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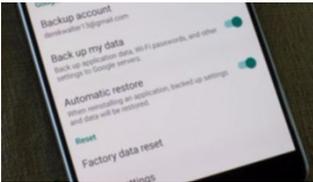
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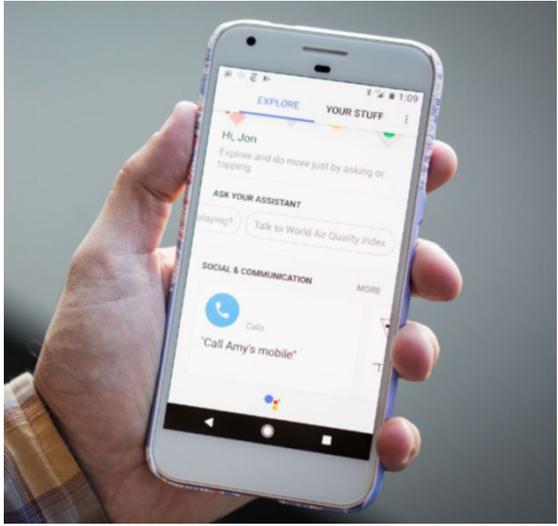


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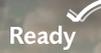
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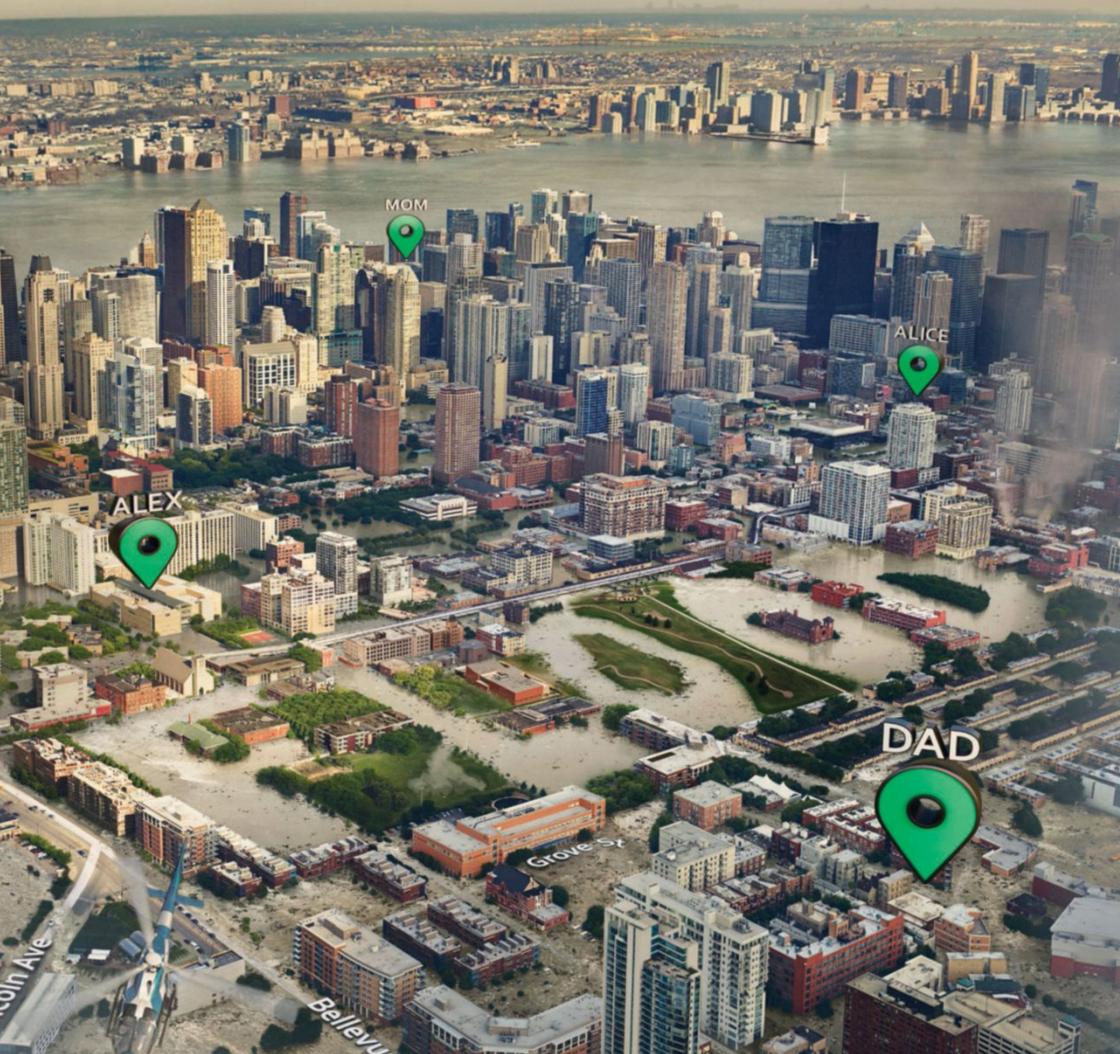
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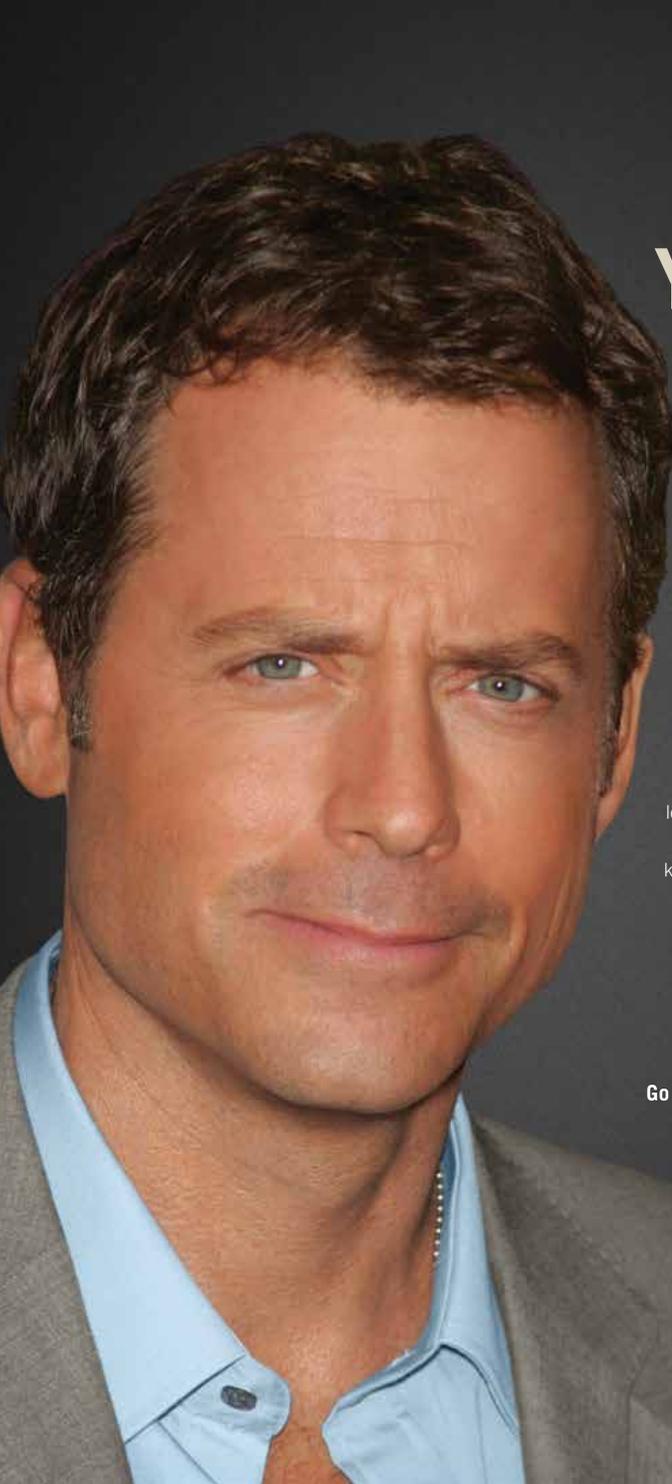
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*According to the Centers for Disease Control and Prevention (CDC), colorectal cancer is the second leading cause of cancer death in the United States when men and women are combined.



AMD Threadripper prices undercut Intel's Core i9 by as much as \$1,000

BY MARK HACHMAN

AMD HAS REVEALED the prices for some of its Threadripper CPUs, using the same effective strategy that it executed for its mainstream Ryzen chips: set eye-popping discounts compared to Intel's own Core i9 family, and probably earlier release dates, too.

IMAGE: GORDON MAH UNG

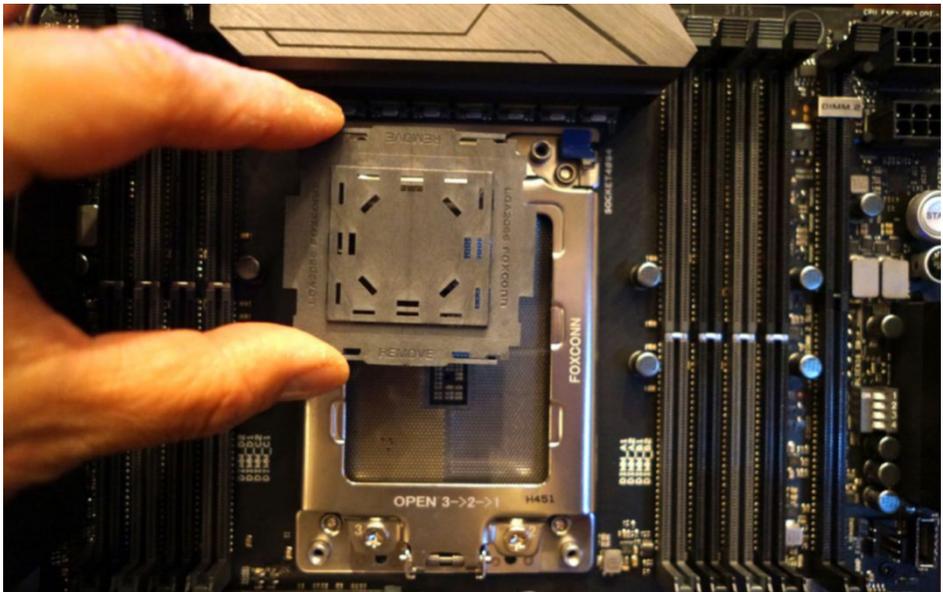
Recently, AMD disclosed the model numbers, price, and rough availability of both the 12- and 16-core AMD Threadripper chips, designed for the upper echelons of gaming and content-creation PCs:

- The **\$999** 16-core, 32-thread 3.4GHz Threadripper 1950X
- The **\$799** 12-core, 24-thread 3.5GHz Threadripper 1920X

Given that information, we also know the difference between what Intel and AMD will charge for their respective offerings. You'll pay \$700 less for a 1950X than for Intel's 16-core, 32-thread Core i9-7960X, and a thousand dollars less than Intel's 18-core, 36-thread Core i9-7980XE. On the lower end, the Threadripper 12-core 1920X costs \$400 less than the 12-core Core i9-7920X, and \$600 less than the 14-core Core i9-7940X.

AMD says that it will begin shipping Ryzen Threadripper CPUs and motherboards in early August. The company also confirmed that pre-orders of Alienware's Area-51 (go.pcworld.com/a51) systems will begin on July 27.

AMD previously revealed the size of the Threadripper socket, which dwarfs the Core i9.



Why this matters: AMD's disclosure is a new thrust in the ongoing slow-motion fencing match between Threadripper and Intel's Core i9 (go.pcworld.com/i91). Though it's deeply important for AMD to offer a microprocessor to compete with the Core i9, both Threadripper and Core i9 are Ferraris in the chip world—a world in which most users still drive a minivan. The Motley Fool reporter Ashlaf Eassa noted (go.pcworld.com/no1) that of the four most popular PC microprocessors sold by Amazon (go.pcworld.com/popu), all cost around \$200 to \$300, including a pair of AMD Ryzen 7 chips.

AMD's play for chip cachet

Nevertheless, AMD's decision to discount the Threadripper so deeply ensures that consumers will at least consider it if they're leaning toward an elite processor for gaming and high-performance tasks, analysts say.

"This is an important positioning play for AMD, as having a great high-end helps sell the mid-range, but I think they'll sell every one they make," said Patrick Moorhead, a former AMD fellow and now an independent analyst with Moor Insights. "Video professionals, developers, and consumers who want to say they have the best in

Intel still hasn't

provided all of the details for all of its new chips, but here's the latest, official word.

UNLOCKED INTEL® CORE™ X-SERIES PROCESSOR FAMILY

	Processor number ¹	Base clock speed (GHz)	Intel® Turbo Boost Technology 2.0 frequency ² (GHz)	Intel® Turbo Boost Max Technology 3.0 frequency ³ (GHz)	Cores/threads	L3 cache	PCI Express ⁴ 3.0 lanes	Memory support	TDP	Socket (LGA)	RCP pricing (USD 1K)
NEW	Intel® Core™ i9-7980XE	-	-	-	18/36	-	-	-	-	2066	\$1,999
NEW	Intel® Core™ i9-7960X	-	-	-	16/32	-	-	-	-	2066	\$1,699
NEW	Intel® Core™ i9-7940X	-	-	-	14/28	-	-	-	-	2066	\$1,399
NEW	Intel® Core™ i9-7920X	-	-	-	12/24	-	-	-	-	2066	\$1,199
NEW	Intel® Core™ i9-7900X	3.3	4.3	4.5	10/20	13.75 MB	44	Four channels DDR4-2666	140W	2066	\$999
NEW	Intel® Core™ i7-7820X	3.6	4.3	4.5	8/16	11 MB	28	Four channels DDR4-2666	140W	2066	\$599
NEW	Intel® Core™ i7-7800X	3.5	4.0	NA	6/12	8.25 MB	28	Four channels DDR4-2400	140W	2066	\$389
NEW	Intel® Core™ i7-7740X	4.3	4.5	NA	4/8	8 MB	16	Two channels DDR4-2666	112W	2066	\$339
NEW	Intel® Core™ i5-7640X	4.0	4.2	NA	4/4	6 MB	16	Two channels DDR4-2666	112W	2066	\$242

technology will gravitate toward Threadripper.”

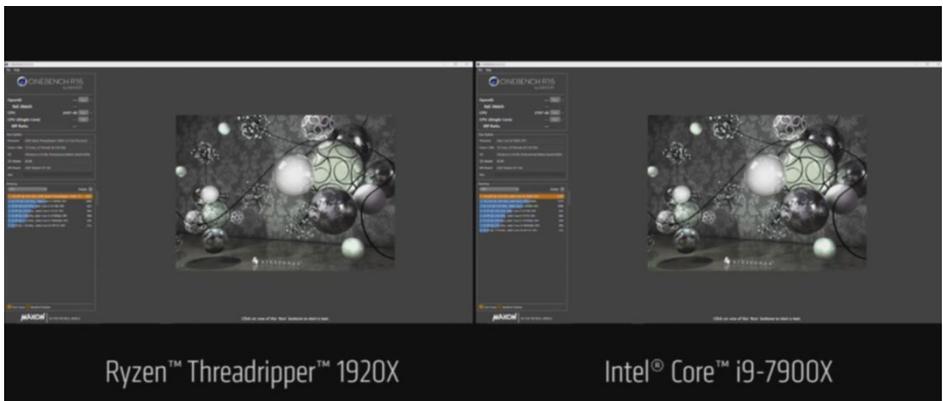
In fact, AMD seems to have its finger on two key triggers that help drive sales: price and availability. Intel hasn’t said exactly when it will begin shipping its Core i9 chips, though availability began in mid-June with its low-end Core i7 chips (go.pcworld.com/ju), and will run all the way through a scheduled October launch for the 18-core Core i9-7980XE. It’s very possible that an August Threadripper launch will beat Intel to market by a matter of weeks, if not months.

The announcement of Threadripper’s prices fills in another major hole in our knowledge of AMD’s elite chip. We already know that Threadripper’s new TR4 socket (go.pcworld.com/tr4) will be absolutely enormous. You’ll find sockets like it on motherboards such as the Asus Zenith Extreme, presumably part of the contingent that AMD’s partners will release in August. The X399-based motherboard will feature eight DIMM slots for up to 128GB of DDR4 RAM, four x16 PCI-E gen. 3 slots, a U.2 slot, three M.2 slots, and 12 USB 3.1 ports.

The final question? Performance. Threadripper will be based on the same underlying architecture powering AMD’s Ryzen chips, so our reviews of Ryzen 7 (go.pcworld.com/ry7) and Ryzen 5 (go.pcworld.com/ry5) can give you insights into its potential: the more simultaneous tasks being asked of it, the better.

“[A]s I am seeing Infinity Fabric scale well to 64 threads on EPYC, and

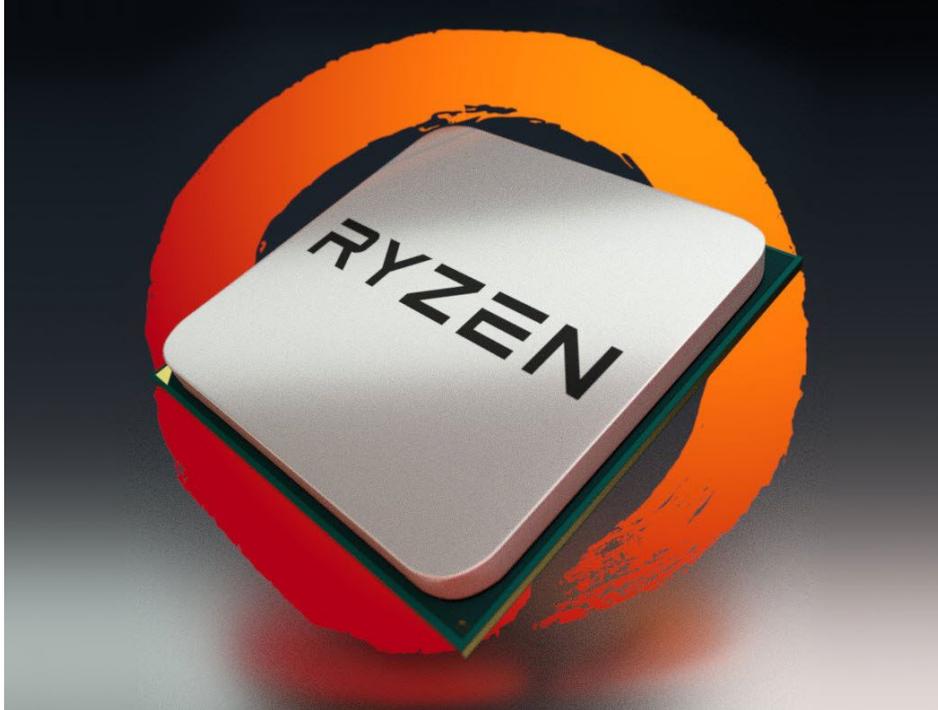
AMD’s Threadripper 1920X vs. Intel’s Core i9-7900X in the Cinebench R15 benchmark.





Threadripper is 32 threads, I think we will see much of a replay of what we saw on Ryzen 7,” Moorhead said. “That is, extremely well positioned in multi-threaded workloads and competitive in lower threaded workloads.”

In a video (go.pcworld.com/tr) showing how the Threadripper chips compare against Intel’s most powerful currently available CPU, the \$999 10-core Core i9-7900X, AMD tested the multi-threaded Cinebench R15 benchmark on all three. The \$799 Threadripper 1920X turned in a score of 2431 compared to the Core i9-7900X’s 2167, while the flagship \$999 Threadripper 1950X blew past both of those at 3062. 📺



AMD's Ryzen 3 lineup brings competitive quad-core CPUs to the masses

BY BRAD CHACOS

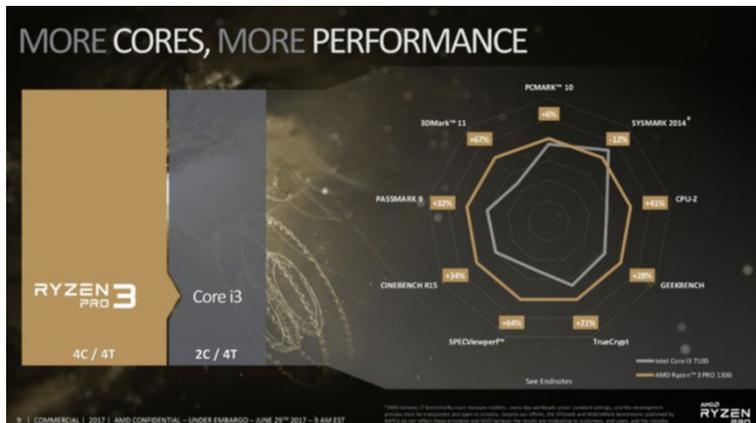
AMD CONTINUES ITS quest to democratize multicore computing. It recently revealed hard details about Ryzen 3 processors with twice as many CPU cores as their Intel rivals.

Only a pair of Ryzen 3 chips will be available when the lineup launches on July 27. Both the Ryzen 3 1200 and the Ryzen 3 1300X rock four cores and four threads, meaning they have double the physical cores as Intel's dual-core i3 chips, but lack the simultaneous multi-threading that allow AMD's Ryzen 5 (go.pcworld.com/ry5) and Ryzen 7 (go.pcworld.com/ry7) CPUs to press their core count

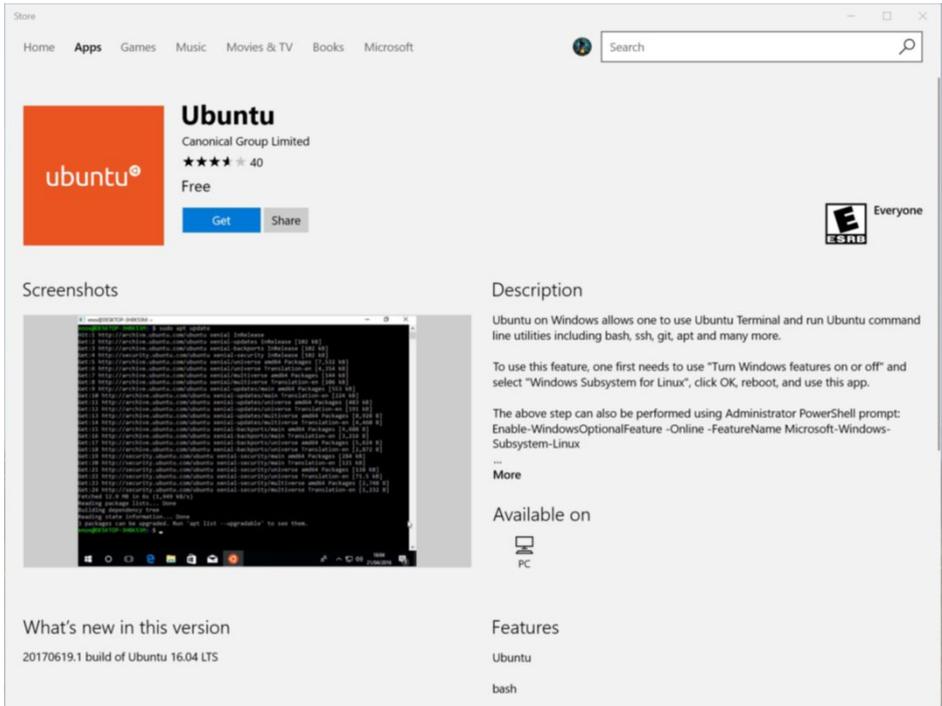
advantage even further. The Ryzen 3 1200 has a 3.1GHz base clock capable of boosting to 3.4GHz when needed, and the Ryzen 3 1300X hums along between 3.5GHz and 3.7GHz.

AMD didn't reveal any fresh performance comparisons against Intel's chips, but an earlier tease for the Ryzen Pro launch (go.pcworld.com/rpl) pit the quad-core Ryzen 3 1300X against Intel's Core i3-7100 in a variety of tasks. AMD says the Ryzen chip outperformed Intel's CPU in every task except the hotly contested Sysmark 2014 (go.pcworld.com/sys)—though you should always take vendor-supplied metrics with a big ol' pinch of salt until they're confirmed by independent testing.

The only major question left? Pricing. AMD didn't disclose how much the Ryzen 3 processors will cost when the chips release on July 27. They're likely to be pretty damned affordable though, as the step-up Ryzen 5 series bottoms out at \$169 for the 4-core, 8-thread Ryzen 5 1400, and the Core i3-7100 that AMD compared the Ryzen 3 1300X against retails for \$117. 🛑



Ryzen 3 vs
Core i3,
according to
AMD.



Windows 10 Build 16241 gives the best sneak peek yet at the Fall Creators Update

BY MARK HACHMAN

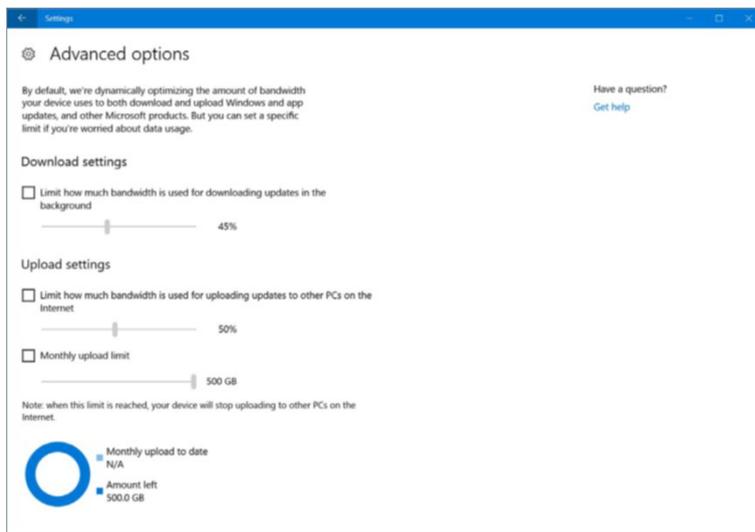
AS WINDOWS 10'S next big release date nears, the latest Insider Preview Build 16241 gives us a solid sneak peek at what the Fall Creators Update will look like. You'll see a some significant new features, including Ubuntu support, update delivery options, and

improved Task Manager visibility. But tellingly, Microsoft also opened its final “bug bash” challenge. That means the Windows 10 team is just about ready to button up the OS for its promised September debut.

Build 16241 also shows it’s serious because of the nature of its new features, emphasizing nuts-and-bolts improvements over new capabilities. For example, Windows 10 now offers a great deal more granularity into how Windows updates will be delivered, and how you can manage their bandwidth. Task Manager adds deeper insights into what’s going on with your GPU. Microsoft is also preparing for the launch of mixed-reality headsets with several updates to its MR capabilities.

Why this is important: Build 16241 marks the final lap in the race to the Fall Creators Update. Sure, it shows off some significant new features, but the simultaneous bug bash announcement signals that those will be the last additions. Remember, Microsoft has committed to a schedule of Windows upgrades (go.pcworld.com/wu) in both

Now you’ll have a greater degree of visibility into what Windows is consuming.



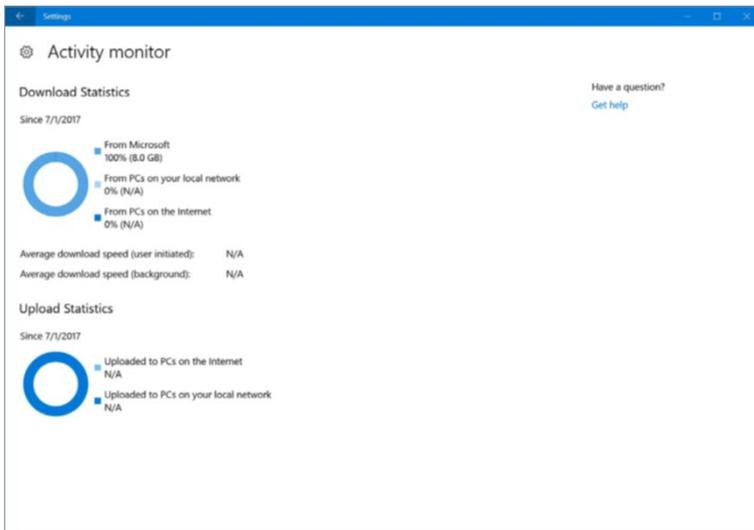
March and September. That means the “shipping” version of the Fall Creators Update is just weeks away.

A greater degree of visibility within Windows

Massive Windows updates are part and parcel of owning a Windows machine. That doesn't mean you have to like them, however. Part of the new Windows 10 Build 16241 includes what Microsoft calls Delivery Optimization Advanced Options, where you'll be able to manage how much bandwidth Windows uses for updates. Typically, Windows tries to throttle itself so as not to monopolize your connection. If you're on a low-bandwidth pipe and watching Netflix, for example, the amount of Windows update data will slow to a crawl.

What Windows doesn't know, however, is how much bandwidth is being used across your network, not only by other phones and PCs downloading information from the Internet, but also how much data is being sent from device to device. Now, you can manage that data.

That's important for two reasons: The first is just the impact on your own network performance. But for those who live in rural areas



Now you'll have a greater degree of visibility into what Windows is consuming.

or have signed up for a broadband plan with a strict data cap, managing that flow of information can be vital. Remember that your PC can also be used as a local “node” to send updates around the neighborhood, though you can turn that off (go.pcworld.com/of).

To show how much data Windows actually requires, Build 16241 includes the new Activity Monitor, which tracks data to and from your network, specific to Windows and its updates.

If this level of visibility appeals to you, you’ll probably be happy to learn that Microsoft tweaked the GPU portion of Task Manager once again. Now, you can view the active GPU’s name and see which of its functions (including 3D, video decoding, and video processing) are currently active. Microsoft also applied more descriptive labels to the tab processes used by Microsoft Edge, allowing you to see whether a particular webpage is slowing your system down, or a more generic service.

Prepping for mixed reality

Microsoft includes support for some fun in the latest build, too. Linux fans should be happy to know that the Bash shell now supports Ubuntu—an app that can be downloaded from the Windows Store.

Microsoft has also begun hammering out bugs within its mixed-reality devices—which have yet to begin shipping. It’s unclear



Microsoft's latest Insider

build includes several fixes to make mixed reality a true reality.



whether headsets like Acer's mixed-reality devices (go.pcworld.com/rd), which were shown off at the Build conference in May, will be ready in time for the Fall Creators Update launch, but Microsoft is apparently working hard to support them. The latest build includes support for USB motion controllers (with wireless support pledged soon) as well as a host of other improvements, including speech commands and a better teleportation experience. (In MR, users "jump" from spot to spot using what Microsoft calls "teleportation.")

We expected Microsoft to take a somewhat conservative approach to the Windows 10 Fall Creators Update, and so far it seems to be paying off. Assuming that the bug bash goes smoothly, that gives Microsoft about five weeks before September begins, and some wiggle room within that to ship the "final" version of the Fall Creators Update. Look for more of the pieces to fall into place over the coming weeks. 🔌



AMD, Nvidia coin-mining cards appear as gaming GPU shortage intensifies

BY BRAD CHACOS

IT'S DAMNED NEAR impossible to buy a reasonably priced graphics card right now. First AMD's Radeon cards disappeared (go.pcworld.com/rcd), then GeForce cards began to dry up too (go.pcworld.com/gfc). The culprit? Cryptocurrency miners chasing price bubbles in Ethereum, Zcash, et cetera. But new mining-dedicated graphics cards

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from AMD and Nvidia's hardware partners might help ease the dearth of gaming hardware.

Maybe? Hopefully? Okay, probably not.

A swarm of coin-mining cards have hit online e-tailers recently, as AnandTech (go.pcworld.com/ant) reports. Most are based on AMD's more mining-friendly Radeon "Polaris" GPUs, but you'll also find a couple of cards based on Nvidia designs. Notably, those use "GP106" branding—that's the name of the GPU itself—rather than being called GTX 1060 cards.

We'll get to other crucial differences in a bit. First, here's a rundown of the coin mining cards available so far—in theory. In reality, they're already all sold out. Surprise!

Asus: MINING-P106-6G (go.pcworld.com/6g) and MINING-RX470-4G (go.pcworld.com/4g)

Sapphire: 11256-31-21G (go.pcworld.com/31), 11256-21-21G (go.pcworld.com/21), 11256-35-10G (go.pcworld.com/35), 11256-36-10G (go.pcworld.com/36), 11256-37-10G (go.pcworld.com/37), and the 11256-38-10G (go.pcworld.com/38) are all based on the older Radeon

Asus says its Nvidia-powered cryptocurrency card is faster at mining than consumer GeForce hardware.

RX 470, with varying memory, clock speed, and power configurations that can affect mining speed. The 11267-11-10G (go.pcworld.com/111) is based on the RX 560—an odd choice, since that low-powered graphics card isn't compelling to most miners.

MSI: P106-100 Miner 6G (go.pcworld.com/p106)

PC Perspective (go.pcworld.com/pcp) reports that Inno 3D, EVGA, Zotac, and Colorful are also working on dedicated mining cards, and that mining cards based on the GTX 1070's "GP104" GPU are on the way as well.

This mining hardware differs from consumer graphics cards in key ways, with warranty length being one of the most important. Sapphire's mining cards on Overclockers UK list a one-year warranty, while the versions sold on Newegg offer a scant 180 days of protection. The company's consumer graphics cards are guaranteed for two years, by comparison. Miners keep GPUs churning 24/7 so the limited warranty makes sense.

The new gear looks similar to traditional graphics cards—almost. Since you don't need to hook mining hardware up to a monitor, many of the cryptocurrency-dedicated cards ditch display connectors completely, while others limit themselves to a single DVI port. That

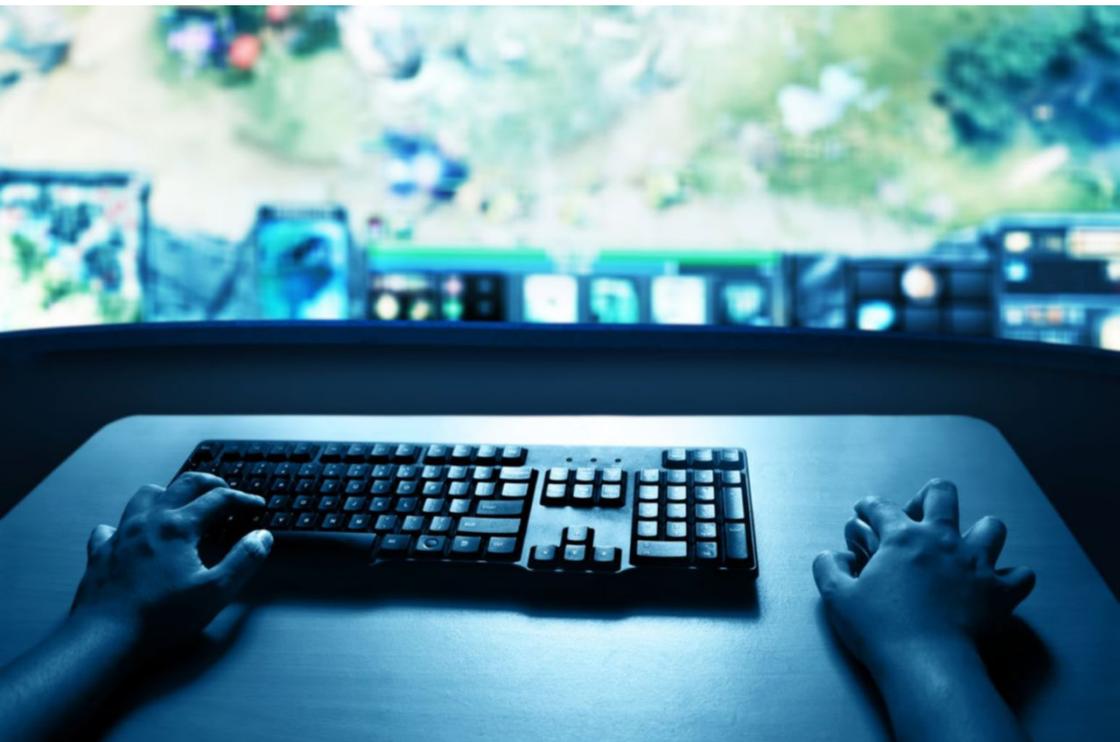


should make it easy to spot these gaming lemons if unscrupulous folks try to pass them off as proper graphics cards whenever the mining bubble bursts.

The impact on you at home: That's the million dollar question, isn't it? Inflated prices have made it impossible to build a budget gaming PC (go.pcworld.com/bgpc), or to buy anything but extremely low-end or high-end graphics cards right now.

Don't expect these mining cards to be a savior though.

Miners are gobbling up all the hardware they can find right now. These new coin-mining cards are just more food for that hungry maw. And while the limited warranties and display connections probably let PC vendors create cards from GPUs that failed quality assurance for consumer hardware, the intense specialization might make them less attractive for hardcore miners. Cryptocurrency mining is all about the return on investment, and reselling graphics cards after bubbles burst is a big part of that calculation. No gamer would want to buy these used. 🛑



The best PC games of 2017 (so far)

BY HAYDEN DINGMAN

USUALLY I START these mid-year lists of the best PC games with “Can you believe it’s already June?” But I think I speak for everyone when I say, “Wow, we’re only halfway through 2017? Seriously?” This has been one of the busiest spring release windows I’ve ever seen, with dozens of major PC games already released this year.

Sure, a few we were looking forward to turned out to be high-profile flops (cough *Mass Effect: Andromeda* [go.pcworld.com/mea] cough), but there have also been some instant classics—*NieR: Automata*, *Prey*, *Thimbleweed Park*, and more.

Look for those and more inside, as we round up the best PC games of 2017—so far, at least. This fall’s looking even more packed.

Prey

It’s not the story you tell, it’s how you tell it. You could easily look at *Prey* (go.pcworld.com/pre) and dismiss it as same-old, same-old. Immersive sim on a space ship? Oh, so it’s *System Shock 3*. And indeed that’s the target Arkane aimed at when it started this whole project.

What it lacks in originality it more than makes up for in style, though. *Dishonored*’s take (go.pcworld.com/dt) on the genre is always slow, plodding, and methodical. Creative, to a point—but restrained by the tools at your disposal. *Prey* has no such restraints. The fact that speedrunners have beaten the game in seven minutes (go.pcworld.com/7m) is testament to the freedom *Prey* gives you, as is the fact that your first “gun” is good mostly for building platforms and



accessing those hard-to-reach areas.

Is *Preya* a revolution? A reinvention of old ideas? Not in the slightest. But it takes much of what made *System Shock 2* great, repackages it in a modern game with modern design and modern tech, and runs with it. It's one hell of a space station and one hell of a game (go.pcworld.com/hog).

NieR: Automata

I didn't really understand *NieR: Automata* (go.pcworld.com/nau) until the credits ran for the fifth time. It's an RPG that breaks all genre conventions from the get-go, with lengthy bullet-hell sequences interspersed between the fast-paced and fluid combat Platinum's games are known for. And it's a game that features singing robots, villains named Adam and Eve, and all sorts of other oddities I'd hate to spoil.

But it only gets wilder the longer you play. There's a lull in the middle as you go for the second ending—that section's probably the weakest part. It's worth it to push through though, as endings C and D bring the story to some wild places and ending E...well, I can't say anything at all. Except that it's worth the journey.

The PC port has some issues, and I might have abstained from



putting *NieR:Automata* on this list if it were a lesser game. But the problems are at least easily fixed with a well-maintained fan patch (go.pcworld.com/wmf). Grab it and you're set.

Night in the Woods

Night in the Woods (go.pcworld.com/nw) looks maybe a bit too cutesy for its own good. I still don't know why everyone's an animal, except... well, they just are. It doesn't really matter though, because *Night in the Woods* features extraordinary character writing, with some of the best moment-to-moment dialogue I've seen in a game. Not in the "You're the hero and you're fighting evil!" way, but the much-harder-to-pull-off "You're a normal person and this is a sketch of your life" way. Chats with your parents. Chats with your friends. Chats with neighbors. It's identifiable on a personal level that few games achieve.

And that's great, but when I think back on *Night in the Woods*, it's the town I remember. Underneath the twee story of a college-aged kid looking for somewhere to belong, there's a deeper story about rural America—specifically, about an economically depressed mining town, the toll taken on the people who call it home, and the slow decay after the boom years are over. It's good (go.pcworld.com/ig). And timely.





Thimbleweed Park

The Kickstarter campaign promised a “long lost LucasArts adventure” and that’s exactly what Ron Gilbert, Gary Winnick, and Co. delivered with *Thimbleweed Park* (go.pcworld.com/tp). It’s a point-and-click the way point-and-clicks were made in their heyday, complete with the SCUMM-style graphics and the block of verbs in the bottom left corner.

But it’s also 2017’s take on the ’90s adventure game. The Twin Peaks–esque story of a murder in a strange town filled with strange people is quickly usurped by meta-humor, in-jokes, and just all-around bizarre occurrences—some explained, some left to the imagination. *Thimbleweed Park*’s both a brilliant homage and a brilliant game in its own right (go.pcworld.com/bgj).

Torment: Tides of Numenera

Torment: Tides of Numenera (go.pcworld.com/ttn) might not reach the same heights as its spiritual predecessor *Planescape: Torment*, nor will it perhaps last as long in people’s hearts. But that’s a bit of an “Aim for the moon, land among the stars” deal, because *Torment: Tides of Numenera* is still an excellent throwback CRPG (go.pcworld.com/atc).



Why? Because it's all so damn weird. That's what made *Planescape: Torment* a joy to play, and it's *Tides of Numenera's* strong suit too. Whether it's a city contained within a dimension-spanning slug, an orphan from another time and place, a garden where only the person you're talking with can hear you and vice versa—the game is just full of wondrous events and areas that make it a joy to explore.

There are definite issues. Combat is superfluous, which doesn't annoy me but may annoy some. The story wraps up too quickly and ties together a bit too neatly. There are definitely aspects I would've wanted to see fleshed out. But what's here is still an excellent journey despite its flaws.

Everything

Everything (go.pcworld.com/ev) is a philosophical treatise. A game, sure, but also a way of looking at the universe, of understanding the world around us. One that'll be innately familiar to lovers of Carl Sagan's *Cosmos*, for instance—a world interconnected, a simulation of...well, everything. And one where everything is related to every other, where we're defined by our similarities more than our



differences.

What this means for you, the player? You're put in control of an object—a cow, a bear, a pencil, a streetlamp, a cigarette butt, a grain of pollen—and can, at will, scale up into a larger one or down into a smaller one. Maybe you'll spend a few minutes as a cloud, or an island, or a single electron. There are over a thousand objects in *Everything*, and you can control each of them in some manner. Oh, and periodically you'll stumble upon excerpts of talks by philosopher Alan Watts and listen to him discussing how all beings are related, and actually part of one huge organism.

It's a game that demands a particular mindset and a willingness to approach it on its own terms, but *Everything* is stunningly ambitious. There's certainly nothing else quite like it.

Snake Pass

Snake Pass (go.pcworld.com/sp1) is a game built around a single idea: You're a snake. Really. That's it. It may look like a mid-'90s platformer, with its cartoon characters and that bright, colorful palette. You're a snake, though, and thus have no legs with which to platform.



Instead you're reduced to snaking around a level—coiling yourself around poles, wriggling across ledges, and clambering your way up cliffs like a sentient vine. Which is basically what you are. It's excellent, almost more of a puzzle game than a platformer, and despite being overshadowed by the release of Yooka-Laylee (go.pcworld.com/yl) in the same window I think *Snake Pass* is probably the stronger throwback game.

Stories Untold

Stories Untold (go.pcworld.com/su) is really good until it kind-of sort-of isn't. Which is to say: The last chapter is a letdown.

It's mainly a letdown, though, because it tries to wrap a fat, ugly bow around what is, up until that moment, a fantastic and somewhat spooky anthology series like *The Twilight Zone* or *The Outer Limits*. *Stories Untold* is a love letter to analog technology, a fact that doesn't surprise me a bit after learning that some of the *Alien: Isolation* (go.pcworld.com/ai) crew worked on it. More specifically, it's a game where you use analog technology to investigate the paranormal—say, by using medical equipment to experiment on a strange artifact, or



typing coordinates into an elaborate radio system from your snowed-in lodge.

Everything goes wrong, obviously.

As I said, the last chapter is a bit of a lark. What comes before is more than good enough to make up for it, though. *Stories Untold* is immensely creative, and proof that we're not done inventing great game mechanics yet—even if those mechanics are sometimes drawn from the past.

Cosmic Express

"It's a puzzle game with trains." Yeah, okay. But *Cosmic Express* (go.pcworld.com/ce) is so much more. First of all, they're space trains.

All kidding aside, *Cosmic Express* is also the best puzzle game I've played this year. The



concept is simple—just get the trains to the exit, picking up and depositing all the aliens in their homes along the way. Like last year’s *Stephen’s Sausage Roll* (go.pcworld.com/ssr), however, this simple setup disguises a fiendish puzzle game that will have you drawing and re-drawing tracks all the livelong day.

What Remains of Edith Finch

What Remains of Edith Finch (go.pcworld.com/wre) is one spectacular moment after another. You’re sent to the old Finch family home for what first seems like a fairly uninspired “walking simulator” type game, until suddenly it’s not that at all. Instead you’re paraded through the dying moments of every member of the extended Finch family, a series of incredible vignettes each with its own aesthetic, its own moral (if we can call it that), and its own contribution to the greater family story.

To say much more would be to spoil the game, because so much of it is predicated on the surprise—on each 5- to 10-minute character sketch telling you all you need to know about the people involved, their hopes and dreams, and ultimately their fates. It’s one of the rare instances where game and storytelling are perfectly intertwined, and either without the other would suffer immensely.

It’s my favorite game so far this year.





BONUS: Planescape Torment Enhanced Edition

It's bit silly to nominate a game from 1999 for any sort of award in 2017—especially one that's already as well decorated and acclaimed as *Planescape: Torment*.

That being said, Beamdog finally released *Planescape: Torment Enhanced Edition* (go.pcworld.com/pte) in April, making the game much more accessible (go.pcworld.com/mma) for the average person with native widescreen support, 4K resolution, a remastered soundtrack, zooming, tab highlighting, and more. Sure, you could've managed all that with mods before—I did that exact thing back in January—but this is the game with minimal mucking about. If you've always heard great things about *Planescape* and never gotten around to it, there's really no excuse anymore.

BONUS: PLAYERUNKNOWN's Battlegrounds

Two caveats about *PlayerUnknown's Battlegrounds* (go.pcworld.com/pbg). First, it's still in Early Access. Second, the name is just terrible. We'll be calling it *PUBG* from here on out.

We never really put Early Access titles on these sorts of lists, or even pay them much attention because, well, they're not done. We'd be remiss if we didn't include *PUBG* though. Not only has the game sold about a bajillion copies already, but it's so damn fun. It's a battle royale set on a massive island where your goal is to gather equipment, find the coolest clothes, and survive longer than everyone else. That last one is probably most important.

Sound familiar? Developer Brendan "PlayerUnknown" Greene authored a similar Arma mod back in the day and then helped develop *H1Z1: King of the Kill*. But *PUBG* is the best of the bunch, managing to mimic Arma's realism without Arma's clunkiness and frustration. There's no other feeling like outlasting 90-plus competitors, making it into the final ten, and waiting to die.

Pro-tip: Install it on an SSD. That alleviates some of the more egregious performance problems. And remember, it's still in Early Access. 🔌





Total War Saga series focused on smaller ‘powder-keg’ moments in history

BY HAYDEN DINGMAN

HOW MUCH TOTAL War is too much? It seems like Creative Assembly’s determined to discover the answer, recently announcing yet another spin-off of the strategy series. In addition to the mainline historical *Total War* and the fantastical *Total Warhammer*, we’ll now see *Total War Saga* games.

And soon. While *Total Warhammer 2* releases this fall, the first *Total War Saga* game will release “before the next major historical release in the franchise,” as this press release puts it. Sometime next year, probably.

So what is *Total War Saga*? I’ll let Creative Assembly’s Jack Lusted give

you the short of it. From the announcement:

There are key, pivotal points in history which don't necessarily revolve around a single character, and only lasted a few months or few decades at most. Such moments also tend to be constrained to a tight geographic area as well.

"These moments are perfect fuel for Total War. They're a powder keg, where anything can happen and history could have gone in any direction. So, Total War Saga games will be the same mix of turn-based campaign strategy, real-time battle tactics and hundreds if not thousands of hours of gameplay as a regular Total War game, but focused down on a distinct moment."

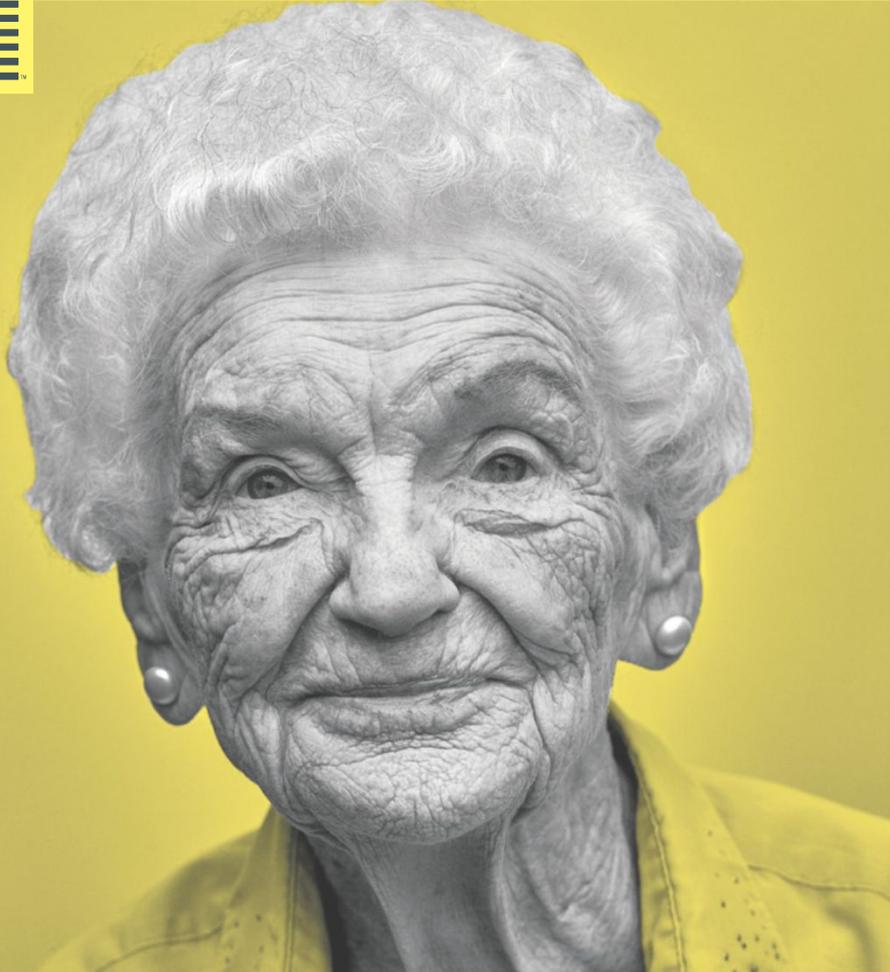
The easiest point of comparison, and the one used by Lusted in today's announcement, is the much-loved *Shogun 2: Fall of the Samurai*. A stand-alone expansion, *Fall of the Samurai* took what people loved about *Shogun 2* and then drilled down on a specific period in the 1800s—greater detail, smaller time-span, same general feel and scope.

Personally I'd argue the same is true of the seminal *Rome: Total War* though—the 2004 original. While covering perhaps a slightly longer era in history and more land area, *Rome* was primarily about the fall of the Roman Republic and the rise of the Roman Empire. In retrospect, it would've made perfect fodder for one of these *Saga* games.

And maybe it still will. Lusted teased the first game in the announcement, though we're still a ways off from anything official, saying "It's another spiritual follow-up to *Total War: Rome II*, like *Total War: Attila*, and moves the time period forward in much the same way." Expect more in the coming months.

As for a real, proper historical *Total War*? It's still in the works, still focused on an entirely new era for the *Total War* series, and Creative Assembly will still "be talking about it much more in the future." At this point I wouldn't be surprised if the game's weren't released until 2050 and the "new era" is early-2000s warfare.

Oh well. At least this first *Saga* game should tide you over. 🍷



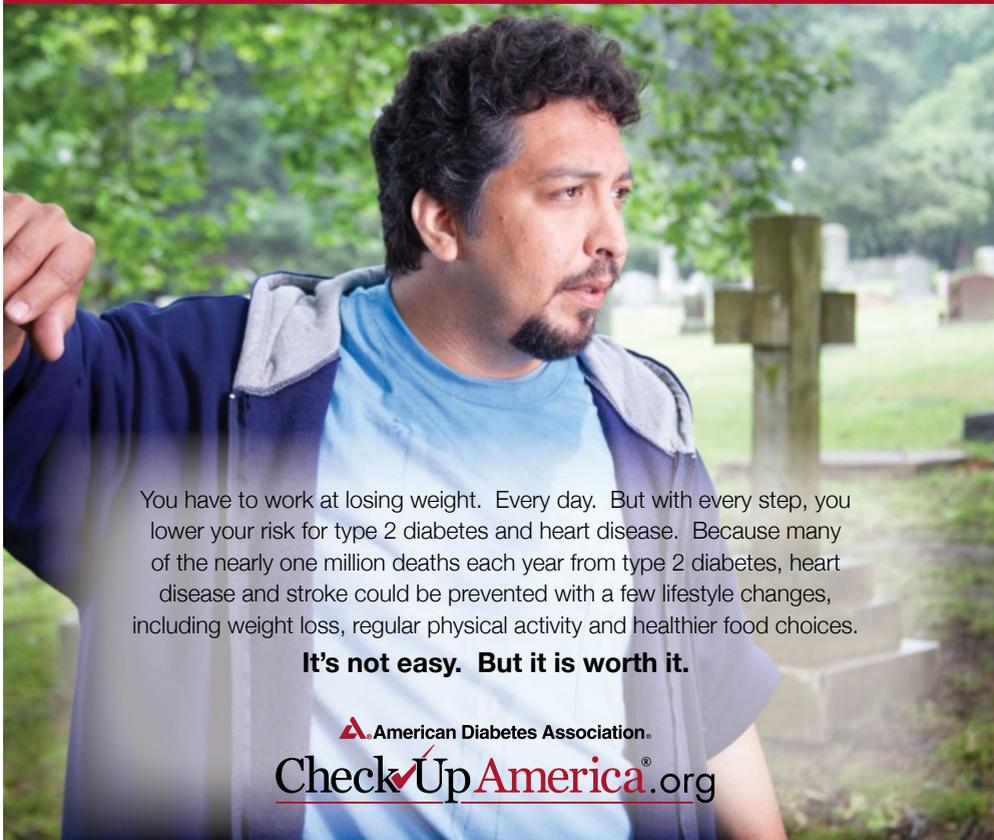
AMERICA, LET'S DO LUNCH.

Lola Silvestri, SINCE 1921. Conversation and good company are her domain. Now, she and 1 in 6 seniors face the threat of hunger and millions more live in isolation. So pop by, drop off a hot meal and say a warm hello. Volunteer for Meals on Wheels at AmericaLetsDoLunch.org

Gaining weight was easy. Losing it's a lot harder...



but very much worth the effort.



You have to work at losing weight. Every day. But with every step, you lower your risk for type 2 diabetes and heart disease. Because many of the nearly one million deaths each year from type 2 diabetes, heart disease and stroke could be prevented with a few lifestyle changes, including weight loss, regular physical activity and healthier food choices.

It's not easy. But it is worth it.

 American Diabetes Association.

Check  **Up** **America**.org

Learn how you can help stop diabetes by losing weight, eating healthy and staying active.
Visit checkupamerica.org or call 1-800-DIABETES.

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TESTED IN PCWORLD LABS

In this section, hardware & software goes through rigorous testing.

REVIEWS & RATINGS



Intel Core i9: The fastest consumer CPU prepares for Ryzen war

BY GORDON MAH UNG

WE'RE REVIEWING THE first Core i9 chip—Intel's 10-core Core i9-7900X (\$1,000 on Newegg, go.pcworld.com/1on)—as a veritable CPU storm looms. Sure, Core i9 blew in as the most powerful CPU the company has ever sold to consumers, and it's currently the fastest Core-series CPU available. But an ill wind is blowing: AMD's Ryzen 5 and Ryzen 7 chips offer stiff competition in the low end, while its massive

IMAGE: INTEL

12-core and 16-core Threadripper CPUs loom on the high end.

Because there's so much to say about Core i9, we put the prices, features and FAQs (go.pcworld.com/pff) into a separate story you'll want to read for background. For this review, we'll walk through some of the under-the-hood issues directly related to performance, and then we'll dive into the benchmarks.

Core i9, under the hood

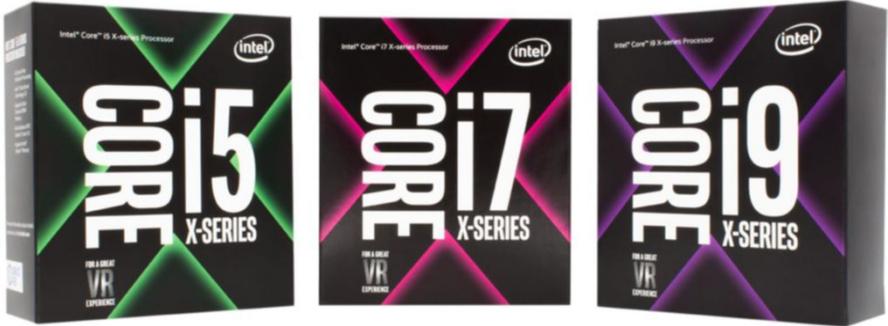
Core i9 is the first new "Core i" Intel has introduced in 10 years. The company guarded the secret so closely that it even intentionally mislabeled the chips (including our review sample) as "Core i7" to throw off leakers. In fact, the review sample you see here still identifies itself as Core i7 rather than a Core i9.

Like most major Intel launches, the Core i9 family represents a new platform, not just a new CPU, which means a new chipset, the X299, and a new socket, the LGA2066, all incompatible with previous CPUs.

The new platform also does something no previous one did by unifying two CPU families. Before today, if you wanted the company's

UNLOCKED INTEL® CORE™ X-SERIES PROCESSOR FAMILY											
Processor number ¹	Base clock speed (GHz)	Intel® Turbo Boost Technology 2.0 frequency ² (GHz)	Intel® Turbo Boost Technology 3.0 Frequency ¹ (GHz)	Intel® Turbo Boost Technology 2.0 All-Core frequency ³ (GHz)	Cores/ threads	L3 cache	PCI express 3.0 lanes	Memory support	TDP	Socket (LGA)	RCP Pricing (1K USD)
i9-7980XE NEW	TBD	TBD	TBD	TBD	18/36	TBD	TBD	TBD	TBD	2066	\$1,999
i9-7960X NEW	TBD	TBD	TBD	TBD	16/32	TBD	TBD	TBD	TBD	2066	\$1,699
i9-7940X NEW	TBD	TBD	TBD	TBD	14/28	TBD	TBD	TBD	TBD	2066	\$1,399
i9-7920X NEW	TBD	TBD	TBD	TBD	12/24	TBD	TBD	TBD	TBD	2066	\$1,199
i9-7900X NEW	3.3	4.3	4.5	4.0	10/20	13.75 MB	44	Four channels DDR4-2666	140W	2066	\$999
i7-7820X NEW	3.6	4.3	4.5	4.0	8/16	11 MB	28	Four channels DDR4-2666	140W	2066	\$599
i7-7800X NEW	3.5	4.0	NA	4.0	6/12	8.25 MB	28	Four channels DDR4-2400	140W	2066	\$389
i7-7740X NEW	4.3	4.5	NA	4.5	4/8	8 MB	16	Two channels DDR4-2666	112W	2066	\$339
i5-7640X NEW	4.0	4.2	NA	4.0	4/4	6 MB	16	Two channels DDR4-2666	112W	2066	\$242

The **Core X series** is made up of CPUs constructed with Skylake-X cores and Kaby Lake-X cores. The monster 18-core part is due in October.



latest Kaby Lake core, you had to buy a motherboard using the LGA1151 socket. And if you wanted to buy, say, a 6-core Skylake CPU such as Intel's Core i7-6800K, you had to buy an LGA2011 V3-based motherboard.

With X299 and LGA2066, you can now pick your poison, because the platform encompasses everything from a 4-core Core i5 Kaby Lake CPU to an 18-core Core i9 Extreme Edition, which is a Skylake CPU. For clarity's sake, the Kaby Lake CPUs, also called Kaby Lake-X, are the Core i5-7640X and the Core i7-7740X. The rest of the Core i7 and Core i9 CPUs are Skylake, collectively called Skylake-X.

This union has been greeted with some confusion and trepidation. It's likely that X299 motherboards will be expensive. Some are rightly wondering who would buy a \$350 motherboard to install a \$250 CPU.

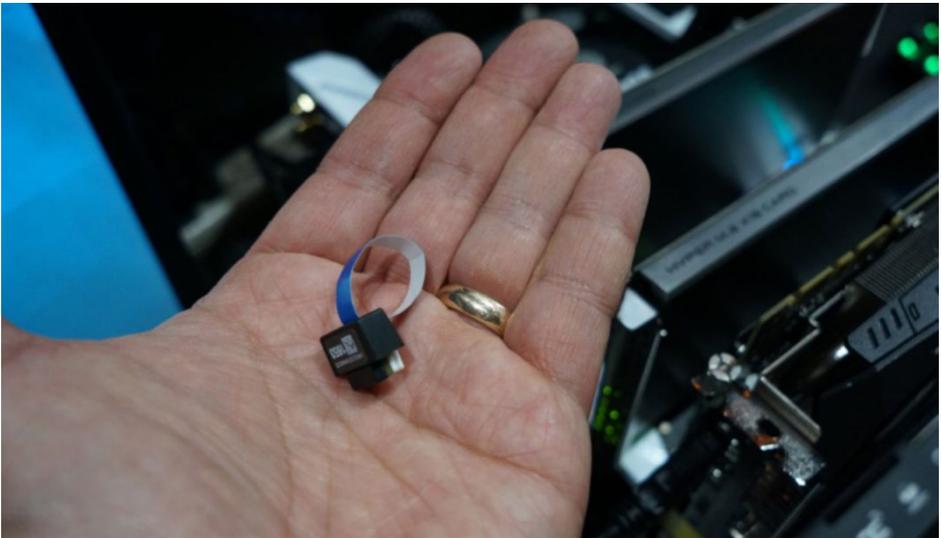
Intel's motives for the Kaby Lake-X may actually be a nod to the overclocking sports. Unlike LGA1151-socketed Kaby Lake chips, Kaby Lake-X chips have no integrated graphics capability. In fact, we've been told the chips physically have no IGP on the die at all. This allows the two Kaby Lake-X chips to overclock potentially far higher than the LGA1151 versions. At the recent Computex show in Taipei, in fact, Intel said a record was set for the highest overclock of a Kaby Lake chip, and it was on X299.

In a perfect world, we'd all have 18-core CPUs, but the truth is there are those who buy cheap CPUs on nice motherboards. Kaby Lake-X is for you.

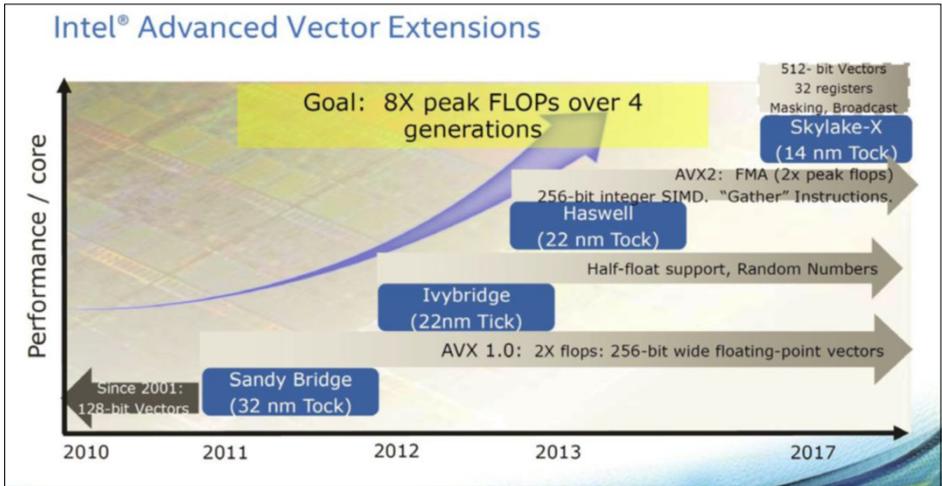
PCIe lanes: Still being rationed

Still, having Kaby Lake-X and Skylake-X on the same socket is bound to create confusion. Exhibit A is the PCIe rationing. With the Core i9-7900X, for example, you get quad-channel memory support and 44 PCIe Gen 3 lanes directly from the CPU. If you were to drop a Core i7-7740K into the same build, the motherboard drops down to dual-channel memory support and, perhaps worse, the PCIe lanes drops down to 16 lanes because the Kaby Lake core doesn't support more. That means some of the slots on a motherboard would fall back in performance or be completely disabled.

While Kaby Lake-X's 16-lane limit is due to the CPU's design, Intel dials back PCIe lanes on Skylake-X intentionally. Rather than the 44 lanes the 10-core version gets, the 6-core and 8-core versions of Skylake-X get just 28 lanes. From what we understand, there's no technical reason for it, just "market segmentation," which is a business school way of saying, "so we can charge you more." Oy.



You may have to purchase a special dongle key like this if you want to use X299's VROC feature enabling RAID up to 20 NVMe drives.



Intel VROC

Even more controversial than PCIe rationing is Intel’s VROC, or Virtual RAID on CPU. It’s a nifty feature on Skylake-X that allows a user to configure up to 20 NVMe PCIe drives in RAID into a single bootable partition.

The problem? Intel apparently intends to charge more money for the feature. Details haven’t been released, but vendors at Computex told us they believed RAID 0 would be free, RAID 1 would cost \$99, and RAID 5 and RAID 10 could cost \$299. Once you’ve ponied up the cash, you get a hardware dongle that unlocks the feature.

It gets worse: VROC will work only with Intel SSDs and pricier Skylake-X parts. If you buy Kaby Lake-X, you’re shut out. VROC also applies only to PCIe RAID that runs directly through the CPU’s PCIe lanes. X299 still supports various RAID 0, 1, 5, 10 through the chipset, but the chipset RAID won’t touch the performance you get from VROC.

We’ll reserve final judgment until Intel confirms pricing. Considering the face-palms it caused at Computex, we’re interested to see how this shakes out.

AVX 512 in the Skylake-X promises far more performance—but only if the code supports it.

How Core i9 changes Skylake

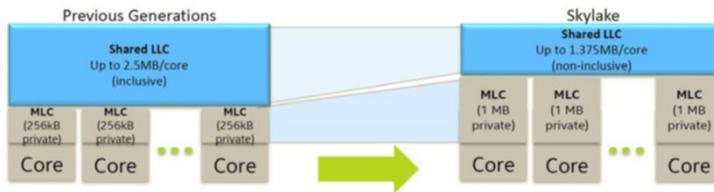
Once you've gotten beyond the platform confusion and controversy, there's a reward. The Skylake-X chip itself is indeed something to admire, because it's built unlike any previous high-end Intel consumer chip.

Previous "enthusiast" or "extreme" CPUs have mostly been the same. That is, a 4-core Haswell Core i7-4770K wasn't all that different from from an 8-core Haswell-E Core i7-5960X except for the support of quad-channel RAM.

With Skylake-X, Intel breaks from tradition, with some major tinkering under the hood. The most noticeable is an increase in Mid-Level Cache (MLC), or L2 cache: Intel has quadrupled it to 1MB per core, up from 256KB in last year's Broadwell-E and the majority of Intel's CPUs. The Last-Level Cache (L3) actually gets smaller, with 1.375MB per core versus the 2.5MB of the previous Broadwell-E chip, but Intel compensates with the larger MLC and also the use of a non-inclusive cache design. Compared to the inclusive design in Broadwell-E, which might keep data that's not needed, non-inclusive cache attempts to track what should be in the cache so it can more efficiently use the available space.

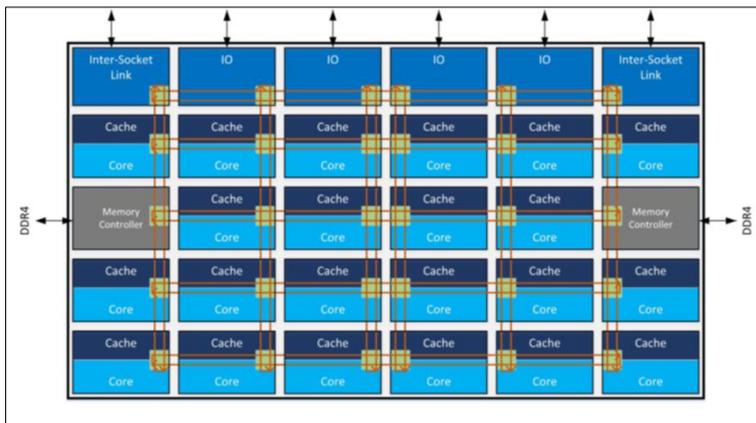
Skylake is very different from Skylake-X, and much of that has to do with the cache, AVX512, and a new mesh interface.

Rebalancing the Cache Hierarchy



- Shift cache balance from shared-distributed to private-local by enlarging MLC
- Shared LLC retained to benefit shared data and to enable capacity balancing

High hit rate on low latency MLC increases performance



The ring bus architecture of recent CPUs gets dumped for a mesh architecture that can scale up far more cores.

Intel also ditches the ring bus architecture it has used for several years (including Kaby Lake and Skylake) for a new mesh architecture. If you think of a quad-core CPU as four homes connected by a bus line that makes stops at each home, it's perfectly fine until you add, say, 12 or 18 homes to the community. You could connect two bus lines together, but that still isn't as fast as simply driving from one home to the next, which is what the new mesh architecture does.

Intel's use of a mesh design clearly puts it on a better footing to compete with Threadripper (go.pcworld.com/tdr), as more and more cores are added to CPUs. AMD's Ryzen series uses something it calls an Infinity Fabric, which is essentially a super-high-speed mesh network.

The last feature worth noting is the improved Turbo Boost Max 3.0. This is the feature wherein Intel identifies the "best" CPU core at the factory and gives it a little more boost speed. With Broadwell-E CPUs, only one core was chosen. With Skylake-X, two cores are identified as the "best" and allowed to run a couple of hundred megahertz faster.

Performance

Intel sent us the Core i9-7900X in an Asus Prime X299-Deluxe motherboard. We ran the testbed with the Anniversary Update build of Windows 10. Yes, we know, the world has moved on to the Creators



**Core Wars:
Episode IV** (can you spot the boo-boo in this picture?)

Update (go.pcworld.com/cr1), but in order to compare it with past CPUs we stuck with this earlier build.

All of the systems (except where noted) used a GeForce GTX 1080 Founders Edition, 32GB of DDR4/2133 RAM, and HyperX 240GB Savage SATA SSDs. For our Adobe Premiere CC 2017 test, the source project and the target drive used a Plextor M8pe PCIe SSD in all but the Core i5 and the Ryzen 5 CPUs. This exception is due to a problem with the Ryzen 5's motherboard, which failed to recognize the Plextor drive. A Samsung 960 Pro NVMe SSD was swapped in.

Where we sourced from our previous tests, those tests used the same Nvidia drivers, the same OS, and the same hardware that we used for this Core i9-7900X review. We did, however, decide to update the testbed for the original 10-core Broadwell-E Core i7-6950X. That test was originally conducted on a very early Asrock X99 motherboard that didn't fully support Intel's new Turbo Boost Max 3.0 technology. This time around, we used the same Asus X99-Deluxe II that we used for testing the two Broadwell-E chips in the comparison pool.

Cinebench R15 performance

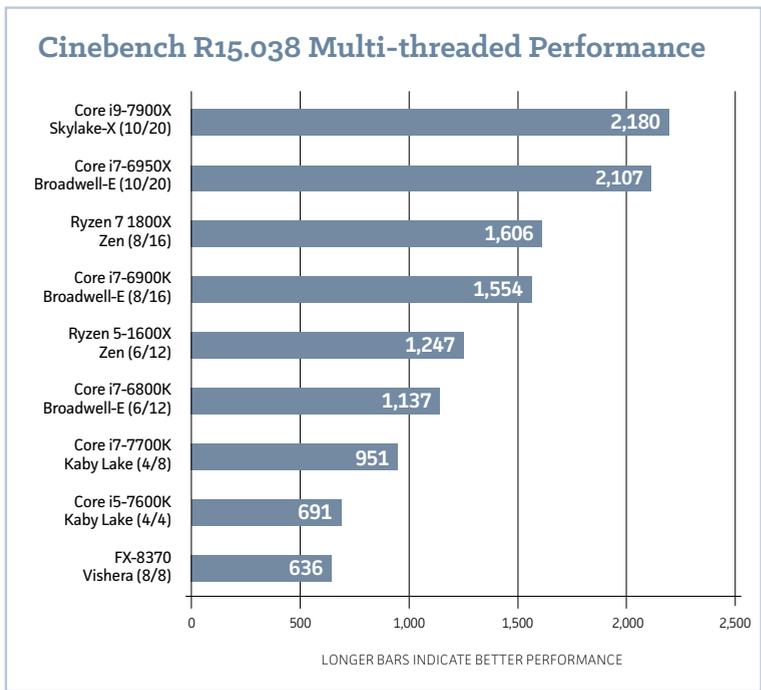
Our first test is Maxon's Cinebench R15. It's a free benchmark based on the same rendering engine used in Maxon's Cinema4D product. It

scales well with core count and frequency and is pretty much a pure CPU test. The results speak well for the the 10-core CPUs when compared to the 8-core parts. Even though we're increasing thread count by only 22 percent, we're seeing almost a 30-percent increase in performance.

The difference between the 10-core Broadwell-E Core i7-6950X and the 10-core Skylake-X Core i9-7900X is less than expected. According to Intel, you might see up to a 10-percent difference in multi-threaded tasks and up to 15 percent in single-threaded tasks when compared to the Broadwell-E 10-core. In Cinebench, we're seeing just about 3.5 percent.

What changed? The motherboard. What we're likely seeing is a result of more than a year of tuning by Asus of its X99 platform. It just pushes the CPU far harder and far faster than the first motherboard.

Multi-threaded performance of the 10-cores is well in front of the 8-core chips.



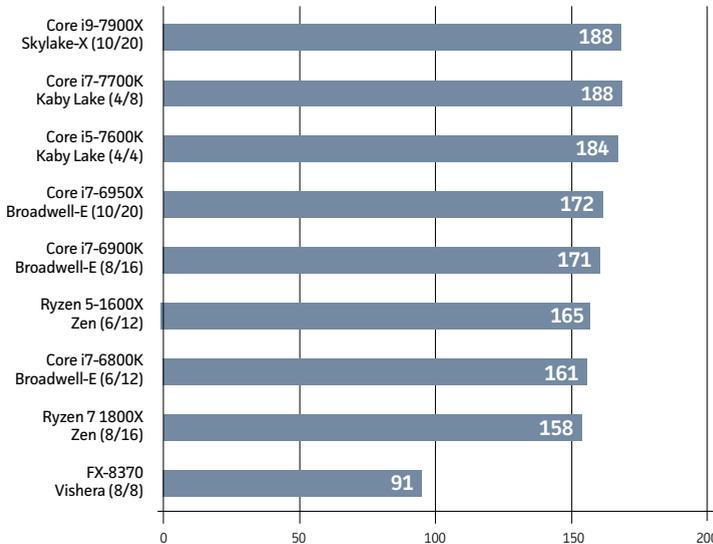
Our initial [review](#) of the CPU in this test gave it a score of 1,792, which is quite a bit off from the 2,107 we're seeing from it now. Other initial reviews put the chip in the low-1,800s. If that score remained true, Skylake-X would be almost 20 percent faster than Broadwell-E.

We also ran Cinebench R15 limited to just a single thread. Because the vast majority of applications and games still rely on a single thread, the performance here is just as important as it is on multi-threaded tests. The 10-core Broadwell-E now drops back a few spots, as its clock speeds can't keep up with the 10-core Skylake-X chip's. You can also see that the CPUs with the higher clock speeds move ahead of the 6- and 8-core chips. All except for the 10-core Core i9-7900X.

Large 8- and 10-core chips have had trouble keeping up with the spry quad-cores in high clock speeds. Intel started fixing that in Broadwell-E, but if this Cinebench result holds true, Skylake-X has the

The single-threaded performance of the Core i9-7900X matches that of the speedy Core i7-7700K.

Cinebench R15.038 Single-threaded Performance



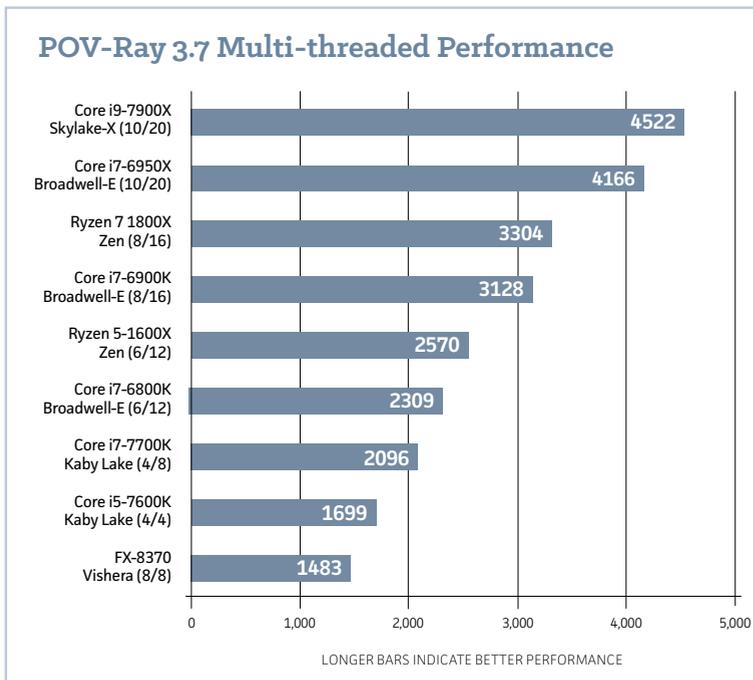
LONGER BARS INDICATE BETTER PERFORMANCE

potential to hang with Kaby Lake just fine.

POV-Ray performance

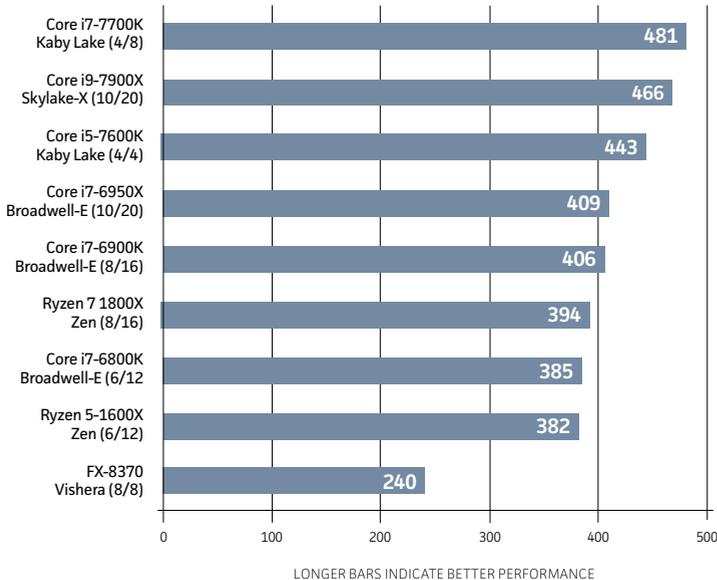
The second test we'll highlight is the POV-Ray. It's a free ray tracer that goes back to the Commodore Amiga. Using the built-in benchmark, we saw the 10-core Core i9 outpace the 10-core Core i7 by about 8 percent, which is closer to Intel's 10-percent claim. Against the 8-core Core i7-6900K, we're seeing Skylake-X outpace it by roughly 36 percent.

POV-Ray also has a single-threaded test. Although the Core i9-7900X can't quite keep up with the spry Core i7-7700K, it's pretty close. We're seeing about a 13-percent gap between the Core i9 and the Core i7-6950X, too, which is just a hair shy of Intel's claim of 15 percent.



In POV-Ray,
the 10-Core
core i9 easily
outpaces the
10-core Core i7.

POV-Ray 3.7 Single-threaded Performance



The 10-core Core i9-7900X can't quite keep up with the 4-core Core i7-7700K.

Blender performance

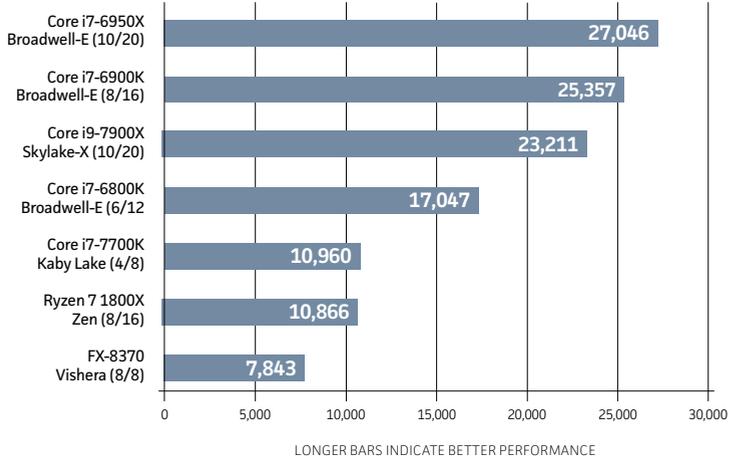
Our last 3D rendering test is the open-source Blender test. Using Peter Pan's popular BMW benchmark we're seeing a scant 2 percent gap between the 10-core Core i9 and 10-core Core i7 chips.

For kicks, we also used Blender on AMD's custom Ryzen workload (which you can find here: go.pcworld.com/h.) The performance difference between Core i9 and Core i7 is minimal.

WinRAR performance

Moving on to compression tests, we used WinRAR's built-in benchmark to measure the compression performance of the various chips. One thing you'll notice is we no longer break out the performance of the Ryzen 5 1600X and the Core i5-7600K CPUs. That's because both of those were tested with the RAM set at DDR4/2933.

WinRAR 5.40 (KB/s)



WinRAR 5.40 seems to favor the Core i7-6950X over the newer Core i9-7900X, though it's unclear why.

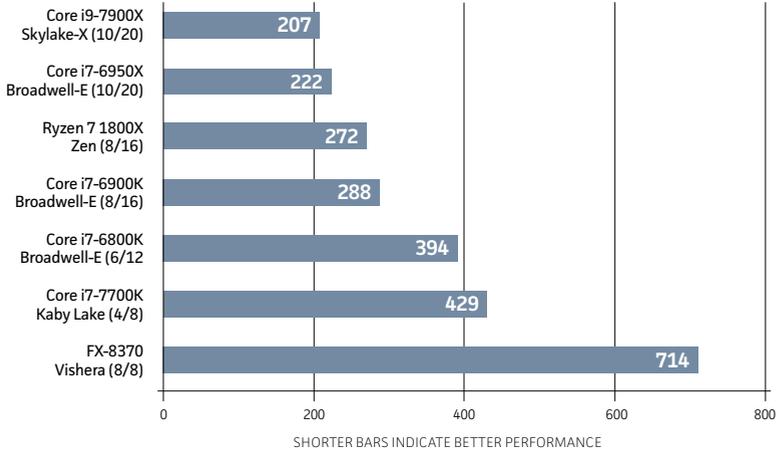
Memory bandwidth doesn't matter that much in 3D rendering tests, but it definitely can tilt the scales in compression tests. Rather than cloud the results, we're dropping them.

One thing you'll notice is that the 10-core Core i9 suddenly takes second place to the 10-core Core i7 chip. We also tried this test with the latest beta version of WinRAR and saw no change. We surmised this might be the cache design of the new chip, but after talking with Intel, the company suggested it could be the new mesh design.

7-Zip performance

A second compression test we ran is 7-Zip's built-in benchmark. Like WinRAR, we suspect it prefers the cache design of the Core i7-6950X more than the new one in the Core i9-7900X. It's not enough to matter, but the upshot is there are going to be some applications favor Broadwell-E over Skylake-X.

Premiere CC 2017 4K Video CPU Encode to Blu-ray (sec)



Pure CPU encoding in Premiere CC 2017 gives the big 10 cores the nod in performance.

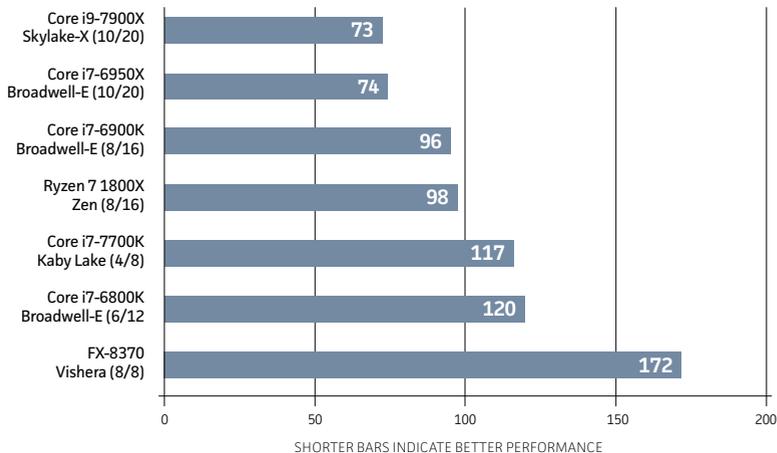
Adobe Premiere Creative Cloud 2017 performance

For video editing, we tasked the CPUs with exporting a video shot by our studio on a Sony 4K camera. The project was exported using the Blu-ray preset and the Maximum Render option enabled in Premiere, which helps when video is resized. We also opted to use the Mercury software engine, which relies on the CPU for the encode rather than the GPU. Many use the GPU for encoding today, but CPU encoding is still the standard for image quality.

The Core i9-7900X registered about a 7 percent advantage over the Core i7-6950X CPU, which isn't bad, and close to the "up to 10 percent" Intel promised.

We know people will say none of this matters because "I use my GPU for encoding," so we also ran the same test using the Mercury CUDA engine in Premiere CC 2017. This means the GeForce GTX 1080 was

Premiere CC 2017 4K Video GPU Encode to Blu-ray (sec)



GPU encoding in Premiere CC 2017 offers a nice performance boost, but a faster CPU matters more.

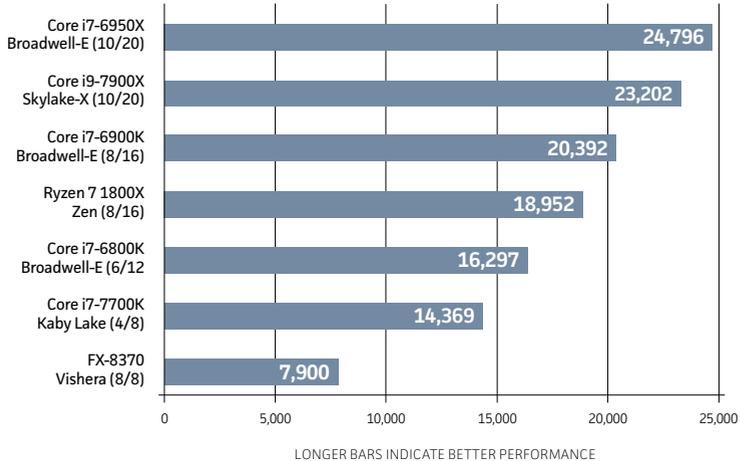
tasked for much of the heavy lifting.

We saw an immediate improvement in export times, but if you look at the results—the CPU still matters. In fact, the 10-core boxes still win by a decent amount. If you were encoding a multi-hour project, the 10 cores would be worth the extra cash.

Handbrake encode

Our last encoding test uses the free Handbrake to convert a 30GB 1080p MKV file using Handbrake 0.9.9 Android Tablet preset. The test is multi-threaded and scales well with clock speed. The winner is the Core i9-7900X, which comes in—cha-ching—about 10 percent faster than the 10-core Core i7-6950X. We're also seeing nice scaling: The 10-core is about 30 percent faster than the 8-core Core i7-6900K and 60 percent faster than the 6-core Core i7-6800K.

3DMark FireStrike Physics

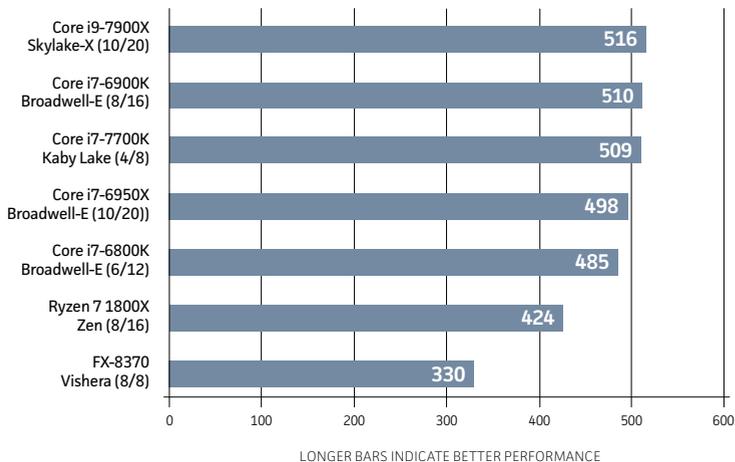


3DMark's Fire Strike Physics tests CPUs using a real game physics engine.

3DMark Fire Strike performance

For gaming performance, we first run Futuremark's 3DMark Fire Strike. We're reporting only the physics portion of the test, as that's the only one that matters for the CPU. The test uses a real-world physics engine that scales well with core count. Oddly, the Core i7-6950X nudges the Core i9-7900X out of the way, perhaps because of the cache difference between the chips or the mesh architecture. Note, though, that this is a theoretical test of what a game could do if it stressed all those cores. In reality, games don't devote this much to game physics.

Tomb Raider Normal 19x10 (avg FPS)



Running the older Tomb

Raider game at 1920x1080 and normal settings, it's pretty much a wash among the Intel CPUs.

Tomb Raider performance

Moving on to a real game, we use Ubisoft's older Tomb Raider to measure CPU performance by running the game at 1920x1080 resolution and the normal preset. At this low game setting and relatively low resolution for a GeForce GTX 1080, the only difference we're likely seeing is clock speed. Each CPU's cache can occasionally move the needle, too.

The Ryzen 7 1800X chip performance is off, likely due to code that isn't optimized (go.pcworld.com/cti) for its microarchitecture. Case in point, Rise of the Tomb Raider recently received an update that greatly helped Ryzen out. And for the most part, it's not an issue at higher game settings where the GPU is the bottleneck on performance.

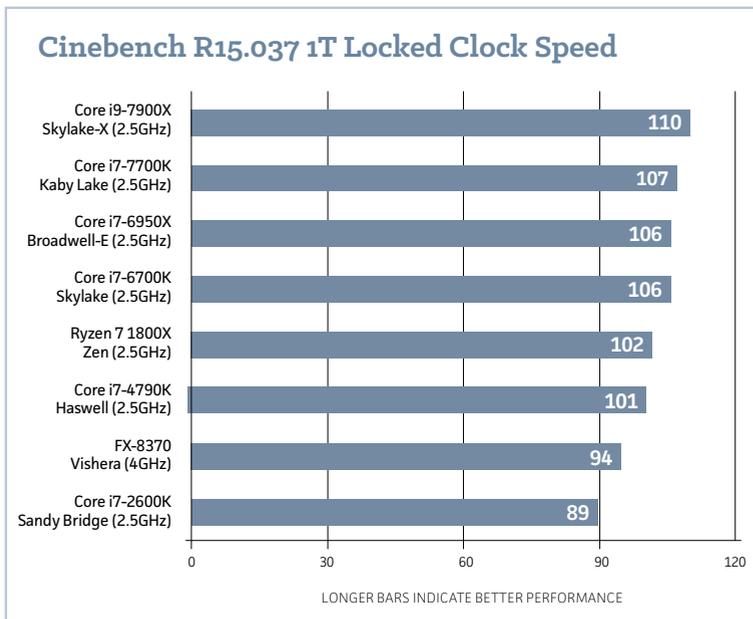
You can also see from our results why Ryzen's performance was so confusing: CPUs don't matter in conventional gaming as much as people wish they would.

Tom Clancy's Rainbow Six Siege performance

We'll close out our gaming performance of Skylake-X with the more modern Tom Clancy's Rainbow Six Siege. The Core i9-7900X is slightly slower than the Kaby Lake and 8- and 10-core Broadwell-E chips. We suspect, again, that the game slightly favors the cache design of Broadwell-E and Kaby Lake, but it's not a big deal. Lackluster Ryzen performance is again possibly linked to game optimization.

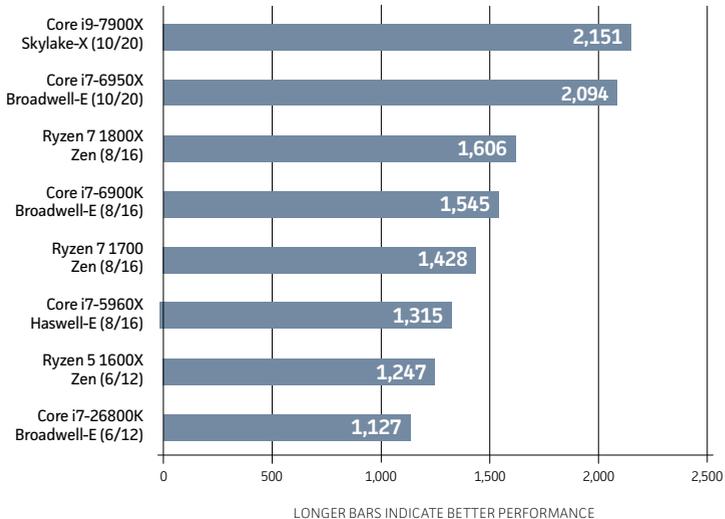
IPC performance

One difficult thing to discern with most of these benchmarks is just how "efficient" each CPU microarchitecture is. One way to tease that out is by running a test using a single thread, with all the CPUs locked to the same clock speed. We locked most of the CPUs here to 2.5GHz and turned off any Turbo Boost. We then ran Cinebench R15.037 (which we used to generate scores for the older CPUs).



We locked down almost all of the CPUs to 2.5GHz to test the IPC. No, the AMD FX isn't holding its own: It's at 4GHz vs. 2.5GHz for the other CPUs.

Cinebench R15 Multi-threaded Performance



10 cores are indeed faster than 8 cores.

We can see that instructions per clock (IPC) has built itself up slowly from the days of Sandy Bridge. Skylake-X comes out in front of even Kaby Lake, surprisingly.

Note: The FX-8370 is fast because we couldn't underclock the CPU to 2.5GHz, so we just used its score running at 4GHz. Yes, the performance of Vishera at 4GHz is still below that of a Haswell CPU running at 2.5GHz. Woof.

IPC isn't everything, so we'll close this out with a big chart of Cinebench R15 scores that we've personally run on various CPU models. Keep in mind, they're not exactly one-to-one, as some CPUs have higher-clocked RAM, or run on DDR3 instead of DDR4. But Cinebench is mostly a CPU benchmark, so memory bandwidth doesn't affect it as much as it would in some tests.

Conclusion

If you point your eyes at that last chart, which includes just about every Intel design represented since Sandy Bridge, you can only conclude that the new Core i9-7900X is the fastest consumer CPU ever produced by Intel. There's just no argument. The fact that it's [being offered at \\$1,000](#) compared to the \$1,723 tag on the previous 10-core part is another reason for the PC community to cheer.

The problem is, it's a different world now. At \$1,000 for a 10-core chip, you're paying about 100 percent over an 8-core Ryzen 7 chip for about 30 percent more performance. Even worse, we still don't know what price AMD set for its 12-core and 16-core Threadripper chips. If AMD introduces a 12-core CPU at \$850, as some predict, a 10-core Core i9 for \$1,000 loses its luster.

For now, the Core i9-7900X reigns as the fastest consumer CPU on the planet. But it should be looking over its shoulder, as will we, for Threadripper. 🔌





Surface Laptop: Microsoft's MacBook Air killer nails what students need

BY MARK HACHMAN

OUR SURFACE LAPTOP review considers Microsoft's new notebook in three ways: first, as a stylish ultrabook, designed to compete with Apple's MacBook Air on college campuses. It's also a showcase for Windows 10 S, limiting users to Windows Store apps but with an unexpected benefit to battery life. But if you want more flexibility, you can upgrade to Windows 10 Pro—and we've tested that, too.

After using the Surface Laptop as a Windows 10 S machine, I can say it does a great job of addressing exactly what college students need. More sophisticated users might want to look a bit further afield, though, or at least bail out of Windows 10 S early on.

An ultrabook with style

The Surface Laptop follows in the formidable footsteps of the Surface Pro, Surface Book, and Surface Studio—all category-defining products with prices to match. The Surface Laptop is a striking ultrabook with prices that are attainable, if not overly affordable. For now, the Surface Laptop ships in four configurations:

- Intel Core i5/4GB RAM/128GB SSD: \$999
- Intel Core i5/8GB RAM/256GB SSD: \$1,299
- Intel Core i7/8GB RAM/256GB SSD: \$1,599
- Intel Core i7/16GB RAM/512GB SSD: \$2,199

Microsoft also separately ships a Surface Arc Mouse (go.pcworld.com/sam), which is color-coordinated to match the Surface Laptop. The Surface Pen and Surface Dial will work with the Laptop, but they're not required.

We reviewed the \$1,299 model, which I'd consider to be the price/performance sweet spot, assuming a college student with generous parents. Though gamers want 16GB of RAM, 8GB is sufficient for web browsing and some basic apps, and 256GB of storage is finally becoming more of the norm.

Just as important as what's inside is the Surface Laptop's outside, which is dressed to kill MacBook Airs. Lifting the tinted aluminum veneer of the lid to reveal the softer Alcantara fabric of the keyboard tray

Microsoft Surface Laptop

AT A GLANCE

Microsoft's Surface Laptop is a reasonably-priced premium laptop whose excellent battery life and light weight outweigh any restrictions placed upon users by the Windows 10 S operating system.

PROS

- Fantastic battery life inside an ultrabook chassis
- Reasonably priced, for a Surface
- Free (for now) upgrade to Windows 10 Pro

CONS

- App restrictions can make Windows 10 S frustrating
- Limited port selection
- Other notebooks offer more advanced features, like USB-C

\$1,299





Microsoft offers four colors for the Surface Laptop, though they're currently not available throughout the full product line.

beneath evokes the elegance of a jewelry box. Microsoft also streamlined the exterior by eliminating the volume control rocker switch and power button, moving them to the keyboard.

The Surface Laptop is very thin, just 0.57 inches at most, compared to the MacBook Air's 0.68-inch profile. At 12.13 x 8.79 inches, it's also a little smaller than the MacBook Air. Grab the Surface Laptop by its keyboard, and its 2.76-pound weight (3.2 pounds with charger) will feel impressively light.

There's one catch: The base \$999 Core i5 model ships only in the silvery "platinum" color. The only configuration to offer the three other color options (graphite gold, burgundy, cobalt blue) is the model we tested. While Microsoft should eventually offer the additional colors across the entire product line, it hasn't yet—a situation that's sure to frustrate some consumers.

A surprising lack of ports

Thin ultrabooks have to give up something, and the Surface Laptop's configuration is no different. Most of it is good: Our unit houses a 2.5GHz Core i5-7200U, part of the 7th-generation Kaby Lake family. Each of the Core i5 options includes an Intel HD 620 graphics core,

while the Core i7 version includes the powerful (for integrated graphics, that is) Iris Plus 640 core which we tested on the new Surface Pro (go.pcworld.com/nsp). For college papers and web browsing, an HD 620 core will be just fine.

One of the hallmarks of the Surface lineup is the display, and I enjoy Microsoft's bright PixelSense 10-point touchscreens. The Surface Laptop's 13.5-inch, 2256x1504 (201 ppi) version, aligned in Microsoft's standard 3:2 ratio, lives up to the name. The IPS panel pumps out 365 lumens, enough even for outdoor use.

Some competing devices offer 4K displays. Keep in mind, though, that pushing more pixels requires more power, and one of the strengths of the Surface Laptop is its excellent battery life.

On the right side of the Laptop is Microsoft's Surface connector, maintaining compatibility with older chargers as well as optional peripherals like the Surface Dock. The other ports—USB 3.0 Type A, miniDisplayPort, headphone—appear on the left side of the chassis.

There is no miniSD or other removable storage slot, recognition that photos and other files are more often stored online or on USB sticks. I can agree with that rationale, though the single USB-A port looks awfully lonely, and the lack of USB-C is the opposite of future-proofing.



Would an additional USB connector have killed you, Microsoft?

The Surface Laptop reclines about as far as the Surface Book, about 50 degrees or so off the horizontal. Unlike the Surface Book, however, there's no accordion hinge. Instead, a barely-visible hinge smoothly moves the display back and forth. The screen tends to wobble a bit when inking or when the keyboard moves sharply.

The keyboard: Microsoft kept what works, mostly

You can sum up the Surface Laptop's keyboard simply: Aside from one small modification, Microsoft bundled the Surface Pro's backlit keyboard with the Surface Book's touchpad. The space allocated to the keyboard on both devices is literally the same—4 x 10.75 inches—and the touchpad dimensions on both the Book and the Laptop are identical.

That said, the Surface Laptop's typing experience falls slightly short of the Surface Book's. I prefer the fluidity of the Surface Book's keys. There's also a bit of structural give in the Laptop's keyboard that isn't present on the Book. To test it, I placed a small screw between the R, T,



Though the Laptop doesn't require the Surface Pen, it immediately wrote and "erased" digital ink, without any setup.



Surface Book trackpad, meet the Surface Pro (2017) keyboard.



I never powered off the Laptop by accident, but it's still an odd place to put such an important button.

F, and G keys. On the Laptop, I noticed a bit of bowing that wasn't present on the Surface Book, which expresses itself as a slightly mushy feel that's independent of the keys.

The Surface Laptop's touchpad feels great, slightly oilier than the Book's aluminum surface. Clicking and gestures worked as expected.

A pair of "omnisonic" speakers are buried beneath the keyboard. The volume reaches satisfactory levels, slightly vibrating the keys as you type upon them. Naturally, there's not a lot of bass, and I'd recommend headphones.

Windows 10 S: Lack of choice is frustrating

In a bid to make the Surface Laptop as manageable as Chromebooks powered by Google's Chrome OS, Microsoft designed the Surface Laptop and other education-minded PCs around Windows 10 S, an optimized version of Windows 10. Windows 10 S restricts Surface Laptop users to apps found within the Windows Store, and adds a few manageability features found in Windows 10 Pro to help

administrators keep tabs on the devices. (For a deeper dive into Windows 10 S, please see our Windows 10 S FAQ: go.pcworld.com/10s.)

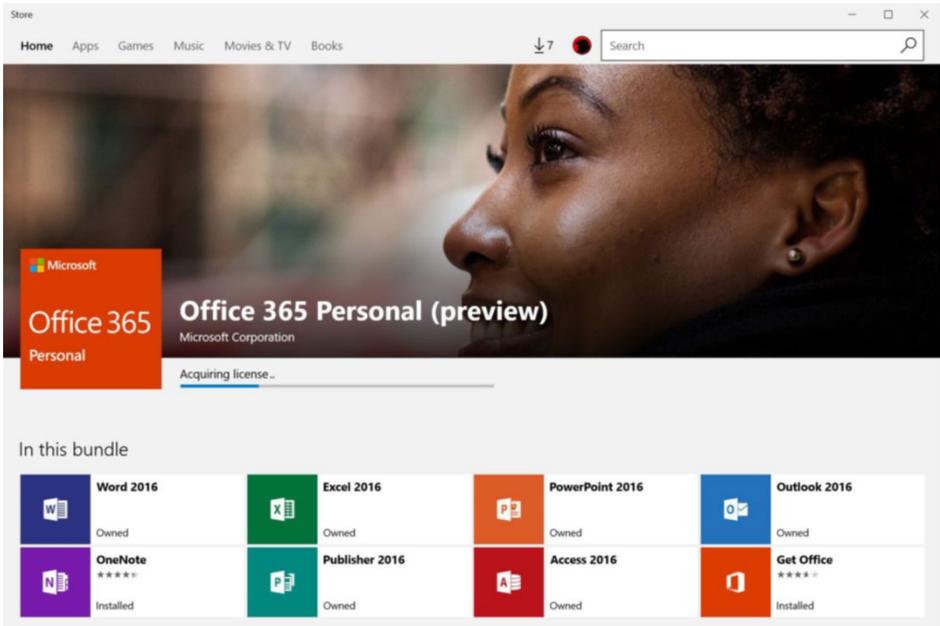
Windows 10 S provides an extra layer of security, Microsoft says, as well as quicker boot times than Windows 10 Pro. Holes have already been poked through these claims: Windows 10 S was breached (go.pcworld.com/bba) by a researcher using Word macros, which are only blocked (go.pcworld.com/ob1) if you have an Office 365 subscription. And in our tests, the Surface Laptop took 19 seconds to cold-boot to the desktop, compared to 18 seconds when we reconfigured it for Windows 10 Pro.

Our Surface Laptop did, however, come with device encryption enabled, helping protect files from unauthorized access. That's a feature normally associated with Windows 10 Pro.

Restricting Windows 10 S users to the Windows Store understandably concerns some users. For one, you're subject to the



You can move apps around like any other file, but you simply can't run them unless they're Microsoft-approved.



whims of Microsoft: As longtime users know, Microsoft’s Store has ranged from abysmal to where it is now, an adequate-to-decent experience. Unfortunately, not every app within the Store can be used by Windows 10 S, including some Win32 apps that Microsoft has begun publishing. If you do try to use a prohibited app, you’ll know it: A pop-up window will appear, with a link to the Windows 10 Pro upgrade at the bottom.

Microsoft recently made its Office apps accessible through the Store in preview, and they worked smoothly, without any bugs that I could find. The Surface Laptop ships with a year’s subscription to Office 365 Personal, good for a single device like the Laptop.

The biggest app hurdle that Windows 10 S users will likely encounter, though, is something rather prosaic: their choice of browser. Because browsers like Chrome, Firefox, and Opera aren’t found within the Store at the time of this review, you’ll be forced to use Edge. Exporting bookmarks from another browser and importing

Many common apps aren’t in the Microsoft Store. Luckily, Microsoft Office is one of the exceptions—but you’ll need to use the built-in Get Office app to find it.

them into Edge is simply a pain—and forget about saved passwords. Worse, Edge Favorites I'd saved in a Windows 10 Pro machine refused to carry over to Windows 10 S. Windows 10 S also returns search results from Bing alone, though nothing prevents you from bookmarking Google.com.

That web-based approach works well for some apps that haven't made it into the Store. I've never been a fan of using a dedicated Windows app for Twitter, for example, though I use Slack's app. With Edge, I could put both services into a tab and snap them to a corner of my screen.

I was a little shocked to discover that apps I didn't consider to be apps were also blocked, namely the Command Line. It doesn't appear within Windows 10 S, and commands that would normally launch Command Line or PowerShell simply don't work—or, if they do, a Command Line window will blink into existence and then “pop,” or crash.

For those users who want a little more, Windows 10 S does provide an escape hatch: a built-in upgrade path to Windows 10 Pro. Until the end of the year, it's a free upgrade.

In fact, we can report that the upgrade to Windows 10 Pro went flawlessly. From the Switch To Windows 10 Pro screen below, we simply clicked the button and away we went. Microsoft advises

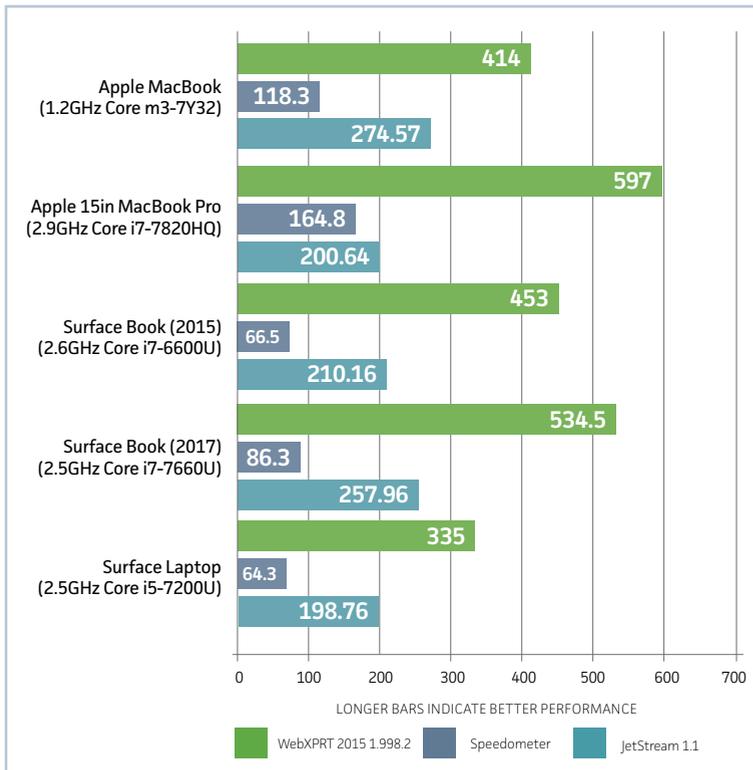


Upgrading to Windows 10 Pro can be done via the Microsoft Store.

backing up all critical documents and files (a good idea in any case) though I didn't notice any corrupted or missing files. After a Prepare To Switch screen, I simply had to wait through a single reboot. All told, the process took a bit less than five minutes—far less than the Creators Update installation process.

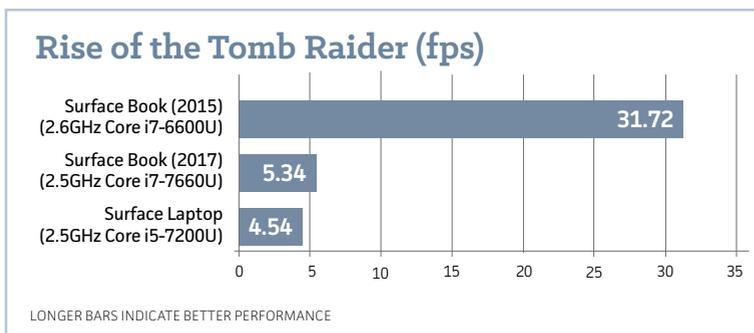
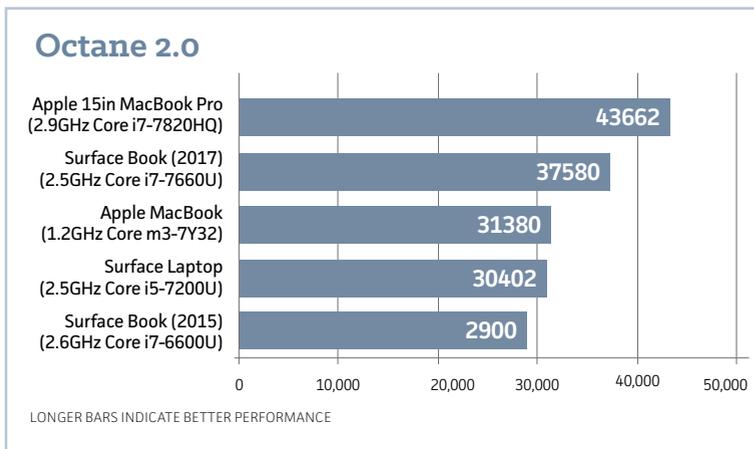
Windows 10 S performance

Because we couldn't run many of our conventional benchmarks on Windows 10 S, we first selected browser-based tests that could stress the Surface Laptop. Then we upgraded the Laptop to Windows 10 Pro to run traditional benchmarks. We've left the older benchmarks at top for reference, and our standard benchmark charts follow.

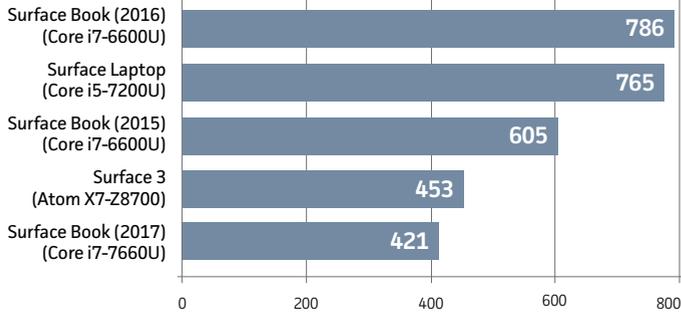


We first compared the Surface Laptop to machines including the Surface Book (go.pcworld.com/sbb) and the recent Surface Pro. Recall that Microsoft also claims the Core i5 Surface Laptop is 50 percent faster than the Core i7 MacBook Air. We didn't have a recent MacBook Air to test, so we compared it to the 15-inch MacBook Pro, as well as a Core m3-based MacBook. The Surface Laptop was slower than all of them, at least where these browser-based benchmarks were concerned.

The chart shows both Speedometer and Jetstream, which measure the responsiveness of Web applications, which is tied to the CPU's



Battery Life



LONGER BARS INDICATE BETTER PERFORMANCE

processing power. WebXPRT asks the processor to perform more intensive tasks, such as photo enhancement and album organization.

Octane 2.0 (below), a Google benchmark, performs a suite of tests measuring how well a system performs JavaScript.

Just for fun, we also ran a built-in benchmark from *Rise of the Tomb Raider*, a game that's available via the Windows Store (below). Thirty frames per second is considered to be the minimum for gameplay. The Surface Laptop's four fps is not remotely playable. We'll dig into this more once we unlock the Laptop with Windows 10 Pro.

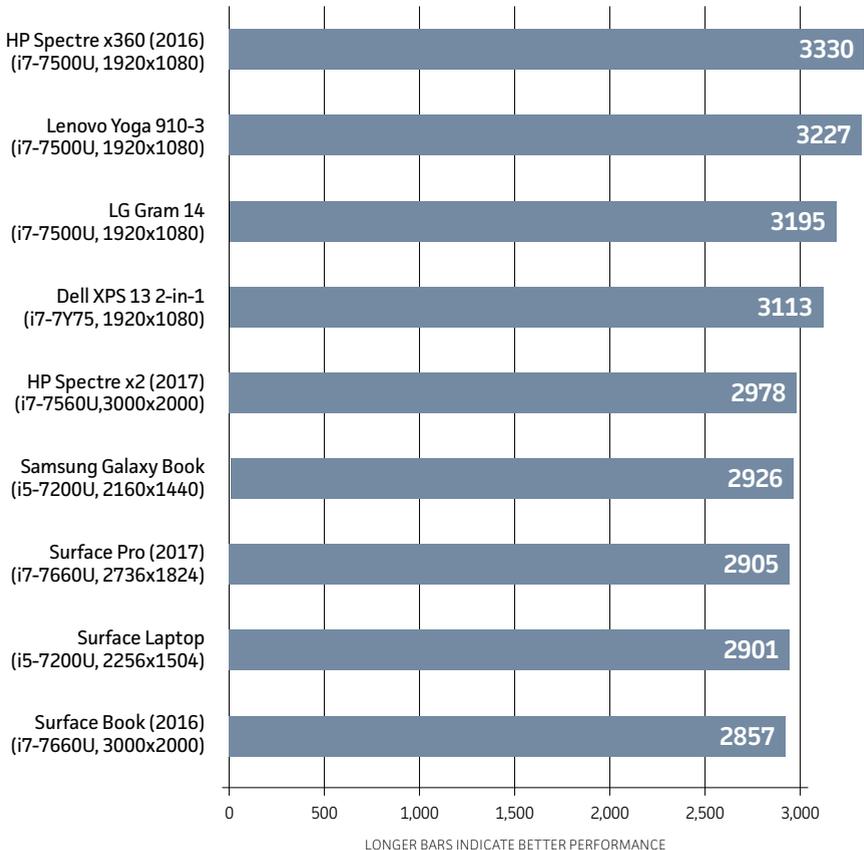
One of the areas in which the Surface Laptop absolutely shines, however, is battery life (see above). Color us a little skeptical after Microsoft's claims of 13.5 hours for the Surface Pro proved to be only 8 hours. We're beginning to think that may have been the fault of the Iris Plus chip, because the battery inside the Surface Laptop with Intel's HD 620 lasted a whopping 12 hours and 45 minutes, continually stressed as we looped a 4K video. That stamina is what students need as they go from classes to the library.

After upgrading to Windows 10 Pro, however, a wealth of new benchmarks became available, together with the ability to compare them to a number of competitive laptops and tablets. As the numbers demonstrate, the Surface Laptop performs well, though not at the top of its class.

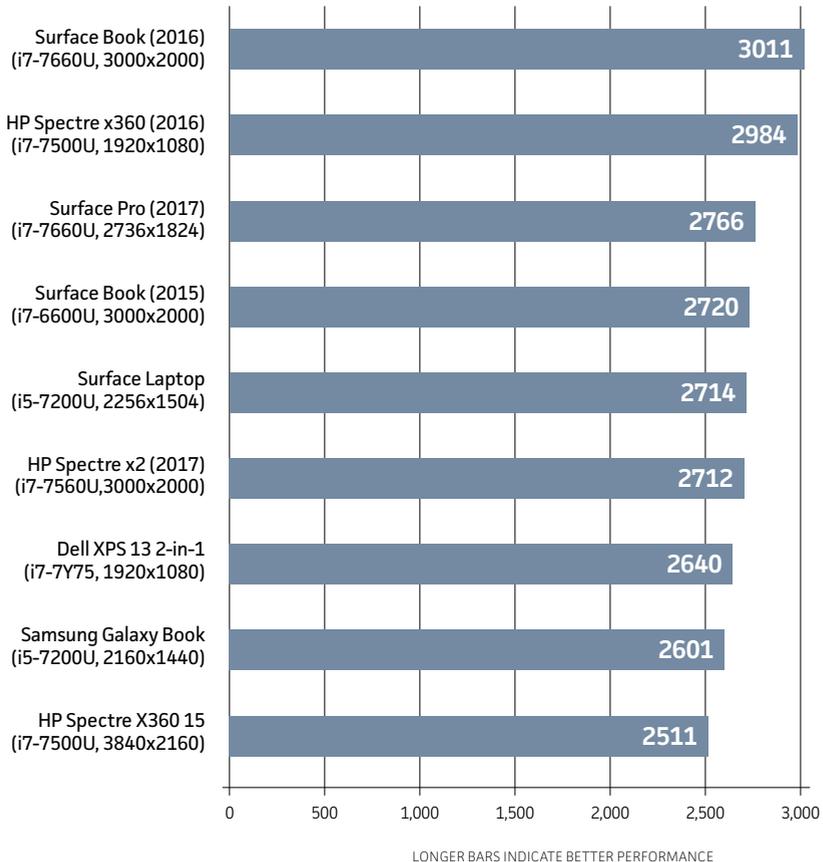
Windows 10 Pro performance: Pretty good

We use PCMark's Work, Home, and Creative benchmarks to measure standard computing tasks. As you might imagine, some of the functions overlap from test to test. Nevertheless, you'll find more office-productivity measurements in the Work test (below),

PCMark 8 Work 2.0 (Native Resolution)



PCMark 8 Home 3.0 (Native Resolution)



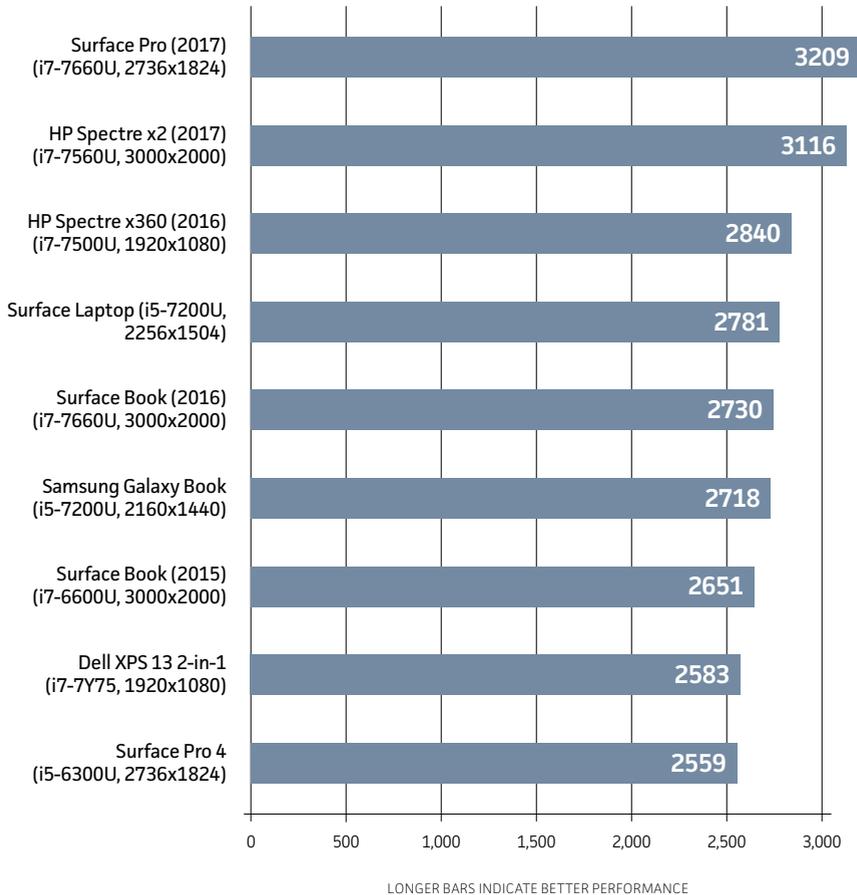
transitioning into light gaming and photo manipulation in the Home test (next page), as well as more strenuous workloads in the Creative test (two pages ahead).

It's hard to imagine any of today's laptops falling down under the stress of typing a Word document, as the Work test measures. Of the

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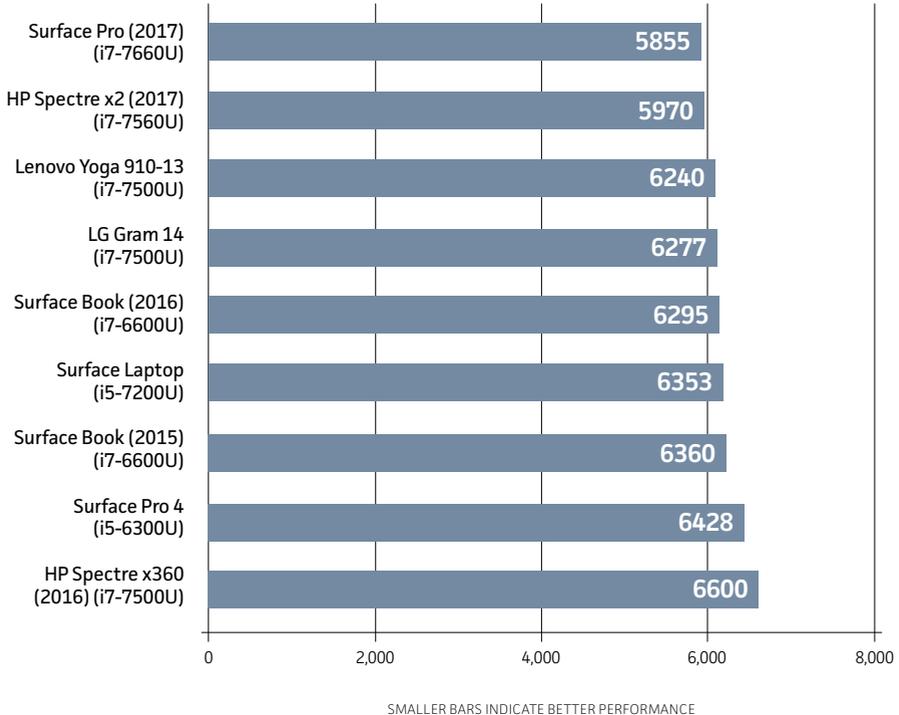
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PCMark 8 Creative 3.0 (Native Resolution)



three PCMark tests, the Creative one is usually the better benchmark, performing a suite of real-world tasks. You can see it even slightly outperforms the original Surface Book, meaning it's a solid choice for everyday computing.

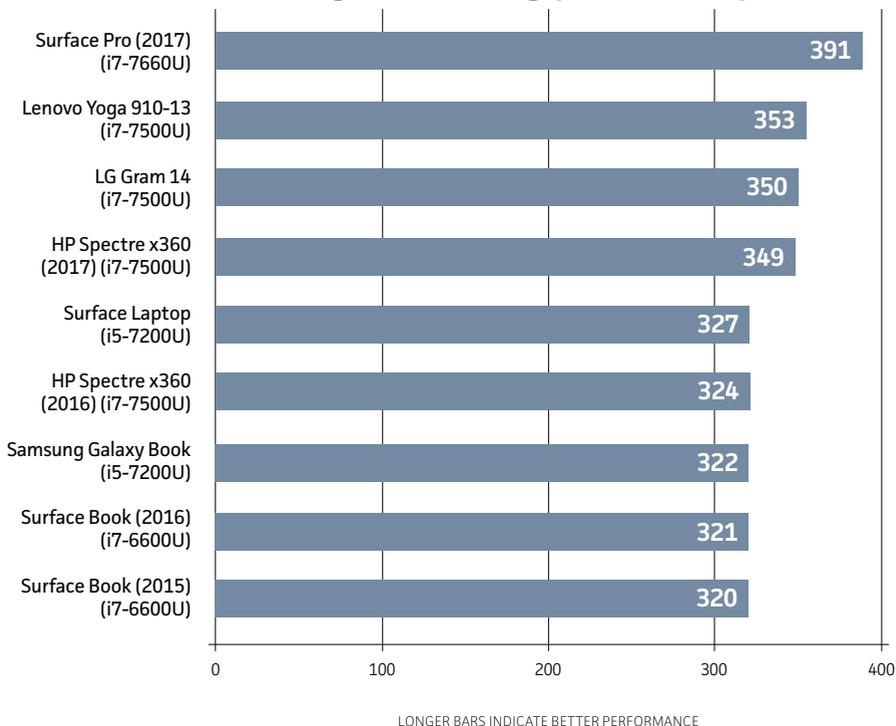
HandBrake 0.99.0 Encoding (H.264) (seconds)



We use two additional tests to stress the Laptop’s CPU: the open-source video conversion tool, HandBrake; and Maxon’s Cinebench benchmark. Though HandBrake (next page) is a useful tool for converting video—for example, shrinking down a video to an appropriate size for a tablet—it also measures how well the CPU will hold up over prolonged load.

Cinebench (next page) stresses the CPU in a different way: asking a single core of the microprocessor to render a scene, and also asking all of its cores to complete the task as quickly as possible. While design students would probably be given workstation time to complete

Cinebench R15 Image Processing (All Threads)

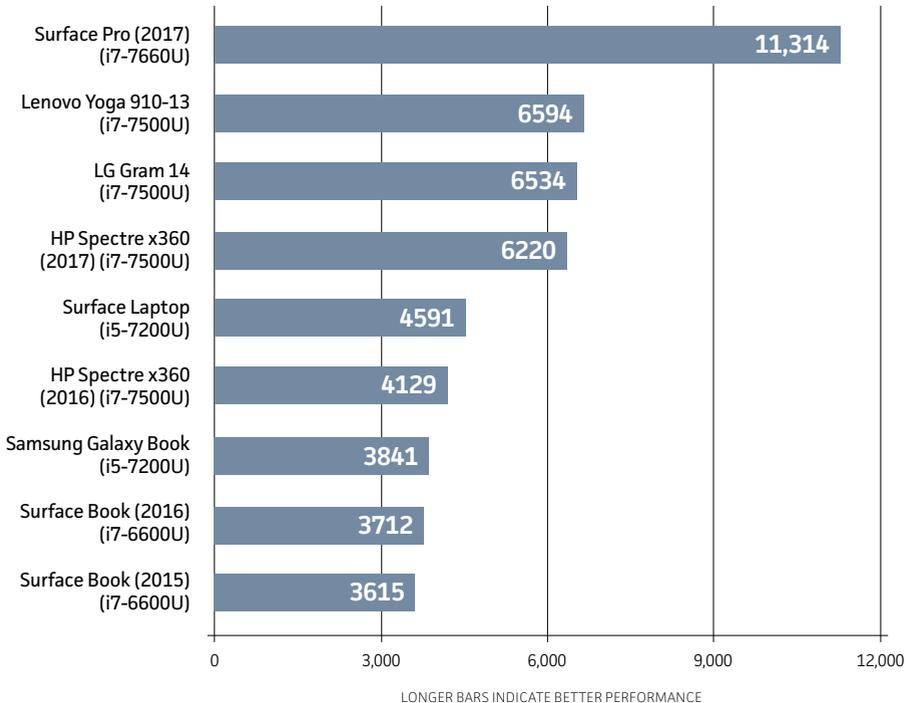


these tasks, it's possible students would also need to have a decent rendering engine on their lap.

We then turn to 3DMark, and the firm's Sky Diver 3D graphics benchmark (next page). Generally, Sky Diver's graphics load is a little too much for a laptop like the Surface Laptop, and we've already seen how poorly it fares on the Tomb Raider benchmark.

Finally, there's our follow-up battery life test. We already ran one with Windows 10 S, but we wanted to see how Windows 10 Pro affected the battery life. After setting the same test parameters (full battery, and with the display at a fixed, moderately bright level), we

3DMark 8 Sky Diver 1.0 Overall (Demo Mode Off)

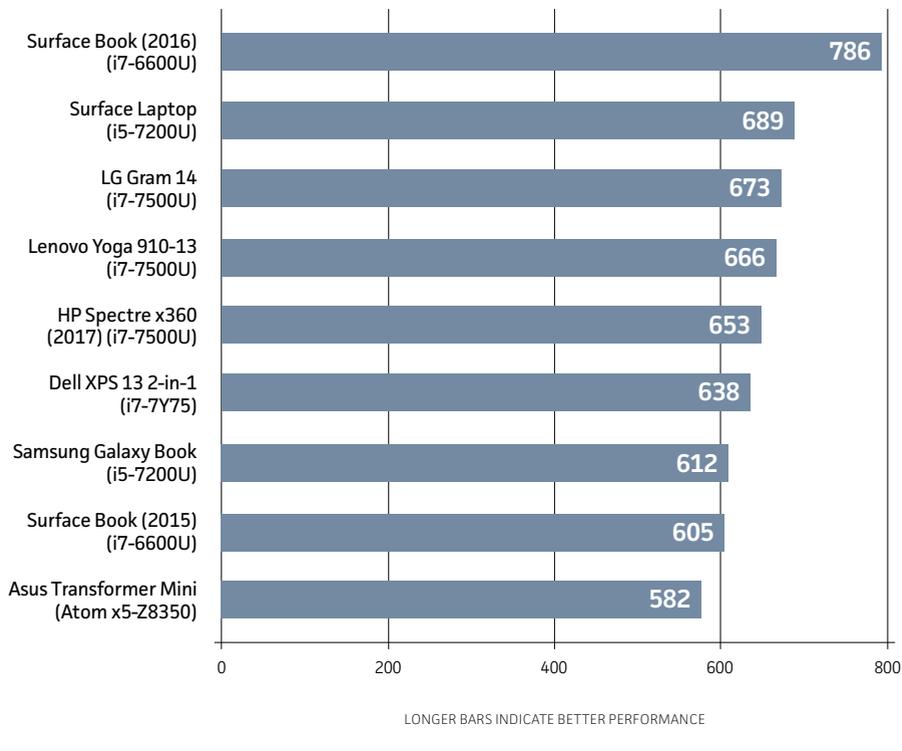


loop a 4K video over and over until the battery runs down.

The results are interesting: On Windows 10 S, the Laptop took 765 minutes to expire, as shown above. But when we upgraded to Windows 10 Pro, battery life dropped sharply: 654 minutes when Windows 10's battery slider was dialed up to emphasize performance, and 689 minutes when we slid the power slider to emphasize battery life. That's more than an entire hour lost when switching from Windows 10 S to Windows 10 Pro.

These more detailed performance tests mostly show how Windows 10 S benefits battery life. Given that no other tests showed a dramatic change, we're leaving the basic score of the Surface Laptop unchanged.

Battery Life, Windows 10 Pro/Home (minutes)



Conclusion: A great choice for back-to-school

Oddly, the Surface Laptop feels like progress forward and back, all at once. Microsoft originally designed the Surface lineup to hustle its hardware partners into the future, implicitly stripping Apple of its design cachet and encouraging consumers to buy new PCs. Now, the Surface Laptop has stepped down a rung, challenging some of the cheaper, more mainstream product lines of its hardware partners to keep up. Laptops like HP's latest Spectre x360 (go.pcworld.com/x36) already do, but other vendors could use a push.

As someone who enjoys diving down into a Settings menu or



Microsoft's Surface Book (top), the Surface Laptop, and an Apple MacBook Air from 2010.

adjusting the registry, Windows 10 S feels cramped. I have to believe most college students will encounter some app they either need or want before too long, and chafe at the restrictions. Sure, the upgrade to Windows 10 Pro is free for now, but it should be free forever.

I'm also still a bit leery of Microsoft's port choices. Apple received praise for eliminating the floppy drive and DVD-ROM, but received criticism for the single Lightning port that forced users into a web of dongles. In four years, will students curse Microsoft's cheapness, and reluctance to invest in USB-C? Maybe, though today a USB-A connector is still the right choice. The tipping point to USB-C isn't that far away, though.

That doesn't change what Microsoft has accomplished with the Surface Laptop. Decent performance, a stylish exterior, and outstanding battery life check all the boxes of a product designed to upend the MacBook Air. Sure, the Surface Laptop might not have as much to write home about as its fancier Surface kin. But for Microsoft, that's nothing as long as the Surface Laptop is what those students are writing on. 



Intel SSD 545s: The next great budget SSD has arrived

BY JON L. JACOBI

MEET THE NEXT great budget SSD. Intel's 545s is an affordable yet reasonably fast SSD that finally demotes Samsung's EVO (go.pcworld.com/sevo) from the top spot in the consumer space. At \$180 for 512GB, the 545s offers all the capacity and cost advantages of TLC NAND plus the sustained write speed of MLC NAND.

Design and specs

Our first glimpse of the 545s with its raised edges had us thinking ‘sardine tin’ in a positive way: sleek and shiny. The drive’s 7mm profile appears thinner thanks to the indented upper and lower surfaces.

Inside our test unit was a Silicon Motion SM2259 controller and 512GB of Intel’s new 256-gigabit, 64-layer stacked (3D) floating-gate type NAND. Perhaps it’s the gate that’s responsible for the performance—Intel wasn’t saying, and in fact the company didn’t play up performance as much as it played up the longevity and reliability behind the five-year warranty. Most drives this price are warrantied for only three years. The 288 TBW (TeraBytes Written) rating is also exceptional—the company apparently has a lot of faith in the controller and its NAND.

Don’t turn up your nose at the SATA interface just yet. It’s still the most popular way people add storage to a PC.



Intel SSD 545s

AT A GLANCE

Supplanting the Samsung EVO as the top dog in the low-end SSD market, the Intel 545S is the first bargain TLC drive we’ve tested that won’t invoke buyer’s remorse the first time you have to write a lot of data to it. It’s not as fast as an MLC drive, but darn close. The 5-year warranty and 288 TBW rating are major perks as well.

PROS

- Very affordable
- Doesn’t slow down writing large data sets, as most TLC SSDs do
- Slender, attractive 7mm profile
- 5-year warranty and high write rating

CONS

- Not quite as fast overall as an MLC SSD

\$180



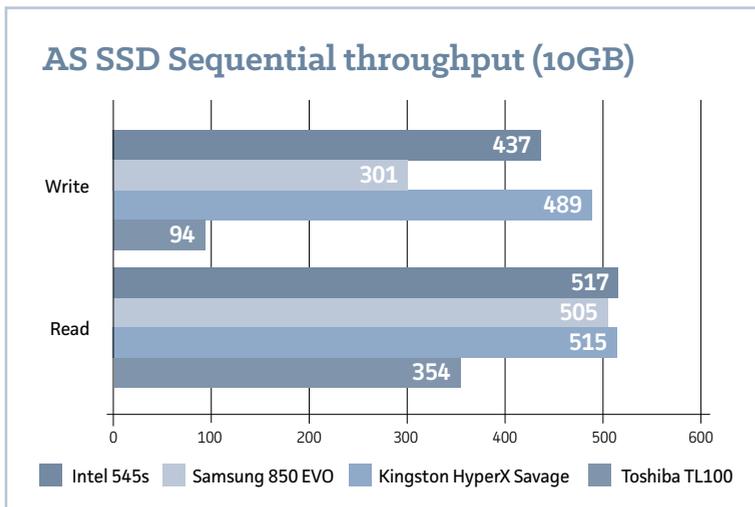
Performance

We'll get to the charts in a second, but the most telling part of the test experience was watching the Windows progress bar/throughput meter during our 20GB single file write test. Unlike with most TLC drives, speeds never dropped, staying the course at an impressive 420MBps to 430MBps.

Of course, we entertained the notion that Intel had simply upped the amount of cache, so we tried copying 60GB. Same deal. Even if this is the result of a large or variable amount of TLC NAND being treated as MLC NAND, it still means few users would ever experience a slowdown. Even full Blu-ray (not ultra) movie rips weigh in at only 30GB, and a typical game on Steam is less than that.

Hands-on, the 545s was the smoothest, most consistent performer we've seen in a while. The OS popped, all types of file operations were silky, and there were no stutters when opening apps. The Samsung EVO is also smooth and consistent, but it drops to around 300MBps writing when it runs out of TLC-as-MLC cache.

The EVO, unlike the 545s, does have its RAPID caching software, which can significantly boost everyday performance by using system



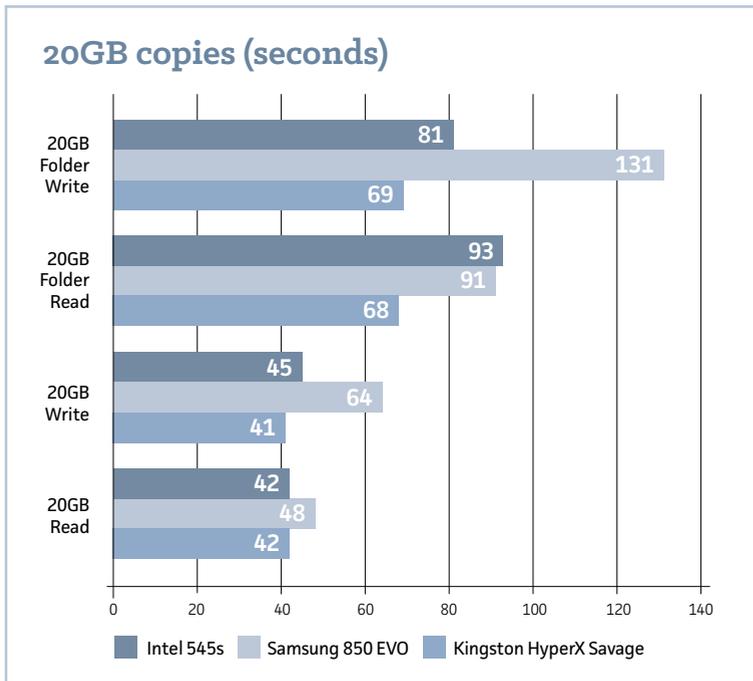
The Intel 545s

blew away its Samsung 850 EVO rival and even came respectably close to Kingston's HyperX Savage—an MLC drive.

RAM as cache. We're not fans of memory caching as it increases the risk of data loss due to power failure, so we're only mentioning that to ward off comments.

By the numbers, the 545s spanked the TLC competition, but Kingston's HyperX Savage and its MLC NAND led the way.

Note that the Toshiba TL100 in the chart on the previous page is included to show just how slow TLC NAND can be.



Though it's not quite a match for the Kingston HyperX Savage and its MLC NAND, overall, the Intel 545s comes close and is by far the fastest TLC SSD we've tested.

As you can see above, you're losing very little in performance, even to MLC drives, with the 545s, and at \$180, it's significantly cheaper than the competition. On Amazon the 480GB Kingston HyperX Savage currently sells for around \$200, and the 500GB Samsung 850 EVO costs around \$220.

There will eventually be 256GB, 1TB, and 2TB versions of the 545s, as well as M.2 variants.

Conclusion

Intel's 545s is the first TLC SSD we can recommend to consumers without shouting our standard caveat—"Unless of course, you find a similarly-priced MLC drive," which you quite often can. That warning is due to TLC's slower sustained write speeds with large data sets. We're not backing off entirely, but the 545s's performance comes close enough to that of a fast MLC drive, that we're just whispering it.

Otherwise, given its super-low price, outstanding warranty, and overall good performance—it's pretty much the SATA SSD you should buy. And absolutely the TLC SATA SSD you should buy. 🔥

Gigabyte Aero 15: A near-perfect power user's laptop



BY GORDON MAH UNG

GIGABYTE'S AERO 15 is a powerhouse laptop that hits a lot of high notes. Quad-core Intel Core i7-7700HQ CPU? Check. Dual M.2 SSD slots? Check. Up to 32GB of RAM? Check. Nice 15.6-inch screen? Check. Powerful Nvidia GeForce GTX 1060 GPU? Check.

It's this last point (well, and the garish colors) that will have many calling the Aero 15 a gaming-laptop rather than what it really is: a powerful, portable laptop that can do it all, and with decent battery

life to boot. Even the weight's bearable at 4.6 pounds. We have some objections to its design, but it's still well worth a look.

A splash of color in a brushed-metal world

The Gigabyte Aero 15 comes in three colors: A standard low-profile black (\$1,899), Hemi Orange (also \$1,899), and Lime Green, which is \$1,999—that's not a typo, Lime Green is more expensive than the other two colors. Perhaps because that model most closely resembles a 1971 Dodge Challenger (see for yourself, below). I have to say, the intense hues are surprisingly refreshing amid a sea of brushed-metal and black shells.

Speaking of shells, the Aero 15's lid and bottom panel are aluminum, as well as portions of the frame around the keyboard. We're disappointed that the keyboard tray is plastic, but this no doubt shaved off a bit of cost.



The Aero 15 is green. Very green. (And orange and black, too.)

Gigabyte Aero 15

AT A GLANCE

The Gigabyte Aero 15 is a ground-breaking laptop that manages to have it all—great CPU, great GPU, great battery life—in a truly portable package. It's nearly perfect, but some flaws mostly centered around the keyboard bear mention.

PROS

- Powerful parts: quad-core Kaby Lake CPU and GeForce GTX 1060 6GB
- Reasonably light and thin
- Decent battery life for this class of laptop

CONS

- Wonky keyboard issue with certain key combinations
- Laptop goes to sleep too quickly when you close lid
- Integrated webcam is mounted below the display for least-flattering view

\$1,899





Separated at birth? You be the judge.

The 15.6-inch, 1920x1080 screen has many pluses and a few minuses. Instead of the more common IPS or TN technology it uses MVA, which has a reputation for slower response times and issues with color accuracy. We've seen bad examples and good examples of MVA, and the Aero 15's is in the good pile, with wide viewing angles and factory calibration to Pantone X-rite color standards (at 100-percent



Gigabyte puts the webcam down low, like Dell's XPS 13 and XPS 15, but at least it's in the center.

brightness). Off-axis viewing is also quite good. The biggest drawback we found is the 285-nit maximum brightness, which is on the lower end of average for a laptop.

Like Dell's XPS 15, Gigabyte's Aero 15 employs a near bezel-less display design. This helps make the laptop fairly compact, but it also forces the built-in webcam to peer upward at you from the bottom of the screen. Gigabyte centers the camera, but expect your video-conferencing colleagues to get good look at your neck wattle.



15.6-inch power: Dell's XPS 15 on top of a Gigabyte Aero 15, an Asus ROG GX501, and an Alienware 15 R4.

Keyboard and trackpad

With the keyboard and trackpad, we have another mix of good and bad news. Let's get the bad news out of the way first: the Aero 15's ongoing problems with extended keyboard combinations. When we first tested our Aero 15 unit, it had problems recognizing certain key combinations, such as simultaneous use of Ctrl-Shift-C. Since the Aero 15 shipped, Gigabyte has released at least three firmware updates for the keyboard. Some problems have cleared up, but users are still finding combinations that don't work right.

Gigabyte said it is continuing to work on the problem and is

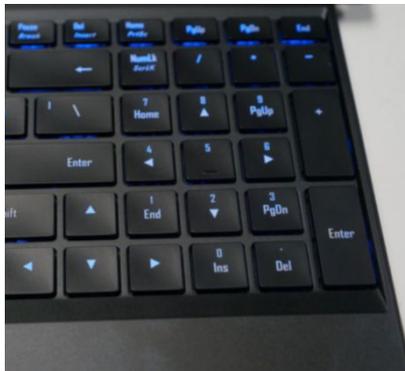
The per-key lighting on the Aero 15 is bright in an office setting and dazzling at night.



encouraging frustrated users to contact its support line. Is that enough to make you comfortable buying the Aero 15? That's something only you can answer.

The keyboard itself is pretty good. What we especially appreciate is the per-key lighting, which is almost as good as what you'll find in Razer's Blade laptops (go.pcworld.com/rbl). It's far brighter than most keyboards we've seen and simply dazzling at night. The software to program the colors works well enough, and there's a good selection of pre-programmed patterns. You can also bind macros to every single key on the keyboard.

An apparent bonus introduces some compromise. Gigabyte added a 10-key numeric pad on the



The '0' is badly placed for a 10-key design and sure to anger everyone in corporate accounts payable.

right-hand side of the keyboard. Because of how the cursor keys were squeezed in next to it, however, the numeric pad's '0' was reduced from being a double-wide key under the '1' and '2' (the traditional design) to being a single key under the '2.' The bean-counter types who use a 10-key constantly won't appreciate how this small change will mess with their muscle memory. Gigabyte laptop designers, if you notice your expense reports take longer than usual to process, this is the reason why.

Even if you don't use the 10-key pad, it will mess with you anyway because it shifts a few other things to the left. The trackpad, made by Elan, with a glass layer that feels near-frictionless, is uncomfortably shifted from the expected center to the left. Left-leaning, too, are the keyboard's home keys. If these change threaten to throw off your productivity, look elsewhere.

We have two more complaints. The first is an odd harmonic, almost Kazoo-like (go.pcworld.com/kaz) sound that occurs not when the GPU's fan is working hardest, but when it slows down one notch. We're

The Gigabyte Aero 15 is fed by a 150-watt power brick, but fortunately it's thinner than the laptop. The brick also includes a USB Type A port that puts out up to 10 watts.



also not fans of the lid angle Gigabyte has chosen for triggering the laptop to go to sleep. On most laptops, you can tilt the screen to within 10 to 15 percent of closing before this happens. On the Aero 15, it goes to sleep when the lid's as high as 45 degrees, which is too soon.

Ports

Where Gigabyte makes up for all that is in the massive number of ports. The right side features an SD card reader, Thunderbolt 3, and two USB 3.1 Gen 1 Type A (5GBps). And yes, that Thunderbolt 3 port operates at the full x4 PCIe speed (Yes, we're looking at you, XPS 15 (go.pcworld.com/ps15), with your x2 Thunderbolt 3 port).



The right side of the Aero 15 gives you an SD card reader, Thunderbolt 3 port, two USB Type A at 5GBps

The right side of the Aero 15 gives you a combo analog audio jack, miniDisplayPort 1.3, HDMI 2.0, another USB 3.1 Gen 1 Type A, and a Gigabit ethernet port running off of Realtek silicon. All told, Gigabyte says the Aero 15 can run three external monitors on the ports it has.



Look at all this: Gigabit ethernet, USB, HDMI 2.0, and mini-DisplayPort 1.3. Nice selection for a laptop.

The Anti-MacBook Pro 15: The Gigabyte Aero 15 features two memory slots for RAM and two M.2 slots for SSDs. You can even upgrade the Wi-Fi module.



What's inside

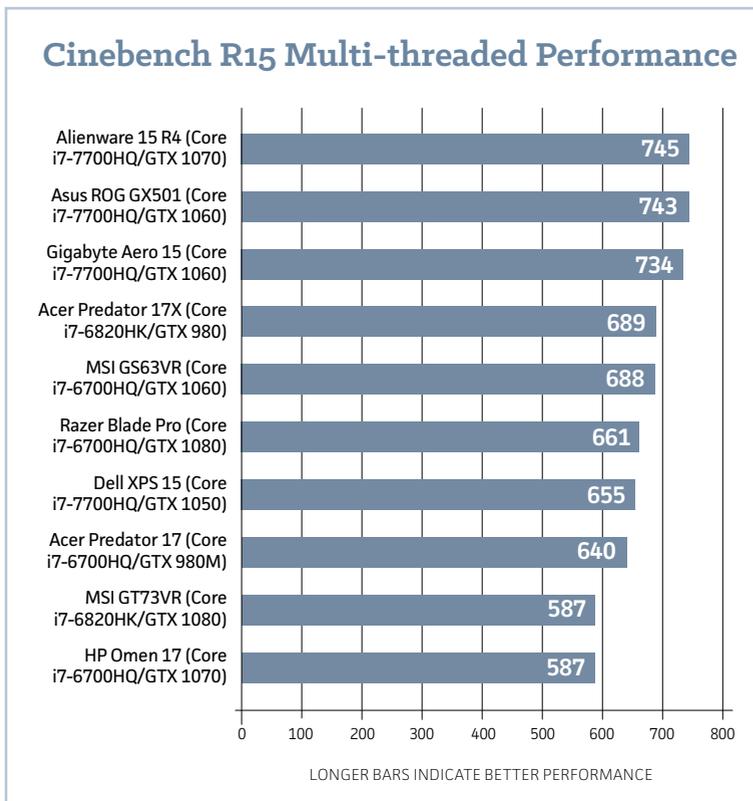
You know the laptop here has a Core i7-7700HQ, 16GB of DDR4/2400 (in single-channel mode), and GeForce GTX 1060 with 6GB of RAM. For storage, Gigabyte shipped our \$1,899 unit with a Lite-On 512GB M.2 drive operating in SATA mode. This is likely for cost, but Gigabyte says the unit will run not just one, but two M.2 drives in PCIe mode. Overall, this is a nice storage combination, as it allows you to run two drives. Dell's XPS 15 has the physical space to run a hard drive plus an M.2 drive, but when its larger battery option is selected, there's no room for the hard drive. Asus' new ROG GX501 also has room for only one M.2 drive.

Performance

If you want to browse the web and run Office, a dual-core with integrated graphics is more than enough. People generally buy 15.6-inch laptops for the power, so let's find out how the Aero 15 stacks up against the competition.

Cinebench R15 Performance

Our first test is Maxon's Cinebench R15, which measures performance while rendering a 3D image. This test is almost pure CPU and gives you a good idea of how well a laptop will perform under multi-threaded tasks. For the most part, it's a dead-on tie with the Kaby Lake laptops. The only outlier is the Dell XPS 15, which turns in an oddly slower result. With multiple runs and the latest BIOS, the XPS 15's score was just off.

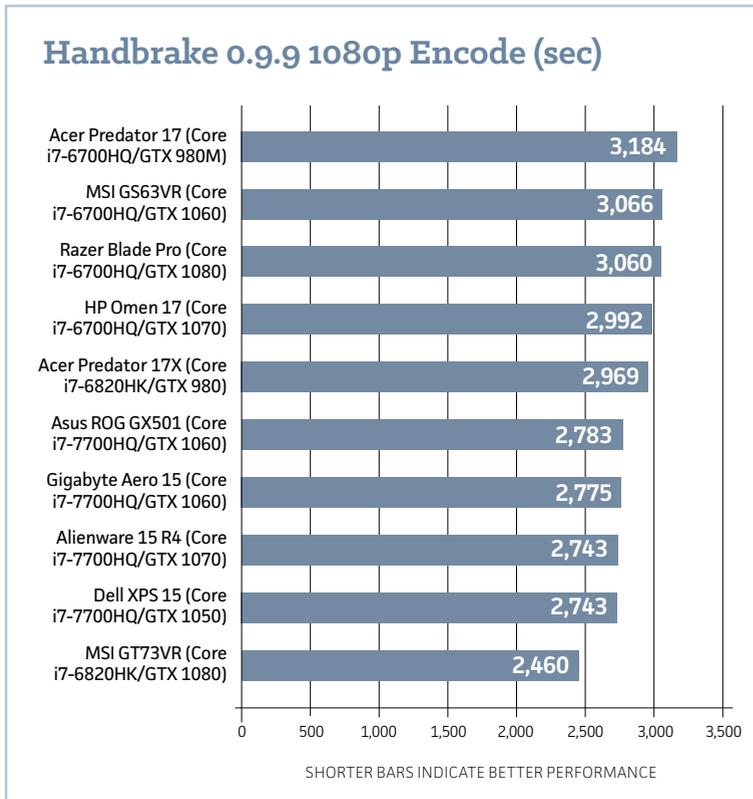


In the Cinebench R15 test, the Kaby Lake laptops lead, except for the Dell XPS 15 which is oddly slightly slower.

Handbrake Performance

Our second test uses the free Handbrake encoder to convert a 1080p 30GB MKV file using the built-in Android Tablet preset. It's mostly a tie here among the Aero 15, the XPS 15, the ROG GX501 and the Alienware 15 R4. The MSI's score for this particular test was likely taken with the laptop in its overclocked mode.

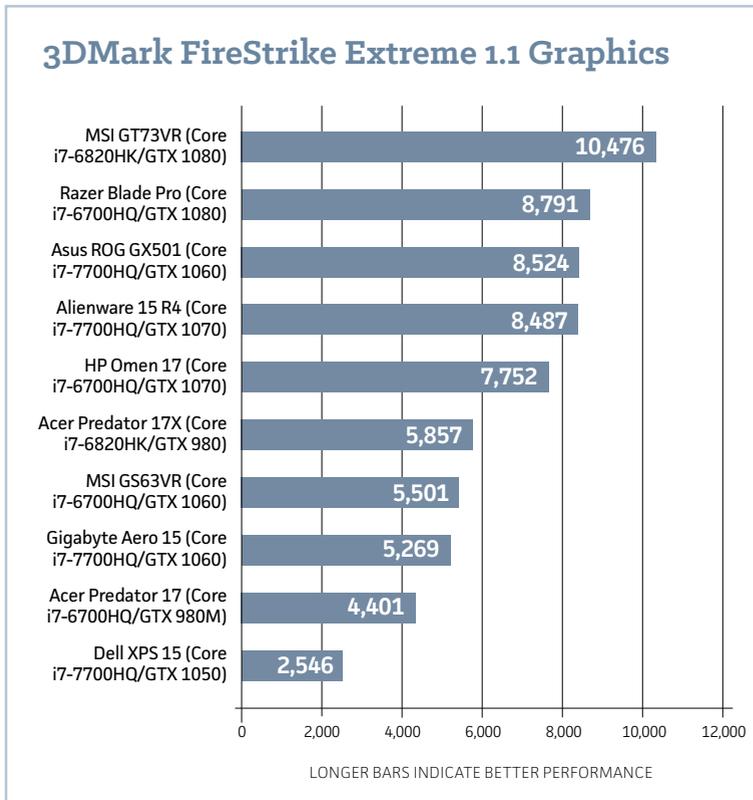
In our encoding test, the Gigabyte Aero 15 is dead-even with other Intel Kaby Lake-based laptops, all of which give the Skylake-based laptops a good drubbing.



In our encoding test, the Gigabyte Aero 15 is dead-even with other Intel Kaby Lake-based laptops, all of which give the Skylake-based laptops a good drubbing.

3DMark Fire Strike Extreme Performance

Enough about the CPU. You came here for the GPU performance, so first up is 3DMark Fire Strike Extreme graphics performance. This older Futuremark test is pretty much a pure graphics gauntlet. Although synthetic, it's still an accurate measurement of graphics performance. The Aero 15 is pretty much tied with the other GTX 1060 laptop. Both GTX 1060 laptops represent very well against the older GTX 980 and GTX 980M, too.

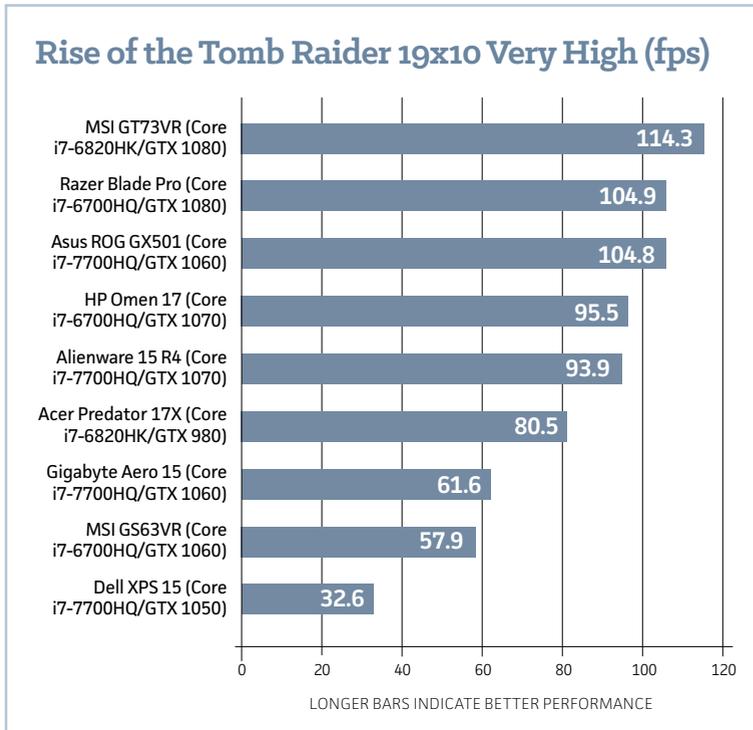


3DMark Fire Strike Graphics test is a pure graphics test that's still useful for gauging theoretical performance.

Rise of the Tomb Raider Performance

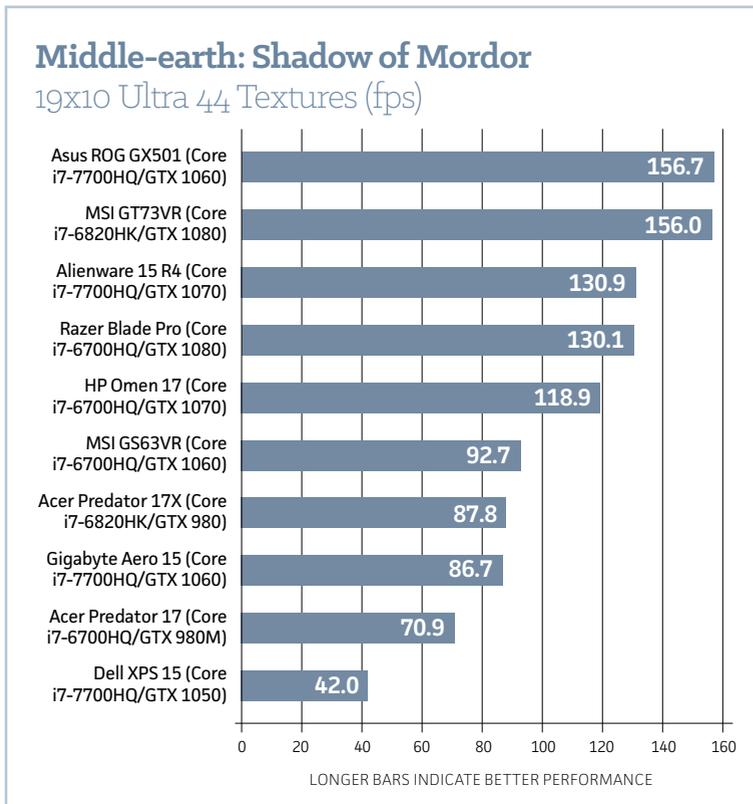
In actual gaming performance, we ran *Rise of the Tomb Raider* on the Very High setting at 1920x1080. This game is particularly punishing, and the GeForce GTX 1060 6GB cards can push a comfortable 60 fps. But glance at the chart and you can see faster—and pricier—GPUs do indeed pay dividends in performance. It's also clear that although the GTX 1060 can match a GTX 980, it won't do that all the time, as the older Predator 17 X leaves both GTX 1060 laptops in the dust.

In a real game, the Aero 15 can push a comfortable 60 fps.



Middle-earth: Shadow of Mordor Performance

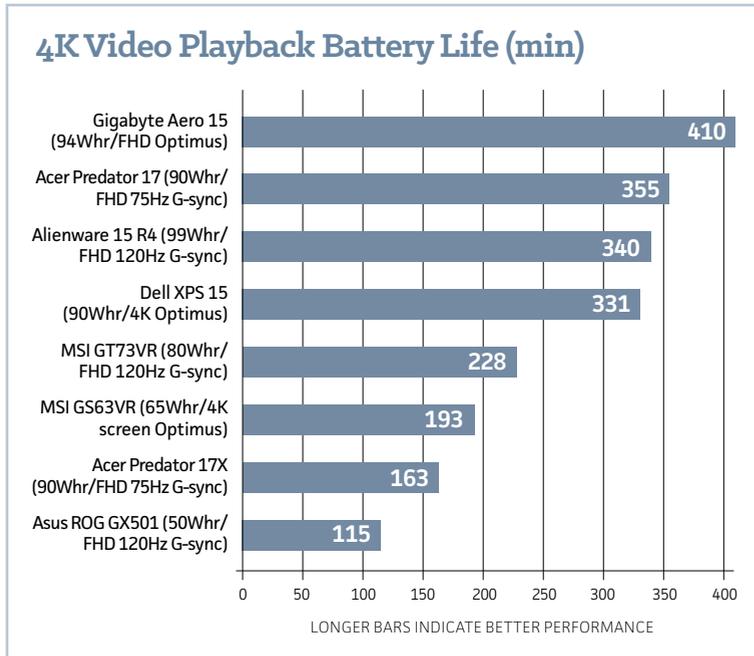
The last game we ran is *Middle-earth: Shadow of Mordor* at 1920x1080 resolution on the Ultra setting and with the 4K texture pack loaded. In this game, the GTX 1060 in the Aero 15 matches the GTX 980 in the Acer Predator 17 X, but both are outclassed by the GTX 1070- and GTX 1080-equipped laptops by a healthy margin. Just remember though: The Aero 15 is a comparatively lightweight 4.6 pounds.



In Middle-earth: Shadow of Mordor, the Aero 15 slots in where you would expect a GTX 1060-based laptop to place. What's impressive is the performance against older, huskier GTX 980 laptops.

Video playback and battery life

On large gaming laptops, we've typically ignored battery life because they live most of their lives plugged into AC and typically operate more as semi-portable gaming desktops than laptops. But gaming-capable laptops have truly evolved in the last few years and people are starting to expect longer battery life when they're not gaming. (When gaming on any real gaming laptop, you can basically expect an hour of battery if you're lucky.)



For a laptop with this level of gaming chops, the Gigabyte Aero 15 offers pretty exceptional battery life for mundane tasks as watching 4K video.

To measure battery life for low-impact use, we play a 4K movie using Windows 10's Movies & TV player at an office-bright 250 to 260 nits. This is an area where the Aero 15 truly excels, giving us nearly seven hours of video playback. The only real competitors here, the Dell XPS 15 and the Asus ROG GX501, are a disadvantage: The Dell features a 4K touch screen, which is likely more power hungry than the Aero 15's FHD panel. The ROG GX501 features a fairly tiny battery that's almost

half the size of the Aero 15's. The only other comparable laptop here is the older MSI GS63VR, which also has a 4K panel, plus a slightly undersized 65 watt-hour battery. The upshot is a pretty big win for a laptop that has real gaming chops.

Conclusion

The Gigabyte Aero 15 is a ground-breaking laptop that manages to have it all—great CPU, great GPU, great battery life—in a truly portable package. It's a combination that no other laptop maker has achieved until now.

The Aero 15's biggest flaws seem to emanate from its keyboard: its struggles with key combinations, let alone the rejiggering of some oft-used buttons and the trackpad. Still, we're extremely impressed by the Aero 15, which is almost—almost—the ultimate power user's laptop. 



Watch the
video at
go.pcworld.com/vrti



MSI's GT75VR Titan brings high-end HDR display tech to a gaming laptop

BY HAYDEN DINGMAN

THERE ARE BIG laptops, and then there's MSI's Titan series. Weighing in at 9.7 pounds and featuring a dozen cooling pipes, an Nvidia GTX 1080, and a full mechanical keyboard, the GT75VR Titan can't quite match the \$9,000 decadence of Acer's Predator 21 X (go.pcworld.com/21x), but it's still one of the largest and most feature-packed

laptops around.

The feature I expect will make the most difference, though not necessarily the one that will be most talked about? An HDR-ready display (go.pcworld.com/drr)—two, actually, because you can get the GT75VR in 1080 and 4K variants. HDR is still a rarity in desktop displays, let alone in laptops—we’ve only seen one or two announced with the capability so far. MSI actually dropped from an 18-inch Titan down to a 17-inch Titan because of the greater availability of displays at the smaller size. The upgrade in screen technology immediately puts the GT75VR in an elite group.

Don’t discount the keyboard, either. MSI’s older Titans were infamous for packing a full Cherry MX Brown keyboard into the frame. While it made for a spectacular back-of-box feature, it wasn’t the most practical. To accommodate the keyboard it had to be placed at the front of the laptop, sans wrist rest, which made for an awkward typing experience.

For the GT75VR, MSI turned to SteelSeries to custom-design a brand-new mechanical switch—neither a Cherry knockoff nor SteelSeries’s own proprietary “QS1” switch. Instead SteelSeries designed a mechanical switch for laptops, similar to what Razer did with the 2016 Blade Pro. It has the footprint of a standard scissor



switch, but the inner workings of a mechanical.

I like MSI's better. It's clicky, it still has the tactile feel you'd expect from a mechanical, but it also seems to present a smoother typing experience than Razer's (where I often found myself missing keystrokes). Is it as nice as typing on a real Cherry MX desktop keyboard? No. But it's certainly nicer than typing on a Cherry MX keyboard awkwardly crammed into a laptop chassis, even if this solution is less impressive to the eye.

A bit weird to open a discussion of the super-powered GT75VR Titan with its screen and its keyboard, but those are the most interesting features. Inside,

things are more standardized: Intel Core i7-7820HK and either a GTX 1070, dual GTX 1070s, or a single GTX 1080. Unlike the 18-inch Titan there is no dual GTX 1080 model here, with the reason likely being power.

MSI has the GT75VR Titan beating out competing laptops with the same specs, attributing it in part to the GT75VR's superior cooling. A dozen or so heat pipes (depending on model), two huge fans—there's even a button to temporarily turn all the fans to 100 percent, rapidly cooling the system while also turning the laptop into a miniature jet engine.

All that cooling comes with a price, as again: The GT75VR is enormous. Over nine pounds! The weight's better-balanced than some of the other "semi-portable" or "desktop replacement" laptops I've used, but the Titan lives up to its name. Don't expect to carry it around very often. If you're my colleague Gordon Mah Ung, that's a price you're willing to pay for maximum power. The rest of you? Well, you might be better served by one of MSI's ultra-thin Max-Q laptops.

Whether heat is really the reason behind the GT75VR's excellent performance, or indeed, whether the GT75VR's performance is all MSI claims it to be, are questions that will have to wait for a proper review, which we hope to have in the coming months. 

All that cooling comes with a price, as again: The GT75VR is enormous. Over nine pounds!



Watch the
video at
[go.pcworld.
com/rvfs](https://go.pcworld.com/rvfs)



Hands-on: AMD's Radeon Vega Frontier Edition vs Nvidia Titan Xp

BY GORDON MAH UNG

AMD'S RADEON VEGA Frontier Edition may be a graphics card for workstations, but gamers are just as eager to see what this GPU can tell us about the coming consumer version. AMD has already made a splash with its Ryzen and Ryzen Threadripper CPUs, and now Vega can help complete a high-performance puzzle. To show how the Radeon

Vega Frontier Edition could benefit workstations, AMD officials gave us a hands-on preview of one of the first production cards.

What it is

We've published full details on the Radeon Vega Frontier Edition (go.pcworld.com/rvf), but here's the short story: The Frontier Edition is based on AMD's new Vega core and features 16GB of advanced HBM2 RAM. And it's a doozy in every way possible: The air-cooled card will cost \$999, while the liquid-cooled version will cost an additional \$500. The air-cooled card we saw has a 300-watt TDP, while the liquid-cooled one demands up to 375 watts.

AMD has maintained from the start that the Radeon Vega Frontier Edition is not aimed at gamers, but rather at "data scientists, immersion engineers, and product designers." What that translates to is a card that, in theory, gives professionals more performance for the money than the pricey Nvidia Quadro competition.



The new Radeon Vega Frontier Edition (top) is slightly longer than the original Radeon RX 480 (bottom).



Nvidia's Titan Xp on the left and AMD's new prosumer Radeon Vega Frontier Edition on the right.

What we tested

AMD set up two PCs with identical everything: Ryzen 7 1800X CPUs, 32GB of DDR4/2400, SSDs, 4K panels, and even the same mouse and keyboard. Both machines ran Windows 10 Enterprise edition. One machine featured the current GeForce Titan Xp (go.pcworld.com/gtx1), while the second machine ran one of the first air-cooled production-level Radeon Vega Frontier Edition cards AMD has built.

And by “built,” we mean built. AMD told us that for Frontier Edition, the lovely blue anodized heat shroud, Radeon logo, and glowing yellow “R” were all finished in California. So, made in ‘Murica—at least the last part. The same isn’t likely to happen with the consumer version, but it’s a nice touch.

As much as people want, wish, and imagine Frontier Edition to be the stand-in for a gaming Radeon RX version today, it’s not. AMD’s first demo was a simulated workflow in a design firm.

With the Frontier Edition machine running an 8K Dell panel (go.pcworld.com/8kd) and a second panel at 1080p, plus an HTC Vive, AMD opened up a theoretical car design in the Solidworks engineering application. Panning, spinning, and moving the car looked reasonably fast, as expected. Once the model was “done” and ready to be examined, it was exported using AMD’s ProRender plug-in to Unreal Engine 4, where it could be viewed using the HTC Vive.

AMD's director of professional products, Nick Pandher, said it may seem unusual for a game engine to be paired with an engineering app, but many small- to mid-size design firms actually operate this way today. Unlike the proprietary visualization tools that were once all the rage, off-the-shelf tools use game engines such as Unreal Engine and standard VR gear.

Is it fast?

People always want to know, "How fast?" For that, we turned to our pair of matching PCs and SPECViewperf, the workstation gold standard for measuring visualization performance on hardware.

In the given time we had to run tests, we saw the Frontier Edition outscore the Titan Xp by 28 percent in Catia and Creo to 50 percent in SolidWorks. We also ran Maxon's Cinebench, a popular OpenGL benchmark, in which the Frontier Edition was about 14 percent faster. The numbers echo what we already knew about the Frontier Edition, but this time we could see the performance demonstrations live.



The Radeon Vega Frontier Edition features a GPU tach that communicates the load on the card. The DIP switches to the left let you change the color of the LEDs.

Radeon Vega Frontier Edition is certainly faster in the tests we witnessed, but to be fair, it's comparing an ostensibly consumer-focused Titan Xp card to the pro-level Frontier Edition. Nvidia's Titan Xp, for example, officially works only with consumer drivers, while the company's Quadro workstation products (go.pcworld.com/qw) offer a lot more performance.

Here's the disruptive thing

That brings us to the disruptive part of AMD's push: Although powerful, Titan Xp is limited to consumer drivers. To approach the performance of the Radeon Vega Frontier Edition with an Nvidia product, you'd have

to step up to at least a \$2,000 Quadro P5000. A P6000 card, which is kind of the professional equivalent of a Titan Xp, is nearly \$6,000.

AMD blames these high prices for driving many prosumers to order workstation-class systems with lower-end professional cards so they can replace them with faster consumer GPUs. AMD believes the Frontier Edition can end this madness and give the company a triumphant return to the professional workstation card game.

Note that the Frontier Edition will do so with pro-optimized software support, though the drivers for the Radeon Vega Frontier Edition won't actually be fully certified. AMD contends that the new GPU design and the HBM2 memory matter as much as the drivers in making Radeon relevant for workstations again.

What about gaming?

AMD didn't show us all this out of kindness. The company is reasonably concerned about how gamers are sizing up the Radeon Vega Frontier



Three DisplayPort 1.4 ports plus an HDMI 2.0 port grace the back of AMD's new Radeon Vega Frontier Edition card.



Three DisplayPort 1.4 ports plus an HDMI 2.0 port grace the back of AMD's new Radeon Vega Frontier Edition card.

Edition. AMD cautions that consumer-class drivers are a work in progress, and at the risk of repeating itself, the Frontier Edition isn't a GPU for gamers. AMD does, however, expect Frontier Edition buyers to use the card for gaming within the context of their work. A game developer, for example, would want good performance when testing the game he or she is building. Game performance in VR for professional visualization will also matter, the company says.

Just a taste

While AMD didn't want to reveal any gaming performance, it agreed to give us a taste of how Radeon Vega Frontier Edition performs in gaming. So we switched out the 8K Dell panel for a pair of Acer 34-inch, wide-aspect 3440x1440 panels, and played games on both the Titan Xp and the Radeon Vega Frontier Edition.

To show that it wasn't just an API advantage, AMD let us play Doom using Vulkan, Prey using DirectX 11, and Sniper Elite 4 using DirectX 12. All of the games were set to their highest game



The **Radeon Vega Frontier Edition** (top) is roughly the same physical dimensions as an Nvidia Titan Xp.

settings, and we played at the native resolution of the panels. Although the identical panels were FreeSync-based, FreeSync was switched off on the AMD GPU.

Switching back and forth between the two systems, we'd be hard pressed to tell the difference between the Titan Xp and the Radeon Vega Frontier Edition. While you'd expect such performance from a \$1,000 card, many have been concerned that Vega just won't perform.

From what we've seen, that concern is likely unwarranted. Vega FE appears to be plenty fast and, at least for the settings and the games we played, indistinguishable from the competition. Our original estimates after seeing Radeon Vega Frontier Edition with Sniper Elite 4 at Computex still hold: The cards appears to be faster than Nvidia's GTX 1080 and close to that of a GTX 1080 Ti card.

We'll withhold final judgement until we get our own part to test—the consumer-focused gaming card, most likely. All of the waiting will soon be over: Radeon Vega Frontier Edition cards should begin shipping Monday, and the curtain will finally rise on RX Vega in late July. 



Xbox One X PC Build: Can you do it for \$500?

BY ALAINA YEE

MICROSOFT'S XBOX ONE X presents an interesting challenge for PC builders. Sure, if you want raw power, nothing beats the PC. But can you put together an Xbox One X (go.pcworld.com/xo) equivalent for \$500?

At that price point (and outside of that golden window (go.pcworld.com/gw) of Black Friday sales and stellar combo/bundle deals on PC components), you're pushing the limits of what's possible, particularly

if you want to completely replicate the same experience Microsoft is promising hardcore console fans. Given today's high RAM prices, the low availability of certain GPUs, and the dearth of 4K UHD drives, the results don't come out cleanly in favor of a DIY PC.

Build #1: A basic 4K/30-fps gaming PC

To start, we'll walk through a baseline build, which makes a few sacrifices but should still perform at 4K/30 fps.

Part	Name	Price
CPU	AMD FX-8300 (3.3GHz, 8-core) (go.pcworld.com/8c)	\$90
Motherboard	ASRock 970 Pro3 R2.0 ATX AM3+ ^{3,4} (go.pcworld.com/am3)	\$45
RAM	Patriot Signature 8GB DDR3/1600 (1x8GB) (go.pcworld.com/ps8)	\$47
Graphics card	Gigabyte Radeon RX 580 8GB Gaming 8G ⁵ (go.pcworld.com/8g)	\$266
Storage	Western Digital 1TB Caviar Blue 3.5" 7200RPM HDD (go.pcworld.com/cb1)	\$50
Optical drive	LG UH12NS40 Blu-Ray drive (go.pcworld.com/brd)	\$43
PSU	Thermaltake SMART 550W 80+ Bronze ⁶ (go.pcworld.com/80b)	\$35
Case	Thermaltake Versa H21 ATX Mid Tower (go.pcworld.com/atx)	\$34
OS	Windows 10 OEM license (go.pcworld.com/mli)	\$32
Shipping	Motherboard (\$1), Graphics Card (\$9)	\$10
Total		\$652

Build notes

1. Prices current as of June 15, 2017.
2. Retailers chosen with shipping costs in mind—and the assumption most people have an Amazon Prime account.
3. Cheap AM3+ motherboards like the ASRock 970 Pro R2.0 lack on-board Wi-Fi, so if you want wireless connectivity, prepare to shell out for either a Wi-Fi adapter or a better motherboard.
4. The price for this ASRock motherboard is after a \$20 mail-in rebate.
5. See the Build Summary section for notes on availability.
6. This price is after \$20 mail-in rebate.

Build breakdown

When comparing our build to the Xbox One X piece by piece, each

platform's advantages are clear. Our PC has more flexibility and muscle, while the Xbox One X is both highly compact and set in stone.

For the Xbox One X's CPU, GPU, and memory, Microsoft chose a custom AMD APU that features eight 2.3GHz custom x86 cores, 40 Radeon compute units running at 1,172MHz, and 12GB of GDDR5 memory. AMD doesn't have an equivalent APU available for DIY build purposes, so I chose to walk the line between the Xbox One X's specs and recommended specs for a smooth PC gaming experience. In our build is the eight-core 3.3GHz AMD FX-8300, 8GB of DDR3/1600 RAM, and an 8GB Radeon RX 580. (My GPU choice does have one catch, which I've noted in the Build Summary below.)

This configuration nets you a (faster) eight-core CPU, enough RAM to avoid bottlenecks in system performance, and a GPU capable of 4K gaming at a minimum of 30 fps on Medium settings. However, some Xbox One X games may end up running more smoothly or with better visual fidelity on console than on this homebrew 4K machine. Unlike with the PC, developers can fine-tune their games for Microsoft's





The Xbox One X hard drive, as shown at Microsoft's Xbox showcase at E3 2017.

console through a low-level API.

For storage, Microsoft hasn't yet shared details on drive speed, type, or interface. All we currently know is what Digital Foundry (go.pcworld.com/df) revealed in its April 2017 preview: The Xbox One X will have a "1TB hard drive with a 50 percent increase in bandwidth."

Without knowing how Microsoft arrived at that 50 percent figure, we could spend a lot of time speculating on what it means. (Do they mean a shift from SATA II/3Gbps to SATA III/6Gbps? Use of a solid-state hybrid drive? A larger cache?) Instead, I chose to keep this exercise simple and selected a SATA III 7200rpm Western Digital hard-disk drive. While it's possible that the Xbox One X's \$500 price tag includes a SSHD, like in its now-discontinued Xbox One Elite model, that raises the price of this build without explicit cause.

The final pieces of this build are straightforward. In fact, you can use any reputable 500W power supply (the minimum you'll need for this build), ATX case, and Blu-ray drive—the ones listed in our build were chosen for how cheap they were at the time of publication.

Speaking of that Blu-ray drive, it's a far step down from the Xbox

One X's 4K UHD Blu-ray drive. To stay even remotely near a final total of \$500, you have to ditch support for playback of 4K UHD discs. So that means you can't play your collection of 4K UHD movies in HDR on a compatible TV, if you already own one.

As for the operating system, we can't go as cheap as the Xbox One X's included variant of Windows 10, but we can get a W10 Home license at a heavy discount. How? By using a trick that Brad Chacos has mentioned to our staff for a while now: Buying a product key through Kinguin (go.pcworld.com/k). It works, but be sure to get the Buyer Protection—the site functions like an eBay for software, and that insurance will protect you from shady sellers.

Build summary

As mentioned above, we wanted to replicate both the functionality and the price of the Xbox One X as closely as possible. You can't do an exact 1:1 duplicate, thanks to a mix of Microsoft's custom hardware design and slow release of specs, but this build is a fairly decent compromise between Xbox One X's main features and the cost of PC

components. This rig should play games in 4K at a minimum of 30 fps on a Medium graphics setting, support HDR, and play optical discs.

However, it's more expensive than an Xbox One X by \$152 (or more, if you're bad about filing mail-in rebates). It lacks support for 4K UHD Blu-ray discs. It uses a GPU that's extremely difficult to find right now, so currently you'd have to pay more for a used RX 580 or buy a graphics card with less memory (Nvidia's 6GB GTX 1060 instead of a 8GB Radeon RX 580). It doesn't have built-in Wi-Fi support. And it's not nearly as compact or small.

As for the operating system, we can't go as cheap as the Xbox One X's included variant of Windows 10, but we can get a W10 Home license at a heavy discount. How?

Build #2: The upgraded 4K/30-fps gaming PC

Our second build swaps out the standard Blu-ray drive for a 4K UHD Blu-ray drive—and changes the CPU and motherboard configuration as well.

Part	Name	Price
CPU	Intel Core i5-7400 (3.0GHz, 4-Core) (go.pcworld.com/74)	\$187
Motherboard	ASRock Fatal1ty Z270 GAMING-ITX/AC ³ (go.pcworld.com/asr)	\$149
RAM	Crucial 8GB DDR4/2133 (1x8GB) (go.pcworld.com/c8g)	\$55
Graphics card	Gigabyte Radeon RX 580 8GB Gaming 8G ⁴ (go.pcworld.com/8g)	\$266
Storage	Western Digital 1TB Caviar Blue 3.5" 7200RPM HDD (go.pcworld.com/cb1)	\$50
Optical drive	Pioneer BDR-211UBK 4K UHD Blu-Ray drive (go.pcworld.com/brk)	\$130
PSU	Thermaltake SMART 550W 80+ Bronze ⁵ (go.pcworld.com/80b)	\$35
Case	Rosewill Dual Fan Micro ATX Mini Tower (go.pcworld.com/mt)	\$28
OS	Windows 10 OEM license (go.pcworld.com/mli)	\$32
Shipping	Optical Drive (\$1), Motherboard (\$2), Graphics Card (\$9)	\$12
Total		\$944

Build notes

1. Prices current as of June 15, 2017.
2. Retailers chosen with shipping costs in mind—and the assumption most people have an Amazon Prime account.
3. The price for this ASRock motherboard is after \$10 mail-in rebate.
4. See the Build Summary section for notes on availability.
5. This price is after \$20 mail-in rebate.

Build breakdown

For the most part, this build shares the same approach as our first one. The key difference is the addition of Pioneer's 4K UHD Blu-ray drive to closely match what the Xbox One X has.

That 4K UHD Blu-ray drive makes this build quite a bit more expensive than an Xbox One X. The BDR-211UBK itself is \$130, and its highly restrictive system requirements also require a more expensive CPU and motherboard. The cheapest compatible processor is a \$187 Kaby Lake Core i5-7400, and since only a few motherboards support (go.pcworld.com/mbs) the draconian DRM specifications for 4K UHD Blu-ray disc playback, the lowest-cost option is \$149.

For the moment, you can't get around this painful jump in cost. Pioneer has the only options for a 4K UHD Blu-ray drive currently—



and this one we've picked is the cheaper of the two.

Build summary

This upgraded rig nails the Xbox One X's main features: It should run games in 4K at a minimum of 30 fps on a Medium graphics setting, support HDR, and play 4K UHD optical discs.

However, like the first build in this article, it has its downsides. First of all, if you build this PC at this very moment, you'll have a rough time finding an RX 580. You'll end up paying more or purchasing a GTX 1060 (which has less memory) instead.

It's also much more expensive than the Xbox One X. At \$944, you could buy the Xbox One X almost twice over.

Final thoughts

For the moment, Microsoft's created a machine that the DIY PC crowd can't currently match—not when you try to copy both its feature set and cost at the same time, at least. The 4K UHD Blu-ray disc drive really throws a wrench into this build challenge, and even without it, the Xbox One X holds its own. This situation might be a first, given how often PC gamers tout benefits that console fans miss out on.

Still, it's not a complete victory for the Xbox One X. PC gaming



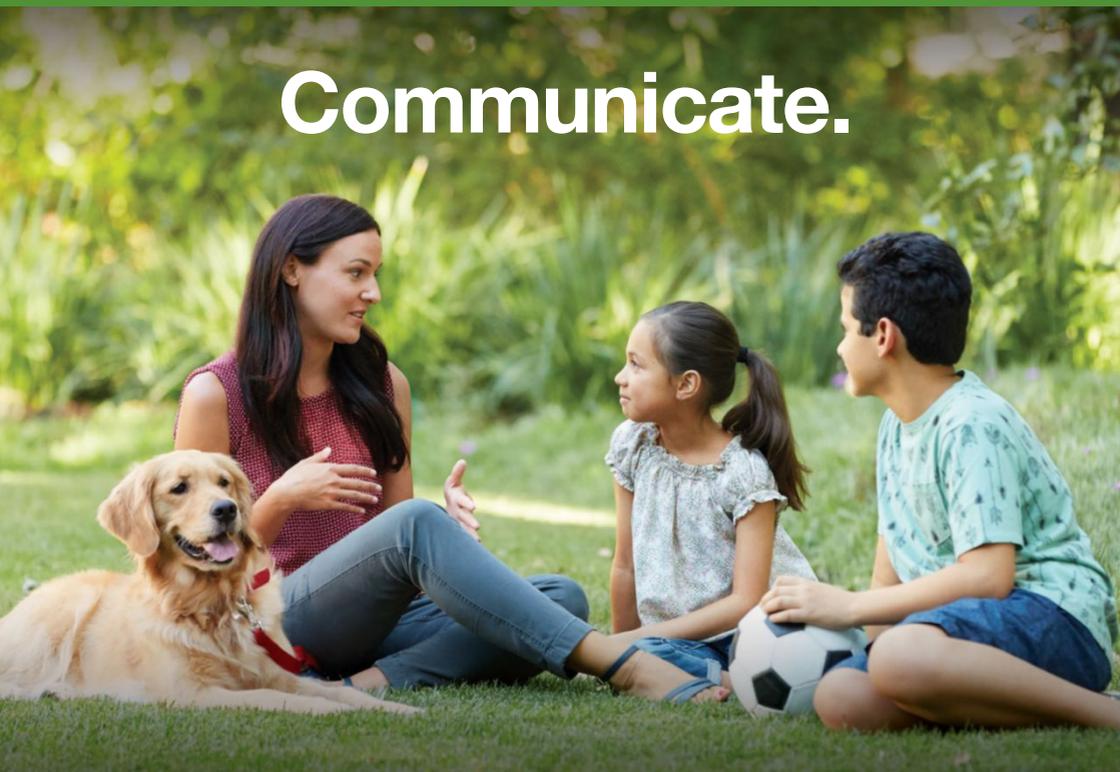
doesn't require an optical drive, after all, so you can enjoy 4K gaming, 4K video content, and HDR through digital downloads. (The RX 580 will handle all that just fine.) That already drops the cost of the cheaper build we priced out.

Beyond that, these builds could change the closer we get to the Xbox One X's launch date. When AMD's Ryzen 3 line launches, it might offer even better CPU performance for the same price as the FX-8300. Prices might come down for RAM and Pioneer's 4K UHD Blu-ray drive. Availability for the RX 580 may increase again. And of course, the holiday shopping season should yield some sweet deals on at least some of these build components. By November 7th, the Xbox One X may be far easier to reproduce as a punchy \$500 PC. 🔌

A photograph of a residential street that has been completely flooded. In the foreground, a white speed limit sign with black text reads "SPEED LIMIT 20". The water is dark and reflects the surrounding environment. In the background, there are houses with windows and some green bushes.

SPEED
LIMIT
20

Don't Wait.

A photograph of a family sitting on a green lawn. A woman with long dark hair is sitting on the left, talking to a young girl and a young boy. A golden retriever is lying on the grass to the left of the woman. The background is filled with lush green plants and trees.

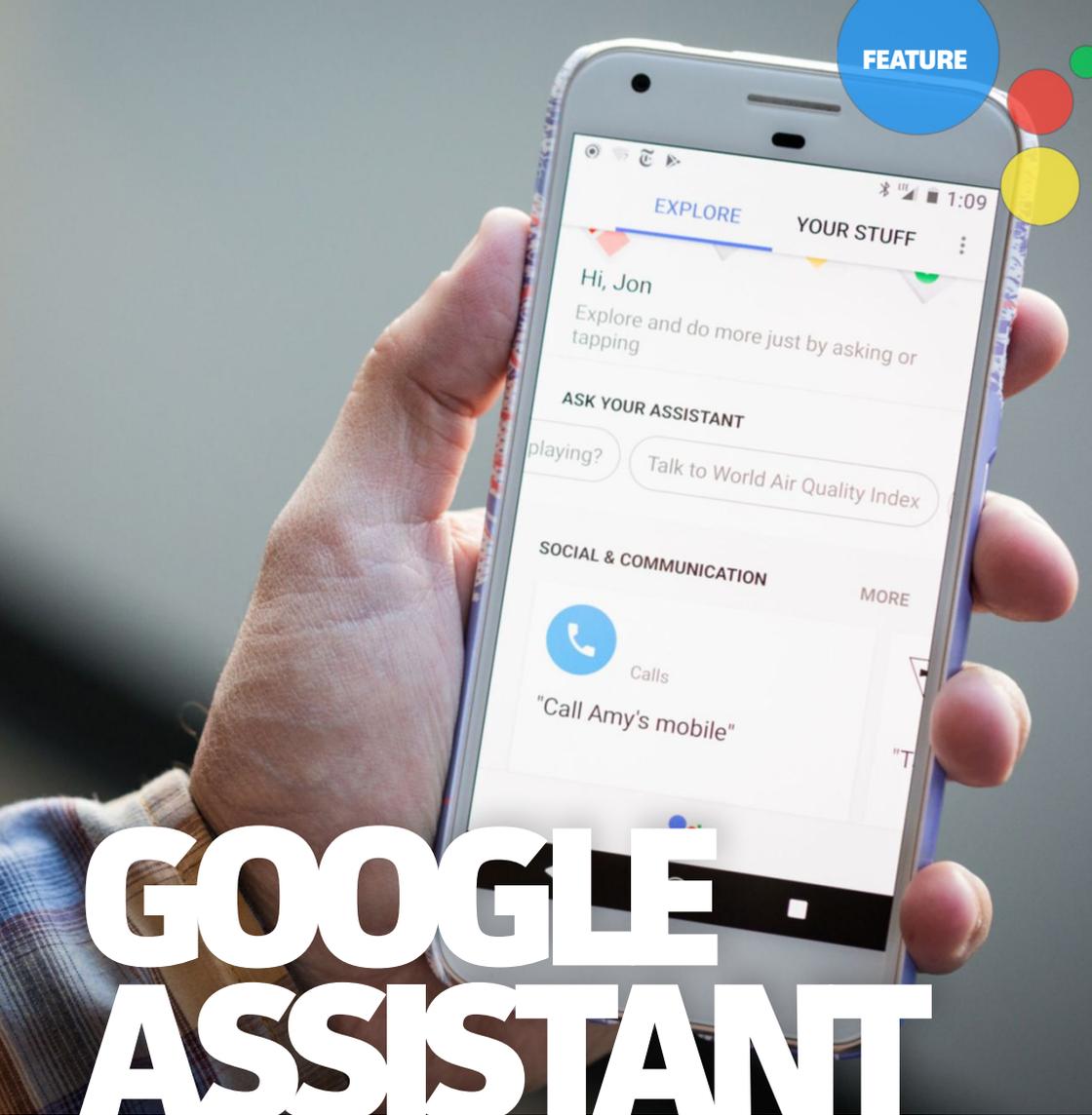
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FEATURE



GOOGLE ASSISTANT

5 KILLER NEW FEATURES YOU SHOULD BE USING

BY RYAN WHITWAM

FEATURE GOOGLE ASSISTANT

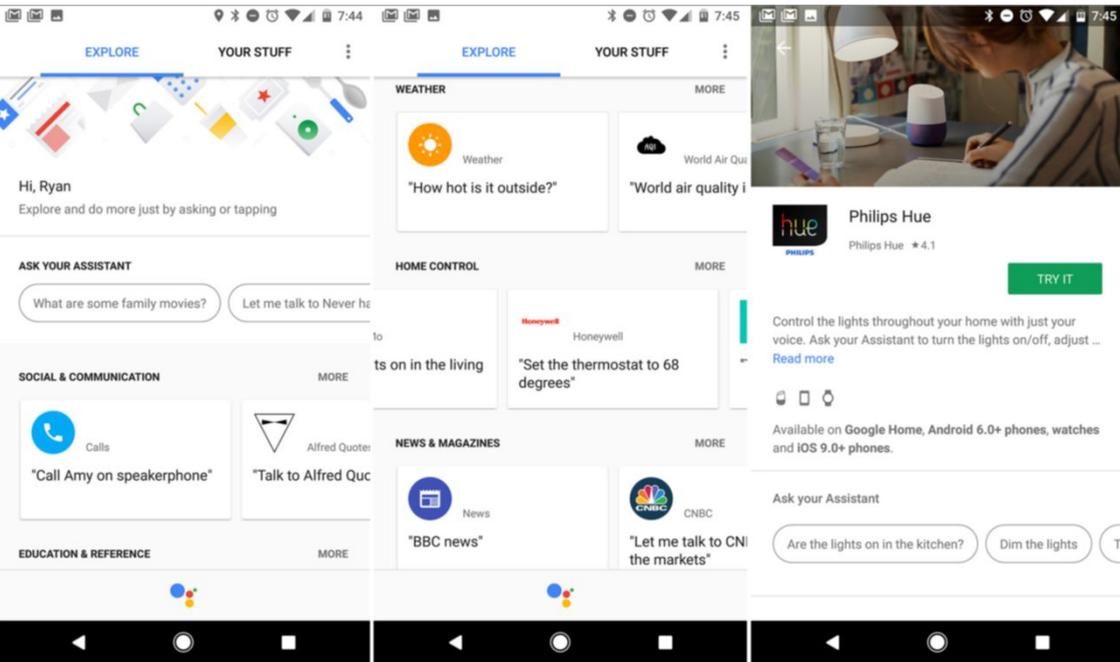
Google has had voice search features in Android for years, but when Google Assistant rolled out on the Pixel in October 2016, everything finally came together. You can now get Assistant on plenty of Android devices, and Google just improved the platform with a raft of new features in recent weeks.

It can be easy to miss the improvements if you don't obsessively keep an eye on the news, so here they are in one place: the five coolest new features in Google Assistant.

EXPLORE MENU

Google used to hide all of Assistant's features in a series of esoteric, buried menus. Now, there's a much more sensible way to find out what sort of cool things you can do with Assistant in the Explore menu.

To access this menu, open Assistant and tap the blue drawer icon in the upper right corner. Here, you can find all the services supported by

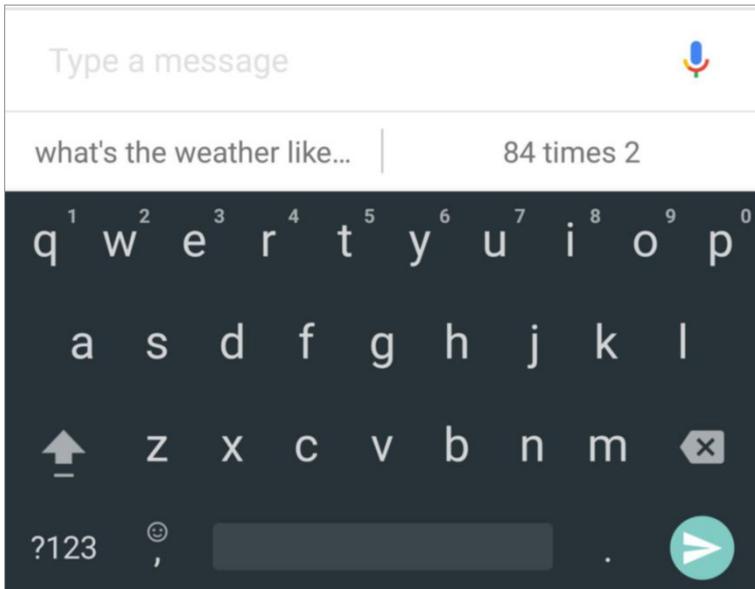


Assistant broken down into categories like Social & Communication, Education & Reference, Games & Fun, and more. Each tile links to a full info page where you can see sample commands and (if necessary) link your account. Bottom line: Checking out the Explore menu is the easiest way to keep track of newly added apps and services.

There are also some general Assistant command suggestions at the top. You don't even have to speak the suggestions, just tap the bubble and they'll be dropped right into Assistant.

TYPING TO ASSISTANT

Google Assistant first appeared in the Allo app, and in that iteration, you could input text to “chat” with the Google bot. But the more powerful baked-in phone version of Assistant began its life with only voice input. That's fine when you're in a situation where you can talk to your phone, but voice dictation isn't always appropriate. Well, thanks to the recent update, you can now type your questions and commands, too.



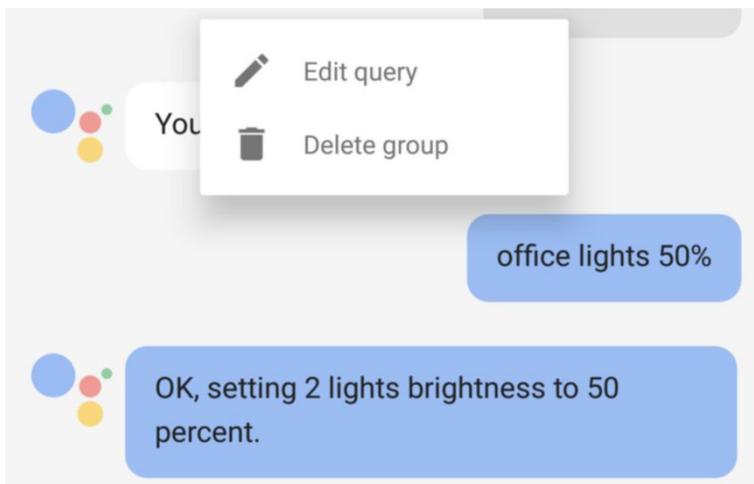
To access the keyboard in Assistant, just long-press your home button as you normally would. But instead of speaking right away, tap the keyboard icon in the lower left corner. Assistant will expand to fill the screen, and you can begin typing. Assistant will respond to all the same commands that you'd use in a voice-dictation situation, and you'll also find contextual suggestions above the keyboard. And because these suggestions are part of Assistant, they appear no matter which keyboard app you're using.

EDITABLE HISTORY

Google Assistant used to be a transient experience—whatever you said to Assistant would be lost to the ether as soon as you left the Assistant UI. But now there's a full history of your commands, and you can edit them too.

To access your Assistant history, you need only drag up on the overlay when Assistant pops up. This will drop you into a full-screen interface that shows your recent queries. Scroll up to see everything you've asked and how Assistant answered.

Editing is a snap, too. Long-press on a query, and it will be highlighted along with Assistant's reply. From there, you can either



delete or edit it. Deleting will completely remove the query (and associated activity) from the history. This is just like removing something from your Google search history, so it won't be used to inform future search and Assistant predictions.

If you choose to edit a query, the query will be dropped into the text field along with an open keyboard. You can tap Send to immediately repeat the command, or make some changes and send it again. Just note that none of this undoes the actions performed when the command was first issued.

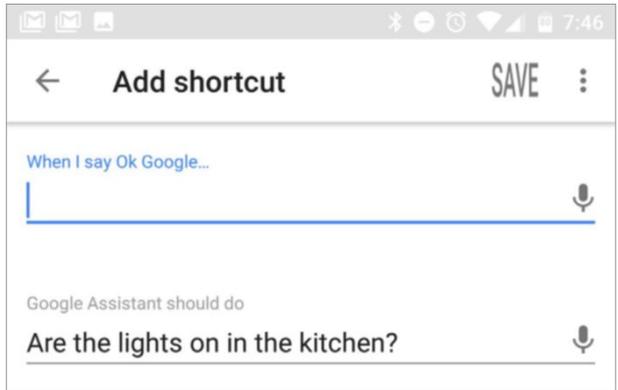
SHORTCUTS

There are dozens of services and apps integrated with Assistant already, but some of them get preferential treatment. For example, you can tell Google to control your Hue lights directly, but lights connected through Homey require you to preface all commands with

Tell Homey. It can get a bit tedious, but shortcuts are here to help.

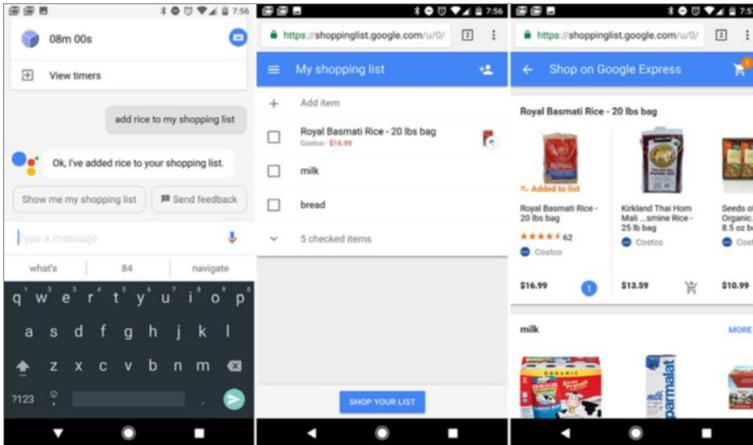
To create a shortcut, find the service you want to have quicker access to in the Explore tab. There will be an option on the info page to add a new shortcut. The shortcut screen has a box for what you want to say, and one below that for what you want Assistant to actually do in response.

In the top box, input whatever snappy shortcut phrase you want. It tends to work better if you use the microphone button to speak the shortcut. Assistant will sometimes put a sample command in the bottom box, but you can change that to the command you want. It has to be the full phrase you'd say to Assistant, including the **Tell [X]** part if needed. Once your shortcut is saved, it'll work by voice and text.



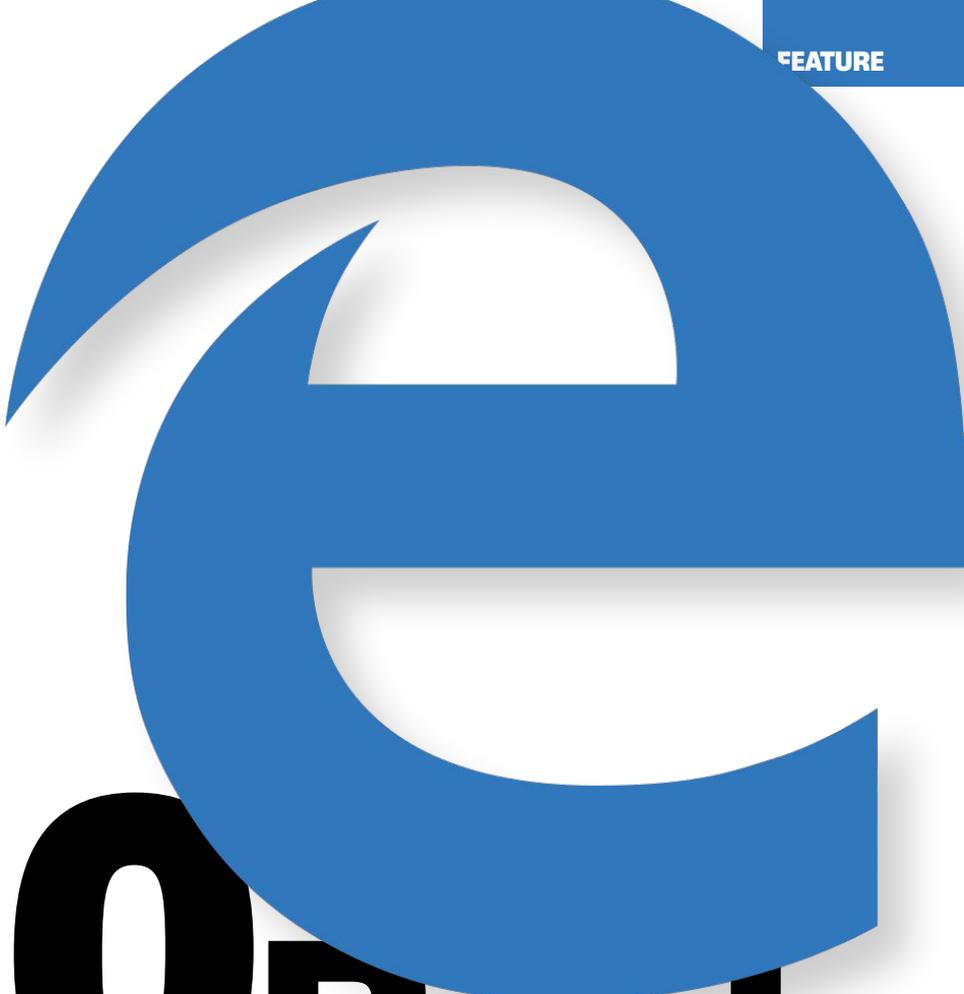
GOOGLE EXPRESS SHOPPING LIST

Google Assistant has always been able to add items to a shopping list, but that list used to live solely in Google Keep. As such, it was just a list. But Google recently changed the shopping list functionality to plug directly into its Google Express delivery service, which could be very useful if you use it.



All you have to do is say, **Add [item name] to my shopping list.** It will show up in your Google Express shopping list instantly. You can access that list in the Google Express app, or simply say **Show me my shopping list.** That takes you to the online version of your list, which can be shared with any of your contacts. If you're a Google Express subscriber, you can tap Shop Your List to get filtered search results from supported local retailers. Add items to your cart, and you're done.

Assistant has existed for less than a year, but already it's learning new tricks and becoming more useful. You should give these new features a shot if you wrote off Assistant when it launched last year. 🔌



10 Best Edge *(SO FAR)* Extensions

BY IAN PAUL

Ever since the Windows 10 Anniversary Update rolled out last August, Microsoft Edge has offered third-party extensions (go.pcworld.com/tpe) to increase the functionality and customizability of the browser. Despite the popularity of extensions in other browsers, however, Edge has yet to secure a large number of add-ons in the first nine months of its extensibility.

At the time of this writing, there were less than 40 extensions available in the Windows Store compared to the hundreds available in the catalogs for Chrome and Firefox.

Nevertheless, the Edge catalog is at least big enough that we can start looking at what's useful and interesting for Edge users.

Here's our current list of the top 10 browser extensions in Edge.

Adblock Plus



A privacy-conscious user or just someone who hates being accosted by excessive ads won't get very far without a solid ad blocker. From the beginning, Adblock Plus (go.pcworld.com/abp) has been part of Edge's extension catalog.

This popular extension behaves here just as it does on other browsers. You install it and the extension starts blocking ads. If you ever want to stop ABP from working on a certain site, just click on the icon, and then click Enabled on this site from the drop-down menu to undo that action.

Ghostery



Another popular choice for the privacy conscious is Ghostery (go.pcworld.com/gh1). This extension isn't an ad blocker, per se, but the result is similar since it goes after and stops tracking technologies, many of which are attached to ads. That said, some ads will get through. If that bothers you, use it in conjunction with an ad blocker.

Save to Pocket



Popular read-it-later service Pocket (go.pcworld.com/stp) uses a browser extension so you can easily save items as you browse with Microsoft Edge. There's not much to it. Once the extension is installed, click on the icon to sign in. Next, just browse the web as you normally would, and when you come across an article you'd like to save, click the icon to stash it in your read-it-later list.

You can then read your collected articles via Pocket's website or its Android and iOS apps.

Tampermonkey



Advanced users who don't like the look or feel of a popular website can probably find a Tampermonkey (go.pcworld.com/tmp) script to change it, or even add new features. This extension is the non-Firefox user's alternative to Greasemonkey, and it's a great choice.

You can find scripts in Tampermonkey to disable leaky paywalls you find around the web, stop ad-block blockers, and alter the look and feel of sites like Facebook and YouTube.

The one warning about Tampermonkey is that it relies on user-generated scripts to be of any use. Avoid scripts from untrusted sources to keep your PC safe from malicious shenanigans.

Reddit Enhancement Suite



Another classic that's been around since the beginning of Edge extensions, Reddit Enhancement Suite (go.pcworld.com/res) tweaks your Reddit experience. Change the background, preview comments before you publish them, switch accounts quickly, open images inline instead of on a new tab, and many, many other improvements, all of which are optional.

RES isn't really a single extension, but a warehouse of various user-contributed optional features. If you love Reddit, you can spend a lot of time with this extension customizing your experience.

Microsoft Translator



Chrome has this feature built in, but if you want to read an article in French, German, or Japanese within Edge, Microsoft Translator (go.pcworld.com/mt1) can make it happen.

When you land on a page in a foreign language, click the Translator icon to the far right of the URL address bar, and in a few seconds you'll be reading a rough machine translation of the page. It's rarely ever perfect, but you'll get the gist of what's being said.

LastPass



The browser-based password manager LastPass (go.pcworld.com/lpa) has had a tough few months with security issues (go.pcworld.com/si), but it's still a solid and easy-to-use choice for managing your passwords. It can also store secure notes, create personal profiles with credit card information, and even let you attach files to entries if necessary.

LastPass offers a free service or you can pay \$12 per year to use LastPass across all your devices.

RoboForm



If LastPass isn't your thing, there's also RoboForm (go.pcworld.com/rfo). This password manager has similar features to LastPass: one-click login, a password manager and generator, a web form filler, and encrypted notes.

Like LastPass, there's a free version of RoboForm or you can use the paid version for \$20 for 18 months, which works out to about \$13 per year.

Web clippers: OneNote and Evernote

We're not going to bother debating which note-taking app is superior. Each product has its advocates and solid reasons for using one over the other. So why fight? Both OneNote (go.pcworld.com/ono) and Evernote (go.pcworld.com/evno) have a web clipper available for

Edge, allowing you to take snippets from the web and add them to your notes. Use your favorite and pretend the other doesn't exist, at least until the inevitable moment comes when you want to see how the other half clips.

BuiltWith Technology Profiler



This one's for the web geeks. BuiltWith Technology Profiler (go.pcworld.com/bwt) is an interesting extension that tries to gather as much information as it can about the various underlying elements of any website you're visiting. You can look at the type of server the site is using, what kind of ad trackers are on the site, what the social widgets are, the various web technologies used to create the site, the SSL certificate provider, and even which content delivery network it uses. All of this information is neatly organized in the extension's drop-down panel.

Just install the extension, click on it, and after a few seconds you'll see the results.

There you have it: our favorite Edge extensions so far. With any luck this list will change as the Edge extensions catalog expands. 🔌

WHEN YOU see
BULLYING,
use THIS
EM  JI
TO do SOMETHING
ABOUT it.

HERE'S HOW

CONTENTS

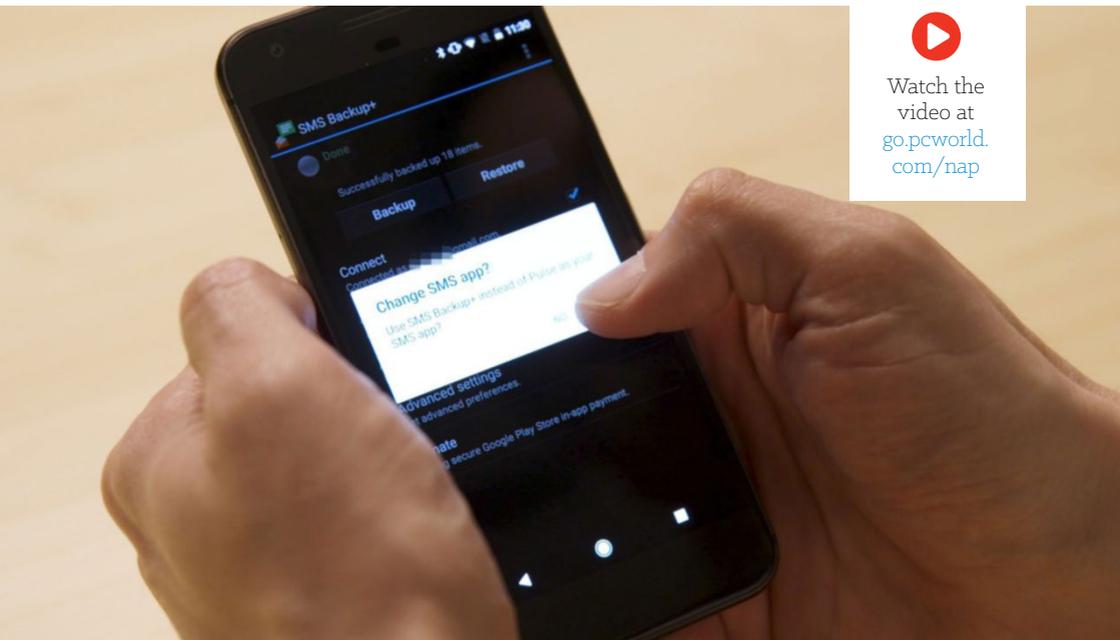
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How to build, maintain,
and fix your tech gear.

HERE'S
HOW



Watch the
video at
go.pcworld.com/nap



Transfer everything from your old Android phone to your new one

BY MICHAEL SIMON & DEREK WALTER

MOVING TO A new phone can be a pain. Android might have the edge over iOS when it comes to tight integration with cloud services, but Google still has a ways to go when it comes to effortlessly transferring all your data off your old phone and onto the new one.

But it has gotten better. You'll need to rely heavily on Google's services, of course, but with Android Nougat, moving your personal info has never been easier. It'll still take some vigilance and a little work, but you don't need to be an Android whiz anymore to ensure your data is ready to move the next time a catastrophe hits your phone—or you just really want a new one.

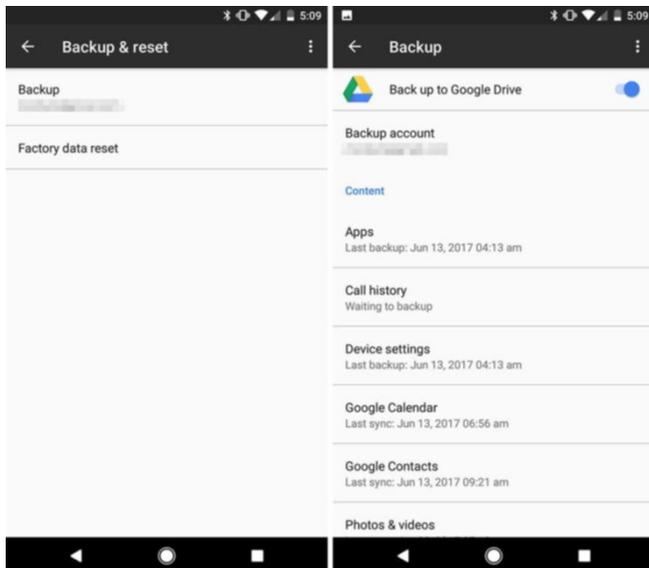
Know your backup options

Before you can do anything, you'll need to make sure your old phone is signed in to your Google account. It almost certainly is, but head over to the Google tab in Settings to make sure.

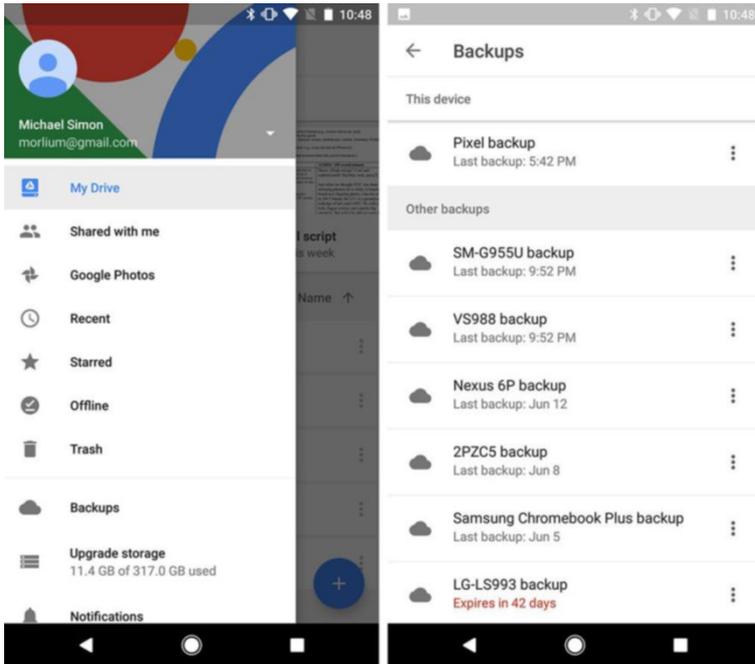
Then, you'll need to find your phone's backup settings. On Pixel and

Nexus devices there's a Backup & Reset option under the Personal tab in Settings, but the location varies on other phones. The easiest way to find it is to type **backup** into the Settings search bar.

Once you're there, you'll see a couple options. On Pixel and Nexus phones, there's a Back Up To Google Drive switch that will enable several types of content to be backed up, including installed apps



On Pixel and Nexus phones, you can back up mostly everything to your Google Drive.



Your Google Drive is the gatekeeper for all your backups.

and accompanying data, call history, device settings, calendar entries, contacts, photos and videos, and, exclusive to Pixel phones, SMS messages. It'll be backed up automatically overnight, so once you switch it on, you won't have to give it another thought.

On other phones, you'll see a Back Up My Data toggle. Turning it blue will ensure that your application data, Wi-Fi passwords, and various phone settings are sent to Google servers and at the ready when you sign in to a new phone. This way you won't have to re-enter passwords to networks you've already saved. Yes, that means Google probably has all the world's Wi-Fi passwords. But that's a story for another day.

You'll also see a second toggle called Automatic Restore. Turning that one on will restore the data and settings if you decide to reinstall

a previously deleted app.

Since backups work through Google Drive, if you head over to the app, you'll see a Backups option in the sidebar. Inside you'll see a list of any device that has been backed up, with your current phone occupying the top slot (likely with a funky name like SM-G955U or 2PZC5). Tap it and you'll be able to see when the last backup took place and which apps were included in it.

Mail, calendar, and contacts

If you don't want to use Google Drive backups, you can still make sure your most important things make it over when you power on your new phone.

Mail, of course, is the easiest. If you use Gmail, you need only sign in to your Google account to bring over all of your messages. And your other accounts, whether Outlook, iCloud, or Hotmail, will be just as easy. Simply download your favorite app, type in your username and password, and you'll be on your way. Additionally, there are numerous apps such as Newton (go.pcworld.com/nwt) and Blue Mail (go.pcworld.com/bm1) that will keep multiple accounts synced with a single login.

For people and appointments, Google has you covered here, too. Even without a proper Google Drive backup, any entries inputted into Calendar on your phone will automatically appear on your new phone as soon as you open the app. The same is true with Contacts. Whether you're opening the app itself or using the Phone app, your contact list will be fully synced with your new phone, no matter which phone you're switching from or to.

Photos and music

Photos are rapidly becoming the one thing that absolutely needs to be transferred from one phone to the next, and Google has built a fantastic way to do it in its Photos app.

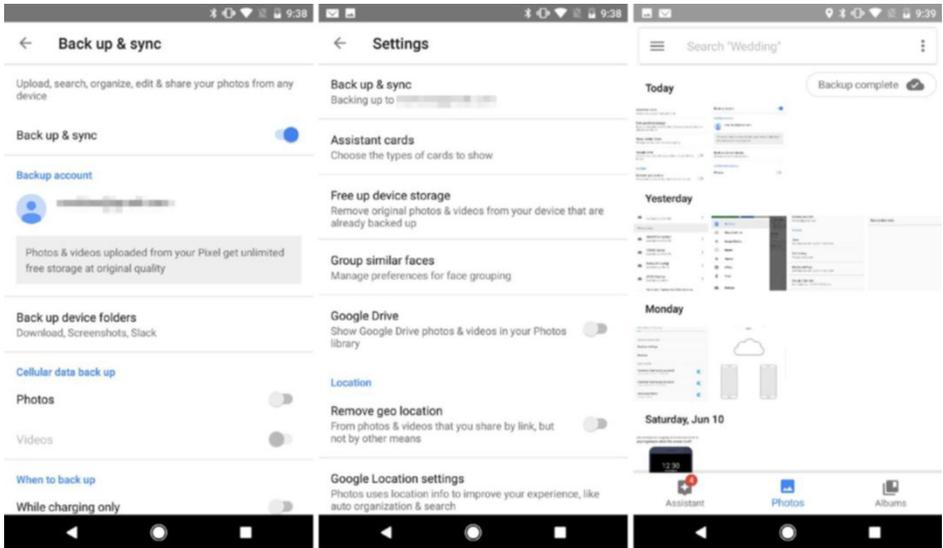
Available for all phones, it's far and away the best photo management

If you use Gmail, you need only sign in to your Google account to bring over all of your messages.

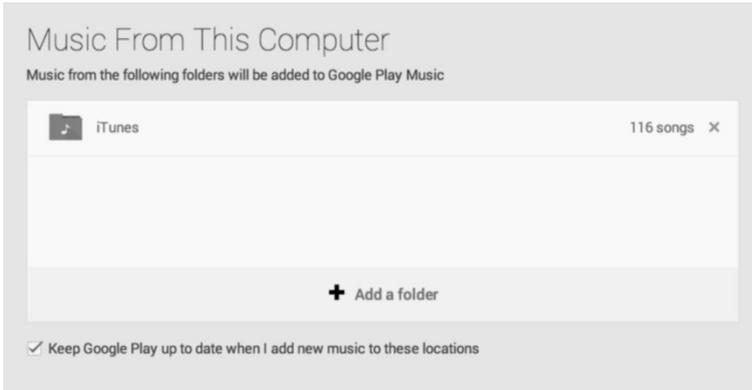
option, backups aside, so if you're not regularly using it, you should be. To make sure it's backing up everything, head over to the Settings in the sidebar and tap Back Up & Sync. Make sure the toggle is blue and the backup account is the same as the one you use for everything else.

Google lets you back up as many high-quality photos as you'd like, and it won't count against your Google Drive storage. If that's not enough resolution for you, you can opt to back up the full-sized original photos to your Google Drive, but it'll cost you. While Google gives Pixel users unlimited backups of their original photos, anyone else will have to use their allotted Google Drive space, so you might have to bump up your storage to accommodate the extra gigabytes. Google Drive users only get 15GB free, so if your camera roll is bigger than that, you can pay \$1.99 a month for 100GB or \$9.99 a month for 1TB of storage. But whichever size you choose, all of your photos will appear when you open the Google Photos app on your new phone.

When it comes to music, there are two ways to do it. If you already



Google Photos is hands down the best way to back up your pictures.



Google Play Music will let you store up to 100,000 songs in the cloud for free.

subscribe to a streaming service like Spotify, Google Play Music, or Apple Music, just head over to the app in your new phone and sign in to access all of your songs.

But if you aren't a streamer, Google Play Music will still help you get your groove on, letting you store up to 100,000 tracks for free. To get it to work, you'll need to head over to the Google Play Music site, sign in with your Google account, and install the Music Manager app on your PC. After you select the source of your tunes, the app does much of the work, uploading whatever it finds and adding it to your music library in the cloud. Big libraries will take a little time, but for the most part the process is simple and speedy.

Then, when you sign in to Play Music on your new phone, all your tracks will magically appear. You can choose to keep those songs in the cloud if you're tight on storage, or download them to your new phone so you can rock out no matter how spotty your signal gets.

Passwords and bookmarks

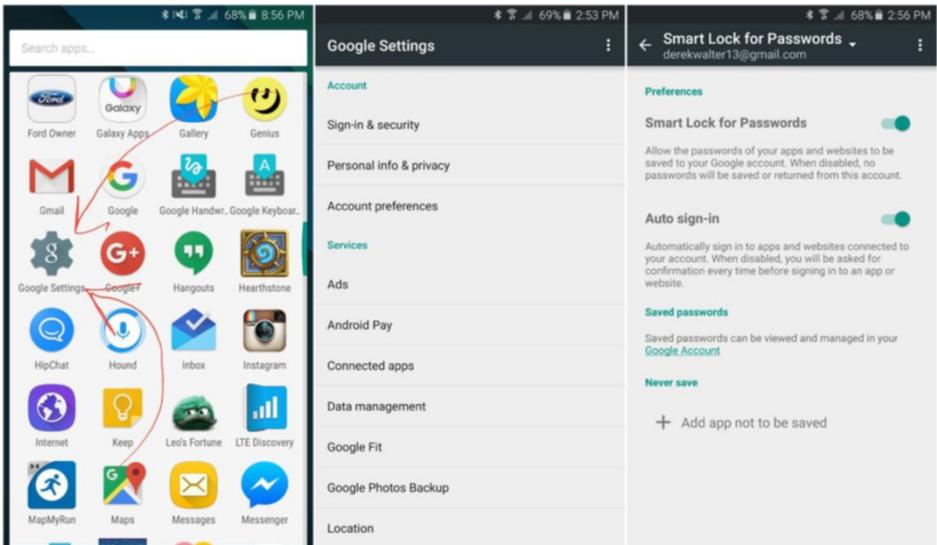
If you use Chrome on your phone, you can also take your browser history, passwords, and bookmarks to your new phone. First, head over to the Google tab in Settings (on pre-Marshmallow phones it will be a separate app called Google Settings), and scroll down to the Smart

Lock For Passwords option.

This settings stores passwords from supporting apps and Chrome sites to your Google account. Switch it on, and the next time you sign in to Chrome on your new phone you won't have to re-enter the same passwords over and over. It works on third-party apps, too, as long as the developers have built-in support.

If you're leery about app passwords being stored in your Google account, you can blacklist any app from using Smart Lock. Or you can forgo it altogether and download a password manager. There are plenty of great ones out there, including Dashlane (go.pcworld.com/dl), LastPass (go.pcworld.com/lp), and 1Password (go.pcworld.com/1p), and they'll all store your passwords in an encrypted locker. Most charge a fee, but it's worth it.

For the rest of your web needs, head over to the Chrome settings. Tap on your account name and then sync to see everything that you want to store in the cloud, including bookmarks, history, open tabs,



On pre-Marshmallow phones, Google Settings is its own app, but it'll take you to the same place.

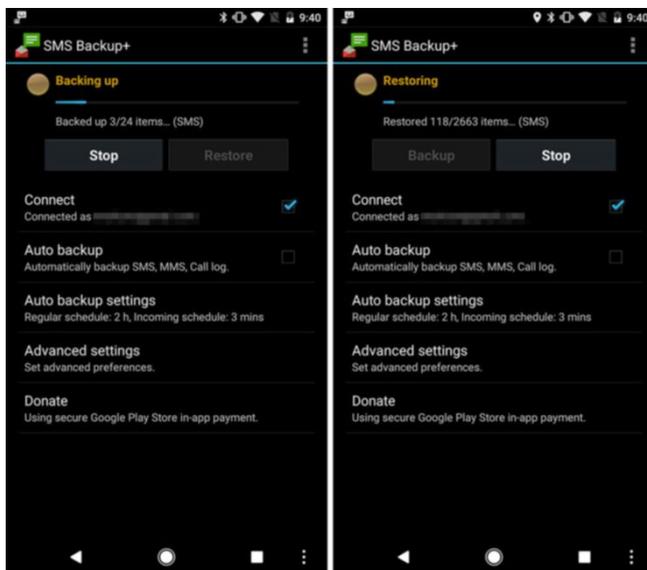
and saved credit cards. Once you select the ones you want, they will all be available when you sign in to Chrome on your new device.

SMS and MMS messages

This one is a little trickier than the others. If you own a Pixel phone on Android 7.1 or later, there is an option for backing up your SMS messages, though it will leave behind any photos or videos. If you use Allo, you can turn on chat backups in the latest version of the app, and everything will be synced to your new device, including media. And, of course, if you use WhatsApp, Telegram, Facebook Messenger, or some other third-party service, you only need to sign in to the appropriate app to access your full chat history.

But the most fool-proof way to move all of your messages from Android Messages or your text-messaging app of choice to a new phone is an over-the-top service. There are several in the Play Store—SMS Backup+ and SMS Backup & Restore are two of the most popular and highest rated—and they act as a sort of middleman that collects your messages until you're ready to transfer them to a new app.

It's not the speediest process, so you'll need to carve out some time to let it run if you have a lot of messages, but it works quite well. In a recent test, we used SMS Backup+ to back up and restore a batch of more than 2,000 messages on a test device without a



SMS Backup Plus will move over all of your conversations from your old phone to your new one.

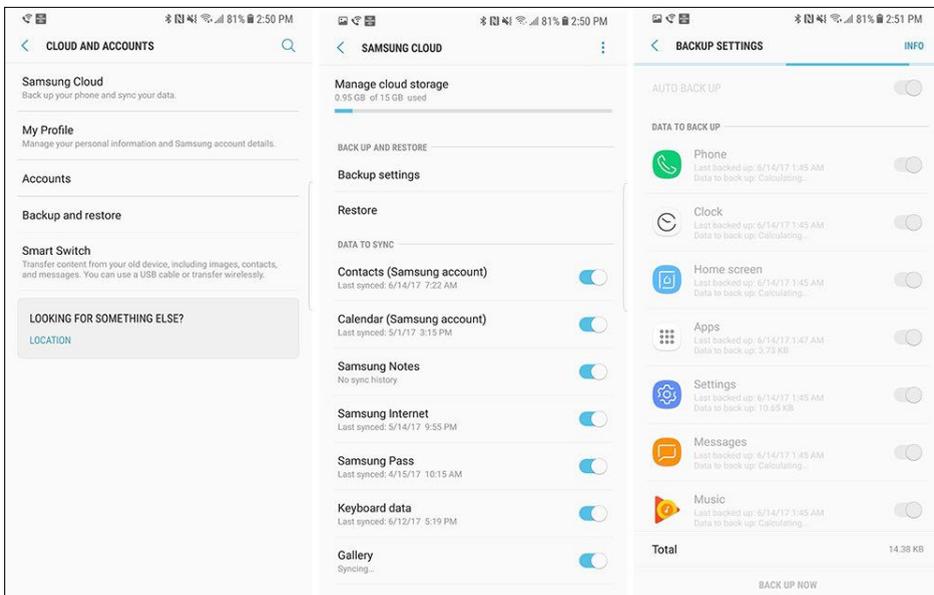
problem. It's baffling why Google hasn't implemented a similar system in Android, but for now, apps like SMS Backup+ will certainly do the trick.

One word of warning, however: Don't wipe your old phone until you're sure your messages have appeared on your new one. This way you'll be able to start over if something goes awry during the transfer.

Some software to ease the move

Most Android phone makers offer their own helping hands when it comes to moving over your stuff. Granted, they'll work best when changing to the same brand (like a Galaxy S7 to a Galaxy S8), but they all generally do a fine job.

Samsung offers its own service called Smart Switch (go.pcworld.com/ssw) that's now built right into Settings on the Galaxy S8. Turn it on and it will sync the same things Google does (contacts, calendar



Samsung has its own backup system built into the Settings in the Galaxy S8.

entries, etc.), plus your notes, alarms, messages, and even your home screen layout to your new phone. It works with non-Samsung phones as well, though

it works best if you also use Samsung's own Galaxy apps.

LG also offers an app called Mobile Switch (go.pcworld.com/msw) that lets you wirelessly transfer your photos, video, music, text messages, and apps from one LG phone to another. In our experience, the results were pretty spotty, so you'll probably be better off using the other methods outlined here.

The bottom line is, with the right combination of apps and cloud services you don't have to worry about leaving anything behind anymore when you get a new phone. No matter if you want your messages, music, or mail, your Google account is the No. 1 tool in your arsenal, and it's quickly becoming a one-stop shop for backing up and transferring everything from one phone to another. 📶

The bottom line is, with the right combination of apps and cloud services you don't have to worry about leaving anything behind anymore when you get a new phone.



How to set up a wireless router

BY MICHAEL BROWN

SETTING UP A wireless router doesn't have to be an ordeal. And while router manufacturers must be commended for making it easier to install their products, these tips will make the process even simpler. I'll also show you how to make sure your home network is as secure as it can be, and I'll explain some networking details that user manuals often gloss over.

The majority of router manufacturers now offer smartphone and tablet apps that you can use for first-time installation and subsequent tweaking. In fact, some companies no longer bother with browser-based user interfaces at all. I think it's best to have both options so *you*

can decide which approach is best (personally, I prefer using the browser because the display connected to my PC is bigger and easier to see).

Step 1: Place your wireless router

As any router manufacturer will tell you, the best place to locate your wireless router is in an open area in the center of your home. It's great advice, because it will provide the most even coverage. It's also impossible for most people to do, because you need to connect your router to the broadband gateway your Internet service provider (ISP) has provided you with. That equipment (be it a cable or DSL modem or—if you're really lucky—a fiber gateway) is invariably installed at a perimeter wall.

If you can't put your wireless router in the center of your home, at least try to avoid putting it in a closet that will crimp its range. You don't need to move the gateway, but you can use a longer (and very inexpensive) CAT5e or CAT6 cable to connect the router to the gateway's ethernet port so you can put it out in the open. If you're



The best place to locate your router is in the center of your home. There just happens to be a wet bar at the center of my home.



Many newer routers, such as the TP-Link Deco M5 show here, have auto-sensing ethernet ports that configure themselves for WAN or LAN duty based on the signal they receive from the cable.

really ambitious, you could run a pair of ethernet cables through your walls to that ideal central location (one cable to connect the router to your gateway, and a second to connect it to an ethernet switch—perhaps in the closet with the gateway).

But there's also an easier option: the mesh-style router. In this system, you locate one node wherever your gateway is, and then place subsequent nodes in different rooms of your home. Your data will wirelessly hop from one node to the next, and you'll have a strong Wi-Fi signal nearly everywhere in your house.

But, caution: Don't put a wireless node in a Wi-Fi dead spot—it won't be able to connect to your network any better than any client device. Instead, place the node where its wireless signal can reach that dead spot.

Some routers have a designated WAN (Wide Area Network) port for connecting to the gateway, while others have auto-sensing ports that automatically configure themselves as WAN or LAN (Local Area Network, i.e., your home network). You'll need to perform some preliminary steps first, so don't disconnect or turn anything off just yet.

Step 2: Configure your wireless router gateway

Most ISPs provide their customers with modems—aka gateways—that have routers built in. Unfortunately, these integrated modem/routers are usually of much poorer quality than stand-alone routers, and none that I know of allow you to build out mesh networks that have multiple wireless access points (or APs) that enable you to blanket your home with Wi-Fi (although Comcast will offer such a feature soon, go.pcworld.com/aps).

If your gateway has an integrated router, you'll need to configure the gateway to disable the router and pass the WAN IP address (the unique Internet Protocol address that the ISP assigns to your account) and all network traffic through to your new router. This is necessary to avoid double-NAT scenarios, among other things. (Here's an explanation of double NAT and why you want to avoid it: go.pcworld.com/nat.) You'll need to know the IP address that the gateway is using (you'll typically find this on a label on the gateway itself). Enter the IP address into a

The screenshot shows the AT&T Motorola gateway configuration interface. The page is titled "IP Passthrough" and is part of the "Firewall" section. The configuration options are as follows:

- Allocation Mode:** Passthrough (selected)
- Default Server Internal Address:** [Empty text box]
- Passthrough Mode:** DHCP/Static (selected)
- Passthrough Fixed MAC Address:** [Empty text box]
- Passthrough DHCP Lease:** 0 Days, 0 Hours, 10 Minutes, 0 Seconds

Buttons for "Save" and "Cancel" are visible at the bottom left. A "Help" section on the right provides additional information:

Allocation Mode:

- Off:** The default server and IP Passthrough features are both disabled.
- Default Server:** Allows the device to forward all externally initiated IP traffic (TCP and UDP protocols only) to a default host on the LAN. You might need this if you cannot anticipate what port number or packet protocol an in-bound application might use. For example, some network games select arbitrary port numbers when a connection is opened. Or you might want all unsolicited traffic to go to a specific LAN host.
- Passthrough:** Allows the device's public IP address to be assigned to a single LAN client.

Default Server Internal Address: The IP Address of the device to receive the unexpected or unknown traffic.

Passthrough Mode: The method in which the WAN IP address will be assigned to the selected LAN client.

- DHCP/Static:** The WAN IP address will be handed out by the device's DHCP server to the first LAN client that requests a DHCP lease. It may be helpful, after the device has obtained a WAN IP address, to cycle the desired LAN client's interface or reboot it. On disabling this feature, you should reboot the LAN client.

If your broadband gateway also has a built-in router, such as this Motorola NVG510, you'll need to put the gateway's router into "bridge" or "passthrough" mode to use your own router.

web browser to access the gateway's configuration screen.

Some gateways have what's known as a Bridge mode for working with a secondary router; others handle it differently. You might need to contact your ISP for help with this step, as some won't allow you to configure the gateway yourself.

My ISP, AT&T U-verse, provided me with a Motorola NVG510 DSL gateway/router combo. Configuring that device to work with a router involves logging in to the gateway, navigating to the Firewall menu, and setting it to Passthrough mode. You then further set the Passthrough mode to DHCP-fixed and provide your router's MAC (Media Access Control) address.

DHCP is an acronym for Dynamic Host Configuration Protocol Server, which dynamically assigns IP addresses to the devices on your network (I'll go into more detail on this in a bit). The MAC address is a unique identifier for a router—no two are alike. Once again, the process for your gateway could be different, but the result will be the same. You'll also need to find the setting that turns off your gateway's Wi-Fi access point, so that you're not running a second—and useless—Wi-Fi network. When you've finished making these changes, reboot your gateway.



The Motorola NVG510 is a DSL modem that AT&T sometimes provides its U-Verse broadband customers. It has a broadband connector, a phone jack for internet phone service, and a four-port ethernet switch.



Connect your gateway to your router's WAN port using a CAT5e or CAT6 cable (the gray cable in this photo). The red cable goes from the router to a PC, while the thinner cable plugged into the green port on the gateway connects to a phone jack in the wall.

Step 3: Connect your gateway to your new router

Turn off your gateway (unplug the power supply if there's no on/off switch). If an ethernet cable is plugged into the gateway's LAN port, unplug it and plug it into your router's WAN port (once again, some routers have dedicated WAN and LAN ports; others have auto-sensing ports). If there is no ethernet cable plugged into the gateway's LAN port, an ethernet cable should have come with your router. Use it to connect the gateway to your router. Turn your gateway back on and wait a minute or two for it to boot up. Next, plug in your router's power supply and turn it on. Wait another minute or two for it to boot.

Step 4: Change your wireless router's admin password

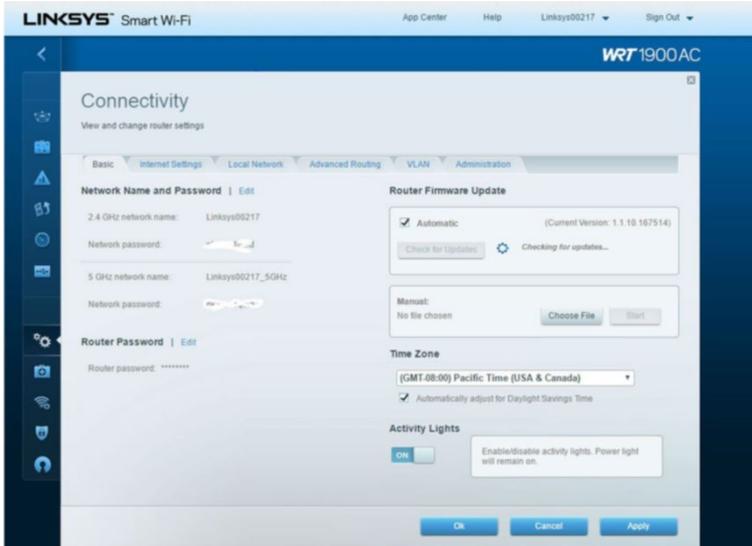
Many router manufacturers provide smartphone apps for configuring their routers. Use it if your new router has one (in some cases, that might be the only way you can configure the router). If there's no app, or if you'd prefer to use the router's browser-based user interface, connect your PC to the router using an ethernet cable. Type the router's IP address in your web browser's address window and hit the Enter key. The router's IP address might be printed on the router itself; it will look like 192.168.1.1 or something similar.

You'll need the router's admin login and password to log in to it. This information might be printed on the router itself, but you might also find it in the user manual. Enter the required credentials and hit Enter. You should immediately change the default admin password because it's not secure. Create something unique and either write it down or enter it into a password manager program such as LastPass. You will need it later to make changes and updates. If you forget the admin password, you'll need to perform a hardware reset, and that could undo any customizations you've made.

You should immediately change the default admin password because it's not secure. Create something unique and either write it down or enter it into a password manager program such as LastPass.

Step 5: Update the router's firmware

Router manufacturers often release new firmware after they've shipped the router. The new firmware might contain critical bug fixes as well as security and performance improvements, so always make sure you have the latest version. Most routers will check for new firmware, but few of them do this automatically—you typically need to at least click a button on the router's configuration app. Take a look at your router's documentation for details. You'll need to reboot the router after a firmware update.



The first steps you should take when configuring your router is to change the admin password and update its firmware to the latest version available.

Step 6: Establish a password for your Wi-Fi network

Some routers come from the factory with a pre-assigned Wi-Fi password (they might even put it on a label on the router itself). Many others will at least prompt you to create one when you first set the router up. Be sure to configure the router to use at least WPA2 (second generation Wi-Fi Protected Access) encryption. The much older WEP (Wired Equivalent Password) is absolutely insecure and should not be used. No recent vintage router will use it by default, but most still support it in case you have legacy devices that can only use WEP. If you're still using wireless devices that fall in that category, you should retire them because they're leaving your entire network vulnerable to the most casual hacker.

The process for setting your router's Wi-Fi password will vary from one model to the next. On the Linksys WRT1900AC router I use, for example, the settings reside in both the Connectivity and Wireless

tabs (but not the Security tab, which is where you might expect them to be). If you have a dual-band router, you'll need to assign passwords for both your 2.4GHz and 5GHz networks. They can be different passwords, but you'll be happier if you use the same password for each (and you won't be any more secure if you make them different). The password should be relatively complex and include letters, numbers, and special characters. Here again, you'll find a password manager to be extremely useful unless you have a very good memory. If you operate one or more guest networks, you'll need to create a password for those as well.

Step 7: Enjoy your Wi-Fi network!

If everything went according to plan, you should be able to log on to your new Wi-Fi network using the Wi-Fi password you just created. If your router has a guest network, take full advantage of it: These usually allow your guests to access the Internet while walling them off from the rest of your network and the computers and storage devices connected to it. 🏠



A young girl with her hair in a bun is seen from behind, jumping rope on a paved sidewalk. She is wearing a grey t-shirt with "NFL PLAY 60" printed on the back in blue and white. The rope is blue with pink handles. In the background, there is a brick building and green foliage. A semi-transparent white box with red text is overlaid on the middle of the image.

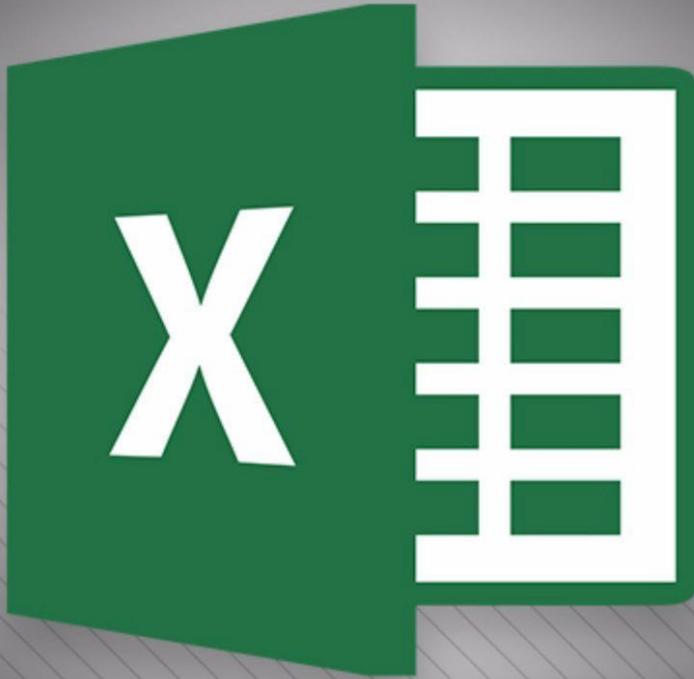
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7 Excel tips for huge spreadsheets: Split Screen, Freeze Panes, Format Painter and more

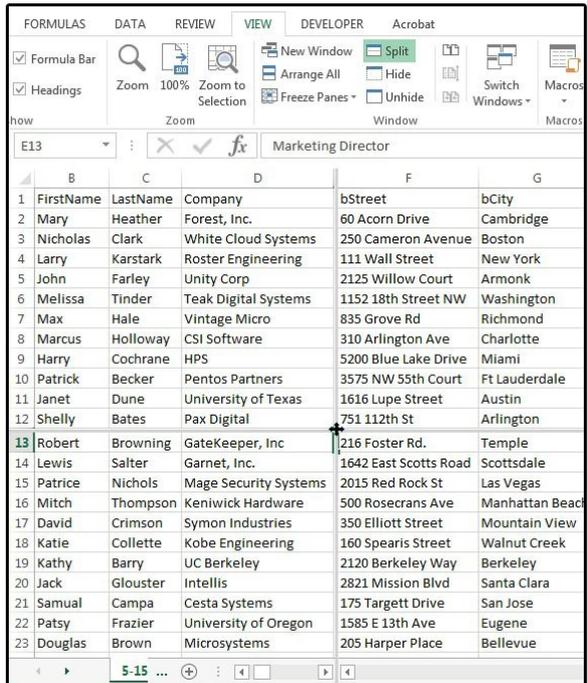
BY JD SARTAIN

THE BIGGER AND uglier your Excel spreadsheet gets, the more you need to use certain features or tricks to keep a handle on the data. The seven features covered here will help you navigate, organize, and readjust your spreadsheet with as little hassle as possible.

1. Split Screen

One of the most helpful features for large spreadsheets is the Split Screen command. Split Screen allows you to view two, three, or four windows of your spreadsheet at one time. Use this feature to work on one section of your spreadsheet while you view another section; or use it to compare (side by side) two sections of the spreadsheet. Once you try it, you'll find lots of reasons to use it.

- a. First, position your cursor where you'd like the screen to split. For example, if you want to divide the screen into four equal sections, position the cursor in the center of the spreadsheet.
- b. Next, select View > Split.
- c. If you want to move the split, position your cursor at the apex of the split bars. When the cross-with-arrow-points appears, click and hold, then drag the cross-with-arrow-points across the screen until the screen is divided to your satisfaction.
- d. To remove the Split, click View > Split (again).

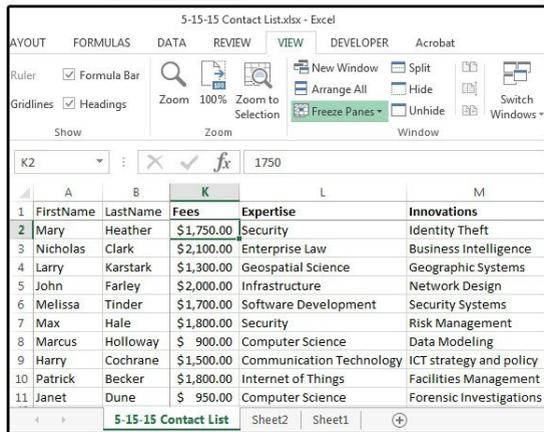
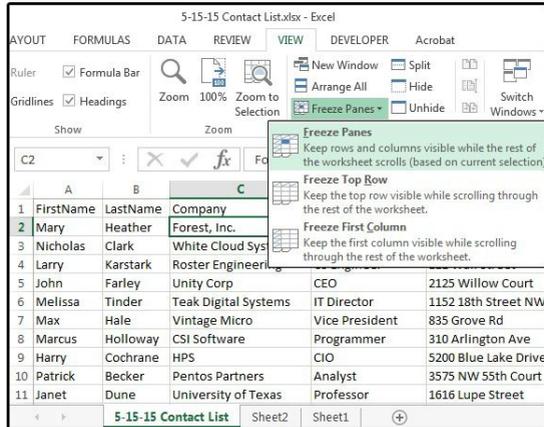


Use **View > Split** to split or unsplit a screen in Excel.

2. Freeze Frames

The other great feature for large spreadsheets is Freeze Frames. People generally freeze frames so they can see the column headers as they scroll down the page, or the first row as they scroll across, as they usually contain the spreadsheet's unique fields such as client name, part number, or item number. Use the following instructions to freeze columns A and B (first and last name) and row 1, the field names (column headers).

- Position your cursor on cell C2.
- Click View > Freeze Frames > Freeze Frames. Notice that Excel inserts a thin line below row 1 and to the right of column B.
- Cursor down, and all the rows scroll up except row 1. Cursor right, and columns A and B are stationary, while the remaining columns move to the left.
- Now when you update the fees in column K, you can see the names of the individuals who owe those fees.



Use Freeze Frames to keep key columns and rows in view.

Note: You can also choose to just Freeze First Row or Freeze First Column.

- To unfreeze frames, click View > Freeze Frames > Unfreeze Frames.

3. Quickly insert or delete columns and rows

Generally, if you want to insert or delete columns and rows, you position your cursor to the right of the column or just below the row

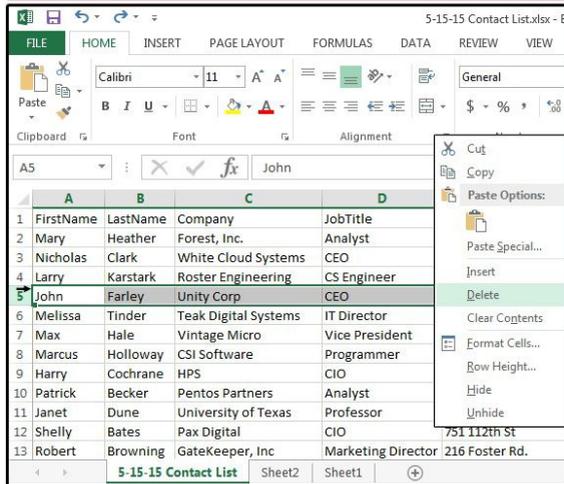
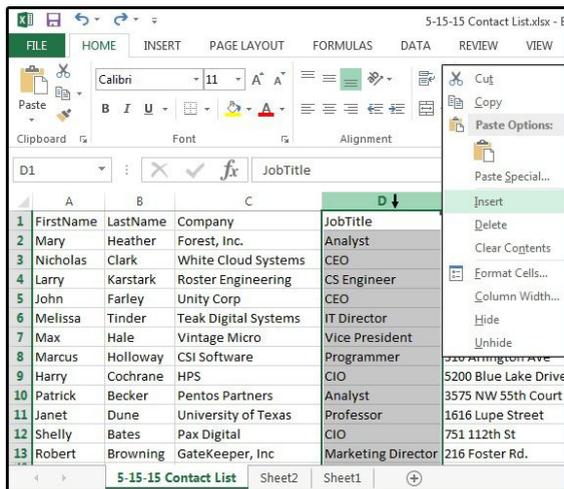
where you want the new column or row inserted (columns insert to the left, and rows insert above, the cursor). For deleting, obviously, you place the cursor on the column or row for deletion.

- a. Next you select Home > Insert > Rows (or Columns). You can also insert cells or additional sheets here. Deleting works the same way: Home > Delete > Rows (or Columns, Cells, Sheet).
- b. Another, quicker way to perform this same function: Position the cursor on the column letter (such as column D) or the row letter (such as row 5), and when the black arrow appears, right-click.
- c. From the drop-down menu select Insert or Delete, and the columns or rows drop in or disappear instantly.

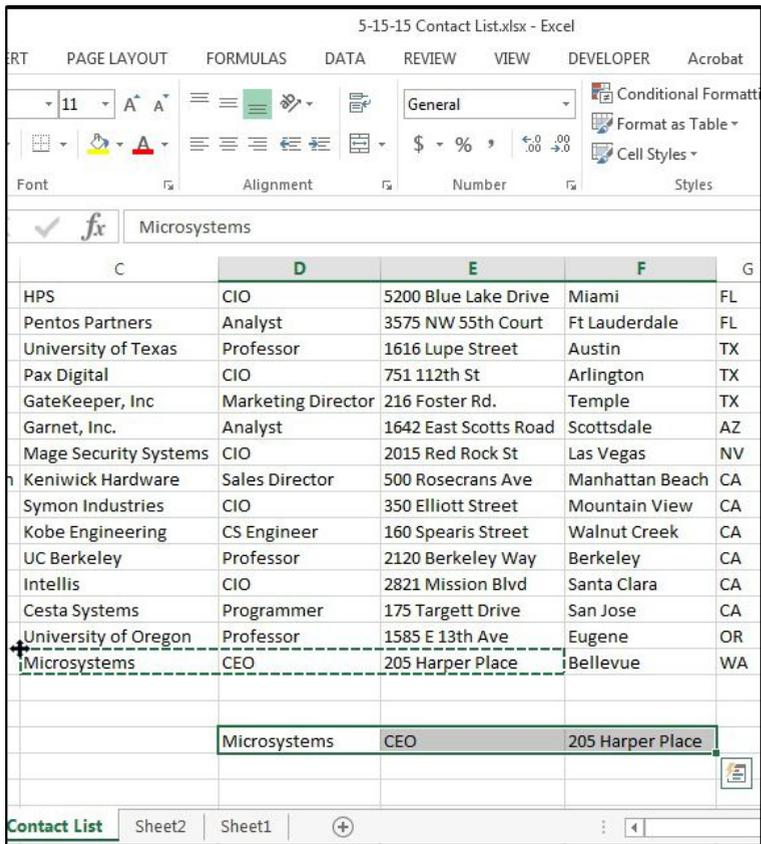
4. Quick Cut and Paste

- a. Move your cursor to one or several cells that contain data you'd like to move, and select those cells.
- b. Position the cursor over the top left corner of the first cell in the range (or the top right or bottom left corner). When the cursor changes to a cross with arrow points, hold down the left mouse button and drag the cells to the new location, then release the mouse button.

Note: You cannot use the bottom-right cell, which has a tiny green square over the corner. This is an access link to the Quick Analysis Tool (whose icon you can see in the image here).



Excel offers some shortcuts for inserting or deleting columns and rows.



Cut and Paste
data quickly
with these
tricks.

5. Format Painter

Format Painter is a great little treasure. You know what a hassle it is to constantly format and reformat cells. Use this feature to do it automatically in seconds.

- a. Move to a cell that contains the format you want to use (such as K2).
- b. Click the Format Painter icon (it looks like a paintbrush) in the Clipboard group under the Home tab.

	K	L	M
		Unformatted	
1	Fees	Cells	Expertis
2	\$ 1,750.00	800	Security
3	\$ 2,100.00	1560.00%	Enterpri
4	\$ 1,300.00	292.8	Geospat
5	\$ 2,000.00	3/5/1902	Infrastru
6	\$ 1,700.00	3551.1	Softwar
7	\$ 1,800.00	612.33	Security
8	\$ 900.00	5893.22	Comput
9	\$ 1,500.00	15189.2	Commun
10	\$ 1,800.00	5595	Internet
11	\$ 950.00	7889.22	Comput
12	\$ 1,500.00	1/12/1910	Security
13	\$ 1,000.00	4958	Marketi
14	\$ 1,600.00	159.68	IT System
15	\$ 1,650.00	696.01	Hardwar
16	\$ 1,100.00	894.23	IT Marke
17	\$ 1,600.00	5/3/1901	Wireles
18	\$ 1,200.00	696.25	CS Engin
19	\$ 900.00	559.22	Virtual P
20	\$ 1,550.00	784.21	Softwar
21	\$ 800.00	596.22	Mobile T
22	\$ 875.00	468.22	Science

	K	L	M
		Formatted	
1	Fees	Cells	Expertis
2	\$ 1,750.00	\$ 800.00	Security
3	\$ 2,100.00	\$ 15.60	Enterpri
4	\$ 1,300.00	\$ 292.80	Geospat
5	\$ 2,000.00	\$ 795.00	Infrastru
6	\$ 1,700.00	\$ 3,551.10	Softwar
7	\$ 1,800.00	\$ 612.33	Security
8	\$ 900.00	\$ 5,893.22	Comput
9	\$ 1,500.00	\$ 15,189.20	Commun
10	\$ 1,800.00	\$ 5,595.00	Internet
11	\$ 950.00	\$ 7,889.22	Comput
12	\$ 1,500.00	\$ 3,665.00	Security
13	\$ 1,000.00	\$ 4,958.00	Marketi
14	\$ 1,600.00	\$ 159.68	IT System
15	\$ 1,650.00	\$ 696.01	Hardwar
16	\$ 1,100.00	\$ 894.23	IT Marke
17	\$ 1,600.00	\$ 489.57	Wireles
18	\$ 1,200.00	\$ 696.25	CS Engin
19	\$ 900.00	\$ 559.22	Virtual P
20	\$ 1,550.00	\$ 784.21	Softwar
21	\$ 800.00	\$ 596.22	Mobile T
22	\$ 875.00	\$ 468.22	Science

Format Painter takes the pain out of formatting large blocks of a spreadsheet.

- c. Cursor to the cell, cells, column, or row that you want to copy that format to—in this case, currency.
- d. Place your cursor—which becomes a fat plus sign with a paintbrush beside it—on the first cell in column L (L2), then drag the highlight down through L22 and release the mouse button.

6. One corner click

- a. Another fast and easy tip that selects the entire spreadsheet, not

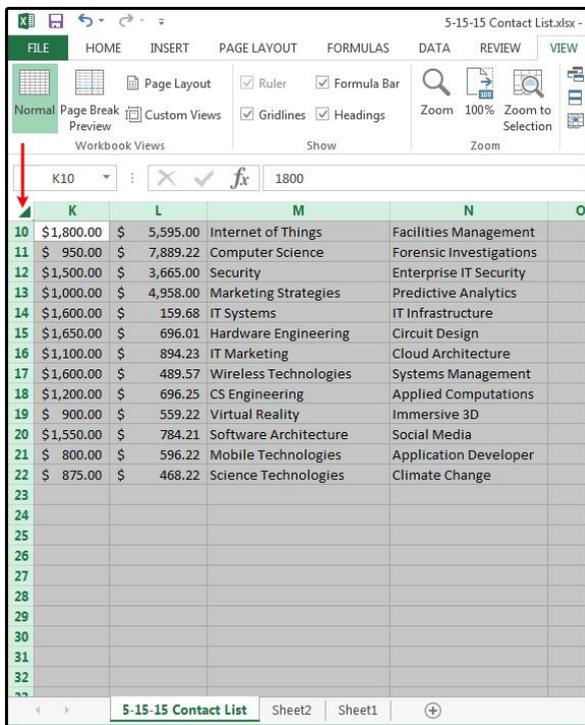
just the cells that contain data, is the small green arrow in the top left corner, between the row numbers and column letters. Click this arrow once, and Excel selects everything, from cell A1 to cell XFD1048576.

- b. Pressing Ctrl-A also selects all, but, in this case, *all* means just the cells that contain data. Press Ctrl+A twice, however, and it selects the entire spreadsheet.

7. Bonus tip: Leading zeroes

And last, for our bonus tip: how to enter numbers with leading zeros, such as zip codes that begin with zeros. Just enter an apostrophe in front of the number; for example: **'02120**.

Notice that now there's a green triangle in the top left corner of every cell where you've made this change. That's because introducing the apostrophe could create problems if you try to use that number in a function or formula, so Excel wants to confirm your intent.

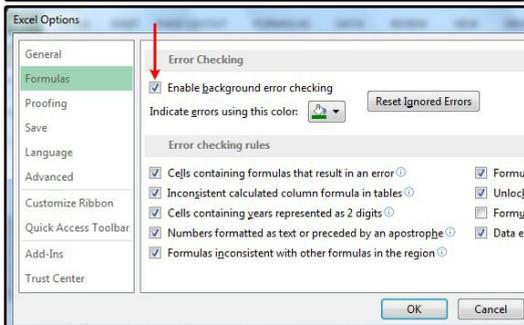
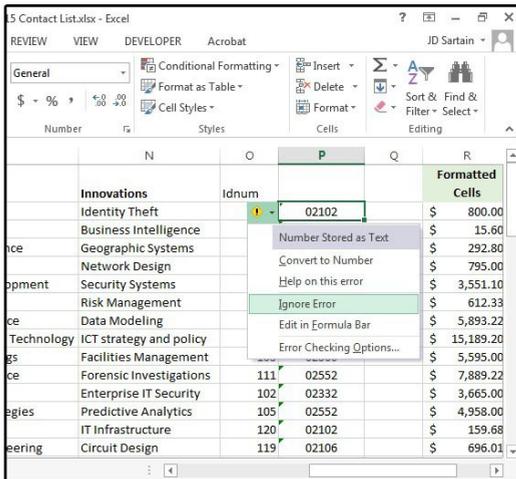


One Corner Click to Select Entire Spreadsheet.

- a. To find out your options, click the green triangle. A warning-sign icon (a yellow diamond with an exclamation point) will appear next to the cell.
- b. Place your cursor on the warning icon, then click the down-arrow that appears on the right side.
- c. Choose Ignore Error from the drop-down menu. Note; however, that this removes the mark only from that specific cell.

- d. To remove all the green triangles in this column, select File > Options > Formulas. Scroll down to the Error Checking section and uncheck the checkmark in the box that says Enable Background Error Checking. And just like that, all the green triangles are gone. 🛑

How to handle leading zeroes in Excel.



Tech Spotlight

A video showcase of
the latest trends



Watch the
video at
go.pcworld.com/iwigig



Intel's WiGig technology: **wireless VR**

legs). We checked out a prototype at E3 2017, and you could start seeing it in retail products within a year.

» Virtual reality could get less awkward with Intel's WiGig technology, which lets you shed the wires that tether you to a PC (or tangle up around your