real-time ray-tracing capabilities in modern GeForce graphics cards, and games like *Overwatch* have graced Nvidia's GeForce Now for most of the gaming-from-the-cloud service's multi-year

beta. But a mere week after GeForce Now fully launched and obliterated Google Stadia's value proposition (go.pcworld.com/gnow), Activision Blizzard's games are being yanked from the service at the publisher's request, effective immediately.

No more playing *Overwatch* on your crappy old laptop. No more *Diablo III* on your phone. No more playing the latest *World of Warcraft*

raid boss in way better fidelity than your potato PC can normally handle. No more real-time ray tracing from the cloud in *Modern Warfare*.

Nvidia announced its removal with the following statement (go.pcworld.com/nvst):

"As we take GeForce NOW to the next step in its evolution, we've worked with publishers to onboard a robust catalog of your PC games. This means continually adding new games, and on occasion, having to remove games—similar to other digital service providers.

"Per their request, please be advised Activision Blizzard games will be removed from the service. While unfortunate, we hope to work together with Activision Blizzard to reenable these games and more in the future.

"In addition to the hundreds of games currently supported, we have over 1,500 games that developers have asked to be on-boarded to the service. Look for weekly updates as to new games we are adding."

On the plus side, since Bungie recently broke away from Activision Blizzard, you'll still be able to play *Destiny 2* on GeForce Now. The game is central to Google Stadia's \$10 per month Pro subscription, but you can play it for no cost whatsoever on GeForce Now, as the base game's free-to-play and Nvidia offers a totally free-as-in-beer-free tier (go.pcworld.com/frbr).

Still, Activision Blizzard's withdrawal is a major, major bummer. Sure, GeForce Now still offers vastly more games than Stadia and other cloud-based challengers, but Blizzard's *Warcraft*, *Diablo*, *StarCraft*, and *Hearthstone*

are some of the most-played and most-loved franchises in PC history. *Call of Duty*, meanwhile, tops sales charts year-in and year-out, and *Modern Warfare*'s removal means you won't be able to try out its ray tracing with your fancy GeForce Now Founders subscription. This hurts.

We spoke at length about GeForce Now and why it rocks on a recent episode of our Full Nerd podcast (go.pcworld.com/p124), and its value proposition isn't limited to gamers alone. Nvidia's service doesn't sell you games directly. Instead, it basically rents you a gaming PC in the cloud, and you sign into gaming platforms like Steam, the Epic Game Store, and (formerly) Battle.net to play games you already own. Nvidia doesn't take an extra cut. By giving you access to more powerful hardware than you might already own, GeForce Now effectively encourages you to buy more games through existing storefronts. It feels like a win-win for everybody involved.

In his hands-on with the service, my *Macworld* colleague Leif Johnson (go.pcworld.com/gnr) stated that GeForce Now is probably as good as Mac gaming is ever going to get.

"Blizzard, which famously used to simultaneously release PC and Mac games at once, has yet to release a Mac port of *Overwatch* five years after its release," he wrote. "...Nor is there any reason to pour around \$1,000 into an external GPU and graphics card (go.pcworld.com/gpue) just so



Nvidia's GeForce Now lets you play PC games across a wide variety of devices.

you can play something as graphically uncomplicated as *World of Warcraft* on your MacBook with the settings at maximum.”

Fortunately, GeForce Now remains an outstanding value proposition. While Stadia is limited to a couple dozen titles that won't work on any other platforms, Nvidia's service still supports nearly 400 games, with new titles added every week. You can also install another 1,000 or so “single-session” games through Steam, which haven't been officially optimized for the service yet, but can still be played on-demand, with Steam cloud saves tracking your progress. Since Activision Blizzard's biggest titles live in the company's own Battle.net client, don't expect that to work as a side-door here.

Fingers crossed that Activision Blizzard and other holdout publishers like EA decide to play nice with GeForce Now—and again, Nvidia's service only lets you play games you

already own and paid for on other platforms. It's not an all-you-can-eat-buffet subscription like Netflix or Hulu. Activision isn't losing out even if the company decides to start its own rival cloud gaming service. GeForce Now is more like playing a game you already own on another PC, just one in the cloud. If you're as bummed about this decision as we are, your best course of action is reaching out directly to Activision Blizzard's support (go.pcworld.com/blzd) and letting them know it, especially if the decision prevents you from playing games you've purchased.

In the meantime, if you need to level up your hardware to be able to play Activision Blizzard games you used to play over GeForce Now, be sure to check out our guide to the best graphics cards for PC gaming (go.pcworld.com/grcr). Local games aren't disappearing anytime soon, as this headache proves. 

Discover the unsearchable



Discover the forest

Find a trail near you at
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1 in 7 children faces hunger.

There's more than enough food in America for every child who struggles with hunger. Help get kids the food they need by supporting Feeding America, the nationwide network of food banks. Together, we can solve hunger™. Join us at **FeedingAmerica.org**



Microsoft Surface Pro 7: Still the best Windows tablet you can buy

For now, Microsoft owns the Windows tablet category. **BY MARK HACHMAN**



Microsoft's Surface Pro 7, the latest in the company's excellent Surface Pro series, continues the tradition of

being a durable, dependable tablet for the ages. It's measurably better this time around, too, with an internal upgrade to Intel's 10th-gen, 10nm Ice Lake chip and a nod to the future, a USB-C port. There are many good reasons why the Surface Pro 7 won our Editor's Choice award, as you'll see in our review.

Granted, it's a lot easier to be the best game in town when rival Windows tablets are

few and far between. At this point, the field consists largely of Microsoft's Surface Pro models, the Surface Pro X (go.pcworld.com/msfx), Lenovo's ThinkPad X1 Tablet (go.pcworld.com/x1ta), monstrous tablet workstations like the HP Zbook X2 (go.pcworld.com/zbx2), and our longstanding favorite, the Lenovo IdeaPad Miix 520 (go.pcworld.com/miix). There's a definite gap between these and \$300-ish Atom-powered tablets from names like RCA and iView, which we wouldn't necessarily recommend. If you're looking for a full-fledged computer that's extremely portable and can even work as a

tablet, the Surface Pro 7 is your best choice.

BASIC SPECS

The Surface Pro 7 is a full-fledged PC made superportable. You won't get discrete graphics, but you will get CPU choices up to a Core i7, and generous RAM and storage options. Here are the full specs:

Display: 12.3-inch PixelSense display (2736x1824)

Processor: Intel Core i3-1005G1, Core i5-1035G4, Core i7-1065G7 (as tested)

Graphics: Iris Plus 940

Memory: 4GB, 8GB, 16GB LPDDR4x

(as tested)

Storage: 128GB, 256GB (as tested), 512GB, 1TB SSD

Ports: 1 USB Type C, 1 USB Type A, MicroSDXC reader, Surface Connect, 3.5mm audio jack

Camera: 5MP front-facing, 8MP rear-facing, w/1080p video

Battery: 43.2Wh (reported)

Wireless: WiFi 6 (802.11ax), Bluetooth 5

Operating system: Windows 10 Home, version 1909

Dimensions (inches): 11.5 x 7.9 x 0.33 inches (8.5mm)



Microsoft's Surface Pro 7 virtually requires a Type Cover of some sort, transforming it into a lightweight laptop.

Yes, the Microsoft Surface Pro 7 is indeed a tablet.



Weight: 1.74 pounds, 2.42 pounds with Signature Type Cover, 3.04 pounds total with charger

Colors: Platinum, Black

Price: \$1,399 MSRP as tested, \$1,199 at Microsoft (go.pcworld.com/amp7); prices range from \$675 to \$2,099

Optional accessories: Surface Pro Signature Type Cover (\$160 on Amazon [go.pcworld.com/sgcv]), Surface Pen (\$100 on microsoft.com [go.pcworld.com/mspn]).

The Microsoft Surface Pro 7 offers the same tablet experience as in years past: Prop it up with its iconic kickstand, connect the “optional” Surface Signature Keyboard (that you’ll want unless you’re seriously tablet-centric), and get to work. A Surface Pen, as always, is optional. Though it’s among the most portable of Microsoft’s Surface offerings, the tablet isn’t quite the mobile-forward design that you might have hoped—that’s left

to the Surface Pro X (\$900 on Amazon [go.pcworld.com/msfx]), though that tablet ships with its own set of issues.

Our Surface Pro 7 test unit shares an Intel Core Ice Lake processor with the Surface Laptop 3 (for Business [go.pcworld.com/3bus]), a substantial improvement in processing power from the prior generation. Traditionally, this has been what’s separated one Surface Pro from its predecessor.

Versus a modern laptop or Android tablet, the Surface Pro 7’s bezels are relatively ginormous: about a half-inch along the left and right bezel of the device, and slightly less along the top and bottom. They’re a necessary evil for enjoying the Surface Pro 7 as an actual tablet, and holding it by its edges. Still, the large, chunky bezels give it a rather dated look.

The built-in, glossy 2736x1824 display remains unchanged from previous models,

slightly less than the true 3000x2000 resolution of, say, the Lenovo ThinkPad X1 Tablet (3rd Gen; go.pcworld.com/x1ta). Microsoft hasn't moved to OLED technology yet, unfortunately. The 396 nits of brightness that the display puts out is in line with that of previous Surface tablets, and not too far out of line with rival notebooks and tablets. It's still not bright enough for working in full sunlight, though, especially as the glossy display is very reflective. Inside my somewhat dim basement office, though, the Surface Pro 7 was a pleasure to work upon.

By the way, while Microsoft claims that users may be able to open the Surface Laptop 3 and upgrade the SSD (go.pcworld.com/Open), the Surface Pro 7 is decidedly sealed (go.pcworld.com/seal).

A SOLID KEYBOARD AND TYPING EXPERIENCE

As always, if you do buy the Surface Pro 7, be sure and budget for a Surface Pro Signature Type Cover, \$160 from Microsoft (go.pcworld.com/prsg). (We've also seen discounted prices from Amazon [go.pcworld.com/cvsg].) Unofficially, you have cheaper alternatives: If you can track down the Surface Type Cover for the Surface Pro 3 (with a pen loop!) or the \$50 Surface 3 Type Cover (go.pcworld.com/3tcv), they'd both work—I attached each in turn to the Surface Pro 7 and

wrote a couple of paragraphs in this review. They rattle a bit, and the layout is slightly different compared to the more modern Signature Type Covers that begin with the Surface Pro 4. But they cost a lot less.

The older Type Covers feature larger keys, though with less key travel and resistance. In some ways, I prefer the



After a decade or so, the Surface Pro's kickstand might be taken for granted. Don't—it's still a key part of the Surface Pro 7's value. The power button and volume rocker are on the top of the tablet.



Microsoft's Surface Signature keyboards provide a comfortable typing experience.

older Type Covers, as there's a happy medium between the need to depress the keys and the desire to glide over them quickly. Over succeeding generations, the Type Cover's individual keys have shrunk, giving more room to the trackpad. Like any keyboard, however, the feel is subject to individual interpretation.

The Type Cover also protects the Surface Pro's display. The more modern Type Covers feel a bit stiffer and more sturdy, suggesting they might shelter the screen even more. They also offer three levels of backlighting, or no lighting at all.

We were sent the Charcoal Signature Type

Cover to accompany the Surface Pro 7. Other color options include Poppy Red and Ice Blue. All three are coated in the soft, yet durable Alcantara fabric, which seems a bit less furry than in generations past.

As you might expect, the Type Cover includes a Microsoft Precision Touchpad, which easily processes taps and other gestures. It's clickable over its entire surface, though it requires a bit more effort near the top.

At this point, Microsoft has done a surprisingly good job of nailing the inking experience. You'll have to buy a Surface Pen, sure. But setup is a breeze, with a quick walk-through via the Surface app. A click of the rubber eraser and the Surface Pro 7 launches the Whiteboard



The long magnetic strip at the top of the keyboard feels a bit weaker than usual in this current version of the Signature Type Cover.

app—not my first choice for drawing, but a real pleasure to use nevertheless. Digital ink flows smoothly as the Pen glides over the display, and the pen connects magnetically to the side of the tablet.

Note that the Camera app turns on the user-facing camera by default—perhaps assuming you live within Skype. The rear-facing camera offers normal and panorama photography, plus document-scanning and whiteboarding options. Virtually everything on the Surface Pro 7 is about productivity.

PORTS: USB-C, BUT NO THUNDERBOLT YET

If you've owned a previous Surface, you'll be happy to know that the Surface Connector remains the same, allowing you to use an old Surface charger with the new model. The same goes for the Surface Dock, which Microsoft has never updated.

What is new about the Surface Pro 7 is the addition of the USB-C port—and the removal of miniDisplayPort. In all, this is a net positive for the Surface Pro lineup, given the wide and varied range of USB-C hubs to compensate for a single, dedicated port. Tablets like Lenovo's ThinkPad X1 tablet have previously offered more flexible port options, and it's nice to see Microsoft's prosumer tablet line catch up. The Surface Pro X offers a pair of USB-C ports, however, compared to the Surface Pro 7's single port.

Some rivals go beyond this to offer a Thunderbolt-enabled USB-C port, which allows more bandwidth for connecting to secondary monitors and the like. In the Surface Pro 7's case, its USB-C port (specifically USB 3.1 Gen 2, at 10GBps, using DisplayPort 1.4) will accommodate a pair of external 4K displays at 60Hz. The Surface Pro X's capabilities slightly outshine the Surface Pro 7's: It can connect up to two 4096x2304 displays using its pair of USB-C ports.

The Surface Pro 7's USB-C port can also



Microsoft removed the miniDisplayPort connector and replaced it with a USB-C port. The Surface Connector for the Surface Dock remains.



On the other side of the tablet is a lonely 3.5mm headphone jack.

be used to charge the tablet, which offers additional flexibility. Like the Surface Laptop 3, the included charger offers quick-charge capabilities, too.

We've beat this drum before, but we'll sound it again: If the Surface Pro series had Thunderbolt as well as the Surface Connector, you'd have two high-speed I/O interfaces. You can still connect to the Surface Dock. But there seems to be a missed opportunity here.

Don't forget about the microSD card slot under the kickstand, as in previous models. Sure, Microsoft would like you to upload your smartphone photos directly to the cloud. But as long as point-and-shoot cameras exist, schlepping the microSD card from the camera to the phone remains an easy way to upload your photos. Most USB-C hubs already

include a microSD slot, however.

So far, Microsoft hasn't announced an SP7 with an integrated or external SIM. For that, you'll want the Surface Pro X.

UNEXPECTEDLY NICE AUDIO

Microsoft has usually designed its tablets with audio in mind. Microsoft's Surface Pro 7 offers a wide, balanced range of highs and lows, though you'll still miss some of the deeper bass notes.

The Surface Pro 7 includes Dolby Audio within the Realtek Audio Console app, and the sound enhancement is on by default. Though the app doesn't provide any equalizer functions, the default configuration sounds suitably balanced for

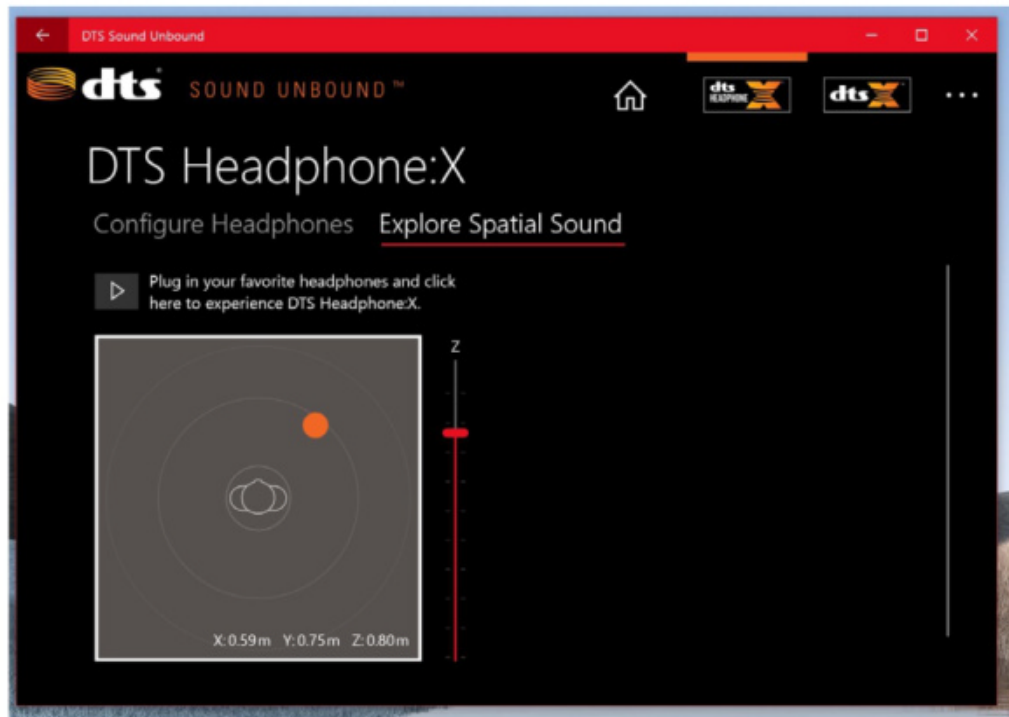
you to enjoy audio over the tablet's speakers—still a rare luxury in today's laptops.

DTS Sound Unbound is a surprise, a paid app that's bundled with the tablet. It asks you to pay a whopping \$15 to unlock surround sound from both your speakers and headphones, similar to what THX offers for free with

Walmart's Motile laptop (go.pcworld.com/motl). To my ears, the DTS solution sounded much better than what THX offered, and the positional audio was the best I can recall since Aural Semiconductor's HRTF positional audio demo two decades ago.

PERFORMANCE: TOP OF THE TABLETS

It would be nice to wave away some of the Surface Pro 7's performance requirements, in an argument that a simple tablet deserves some concessions. That argument holds more water with the Surface Go (go.pcworld.com/sfgo), hovering around \$500. Because there's a strong chance that our \$1,200 Surface Pro 7 will replace a notebook PC as a



If you buy a Surface Pro 7, check out the free 15-day trial of the DTS Sound Unbound app. The positional demo is unreasonably fun.

primary device, however, we can't use the same criteria.

We also can't directly compare the Surface Pro 7 to Microsoft's recent Surface Pro X in all but a small handful of benchmarks. In large part, that's because the two devices use different microprocessors: The Surface Pro 7 uses Intel's mobile Ice Lake chip, while the Surface Pro X uses a custom chip based on Qualcomm's Snapdragon architecture. The latter can't run most benchmarks that we use to test Windows laptops and desktops, but you'll see it in a few where they intersect.

Given the somewhat limited comparison set, we've also included the Ice Lake-based Surface Laptop 3 for Business. This laptop

and its tablet cousin actually bear a close resemblance on paper—they share the same exact processor and GPU, clocked identically. As you’ll see from the CPU-specific Cinebench test below, the CPU performance of both the Surface Pro 7 and the Surface Laptop 3 are close.

Our daily experiences with the Surface Pro 7—everyday Office use, web browsing, and the like—were more than acceptable. The Surface Pro 7 also offers “instant on” capabilities, waking almost instantly with a combination of the Windows Hello-enabled camera and a fast internal SSD.

Our first test is the older PCMark Creative

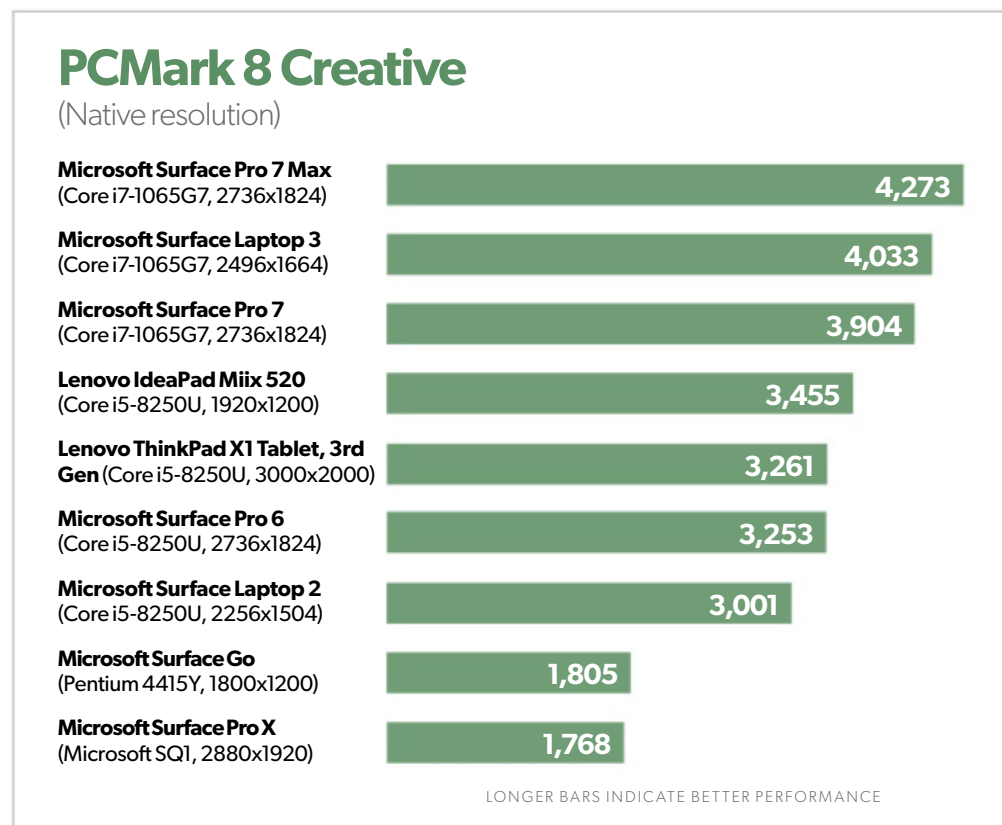
benchmark, used in part because we could pull results from a couple years’ worth of tablets. It measures light gaming, photo and video editing, and web browsing. Not surprisingly, the Surface Pro 7 excels.

Note that the default behavior for the Surface Pro 7, like the Surface Laptop 3, is to prolong battery life, sometimes at the expense of performance. That’s a perfectly acceptable choice, but we also tested while maximizing the performance (noted with “Max” in the tables). In some tests, that made a difference. In others, it didn’t.

In terms of pure CPU workloads, we use the Cinebench benchmark, which renders a

CGI scene using the full power of the CPU. The Core i7-1065G7 is a 4-core, 8-thread processor, just like the older chips that power the Lenovo IdeaPad Miix and ThinkPad X1 Tablets. But it’s fabricated at 10nm, giving it a performance advantage over the older 14nm chips.

Our other CPU benchmark is a stress test, a prolonged



Especially when you dial up the performance, Microsoft’s Surface Pro 7 is the fastest tablet around for everyday use, as measured by PCMark 8.

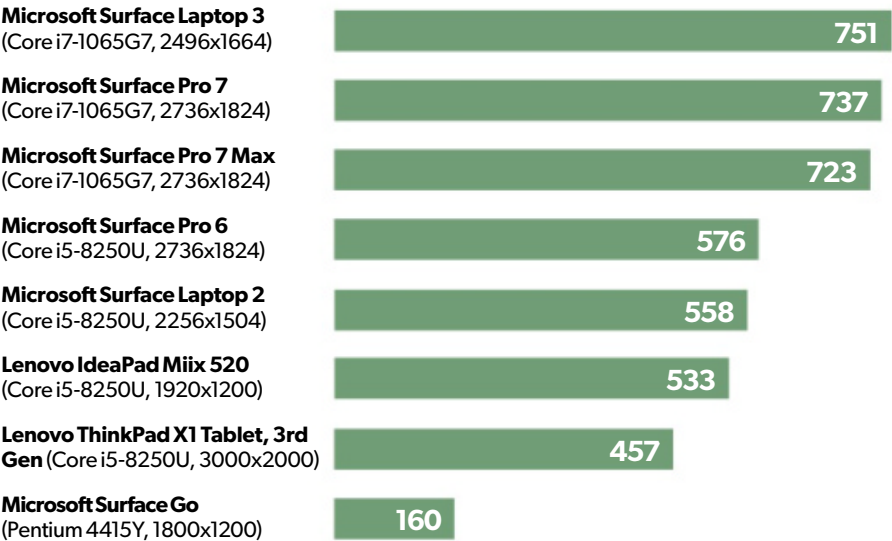
Two identical processors, two nearly identical scores.

transcoding exercise using the open-source HandBrake app. It tests both the CPU’s stamina and the device’s ability to stay cool during a rigorous workload. The Surface Pro 7 delivers decent performance here, but we suspect some slight throttling may be at work.

When it comes to graphics benchmarks, the differences become clear. We saw some rather significant differences in GPU frame rate in our 3DMark Sky Diver test, which developer UL touts as a benchmark for gaming machines.

Cinebench R15.038

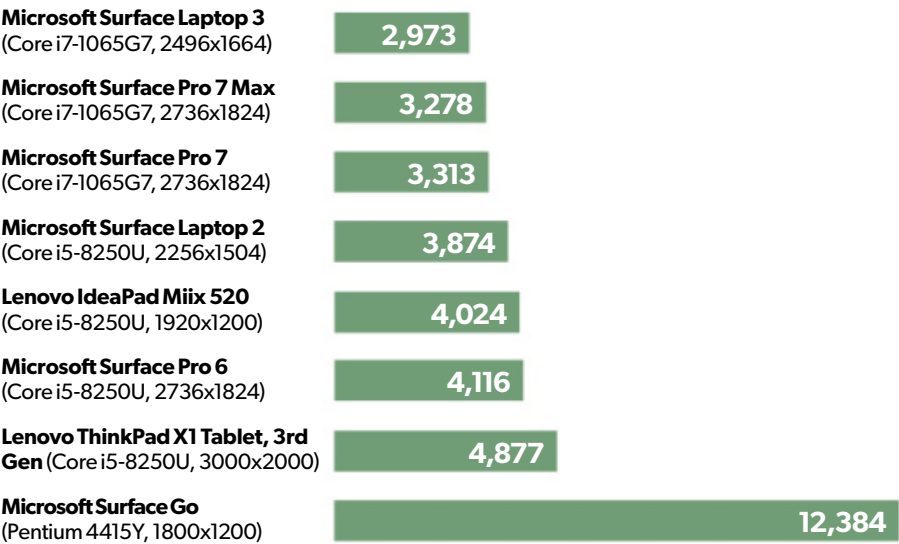
(All threads)



LONGER BARS INDICATE BETTER PERFORMANCE

HandBrake 0.99.0 Encoding (H.264)

(Seconds)

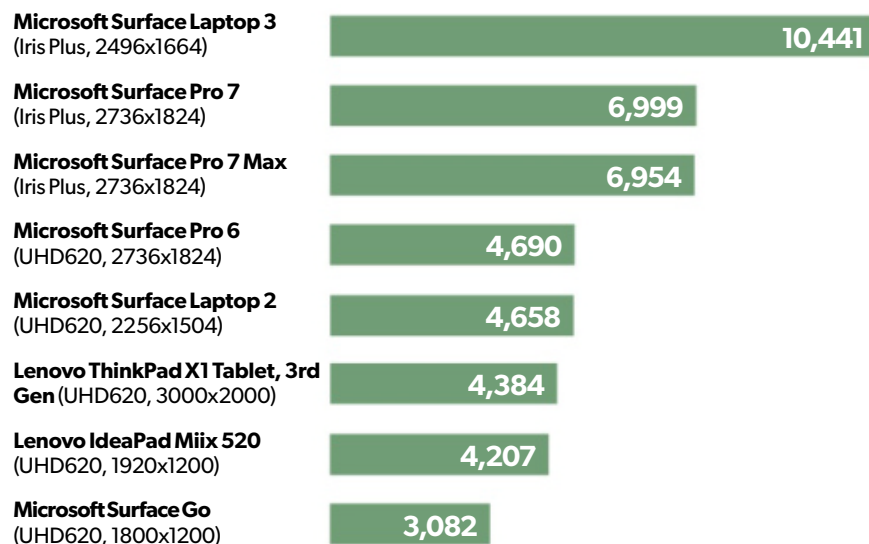


SHORTER BARS INDICATE BETTER PERFORMANCE

The chart is distorted by the agonizingly slow performance of the Microsoft Surface Go, but the Surface Pro 7 is still superior. Better cooling on the Surface Laptop 3 helps its prevail.

3DMark 8 Sky Diver 1.0 Overall

(Demo Mode Off)



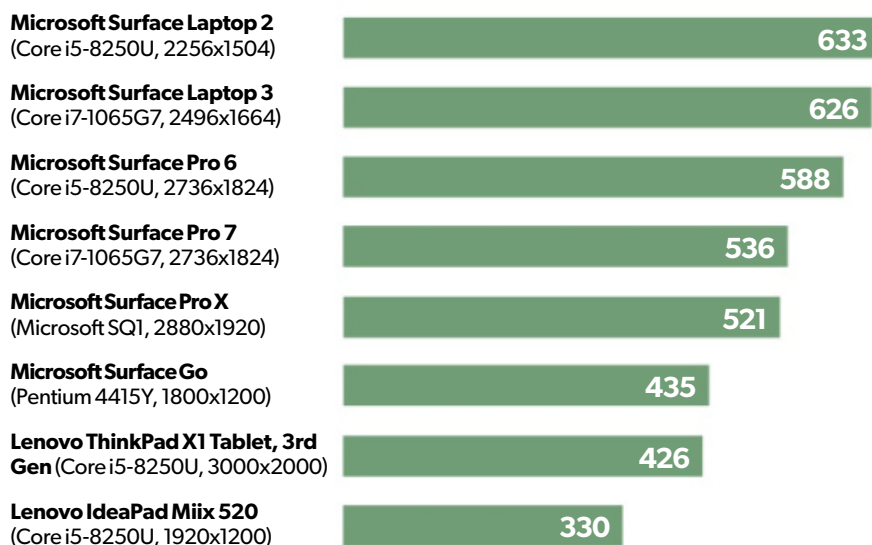
LONGER BARS INDICATE BETTER PERFORMANCE

The Sky Diver benchmark shows sharp differences between the Surface Laptop 3 and the Surface Pro 7, but there is also a pronounced performance improvement on the older tablets.

Though the Surface Laptop 3 for Business and the Surface Pro 7 share a common CPU and GPU platform, the differences in this benchmark are stark. Why? Using Intel's Power Gadget widget, we traced the GPU power and frequency as it ran the benchmark. The Surface Pro 7 seems to throttle the GPU pretty hard in this particular test. Though the SP7's GPU occasionally spikes to a peak speed of 3.7GHz, it tends to run at

Battery Life

(Minutes)



LONGER BARS INDICATE BETTER PERFORMANCE

The Surface Pro 7 delivers about what we'd expect of a prosumer-level tablet's battery: about 9 hours from a 43Wh supply.

prolonged periods at 267MHz. The Surface Laptop 3's typical speed is 283MHz, and with much longer prolonged "spikes" of 3.35GHz to 3.75GHz. This translates to better prolonged graphics performance.

The gist of this result is that quasi-modern games like *Grand Theft Auto V* will play, though you'll have to dial down the resolution to 720p or so and turn off most of the advanced graphics options. The Iris Plus graphics integrated into Intel's Core i7-1065G7 provides decent GPU performance, almost (but not quite) to the point of a low-end discrete GPU.

As noted above, we definitely see some throttling going on within the Ice Lake GPU, resulting in a sharp difference between the Surface Laptop 3 and the Surface Pro 7. Stay focused on the real message, though: The Surface Pro 7 outperforms all other tablets we've tested by a substantial amount.

Finally, we look at battery life. We charge to full and then pull the plug as we loop a 4K video, with volume set to about 50 percent, until the battery dies. At a design capacity of 43.2Wh, it's a tad smaller than the Surface Pro 6's 45Wh battery. (Full charge capacity on the SP7 was 46.4Wh, indicating some variation in the manufacturing.) The older Core i5-8250U can run as low as 10W, while the i7-1065G7 runs as low as 12W. Did that make a difference? Perhaps. In any event, battery life just shy of 9 hours is satisfactory.

BOTTOM LINE

It's no surprise that the Microsoft Surface Pro 7 comes out on top within its limited field of competitors, especially because it's the first Windows tablet we've seen with the Intel Ice Lake platform.

The Surface Pro design retains some advantages. For many, the inclusion of a USB-C and an older USB Type-A port represents an ideal compromise, even if we would have preferred Thunderbolt. The kickstand is overlooked as an absolute necessity for desk work. Even the chunky bezels make the tablet easier to tote from room to room while playing Spotify or Netflix.

Surface pioneered the Windows tablet market and has delivered a quality experience generation after generation in the years since. Nothing has changed in that regard. Right now, the Surface Pro 7 is the best Windows tablet you can buy. 

Microsoft Surface Pro 7



PROS

- Powerful Intel Ice Lake CPU boosts performance.
- USB-C, USB-A ports allow for peripheral flexibility.

CONS

- Lack of Thunderbolt and WWAN option are disappointing.

BOTTOM LINE

Microsoft updates its Surface Pro 7 Windows tablet with a powerful Intel Ice Lake chip and a modern USB-C port.

\$1,499

HP Elite Dragonfly: The corporate laptop that's too good for your boss

It's thin, light, and beautiful, with a battery that won't quit. **BY GORDON MAH UNG**



The HP Elite Dragonfly is a corporate laptop made to please your manager—and isn't that the best way to get

ahead in the working world? With a fingerprint-resistant finish, a beautiful cerulean magnesium body, and shoulder-friendly weight, the Elite Dragonfly is sure to earn you permission to leave 15 minutes early on Friday

(thanks, boss!).

Just remember, the Elite Dragonfly is designed for the boardroom, not the racetrack, so don't expect blazing speed. What you will get is a solid configuration with some premium options; good performance, amazing battery life; and let's not forget the truly classy design. Hmm, maybe this laptop is too good for your boss?



INCREDIBLY LIGHT WEIGHT, INSANE BATTERY LIFE

The Elite Dragonfly's main claim to fame is its weight, which approaches 2.2 pounds when equipped with the base 38-watt-hour battery. The trade-off is that paltry battery capacity. HP also offers a 55-watt-hour battery for additional cost. Personally, we'd opt for the larger battery (supplied in our review unit), which increases the weight by just 3 ounces to 2.5 pounds.

Because your boss is likely to be butter-fingered, the

Elite Dragonfly also has a better chance of hitting the floor—and maybe surviving—as HP said it passes nine MIL-STD drop tests in drop, shock, and vibration.

What's inside still matters, though, and like most corporate premium laptops, the Elite Dragonfly features the top-end, 8th-gen Intel Core i7-8665U. You can view the full details of the Core i7-8665U on Intel's ARK database (go.pcworld.com/akdb), but in performance you get about 200MHz higher clocks in Turbo Boost and 100MHz higher base clocks on paper. Most important is actually the support for Intel's vPro feature, which enables easier management of the laptop in a fleet environment, where 200 or 2,000 have to be accounted for.

The Core i7-8665U also supports Intel's



HP's Elite Dragonfly is a lightweight convertible laptop.

TSX-NI and Stable Platform features. Even though the latter promises better performance for multi-threaded apps, it's supported on very few CPUs despite being introduced four generations ago with the Haswell line.

SPECS AND FEATURES

The Elite Dragonfly embraces its executive-laptop status, delivering a feature list that's first-class all the way. Here are the details:

CPU: 8th-gen quad-core Intel Core i7-8665U with vPro support

GPU: Integrated Intel UHD620

RAM: 16GB LPDDR3/2133 in dual-channel mode

Display: HP offers three screen options for the Dragonfly: A 4K UHD OLED screen that hits 500 nits; a blazing 850-nit Sure View Gen 3 FHD screen that lets you switch on a privacy mode so those to your right and left can't read the screen; and a power-sipping 1 watt FHD screen, which was configured in our review model.

Storage: Our review sample included a 512GB capacity Intel H10 Optane Memory hybrid drive. You can read our review of the

H10 (go.pcworld.com/ih10) for the full details on the drive, but we're generally fans of it.

PORTS

You won't have to worry about your boss barging into your cubicle to steal—borrow—another dongle. The Elite Dragonfly features two Thunderbolt 3 ports, an analog combo jack, a wedge-style lock port, and a USB Type A port. The Elite Dragonfly also somehow manages to pack a full HDMI port into its svelte body. We wish the Thunderbolt ports weren't both on the right side, however, as they could impede mouse usage.

Our review unit featured an Intel 4G XMM7360 CAT 9 modem. That's Intel's older



Despite its relatively thin body, the Elite Dragonfly still features USB Type A and full-size HDMI ports, along with two Thunderbolt 3 ports.



The Elite Dragonfly's left side features a USB Type A port, a power button, a lock port, and a SIM slot.

and slower 4G chip. If you want a CAT 16 modem, HP also offers an XMM7560 upgrade. And yes, if your boss asks, just say it's a "5G modem" anyway.

KEYBOARD AND TRACKPAD

The input devices are top-notch, starting with a full-travel dome keyboard. There are two levels of backlighting (plus, no lighting at all). Keys are generally well placed, but HP does combine many key functions, such as pressing the function key and the right shift button to access the print screen. HP's reason for not having a dedicated print screen button is so it can have dedicated keys to access the calendar as well as several IP-based video

conferencing apps.

One feature we do like is the dedicated mic mute button. It lights up, so no one can say they didn't know they weren't on mute when they bad-mouth the CEO during a videoconference.

Speaking of privacy, HP has also cleverly integrated a physical shutter over the camera. Unfortunately it also blocks the infrared camera, so you can't use the Windows Hello facial recognition when the shutter's active. Luckily there's a fingerprint reader as an alternate authentication method.

The Synaptics trackpad is glass and fairly smooth. The trackpad is compliant with Microsoft's Precision touchpad requirement,



The HP keyboard is a full-travel rubber dome design and features dedicated keys for the calendar, VOIP and muting the microphone.

which is an indication of its accuracy.

OLEOPHOBIC COATING

Here's another fairly unique feature on the Elite Dragonfly: an oleophobic coating to help it repel fingerprints and other greasy marks. We tested it against our typical snack fare, and found it effectively repelled most smudges from fingers that had recently handled corn chips and nacho tortilla chips. However, it was no match for the gold standard of potato chips, which caused our fingers to leave a snail-like trail on the palm rest. The oleophobic coating helps, but don't expect it to work miracles.

SECURITY FEATURES APLENTY

As a corporate laptop, the Elite Dragonfly is hardened against attacks, including those to the BIOS. HP says it can both detect scary UEFI-targeting root kits and recover from them. The Dragonfly also integrates Bromium's security technology (go.pcworld.com/brom) in its Sure Click feature. It basically takes the sandboxing approach of many browsers, but enforces it in hardware.

Set up as a consumer would, the Sure Click would automatically sandbox PDF files in micro-virtual machines. By default, risky attachments are opened in micro-virtual machines using the Chromium browser.

With its hardware-based security, the Elite Dragonfly lets you set up the laptop with

measures ranging from prudent to Draconian. As with all security procedures, the levels of pain are up to the administrator.

CPU PERFORMANCE

The Elite Dragonfly's performance reflects the priorities of corporate laptops, which put security and reliability over raw speed. You can see that odd dynamic right here: The 8th-gen Core i7-8665U in the Elite Dragonfly has a higher clock speed than the common consumer Core i7-8565U CPU. But one look below and you won't see it.

Maxon's 3D rendering Cinebench R15 benchmark, which measures a CPU's multi-threaded performance, shows the Elite Dragonfly under-performing against laptops with slower CPUs.

When we task Cinebench with using a single CPU core, the situation doesn't change much: The Dragonfly is still a little slower than most other laptops. The good news is that in single-threaded tasks—which is the bulk of what's done on small, thin laptops—it's not a big deal at all.

Our harshest test of a CPU uses the free HandBrake utility to encode a 30GB 1080p file. The task typically takes an hour on thin-and-light laptops, and it stresses the cooling capabilities of any laptop. We again see the Elite Dragonfly underperform other laptops.

If you're starting to wonder just why the CPU has a higher boost clock on paper, but is actually slower, the reason is that it's a business

Like most business-class laptops, the Elite Dragonfly doesn't set any performance records.

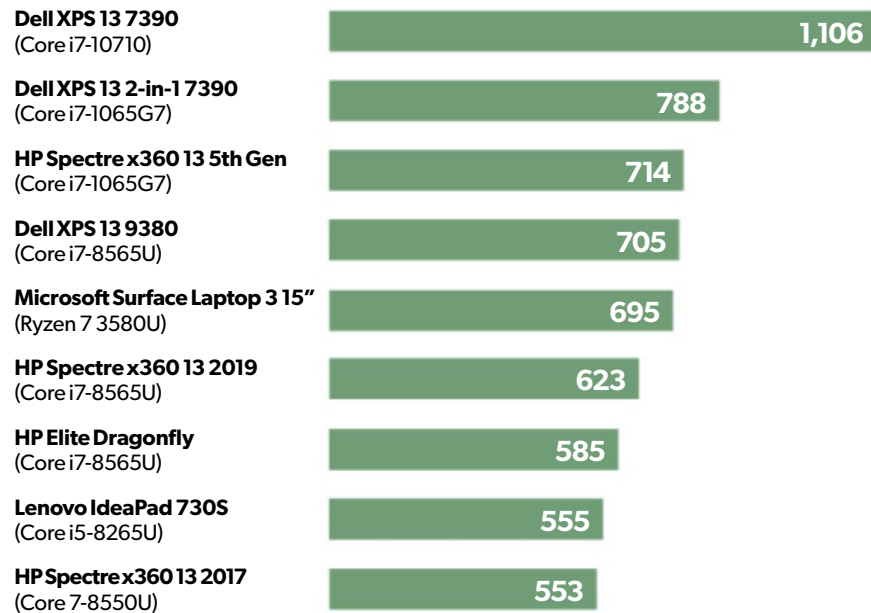
laptop. Yes, we know, you're wondering why not just buy a slower CPU? The problem is your boss still wants the best.

That's not to say the Core i7-8665U is actually slower than a consumer Core i7-8565U—it's just that to make it that fast, HP would have to add in, say, two fans instead of one, and beefier heat pipes. That adds weight, increases fan noise, and removes space

In single-threaded tasks, the Dragonfly again underperforms against other technically slower CPUs, but not by much.

Cinebench R15.038

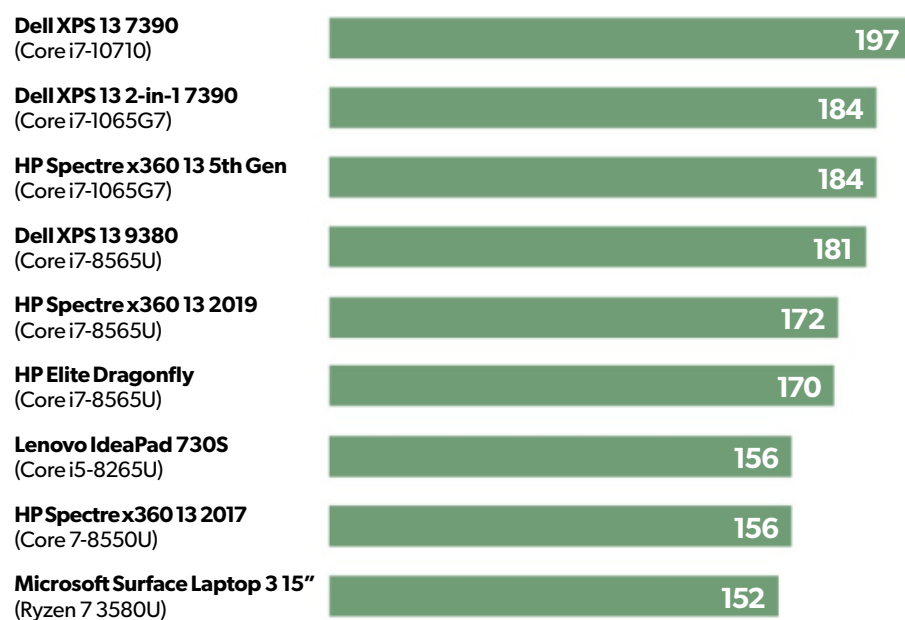
(Multi-core performance)



LONGER BARS INDICATE BETTER PERFORMANCE

Cinebench R15.038

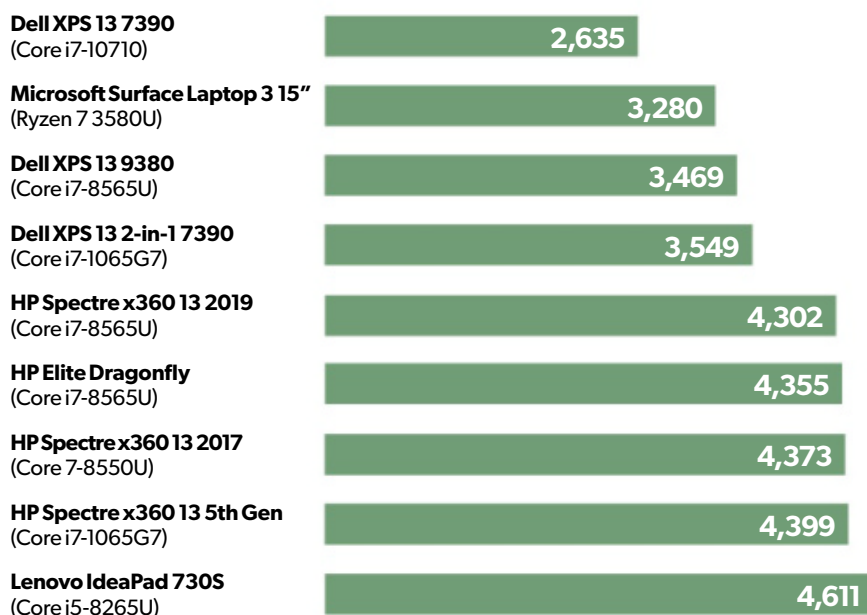
(Single-core performance)



LONGER BARS INDICATE BETTER PERFORMANCE

HandBrake 0.99 Encode

(Seconds)



SHORTER BARS INDICATE BETTER PERFORMANCE

The Dragonfly also comes in well behind other technically slower CPUs in our Handbrake stress test too.

for, say, more battery capacity.

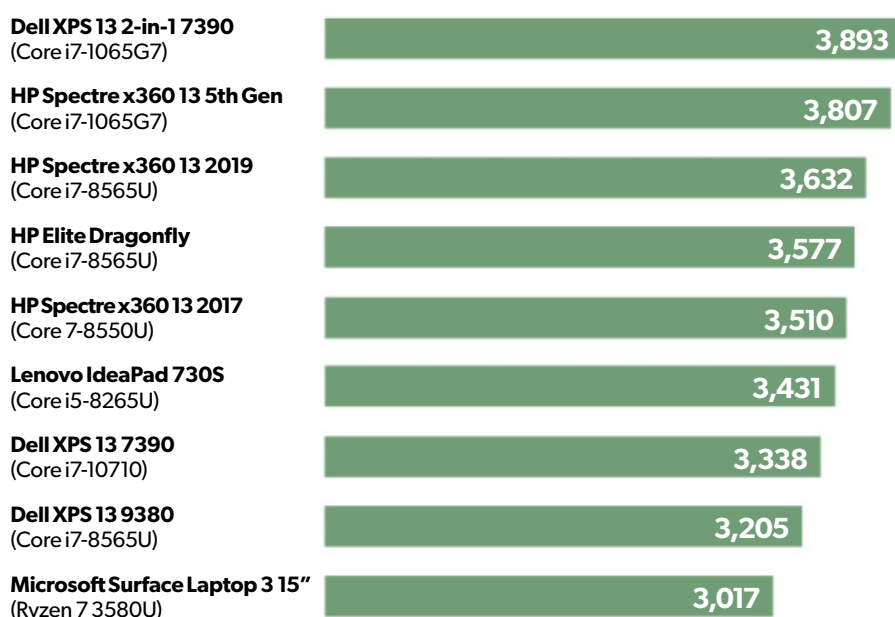
The truth is, none of this matters in a corporate environment. The next test is PCMark 8 using various simulated Corporate Drone tasks of word processing, browsing, video conferencing, and spreadsheeting.

As you can see, that back-of-the-pack performance of the Elite Dragonfly suddenly looks pretty good. The truth is the Elite Dragonfly is just fine for what 95

PC Mark 8 tells us it's all good for the majority of work you'd do on a thin-and-light laptop.

PCMark 8 Work 2.0 Conventional

(Native resolution)



LONGER BARS INDICATE BETTER PERFORMANCE

Graphics performance is in line with that of all other UHD laptops, and fine for your boss to play Flash-based games.

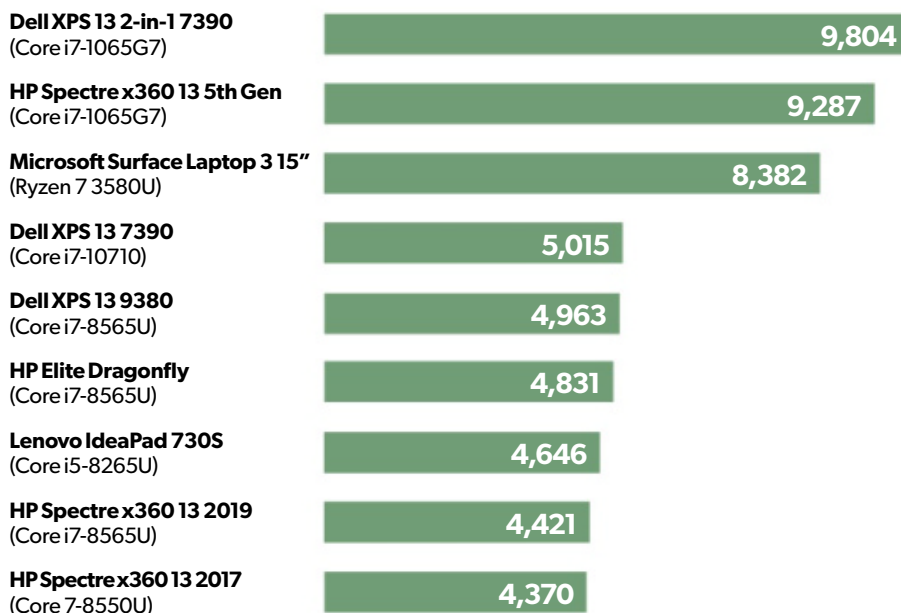
percent of Corporate Drone work requires. Just remember to tell your boss, "it's 200MHz faster!"

Our last pure performance test uses 3DMark to measure the graphics capabilities of the Elite Dragonfly. No surprise, it's basically no better and no worse than most laptops using Intel UHD or HD graphics. We'd recommend that any gaming or graphics be kept to

The HP Elite Dragonfly's battery life doesn't disappoint in our offline video run down test.

3DMark Sky Diver 1.0 Overall

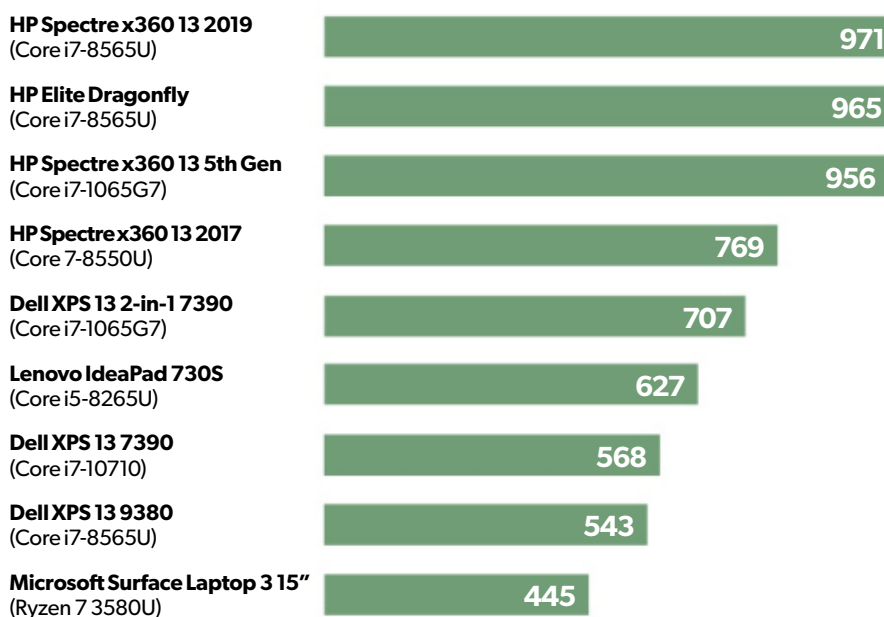
(Demo mode off)



LONGER BARS INDICATE BETTER PERFORMANCE

4K Video Playback Battery Life

(Minutes)



LONGER BARS INDICATE BETTER PERFORMANCE

the bare minimum. If your boss's idea of "gaming" means solitaire or Flash-based games, you'll be OK.

BATTERY PERFORMANCE

Perhaps the most important test for a laptop this portable is battery life. To test that, we loop a 4K video using Microsoft's Movies & TV app. We set the display at a relatively bright 250 to 260 nits, switch off Wi-Fi, and connect a pair of earbuds for sound.

With its "1 watt panel" and large battery, it's no surprise the Elite Dragonfly knocks it out of the park in battery life. And yes, that's about 18 hours of video playback.

Remember: Video playback is mostly on cruise control today. Fire up Office and sit in a spreadsheet all day scrolling around, and you'll likely whack off a third of the run time. Fire up Chrome and fill it with 25 tabs, all looping and downloading continual Flash-based ads, and you can probably expect to cut the run time in half, which is still about nine hours. Fire up any application that grinds on the CPU or GPU for the whole time, and you probably shouldn't expect more than two to three hours at best.

BOTTOM LINE

We'll admit, we're impressed by the HP Elite Dragonfly. It transcends our expectations for corporate laptops. Instead of boring, black, and basic, the Elite Dragonfly is beautiful, impressively light, and surprisingly well-equipped.



For consumers looking for a little more rated durability and versatility in a laptop, the Dragonfly is worth a hard look—if you can stomach the price. As a corporate laptop with manageability features such as vPro and the "faster" Core i7-8665U CPU, it'll set you back \$2,000 to \$2,200. And that's without the optional \$76 HP Active Tilt Pen. You could skip the pricier corporate features and still get a lot of laptop. 

HP Elite Dragonfly



PROS

- Lightweight.
- Long battery life.
- Enhanced security features.

CONS

- CPU performance lags behind others.
- Charging ports only on the right side of laptop, which can hinder mouse use.
- Some key functions force use of separate function key.

BOTTOM LINE

The HP Elite Dragonfly is a corporate laptop offering a solid configuration with some premium options; good performance, amazing battery life; and a truly classy design. It's made for your boss, but whether it's deserved is another matter entirely.

\$2,100

Samsung Portable SSD T7 Touch: Faster, with fingerprint security

This successor to the T5 is thinner and faster and adds a fingerprint scanner, but without adding much to the price. **BY JON L. JACOBI**



Samsung's Portable SSD T7 Touch is a very nice upgrade to the older T5 (which will still be available). It's thinner, a significantly faster reader, and it also sports a fingerprint scanner that you can employ, or not—your choice. Sure, you could get an official FIPS-certified secure drive, but those

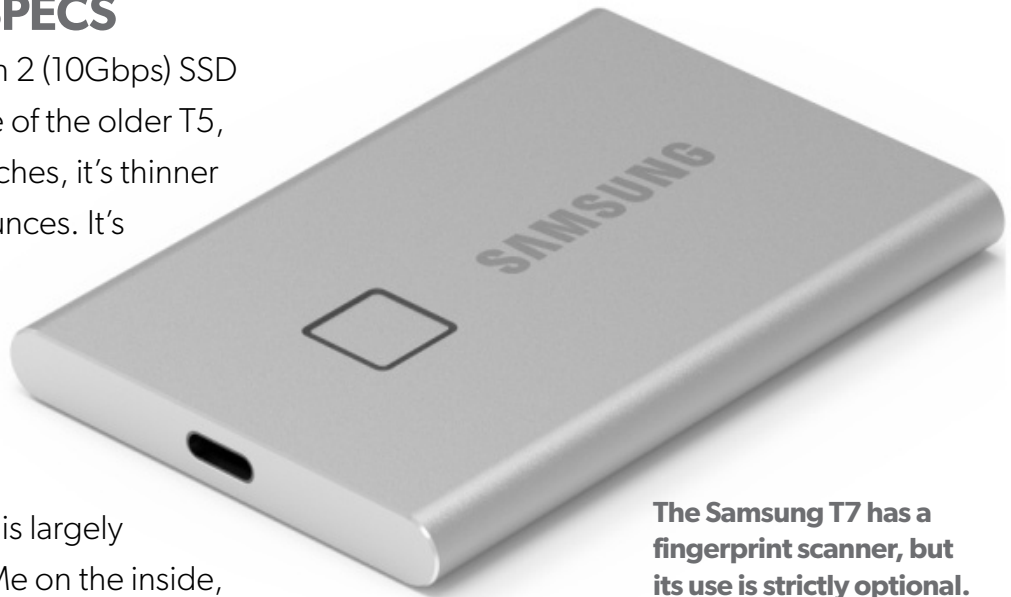
cost far more than the T7, which gives you this extra bit of security while remaining within the price range (currently \$130 on Amazon [go.pcworld.com/smt7]) of a normal USB SSD. That makes it a sweet deal for the average user who still wants effective data protection. (Corporations generally require FIPS, and secure government use always does.)

DESIGN AND SPECS

The T7 is a USB 3.2 Gen 2 (10Gbps) SSD that's roughly the shape of the older T5, but at 3.3 x 2.2 x 0.3 inches, it's thinner and weighs a mere 2 ounces. It's light. Very light. I'd actually prefer if it were a bit more substantial in the palm of my hand. The improved performance is largely because the unit is NVMe on the inside, but Samsung was mum as of the time of this writing as to which type of NAND is employed, whether TLC or QLC.

The T7 ships in three capacities: Our 500GB test unit (\$130 on Amazon [go.pcworld.com/smt7]), plus 1TB (\$230 on Amazon [go.pcworld.com/t71t]), and 2TB (\$400 on B&H Photo [go.pcworld.com/bht7]). That's about what you'd pay for similar non-secure drives, and far less than FIPS-certified units or Thunderbolt SSDs. The drive is available in basic, businesslike charcoal and silver hues. Samsung's three-year warranty is a bit skimpy, and the company also declined to provide a TBW (Terabytes written) reliability rating, but it's unlikely you'll come close to maxing out whatever is inside in even 10 years.

By far the most salient new feature on the T7 is the square fingerprint scanner on top of the unit. It's inactive by default, but you can enable it using the Windows/macOS app that ships with the drive.



The Samsung T7 has a fingerprint scanner, but its use is strictly optional.

So what's it like using the T7 in 256-bit AES hardware encryption mode? Actually, kind of fun with the fingerprint recognition. The scanner responds quickly, and the simple swipe required is a pretty painless routine. You don't need the software to use the scanner other than for initial configuration. A password mode that's less fun and efficient does require the software, but I'm guessing it's there largely in case something goes awry with the scanner.

You can turn off secure mode at any time, but you'll need to go through the entire password selection and fingerprint acquisition routine again to turn it back on. As I said, it's kind of fun. Give it a whirl if you buy a T7.

PERFORMANCE

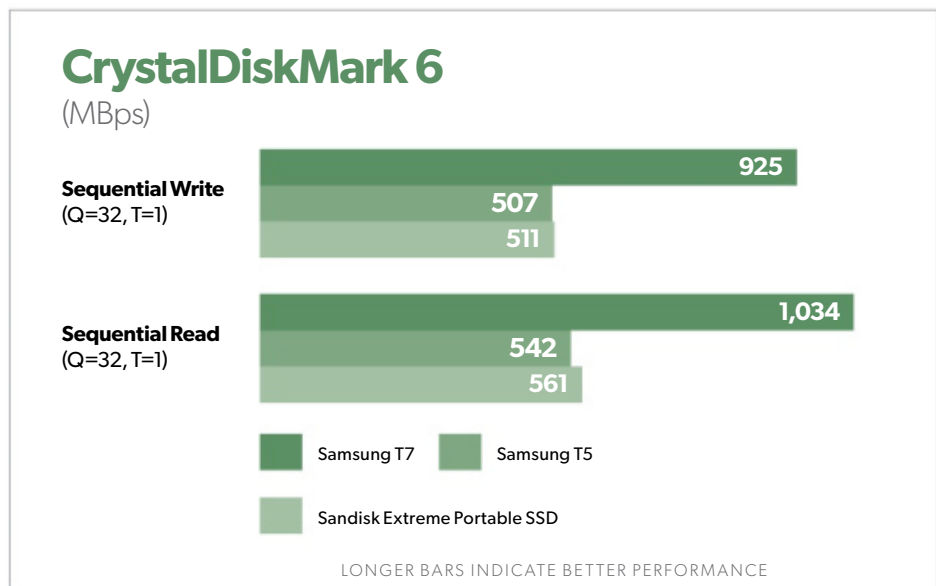
If you saw nothing but the CrystalDiskMark 6 and AS SSD 2 synthetic benchmark results,

you'd think the T7 outperformed the T5 by a mile. While it's reading or writing to cache, it does. Off-cache it's a bit slower. The SSD creates cache by treating some of the NAND as SLC (generally) by writing only 1 bit—a much quicker operation than writing the 3 bits TLC is capable of storing, and especially the 4 bits QLC can store.

Our test 500GB model had around 20GB of cache, so we expect that the 1TB will have 40GB of cache, and the 2TB, 80GB. Samsung and most vendors have historically assigned cache by percentage, but we didn't have the larger-capacity drives to check that theory on the T7. There are smart cache allotment controllers out there that will increase cache according to need, but from the behavior, it doesn't seem as if the T7 is one of them.

According to CrystalDiskMark 6, the T7 is megafast. With very small amounts of data that's true, but in real-world copies, its reading and writing is about half what CDM 6 (and AS SSD—not shown) show. What can we say?

Once the T7 dropped out of cache, it wrote about 50MBps slower than the older T5, which maintains long writes at 350MBps



According to CrystalDiskMark 6, the T7 is megafast. With very small amounts of data it is, but in real-world copies, it's not nearly this fast.

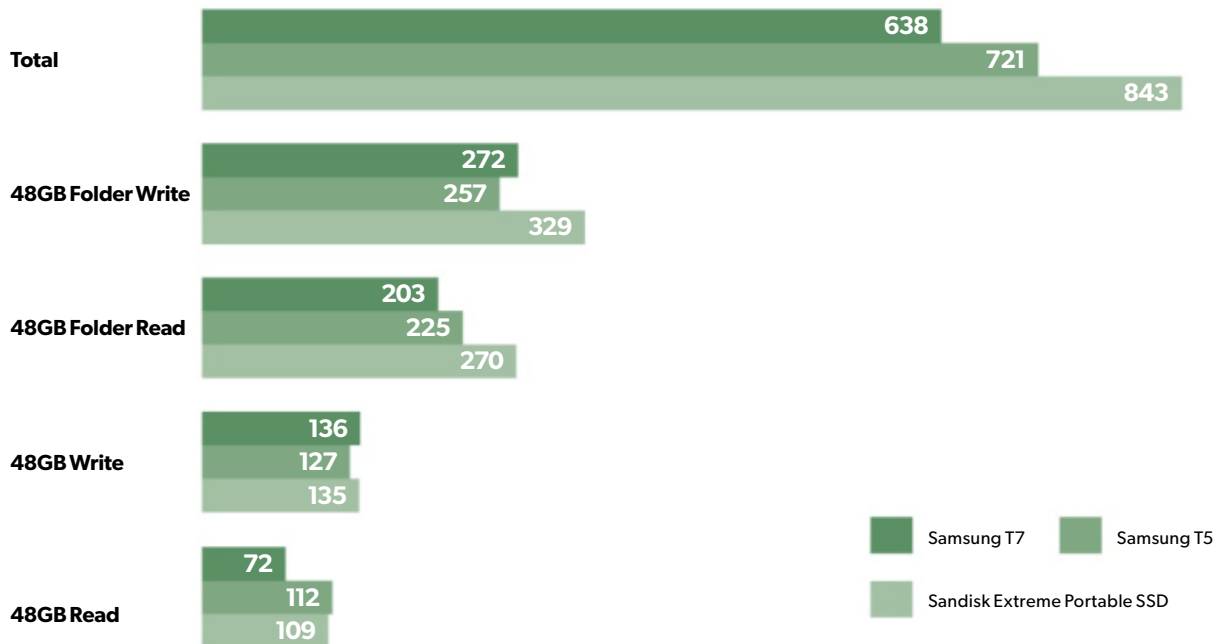
to 375MBps. That deficit slowly catches up with the drive as the amount of data being written increases, so it actually turned in slower 48GB and 450GB write results than the T5. If you write only to the cache, the T7 tops 500MBps and is much faster. That's likely 99 percent of the time for most users.

The T5 (350MBps) is actually a bit faster writing once the T7 runs out of cache (300MBps). With our 500GB T7, that was at roughly the halfway mark in the 48GB write test, allowing the T5 to catch up. The 1GB T7 would likely have posted better numbers in this test.

The 450GB copy shown below is a test we use to reveal cache dropouts with larger-capacity drives, which may allot more cache than the 48GB we're limited to writing from our 50GB RAM disk. It can also illustrate

48GB copies

(Seconds)



The older Samsung T5 is a bit faster writer than the T7, once the latter runs out of cache. On our 500GB T7, that was at roughly the halfway mark in this test, allowing the T5 to catch up.

Tortoise-vs.-Hare (go.pcworld.com/trhr) behavior, as it did with the T7 and T5.

The T7 was eventually caught by the T5 and posted a longer time, as you can see

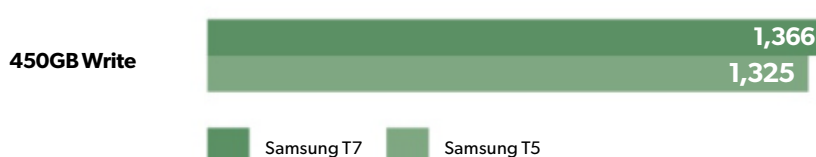
above. The T7's 500MBps write speed while its cache lasted gave it a hefty head start; however, the T5's steady 50MBps advantage off cache allowed it to catch up at the very

end. Again, with the 1TB or 2TB T7 with their larger amounts of cache, this likely would not have happened.

The screen capture below more vividly illustrates the drop in speed when the T7 runs out of cache. Note that 300MBps writing is still

450GB Write

(Seconds)



In our 450GB write test, which we use largely to spot any dips in performance due to running out of cache, the T5 eventually caught the T7. It was near run thing as the T7's cache gave it a hefty head start writing at well over 500MBps.

fast compared to most external 2.5-inch hard drives, though the best modern 3.5-inch hard drives write at 250MBps.

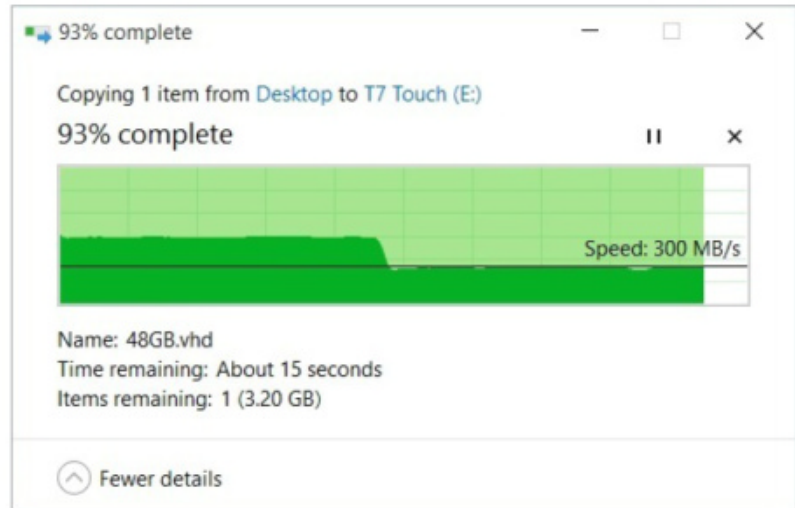
The T7 ran only slightly warm during long transfers. That's nice when you need to grab it and skedaddle as soon as an operation is over. Samsung talks about using encapsulated phase change materials (ePCM), which is a fancy way of describing stuff that radiates heat in a controlled, gradual fashion. Whatever the company is doing, it works.

For everyday use, the T7 is clearly superior to the T5. The deficit in speed on long writes is a minor factor for most users and shouldn't be an issue at all with the larger-capacity drives.

Testing is performed on Windows 10 64-bit running on a Core i7-5820K/Asus X99 Deluxe system with four 16GB Kingston 2666MHz DDR4 modules, a Zotac (Nvidia) GT 710 1GB x2 PCIe graphics card, and an Asmedia ASM2142 USB 3.1 Gen 2 (10Gbs) card. Also on board are a Gigabyte GC-Alpine Thunderbolt 3 card and Softperfect's Ramdisk 3.4.6, which is used for the 48GB read and write tests.

BOTTOM LINE

There's a whole lot to like about the Samsung Portable SSD T7 Touch. It's the fastest portable USB SSD we've tested, and



In our 48GB write test, our Samsung T7 drive slowed from over 500MBps to around 325MBps at around the 20GB mark.

incredibly affordable for a secure drive, albeit one that's not FIPS-certified for government or enterprise use. That fingerprint scanner is there if you need it, and not in the way if you don't. I like it. 🔌

Samsung Portable SSD T7 Touch (500GB)



PROS

- Fast everyday reader and writer.
- Fingerprint scanner (optional use).
- Extremely affordable for a secure drive.
- Runs only warm to the touch.

CONS

- Slightly slower during long-sustained writes than the T5.
- Three-year warranty is on the short side.

BOTTOM LINE

The Samsung Portable SSD T7 Touch is faster (mostly) and lighter than its T5 sibling. It also sports a fingerprint scanner for both biometric and password security while avoiding the high cost of FIPS-certified secure drives. Sweet.

\$129



EVGA GeForce RTX 2060 KO: Ray tracing gets affordable

The EVGA GeForce RTX 2060 KO makes some smart compromises to hit a truly compelling \$300 price point. **BY BRAD CHACOS**



The EVGA GeForce RTX 2060 KO offers something for everybody.

Gamers like you and me get a custom GeForce RTX 2060 graphics card and all its benefits—great 1080p gaming, good 1440p gaming, and real-time ray tracing—for just \$300, a full \$50 below the RTX 2060's suggested price. EVGA steals the

spotlight in a crucial segment of the market by significantly undercutting its competitors. And Nvidia gets to clear out stock for a different GPU, surprisingly enough, while fielding a headache-free rival to the new \$280 Radeon RX 5600 XT (go.pcworld.com/plrd).

Okay, maybe AMD doesn't get anything out of it.

EVGA's graphics card cuts some corners

to hit the \$300 mark, but they’re wholly reasonable tweaks, and the lower price point makes Nvidia’s entry-level ray-tracing option much more appealing. So does EVGA’s \$300 GeForce RTX 2060 KO and overclocked \$320 RTX 2060 KO Ultra manage to knock out AMD’s latest GPU? And what about Nvidia’s own RTX 2060 Founders Edition (go.pcworld.com/60fd), which just received a price cut to \$300 itself (go.pcworld.com/300c)? Let’s dig in.

SPECS, FEATURES, AND PRICE

Surprise! The EVGA GeForce RTX 2060 KO doesn’t use the TU106 GPU found inside other GeForce RTX 2060 cards, at least in our review sample. Instead, it revolves around a version of the TU104 GPU found inside the much more powerful GeForce RTX 2080, but cut-down to match TU106’s specifications.

That means the EVGA KO packs the same 1,920 CUDA cores and 30 dedicated ray-tracing cores as other RTX 2060s, tied to the same 6GB of GDDR6 VRAM with a 192-bit bus, bringing the total overall memory bandwidth to a blistering 336Gbps. It behaves exactly like its TU106-based siblings in both gaming and ray-tracing performance in our testing. Gamers Nexus (go.pcworld.com/gnxs) discovered one key performance difference: The TU104-based EVGA KO performs up to 57 percent faster in Blender rendering tasks. That’s a very niche

use case, but if you use Blender, it’s enough to push you toward the EVGA KO over rival RTX 2060 models.

EVGA offers two different variants (go.pcworld.com/2dif). The \$300 GeForce RTX 2060 KO (go.pcworld.com/gfko) sticks to the GPU’s stock 1,680MHz Boost clock speeds, while the \$320 EVGA RTX 2060 KO Ultra (go.pcworld.com/koul) offers a mild overclock to 1,755MHz. You can overclock them further yourself, but EVGA prevents users from increasing the power limit to keep from overloading the board’s 4-phase VRM. The KO and KO Ultra are identical other than the clock speeds. We’re reviewing both configurations: EVGA sent us the Ultra model along with the BIOS for the cheaper version, so we could test both.

GPU ENGINE SPECS

Nvidia CUDA cores	1,920
RTX-OPS	37T
Giga Rays/s	5
Boost Clock (MHz)	1,680
Base Clock (MHz)	1,365

MEMORY SPECS

Memory Speed	14 Gbps
Standard Memory Config	6 GB GDDR6
Memory Interface Width	192-bit
Memory Bandwidth (GB/s)	336 GB/s



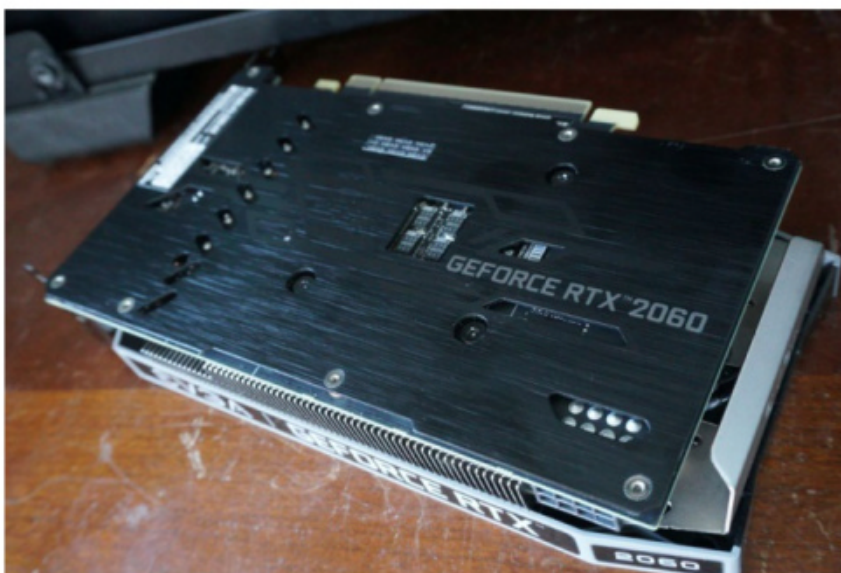
Port report.

You'll notice some cost-saving measures as soon as you take the EVGA RTX 2060 KO out of the box. It's a tiny card that reuses the design of the \$240 EVGA GeForce GTX 1660 Super SC (go.pcworld.com/spsc), eliminating development costs for another custom cooler. The shroud's plastic, rather than metal, and lacks the RGB lighting options found on most modern custom graphics cards. The KO also sticks to a very basic port configuration, with singular DisplayPort, HDMI, and DVI connections. Those are all reasonable downgrades to shave \$50 off the normal cost of RTX 2060 models, in our opinion.

EVGA still managed to sneak some nice extras onto the card despite its budget price, however. The RTX 2060

KO includes a metal backplate that looks nice and clean in your case, while the two large fans adorning the shroud support the crucial idle fan stop feature. Idle fan stop prevents the fans from spinning when the GPU isn't under heavy load, creating an utterly silent environment when you're just tooling around on your desktop. EVGA's Precision X1 monitoring and overclocking software remains among the best available, too.

Of course, as a GeForce RTX 20-series graphics card, the EVGA KO can run real-time ray tracing in the games that support it, and it supports all Nvidia's latest hardware innovations. Check out our Turing architecture deep-dive for more information on that front





The EVGA GeForce RTX 2060 KO uses a single 8-pin power connection.

(go.pcworld.com/trar). On the software side, the EVGA KO plays nice with GeForce Experience and its myriad features, including Ansel super screenshots, ShadowPlay video recording (go.pcworld.com/shad), integer scaling for retro games, low-latency modes for competitive titles, and more.

But onto the real question: How does it game?

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 (\$350 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 (\$420 on Amazon at go.pcworld.com/c240)
- 64GB HyperX Predator RGB DDR4/2933 (\$420 on Amazon)
- EVGA 1200W SuperNova P2 power supply (\$230 on Amazon at go.pcworld.com/mxmc)
- Corsair Crystal 570X

RGB case, with front and top panels removed and an extra rear fan installed for improved airflow (\$130 on Amazon at go.pcworld.com/crst)

- 2x 500GB Samsung 860 EVO SSDs (\$78 each on Amazon at go.pcworld.com/smev)

We're reviewing both the \$300 EVGA GeForce RTX 2060 KO and the \$320 RTX 2060 KO Ultra. Because the cards are identical other than clock speeds, EVGA supplied us with the KO Ultra as well as a VBIOS that transforms the card into the cheaper model.

The RTX 2060 is a known quantity at this point, so we're comparing EVGA's card only against its most direct rivals: The \$280 Radeon RX 5600 XT, the Nvidia GeForce RTX 2060 Founders Edition (go.pcworld.com/60fd; which itself recently dropped in price to \$300), and AMD's reference \$350 Radeon RX 5700 (go.pcworld.com/r57x).

The Radeon RX 5600 XT had a messy launch due to a last-second VBIOS upgrade that won't be applicable to every model (go.pcworld.com).

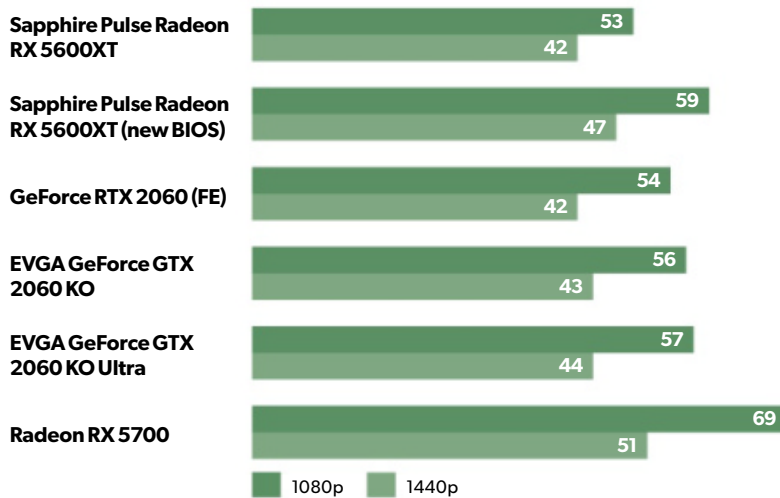
[com/vbis](#)), and often won't be applied to the first wave of stock on store shelves even if you're getting a faster version. We've included results for both the reference configuration and the faster VBIOS provided for the Sapphire Pulse Radeon RX 5600 XT ([go.pcworld.com/plrd](#)).

Each game is tested using its in-game benchmark at the highest possible graphics presets unless otherwise noted, with VSync, frame rate caps, real-time ray-tracing or DLSS effects, and FreeSync/G-Sync disabled. We've enabled temporal anti-aliasing (TAA) to

push these cards to their limits. We run each benchmark at least three times and list the average result for each test.

Metro Exodus

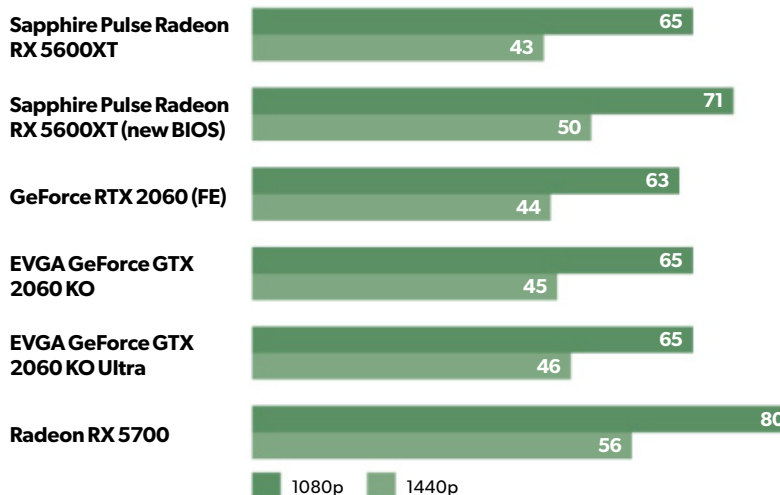
(Frames per second)



LONGER BARS INDICATE BETTER PERFORMANCE

Borderlands 3

(Frames per second)



LONGER BARS INDICATE BETTER PERFORMANCE

GAMING BENCHMARKS

Metro Exodus

One of the best games of 2019, *Metro Exodus* is one of the best-looking games around, too. The latest version of the 4A Engine provides incredibly lush, ultra-detailed visuals, with one of the most stunning real-time ray-tracing implementations released yet. We test in DirectX 12 mode with ray tracing and DLSS disabled.

Borderlands 3

Borderlands is back! Gearbox's game defaults to DX12, so we do as well, and gives us a glimpse at the ultra-popular Unreal Engine 4's performance—though this game's implementation leans heavily in AMD's favor.

The Division 2

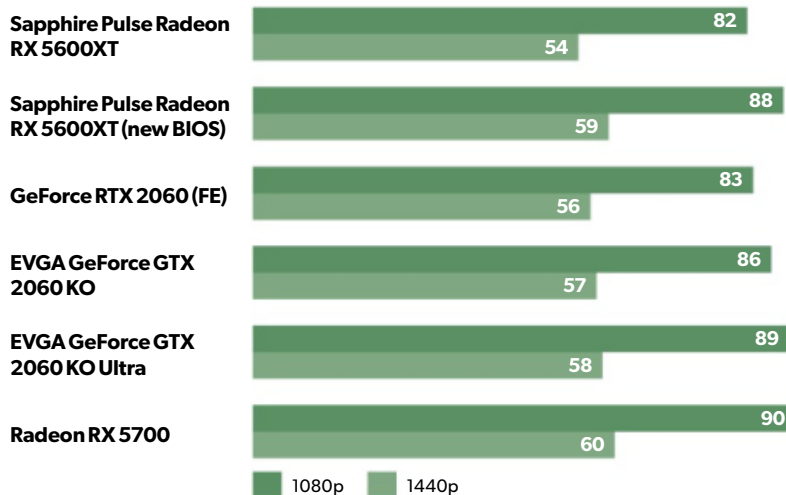
The Division 2 is one of the best looter-shooters ever created. The luscious visuals generated by Ubisoft's Snowdrop engine make it even easier to get lost in post-apocalyptic Washington D.C. The built-in benchmark cycles through four "zones" to test an array of environments, and we test with the DirectX 12 renderer enabled.

Strange Brigade

Strange Brigade is 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. Last year, we used the DX12 renderer as it offered improved performance. In 2020, we've switched to the Vulkan renderer with async compute enabled, as it's now your fastest option and Vulkan games are rare indeed.

The Division 2

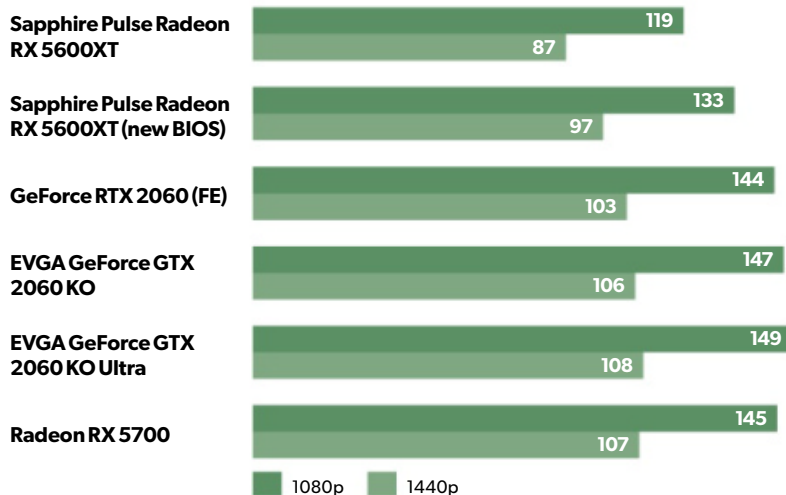
(Frames per second)



LONGER BARS INDICATE BETTER PERFORMANCE

Strange Brigade

(Frames per second)



LONGER BARS INDICATE BETTER PERFORMANCE

Shadow of the Tomb Raider

Shadow of the Tomb Raider concludes the reboot trilogy, and it's gorgeous. Square Enix optimized this game for DX12, and recommends DX11 only if you're using older

hardware or Windows 7, so we test with DX12. *Shadow of the Tomb Raider* uses an enhanced version of the Foundation engine that also powered *Rise of the Tomb Raider* and includes optional real-time ray-tracing features.

Ghost Recon Breakpoint

It may run in DX11, but like its predecessor, *Ghost Recon Breakpoint* and its AnvilNext 2.0 engine absolutely melts GPUs—so much so that we test this game on Very High rather than Ultra settings.

Total War: Three Kingdoms

Most of the games in our suite are shooters or adventure games, but we've included *Total War: Three Kingdoms* to give us a glimpse at RTS performance. It's another DX11 game, running on an improved version of the same engine found in Creative Assembly's previous *Total War* entries.

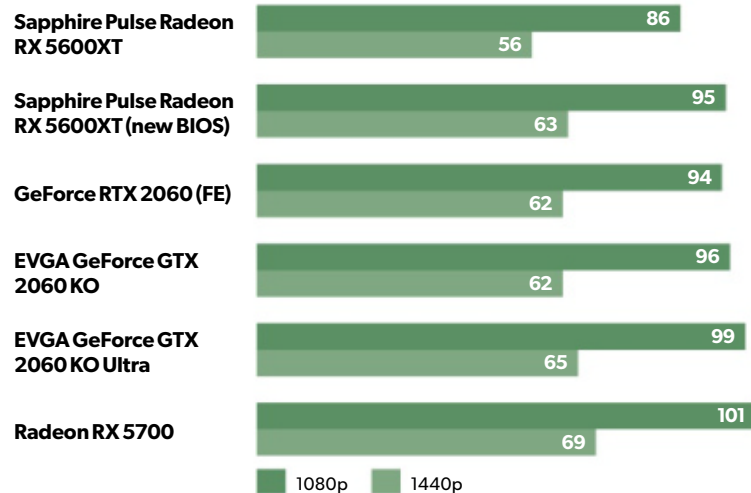
GTA V

This game isn't really a visual barn-burner, but still tops the Steam charts day in and day out. We test *Grand Theft Auto V* with all options

turned to Very High, all Advanced Graphics options except extended shadows enabled, and FXAA. *GTA V* runs on the RAGE engine and has received substantial updates since its initial launch.

Shadow of the Tomb Raider

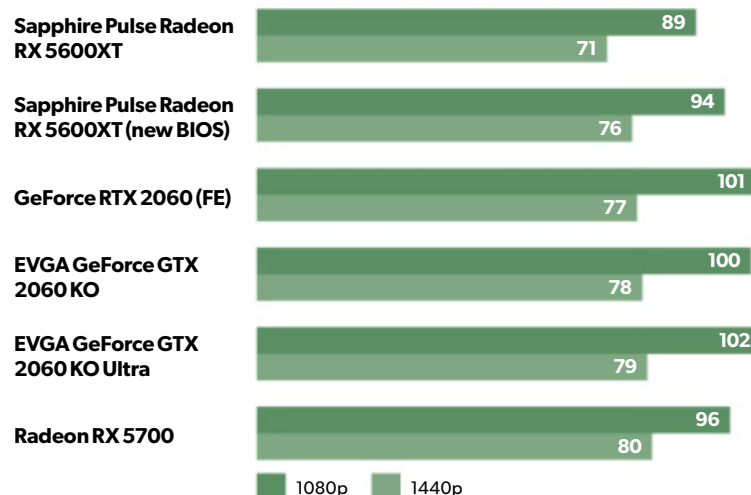
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LONGER BARS INDICATE BETTER PERFORMANCE

Ghost Recon Breakpoint

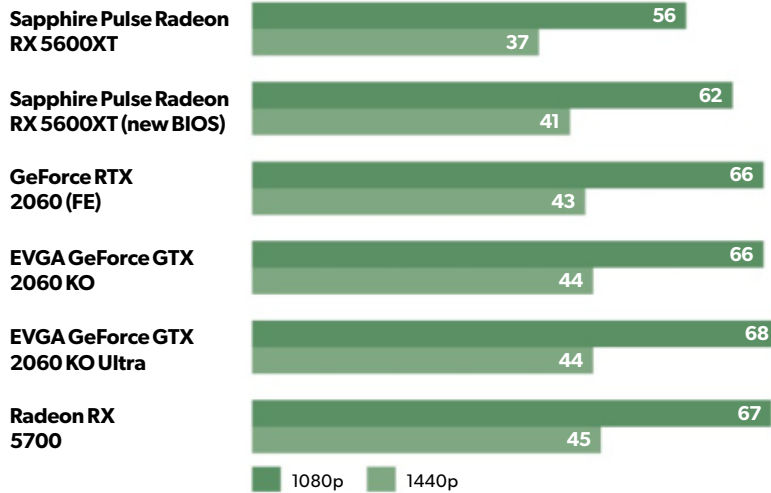
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LONGER BARS INDICATE BETTER PERFORMANCE

Total War: Three Kingdoms

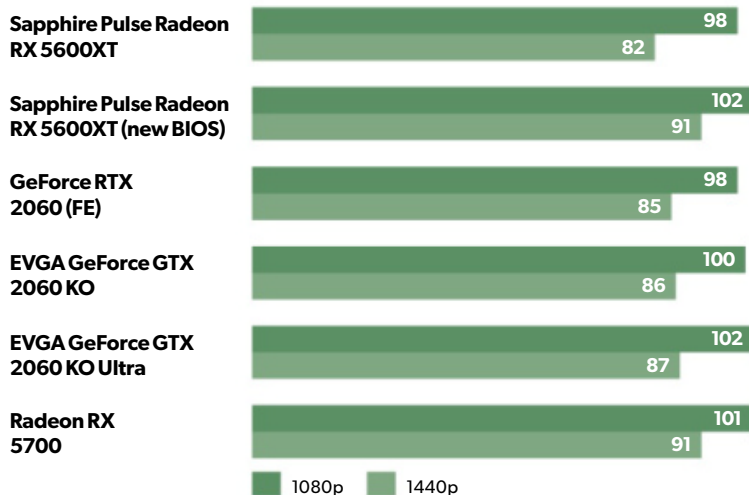
(Frames per second)



LONGER BARS INDICATE BETTER PERFORMANCE

GTA V

(Frames per second)



LONGER BARS INDICATE BETTER PERFORMANCE

reliable (and fun) option than the *Forza* series. It's built on the latest version of Codemasters' buttery-smooth Ego game engine, complete with support for DX12 for the first time. We test two laps on the Australia course, with clear skies.

Real-time ray tracing

Unlike AMD's rival Radeon cards, Nvidia RTX GPUs pack dedicated hardware to enable real-time ray tracing, though the cutting-edge lighting effect can put a big damper on performance depending on the implementation. Nvidia's Deep Learning Super Sampling (DLSS) technology claws back some of those frames in games where it's available, though.

To see if the EVGA KO's unique cut-down TU104 GPU performs differently than the TU106 GPU in standard RTX 2060 models, we've

F1 2019

The latest in a long line of successful racing games, *F1 2019* is a gem to test, supplying a wide array of both graphical and benchmarking options, making it a much more

compared its ray-tracing performance against Nvidia's Founders Edition in *Shadow of the Tomb Raider* and *Metro: Exodus* at 1440p resolution.

(Spoiler: The KO isn't faster.) *Tomb Raider*

lacks DLSS, and we've tested it with ray-traced shadows set to both Medium and Ultra. *Metro Exodus* supports DLSS.

We tested it using the RTX preset in the benchmark, which sets its ray tracing to High and activates DLSS. A more intense Ultra setting is also available, but we didn't test it here.

POWER DRAW, THERMALS, AND NOISE

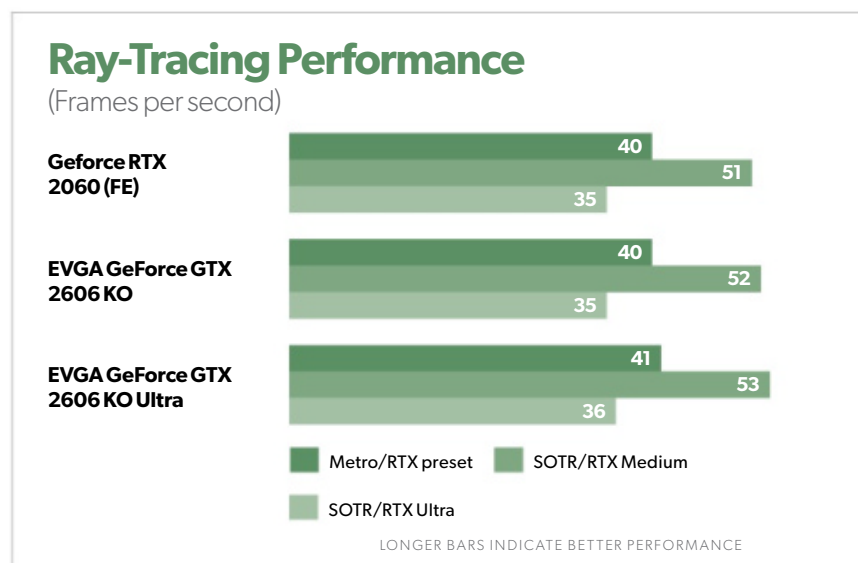
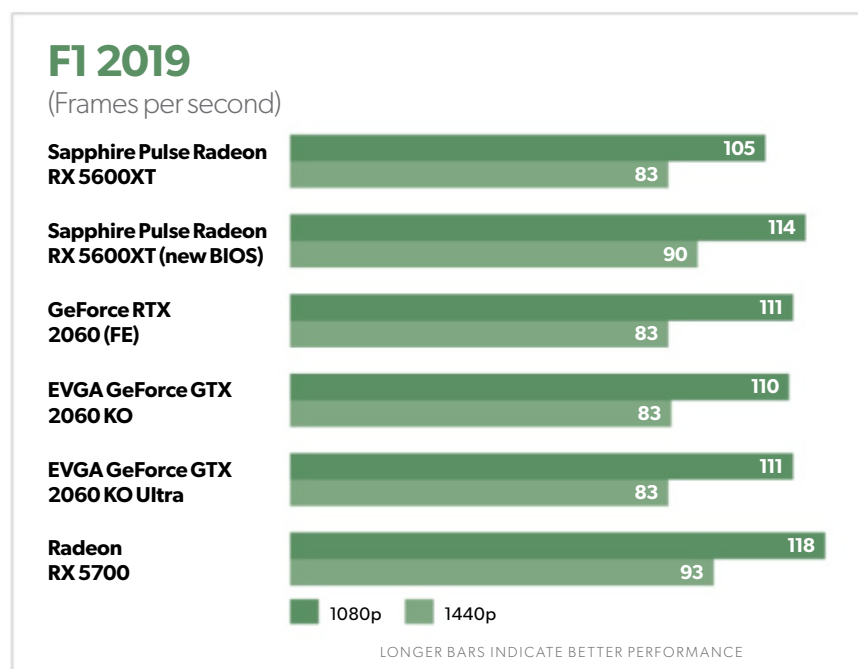
We test power draw by looping the *F1 2019* benchmark for about 20 minutes after we've benchmarked everything else and noting the highest reading on our Watts Up Pro meter. The initial part of the race, where all competing cars are onscreen simultaneously,

tends to be the most demanding portion.

Here's where the switch from TU106 to a cut-down TU104 GPU makes a slight difference. The EVGA GeForce RTX 2060 KO sucks down slightly more power than the Nvidia Founders Edition. Not by much though. It's interesting to note, but it isn't a practical consideration in the real world.

We test thermals by leaving GPU-Z open during the *F1 2019* power draw test, noting the highest maximum temperature at the end.

Despite its small stature and reused cooling design, the EVGA RTX 2060 KO stays nice and cool, never going above 73 degrees even in its overclocked form. It's not all roses though. Subjectively, the EVGA KO gets louder than



most graphics cards in this price range to hit those chilly temperatures, and it's more audible than the Founders Edition's dual fan setup or the whisper-quiet cooler on the Sapphire Pulse Radeon RX 5600 XT. Our

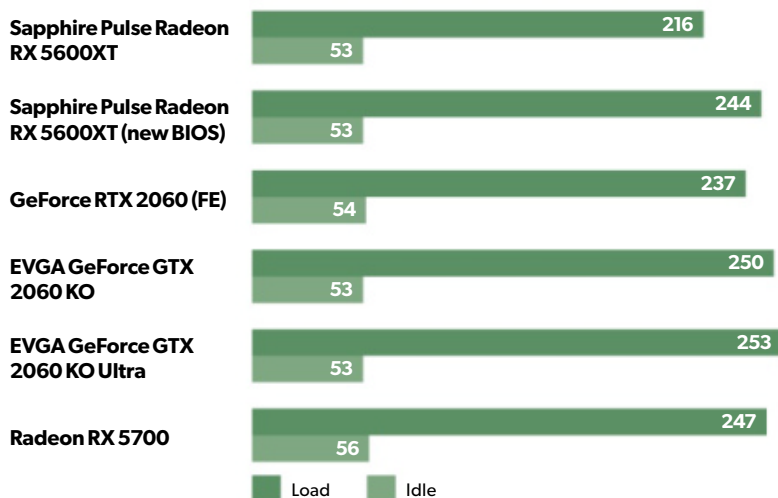
review sample had some slight coil whine during especially intense gaming scenes as well.

Still, the sound levels aren't bad, and the KO proves quieter than AMD's recent blower-

style reference coolers. It's a reasonable compromise to hit the \$300 price point. The EVGA KO's wonderful idle fan stop feature, which Nvidia's Founders Edition card lacks, makes it much preferable to use when you're not gaming, as it's silent during desktop use.

Whole System Power Draw

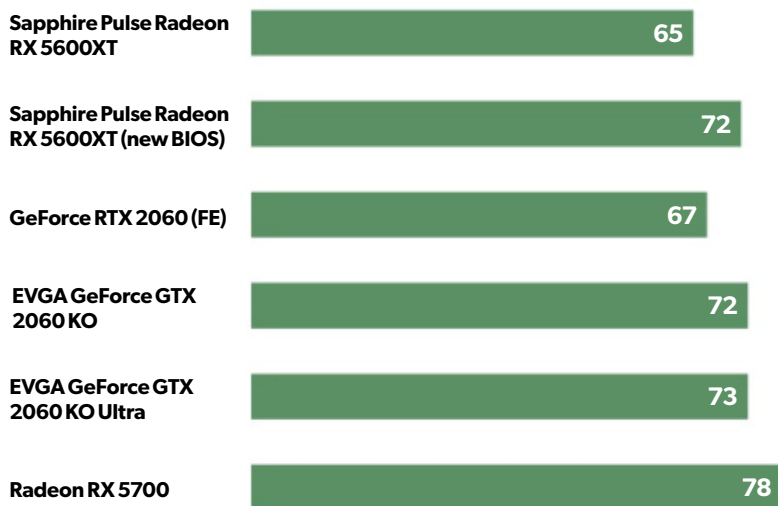
(Watts)



SHORTER BARS INDICATE BETTER PERFORMANCE

Max GPU temperature under load

(Celsius)



SHORTER BARS INDICATE BETTER PERFORMANCE

BOTTOM LINE

If you're on the hunt for a solid 1440p graphics card, or one capable of feeding an ultra-fast 144Hz 1080p monitor, the \$300 EVGA GeForce RTX 2060 KO should be on your shortlist, especially if you're interested in real-time ray-tracing capabilities. It's a steal.

At \$350, the normal price for GeForce RTX 2060 models, we tend to recommend the Radeon RX 5700 (go.pcworld.com/r57x) for 1440p gaming, as it's slightly faster and has 2GB more memory, bringing it to 8GB of GDDR6 in total. But



EVGA's cheap RTX 2060 is much more appealing at \$50 less. It's almost as fast as the RX 5700 in most games, trading blows with the excellent Sapphire Pulse Radeon RX 5600 XT (go.pcworld.com/plrd), which costs \$290.

AMD's Radeon RX 5600 XT had a messy launch, however, with some models being much faster (go.pcworld.com/fscd) than others thanks to a last-second BIOS upgrade. The first wave of faster cards on store shelves will probably require users to upgrade their BIOS to get the additional performance. The EVGA GeForce RTX 2060 KO is significantly faster than Radeon RX 5600 XT models that don't get upgraded memory speeds, and that's the majority currently—faster, upgraded models are few and far between.

EVGA's card doesn't have to deal with any of that software headache. It just works out of the box. And that price. At \$300, the KO undercuts most dual-fan RTX 2060 models by \$40 or more, delivering excellent gaming performance at a steep discount. Better yet, at \$300 and with performance comparable to the Sapphire Pulse Radeon RX 5600 XT, you're basically only paying a \$10 premium for real-time ray tracing. The cutting-edge lighting technology is still in its infancy, with only a handful of games supporting it thus far, but it's very much on the upswing and well worth the investment in for such a minimal surcharge.

Nvidia's own GeForce RTX 2060 Founders Edition (go.pcworld.com/60fd) dropped to \$300 to counter the Radeon RX

5600 XT, and it's also worth considering. We prefer the premium metallic look of the Founders Edition, and Nvidia's card runs a bit quieter under load, but the 2060 FE lacks the EVGA KO's crucial idle fan stop feature, which creates a silent desktop browsing experience. They're both solid options, though it remains to be seen how many Founders Edition cards Nvidia makes available at this price. That luxurious shroud ain't cheap. EVGA's card has seen high demand too, however.

EVGA cut some corners to achieve this awesome price. The KO sports a plastic shroud reused from a lower-end GTX 1660 design (albeit augmented by a fetching metal backplate), and its fans get a little loud to maintain chilly temperatures. The port selection is basic. Overclockers will want to look elsewhere, as you can't increase the card's

power limit, and the minuscule performance boost provided by the pricier EVGA RTX 2060 KO Ultra (go.pcworld.com/koul) isn't worth the extra \$20. At \$320, it's probably worth looking instead for a quieter, fuller-featured RTX 2060 model on sale for a few dollars more.

Don't let that dissuade you though. This is a great, no-frills graphics card for people who just want to put their graphics card in their system and play. The \$300 EVGA GeForce RTX 2060 KO (go.pcworld.com/gfko) delivers everything you need for a kick-ass gaming experience, even ray tracing, and it made some reasonable sacrifices to hit a truly compelling price point—no confusing BIOS upgrades required. It's highly, highly recommended. You can find more feature-packed GeForce RTX 2060 models, but they'll cost you a whole lot more. 🔌

EVGA GeForce RTX 2060 KO



PROS

- Great 1440p and 1080p gaming performance.
- Outstanding price vs. other RTX 2060 models.
- RTX hardware for ray tracing and DLSS.
- Metal backplate, idle fan stop features.

CONS

- Ray tracing and DLSS picking up steam, but not widely available in games yet.
- Basic, no-frills design.
- A little louder than rival GPUs.

BOTTOM LINE

The EVGA GeForce RTX 2060 KO makes some smart compromises to bring real-time ray tracing under \$300, drastically undercutting its rivals.

\$300

EVGA GeForce RTX 2060 KO Ultra



PROS

- Great 1440p and 1080p gaming performance.
- RTX hardware for ray tracing and DLSS.
- Metal backplate, idle fan stop features.

CONS

- Basic, no-frills design.
- A little louder than rival GPUs.
- Overclock offers little real-world performance for \$20 premium.

BOTTOM LINE

The EVGA GeForce RTX 2060 KO is a solid low-cost RTX 2060 option, but isn't as successful as its non-Ultra sibling because its slight overclock isn't worth a \$20 premium.

\$319



HP Pavilion Gaming Laptop: Affordable gaming with caveats

The dim display and lack of real mouse buttons could frustrate some. **BY HAYDEN DINGMAN**

HP's Pavilion Gaming Laptop may seem like a relic from years past, given the rise of HP's Omen line. Granted, the Pavilion line lacks Omen's "For Gamers, By Gamers" cred, but... well, what's in a name, really? The Pavilion

Gaming Laptop is just an Omen in disguise, an entry-level peer with mainstream branding.

VARIANTS

The pricing is mainstream, too. The Pavilion Gaming Laptop starts at just \$640 for a base

Pavilion 15t model on hp.com (go.pcworld.com/hp5t), with Intel Core i5-9300H and a last-gen GTX 1050. The model we received is essentially HP's "high-end" unit, the poetically named 15-dk0045cl, a \$1,250 version sold at Costco (go.pcworld.com/csko) and equipped with an Intel Core i7-9750H, an Nvidia GeForce GTX 1660 Ti, 16GB of DDR4 RAM, a 256GB M.2 SSD, and a 1TB HDD. It's a good deal. If you're not a Costco member, an identical model based on the Pavilion Gaming Laptop 15t at hp.com costs \$1,440 (go.pcworld.com/hp5t). The similar Pavilion 15-dk0046nr is available for \$1,300 on hp.com (go.pcworld.com/46nr) with a Core i7-9750H, 12GB of RAM and a 256GB SSD, and a step down in graphics to Nvidia's GTX 1650.

Storage is a place you can skimp, depending on your needs. On hp.com, opting for only the 256GB SSD saves \$100, though you'll be packing games in like sardines at that point. A 512GB SSD might be the better option—still small by modern standards, but more than enough to keep a few games installed at all times, and you'll still save \$50 over the 256GB SSD/1TB HDD combo.

Aim low, or you might as well check out



Omen, which is only a little more expensive. For instance, you can configure a Pavilion Gaming Laptop 15t on hp.com for \$1,490 (go.pcworld.com/hp5t) with a Core i7-9750H, GTX 1660 Ti, a 512GB SSD, and a 144Hz display. The same configuration in an Omen Laptop 15t on hp.com is \$1,550 (go.pcworld.com/o15t). It's only a \$60 difference, but the Omen line is arguably slightly better, as you'll see when we delve into the design.

DESIGN

The difference is in the details—some small ones, but also some very important ones. Let's start with the aesthetics.

The Pavilion Gaming Laptop looks every bit as good as HP's Omen lineup. It features

the same centered hinge as the Omen 17 ([go.pcworld.com/om17](https://www.pcworld.com/om17)) we reviewed in November, the same almost-rectangular shape. But where the Omen opted for a brushed-metal look inside and outside, the Pavilion goes with a matte-black finish—and a proper HP logo, instead of Omen’s demon-face.

Honestly? I prefer the Pavilion Gaming Laptop to the Omen cousin. It’s a go-anywhere laptop, a day-to-day workhorse that also plays games on the weekends. Even the “Acid Green” variant we reviewed is fairly inoffensive. The electric-green keyboard backlighting invites Razer comparisons, but HP went with a jewel-tone emerald accent for the lid logo that’s eye-catching but not eye-searing, a fine line to walk. I recommend paying \$10 for the white logo and backlighting if you really want to blend in, but I have no problem with the Pavilion Gaming Laptop aesthetically.

Unfortunately most of the other differences between the Pavilion and the Omen go in the latter’s favor. First and foremost, the 15.6-inch display. This is an area where lower-cost laptops often skimp, because the display is one of the priciest components.

The Pavilion Gaming Laptop defaults to a standard

1080p IPS screen with a 60Hz refresh rate. Not every laptop needs to be 144Hz or 4K resolution—but it does need to be bright enough to see. I’m frustrated because I just applauded HP for equipping the Omen with a bright 362-nit screen, a rarity for budget-conscious manufacturers. The Pavilion Gaming Laptop tops out at 250 nits plugged in, our baseline for viewing comfort. However, it dims to 200 nits unplugged, far short of that baseline, which we use for battery benchmarking.

What that means for you depends on your use case. The Pavilion Gaming Laptop is plenty bright with the lights out, so late-night gaming sessions are fine. Even a single overhead light is enough to wash out the Pavilion Gaming Laptops’s display, though, and window glare can be a real problem during the day, especially unplugged. Picture:





Those huge glass panes at the airport, and you squinting to see your screen.

HP does offer two additional display options: 1080p at 144Hz, and 4K. Assuming the 144Hz variant is the same used on the Omen though, it's probably worth the \$100 upgrade. That alone would add a half-star to our rating here.

Below the display, you'll find a row of upward-firing speakers. This, too, differs from the Omen, and I don't necessarily hate the change in isolation. The Pavilion Gaming Laptop gets loud, and the audio output is reasonably clear. These speakers are decent for watching YouTube, fine for listening to some slightly tinny music, and... well, pretty unpleasant for gaming. Use a headset.

The larger issue, though is that the speakers came at the cost of a larger trackpad and dedicated mouse buttons.

I've said it again and again,

but I think dedicated left- and right-click buttons are a must for gaming laptops. Sure, you'll plug in a real mouse for anything serious, but there are plenty of times when I'm on the road without a mouse, or where a mouse isn't feasible (i.e., airplanes). In those situations, having reliable left- and right-click buttons is crucial to playing even simple adventure games. Tap-to-click isn't good enough, and it's a shame HP went that route with the Pavilion Gaming Laptop. It's the one aspect where head-to-head the Omen



definitively comes out on top.

You could also argue the Omen keyboard's zone RGB lighting is better than the flat single-color lighting on the Pavilion, though that's less crucial. Just be sure to get the color variant you prefer,

either green or white. Regardless, HP's laptop keyboards continue to impress me. They're stiff, but with a satisfying click.

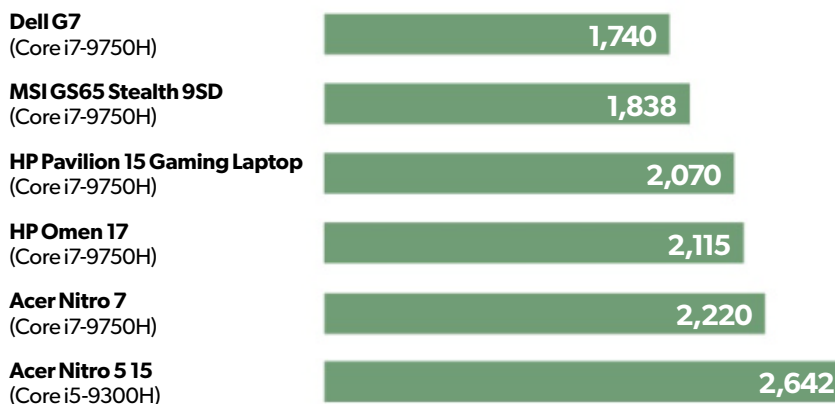
Lastly, ports. As I said in our Omen review, "Accolades for putting all the ports on the side." Too many gaming laptops put important I/O on the rear—great for keeping cables out of the way on a desk, but a pain to access on the road. The Pavilion Gaming Laptop includes power, two USB 3.0 ports, and a 3.5mm jack on the right side, plus HDMI-out, an additional USB-A 3.0 port, ethernet, an SD card reader, and a USB-C port on the left.

PERFORMANCE

Don't expect record-setting benchmarks here. Yes, we tested the "high-end" Pavilion 15 with a Core i7-9750H, GTX 1660 Ti, and 16GB of RAM, but the quotation marks are there for a reason. What's high-end for the

HandBrake 0.99.0 Encoding (H.264)

(Seconds)



SHORTER BARS INDICATE BETTER PERFORMANCE

Pavilion line is solidly mid-tier elsewhere, the reliable family sedan of gaming laptops.

With both the Omen and Pavilion lines, HP opted for Intel's familiar Core i7-9750H part, allowing us to do some head-to-head testing. And you know what? The Pavilion Gaming Laptop really is an Omen in disguise. Below you'll see the results of our HandBrake test, wherein we use the free utility to encode a 30GB MKV file down to the "Android Tablet" preset.

We've tested and tested and tested the Core i7-9750H and the Core i7-8750H before it, so any deviation sticks out. Notice that the Pavilion Gaming Laptop drastically underperforms compared to the Dell G7 and MSI GS65—with the Omen 17 sitting right alongside. Both struggled with this task, taking nearly five minutes longer than the norm.

As I said in our Omen 17 review, it doesn't really matter. Most games are constrained by the GPU, not the CPU.

Day-to-day use is unlikely to tax a CPU as hard as HandBrake, and short-burst performance is less impacted, as evidenced by our Cinebench testing below.

The HandBrake results are interesting, though, if only because there's a clear relationship between the Omen and Pavilion lines. These really are two flavors of the same laptop, one aimed low-end and one high-end, with some minor overlap in the middle.

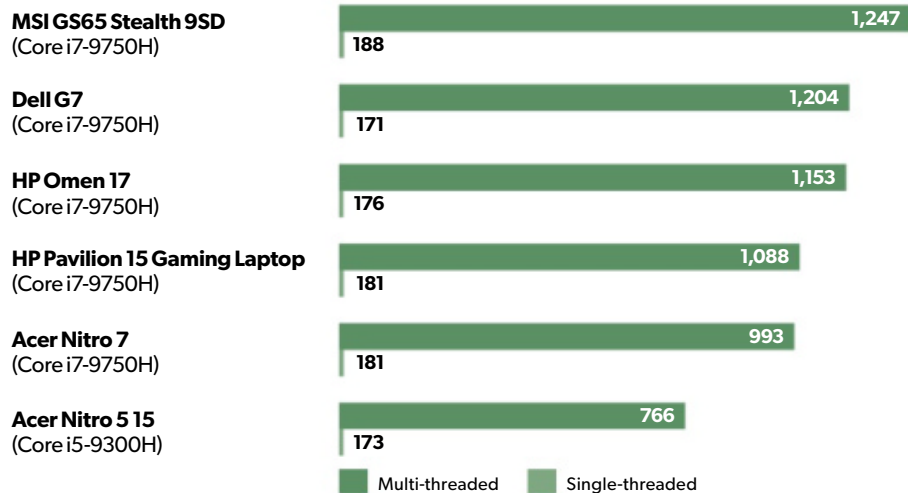
I do wish we'd tested an HP Omen with a GTX 1660 Ti so we could do further direct comparisons. Alas, the Omen 17 we tested (go.pcworld.com/om17) in November contained a full-size RTX 2070, a high-performance powerhouse.

The GTX 1660 Ti is a humbler card, somewhere between the power

of the last-gen GTX 1060 and the RTX 2060, and without the ray-tracing capabilities provided by the latter. It handily beats out the GTX 1650, though—important, given that it's a lower-cost option for the Pavilion Gaming Laptop. You're much better off with a GTX

Cinebench R15.038

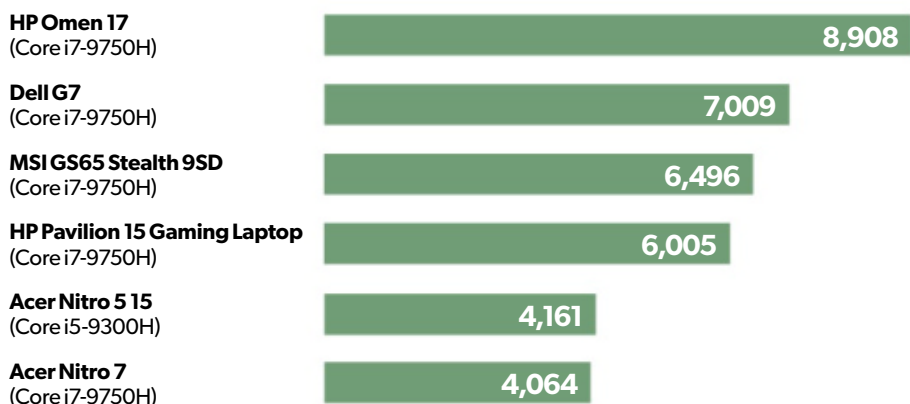
(All threads)



LONGER BARS INDICATE BETTER PERFORMANCE

3DMark FireStrike Extreme 1.1 Graphics

(Demo mode off)



LONGER BARS INDICATE BETTER PERFORMANCE

1660 Ti, as evidenced by our 3DMark testing.

Is the GTX 1660 Ti worth the extra \$270 HP charges? That's a steep price, but I think so. The GTX 1650 works, but barely. With new consoles coming next year, the GTX 1660 Ti is a slightly more future-proofed option. It's still going to struggle to run newer games with all the bells and whistles, but it should remain viable an extra two or three years longer than the GTX 1650—and by then we'll be well into the next hardware cycle, and upgrading won't feel as volatile.

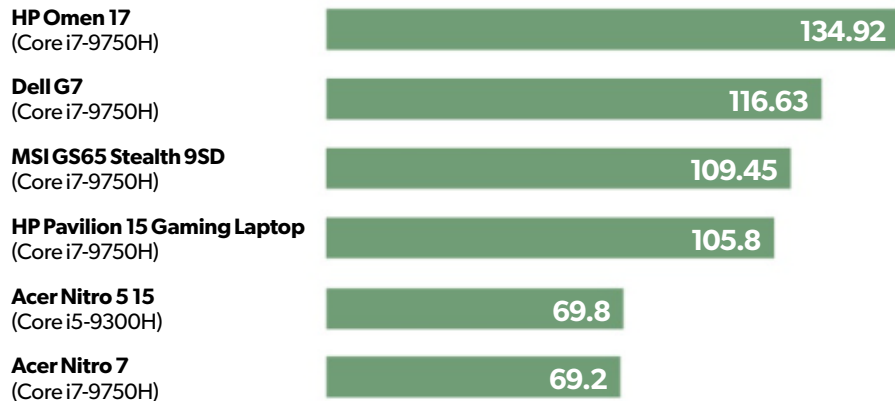
The gap in performance is even more evident in real-world testing, where the GTX 1650 struggles to run *Shadow of Mordor* at Ultra—a six-year-old game—while the GTX 1660 Ti breezes past the 100-frames-per-second mark. *Rise of the Tomb Raider* is less

impressive as that game is more CPU-constrained, but there's still a jump between the GTX 1650 and the GTX 1660 Ti.

Per usual, we end on battery. Based on our chart, the Pavilion 15 handily beats the Omen—and several other gaming laptops as well. Lasting well over five hours, battery life is

Middle Earth: Shadow of Mordor

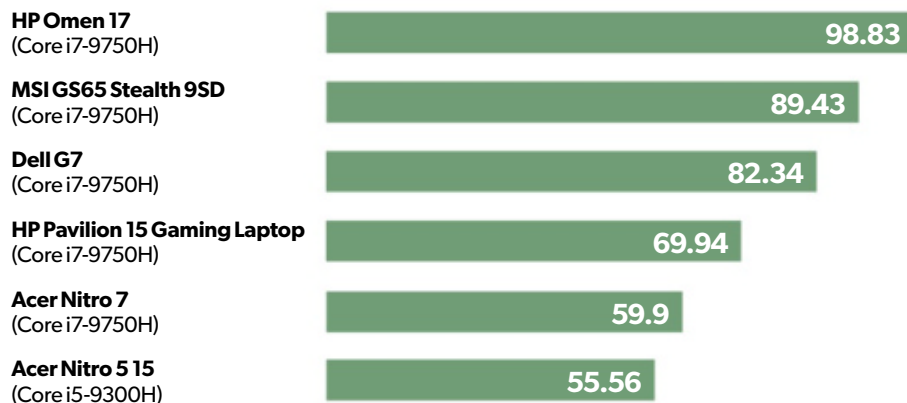
(Frames per second)



LONGER BARS INDICATE BETTER PERFORMANCE

Rise of the Tomb Raider

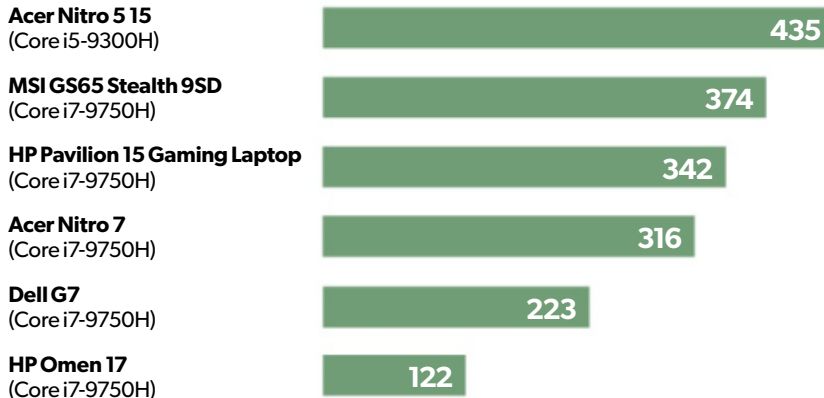
(Frames per second)



LONGER BARS INDICATE BETTER PERFORMANCE

4K Video Playback Battery Life

(Minutes)



LONGER BARS INDICATE BETTER PERFORMANCE

that we reviewed is a hard sell. It's close in price to a similarly configured Omen, but with a dismal display and no mouse buttons. You'd be better off spending more for the Omen, I promise.

The Pavilion Gaming Laptop nevertheless punches well above its weight in the entry-level range. If

actually very respectable.

Remember that the numbers don't tell the whole story. We typically do our battery testing at 250 nits, but as I said earlier the Pavilion Gaming Laptop dims to 200 nits when unplugged. Thus our result here comes with an enormous asterisk, because the screen might be too dark for you to actually use the Pavilion Gaming Laptop, no matter how long it lasts. That said, the Omen 17 we tested had a better screen but terrible battery life. It's a compromise either way.

BOTTOM LINE

I came into this thinking I'd find a pitched battle between HP's Pavilion and Omen lines. Really, they're just two sides of a coin. The Pavilion's your entry-level Omen, whether HP's willing to call it that or not.

As such, I think the Pavilion Gaming Laptop

you're looking for a sub-\$1,000 gaming laptop, HP's built one every bit as sturdy and refined as its high-end counterparts—because at the core, they're the same laptop. Branding is funny sometimes, eh? 

HP Pavilion Gaming Laptop 15-dk0045cl



PROS

- Understated design.
- Solid deal on entry-level hardware.
- Long battery life.

CONS

- Lacks dedicated left and right mouse buttons.
- Dim screen.
- Intel's Core i7-9750H underperforms in HP's implementation.

BOTTOM LINE

HP's Pavilion Gaming Laptop (15-dk0045cl) is just a low-end Omen without the Omen branding—and more importantly, without the Omen's better-looking screen.

\$1,250

Kentucky Route Zero: The game that defined (and was defined by) a decade

Wild horses couldn't drag me away. **BY HAYDEN DINGMAN**



It's said that Velvet Underground's first album sold dismally, but that everyone who bought a copy later

started a band. *Kentucky Route Zero* didn't sell quite so poorly, but it's destined to take up a similar position in the game industry's psyche I think. It defined a decade, and was in turn defined by that decade.

I hadn't touched it until this week. The first chapter released in 2013, before I got paid to

write about games. I naively thought, "I'll play it when it's done." Now I'm seven years older and coming up on my seventh anniversary at *PCWorld*. Everything has changed. *Kentucky Route Zero* has finally finished.

And oh, what a journey.

THE ROAD LESS TRAVELED

Coming to *Kentucky Route Zero* this late is fascinating because there's a sense of familiarity that I doubt existed in 2013. It is still one of the

strangest and most ambitious games I've ever played—and yet slightly less so, because like the Velvet Underground, *Kentucky Route Zero* has gone on to inform so much that came after. Even if you've never played a single moment of it, you've probably played something made by someone who did.

Disco Elysium (go.pcworld.com/dsel) seems like an obvious heir, its prosaic and dreamlike writing very reminiscent of *Kentucky Route Zero*. *Where the Water Tastes Like Wine* (go.pcworld.com/wine) and its Americana folklore and fascination with the open road, that's another. Inkle's games (go.pcworld.com/inkl), and the idea that lots of small choices are more important than a few massive ones. *Celeste* (go.pcworld.com/celt), and how it handles conversations. And the list goes on, a list that includes *Night in the Woods* (go.pcworld.com/ntwd), *Paratopic*, maybe even *Control* (go.pcworld.com/cntl).

Perhaps I'm wrong. It's hard to point fingers and name names, to say, "Well this

game was clearly influenced by *Kentucky Route Zero*." Not without the developers copping to it, anyway. I recognize so many other games within *Kentucky Route Zero* though, or rather the reverse.

And the common denominator is writing.

Kentucky Route Zero is a game of conversations. There is walking between conversations, and a genre purist might call it an adventure game. Like *Heaven's Vault* though, or *Disco Elysium*, the walking is only ever in service of more reading and the occasional stunning vista.

You start the game as Conway, a truck driver with one last delivery to make. Trouble is, he can't find the address, a "5 Dogwood Drive." He and his dog have stopped at a gas station to ask directions, only to find out his destination lies down the titular Route Zero. Where's Route Zero? Nobody really knows—but oh, Weaver Marquez might be able to help you find out, and so off you go to find her.

That's the hook.

Forget the mystery for a minute though. Something more important happens in that first scene. In the first conversation, even. You walk up to the gas station attendant, introduce yourself, and then





the attendant asks for your dog's name. Three options pop up: "Homer," "Blue," or "Just some dog, I don't know his name."

Moments later the attendant tells you to log into his computer, says the password is something "lyrical," and that you'll "feel it out." Again, multiple options are given, lines like fragments of a poem.

"Wheels slide loose,"
 "The stars drop away,"
 "You just breathe road," and so on. There is no right answer, no puzzle to solve. Whatever you choose, that's his password. The decision matters because you chose it,

not because someone references it six hours later.

Even by 2020 standards, with many of the games it inspired already in the rearview, *Kentucky Route Zero* has a remarkable view of the player's role. It's authorial almost, allowing you to not only define the character you're playing but the world he lives in. And even





that's not entirely correct, as *Kentucky Route Zero* soon expands to multiple characters with multiple viewpoints, and you're often controlling both parts of a back-and-forth conversation. You're the writer, the director, the actors, all of it.

The entire undertaking is sprawling and unwieldy and messy and disjointed, and in some way I think that's why it's successful. It's unlikely that every part of *Kentucky Route Zero* will resonate with every person, but you're almost guaranteed to find something to latch onto.

It's about found family and lost family, the burdens of capitalism and the ways we define ourselves by our work, the slow decline of rural America but also the mythology around it, self-determination versus community, gentrification, the small rituals we perform daily.

And sometimes it's about none of that. *Kentucky Route Zero* rewards picking apart its every scene, but it's also a joy to simply exist

within its world. On that level, it's a surreal road trip about a non-Euclidean highway and TV repairs and two android musicians and a museum filled with houses. It's a young boy and his big brother, an eagle, and the

flights they take together nightly. It's an impossible forest, a captivating visual reference to Magritte's painting "The Blank Signature." It's an underground lake and the restaurant that floats in the middle, serving up strange creatures to its loyal patrons. It's a telephone hotline that says "For the monument to something that we don't remember, press three."

And sometimes it's a 40-minute theater production, an homage to *Waiting for Godot* that you sit and watch in real-time. Sit, watch, and do nothing—except you're a participant in the play, and your role is to do nothing, so really you're an actor...right?

Kentucky Route Zero is a weird and wonderful experiment that I find almost impossible to write about in its fullest sense. Instead, certain sequences keep playing out in my head.

One in particular has stuck with me. Towards the end of Act IV you find yourself in what used to

be a train station, before it was flooded. It was then reclaimed for use by the phone company, housing the switchboards and the operators needed to run them. Then the omnipresent Consolidated Power Company (a key antagonist) bought up the phone lines and fired all but one of the operators, saying they needed her to train an automated system to eventually do the work.

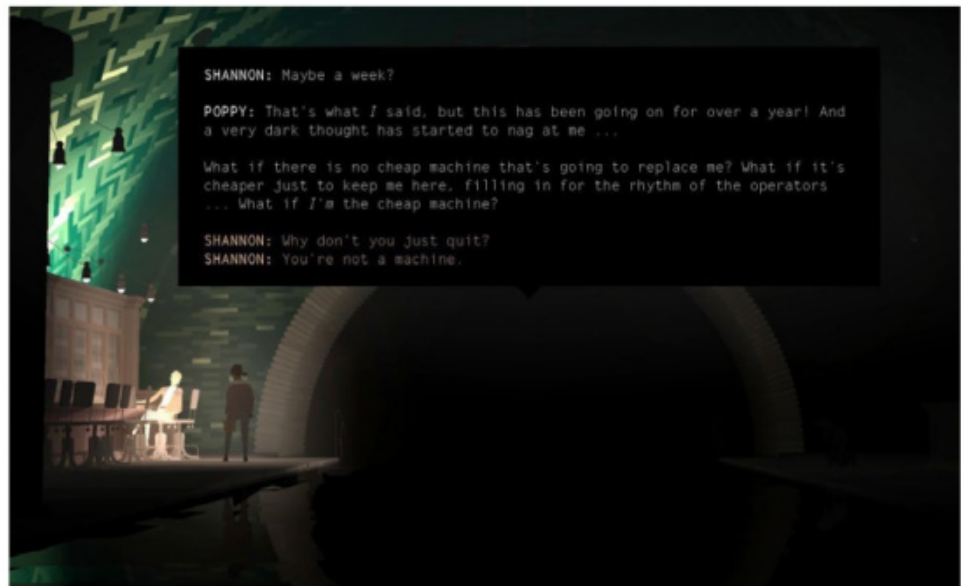
She explains all this, the slow decay of this once vibrant work environment, victim to an unfeeling and unsympathetic corporation. And then, having talked through it, she realizes the truth: That there is no automated system, no relief coming, and that the Consolidated Power Company simply fired

everyone else and left her here in the dark to do the work of thirteen people, forever.

That it's cheaper for them that way.

I don't know why that sequence hit me so hard. Of all the criticisms *Kentucky Route Zero* levies at capitalism, this is neither the subtlest nor the most poignant. I suspect it's because journalism's taken on that same feeling for me, of everyone making do with less and less. Less

money, less people, less time. To be clear, journalism is not the only industry suffering under those conditions, and I am (comparatively) blessed to work with *PCWorld* of all outlets. But still, for a moment I recognized me and my compatriots and



my friends in that poor telephone operator, waiting for another golden age that will likely never come.

Anyway, *Kentucky Route Zero* is the type of game best enjoyed in the wee hours of the night, an hour at a time. And it's the type of game best enjoyed twice, or maybe even three times. I've now replayed the first episode (or act), and it's amazing how much is set up in those early hours that doesn't pay off until three, even four acts later. *Seven years*. A lifetime, for me and for the country and for the development team as well.

Auteur theory is unpopular in video games, and for good reason. It usually entails misallocation of credit, either unintentional or intentional. In the case of the former, the "lone genius" getting praised for the work of the team. In the latter, "a giant asshole" stealing that same praise.

It seems relevant in light of *Kentucky Route Zero* though. Cardboard Computer is three people, and you can almost feel them change over time, and the game changing with them. Even taken all in one sitting, or maybe especially when taken in one sitting, it's hard not to notice how certain story threads are entertained and then cast aside, how certain themes become more or less prominent as you venture through the five acts.

As I said, it's a game that defined a decade and was defined by it in turn. It was one of the earliest crowdfunding successes, completed after crowdfunding mostly died off. An entire console generation passed. The indie scene

rose and fell and then rose again. Eons passed.

And now it's finally over. I hope the developers get some rest.

BOTTOM LINE

Above all, *Kentucky Route Zero* is an argument that games can be more. That argument isn't nearly so revolutionary now as it was in 2011 when development began, or 2013 when the first act released. We've (thankfully) made some decent progress in the years since. People bought *Kentucky Route Zero*, and those people did go start their proverbial bands.

It's still a stunning piece of fiction though. Surprising from beginning to end, I finished and felt heavy—my head, my heart, all of me just heavy. Two days later and I'm still digesting it, still figuring out what it means for me as a person and a writer.

Hell, maybe I'll start a band too. 

Kentucky Route Zero



PROS

- Surprising from beginning to end.
- Plays with dialogue and scenery in fascinating ways.
- Uses magical realism as a vessel for a rich subtextual layer.

CONS

- Movement can be finicky.
- Less revolutionary now than it was in 2013.

BOTTOM LINE

A magical adventure almost a decade in the making, *Kentucky Route Zero* is every bit as good as you've heard—and maybe more.

\$24.99

RECYCLING **IS** CREATING

When you recycle, you create something new.

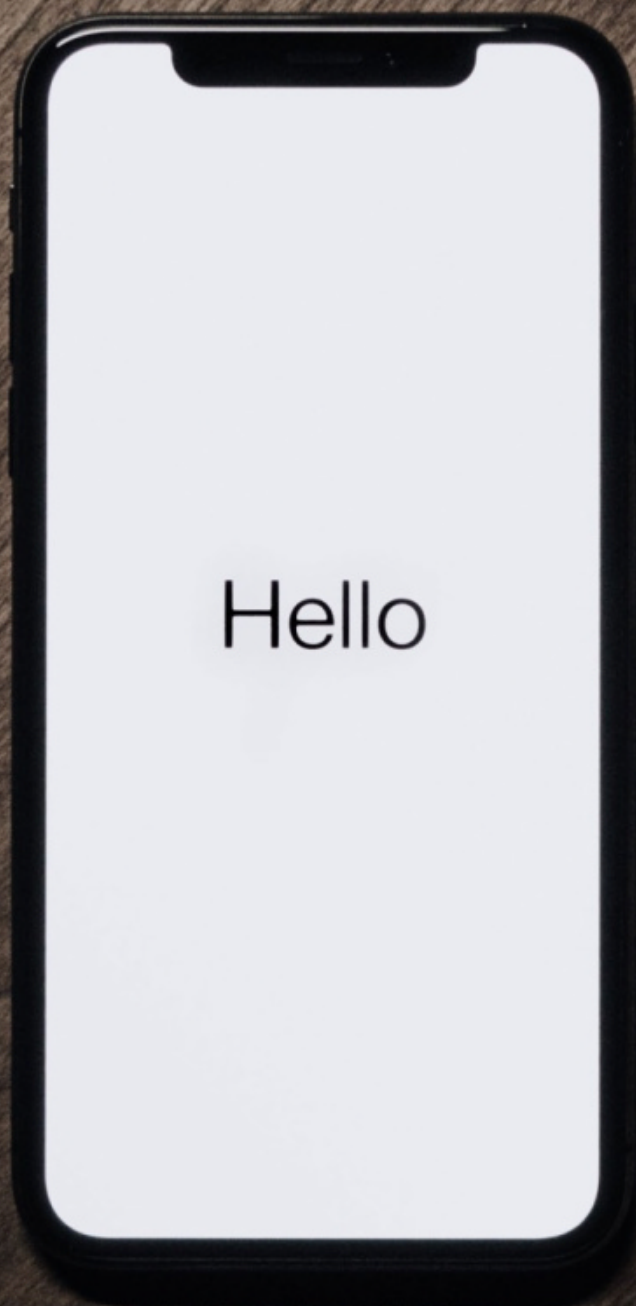


His first football season, Isaiah told us, ‘Wear a jersey with my name on it. I want everyone to know you’re here for me.’

Darnell and Denna, adopted 16-year-old Isaiah



I SWITCHED FROM ANDROID TO iPHONE:



HERE'S WHERE APPLE'S PHONE WINS & FAILS

WHAT HAPPENS WHEN AN ANDROID DIE-HARD SWITCHES TO iPHONE? OUR ANDROID EXPERT EXPLAINS WHERE APPLE IMPRESSED HIM—AND WHERE HE EXPERIENCED MAJOR PAIN POINTS.

BY RYAN WHITWAM

I hopped on the Android bandwagon early: I sold my iPhone 3G in 2009, bought an HTC Hero, and never looked back. I've been using Android every day since then, writing about Google's platform as a tech journalist. Nonetheless, I've tried to keep pace with iPhone developments, and recently set aside a week of my life to get reacquainted with Apple's smartphone.

I put all my Android phones in a drawer and settled into life with the iPhone 11 Pro. Admittedly, the iPhone does some things extremely well, even for a long-time Android user like myself. However, there are also plenty of things I hate with a fiery passion.

WHERE THE IPHONE WINS

Apple's Taptic Engine: Haptics are an under-appreciated but important aspect of interacting with a smartphone, and Apple understands this. The "Taptic Engine" is essentially a giant vibration motor bolted right to the iPhone's frame, and it's fantastic. The haptic feedback is tight and powerful, surpassing all Android phones on the market. It can almost feel like you're pressing physical buttons on the screen sometimes. Google's Pixel phones have by far the best haptics on Android, but even those devices are far behind Apple.

Gesture navigation: I was

skeptical when Apple decided to make gestures mandatory for navigating its phone, but its gesture scheme is a significant improvement on a physical button. In fact, Apple's gesture approach is the best I've seen. The gestures are all incredibly smooth and don't require long swipes—it feels like you're flinging the UI around. I also appreciate that the gesture pill at the bottom of the screen doesn't take up too much space. There's a reason Google straight-up copied some of Apple's gestures in Android 10.

Battery performance: Apple prioritizes battery life on the iPhone, and that's a refreshing change for me. The early days of Android were a free-for-all in which app developers could do almost anything, and many apps siphoned off battery power with impunity. Google has tamped down on the



iPhone gestures beat Android phone gestures. They just do.

worst excesses, but iOS has always been more measured. It slowly added new features to the OS, and apps are kinder to your battery as a result. The iPhone 11 Pro will last an entire day, even if you use it heavily. It's about on a par with Android phones with 20 to 30 percent larger batteries.



The iPhone's silent mode switch sure comes in handy.

Silent switch: The

iPhone's silent mode switch is a quick, simple way to shut up your phone. My old iPhone 3G had one, and I'm happy Apple has stuck with it. There are still ringer volume controls and a Do Not Disturb mode, but you have to wake up the phone to use those. The iPhone's switch doesn't move far, but it has delightful tactile click, and you get haptic feedback when activating silent mode. It's so easy and reliable, you can change the ringer mode while the phone is in your pocket.

True Tone display: Color accuracy is a noble ideal, but that's not always good for a phone display you might be staring at for hours. Apple's True Tone technology tweaks the color temperature of the display based on environmental lighting, making it easier on the eyes. So, you get nice, bright whites outside and warmer, less-distracting tones inside. The iPhone screen "blends in" with the world much better than other phones I've used. Google has a similar feature on the Pixel

4, but it's nowhere near as effective.

AirDrop: Sharing content with the internet at large is easy these days—there's Facebook, Twitter, Snapchat...take your pick. But sharing something securely with a person right next to you is comparatively difficult on Android. On the iPhone, it's a breeze thanks to AirDrop. Just hit the share menu, pick AirDrop, and nearby contacts will appear like magic. The recipient has the option to accept or decline each transfer. If you're daring, you can even allow AirDrop visibility for people who aren't in your contact list.

WHERE THE IPHONE FAILS

The home screen: Ten years after I left the iPhone behind, its home screen remains almost entirely unchanged. This was one of the biggest pain points for me coming over from Android—I missed my app drawer so much. In addition, iOS only supports rudimentary widgets, and they're all crammed

Default apps: Try as you might, you will never escape Apple's default apps on the iPhone. You can install different browsers, email clients, and so on, but they'll be treated like second-class apps on Apple's platform. For example, URLs will always open in Safari. If someone sends you an address, it'll open in Apple Maps. Apple grudgingly added support

No always-on display: Apple was late to the game with OLED screen technology, and it's missing one of the key benefits now that it does use them. Most Android phones have support for an always-on display feature, sometimes called an ambient display. This allows you to see notifications and other information at a glance, and it doesn't drain the battery much because black OLED pixels use no power. Apple doesn't have anything like this, and the iPhone wakes up the full

Notifications:

Apple had just implemented push notifications when I ditched the iPhone years ago. Today, Apple has a notification center that looks a bit like Android's, but the similarities are only skin-deep. The



Apple's insistence on pushing default apps is downright annoying.

iPhone's notifications management is far, far behind Android. The phone dumps notifications into a different section after you've seen them once, making it difficult to track things down. When you do find that notification, the snippet might be too short, and notifications don't expand like they do on Android. You have to open apps to get more context—how barbaric.

Clearing notifications also requires multiple actions (like a swipe, followed by a tap). And then we have the icon badges, which are a profoundly bad way of relaying information to the user. Apps can notify for all kinds of reasons, and the red counter doesn't tell you anything about why an app wants your attention. They also have zero relationship with what's in your notification center.

Lightning and charging: I'm heavily invested in USB Type-C at this point. I have computers, headphones, cameras, and even keyboards that use the new standard. So, moving to Apple's Lightning port was extremely disruptive and it offered zero benefits. USB-C is not only universal, it supports extremely fast charging speeds. Even with Apple's new, faster charger, many Android phones leave it in the dust.



Apple's approach to notifications is just bad UX. Bad, bad, bad.

Apple has already moved to USB-C on tablets and laptops, so it's probably just a matter of time until it does the same on phones. Until then, iPhone users are stuck with this proprietary cable.

Siri: Apple was the first smartphone maker to push a virtual assistant as a game changing feature, and Siri was basically unopposed for several years. But Google Assistant is a much better experience than Siri today. Assistant has more smart home integration, much better general search functionality, and it's much more adept at understanding queries. I also like that Assistant is more fully integrated with my data on Android. Perhaps Apple's careful approach to privacy is part of the problem here, but I'm willing to trade a little privacy for a digital assistant that doesn't make me want to pull my hair out. 🔌

WILL VIRTUAL REALITY FINALLY BREAK OUT IN 2020?

BY HAYDEN DINGMAN

THE HARDWARE IS CHEAP, THE GAMES ARE PROMISING, AND VIRTUAL REALITY COULD FINALLY BE READY FOR THE MAINSTREAM. OR AT LEAST, THE SLIGHTLY MORE MAINSTREAM.



Maybe this will be the year virtual reality goes mainstream. If we say it enough times we'll be right eventually, yeah?

But it really does feel like 2020 might be the year. Four years into consumer virtual reality, I finally feel *excited* again. The hardware is great, and cheaper than ever before. The games are promising, albeit few. And there's a sense that maybe the "We need software to sell hardware to make developing software worthwhile" vicious cycle has finally been overcome. *Maybe*.

I could be wrong. I certainly hate to get excited about virtual reality's prospects in 2020, in a "Fool me twice" sort-of way. I've had my heart broken by VR before. And yet...

QUEST FOR GLORY

If VR does take off in 2020, much of the credit needs to go to Oculus and its Oculus Quest (go.pcworld.com/ocqu). And listen, I love the fidelity of Valve's high-end Index headset (go.pcworld.com/indx) driven by my desktop PC and its Nvidia GeForce RTX 2080 Ti. Who wouldn't? The image quality is fantastic, the tracking is pinpoint precise, the sound is





confined to a small room, but they have a sizable living room that would be perfect for room-scale VR. Not to mention the fact that you can travel with Quest, or take it to a friend's house to demo.

And for an extra \$80, you can have a perfectly capable PC-based VR system anyway. Oculus

phenomenal.

The Quest is none of these things. It looks okay. The tracking is easily broken. The sound is good enough.

It doesn't matter, because Oculus broke free from the tyranny of the tether. Suddenly VR isn't a \$1,500 investment but a \$400 one, period (at least when stock is available). No hidden costs, no "Oh, actually you need to upgrade your graphics card."

Even if you have a gaming PC, Oculus Quest's flexibility is mighty appealing. I have plenty of space to use the Index with my desktop, but still find myself reaching for the Quest simply because it's less hassle. Friends of mine have expressed an interest in Oculus Quest because their PC is

Link (go.pcworld.com/ocln), which went into beta in November, allows you to hook the Oculus Quest up to your PC with a USB-C cable. There are cheaper cables on Amazon for \$20 or so, but Oculus now sells a bespoke cable for \$80 that's both longer and lays flat along the side of the headset, which is a little less janky than having some random Anker cable sticking out the side at a right angle.

It's the headset that VR needed. There's a



place for Index, and its cousin the HTC Vive Pro (go.pcworld.com/vipr). Hell, there's still a place for the original Vive hardware as well (go.pcworld.com/rviv). Oculus Quest is a great untethered headset though and a "good enough" entry-level tethered headset, and it's *cheap as hell*. No surprise people are buying it in droves.

SELL OUT WITH ME

And people *are* buying it. That's, I think, the second part of this story. It's hard to get reliable sales figures, as neither Valve nor Facebook appears interested in making

those numbers public.

There was a lot of encouraging news last year though. First, Mark Zuckerberg claimed during a midyear earnings call that "We're selling [Oculus Quest units] as fast as we can make them."

Soon, even that wasn't enough. The holidays were full of reports of Quest shortages...pretty much everywhere. In fact Quest is *still* sold out on Amazon at the time of this writing, or at least only available through resellers for an inflated price. Placing the order through Oculus's site (go.pcworld.com/oculus), I'm told it will ship by March 4.





Valve's Index is hard to get, too. The first reports of Index shortages came in late November, and by early December it was gone. Valve kept orders open for a few more weeks, with shipping estimates slipping first to February, then to March. And now? Going to the Index's Steam page (go.pcworld.com/inpg), you're met with a Notify Me button. Valve's effectively closed orders until it can meet the existing demand.

Even the much-maligned Oculus Rift S headset (go.pcworld.com/srft) is sold out for the moment. That'd be my last pick for VR now that Quest does everything the Rift S does and more, but Oculus is still struggling to keep up.

Again, it's hard to pin *actual numbers* to any of these headsets. For all we know, Valve

made a dozen Index kits for the holidays, sold out, and is now trying to build a dozen more. Until we see sales figures, it's hard to know otherwise.

And as a percentage of the PC audience? The numbers remain a rounding error. Looking at the Steam Hardware Survey (go.pcworld.com/shas), all the Vive and Rift and Index owners combined still make up less than 1 percent of Steam users. Hell, throw in the Windows Mixed Reality owners as well, you still only get 0.87 percent of the Steam audience owning a VR headset—or about 800,000 people, doing some back-of-napkin math.

Sure, that doesn't account for Oculus Quest owners, nor for those who own a headset but don't keep it regularly hooked



Half-Life: Alyx.

up. Still, VR's a long way from mainstream.

There's interest in the platform though—and growing interest, if the current shortages are anything to go by. People want VR, or at least enough people to outpace whatever Valve and Oculus planned for ahead of time.

HALF-LIFE, AND MORE

While Oculus deserves most of the credit on the hardware side of virtual reality, it's safe to say Valve deserves most of the credit on the software side.

It feels almost unfair to write that, because Oculus has put a lot more money into VR's software ecosystem since 2016, funded a lot of studios both internal and external, and put out a lot of good-to-great games. *Lone Echo*,

Wilson's Heart (go.pcworld.com/wlht), *Stormland*, *Asgard's Wrath*—Oculus has had a hand in a staggering percentage of the VR games worth mentioning since the Rift's consumer launch.

And they'll continue to do so in 2020. In September, we finally got a look at Respawn's long-awaited partnership with Oculus, and it's *Medal of Honor: Above and Beyond*. That's a huge series to see resurrected on VR, whether or not I came away impressed by our initial demo (go.pcworld.com/mdem). Ready at Dawn's *Lone Echo II* is planned for 2020 as well, and given the original is one of Oculus's (and VR's) strongest titles, I'm hoping the sequel can set the bar even higher.

If there's a forthcoming game fueling a rush on VR headsets though, it's undoubtedly *Half-Life: Alyx* (go.pcworld.com/alyx). Announced in November and set for a March release, it's the first *Half-Life* in over a decade—and it's a VR exclusive.

Note that it's not an *Index* exclusive. Sure, Index owners get the game for free and the Index controllers will have some additional functionality, but Valve's been very clear that you can play *Half-Life: Alyx* on a Rift, Rift S, Quest, Vive, HP Reverb, or whatever the hell you have lying around.

This is Valve's big first-party VR push though. And it's the closest we've got to a system seller. I don't think that's a controversial statement—and I say that as someone who absolutely loves *Google Earth VR* (go.pcworld.com/govr) and *Tilt Brush*, *Job Simulator* and *Vacation Simulator*, *Lone Echo*, *Asgard's Wrath*, *Audioshield* and *Pistol Whip* and *Beat Saber*, *Robo Recall*, *Moss*, and too many more to mention.

Point being, I've played a lot of VR games over the years, and had favorites come and go. I keep a mental shortlist of games for new owners to buy, games that are great to show off to first-timers, and so forth. I imagine every VR headset owner has a similar list.

But none—no matter the quality—have done so much with so little as *Half-Life: Alyx*. With one trailer, Valve upended the entire idea of what a "major" VR title might mean. I don't know if it will be good, or even

interesting. Nor do I know whether it will outsell *Beat Saber*, the success of which made arcade/session-style games *de rigueur* for the last year or two, at the expense of more ambitious (and risky) narrative-heavy experiences.

Still, there's a feeling I think that in *Half-Life: Alyx*, virtual reality finally has its showcase experience. This is Valve's chance, and by extension everyone's chance, to prove the platform's usefulness. That's a lot of weight to put on one game, but it's almost certainly what's fueling recent sales, and if in the future VR is as common as WASD controls and physics engines, I expect March of 2020 will be seen as a major inflection point.

BOTTOM LINE

Or maybe *Half-Life: Alyx* will come and go and VR will continue on as it has, slow and steady. There's that possibility as well. I remember the heady days before the consumer launch of virtual reality, following each new development and thinking "Wow, VR is going to change everything." Four years later, it hasn't. Not even close.

Maybe VR's moment is 2020. Maybe it's 2021. Maybe it's 2031. If nothing else, I'm confident VR isn't disappearing anytime soon, even if "Slow but constant growth" isn't nearly as compelling a story as "One day, everything changed." 



PICTURE SOMEONE STRUGGLING WITH
HUNGER. WHAT DO THEY LOOK LIKE? DO
YOU IMAGINE A CERTAIN AGE, ETHNICITY
OR PART OF THE COUNTRY? TRUTH IS,
HUNGER CAN BE HARD TO RECOGNIZE.
BECAUSE THE 1 IN 8 AMERICANS FACING
IT CAN LOOK LIKE ANYONE. ESPECIALLY
ME. I WAS CREATED BY ARTIFICIAL
INTELLIGENCE FROM PHOTOS OF THE
40 MILLION PEOPLE STRUGGLING
WITH HUNGER IN THIS COUNTRY. A
FACE THAT CHALLENGES YOU TO SEE
HUNGER IN A DIFFERENT LIGHT. I AM
WHAT HUNGER LOOKS LIKE IN AMERICA.
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Based on USDA food security data released in 2018





Use your TV as a computer monitor

Everything you need to know. **BY SARAH JACOBSSON PUREWAL**

You're not the first person who's wondered what it would be like to have a giant desktop monitor. Think of all the multitasking and immersive gaming you could manage if you had a 50- or 60-inch monitor instead of a standard 24-inch monitor! But you've probably noticed that as monitors get bigger, they also tend to get prohibitively expensive.

You've probably already got a big screen in your house, though—a TV. At the end of the day, isn't an HDTV just a giant, living-room-oriented computer monitor?

Not exactly. While you can use a TV as a computer monitor in most cases, that doesn't mean it's the best option. In fact, it's likely less attractive, convenient, and usable than you think (not to mention, probably not that cheap). There's a reason dirt-cheap

32-inch HDTVs aren't flying off the shelves to be used as budget-friendly jumbo screens.

You definitely can use an HDTV as your PC's display, though. Here's everything you need to know about how to set up a TV as a computer monitor—and why you might not want to.

WILL IT EVEN WORK?

The short answer: Yes. You may need a special cable, depending on your PC's outputs and your HDTV's inputs, and you'll need to check a couple of settings, but you shouldn't have too much trouble hooking most modern PCs up to most modern HDTVs.

Modern HDTVs have HDMI outputs. Some older HDTVs have DVI inputs, and some even have VGA inputs specifically designated for "PC use." If your graphics card has an HDMI output, you're good to go: Just use an HDMI cable to connect your PC to your HDMI.

If you're using an older graphics card or motherboard that only has a DVI output, you can snag a cheap DVI-to-HDMI cable and plug it into your HDTV's HDMI output. Amazon sells a six foot AmazonBasics version for just \$7 ([go.pcworld.com/amb7](https://www.amazon.com/AmazonBasics-HDMI-Cable/dp/B009058800)). Although some older HDTVs and some older computers only have VGA inputs/outputs, they aren't an ideal choice. VGA's an analog signal that will give you a far fuzzier, lower-resolution image than you'll



HDMI connectors are ubiquitous, and even Amazon brands its own.

get with an HDMI or DVI cord.

If you want to use your HDTV as a second or third monitor, you may need to use a different port, such as your graphics card's DisplayPort output. In this case, you'll need to use a different cable (DisplayPort-to-HDMI). The main advantage to using the DisplayPort output instead of DVI or VGA is that HDMI and DisplayPort carry both video and audio signals. A DVI-to-HDMI cable can transmit both video and audio if your graphics card supports HDMI audio via DVI—unlikely if it doesn't have any HDMI ports—while VGA only transmits video. If you use DVI or VGA, you will most likely need to connect your PC's audio up to the HDTV separately, or use external speakers or a headset.

Bottom line? Try to stick to HDMI or

DisplayPort-to-HDMI connections if it's possible. It's the easiest solution.

GETTING YOUR PC READY

You'll also need to determine whether your graphics card (or your PC's integrated graphics) is capable of outputting at the resolution of your HDTV. To do this, you will first need to find the resolution of your HDTV by consulting the manufacturer's manual. Some HDTVs have non-standard resolutions; it's not a given that your HDTV will be supported. Most stick to standard 720p, 1080p, or 4K resolutions however. Next, find the maximum resolution your graphics card/integrated graphics supports.

Open the Windows 10 Start menu and head to *Settings > System > Display > Advanced Display Settings > Display* and select Display 1 under *Choose Display*. In the window that pops up, click List All Modes. Find the resolution that matches your HDTV's

resolution and select it.

Will it look good? Maybe. It depends on how you're using it.

HDTV FEATURES TO KEEP IN MIND

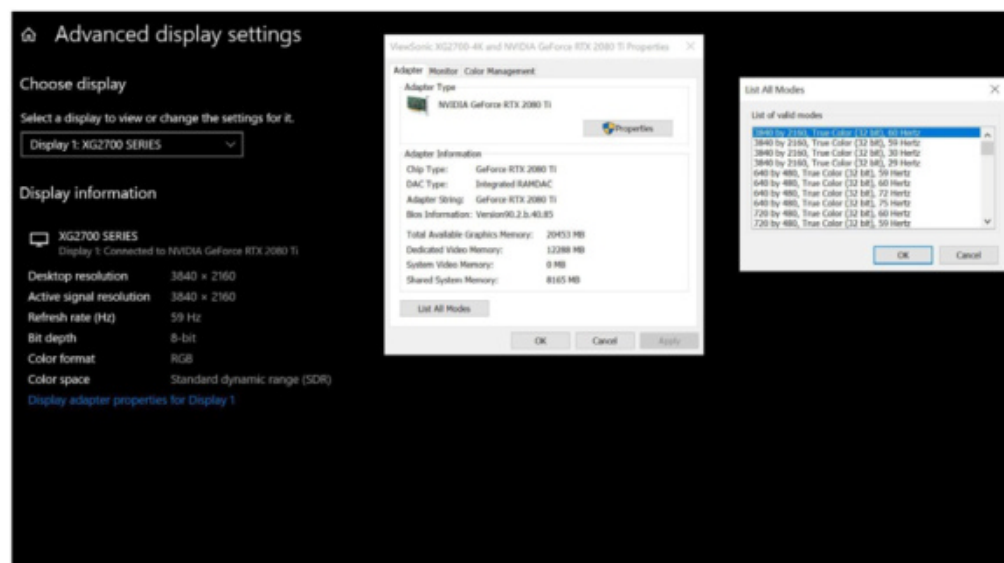
If you're turning your HDTV into a PC-backed multimedia powerhouse, and you plan on using it primarily as a television and streaming hub—e.g., a screen you'll continue to view from several feet away—it will probably look fine. But if you're trying to stick a 60-inch HDTV on a desk, you're more likely to end up with headaches and eye strain.

There are a few different factors to keep in mind if you want to use an HDTV as a computer monitor.

Pixel density

Pixel density, or the number of pixels packed into one square inch of screen (measured in

pixels per inch, or ppi), is the most important factor to consider. A 15.6-inch laptop screen with a 1920 x 1080 resolution has a pixel density of 141.21 ppi, while a 32-inch HDTV screen with the same resolution has



a significantly lower pixel density of 68.84 ppi. The lower the pixel density, the less clear and detailed the image becomes.

But the importance of pixel density decreases with viewing distance. The further you sit from a screen, the lower the pixel density needs to be for you to have a comfortable viewing experience. You won't have any problems looking at a 15.6-inch/141.21 ppi screen from two feet away, but you will find it much harder to view a 32-inch/68.84 ppi screen from the same distance. This is why a "Retina" screen on the iPhone has a pixel density of 326 ppi, but a Retina screen on the MacBook Pro has a pixel density of just 226 ppi.

A normal user typically sits between two and three feet away from a desktop monitor. To comfortably view a monitor at this distance, you should aim for 80 ppi or higher. This means that for 1920x1080 (1080p) resolution, your screen should be

no larger than 27.5 inches diagonally, and for 4K sets, you'll want to max out at 55 inches, like the \$500 TCL 55R617 4K UHD Roku TV (go.pcworld.com/55r6) shown below. We reviewed it, and it's solid.

Important: "4K" is not a market standard. A 4K HDTV can mean 4x720p (3840x2160 resolution) or 4x1080p (4096x2160 resolution). Most models use 3840x2160, but you should check the exact specs of your model to determine pixel density.

Input lag

Input lag (go.pcworld.com/inlg) is the delay between movement you make on your input device (in this case, a mouse and keyboard) and what displays on your screen. While most computer monitors prioritize minimal lag times, HDTVs generally do not—they prioritize (laggy) video processing instead. These extra milliseconds may not seem like they matter, but they will make a massive

difference if you're trying to do something like competitive online gaming.

DisplayLag maintains a good database of input lag times (go.pcworld.com/lgtm), sortable by display type. An input lag of less than 30 milliseconds is considered good for an HDTV if you're using it as an HDTV. For a computer monitor, you'll want





Also pay attention to the type and number of ports. This is only one of two port areas on an LG TV. Many TVs offer ports nearer the side as well for the sake of easy access.

to aim for less than 20 milliseconds, and the lower you can go, the better.

Response time

Often confused with input lag, response time describes how long it takes for a display's pixels to switch colors between scenes. HDTVs and computer monitors can have very different response times. HDTVs tend to prioritize richer colors, higher contrast, and wider viewing angles—all of which lend to a longer response time. Computer monitors tend to drop some of the image processing and viewing angles for faster response times. If you use a display with a slower response time, you may see "ghosting" in fast-paced video and gaming sequences.

Some HDTVs have a game mode setting, which cuts some of the image processing to improve both input lag and response time. If you plan to play PC games on your TV, definitely dig around in your HDTV's options to see if it has this feature.

Refresh rate

Another factor that may affect performance is a display's refresh rate. Refresh rate is the number of times a display "refreshes," or re-draws, its image each second. Most modern displays have a refresh rate of 60Hz, which means they refresh their image 60 times per second. But you've probably also seen higher-end gaming monitors and HDTVs with higher advertised refresh rates—120Hz, 144Hz, or even 240Hz. This can be misleading, however, because a computer monitor with a 120Hz refresh rate may not be the same as an HDTV with a 120Hz refresh rate.

The reason for this is because the content people watch on a television is produced at either 24 fps, 30 fps, or 60 fps. The content people view on a computer monitor can be very different—many games can output frame rates higher than 60 fps if you have a powerful enough graphics card.

An HDTV with a high advertised refresh rate may use post-processing technology to achieve that rate, such as by creating additional frames to upscale content, or by adding black frames between each frame to prevent image blur. The good news is that this probably won't make a difference if you're not playing PC games at very fast frame rates. But if you have a PC designed for the best possible gaming experience, hooking up an HDTV instead of a computer monitor likely means that you're not getting the most out of your machine.

IS IT WORTH IT?

There's no harm trying to connect your computer to a TV you already own to see if it works for you. Go for it!

Our advice varies if you're shopping though. If you're looking to get the best bang for your buck, an HDTV isn't necessarily going to save you money over a monitor. In fact, if you're purchasing a new display, I recommend sticking with the tried-and-true computer monitor. For one thing, smaller, cheaper HDTVs are typically 720p resolution, not 1080p, while similarly priced monitors will almost always be 1080p. So if you're looking for something under 27 inches, an HDTV will probably be more expensive and lower-resolution.

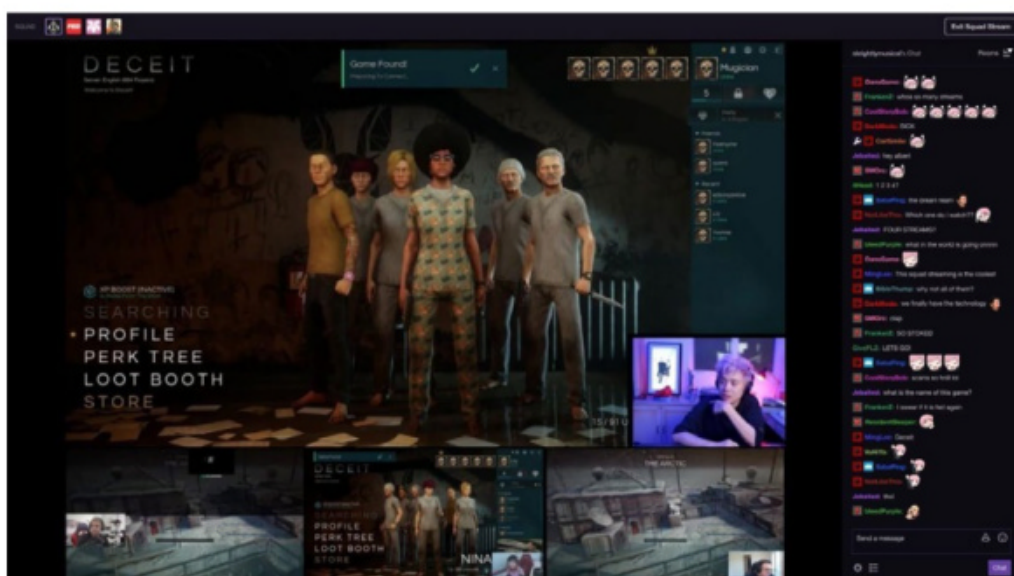
These lower-priced 1080p monitors often support AMD's FreeSync adaptive sync technology (go.pcworld.com/fstc) as well, which can help your games look buttery smooth. You won't find that in a cheap TV.

If you're looking for something larger than 27 inches, remember that pixel density decreases significantly with every few inches you gain, and there's a reason

HDTV-makers suggest sitting several feet away from their displays. If you need a display that will multitask as an up-close work/email display as well as a movie/entertainment display, you'll want something with a high enough pixel density that text won't be a pain to read—and even with a high pixel density, a large display may still cause eye and neck strain if you sit too close to it.

There is an ideal situation in which the HDTV-as-monitor shines, though.

If you want to add an extra display to a single- or multi-display setup for entertainment—say, so you can watch Netflix or Twitter while you write articles, or so you can play Skyrim on a 60-inch screen—then an HDTV can be a very capable (and cool!) monitor replacement. Bonus points if you happen to have an extra HDTV lying around, or if you can pick one up for dirt cheap. 🔌



An HDTV as a secondary monitor is perfect for streaming Twitch, watching Netflix, or keeping an eye on Twitter in real time.



Wallpaper bug from Windows 7's 'final' update will get fixed

Dead OS walking. **BY BRAD CHACOS**

Windows 7 may have gone end-of-life recently, but Microsoft's preparing a postmortem patch to fix a bug introduced in what was supposed to be the final update.

After installing the KB4534310 update (go.pcworld.com/kb45) on Patch Tuesday, many users complained that their wallpaper

turned black. While some forum-goers were quick to grab their torches and pitchforks, convinced it was a last second-middle finger to lingering Windows 7 users, that's not the case whatsoever. It's a bug, and Microsoft's readying a fix for it despite Windows 7 being out of support.

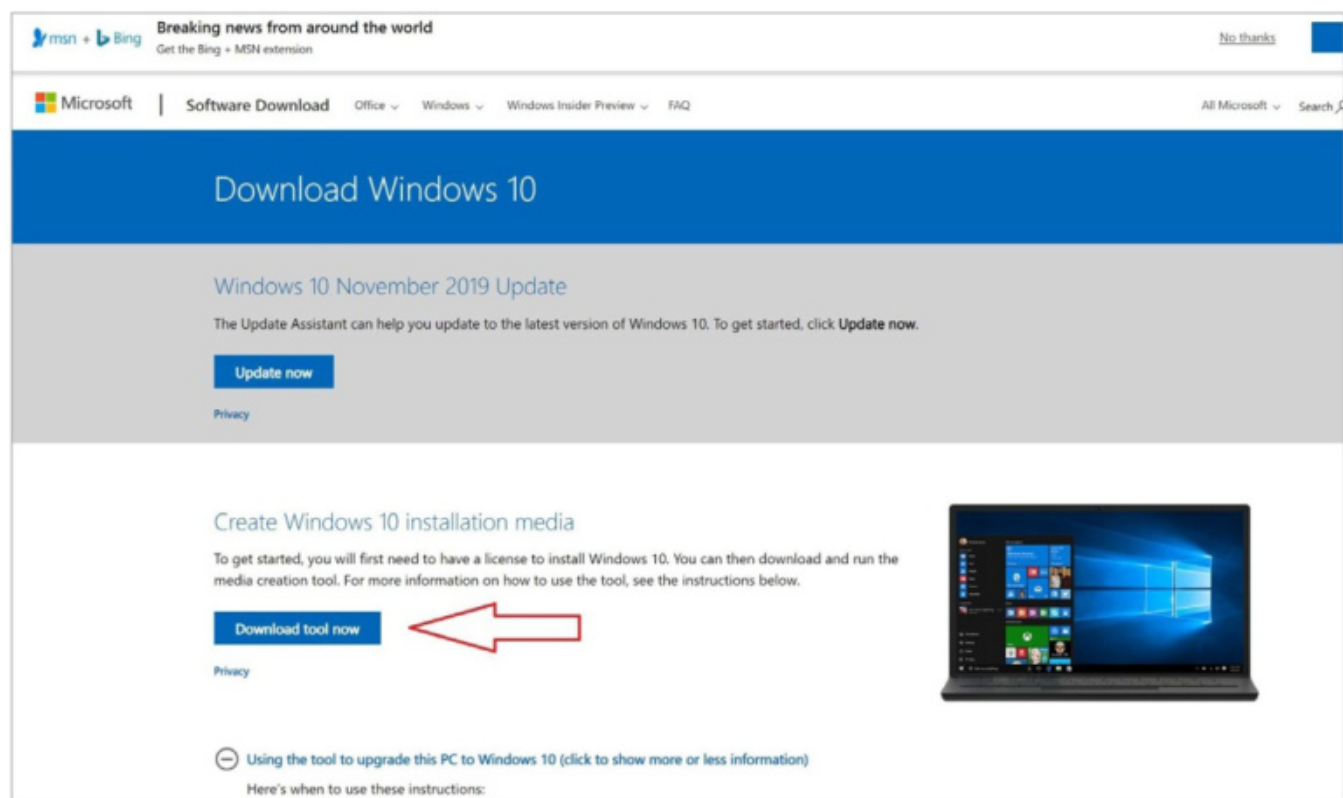
"We are working on a resolution and will provide an update in an upcoming release,

which will be released to all customers running Windows 7 and Windows Server 2008 R2 SP1," the update's support page now says. At first, Microsoft only promised a fix for organizations paying for Extended Security Updates, as the Verge (go.pcworld.com/frw7) noted, but a change of heart's occurred and now everybody's getting it. Good.

In the meantime, the black screens happen when you set your wallpaper to Stretch. Using another configuration option when you're setting your wallpaper works around the issue—Center or selecting a custom-sized image matched to your screen resolution are probably the best Stretch

alternatives, but Fill, Fit, and Tile work too. Once you've switched away from a stretched wallpaper, your imagery should return.

Better yet, you could move to a still-supported operating system at no cost, as Microsoft's free Windows 10 upgrade (go.pcworld.com/f10u) is still officially-unofficially available. Staying on an operating system that isn't receiving security patches is a bad idea. But if you're dead-set on sticking with an end-of-life OS, be sure to grab a security suite (go.pcworld.com/scsu) and read our guide to staying safe on Windows 7 after the security patches stop (go.pcworld.com/scpt). It'll keep you as protected as possible. 🔌



Microsoft's free Windows 10 upgrade is still officially-unofficially available.



How to create Excel macros and automate your spreadsheets

Use macros to combine multiple tasks into a single transaction. **BY JD SARTAIN**

Excel macros are like mini-programs that perform repetitive tasks, saving you a lot of time and typing. For example, it takes Excel less than one-tenth of a second to calculate an entire, massive spreadsheet. It's the manual operations that slow you down. That's why you need macros to combine all of these chores into a single one-second transaction.

EXCEL MACROS: TIPS FOR GETTING STARTED

We're going to show you how to write your first macro. Once you see how easy it is to automate tasks using macros, you'll never go back. First, some tips on how to prepare your data for macros:

- Always begin your macro at the Home position (use the key combination **Ctrl+Home** to get there quickly).

- Use the directional keys to navigate: Up, Down, Right, Left, End, Home, etc., and shortcut keys to expedite movement.

- Keep your macros small and focused on specific tasks. This is best for testing and editing (if needed). You can always combine these mini-macros into one BIG macro later once they're perfected.

- Macros require "relative" cell addresses, which means you "point" to the cells rather than hardcode the actual (or "absolute") cell address (such as A1, B19, C20, etc.) in the macro. Spreadsheets are dynamic, which means they constantly change, which means the cell addresses change.

- Fixed values and static information such as names, addresses, ID numbers, etc. are generally entered in advance and not really part of your macro. Because this data rarely changes (and if it does, it's just to add or remove a new record), it's almost impossible to include this function in a macro.

- Manage your data first: Add, edit, or delete records, then enter the updated values. Then you can execute your macro.

WHY STARTING WITH MINI-MACROS IS EASIER

For this example, we have a store owner who has expanded her territory from a single store to a dozen in 12 different major cities. Now the CEO, she's been managing her

own books for years, which wasn't an easy task for a single store, and now she has 12. She has to collect data from each store and merge it to monitor the health of her entire company.

We created a few mini-macros to perform the following tasks:

1. Collect and combine the data from her 12 stores into one workbook in a Master three-dimensional spreadsheet.

2. Organize and sort the data.

3. Enter the formulas that calculate the combined data.

Once the mini-macros are recorded, tested, and perfected, we can merge them into one big macro or leave them as mini-macros. Either way, keep the mini-macros, because it's much easier and more efficient to edit the smaller macros and re-combine them, than try to step through a long, detailed macro to find errors.

We've provided a sample workbook for the above scenario so you can follow along with our how-to. Feel free to create your own spreadsheet too, of course (go.pcworld.com/wkbk).

PREP WORK: THE MASTER SPREADSHEET

If you're building your spreadsheets from the ground up, start with the Master spreadsheet. Enter the date formula in A1 and the store location in B1. See screen shot opposite.

1. Enter this date formula in cell A1:
=Today (). Now this cell always displays today's date. Be sure; however, that your store location (branch name and number) are entered in B1.

2. Leave row 2 blank. Once the static data and initial dynamic data are entered, we'll use row 2 for the totals. This might seem like a strange custom, but for macro spreadsheets, it's the best way because this row is stationary and always visible.

3. Next, enter the field names (and/or any other field-specific information) in row 3 (e.g., from A3 through J3, or however many fields your spreadsheet requires).

Tip: You can text-wrap the information in the individual cells if the data is lengthy. For example, you can put the store contact information all in one cell and wrap the lines. Press **Alt+ Enter** to insert extra lines in the cells.

4. Next, enter the static data in column A. That is the record information in your spreadsheet that rarely changes. If your business uses product numbers or ID codes, which are unique because there is only one code per product, enter those in column A beginning on row 4 (don't skip to row 5). Other static data fields might include the Product

Description, the Product Price, sales tax percentage, etc.

Do not skip rows or leave any rows blank for column A. Every row must contain the unique field's data—if not a product code, then some other unique identifier. We do this for two reasons:

- Column A is the main navigational column. The macro moves and navigates through the spreadsheet based on the Home (A1) position and column A. The macro will fail if you ignore this rule, because blank rows disrupt the actions of the directional keys.
- If you decide to create multiple/relational tables later for Pivot Reports, you must have a unique, key field to connect the related tables. Check out our Excel pivot tables tutorial for more information ([go](#).

	A	B	C	D	E	F	G	H
1	Sep 30, 2018	Boston Store 1100 555 Commonwealth Avenue Boston, MA 02215 617-555-9720 Nana1100@ComputersUSA.com	Enter formula for column totals in cell C2; C4:C300 for Ttl units sold	Enter current product price in column D	Enter formula for column totals in cell E2 & row formulas in range E4:E500	Enter formula for column totals in cell F2 & row formulas in range F4:F500	Enter formula for column totals in cell G2 & row formulas in range G4:G500	Enter formula for column totals in cell H2 & row totals in range H4:H500
2	GRAND TOTALS							
3	Model Number	Description	Quantity	Price	Ext Cost	Discounts	Sales Tax	Totals
4	A584080	Asus Slim						
5	A584105	Asus Laptop						
6	A584106	Asus All-in-One						
7	A584215	Asus Tablet						
8	A584414	Asus Tower						
9	D1718	Dell Tower						
10	D2112	Dell All-in-One						
11	D2654	Dell Laptop						
12	D8180	Dell Tablet						
13	HP2758254	HP Laptop						
14	HP5250121	HP All-in-One						
15	HP8011815	HP Slim						
16	HP6568889	HP Tablet						
17	HP7872533	HP Tower						
18	LE32507	Lenovo Tablet						
19	LE35216	Lenovo Tower						
20	LE45412	Lenovo All-in-One						
21	LE70125	Lenovo Slim						
22	LE90120	Lenovo Laptop						
23	SP3300	Surface Studio Desktop						
24	SP7490	Surface Pro Tablet						
25	SP9200	Surface Pro Laptop						

Build the Master spreadsheet first.

pcworld.com/pivt).

5. Normally, the Product Description resides in column B, the Quantity Sold in column C, Product Price in column D, Extended Cost in E, Discounts in F, Sales Tax in G, and Totals in H. The column totals are across the top on row 2, remember? Format the column widths based on the length of the field names, and adjust the row height to 20 on all rows. Change the Top/Bottom alignment to Center, select the justification you prefer (left, right, center), and then format the spreadsheet "styles" to your preference.

6. Once the master database is set up, do not move anything. If you need to add fields, use the Insert Column command. For example, if you wanted to add a second sales tax, position your cursor anywhere on column H (Totals) and click the tab: Home > Insert > Insert Sheet Columns. The new column drops in to become the new H column, and the Totals column moves over to I. This process does not affect the macro.

7. The same process applies to rows. Normally I would caution you to insert rows "inside" the active

database area. For example, if the formula says =SUM(B3:B20) and you insert or use a row outside of the formula's range like B21, the new record's data is not included in the formula and therefore, does not calculate.

8. Now we'll set up that formula range. Enter the following formulas on row 2 (this is a one-time task):

C2: =SUM(C4:C500)

E2: =SUM(E4:E500)

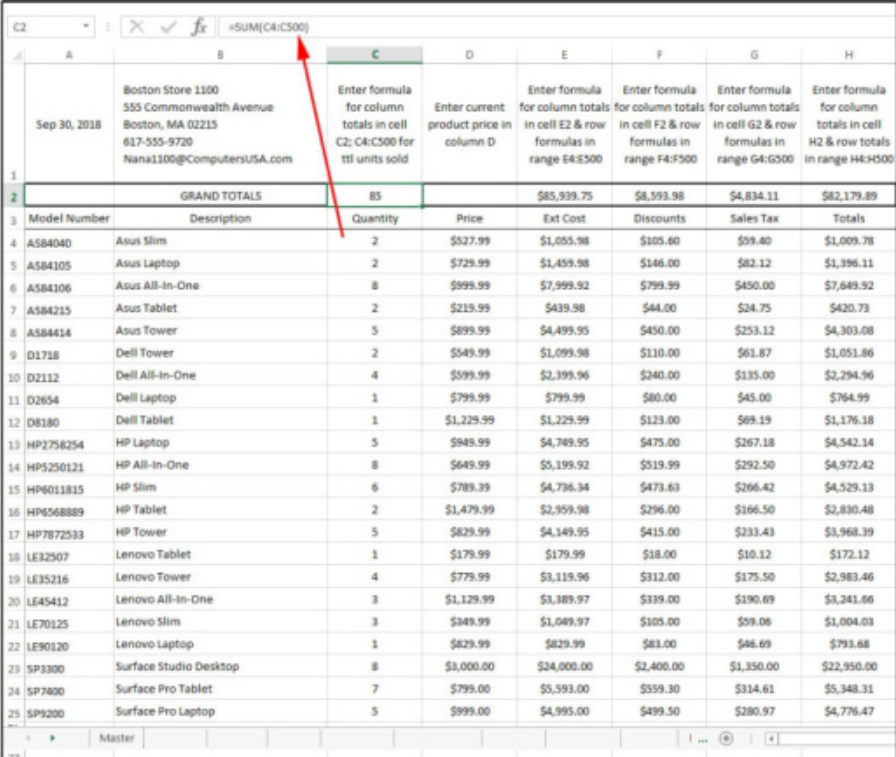
F2: =SUM(F4:F500)

G2: =SUM(G4:G500)

H2: =SUM(H4:H500)

Next, enter the following formulas in these columns (also a one-time event):

E4: =SUM(C4*D4), then copy from E4 down to E5:E500



	A	B	C	D	E	F	G	H
1		Boston Store 1300 555 Commonwealth Avenue Boston, MA 02215 617-555-9720 Nana1100@ComputersUSA.com	Enter formula for column totals in cell C2; C4:C500 for all units sold	Enter current product price in column D	Enter formula for column totals in cell E2 & row formulas in range E4:E500	Enter formula for column totals in cell F2 & row formulas in range F4:F500	Enter formula for column totals in cell G2 & row formulas in range G4:G500	Enter formula for column totals in cell H2 & row formulas in range H4:H500
2		GRAND TOTALS	85		\$85,939.75	\$8,593.98	\$4,834.11	\$82,179.89
3	Model Number	Description	Quantity	Price	Ext Cost	Discounts	Sales Tax	Totals
4	A584040	Asus Slim	2	\$527.99	\$1,055.98	\$105.60	\$99.40	\$1,009.78
5	A584105	Asus Laptop	2	\$728.99	\$1,457.98	\$146.00	\$82.12	\$1,396.11
6	A584106	Asus All-in-One	8	\$999.99	\$7,999.92	\$799.99	\$450.00	\$7,649.92
7	A584215	Asus Tablet	2	\$219.99	\$439.98	\$44.00	\$24.75	\$420.73
8	A584414	Asus Tower	5	\$899.99	\$4,499.95	\$450.00	\$253.12	\$4,303.08
9	D1718	Dell Tower	2	\$549.99	\$1,099.98	\$110.00	\$61.87	\$1,051.86
10	D2112	Dell All-in-One	4	\$599.99	\$2,399.96	\$240.00	\$135.00	\$2,294.96
11	D2654	Dell Laptop	1	\$799.99	\$799.99	\$80.00	\$45.00	\$764.99
12	D6180	Dell Tablet	1	\$1,229.99	\$1,229.99	\$123.00	\$69.19	\$1,176.18
13	HP2758254	HP Laptop	5	\$949.99	\$4,749.95	\$475.00	\$267.18	\$4,542.14
14	HP5250121	HP All-in-One	8	\$649.99	\$5,199.92	\$519.99	\$292.50	\$4,972.42
15	HP6011815	HP Slim	6	\$789.99	\$4,739.94	\$473.63	\$266.42	\$4,529.13
16	HP6568889	HP Tablet	2	\$1,479.99	\$2,959.98	\$296.00	\$166.50	\$2,830.48
17	HP7872533	HP Tower	5	\$829.99	\$4,149.95	\$415.00	\$233.43	\$3,968.39
18	LE32507	Lenovo Tablet	1	\$179.99	\$179.99	\$18.00	\$10.12	\$172.12
19	LE35216	Lenovo Tower	4	\$779.99	\$3,119.96	\$312.00	\$175.50	\$2,983.46
20	LE45412	Lenovo All-in-One	3	\$1,129.99	\$3,389.97	\$339.00	\$190.69	\$3,241.66
21	LE70125	Lenovo Slim	3	\$349.99	\$1,049.97	\$105.00	\$59.06	\$1,004.03
22	LE90120	Lenovo Laptop	1	\$829.99	\$829.99	\$83.00	\$46.69	\$793.68
23	SP3300	Surface Studio Desktop	8	\$3,000.00	\$24,000.00	\$2,400.00	\$1,350.00	\$22,950.00
24	SP7800	Surface Pro Tablet	7	\$799.00	\$5,593.00	\$559.30	\$314.61	\$5,348.31
25	SP9200	Surface Pro Laptop	5	\$999.00	\$4,995.00	\$499.50	\$280.97	\$4,776.47

Enter the formulas to calculate the columns and rows.

F4: **=SUM(E4*10%)**, the current discount percentage in your store, then copy from F4 down to F5:E500

G4: **=SUM(E4-F4)*6.25**, where 6.25 is the sales tax in your area, then copy from G4 down to G5:G500

H4: **=SUM(E4-F4+G4)**, then copy from H4 down to H5:E500

Now that you have all the spreadsheet formulas in place, all you have to do is enter the quantity (column C) for each computer sold (daily, weekly, or monthly). If the prices change, enter the new prices in column D. The rest of this database is all formulas or static information.

9. As seen above, with “macro” spreadsheets, you set the formula range to be many rows beyond the last record, so you can just add new records at the end and not worry about adjusting the range. Because the macro sorts the database, the new records are relocated to the proper position. The spreadsheet data in our example ends on row 210. The formula range extends out to row 500, so it’s safe to add the next new record on row 211.

10. Once the spreadsheet is defined and set up with the structure, static data in place, and

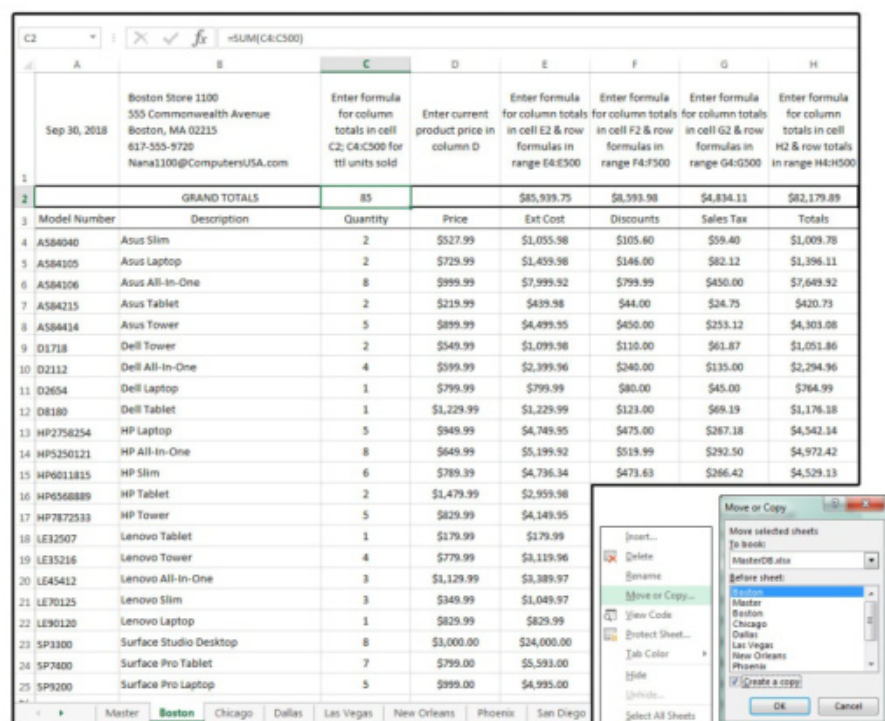
correct formulas, make 12 copies in worksheets 2 through 13. Edit the tabs on the bottom to identify the individual stores.

Change the name of the sheet1 tab to Master, because this is your master database file.

11. Change the location data on row 1 to identify the store information (that matches the store on the tab) on all 12 spreadsheets. Next, email an electronic copy of each branches’ spreadsheet to each of the store managers; for example, send the Boston sheet to Boston, the Dallas sheet to Dallas, etc.

Their copies include the spreadsheet formulas that work on their individual spreadsheets (but not the formulas of the combined spreadsheets in the workbook).

12. The macro provides the formulas for



Copy the Master spreadsheet 12 times, then name the tabs.

the Master. The Master is the spreadsheet for the combined totals of all stores. If you are the one who collates all the data and executes the Master macros AND you also manage an individual store, you must use one of the 12 sheets you copied for your store. The Master is for the grand totals only.

13. Once the branches email their individual spreadsheets, it's safer to copy the individual sheets from the 12 stores' workbooks manually.

PROGRAMMING MACROS

Macro1: Collect and combine data

1. Access your database folder and open your spreadsheet titled MasterDB.xlsx

2. Open one of the new store spreadsheets, such as the one titled

BostonDB.xlsx

3. Move your cursor back to the MasterDB so it's the active sheet.

4. Select the Developer tab and click Record Macro or press **ALT+ L+ R**. The Macro Name field says Macro1, and that's a good name.

5. Enter a shortcut key (if you like) in the Shortcut_key field box (enter the letter M) (you can create a button on the Ribbon menu later).

6. In the Store Macro In field box, click the down arrow and select Personal Macro Workbook from the list, then click OK.

Now you are recording the macro.

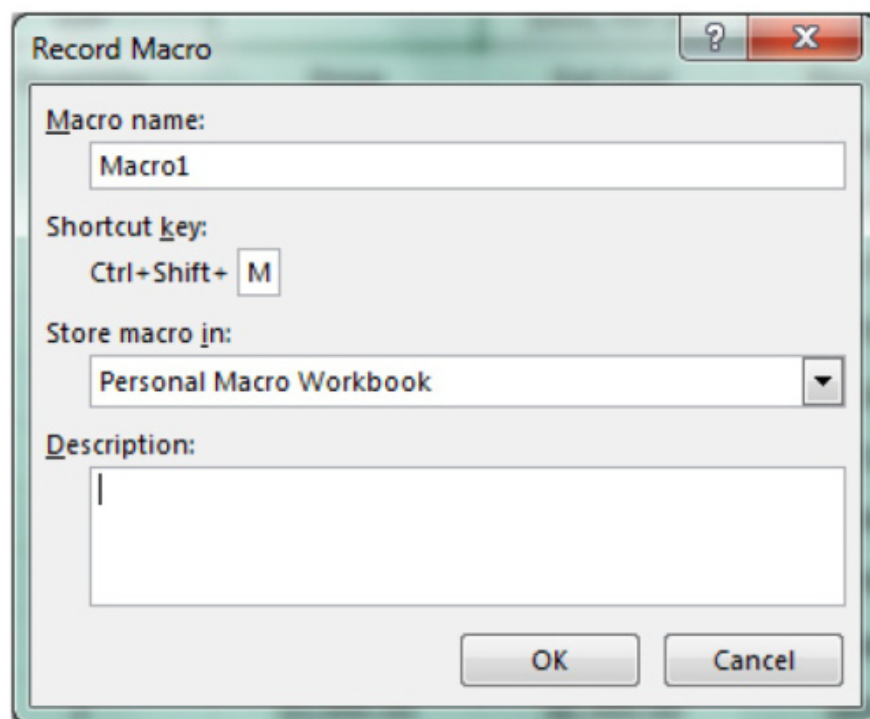
Follow the instructions below, exactly, and use your mouse to navigate around the spreadsheet. Please note that phrases inside

square brackets are tips, notes, and explanations of the instructions. Do not include these phrases or anything they say in your macro.

1. Move back to the BostonDB spreadsheet, then right-click the Boston tab. In the popup menu, select Move or Copy ...

2. In the Move or Copy dialog, check the box that says Copy.

3. In the Move Selected Sheets dialog, click the down



Record macro dialog box, macro shortcut_key.

arrow beside the To Books field box.

4. Select "MasterDB.xlsx" from the list.

5. In the second dialog: Before the Sheet, select the first spreadsheet on the list called "Master," then click OK.

6. Excel copies the sheet and relocates your cursor to the MasterDB. Notice the new

tab that says "Boston2." Verify that the info in cell A1 shows the store number followed by a recent date (9/29/18 in this example). If yes, you're good to go.

7. Right-click the tab of the original Boston spreadsheet and select Delete from the popup menu.

8. Excel warns in a dialog

box: You Can't Undo . . . Delete or Cancel? If you're certain you want to remove it click Delete. Why? Because you want to replace it with the NEW Boston sheet that the Boston manager sent to you.

9. Move the Boston2 tab between the Master and Chicago tabs. If you keep the '2' from Boston2, it will be easier to quickly recognize which sheets have been updated each month.

10. Click **Ctrl+ Home** to relocate cursor to cell A1 and re-enter this date formula: **=TODAY()**, (if this formula is missing), then press the Enter key

Execute the Macro

1. Select the Developer tab again and click Stop Recording or press **ALT+**

Record the macro, combine the data, delete duplicate sheets.

The Record Macro dialog box shows the macro name "Macro1", shortcut key "Ctrl+m", and store macro in "Personal Macro Workbook".

The Excel spreadsheet shows the following data:

	B	C	D	E
2		GRAND TOTALS	84	\$78,116.67
3	Model Number	Description	Quantity	Price
4	HP5250121	HP All-in-One	5	\$649.99
5	HP7872533	HP Tower	4	\$829.99
6	HP6011815	HP Slim	6	\$789.39
7	HP2758254	HP Laptop	2	\$949.99
8	HP6568889	HP Tablet	8	\$1,479.99
9	D2112	Dell All-in-One	2	\$599.99
10	D1718	Dell Tower	4	\$549.99
11	D2654	Dell Laptop	1	\$799.99
12	D8180	Dell Tablet	5	\$1,229.99
13	SP3300	Surface Studio Desktop	4	\$3,000.00
14	SP9200	Surface Pro Laptop	4	\$999.00
15	SP7400	Surface Pro Tablet	3	\$799.00
16	AS84106	Asus All-in-One	2	\$999.99
17	AS84414	Asus Tower	3	\$899.99
18	AS84040	Asus Slim	6	\$527.99
19	AS84105	Asus Laptop	1	\$729.99
20	AS84215	Asus Tablet	1	\$219.99
21	LE45412	Lenovo All-in-One	7	\$1,129.99
22	LE35216	Lenovo Tower	4	\$779.99
23	LE70125	Lenovo Slim	6	\$349.99

The screenshot also shows the context menu for the "Boston" tab, with the "Delete" option selected.

The Microsoft Excel dialog box shows the warning: "You can't undo deleting sheets, and you might be removing some data. If you don't need it, click Delete."

T+ M+ R.

2. Save the Master file, then save the BostonDB file.

3. Go back to the MasterDB spreadsheet and run the macro: Press **Ctrl+ M**.

NOTE: Remember that the plus sign means a “simultaneous” combination keystroke; that is, **Ctrl+ Shift+ J** means: Press and hold down the Ctrl and Shift keys with your left hand, then press the J key with your right hand, then release all three keys simultaneously. The dash (or hyphen) means a “consecutive” combination keystroke, such as End- Down, which means press the End key and release, then press the Down arrow and release. These are NOT interchangeable, so watch the signs.

4. If the macro works as expected, repeat this process again for each of the remaining 11 spreadsheets, then run the macros, save the files, and exit all spreadsheets except the Master.

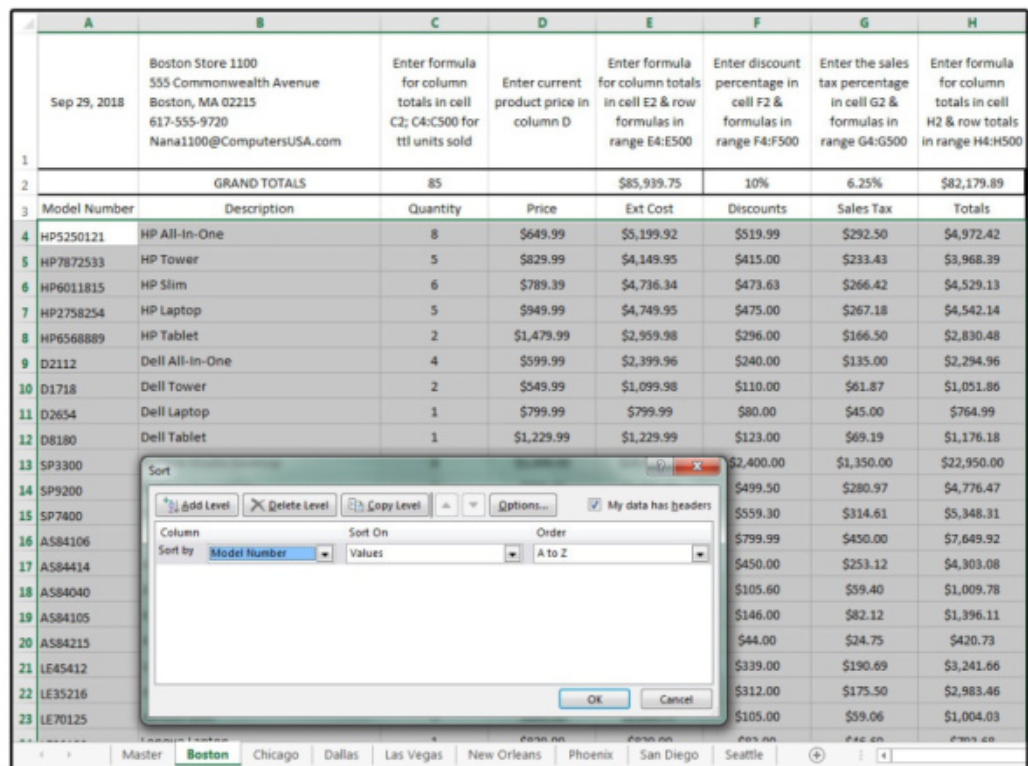
NOTE: The only available shortcut keys are **Ctrl+ M** (which you have already used), **Ctrl+**

Shift+ M, Ctrl+ J, and Ctrl+ Shift+ J.

Because shortcut keys are in short supply and the character combinations don’t make any logical sense anyway, the best solution for your mini macros are macro buttons on the Ribbon menu with names that make sense, such as Boston for the Boston macro and Dallas for the Dallas macro. Check out this other Excel macros how-to (go.pcworld.com/xmcr), where there’s a section with detailed instructions on how to create, name, and use macros (go.pcworld.com/cmcr).

Macro2: Organize and sort data

This one is easy, but with so many spreadsheets, it can be a daunting task if you



	A	B	C	D	E	F	G	H
1	Sep 29, 2018	Boston Store 1100 555 Commonwealth Avenue Boston, MA 02215 617-555-9720 Nana1100@ComputersUSA.com	Enter formula for column totals in cell C2; C4:C500 for ttl units sold	Enter current product price in column D	Enter formula for column totals in cell E2 & row formulas in range E4:E500	Enter discount percentage in cell F2 & formulas in range F4:F500	Enter the sales tax percentage in cell G2 & formulas in range G4:G500	Enter formula for column totals in cell H2 & row totals in range H4:H500
2		GRAND TOTALS	85		\$85,939.75	10%	6.25%	\$82,179.89
3		Model Number	Description	Quantity	Price	Ext Cost	Discounts	Sales Tax
4		HP5250121	HP All-in-One	8	\$649.99	\$5,199.92	\$519.99	\$292.50
5		HP7872533	HP Tower	5	\$829.99	\$4,149.95	\$415.00	\$233.43
6		HP6011815	HP Slim	6	\$789.39	\$4,736.34	\$473.63	\$266.42
7		HP2758254	HP Laptop	5	\$949.99	\$4,749.95	\$475.00	\$267.18
8		HP6568889	HP Tablet	2	\$1,479.99	\$2,959.98	\$296.00	\$166.50
9		D2112	Dell All-in-One	4	\$599.99	\$2,399.96	\$240.00	\$135.00
10		D1718	Dell Tower	2	\$549.99	\$1,099.98	\$110.00	\$61.87
11		D2654	Dell Laptop	1	\$799.99	\$799.99	\$80.00	\$45.00
12		D8180	Dell Tablet	1	\$1,229.99	\$1,229.99	\$123.00	\$69.19
13		SP3300				\$2,400.00	\$1,350.00	\$22,950.00
14		SP9200				\$499.50	\$280.97	\$4,776.47
15		SP7400				\$559.30	\$314.61	\$5,348.31
16		AS84106				\$799.99	\$450.00	\$7,649.92
17		AS84414				\$450.00	\$253.12	\$4,303.08
18		AS84040				\$105.60	\$59.40	\$1,009.78
19		AS84105				\$146.00	\$82.12	\$1,396.11
20		AS84215				\$44.00	\$24.75	\$420.73
21		LE45412				\$339.00	\$190.69	\$3,241.66
22		LE35216				\$312.00	\$175.50	\$2,983.46
23		LE70125				\$105.00	\$59.06	\$1,004.03

Macro sorts the spreadsheet by Model Number.

do it manually. Excel actually provides a way to modify all your spreadsheets at once, but this task is unreliable when sorting.

Follow the Record Macro instructions (4, 5, 6 under Macro1 above) to create this next macro. Name the macro Macro2 and use **Ctrl+ Shift- M** for the shortcut (you can create a button on the Ribbon menu later). This macro affects all the spreadsheets in the MasterDB, so ensure this file is open and active.

1. Press **Ctrl+ Home** [to move cursor to A1].
2. Press the Down arrow key three times.
3. Press **Shift- End- Down- End- Right** [Hold down the Shift key, press the End key and release, press the Down Arrow and release, press the End key and release, press the Right arrow and release].
4. Select *Data > Sort*. In the Sort dialog, choose Model Number from the drop-down list in the Sort By field box, then choose Values from the Sort On field box, and then choose A-Z from the Sort Order field box, and click OK.

5. Press **Ctrl+ Home**.

6. Click the next tab at the bottom to access the next spreadsheet (i.e., Chicago after Boston), and repeat all steps above: 1-6, and then continue with the following instructions below. Remember, the macro is recording through all these steps.

7. Click the Master spreadsheet tab, press **Ctrl+ Home**.

8. Select the Developer tab (from Ribbon menu) and click Stop Recording or press

Alt+ T+ M+ R.

9. Save the Master file, MasterDB.

10. With cursor still in MasterDB spreadsheet, run the macro: Press **Ctrl+ Shift+ M**.

Macro3: Enter formulas

The formulas for the individual stores' spreadsheets are already in place. You entered those back in step #9 of the Prep Work section above. These formulas are for the Master spreadsheet, which calculates all the others and combines the grand totals into one "master" sheet. We use a macro for this process rather than doing it manually 12 times.

Follow the Record Macro instructions (4, 5, 6 under Macro1 above) to create this next macro. Name the macro Macro3 and use **Ctrl+ J** for the shortcut (you can create a button on the Ribbon menu later). This macro affects all the spreadsheets in the MasterDB, so ensure this file is open and active.

1. Press **Ctrl+ Home** [to move cursor to A1].

2. Press **Down- Right- Right**.

3. **=SUM(Boston:Denver!C2) Enter** [Enter this formula in cell C2, where the tabs named Boston and Denver represent the first and last spreadsheet tab names in your workbook. This is excluding the Master, of

Model Number	Description	Quantity	Price	Ext Cost	Discounts	Sales Tax	Totals
HP5250121	HP All-in-One	4	\$649.99	\$2,599.96	\$260.00	\$146.25	\$2,486.21
HP7872533	HP Tower	9	\$829.99	\$7,469.91	\$746.99	\$420.18	\$7,143.10
HP6011815	HP Slim	6	\$789.39	\$4,736.34	\$473.63	\$266.42	\$4,529.13
HP2758254	HP Laptop	8	\$949.99	\$7,599.92	\$759.99	\$427.50	\$7,267.42
HP6568889	HP Tablet	8	\$1,479.99	\$11,839.92	\$1,183.99	\$666.00	\$11,321.92
D2112	Dell All-in-One	12	\$599.99	\$7,199.88	\$719.99	\$404.99	\$6,884.89
D1718	Dell Tower	9	\$549.99	\$4,949.91	\$494.99	\$278.43	\$4,733.35
D2654	Dell Laptop	10	\$799.99	\$7,999.90	\$799.99	\$449.99	\$7,649.90
D8180	Dell Tablet	7	\$1,229.99	\$8,609.93	\$860.99	\$484.31	\$8,233.25
SP3300	Surface Studio Desktop	2	\$3,000.00	\$6,000.00	\$600.00	\$337.50	\$5,737.50
SP9200	Surface Pro Laptop	2	\$999.00	\$1,998.00	\$199.80	\$112.39	\$1,910.59
SP7400	Surface Pro Tablet	4	\$799.00	\$3,196.00	\$319.60	\$179.78	\$3,056.18
AS84106	Asus All-in-One	3	\$999.99	\$2,999.97	\$300.00	\$168.75	\$2,868.72
AS84414	Asus Tower	4	\$899.99	\$3,599.96	\$360.00	\$202.50	\$3,442.46
AS84040	Asus Slim	1	\$527.99	\$527.99	\$52.80	\$29.70	\$504.89
AS84105	Asus Laptop	3	\$729.99	\$2,189.97	\$219.00	\$123.19	\$2,094.16
AS84215	Asus Tablet	7	\$219.99	\$1,539.93	\$153.99	\$86.62	\$1,472.56
LE45412	Lenovo All-in-One	5	\$1,129.99	\$5,649.95	\$565.00	\$317.81	\$5,402.76
LE35216	Lenovo Tower	6	\$779.99	\$4,679.94	\$467.99	\$263.25	\$4,475.19
LE70125	Lenovo Slim	4	\$349.99	\$1,399.96	\$140.00	\$78.75	\$1,338.71
LE90120	Lenovo Laptop	5	\$829.99	\$4,149.95	\$415.00	\$233.43	\$3,968.39
LE32507	Lenovo Tablet	10	\$179.99	\$1,799.90	\$179.99	\$101.24	\$1,721.15

Enter+ calculate formulas in Master for multiple sheets.

course, because you are calculating all the values in cell C2 from the first tab Boston through the last tab Denver and entering the totals in cell C2 of the Master. Then Enter key is pressed).

4. Up arrow, **Ctrl+ C** [Moves cursor back up to cell C2 and copies this formula]

5. Right- Right- Shift- Right- Right- Right Enter [moves cursor to the right twice and stops on cell E2, press the Shift key and hold down while moving to the right three times, which highlights cells E2 thru H2, then press the Enter key].

6. [While these cells are still highlighted, press] **Shift+ Ctrl+ 4.**

7. Alt+ T+ M+ R [Press these keys

simultaneously or select the Developer tab and click Stop Recording].

Save, copy, and distribute

1. Ctrl+ Home.

2. Save the Master file, MasterDB.

3. Send copies of the MasterDB to all store managers.

DEBUGGING YOUR MACROS

Debugging macros in Excel is actually easier than you might think. Printing and

reading through your macros will help you learn more about how Excel's macro language (Visual Basic) works. You don't have to be a programmer to debug macros, and the more you know, the easier it gets.

1. First, create a simple macro so you can see what the various instructions look like in Visual Basic.

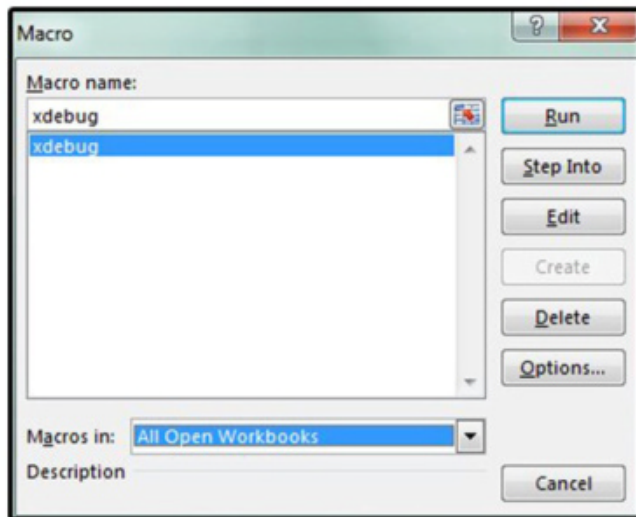
2. Select the Developer tab, then click the Record macro icon/button.

3. Enter the keystrokes that perform the task you are automating, then click the Macro Stop icon/button.

4. To view your macro, click the Macros icon/button or press **Alt+ F8.**

5. The Macros dialog appears,

	A	B	C	D	E
1		Weekly Payroll Accounts			
2		Wage	Commission 10%	Minus Benefits 32%	Total Earnings
3	Paris	\$2,500.00	\$250.00	\$800.00	\$3,550.00
4	Helena	\$2,600.00	\$260.00	\$832.00	\$3,692.00
5	Tristan	\$950.00	\$95.00	\$304.00	\$1,349.00
6	Isolde	\$895.00	\$89.50	\$286.40	\$1,270.90
7	Mark	\$2,200.00	\$220.00	\$704.00	\$3,124.00
8	Cleo	\$2,300.00	\$230.00	\$736.00	\$3,266.00
9	Lance	\$3,600.00	\$360.00	\$1,152.00	\$5,112.00
10	Gwen	\$3,000.00	\$300.00	\$960.00	\$4,260.00
11	Rochester	\$1,900.00	\$190.00	\$608.00	\$2,698.00
12	Jane	\$2,400.00	\$240.00	\$768.00	\$3,408.00
13					\$31,729.90



How to debug a macro.

displaying all the macros saved to the "All Open Workbooks" area.

6. Locate your macro, click to select, then click the Step Into button.

7. Your macro code appears in the Visual Basic macro debug window

The first line says: Sub macroname()

Sub means Subroutine, which alerts Excel that a macro follows. "Sub" begins the macro and "End Sub" ends it. The next line shows the macro name (I named it xdebug()).

Sub xdebug()

The next section says this:

Select Range C3. Then enter formula **=SUM(RC[-1]*10%)** in that ActiveCell

The following commands are similar:

Select Range D3. Then enter formula **=SUM(RC[-2]*32%)** in that ActiveCell

Select Range E3. Then enter formula **=SUM(RC[-3]:RC[-1])** in that ActiveCell
Next, it says:

Select Range C3 through E3 and Copy
Select Range C4 through E12 and Paste
Application.CutCopyMode = False [this means clear the clipboard]

Then it continues with:

Select Range E4
Select the End key, then go down one row
Select Range E13. Then enter formula **w** in that ActiveCell

These next lines are text alignment commands:

Select Range E13

With Selection (format as follows)

.HorizontalAlignment = xlGeneral

.VerticalAlignment = xlCenter

.WrapText = False

.Orientation = 0

.AddIndent = False

.IndentLevel = 0

.ShrinkToFit = False

.ReadingOrder = xlContext

.MergeCells = False

End With

With Selection (format as follows)

.HorizontalAlignment = xlCenter

.VerticalAlignment = xlCenter

.WrapText = False

.Orientation = 0

.AddIndent = False

.IndentLevel = 0

.ShrinkToFit = False

.ReadingOrder = xlContext

.MergeCells = False

End With

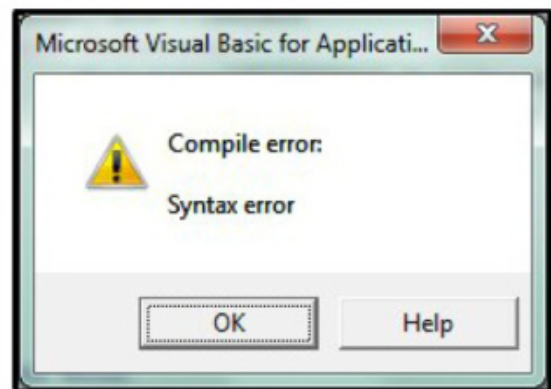
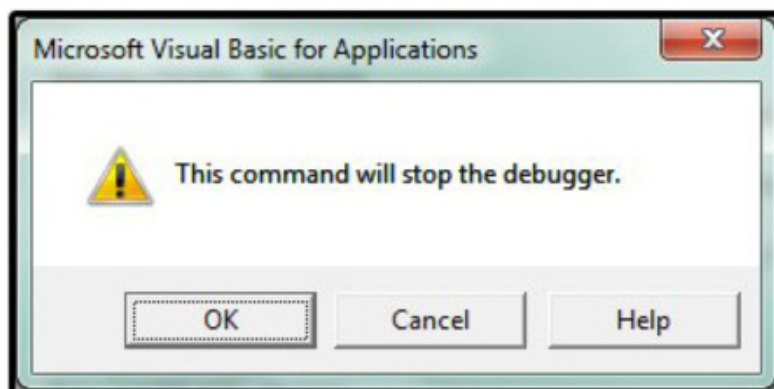
End Sub

Just like HTML and most other languages, certain statements (or commands) that have a beginning or open statement must also have an ending statement.

To make changes, just type them in, then click **Alt+ Q** to return to the spreadsheet. Excel displays a dialog window that says: This command will stop the Debugger. Just click the OK button and the macro disappears.

If you make an editing mistake, exit, then run the macro, Excel displays this error message: Compile Error: Syntax Error. Compile means "convert the code" to whatever format is required to make this program/macro function. Syntax just means "sentence," or basically, you have an error in one of your command sentences.

Click the OK button, and Excel displays the macro code on the screen. The location of the error is in red, so you can go directly to the mistake and fix it. Once repaired, the red text will turn black. Then save it again; Press **Alt+ Q**, run it again, and if the fix was correct, the macro works. 



Understanding macro error messages.

How to use, modify, and create templates in Words

Plus, creating custom interactive templates for special projects. **BY JD SARTAIN**



In Microsoft Word, templates are pre-designed documents that you or someone else (such as Microsoft) creates to use as a pattern for a project. The template could be for a business card, brochure, resume, presentation...the list goes on. Regardless of the purpose, templates provide the design consistency that any organization (or individual) needs to look

professional. (You can also find templates for Excel, PowerPoint, and other applications, but in this article we're focusing on Microsoft Word.)

The template contains a specific layout, style, design and, sometimes, fields and text that are common to every use of that template. Some templates are so complete (such as business cards), you only have to change the individual's name, phone

number, and email address. Others, such as business reports or brochures, could require that everything is changed except the layout and design.

Once you create a template, you can use it over and over. Remember that while you open a template to start a project, you save the project as another file type, such as the basic .docx Word format, for editing, sharing, printing, and more. The template file stays the same, unless or until you want to change it (more on that later).

ACCESS MICROSOFT WORD'S STOCK TEMPLATES

Fortunately for us, Microsoft provides many hundreds of templates for all of its programs. Note that most of Microsoft's templates are online, which means you cannot access them unless you're connected to the Internet.

To open one of the system-provided templates in Word:

1. Open Microsoft Word and select New.
2. Peruse the Suggested Search categories: Business, Personal, Industry,

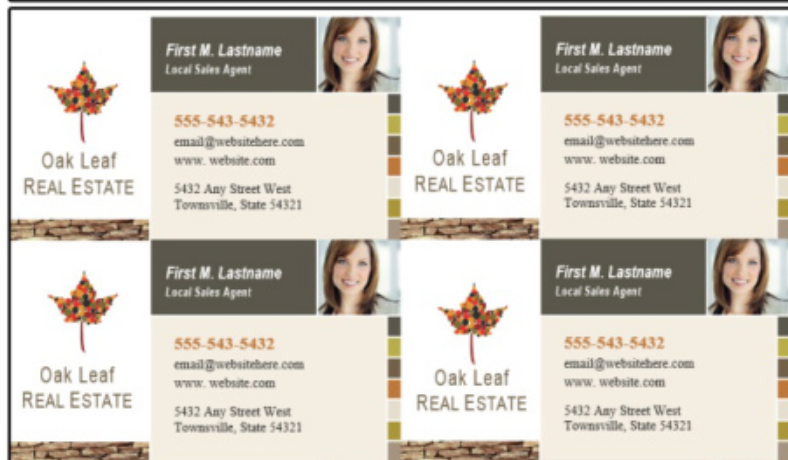
Design Sets, Events, Education, or Letters. For this exercise, select Business.

3. Word displays a message that says, "Searching thousands of online templates."

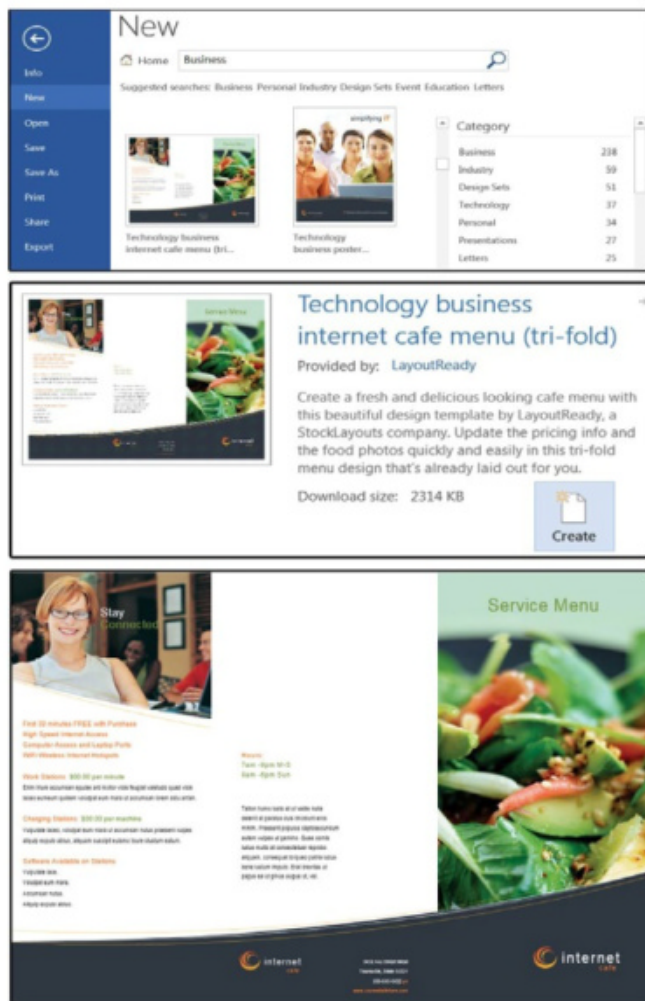
4. Word displays template search results on-screen, plus a comprehensive list of categories in a scrolling panel on the right.

5. Scroll down the page or choose a different category, then select a template that fits your current project.

We selected the Internet Café template. Notice the photos, graphics, and main information, such as hours, are already created in the template. you only have to type over the existing data with your firm's data, and the brochure is complete.



This is a sample template in Microsoft Word.

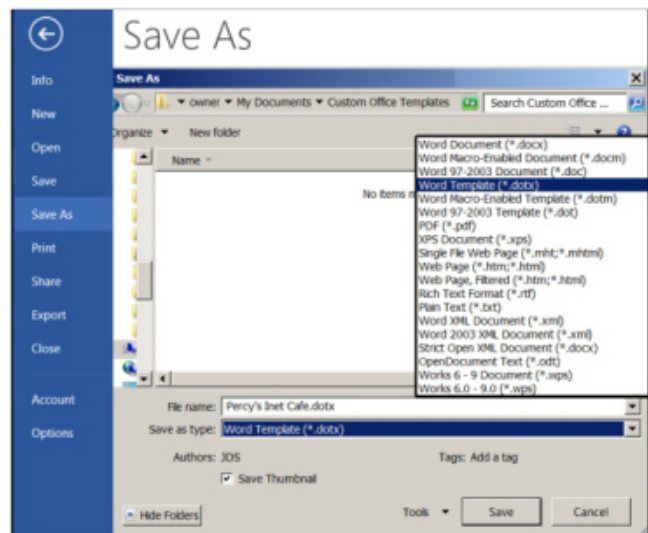


Select a template from a category, then start filling in your own data and images.

MODIFY A MICROSOFT WORD TEMPLATE

You can change the colors, font, photos, logo, and anything else on this template. If you have not selected the Internet Café brochure, please do so now. Before you make any changes, go ahead and save this template with a new filename.

1. If you follow normal document-saving procedures (and you can here), you select *File > Save As > Computer > Browse*. Then



Save the document as a template.

navigate to the applicable folder and give the template a new name.

2. Remember that once you click the down arrow beside the Save As Type in the input box and select Word Template (*.dotx) from the list (and change the name, of course, in the File Name input box), Microsoft automatically puts the file in its own template folder.

3. Once saved as a template, close the file.

4. Now open it again. Note that it is not in the folder you specified. Don't panic. Navigate to *C:\Users\owner\Documents\Custom Office Templates* and your custom templates are there. Select the one you just saved from the list and open it.

5. Change the sections on the new template that will be on every brochure, such as the logo, or contact information. Then save it as a template again by pressing



This Internet Café template has been modified and saved as a document brochure.

Ctrl+ S. It will save in the same location.

6. Next, fill in all the other information and save it—this time, as a document, so you can print it out or share it with others.

Whenever you're ready to create a new brochure, just open the template, enter the new data, and save the completed brochure as a document.

CREATE CUSTOM TEMPLATES IN WORD

Custom templates can be as simple or complex as needed. For example, you might create a template for your company's newsletter, posters for a seminar, or invitations for corporate events. You can also create interactive templates to load on the Intranet, so others can fill in the blanks to print their own envelopes and letterhead,

for instance.

First, create a document—design and format it, add graphics and photos. If it's interactive, select Controls from the Developer tab and create custom input fields for user interaction.

For this exercise, create an announcement flyer for a Meet & Greet conference including lunch, cocktails, and dinner for the company's senior management and its new interns.

- 1.** Start with a blank document.
- 2.** Create two columns: The left

is 4.5 inches and the right is 2.5 inches, and the space between the columns is about 3/8 of an inch. These measurements are only suggestions. Adjust as necessary for your project and the images and graphics you choose.

- 3.** Add a title.

4. Choose a font (we're choosing Century Gothic), style (sans serif), and color (white), for that title.

5. Repeat this process for a subtitle. In our example, we're changing the font color to dark teal.

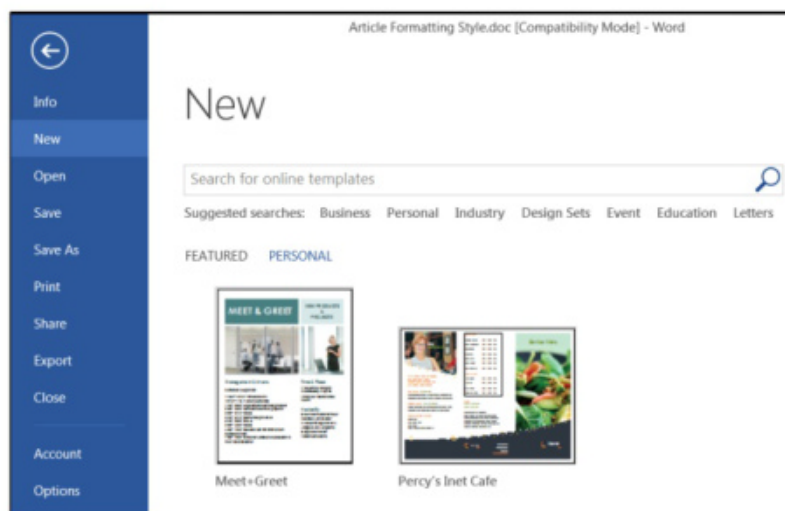
6. Create some graphic boxes for the title (dark teal) and the subtitle (light teal). Select *Insert > Shapes* and choose a rectangle from the icon list.

7. Insert an applicable photo in both columns. Choose *Insert > Pictures* and select

photos from your Pictures Library. Adding images gives you an opportunity to eyeball image sizes and column widths and adjust them as needed.



Create a custom event template.



Open your custom template under New > Personal.

8. Enter the schedule and agenda in column one. Use Century Gothic 14 (in black) for the body text and Century Gothic 18 (in dark teal) for the headers.

9. Enter the time and place plus the conference hosts in column two, with the same fonts and colors for the body text and headers.

10. Once satisfied with the final product, click *Save As > Meet+Greet.docx* (a regular Word document), so you can share or print.

11. Before you exit, also save this document as a template. Click *Save As > Save As Type*, choose *Word Template* [*.dotx] from the list, and save as *Meet+Greet.dotx*. Next conference, the template is ready to get you started.

Once you have some custom templates in your Custom Office Templates folder, when you open Word and select *New*, Word provides a new category on the

backstage menu called *Personal*.

Click this category to see and open your saved templates.

ADD AN INTERACTIVE COMPONENT TO A TEMPLATE

Some templates use interactive controls for user input. For example, imagine that once a month, the branch managers, assistant managers, and loan

originators of a large banking institution have a meeting at one of the 12 branches. It's your assistant's job to email the date, time, location, speakers, topics, and agenda to each attendee. Rather than have that person retype the data in a regular template, you can

create a template where options can be chosen from a list. For example:

1. First, create the template, then decide which fields (date, time, etc.) can be selected from a list.

2. Click the Developer tab.

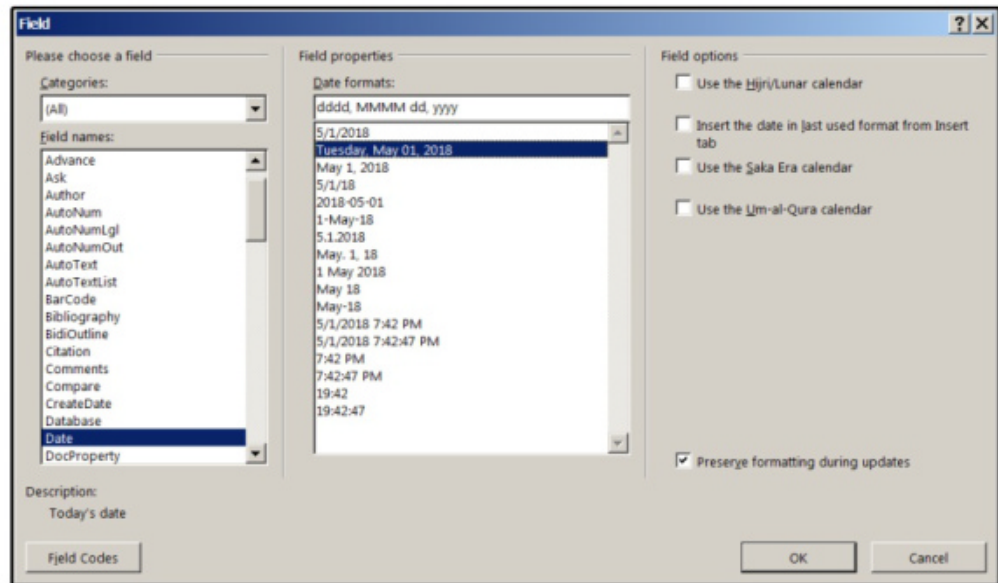
3. Position your cursor on the template where the date goes.

4. Select *Insert > Text > Quick Parts > Field*, then choose Date from the Categories panel and select a date format from the Properties panel. Click OK. Now the date will update automatically.

5. Next, position your cursor on the template where the location goes.

6. Select *Developer > Controls > Combo Box Content Control*. Word places this item on your template.

7. With the Developer tab still selected, click *Controls > Properties*, and the Content



Insert a date field that automatically updates.

Control Properties dialog window opens.

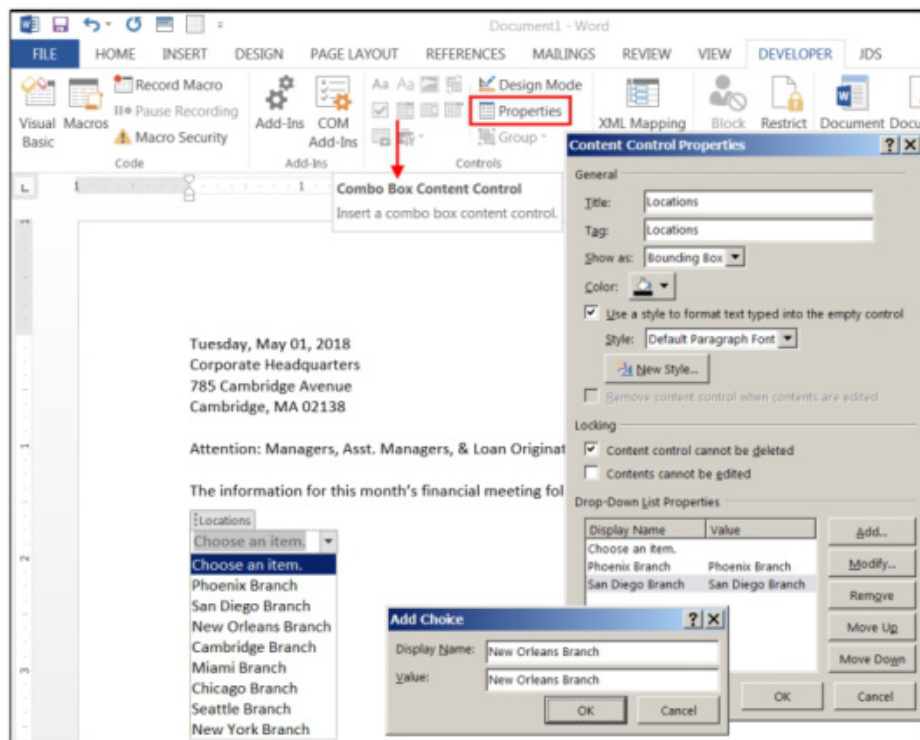
8. Click the Add button, enter a branch name in the Add Choice dialog box, then click OK. Repeat this process until all the branch locations are entered, then click OK again to close this dialog window.

9. If you want to modify, remove, or move an entry up or down, highlight the entry, then click the appropriate button.

10. You can change the color of the Combo Box frame and change or create a custom style (fonts, color, attributes, etc.) for the typeface used inside the Combo Box.

11. Repeat steps 5 through 8 above to create Combo Box Content Controls for the remaining fields: meeting date and time, speakers, and topics.

12. When finished, save the document as a Word Template (*.dotx).



Create a Combo Box Control so users can select options from a list.

TEMPLATE TIPS: CREATE CUSTOM STYLESHEETS

The default stylesheet in MS Word is called normal.dotx. It's not a good idea to alter this stylesheet because, later on, it could result in some unwanted effects. It's best to create custom stylesheets for each custom template. For example, the normal.dotx font is Calibri, paragraphs are left aligned, spacing is 1.15, etc. Heading 1 is Cambria 16 point, etc. You can change these settings manually throughout your document without saving them to the normal stylesheet, and before you save the document as a template.

Once satisfied, use those custom settings for your new stylesheet, which could be named something similar to the

template name. For example, if you're creating a custom brochure template, you might name it and the stylesheet Brochure1. Then future brochures will be much easier to design.

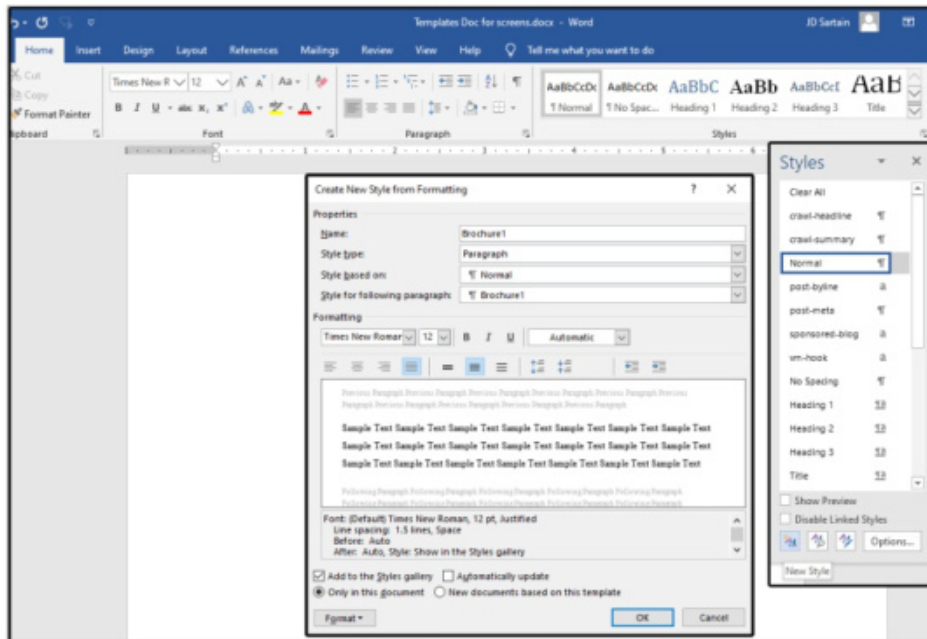
1. Choose the Home tab, then click the small arrow in the bottom right corner of the group called Styles. From the drop-down menu, click the New Styles button (bottom left).

2. In the popup dialog Create New Style from Formatting, enter the name of the style, such as Brochure1.

3. Next select Paragraph from the Style Type field list, which affects the entire paragraph, as opposed to a Character style, that affects only the characters inside a paragraph.

4. You can choose to make the style based on another style, such as the Normal style, one of the Header styles, or No style. If you plan to use most of the formatting features in the Normal style except a few differences, then base it on the Normal style. If the custom style will be completely different, then choose the No style option.

5. Under Formatting, select a Font and Size, then choose a Font Color such as



How to create a custom stylesheet

Brown, Alignment such as Justify, Spacing such as 1.15, and Indents. Notice that the box in the center of the dialog window shows how the paragraph looks with the format options you select.

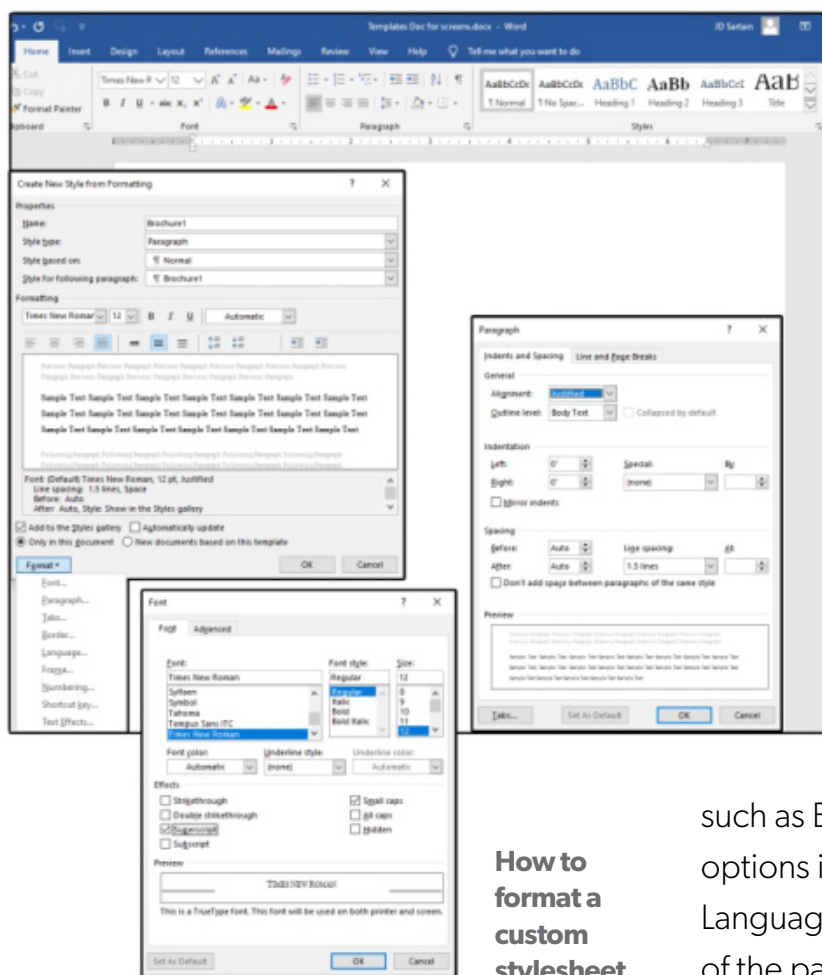
6. In the bottom left corner, click the Format button. Notice the nine options in the drop-down list. In the Font dialog, you can further

customize the font options such as font style (bold, italic, etc.), underline style; Sub- and Superscript, Small Caps, etc.

7. In the Paragraph dialog, you can customize the Indents & Spacing and the Line & Page Breaks. Use the Tabs dialog to customize the alignment and the leader of your tabs, such as the dots between the chapter name and chapter page number on a table of contents.

8. The Borders & Shading dialog provides Border options

such as Box, Shadow, 3D, etc.; and Shading options include colors and patterns. The Language feature is, of course, the language of the paragraph such as French or Italian.



How to format a custom stylesheet.

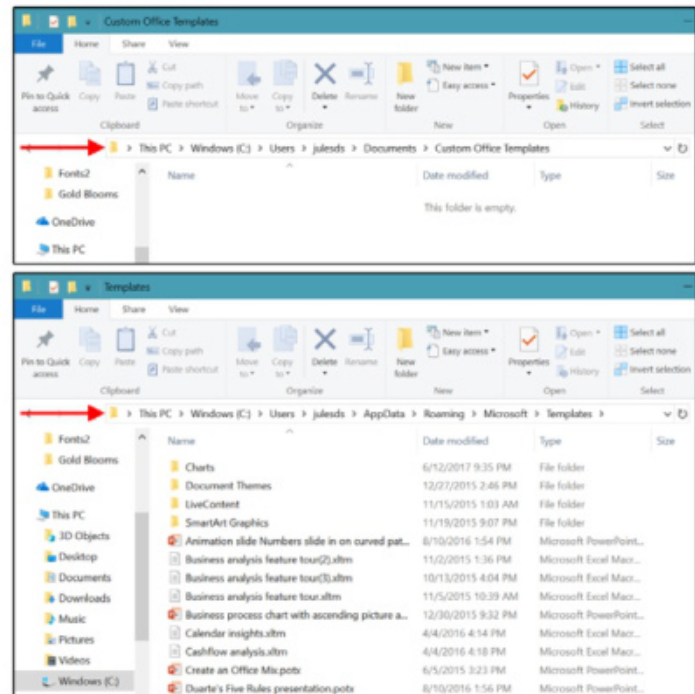
Note that if you want only specific words in another language, such as *c'est la vie* in the middle of a paragraph, then create a character style called French.

9. The Frame option is actually the Text Wrap feature, which includes how the text wraps around a graphic in a paragraph, the spacing around the graphic, and how it's positioned on the page. Choose Numbering to define how you want the numbers to appear such as the standard Arabic numbers, Roman Numerals, or Characters; how they are spaced; and delineated such as with a period after or parentheses, etc. Bullets are also defined under this list choice, which provides standard and custom bullets.

10. Next is the Shortcut Key options, which lets you choose a custom Shortcut key for your Paragraph or Character style, such as **Ctrl+B** for bold (which is a Word default), or define your own. Last on the list is Text Effects, which lets you define the color, gradient, pattern, outline, and transparency of a paragraph such as the title on the title page of a book or manual. Additional Text Effects include Shadow, Reflection, Glow, Soft Edges, and 3D Format.

WHERE TO FIND THE TEMPLATE FILES ON YOUR COMPUTER

The custom templates that you create or modify from one of Microsoft's stock



Where the personal custom templates and the stock templates are located.

templates are stored at `C:\Users\Owner\Documents\Custom Office Templates`, where `<Owner>` is your login name. When you open the Users folder, you'll see your login name on the list of folders. If not there, it should be in the folder that's actually called Owner.

Microsoft stores its templates at:

`C:\Users\<your login name>\AppData\Roaming\Microsoft\Templates`

Again, if you failed to create a unique login name, this folder may be called `<Owner>`. If you can't find it, the AppData folder and all of its files and subfolders are hidden.

To view the Hidden files:

1. Select the *Start/Windows button* >

Control Panel > Appearance and Personalization

2. Select *File Explorer Options/Folder Options* > *Show hidden files and folders*

3. On the next screen, check the tick mark beside *Show hidden files, folders, and drives*, then click *Apply* and *OK*.

To discover the actual name of the Templates folder:

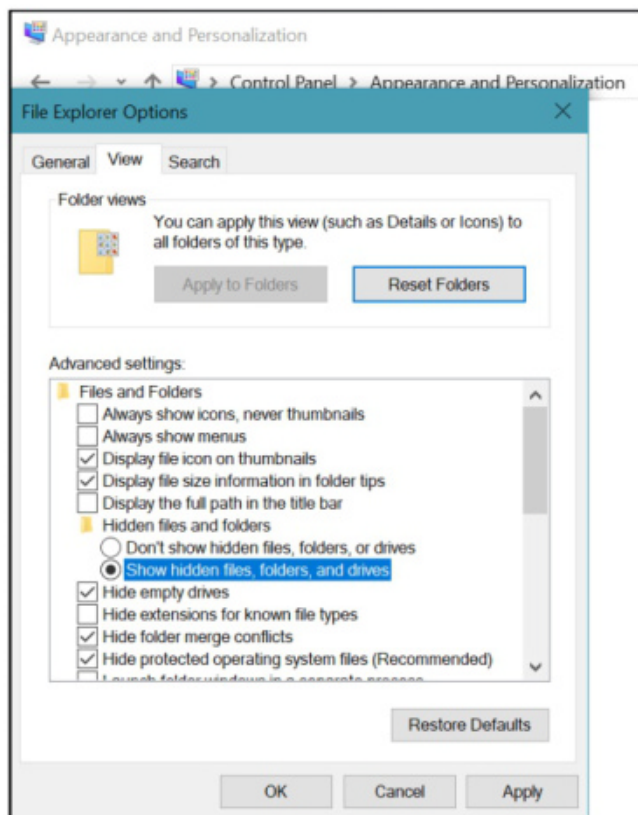
1. Select *File* > *Options* > *Advanced*

2. Scroll about two-thirds of the way down the screen.

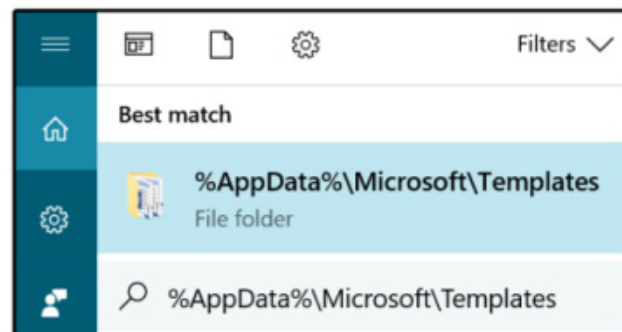
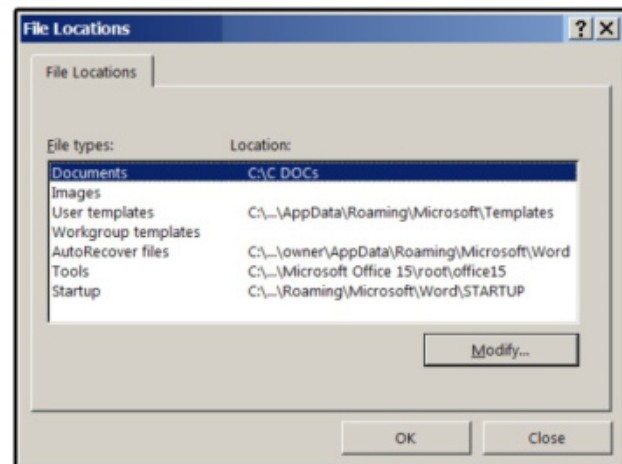
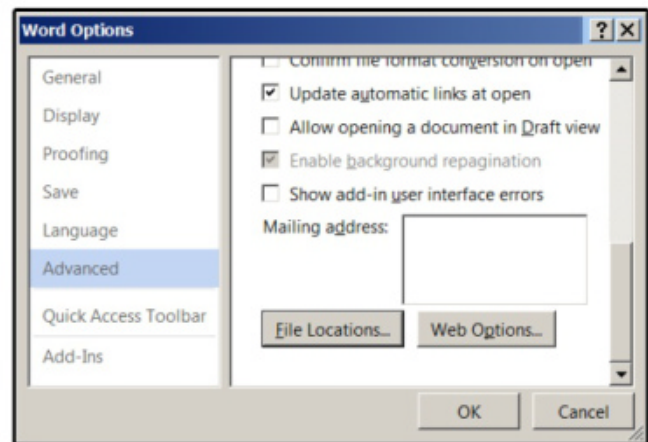
3. Click the *File Locations* button, and the File Locations window appears.

4. Word displays the locations and paths to all the template-related files.

You can also click the Start button, then copy and paste this: **%appdata%\Microsoft\Templates** in the Search box and press Enter. The Templates folder appears in the Start box. Double-click to go straight to the stock templates folder. 



Show Hidden Files and Folders.



Two more ways to locate the stock templates folder.

**PREVENT
WILDFIRES,
FOR THE
LOVE OF THE
OUTDOORS.**

