PCWorld

Microsoft Build's
Biggest Reveals

HoloLens gets some apps, Windows 10 looks ahead to a big update, and much, much more.

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Just because you can't see it doesn't mean it's not there.

Although it's more common in older women, ovarian cancer affects women of all ages, even in their 20s. There is no early detection test, and symptoms can be subtle. But while you can't see it, you can take steps to get ahead of it by knowing your risk factors. Family history of cancer and presence of gene mutations like BRCA are risk factors, so talk to your family and your doctor. This information makes you less likely to ignore vague signs that could indicate disease.

Meanwhile, promising collaborative research will continue to shed light on new advances in diagnosis and treatment of ovarian cancer.

To learn more about symptoms, risk factors and research go to SU2C.org/ovarian

Minnie Driver
Stand Up To Cancer Ambassador

Photo by Martin Schoeller

STAND UP TO CANCER

Ovarian Cancer
Research Fund Alliance

n·o·cc
NATIONAL OVARIAN CANCER COALITION

Stand Up To Cancer is a program of the Entertainment Industry Foundation, a 501(c)(3) non-profit organization.

NEWS

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Microsoft Build's big reveals: The future of Windows, Windows Phone's slumber, and supersmart bots

BY BRAD CHACOS

DEVELOPERS, DEVELOPERS, DEVELOPERS! The ghost of Steve Ballmer past lingers heavily over Microsoft's annual Build conference, but despite ostensibly being an event dedicated to code monkeys, Build's always brimming with consumer-friendly news about the future of Windows, Office, and more. This year was no exception—and it even managed to squeeze in a few eye-opening surprises.

Let's dig in to the biggest reveals from Microsoft Build 2016.

Windows 10 keeps on climbing

A mere four months after announcing that Windows 10 was running on 200 million devices after the holidays, Microsoft's racked up another 70 million new users— Windows 10 is installed on 270 million devices now, the company announced at Build.

Some of those are no doubt due to holiday purchases, and some no doubt stem from Microsoft's heavy-handed upgrade tactics. (In fact, Windows 10 adoption surged in March after Microsoft pushed the upgrade as a recommended update for Windows 7/8 users.) Either way, it's one hell of an impressive number, making Windows 10 the quickest-growing OS in Microsoft's history.
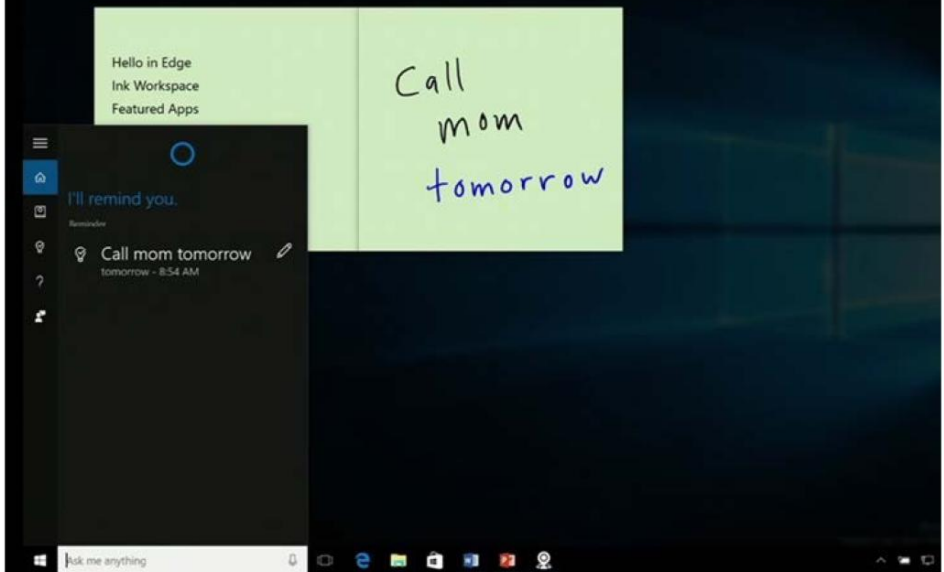
Windows 10 Anniversary Update

The long-rumored Windows "Redstone" now has a name, as Microsoft announced that the far-more-boringly-titled "Windows 10 Anniversary Update" (go.pcworld.com/w10annivupdate) will roll out as a free update to Windows 10 users this summer.

Microsoft didn't talk too much about what's in store, but spent a lot of time showing off the update's new Windows Ink capabilities, which expand on Windows 10's current stylus capabilities. You'll be able to pull up an "ink workspace" with tools and apps that support styli, draw a line between two points and annotate stops in between in Maps, and auto-create reminders based on written notes, for example. It sounds pretty cool.
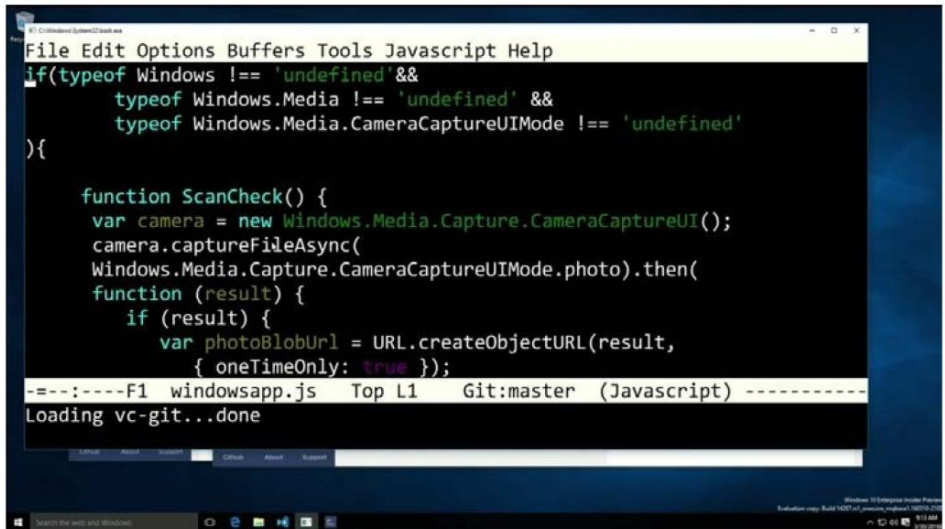
The update extends Windows Hello functionality to Windows Store apps and Microsoft's Edge browser, so you can use biometric authentication to log into apps and services that support the feature. The Anniversary Update will also hit Xbox One, and bring Universal Windows Platform apps along with it.

Oh, and…

Hell freezes over

…the Anniversary Update will bring Linux's legendary Bash shell command (see page 39) to Windows 10. Not emulated or in a virtual machine, either. Microsoft partnered with Canonical to bring native Ubuntu Linux binaries into Windows. This is the real deal, folks—and it's starting to look like Microsoft's love affair with Linux is more than mere dabbling.

Check out *World Beyond Windows* columnist Chris Hoffman's deep dive into Bash on Windows 10 (go.pcworld.com/w10hhbashshell) for full details on how Microsoft and Canonical performed this dark magic.
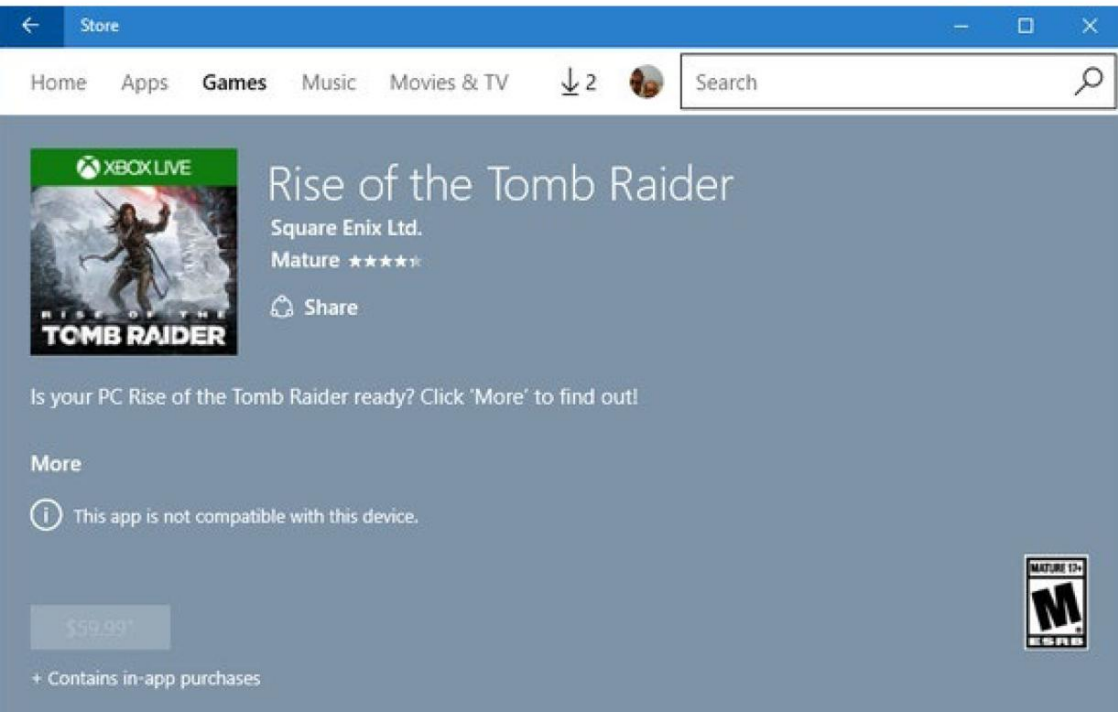
PC gaming concerns

Beyond bringing the Windows 10 Anniversary Update to Xbox, Microsoft's listening to PC gamers concerned with the nerfed Windows Store situation, too. Xbox boss Phil Spencer took the stage to say that Windows Store apps have already begun supporting PCs with multiple graphics cards, with FreeSync and G-Sync support scheduled for May. You'll also be allowed to disable V-Sync in Windows Store games at that time.

The timeline for support for mods, full-screen game usage, and overlays like FRAPS is murkier, but Spencer says they'll all be addressed in the coming months. Microsoft's also adding bundles, season passes, and preorders are coming to the Windows Store.

Universal Windows Platform

Microsoft's also rolling out a new conversion tool that transforms Win32 (read: traditional desktop) software—including games—into the Universal Windows Platform (UWP) apps, with support for Live Tiles, automatic updating through the Windows Store, and more.

   That's a big deal, and some big-name native UWP apps (go.pcworld.com/uwpapps) are on the way, as well. Microsoft said Facebook's working on universal apps for Instagram, Messenger, and Facebook main, in addition to much-needed banking apps from American Express and Bank of America.
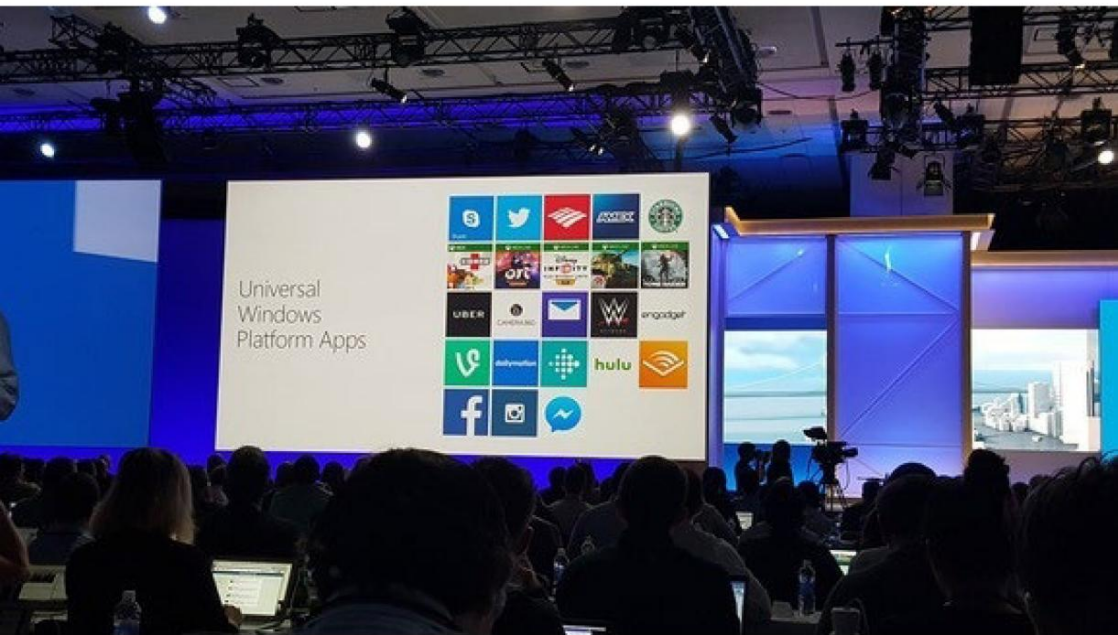
Buh-bye, bit rot

Microsoft's had a tough time convincing users that universal Windows apps are superior to traditional desktop programs, but in a supplementary session at Build, the company talked about a UWP feature that PC enthusiasts should love. Unlike traditional software, universal apps won't suffer from "bit rot" (go.pcworld.com/ uwpappsbitrot) and slow down your PC over time. Could the days of clean installs be behind us?

"A big part of [bit rot], especially on the boot time," Jason Ronald, the principal group program manager of Microsoft Game Studios, explained, "is what people refer to as 'registry bloat.' That's because each time you load a traditional Win32 .EXE application, the registry file within a PC grows and grows."

Universal Windows apps won't be subject to those same conditions, Microsoft says, which means your PC should feel faster, longer.

Xbox's first universal Windows apps

Speaking of apps, Microsoft revealed some of the first universal Windows apps for Xbox One (go.pcworld.com/xboxunivapps) when the Anniversary Update arrives later this summer. Look for Nickelodeon, Dailymotion, NASCAR, and Hulu to launch Xbox versions when the new, singular marketplace hits and makes universal Windows apps even more universal.

HoloLens ships to developers

One of the big draws of universal apps is that they run on any Windows 10–powered platform: PCs, phones, Xboxes, Raspberry Pis, you name it. Another one is about to enter the fray.

After more than a year of teasing and invite-only preorders, the $3,000 HoloLens Dev Edition (go.pcworld.com/hololensships) augmented reality headset has started shipping to developers. We managed to sneak an extensive peek (see *HoloLens Uncensored* on page 23) at the HoloLens Dev Edition early, along with a look at 8ninth's absolutely wild part physical, part virtual holographic desk of the future (go.pcworld.com/holofuturedesk). Check 'em out!

Cortana improvements

Cortana, the personal digital assistant baked into Windows 10, is about to get more powerful and even easier to converse with. Microsoft's building more utility and contextual awareness (go. pcworld.com/contextualaware) into Cortana, including more proactive actions where she offers to perform tasks without even being prompted, and putting it all at your beck and call with powerful natural language tools.

A quick pair of demos by Marcus Ash, the group product manager for Cortana at Microsoft, drove home how useful the new skills can be. In one, he asked Cortana to "send [a colleague] the PowerPoint that I worked on last night." This seemingly simple command is actually deceptively complex; to fulfill it, Cortana has to know what PowerPoint document Ash was talking about, when he was using it, and who the colleague is. Powerful stuff. In another, he asked Cortana "What toy store did I visit during last year's Build?" to summon a location.

Microsoft didn't say when the new features are rolling out, but smart money's on the Windows 10 Anniversary Update's launch.
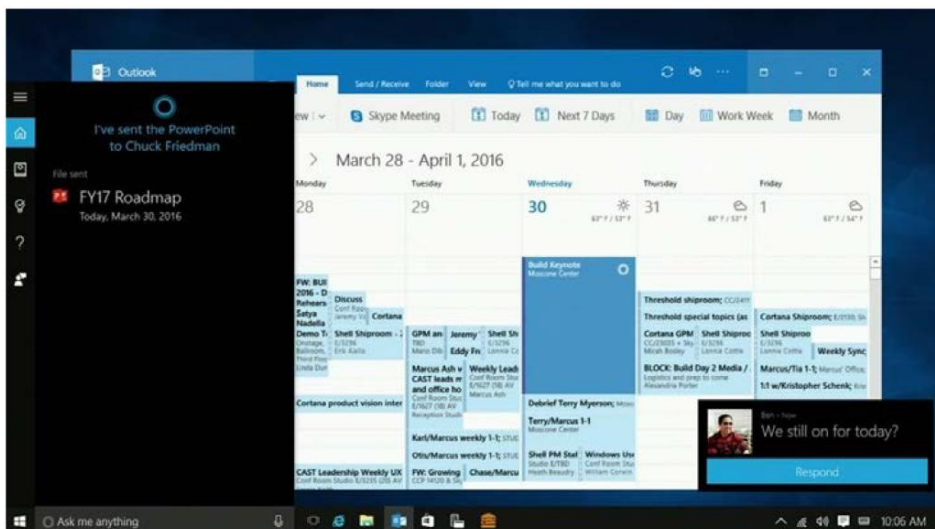
Conversations as a platform

But Cortana's only the beginning. Microsoft CEO Satya Nadella revealed "Conversations as a platform" at Build—an audacious vision of a future filled with personal digital assistants and smart bots that tap into machine learning to organize our lives, all via natural language conversations. Cortana could automatically connect you with a hotel's bot in Skype to arrange a reservation, for example, then follow that up with the unprompted suggestion to arrange a hook-up with a friend who lives in that town.

You'll want to read our full "Conversations as a platform" coverage (go.pcworld.com/winsmartbots) to get all the details. It's a pretty awesome idea, and one that plays into Microsoft's strengths in cloud computing and consumer products. Microsoft's already launched a series of frameworks, APIs, and the Cortana Intelligence Suite for developers to tap into Cortana and create bots of their own.

Skype bots

You may not need to wait long to experience the potential of Microsoft's Conversations vision. The company hopes to infuse Skype chats with artificial intelligence in the future, and it's releasing an updated version of the Skype mobile app (go.pcworld.com/skypebots) with support for bots today. Developers, start your engines.

Review   Tell me what you want to do

Address Check   Attach Attach Signature   Assign   Follow Up ▼   Office   Send   Remind Send Suggest   Share Availability
Book   Names   File ▼   Item ▼   Policy ▼   ! High Importance   Add-ins   eGift   Me   Later ▼   Times   • Open Boomerang
                                        ↓ Low Importance

Boomerang Ribbon Demo-Boomerang   ✕

☑ if there is no reply

in 4 hours	tomorrow morning	tomorrow afternoon
in 2 days	in 4 days	in 1 week
in 2 weeks	in 1 month	random

At a specific time: *(e.g. Monday 9am, Aug 11 3pm PDT)*

Office Ribbon apps

And while those engines roar, devs, turn your attention to Office. At Build, Microsoft announced that Office's interface is becoming a platform all its own, and users will be able to add apps to the Ribbon itself (go.pcworld.com/appstoribbons), making them look and feel like a natural part of Outlook, Excel, PowerPoint, and Word.

In a demo of the potential usefulness of Office Ribbon apps, a service called Boomerang coded menu options (pictured above) that allow users to quickly compare calendars and schedule meetings, all using native Office dialogs. This sort of extensibility feels like it could evolve into a powerful future for Office over time—assuming developers get on board.

Goodnight, Windows Phone

Finally, what wasn't talked about at Build proved just as momentous as all the new stuff. Windows Phone's no-show (go.pcworld.com/winphonesnoshow) demonstrated Microsoft's mobile neglect yet again, and after the keynote, Windows chief Terry Myerson confirmed that while the mobile OS isn't dead, it's definitely on ice (see page 41).

"We're going to do some cool things with phones, but this year phones are an important part of our family but not the tip of the spear," Myerson told The Verge. Phones, he said, "is the wrong place for us to lead."

That must feel like a slap in the face to anybody who plopped down good money for a Lumia 950, but on the bright side, if Microsoft manages to coax developers into creating universal apps, Windows Phones should still see the benefits—even if the core OS stagnates.
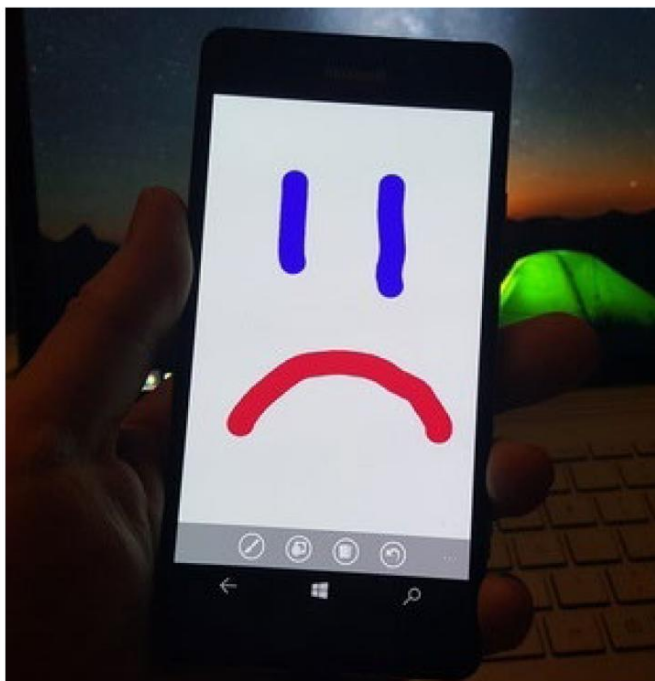
What can I do now?

Cortana <3 Android

But hey, Microsoft didn't neglect mobile entirely. Cortana will soon be able to pull your Android phone notifications over to your Windows 10 PC (go.pcworld.com/w10syncandroid), and even let you dismiss or reply to them—assuming you have Microsoft's Cortana app for Android installed, of course. The same feature won't be available with the iOS version of Cortana, as Apple's mobile ecosystem is much more restrictive.

   Look for Cortana's cross-platform notifications to land in a "future version of Windows"—presumably this summer's Anniversary Update. ⏻

HoloLens uncensored: A candid hands-on with HoloLens Development Edition

BY MARK HACHMAN

IT FEELS LIKE an undercover operation: While Microsoft executives are rehearsing their keynote presentations for Microsoft Build 2016, I am in a hotel room next door to the conference venue, testing out what everyone is coming to see: the HoloLens Development Edition.

This is actually the third time I've gone hands-on with HoloLens hardware, and it is clear Microsoft has used the last 15 months of HoloLens development to craft a remarkably polished experience.

Microsoft has already detailed some of the amazing games and apps (go.pcworld.com/hololensapps) that will ship with the HoloLens Development Edition, but this time I demoed something new: a proof-of-concept HoloLens business app for Citi created by a company called 8ninths. (I'll cover this experience in detail in an future article.) Microsoft plans to let Build attendees use the HoloLens to virtually walk on Mars and play with Actiongrams (go.pcworld.com/hololensactiongrams), but now I get a chance to boot up the HoloLens and try it out in much less controlled conditions: in the real-world confines of a hotel room. Sans Microsoft employees.

The best part: I don't feel the faintest hint of nausea while using the HoloLens. That alone might convince VR holdouts to try augmented reality instead.

Just spin the wheel to tighten or loosen the Microsoft HoloLens. A power button is to the left, and an RFID tag (for security) is to the right.

Surprisingly comfortable

What's new in the HoloLens? There's one major improvement that many may never notice: Previous versions required you to dial in your inter-pupillary distance to ensure that the HoloLens didn't make you dizzy. But now that's apparently handled automatically.

Physically, the HoloLens remains virtually unchanged. It still resembles a hard plastic sun visor with a pair of sunglasses mounted in front. At just over one pound, I find it surprisingly comfortable to wear. You'll need to tighten a small dial in back to ensure that its gently padded headband rests on the brim of your head. And don't let the weight dip down on your nose, as it can squeeze your holographic field of view down to a narrow wedge. But you can also tip the visor hinge down at an angle if you need to.

As before, the HoloLens includes two sets of buttons. The left buttons control the brightness of the holograms, while the right buttons control audio volume. The HoloLens places a pair of small, surround-sound speakers next to your ears. The volume is loud enough to mostly drown out other sounds, but soft enough so that I can tell other people in the room are talking. That's augmented reality in a nutshell, really.

Two pairs of buttons adjust the Microsoft HoloLens hologram brightness, and volume.

Keep the lights down low

Virtual reality (like Oculus Rift) surrounds your head in a bubble of digital data. Augmented reality, meanwhile, superimposes holograms over the real world. Nonetheless, with the HoloLens it still helps to keep the shades drawn. Indeed, the HoloLens' holographic images wash out when I view them against pale walls.

What's more, when we opened the drapes to get more light in the room, the HoloLens suddenly freaked out, crashing the app we were using. No one in the room was quite sure why that happened, but it suggests that the HoloLens is going to be an indoor toy. If nothing else, this version may be unable to accommodate a sharp change in lighting.

Viewed against a dark background, the HoloLens holograms shown beautifully, though I would have preferred just a bit higher resolution. Colors pop and seem to be rendered accurately. I notice a tiny bit of hazing, which helps indicate which portion of my screen could render holograms.

> Viewed against a dark background, the HoloLens holograms shown beautifully, though I would have preferred just a bit higher resolution.

Last May, I criticized Microsoft for shrinking down its HoloLens field of view to about the size of a welding mask—or a smartphone held a few inches away from one's face. But David Dedeine, a key HoloLens developer, has waved away the field of view issue as largely irrelevant (go.pcworld.com/hololensar), and I'm now inclined to agree with him.

The limited field of view becomes annoying when there's a large virtual object in front of you, and you can't see it in its entirety. Ditto when you've forgotten where a virtual object "is" simply because you can no longer see it. But, otherwise, the limited field of view didn't emerge as a problem during my demo. It's like how you don't get annoyed when you can't see a picture hanging on the wall behind you. You know it's still there, and if necessary you can turn your head to find it.

It's the same Windows 10 you're used to

Using the HoloLens is like riding a bike: It's surprisingly familiar, even a

year later. A small virtual pixel that's always in the center of your gaze serves as a "cursor." Look at an icon, and click with an "air tap"—hand forward, index finger up, then index finger down. (Just make sure that you look at your hands while doing so, to ensure the HoloLens "sees" your fingers making the gesture.) Maybe it's just my experience using the device, but the HoloLens records almost all of my taps correctly.

You can also navigate by voice, and it's here that the HoloLens' incredible sensitivity works against it. Because it's a collaborative device, the HoloLens tends to respond to anyone's voice. You literally have to watch what you say to avoid launching an app inadvertently.

If you want to return to the Start menu, just mime the "bloom" gesture—palm up, fingers together, then fingers open. And then you're back to Start.

You may have seen pictures of the Start menu. On top, there's a clock and battery indicator, and an array of tiled applications that you can configure. The tiles don't appear to be "live," though, as they don't display information or rotate. I try out Cortana, but the HoloLens struggles with the hotel's Wi-Fi connection. Unfortunately, I don't have a chance to explore the Settings menu.

Otherwise, though, Microsoft has apparently used the headset's 64GB of onboard storage to full effect. *HoloTour,* which Microsoft has never showed off before, is another app from Asobo, the same

developer that wrote *Young Conker* and *Fragments*. Think of *HoloTour* as Google Earth with a twist: While you explore the globe, you do so from a virtual perspective, with VR views of Machu Picchu and other famous sights available at a click.

I want to see more of these HoloLens apps!

I doubt that the HoloLens will ship with every cool app I've seen during demos, such as *RoboRaid, Young Conker,* and *Fragments*. But the good news is that these apps deliver much more than I ever expected.

HoloLens apps and games load quickly enough, but you'll still have to factor in physical setup: Chances are that you'll be seated in a different position every time you use the headset, so you'll need to "scan" the room with the HoloLens so that it can recognize which physical objects it can interact with. I can see that getting old, fast.

Every time you scan a room into a playspace, you'll need to walk around, "painting" the walls, furniture, floor, and ceiling with a layer of blue tiles that indicates that the area has been scanned. (Asobo's

The Microsoft HoloLens needs to "scan" the room with its camera to create the levels for the game.
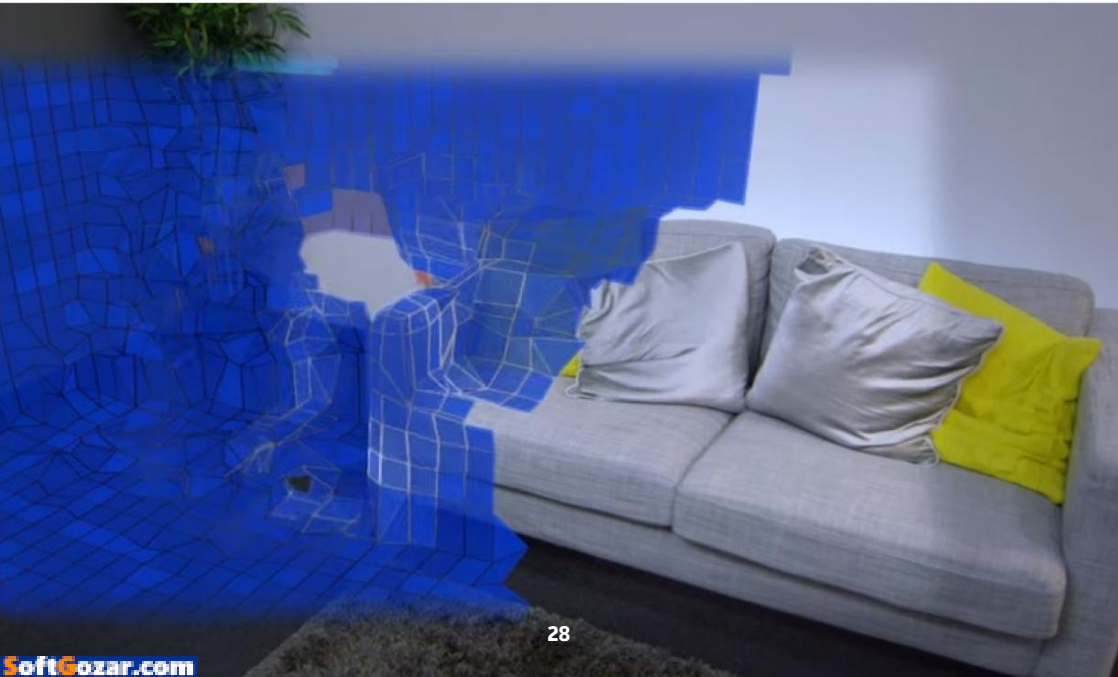
Dedeine lays out the process: go.pcworld.com/hololensDedeine, together with the maximum dimensions of the playspace.) The whole process takes about a minute, though it's a long minute if you just want to scan an entire playspace for a game. But virtual objects can also be quickly pinned to physical objects, so don't expect every app to be like this—just physical-space intensive games and other apps.

The *Conker* app, however, plays it smart, as you can "save" a playspace to the HoloLens. Otherwise, a chirpy voice advises you to "look behind the furniture!" to scan in everything. I can tell you that the HoloLens holograms reached from the window to the front wall, which I'd estimate at about 18 feet or so.

Really, it all looks great. I can't help but wonder if the only thing holding back the HoloLens from a consumer launch is Microsoft's determination to back the HoloLens with a suite of apps so robust that it will make consumers forget all about Windows phones.

In any event, I can't tell you—yet—what it's going to be like to watch a movie on a "100-inch holographic" screen, as Microsoft promises at Build. I can tell you, however, that the first time a squirrel hops out of a zippered "pocket" on your wall, you're going to absolutely flip out. ⏻

I can tell you, however, that the first time a squirrel hops out of a zippered "pocket" on your wall, you're going to absolutely flip out.

Eat your heart out, quad-cores, Intel just dropped a 22-core CPU on us. Boom!

BY GORDON MAH UNG

THINK YOUR EIGHT-CORE PC is cool? Not anymore. Intel is turning loose a 22-core monster of a CPU, dubbed the Xeon E5-2600 V4.

   The CPU's 22 count is made up of Broadwell cores, which when combined with Hyper-Threading, amounts to no fewer than 44 threads in a single-socket computer. On a dual-socket machine, you're looking
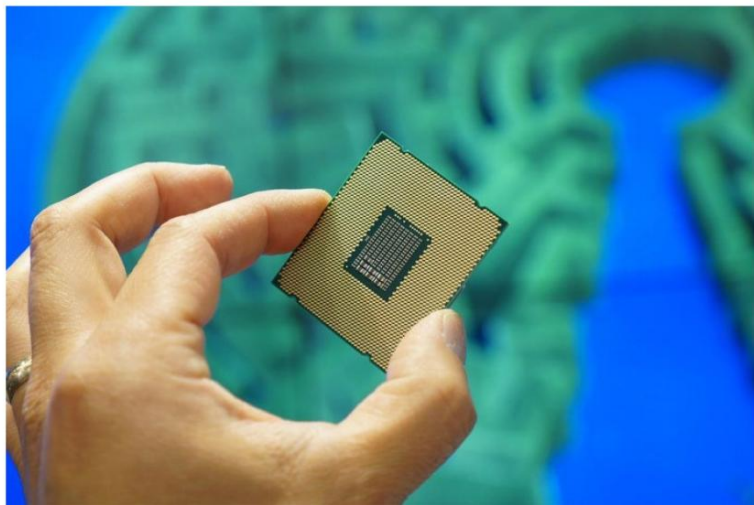
This is the back of a 22-core, 44-thread Intel Xeon E5-2699 v4 chip. Cost? Just $187 per core.

at 88 threads in a workstation. Yes, cue Johnny Dangerously joke here.

The new Xeon E5-2600 V4 hasn't shown up on Intel's ARK product list (ark.intel.com) yet, but the top-end part with 22 cores is the Xeon E5-2699 V4 with a base clock speed of 2.2GHz, 55MB of cache, and a TDP that isn't that crazy at 145 watts. An enthusiast eight-core Haswell-E has a TDP of 140 watts, but runs at 3GHz and supports overclocking.

The price? A cool $4,115. That works out to $187 per core. The same eight-core Core i7-5960X at $1,059 is $132 per core—what a deal, right? The new Xeon series supports DDR4/2400 and up to 12 DIMMs per CPU socket. With registered modules that means 385GB of RAM per chip using 32GB DIMMs.

OK, so you're thinking this doesn't apply to you, Jane or Joe Consumer. But high-core-count Xeons have historically found their way into all kinds of consumer machines.

The Falcon Northwest Tiki (go.pcworld.com/falconnwtiki) I reviewed last year, in fact, featured a Xeon part in an Xbox-sized form factor. The Tiki's Xeon, however, had a piddling 18 cores, based on Haswell.

Xeons are also relevant to the prosumer crowd. Apple's Mac Pro line,

for instance, has long offered core-laden Xeons, as have Boxx's workstations (go.pcworld.com/boxxapexx5).

For the most part though, Intel's big news impacts data centers more than desktop PCs.

"More processor cores are valuable in the data center as long as they have enough memory bandwidth and are big enough to get a lot of work done. This is because workloads can either be virtualized or containerized, which take advantage of multiple cores," said Patrick Moorhead, principal analyst with Moor Insights & Strategy. "On the PC front, we've really moved to accelerated computing where a lot of the heavy lifting, particularly in gaming, VR, and in workstation workloads is being put on the GPU. The CPU is still very important in PCs, but not necessarily one with a ton of smaller cores."

Still, Intel is rumored to be introducing a consumer-focused Core i7 chip later this year with 10-cores under its lid. Code-named Broadwell-E, the chip is expected to work with many existing X99 motherboards and, for the first time, give consumers a 10-core option.

AMD's Zen due later this year is also expected to push the thread and core count, with the chip apparently packing up to 32 cores. With AMD's pivot to support a Hyper-Threading–like approach with Symmetrical Multi-

Intel's Xeon E5 v4 server chips have up to 22 cores.

SoftGozar.com
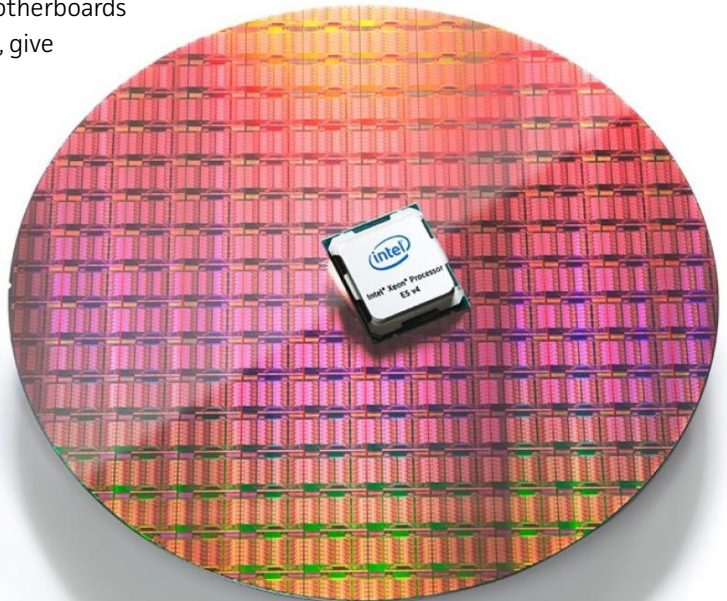
Threading, the Zen CPUs would effectively have 64 threads.

The highest-end Zen isn't likely to be a consumer CPU, but it does appear to signal a looming battle, with thread count (necessary or not) being the carrot to lure consumers to new computers.

Moorhead's not convinced: "I do believe we will see a core and thread war between Intel and AMD, but only in the data center and only with medium-size cores and above."

Why this matters, or not: Does the average consumer really need 22 cores? No. In fact, most people don't even need a quad-core machine. That's starting to change as DirectX 12 games lean more heavily on cores, but even still, you can simply appreciate this for what it is: an awesome amount of compute cores packed into a CPU. ⏻

Who doesn't need a 22-core CPU?

Acer's aluminum Chromebook 14 blends high-end features with a budget-friendly price

BY IAN PAUL

HELLO, BEAUTIFUL. Acer revealed its first-ever 14-inch Chromebook—the aptly named Chromebook 14 (go.pcworld.com/acerchromebook14)—on recently and it sure seems like it was worth the wait (at least on paper). The Google-licious laptop only costs $300, but offers premium touches missing from the majority of the plastic-clad Chromebook army,

like an aluminum chassis, USB 3.1 ports, a trim sub–4 lb. weight, and a whopping 14-hour battery life claim.

That luxuriousness extends to the display. The Chromebook 14 comes in two main versions with either a 1080p or 1366 by 768 resolution IPS display. The 1080p models feature a punier 12-hour battery-life claim, but on the other hand, 1080p IPS displays are a relative rarity among Chromebooks. Processor-wise, the Chromebook 14 comes with either a quad- or dual-core Celeron processor. Acer didn't specify what the quad-core version would be, but the dual-core is the 1.6GHz Celeron N3060.

The Chromebook 14 also comes with two USB 3.1 ports (Type A), HDMI out, a 720p webcam, dual-band 802.11ac Wi-Fi, 16GB or 32GB onboard eMMC storage, and either 2GB or 4GB of RAM.

Acer has yet to specify an exact ship date for all the Chromebook 14 models. In April, Best Buy will start carrying what Acer calls the "premiere model" priced at $300. This version features 32GB of storage, 4GB of RAM, a 1080p display, and a dual-

> The Chromebook 14 comes in two main versions with either a 1080p or 1366 by 768 resolution IPS display.

core processor. If Best Buy isn't your thing, the model is also available right now for pre-order on Amazon.

The impact on you at home: Acer's new Chromebook isn't groundbreaking, but it's a great addition to the midrange of the Chromebook world—especially for business users. Dell's Chromebook 13 was released in 2015 and was a solid choice for business users since it offered solid design and a mix of price ranges and features. But Dell's Chromebook suffers from an almost ThinkPad-like bookishness in its design, while Acer's laptop has style inspired by laptops like the Chromebook Pixel and Apple's MacBook line. It's also got a nice price at $300 for the "premiere model," stuffed with almost everything you'd want in a top model Chromebook without going overboard. ⏻

Intel's face-meltingly fast new SSDs are its first with cutting-edge 3D NAND

BY AGAM SHAH

INTEL PROMISED SUPERFAST and high-capacity SSDs with 3D NAND chips last year, and the company announced the first of those drives at the end March.

The new SSDs stand out for blistering speed, but top out at 2TB of capacity, which may be a disappointment to some customers considering the drives could potentially hold up to 10TB.

The new lineup of SSDs with 3D chips includes the SSD DC P3320, SSD DC 3520, and SSD DC D3700 and D3600. The SSDs are targeted at data centers, workstations, and storage arrays.

Intel remains far behind rival Samsung, which earlier announced the PM1633a SSD, which has 15.36TB of storage. The Samsung drive also uses 3D NAND chips.

The Intel SSDs were built more for speed, durability, and reliability, which is a priority for enterprises, Intel said.

Intel uses 3D NAND flash from Micron, which started shipping (go. pcworld.com/intelmicron) the chips last February. The 3D NAND flash has more density because storage cells are layered on top of each other, an improvement from current SSDs in which flash chips are placed next to each other. The storage chips are also closer, making SSDs faster.

The SSDs also plug into PCI Express 3.0 slots, which are faster than conventional SATA slots. The PCIe storage protocol is formally called NVMe (Non-Volatile Memory Express).

Intel estimates its SSD DC P3320 is significantly faster than conventional SATA SSDs. The SSD will come with up to 2TB capacity.

The SSD has a random read speed of 365,000 input-output per second, which is five times faster than the company's older SSD DC S3510. The random write speed is 22,000 IOPS, which is 1.4 times faster. The sequential read speed is up to 1600 megabytes per second, 3.2 times faster, and the write speed is 1,400 megabytes per second, which is 3.1 times faster.

The price for the SSD DC P3320 wasn't immediately available, and it will ship in the second quarter.

The other SSDs include SSD DC D3700 and D3600, which can take advantage of two PCIe ports to boost SSD speeds. That's similar dual-port SAS (serial-attached SCSI) ports in storage devices.

Those SSDs have random read speeds of up to 470K IOPS, which is 3.9 times faster than comparable dual-SAS drives, and random write speeds of 95,000 IOPS. The sequential read speed is 2,100 megabytes per second, which is 1.8 times faster, and write is 1,500 megabytes per second, which is two times faster.

Intel also introduced the SSD 540s drives for thin and light laptops. Drives with up to 1TB capacity will be available in the 2.5-inch and the smaller m.2 form factors. Intel didn't provide prices or shipment dates.

> The SSD has a random read speed of 365,000 input-output per second, which is five times faster than the company's older SSD DC S3510.

Hell freezes over: Microsoft and Ubuntu bring Linux's Bash shell to Windows 10

BY BRAD CHACOS

MICROSOFT'S LINUX LOVE affair continued at the company's annual Build keynote, with the revelation that popular Linux command-line tool Bash is coming to Windows 10. Whoa.

And no, it's not running in a virtual machine, Cygwin, or an emulator. Microsoft partnered with Canonical, the company behind the popular Ubuntu Linux distribution, to build native Ubuntu binaries directly into Windows 10 that allow Bash to run. And Microsoft's already brought SQL Server (go.pcworld.com/sqllinux)

and Visual Studio (go.pcworld.com/visualstudiolinux) to Linux, and embraced Red Hat (go.pcworld.com/redhatlinux) for Azure services—this commitment to open-source is starting to look pretty darn serious.
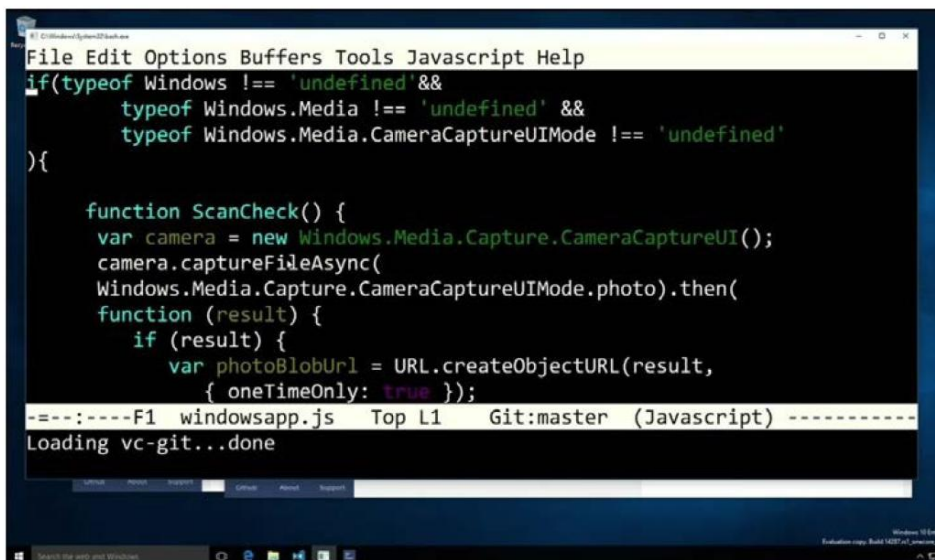
The blog of Microsoft employee Scott Hanselman provided more details about Bash integration than the brief demonstration onstage.

"This is a genuine Ubuntu image on top of Windows with all the Linux tools I use like awk, sed, grep, vi, etc.," he wrote. "It's fast and it's lightweight. The binaries are downloaded by you—using apt-get—just as on Linux, because it is Linux. You can apt-get and download other tools like Ruby, Redis, emacs, and on and on. This is brilliant for developers that use a diverse set of tools like me."

Developers will be able to write .sh Bash scripts in Windows, and even use emacs to edit code.

Look for Windows 10's newfound Bash integration to land with this summer's free Windows 10 Anniversary Update. You'll need to enable Windows 10's Developer Mode and add the feature in order to use it. In the meantime, hit up Hanselman's blog (go.pcworld.com/hanselmanbash) for more details. ⏻

Bash in Windows 10

Microsoft puts Windows Phone on hold

BY MARK HACHMAN

WELL, NOW WE KNOW why Microsoft's Windows Phone didn't appear during Microsoft's Build keynote: it simply isn't on Microsoft's radar screen at the moment.

The question, of course, is whether it will ever be again.

"We're going to do some cool things with phones, but this year phones are an important part of our family but not the tip of the spear," Windows chief Terry Myerson told The Verge.

Phones, Myerson added, "is the wrong place for us to lead."

Why this matters: Myerson's comments have to feel like a bit of a slap at those dedicated Lumia phone fans who have stuck with the company's products through thick and thin. Those numbers are dwindling, however: Holiday sales for Lumia devices plunged to about half that of the year prior, and by now,

most everyone knows that Windows phones have about a one percent share of the worldwide smartphone market. Microsoft said it would close its Lumia Voices Twitter account.

At Microsoft, 'devices' equal Surface, HoloLens

Instead, Myerson said, look for Microsoft to concentrate its hardware engineering powers on devices like the Surface as well as the HoloLens. And you can't argue with that; Microsoft has begun shipping its $3,000 HoloLens Development Edition, and those developers were lined up to try it out as well as a special Destination: Mars app, designed by NASA and featuring astronaut Buzz Aldrin.

If there was anything else to glean from Myerson's comments, it's that he referred to the phone as a "4-inch" screen—the dimensions of the Apple iPhone SE, but relatively smaller than the Lumia 950 and most other larger phones and "phablets." Could Microsoft be thinking of a return to ultraportability in the phone market, replacing the larger screens with something like a HoloLens? It seems like a ridiculous idea, especially with a rumored Surface phone waiting in the wings. But with such a minuscule market share, Microsoft may be thinking outside the box. ⏻

> Could Microsoft be thinking of a return to ultraportability in the phone market, replacing the larger screens with something like a HoloLens?

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This nasty ransomware overwrites your PC's master boot record

The ransomware is distributed by emails masquerading as job applications

BY LUCIAN CONSTANTIN

IT'S HARD ENOUGH for non-technical users to deal with ransomware infections: understanding public-key cryptography, connecting to the Tor anonymity network and paying with Bitcoin cryptocurrency. A new malicious program now makes it even more difficult by completely locking victims out of their computers.

The new Petya ransomware overwrites the master boot record (MBR) of the affected PCs, leaving their operating systems in an unbootable state, researchers from antivirus firm Trend Micro said in a blog post (go.pcworld.com/petyatrendmicro).

The MBR is the code stored in the first sectors of a hard-disk drive. It contains information about the disk's partitions and launches the operating system's boot loader. Without a proper MBR, the computer doesn't know which partitions contain an OS and how to start it.

Trend Micro researchers say Petya is distributed through spam emails that masquerade as job applications. This suggests that its creators target businesses in particular, with the messages being directed at human resources departments.

The emails have a link to a shared Dropbox folder that contains a self-extracting archive posing as the applicant's CV and a fake photo. If the archive is downloaded and executed, the ransomware is installed.

The malicious program will rewrite the computer's MBR and trigger a critical Windows error that causes the computer to reboot—a condition known as a Blue Screen of Death (BSOD).

Following this initial reboot, the rogue MBR code will display a fake Windows check disk operation that normally occurs after a hard-disk error, according to computer experts (go.pcworld.com/petyableepingc) from popular tech support forum BleepingComputer.com.

> The malicious program will rewrite the computer's MBR and trigger a critical Windows error that causes the computer to reboot—a condition known as a Blue Screen of Death (BSOD).

During this operation, the ransomware actually encrypts the master file table (MFT). This is a special file on NTFS partitions that contains information about every other file: their name, size, and mapping to the hard-disk sectors.

Petya does not encrypt the file data itself, which would take a long time for an entire hard drive, but by encrypting the MFT the OS will no longer know where the files are located on disk. The file data can still be read with data recovery applications, but rebuilding the actual files would likely be a lengthy and inexact process, especially in the case of fragmented files that are spread across different storage blocks in different regions of the disk.

After the MFT encryption is done, the rogue Petya MBR code will display the ransom message accompanied by a skull drawn in ASCII characters. The message instructs users to access the attackers' decryption site on the Tor anonymity network and provides them with a unique code that identifies their computer.

The price for the key required to decrypt the MFT is 0.99 bitcoins (BTC), or around US$430.

The price for the key required to decrypt the MFT is 0.99 bitcoins (BTC), or around US$430.

For now, the Petya spam campaign was seen targeting companies from Germany, but there's no guarantee that it will remain localized. In fact most ransomware attacks begin in a country or region and then grow to a global scale as the attackers gain more resources. ⏻

US has asked Apple, Google to help unlock devices in more than 70 cases

BY IAN PAUL

U.S. GOVERNMENT AGENCIES have filed more than 70 orders requiring Apple or Google to help law enforcement agencies unlock mobile devices since 2008, despite the agency insisting its fight with Apple in a recent terrorism case was limited in scope.

The Department of Justice dropped its California case against Apple after the FBI found a way (go.pcworld.com/fbi) to break into one of the San Bernardino shooters' iPhone without assistance.

The U.S. Department of Justice is demanding assistance to unlock mobile devices from Apple or Google in more than 60 cases, according to information from the American Civil Liberties Union. CREDIT: ACLU

But the American Civil Liberties Union has identified 64 cases where representatives of the DOJ have filed All Writs Act orders seeking assistance from Apple or Google to unlock mobile devices. The ACLU's numbers are on top of 12 cases identified by Apple lawyer Marc Zwillinger in mid-February, the group said.

The DOJ and FBI insisted their efforts to require Apple to help them break into an iPhone in the San Bernardino shootings was "just about that one case," ACLU lawyer Eliza Sweren-Becker wrote in a blog post (go.pcworld.com/fbimap). "Even though the FBI no longer needs Apple's help in that case, the FBI's request was part of a sustained government effort to exercise novel law enforcement power."

The All Writs Act, from 1789, allows courts, with some limits, to "issue all writs necessary or appropriate in aid of their respective jurisdictions and agreeable to the usages and principles of law."

"The San Bernardino litigation isn't about trying to set a precedent or send any kind of message," FBI Director James Comey wrote in February.

The FBI has insisted its request in the Apple California case was "narrow."

"The San Bernardino litigation isn't about trying to set a precedent or send any kind of message," FBI Director James Comey wrote in February (go.pcworld.com/fbilead). "The relief we seek is limited and its value increasingly obsolete because the technology continues to evolve. We don't want to break anyone's encryption or set a master key loose on the land."

Asked for comment on the more than 70 cases, an FBI spokesman referred back to that Comey blog post. Many of the cases identified by the ACLU involve the Drug Enforcement Administration, like the FBI a part of the DOJ, or the Department of Homeland Security, a separate agency.

Nine of the cases identified by the ACLU are targeted at Google. But

the company has not received any order "like the one Apple recently fought that demands we build new tools that actively compromise our products' security," a Google spokesman said by email. "We would strongly object to such an order."

In seven of those nine Google cases, the DOJ has requested the company's help with password resets, a different type of assistance than the recent California case in which the FBI wanted Apple to rewrite the iPhone operating system as a way to defeat password protections. In the other two Google cases, the type of assistance is unspecified.

> Although one case dates back to 2008 and a handful back to 2010 and 2011, about 30 of the cases identified by the ACLU are from 2015 or 2016.

Although one case dates back to 2008 and a handful back to 2010 and 2011, about 30 of the cases identified by the ACLU are from 2015 or 2016. Many of the cases involve illegal drugs and not terrorism, the group said.

Apple has resisted the All Writs Orders in many of the recent cases, according to information from Zwillinger. Beyond the California case, the most active case (go.pcworld.com/fbiactive) is in Brooklyn, New York, where the FBI has appealed an order from Magistrate Judge James Orenstein, who ruled that Apple isn't required to assist the agency in a drug case.

The ACLU has published a map (go.pcworld.com/fbimap2) and a list of the All Writs Act cases.

The DOJ has said it still plans to use courts to force smartphone makers to help law enforcement agencies unlock devices. The agency filed a warrant in Sacramento on March 1 asking smartphone makers to help break into a terrorism suspect's phones, Forbes reported. ⏻

How to seize control of your privacy with Mozilla's Firefox browser

BY IAN PAUL

WHEN IT COMES to online privacy, Mozilla's open-source Firefox browser is probably the best choice for keeping your data away from prying eyes. Even though Mozilla does have some behavior-based advertising on its new tab page, it's still by far the browser maker that most respects your right to browse unmolested.

Nevertheless, Firefox does require several tweaks if you want to avoid privacy-invading tactics like ad tracking. Here's a rundown of the basic steps you can take in this browser.

50

Do not track and tracking protection

To get started, open the preferences tab by typing **about: preferences#privacy** into the address bar. Or type **about:preferences** and choose Privacy in the left-hand navigation panel.

First up in the privacy section is tracking. By default, Firefox does not enable the do-not-track feature. You turn it on by clicking the checkbox labeled Request That Sites Not Track You.

With this feature enabled, Firefox will make a request to every website you visit that they do not track you. Unfortunately, sites don't have to honor the request, and few do. To enforce your intentions you need to use an add-on such as Ghostery or the Electronic Frontier Foundation's Privacy Badger (go.pcworld.com/privacybadger-v1). Be further warned, however, that some sites are choosing not to allow

Here, you see the default settings for the Firefox Privacy tab.

people to access content with add-ons like these enabled.

Returning to the tracking section in Firefox, there's a relatively new feature enabled by default called Use Tracking Protection In Private Windows (go.pcworld.com/firefoxtrackprotect). Leave this setting turned on. The new enhanced tracking protection blocks ads and other online trackers when you're in private browsing mode.

Reconciling with history

By default, Firefox remembers your history, which makes it easier to return to a site you visited a day, week, or even a month ago. Click the drop-down menu labeled Firefox Will and you can also tell the browser to never remember your history (the scorched-earth option), or use custom settings. Selecting the latter brings up several new options. At the top is a checkbox for *Always* Use Private Browsing Mode, which is another hard-core privacy choice to make. You can find out the full implications of private browsing mode on Mozilla's support pages (go. pcworld.com/firefoxprivate).

Below that are a variety of options that are pretty straightforward,

but here's how I would suggest setting it up.

Check the box for remembering your browsing and download history, uncheck the box for remembering search and form history, and leave the box checked for Accept Cookies From Sites.

Then under Accept Third-Party Cookies leave it set as *Always*, but change the *Keep Until* option from *They Expire to I Close Firefox*. Finally check the box that says Clear History When Firefox Closes.

This combination of settings allows Firefox to behave normally, but it erases most of your activity once you close the program. It offers some measure of privacy without sacrificing functionality.

Location Bar

Finally we get to the Location Bar settings. The Location Bar is just Mozilla's special name for the browser's address bar.

If you don't want Mozilla to suggest sites based on your history, bookmarks, or open tabs, uncheck the corresponding boxes.

Wrapping up

Those are the main settings you'll want to take care of, but there are a few more options you should tweak before we're done. Click *Search* in the left-hand navigation panel of the Preferences tab.

Firefox shares limited information about your browser's performance with Mozilla.
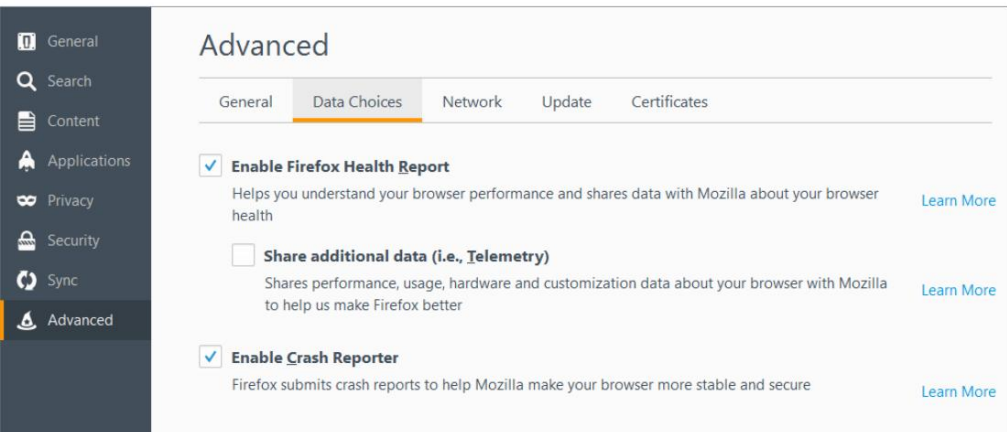
At the top of the search section is a drop-down menu for your default search engine. Choose whatever you'd like, but the most privacy-conscious search provider is DuckDuckGo. It's worth trying for a few days—you can always switch back later.

Back at the main Settings menu, go to *Advanced > Data Choices*. This option shares information with Mozilla about your browser's performance and any crash reports. It's up to you whether to share this data with Mozilla.

Finally, open a new tab and click the settings cog in the upper right corner. By default, you're using the New Tab page, which has a small amount of advertising on it. The easiest option is to choose to show a blank page. For something a little more personal, install the New Tab Override add-on (go.pcworld.com/firefoxnewtab). ⏻

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CONTENTS

Oculus Rift VR headset: The magical, yet unfinished birth of virtual reality

BY HAYDEN DINGMAN

This isn't a normal review. How could it be? We mark the cusp of not just an entirely new technology, but also the culmination of three years reporting on virtual reality. E3 2013, Indiecade, GDC, E3 again (and again), two Oculus Connect conferences, and a bunch more events in between. And now the official consumer-facing virtual reality launch, with—*finally*—the release of the Oculus Rift (oculus.com).

The slow burn's undoubtedly been weird—maybe even frustrating, from an outside perspective. "Oh great, more news about a technology I still can't buy."

But now you can, and the upshot is that, having gone through the original developer's kit (DK1), the second generation (DK2), and two prototypes, we know where VR came from, where it is now, and where it's going—assuming, of course, it goes anywhere at all.

I hope it does. The first consumer Oculus Rift release is rife with bugs and steep system requirements, but when it hits its stride, the Rift truly transports you inside virtual worlds, so you're not just playing

Here's what's actually in the box. Left to right: Remote, position-tracking camera, Rift, and Xbox controller.

games—you're experiencing them. It's magical despite some rough edges. (See the next story on : Oculus Rift's best games and VR experiences.)

What's in the box?

Let's start with the basics: Hardware.

The Oculus Rift is a virtual reality headset, meaning it's essentially a monitor you strap onto your eyes. Lenses then warp the 2160x1200 image you're seeing—made up of two 1080x1200 OLED screens—so your brain perceives a 3D world. Any 3D world you want (or, at least, that developers have built). Watch movies on the moon! Hang out with a whale underwater! Visit North Korea!

It's pretty amazing, in theory. Limitless possibilities. One step closer to the fabled Star Trek Holodeck.

We could get into all sorts of technical details here about low-persistence screens, field of view, lens design, and et cetera but I'm assuming if you're nerdy enough to care then you're also nerdy enough to have studied up beforehand (go.pcworld.com/riftwiki). After all, the consumer Rift is merely an evolution of the two Rift developer kits.

The point, insofar as this review is concerned, is that Oculus has done an excellent job reaching the technical goals it laid out two or three years back in its quest to construct compelling VR hardware: a 90 Hertz OLED display, a decently wide 110-degree field of view, responsive position tracking, and a relatively lightweight and comfortable design.

The latter is particularly important, as design is an important area of distinction between the Rift and its competitors. The consumer Rift ditches the old stretchy-headband fit of the first two dev kits and

Oculus Rift

AT A GLANCE
After years of dev kits and prototypes and behind-closed-door demos, the Oculus Rift is finally ready for consumers. Welcome to VR.

PROS
· Better (sturdier) design than predecessors
· Meets all of Oculus's initial goals for seated VR
· Oculus brings plenty of software to launch, with more on the way

CONS
· Clearly not designed with room-scale VR in mind
· Oculus Store needs work
· Xbox controller is a stopgap solution at best

$599

★★★★★

Tracking Triangle

Top Tab

On-Ear Headphones

Side Tab

About Your Rift

Take a moment to notice the adjustable features of your headset. By customizing the way your headset fits, you'll have a more comfortable VR experience.

replaces it with a more rigid assemblage of stiff fabric and flexible plastic. It makes the Rift a bit harder to store away, but there are numerous benefits.

1. It's easier to put on and take off. "Like a baseball cap," as the Oculus reps are fond of saying—as in, you literally put it on back-to-front like a baseball cap. Simple.

2. It doesn't squeeze your face. The DK2 was already better in this regard than the original dev kit, but the consumer version is another leap forward in comfort. You'll still be left with telltale lines on your face after a VR session, but I've been able to wear it for hours at a time without my nose feeling sore.

3. Despite the looser fit, the Rift stays in place surprisingly well as you toss your head hither and thither in search of murder mystery clues/zombies/hidden coins/what have you. I've had to adjust the headset periodically, but after a while it becomes subconscious, like pushing glasses up your nose.

Other points in Oculus's favor: You can quickly adjust the lens focus by moving a knob on the bottom of the headset. And the Rift has

headphones built into it! I thought this was frivolous when Oculus announced it—after all, I have studio-grade headphones sitting around my apartment. But never underestimate human laziness. Oculus's headphones are "good enough" for day-to-day use, and it's convenient to have the whole contraption all in one piece.

I'm a bit worried about the placement of the headphones, though. When you put the Rift down on a desk, the back edge rests entirely on the headphones, and they don't seem especially sturdy. I've debated whether I need to buy a mannequin head to store the Rift long-term.

Which brings us into the negative portion of this hardware assessment. Let's start with the camera. Oculus's external position-tracking camera works by measuring infrared LEDs on the headset, some of which are now built into the rear of the Rift. However, I found the positional tracking to be slightly less accurate when your head's turned away from the Rift than when you're facing the camera straight-on, and there's still occasionally a jarring leap when you spin 180 degrees.

Furthermore, the Rift's camera doesn't actually track that large a space. It's generally big enough for Oculus's original goals—seated VR. But it's clear that standing VR and room-scale VR in HTC Vive-esque fashion (go.pcworld.com/everestvr) was (or maybe still is) an after-

About Your Remote

Use your remote to navigate VR and access the Universal Menu.

Select Button

Navigation Disk

Volume Down

Volume Up
Back Button

Oculus Button
(Universal Menu)

thought for Oculus. The amount of space tracked by the Rift camera is small, and makes standing-centric games like Farlands a bit of a chore as you try to stay inside the Rift's bounds.

It doesn't help that Oculus never really explains where the Rift's camera should be placed. The DK2 Rift camera mounted on top of a monitor; it was clear where Oculus expected it to go. The consumer Rift ships with the camera mounted on a pole, like a miniature desk lamp. I have no idea where to put it. On the edge of my desk so it tracks more of the floor? On the rear of my desk so I don't casually knock it over? And what angle should it be mounted at?

After a bit of fiddling I think I finally have it in an optimal position for my space, but it's not as set-up-and-go friendly as the design first indicates when you pull it out of the box.

Other issues persist too. As with all VR headsets, residual heat builds up in the display. Though the Rift never became uncomfortably hot, I definitely appreciated the cool, cool breeze against my face when I'd take it off. The tether on the Rift is another sore spot. It's lightweight, but it's also short—much shorter than the Vive's—and tends to get

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hooked under stuff with obnoxious regularity.

And there are no controls built into the headset itself. I'm a bit disappointed because, like the headphones, it's helpful when you're strapping something over your eyes to have it all in one piece. Instead, the Rift ships with a small black remote for simple Oculus Home tasks and low-end games and experiences. The remote's a fine piece of hardware but has a tendency to get lost as soon as it's set down, especially since, you know, you have a VR headset slapped over your eyes, blocking out the real world.

Your other input alternative, until the hand-tracking Oculus Touch controllers release (go.pcworld.com/oculustouch) later this year, is the Rift's packed-in Xbox One controller and…well, it's an Xbox One controller. I understand Oculus wanted a baseline for developers to aim at, but it's not exactly an inspiring piece of hardware for VR. If this

This is your new living room.
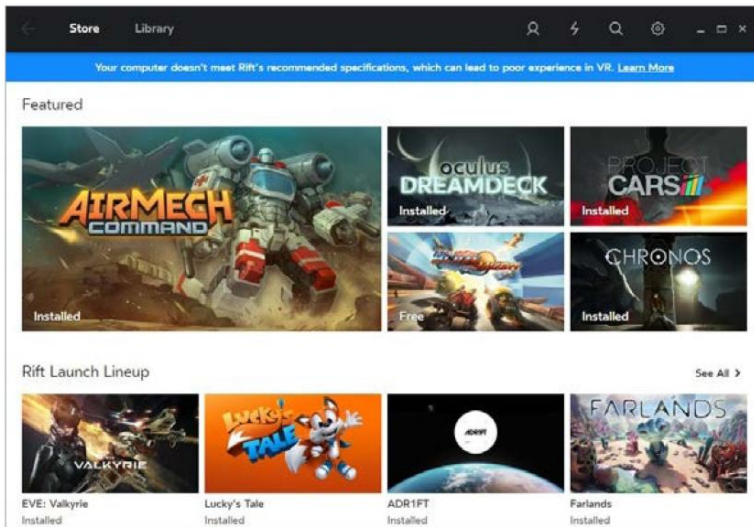
is the default controller for the Rift (go.pcworld.com/riftcontroller), however, then Oculus needs to set some standards—for instance, codifying the Back button (or whatever it's called on the Xbox One) as the Reset Orientation button. Some games use that, but other games use the Y button, and still others rely on the software button built into the Oculus menu. It's a mess.

Die in real life

Ah, the Oculus menu. The perfect time for us to start talking software.

Oculus has built its own little walled garden for the Rift—a storefront, an app library, a firmware updater, a friends list, a virtual environment. And it all comes together in Oculus Home. Put on the Rift and you'll find yourself in a faux-living room, voxel fireplace crackling merrily. The room is dominated by massive floating menus which let you buy apps, install apps, and launch apps from inside the Rift. Or you can take the Rift off and do the same from a more traditional mouse-based environment.

Home is fine. The Oculus Store is fine. It's all fine. It's aesthetically

pleasing, it's easy to use, and the omnipresent pause menu is just as useful as the Steam overlay.

But *it's not Steam*. And I don't just say that in the "I want all my games in the same place" way, though I'm certainly guilty of that line of thinking. The bigger issue is that Oculus doesn't even duplicate Steam's basic functionality, stumbling in several small, but crucial details.

There is, for instance, no way to install games to anything except the C: drive at the moment. That's crazy. In an age where many high-end users are running Windows itself on a 128GB or 256GB SSD, Oculus co-opting all the remaining space is inexcusable when I have 4TB of additional storage in my machine. This problem is supposed to be remedied soon—fine—but it demonstrates Oculus's inexperience in digital games retail.

Installations are also a resource-suck. Downloading data often introduced a noticeable slowdown to my machine, and the actual installation would grind even something as simple as "writing in Notepad" to a halt, taking over my entire processor for the last few steps. I also suffered a crash in the middle of an installation, and the Oculus Store didn't recognize that it'd already downloaded 20GB of data, forcing me to delete the files from the Oculus directory manually and redownload the entire game.

Speaking of which, my processor apparently doesn't "Meet Rift's recommended specifications." How do I know? Because there's a huge banner at the top of the storefront that's impossible to dismiss. This despite the fact that my overclocked Core i5-3570K (a.k.a. the standard gaming-build processor for many years) is faster than the recommended (non-overclockable) i5-4590, and my GeForce GTX 980 Ti (go.pcworld.com/geforceGTX980Ti) more than picks up any slack. Instead of rating compatibility by actual performance like Valve's

You'll find this bit of walled garden goodness buried in an options menu.

Unknown Sources
Allow apps that have not been reviewed by Oculus to run on my Rift.
Learn more.

SteamVR Test (go.pcworld.com/steamvrtest), Oculus tests compatibility by comparing systems to a list of "acceptable hardware," so despite having zero in-game slowdowns all week I'm stuck with this persistent warning in every menu.

And bugs. In addition to the installation crash warning in virtual Oculus home, I've also woken my computer from sleep multiple times to find the Oculus unresponsive. The solution is to close out the Oculus software and relaunch— pretty simple, but come on. Oculus Home is a walled garden for your own hardware. I at least expect basic functionality like "Knowing the Oculus is properly attached" to work on cue.

These problems will be sorted out though. Lest we forget how buggy Steam was at launch, I'll give Oculus the benefit of the doubt and say within six months the looming technical hiccups will be gone.

> Lest we forget how buggy Steam was at launch, I'll give Oculus the benefit of the doubt and say within six months the looming technical hiccups will be gone.

The bigger question is how the Oculus Store will operate in the wild. When can we expect new software? What are the notable "upcoming" titles? Writing this on a Sunday, I saw at least two big Oculus-ready apps—Virtual Desktop (store.steampowered.com/app/382110) and Bazaar (store.steampowered.com/app/455230)—that showed up on Steam for the Monday Rift launch but weren't currently included in the Rift Launch Lineup section on the Oculus Store. Why? And when will those games get added? How hard is it for developers to get games/apps approved through Oculus?

And if I bought a Rift-ready game from Steam, rather than the Oculus Store, do I need to click the "Allow apps that have not been reviewed by Oculus to run on my Rift" button in the Options menu? Will Oculus make that clear to purchasers? And can I then add shortcuts to those Steam games in Oculus Home?

It's a mess, and it's a mess I haven't managed to experiment with during the pre-launch review window because, for instance, there are no consumer Rift-ready demos on Oculus Share for me to try and

sideload. But it's a bit frustrating after the easy democracy and openness of the last three years to see the consumer Rift so locked down from the get-go.

As for the games that are on the store, Oculus has undoubtedly built a solid launch lineup—easily on a par with your average console launch. You can read up on some specific Oculus Rift launch software (go.pcworld. com/bestriftsoftware) I've covered in-depth, but there's something to please everyone. A handful of first-person games, a bunch of third-person, a few tech demos, some apps—all of which do a spectacular job of immersing you inside virtual worlds once they're up and running.

But it's hard to know how things will look six months from now or a year from now, and harder still because many of the best VR experiences at the moment (*Fantastic Contraption, Job Simulator, Dead and Buried*) rely on the Oculus Touch controllers that are still months away from release.

Another sore spot: Some of the games take forever to load. I've waited upwards of a minute for Oculus's own *Farlands* to boot up, despite being forced to install it on my SSD. A minute when you're sitting with the Rift

on, staring into the darkened void, might as well be an eternity.

Bottom line

It's not often that we talk about ratings methodology, but I think it's important here. This is, in effect, the big virtual reality launch. Nothing like the Rift has graced the stage yet—and yet ratings are inherently only useful for comparative purpose.

What use is four stars in a vacuum? Is that four stars for hardware? Four stars for software? A combination of both?

It's not really a vacuum though. Remember what I said earlier: Three years of VR evolution behind closed doors has given us a pretty good idea of where the field is going. What's possible. What work still needs to be done.

So perhaps it's best to say our rating for the Oculus Rift is based on how well we think Oculus accomplished its stated goals: Creating a device that could (and pardon the VR buzzword here) instill a feeling of virtual "presence" in the user, here in 2016. The Rift launch isn't perfect, nor does it feel finished given the conspicuous absence of Oculus's own Touch controllers. But I had moments during my review of the product where hardware concerns slipped away and I just enjoyed rocketing through space or standing in Iceland or relaxing on an alien planet. Not playing at doing those things, but actually doing them.

In that sense, the initial Oculus Rift headset is stunningly successful, despite its high price (go.pcworld.com/riftprice)and missing Touch controllers and first-gen rough edges. Those drawbacks will likely limit this debut to enthusiasts only at the consumer level, but this hardware can truly transport you to exotic locales—once you're in-game, there's no denying that the Rift's experience is literally awesome, especially if you've never tried VR before.

Welcome to virtual reality, and congratulations to everyone at Oculus on the launch. It's been a long time coming. ⏻

> In that sense, the initial Oculus Rift headset is stunningly successful, despite its high price and missing Touch controllers and first-gen rough edges.

The best Oculus Rift games and virtual reality experiences

BY HAYDEN DINGMAN

AFTER YEARS OF teasers and hardware iterations, the Oculus Rift VR headset launches, and it's a magical piece of hardware. But when it comes to splurging on a $600 peripheral—especially one that promises to transport you to virtual reality worlds—I'd wager that software is the more important part of the equation.

So I spent a week trying out everything the Oculus Store's Rift Launch Lineup section offers. It's a huge and diverse list, with experiences ranging from first-person point-and-clicks to third-person dungeon crawlers to real-time strategy games to space dogfighters and virtual tourism. If ever you wondered "Could a person really spend eight or more hours a day in virtual reality?" the answer is "Yes." (Though I wouldn't necessarily recommend it.)

But I've emerged from the warm embrace of the *Matrix* to handpick the fifteen experiences I've enjoyed best out of thirty or so total available at the Rift's launch—ten games, five apps. Some are short two-minute demos, others are hours-long investments. And I hope at least one suits your tastes.

Esper 2

Esper 2 is easily the best game I've played on the Rift—and as I said, I've played a lot of them. In case you missed it on Samsung's Gear VR, *Esper* (coatsink.com/games/esper) and its sequel involve a shady research facility (think Aperture Science) experimenting with telekinesis. You solve puzzles by picking objects up "with your mind."

The first game was a successful, albeit short, demo project but *Esper 2* is a two- to three-hour romp through an ancient temple, a dream sequence, and some other craziness I don't want to spoil. It's a solid puzzler with some excellent *Portal*-style humor, and it's the only VR game of its length that I played from start to finish without wanting to take a break.

And movement is node-based, beaming you from place to place, so it's fairly nausea-free—making *Esper 2* a great game for VR beginners.

Dead Secret

Dead Secret (robotinvader.com/deadsecret) would be a fun, but fairly unremarkable point-and-click adventure if it released in 2D. The game's clearly made by a small team, it's fairly short, the puzzles aren't too difficult, and the more action-heavy sequences can be a chore.

That being said, *Dead Secret* is an entertaining little murder mystery/horror game and—more importantly—it gets the benefit of right time, right place. Meaning: It's the only point-and-click that's ready for Oculus's launch date. The old node-based first-person navigation of *Myst* turns out to be an excellent fit for VR, and I wouldn't be surprised to see a rash of similar adventure games hit the Rift/Vive in the near future, including *Myst* spiritual sequel *Obduction* (go.pcworld.com/obductionrev), of course.

It's a note with a foreign symbol on it. Underneath it reads "NORTH."
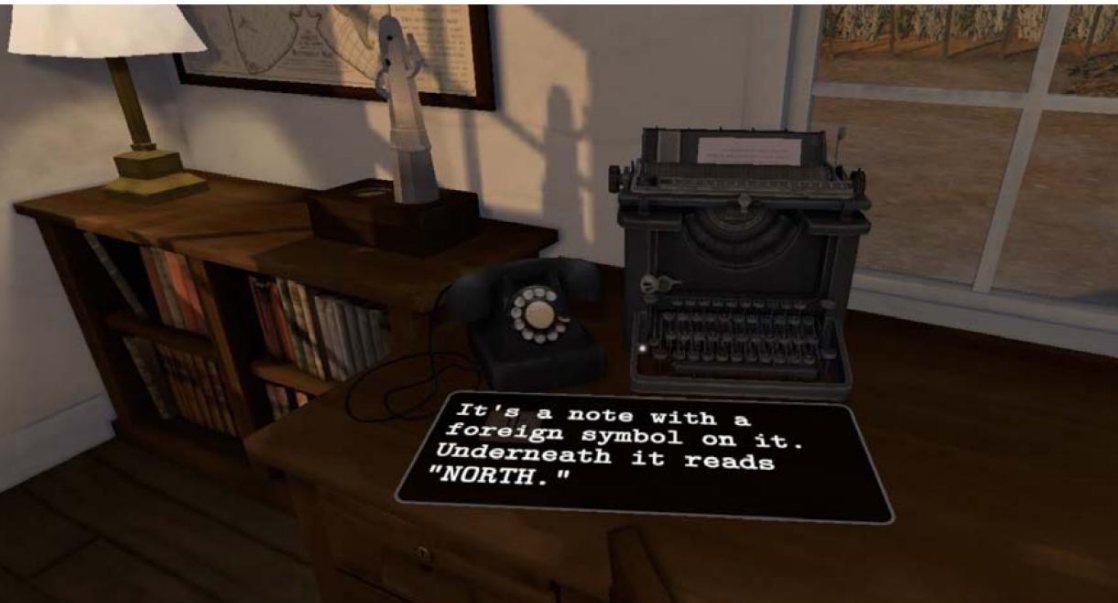
Chronos

Fixed camera angles went out of fashion years ago, but prepare to see them make a comeback in virtual reality! It turns out the ol' *Resident Evil*–style art of fixed cameras is great for eliminating nausea problems in VR.

Chronos (gunfiregames.com) takes advantage of it, creating a third-person action game sort of in the vein of *Dark Souls* (albeit easier) where every room features a new fixed camera angle. It's a bit clumsy at times—the combat's not very forgiving, and it can be frustrating when you swing and miss due to an awkward camera—but it's maybe the longest single-player game on offer for the Rift launch, and it's packed full of spectacle. *Chronos* is one part Cold War bunker and one part fantasy world, and it's full of intrigue.

Apart from *Esper 2*, *Chronos* is probably the best single-player experience the Rift has to offer at launch.

Herobound: Spirit Champion

Herobound is like *Chronos*-lite—which isn't too surprising because it was literally created by the same developer (Gunfire Games: gunfiregames. com) and features the same fixed-camera, room-to-room setup. But where *Chronos* channeled Dark Souls for inspiration, *Herobound* borrows from an iconic green-capped Hyrulean. You're crawling through dungeons themed after the four elements (Earth, Air, Water, Fire) with your trusty sword and bow, opening up new areas as you get new tools.

Yeah, like *Zelda.*

It's addictive, though. The map could use some more finessing, and I ran into a few bugs, but I played for probably two hours at a time. There's nothing in the way of nausea to worry about, and the raised camera angle helps avoid some of the depth-perception problems that plague *Chronos's* combat. If you're looking for a "real game" to play on the Rift, *Herobound* could be a good place to start.

EVE: Valkyrie

EVE: Valkyrie (evevalkyrie.com) is the first game I ever played in virtual reality. Actually, it was the first time I ever used a VR headset. Ever. *Three years ago*. And now it could be the first game you play in virtual reality, since *Valkyrie* comes bundled with every Rift preorder.

It's still great. If you just want to fly around space and explore, *Elite: Dangerous* (go.pcworld.com/elitedangerous) might be more your speed, but *Valkyrie*'s built-for-VR dogfighting is a thrill. I haven't tried any online multiplayer yet because, well, there were barely any headsets out in the wild before this. I have no idea how the servers will hold up, or how many people will be playing.

But the few single-player missions on offer are heavy on spectacle, and the numerous LAN multiplayer matches I've played over the years have all been great. If Valkyrie came free with your Rift preorder there's really no excuse not to try it.

[Disclosure: My roommate works with CCP, the publisher of EVE: Valkyrie, *as part of an external PR agency.]*

Keep Talking and Nobody Explodes

You know that scene in films where the hero's all "Do I cut the red wire or the blue wire?" and the FBI is a hundred miles away flipping through a computer database of bomb schematics so Los Angeles doesn't get nuked? That's *Keep Talking and Nobody Explodes* (bombmanual.com). One person plays bomb defuser. The other looks through a manual and tells them how to go about defusing. Neither can see what the other's doing.

The game's already a hit on Steam (go.pcworld.com/keeping talkinghit), but the first time I played *Keep Talking and Nobody Explodes* was on the Rift, and it's still probably the best way to play if you want full action-hero, sweat trickling down your neck, sweaty-palms stress.

Fly to Kuma

I've spent a ridiculous (maybe embarrassing) amount of time playing this silly little game about pink space bears. *Fly to Kuma* (go.pcworld. com/flytokuma) is a series of puzzle rooms where you guide the aforementioned bears to their spaceship. The problem: The bears just run forward, only turning if they meet an obstacle. You move blocks around to steer the bears so they don't fall off the edge and die.

It's a simple concept, and I don't necessarily think it needed to be in VR. But damn if it's not addictive. I've been using *Fly to Kuma* to take breaks in between more intense experiences, and it's worked wonderfully as a palate cleanser.

Also, the bears are adorable. And they look at you when they run.

Pinball FX2 VR

Fair warning: *Pinball FX2 VR* (pinballfx.com) is pretty goofy. Zen Studios basically took three of its pinball tables (Secrets of the Deep, Epic Quest, and Mars), put them in a fake house, and made it so the room changes when you play them. Secrets of the Deep, for instance, has you playing "underwater," while a shark swims around your house.

The tables are decent though, and it's a fun little pop-in, pop-out arcade experience.

But I'm more excited about what *Pinball FX2 VR* demonstrates for the future of game emulation and preservation. Imagine, for instance, sitting and playing an Atari 2600 in a faux-1970s living room. Or arcade games in Flynn's (youtu.be/07Upyd9EVog).

AirMech

Here's something you might not expect in VR: A real-time strategy game/MOBA (go.pcworld.com/wikipediamoba) hybrid. In AirMech (carbongames.com/airmech) you play robot general to a bunch of warring troops, corralling them down toward the enemy base and occasionally intervening directly in combat.

It lacks the precision of a traditional RTS, but *AirMech* is an interesting take on tabletop war games, with your miniature troops scurrying around the battlefield under your watchful eye. I'm not particularly fond of the cartoon art style and the camera controls could use work, but it's a solid proof-of-concept and I'd love to see someone take a crack at a more realistic setting, *Company of Heroes*– or *Total War*–style.

Farlands

The first day I played *Farlands* (oculus.com/experiences/rift) I thought to myself "Okay, so it's basically like a VR Tamagotchi (en.wikipedia.org/wiki/Tamagotchi)?" Then I came back the second day and was like "Yeah, definitely like a VR Tamagotchi." And then I came back the third day and went "Why the hell can't I stop playing this VR Tamagotchi?"

But I think I know why. I once wrote about an Oculus demo where an alien waved at me and, without thinking about it, I instinctively waved back (go.pcworld.com/alienwave)—to a virtual being. *Farlands* is that demo blown out into a much larger experience. Although *Farlands* is light on the "game" elements (it's essentially a big-budget *Neko Atsume*; go.pcworld.com/nekoatsume), it's excellent at making you feel like you're standing on an alien world. Strange creatures run around, the sun rises and sets in real-time, and you're given time to relax and soak it all in.

It helps that *Farlands* is standing-centric, which is a rarity here at launch. For me, at least, standing helps convince my brain to mostly forget I'm wearing a headset.

Jaunt VR

The Rift might be positioned as a games-first platform, but one of my favorite experiences actually came from Jaunt (jauntvr.com), a curated 360-degree video app. Inside the Travel section was a report done by ABC News—made for virtual reality—on North Korea.

Over the course of a few minutes, Bob Woodruff takes you on a tour of a handful of North Korean landmarks. Nothing truly shocking, given how rigorous North Korea is about shepherding press from place to place, but given that it's unlikely I'll ever go to North Korea it makes for a fascinating (and very professionally done) glimpse of the potential for both virtual tourism and newscasting.

Other highlights: A Paul McCartney concert clip ("Live and Let Die"), shot from both onstage and in the front row, plus a highlight reel of the NHL Winter Classic. It's still infant days for 360-degree video, but Jaunt is an excellent showcase of what's to come.

Oculus Video

There's also Oculus's built-in video app (oculus.com/experiences/rift), which is more focused on traditional video than the 360-degree type. There's Facebook/Twitch/Vimeo integration (but no YouTube), or you can launch your own videos and watch DVD rips/old home movies/your senior film project/Hulk Hogan's sex tape/literally anything in a faux movie theater setting. Or a movie theater on the moon. Or a "movie theater" that's actually a smart phone dropped into some grass, blown up to a thousand times the actual size.

The app needs some work though. It's currently impossible for me to tell what folder it's building my video library from (though I suspect it's Windows' own Videos folder) and it's similarly impossible for me to change the directory it's pulling videos from. Considering most of my videos are on a secondary storage drive, this is a bit of a pain.

Henry

Originally shown as a behind-closed-doors demo, I'm pretty excited to see *Henry* (storystudio.oculus.com/henry) as an Oculus launch title. Built by Oculus Story Studio, the company's internal film team helmed by ex-Pixar vets, *Henry* tells the story of a hedgehog who wants a hug, but his spikes keep getting in the way.

And since *Henry* is all CG, it's able to do some amazing things that can't be emulated by capturing footage in real life. Small things, like Henry's eyes tracking you around the room, or the fact that it's a full 3D environment with position tracking, instead of essentially a camera gimbaled on a stick. It's also a damn good short film in its own right, equal parts funny and tragic.

Lost

It's only maybe two minutes and there's not really a story, but I might like Oculus Story Studio's short film *Lost* even more than I like *Henry*. And no, it's not related to the TV show. There's no numbers or mysterious hatches here.

There is a mysterious forest though, and—oh yeah—a massive robot. Lost clearly takes inspiration from *The Iron Giant*, and that's A-OK with me. Seeing a 100-foot tall robot bend down and look you in the eyes really gives you an idea of how VR can play with scale and perspective. Seeing the same image on a monitor (or even on a theater screen) wouldn't elicit the same reaction.
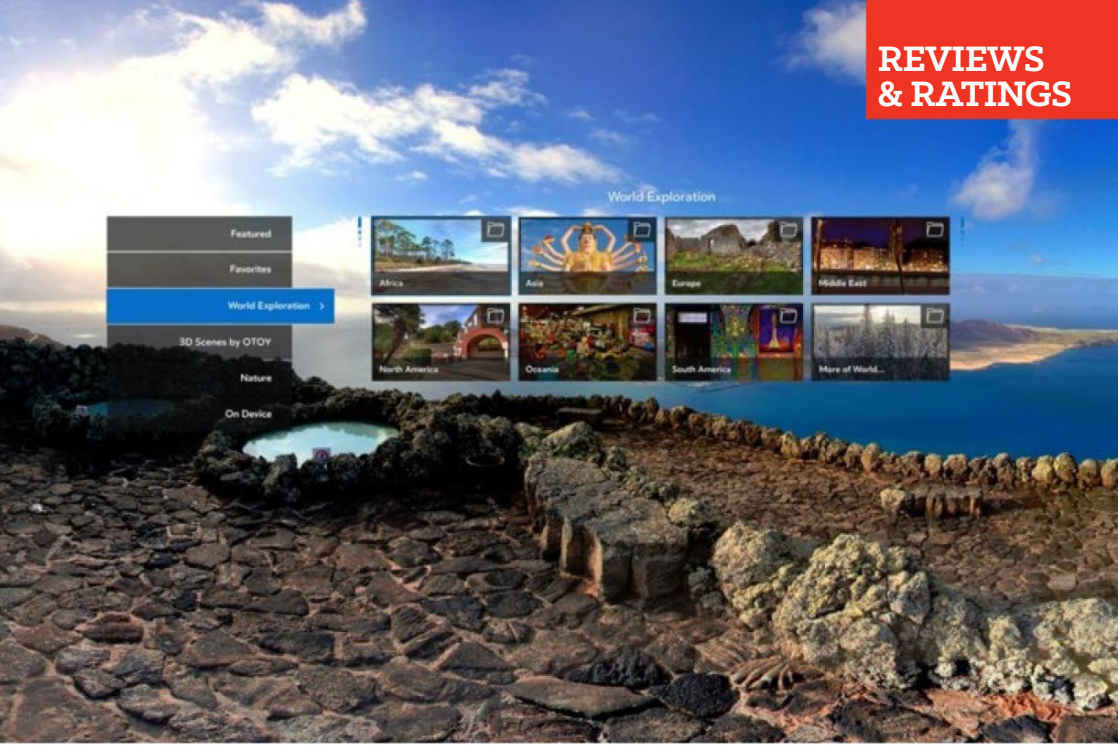
Oculus Photos

I keep coming back to the Oculus Photos app (oculus.com/experiences/rift). I don't know why. It's easily the least system-intensive app Oculus offers. You literally just…look at 360 degree photos.

Again, it's the draw of virtual tourism. Not just to places you may never go, like UNESCO World Heritage sites or the Mos Eisley set in Tunisia, but to places you've already been. There's something oddly fascinating about putting on a headset and suddenly being teleported to the town you grew up in, or to the place you vacationed last summer.

It's a thin recreation, of course—just one step above a normal 2D photograph. But more than once I've donned the Rift intending to play a game and found myself instead looking through snapshots of places from my past. ⏻

Samsung Galaxy TabPro S: This Surface Pro clone is drop-dead gorgeous

BY GORDON MAH UNG

IF TECHNOLOGY WERE people, Samsung's Galaxy TabPro S (go. pcworld.com/galaxytabpros) would clearly be a supermodel: It's willowy thin, extremely lightweight, and has a jaw-dropping OLED screen.

Even better, Samsung's first convertible is a PC. This sleek 12-inch

tablet sports Windows 10 Home, and it's paired with a pretty peppy CPU, too.

Did we mention this machine has an OLED screen? Samsung isn't the only manufacturer to announce an OLED in a PC—Dell, HP, and Lenovo all showed off laptops with OLEDs at CES in January. This is the first one we've seen in a shipping product, though, and it's a doozy.

It has an OLED display! OLED!

Long used in smartphones, organic light-emitting diode (OLED) screens differ from the typical side-lit LED panels found in the majority of laptops and tablets today. Side-lit screens light up the entire display at all times. In order to show black on the screen, the panel has to block the light. As you can imagine, black usually appears more like gray, and any escaping light will create ugly backlight bleed.

That's not the case with an OLED panel. Each pixel can be turned on and off individually, resulting in deeper black levels and more accurate colors.

How beautiful is it? I've always thought the Surface Pro 4 had a nice screen, but when placed side by side in a darkened room with the Samsung TabPro S, the SP4's backlight bleed and grayish blacks were

woefully obvious. The OLED screen also gives the TabPro S's contrast a boost.

Sure, if you go by numbers, the TabPro S's resolution of 2160x1440 might not sound impressive. It's not 4K Ultra HD, nor does it match the Surface Pro 4's 2736x1824. But when it comes to OLED, numbers don't tell the whole story. Overall, the Samsung TabPro S bests the Surface Pro 4's panel for image quality—it's just lovely.

It's not all sunshine and rainbows

OLEDs do have a downside: They can degrade over time. Therefore, some manufacturers attempt to slow this effect in their displays. For example, Dell's 4K Ultra HD OLED (go.pcworld.com/4kultrahdoled) desktop panel has a sensor that switches off the monitor when you're not sitting in front of it, in order to reduce wear and tear on the diodes.

Samsung has also taken steps to protect the Galaxy TabPro S's screen, using a far more annoying approach. The screen dims significantly after one minute of inactivity—and you can't override the feature. The dimming is selective, too. The screen's brightness faded during my tests of graphics, RAM, and memory performance, but not when I fired up a video in Windows 10's media player or ran 3DMark. It also didn't dim when I was actively using a browser window, but when a flash or HTML5 animation is running in the background, it'll get darker.

Samsung Galaxy TabPro S

PROS

· Sumptuous OLED panel
· Thinnest 12-inch Windows tablet we've seen
· Fantastic battery life when playing movies

CONS

· Keys feel loose
· No included USB Type A-to-USB Type C dongle
· Pen technology not yet available for testing

$899

★★★★☆

Samsung didn't officially confirm that this dimming is related to OLED preservation, but I doubt it's a power-saving issue, as the Galaxy TabPro S dims the screen whether on battery or plugged in. Regardless of the intent behind the feature, it's annoying and a potential deal-breaker for some. Not having control over it (at least not that I could find) is very frustrating.

Solid specs, disappointing port

Inside the tablet is an Intel Core m3-6Y30 paired with 4GB of LPDDR3/1600 RAM and a 128GB M.2 SATA SSD. These specs may sound lower-end than you'd expect from a competitor to the Surface Pro 4, which offers Core i5 and Core i7 processors and faster storage. However, the Surface Pro 4's base model is similarly configured, and even when you pit the TabPro S against the SP4's higher-end options, most people won't notice a difference in performance during typical, everyday tasks.

You only get one port on the TabPro S: a reversible USB Type C port for charging and data transfer that supports USB 3.1 10Gbps transfer speeds. (Sorry, Thunderbolt 3 fans—no love this time.) It's unfortunate there's just a single port, since it hinders your ability to charge the

The Galaxy TabPro S keyboard cover wraps around both sides, which offers more protection than the Surface Pro 4 or iPad Pro keyboards.

The Samsung Galaxy TabPro S (right) next to the 13-inch iPad Pro (left). You probably can't see it, but the TabPro S is thinner by a hair.

device when another USB device is plugged in. Sure, you can buy a multiport dongle, but it's still a pain in the behind.

More disappointing is that Samsung didn't include a USB Type A–to–USB Type C dongle in the box. It's unlikely that most people who buy a Galaxy TabPro S will have the foresight to buy a dongle before there's a need to install apps or copy programs from a USB thumb drive. HP's Spectre X2 wins out here, as it's cheaper, sports an LTE modem, and comes with this vital accessory.

The good news is you can charge the Galaxy TabPro S using other USB Type C chargers. For instance, I was able to use the chargers for the Pixel C and the Chromebook Pixel, as well as Innergie's third-party PowerGear USB-C 45.

The Galaxy TabPro S is also one of the thinnest, if not *the* thinnest, convertible device we've ever seen. Samsung states its official measurement as 6.3mm, but my digital calipers say this convertible is just about 6.5mm. For comparison, the 12.9-inch iPad Pro and Pixel C measure 7mm, and the Surface Pro 4 is a plus-size 8.5mm. All these are, of course, without their respective keyboards.

It's more iPad than Surface

Many people have described the Galaxy TabPro S as a Surface Pro (go. pcworld.com/surfacepro4rev) clone, but that's not quite right. Instead, it more closely emulates the iPad Pro (go.pcworld.com/ipadprorev). Why? I believe that the Surface line's signature feature is its kickstand, which lets the convertible stand on its own, without the need of a keyboard cover. So HP's Spectre X2 (go.pcworld.com/hpspectrex2rev)

with its built-in kickstand, for example, is more of a Surface clone in my view.

The TabPro S, on the other hand, is really a beautiful tablet with a clever keyboard case. That case connects using magnets and a set of pins on the bottom side, and when closed, wraps completely around the tablet. (It's a nice touch for those who don't like scuff marks on their device.) When open, the cover props up the tablet at either a 65-degree or, roughly, 165-degree angle. You can't use the keyboard with the tablet laid flat (180 degrees), as the pins won't make contact.

The TabPro S's keyboard looks similar to the Surface Pro 3's, in that

Although not horrible, one of the more disappointing aspects of the Galaxy TabPro S is its loose-feeling keyboard.

The Galaxy TabPro S features two available viewing angles.

all the keys sit flush with each other, but in actual use it's a far different experience. The TabPro S's keys feel sloppy—they're very loose and just a little too slow on the return. It's also a bummer that the keyboard isn't backlit. That feature used to be a luxury, but now it's expected on high-end devices. (Heck, even the budget Surface 3's keyboard cover has backlighting.)

It's not all bad, though. The trackpad is quite usable, though still not as nice as what you'll find on the recent keyboard covers for the Surface Pro line. And Samsung has integrated an NFC reader into the keyboard (there's also one on the back of the tablet). In theory, you can pair a Samsung Galaxy S6 or newer phone with the TabPro S to share the phone's data connection over Bluetooth or unlock the tablet by using the fingerprint reader on the phone. Unfortunately, I couldn't test these two features as the app wasn't ready during our review.

But it still competes with the Surface

Despite the Galaxy TabPro S seeming more like an iPad Pro, there's still

Handbrake 0.9.9 Encode (sec)

Device	Value
Surface 3 (Atom X7-8700)	14,400
Surface 3 (Core i5-4300U)	11,815
Dell Venue 11 Pro (Core M 5Y71)	11,705
Samsung TabPro S (Core m3-6Y30)	10,798
HP Spectre X2 (Core m7-6Y75)	9,898
Surface Pro 4 (Core i5-6300U)	6,428

SHORTER BARS INDICATE BETTER PERFORMANCE
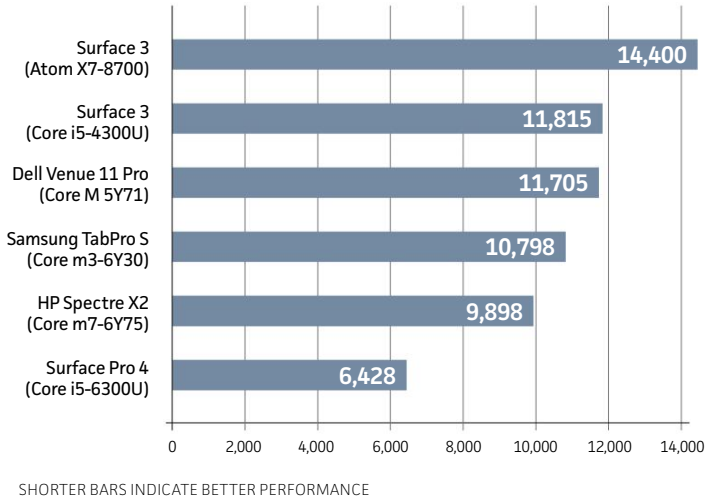
The Core m3 in the Galaxy TabPro S performs reasonably well despite the device's superthin body.

the lingering question of whether it's the convertible that finally beats the latest in the Surface Pro line.

In terms of hot new tech, it just might—that beautiful OLED screen will leave you giddy. It's also much cheaper than the Surface Pro 4. At $899 with the keyboard, the Galaxy TabPro S is surprisingly inexpensive when you consider the screen technology inside. A Surface Pro 4 with similar specs and a keyboard will set you back $1,029.

However, the TabPro S loses to the Surface Pro 4 in the areas that likely matter more. For those who need performance, the higher-end Surface Pro 4 models are just plain faster. The integrated USB Type A port and almost infinitely adjustable angle on the kickstand also give the Surface Pro 4 a leg up. Microsoft also includes a pen with the Surface Pro 4, while Samsung hasn't priced its pen, much less made it available. And of course, you can completely control the screen

brightness on a Surface Pro 4.

For a fanless, wafer-thin PC, the Galaxy TabPro S posts very reasonable performance in the kinds of tasks it will confront.

In our Handbrake encode test, where we take a 30GB 1080p MKV file and transcode it into an MP4 using the default Android Tablet preset, the TabPro S outdid the Surface Pro 3, which is thicker and has a fan. This benchmark hammers all the available cores on the computer, and because it can take a long time to run, the test puts a heavy thermal load on a device's CPU.

Some devices react to this intensive CPU and thermal task by throttling down performance, which is what I've seen in the Surface Pro 3—its Haswell processor drops back as it heats up. Some SP3 owners say their units don't do that, but I think that's because they're not pushing their systems as hard. That's not to say the Galaxy TabPro

3DMark Sky Diver Overall

Device	Score
Surface 3 (Atom X7-8700 / HD)	1,179
Surface Pro 3 (Core i5-4300U / HD 4400)	2,745
Dell Venue 11 Pro (Core M 5Y71 / HD 5500)	1,972
Samsung TabPro S (Core m3-6Y30 / HD 515)	2,640
HP Spectre X2 (Core m7-6Y75 / HD 515)	2,776
Surface Pro 4 (Core i5-6300U / HD 520)	2,615

LONGER BARS INDICATE BETTER PERFORMANCE
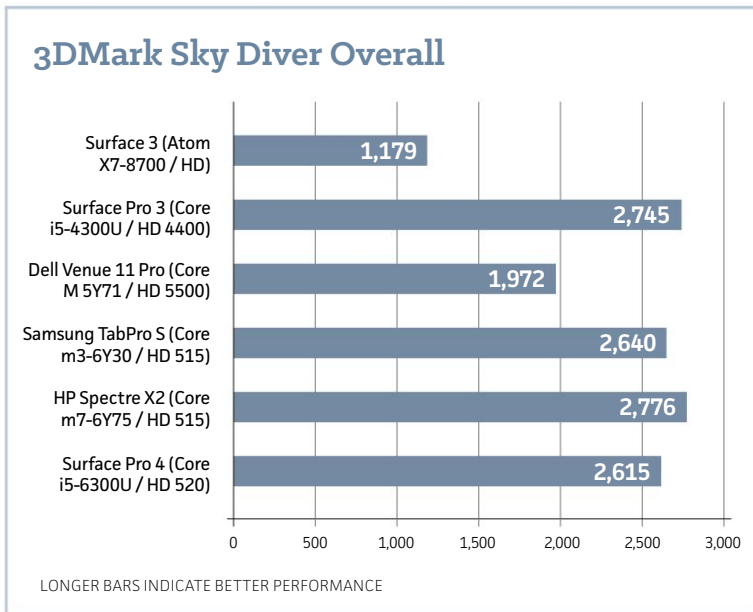
3DMark Sky Diver is mostly influenced by the GPU in each tablet, so the Core i5 chips don't maintain much of a lead as they use similar graphics cores.

PCMark 8 Work Conventional Overall

Surface Book (Core i7-6600/GeForce)	2,744
Toshiba Radius 12 (Core i7-6500U)	3,114
Surface Pro 4 (Core i5-6300U	2,619
Dell XPS 13 (Core i5-6200U)	2,887
Dell XPS 13 (Core i5-5200U)	2,719
Surface Pro 3 (Core i5-4300U)	2,810
HP Spectre X2 (Core m7-6Y75)	2,795
Dell Venue 11 Pro (Core M 5Y71)	2,620
Samsung TabPro S (Core m3-6Y30)	2,287
Asus Zenbook UX305 (Core m3-6Y30)	2,672
Asus Zenbook UX305 (Core M-5Y10)	2,393
Surface 3 (Atom X7-8700)	1,717

LONGER BARS INDICATE BETTER PERFORMANCE

In office tasks, you'd be hard-pressed to tell the difference between a Core m3 and Core i5 chip.

S doesn't slow down or throttle as it heats up, but it's on a minor level.

In graphics performance, there's not much of a gap between the TabPro S and most midrange Core i5 chips and even a few Core i7 processors, which use nearly the same graphics core. I attribute variances among the midrange Surface Pro models, the TabPro S, and the Spectre X2 to any number of minor reasons. For example, a small margin of variance always exists between benchmark runs, and then there are things like background static or even the temperature of the

4K Movie Playback High Brightness (min)

Device	Minutes
Surface Book (Core i7-6600U / 68 WHr)	637
Samsung Galaxy TabPro S (Core m3-6Y30 / 39 WHr)	530
Dell XPS 13 (Core i5-6200U / 57 WHr)	529
Surface 3 (Atom X7-8700 / 27 WHr)	453
Asus Zenbook UX305 (Core m3-6Y30 / 45 WHr)	396
Surface Pro 4 (Core i5-6300U / 38 WHr)	386
HP Spectre X2 (Core m7-6Y75 / 41 WHr)	375
Toshiba Radius 12 (Core i7-6500U / 41 WHr)	314
Acer Switch 11V (Core M-5Y10c / 33 WHr)	287
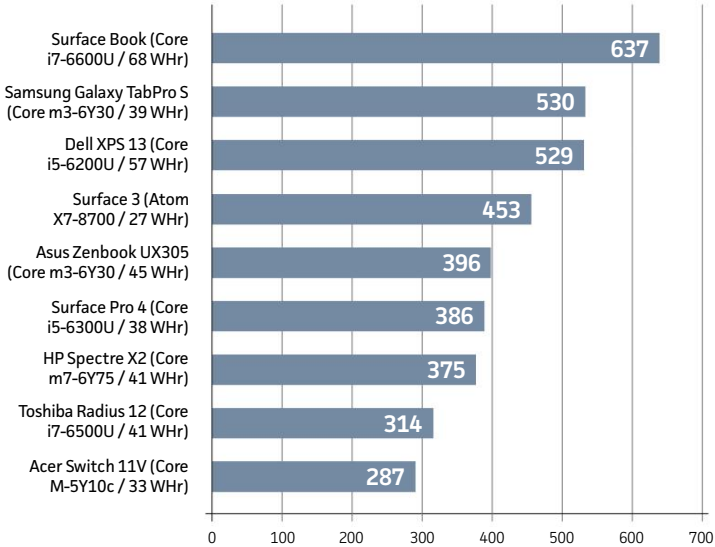
LONGER BARS INDICATE BETTER PERFORMANCE

The video playback life of the Samsung Galaxy TabPro S is spectacular considering its battery size.

room when the benchmark was run.

The bottom line is that with integrated graphics, the TabPro S can play Minecraft with a few settings turned down, but forget trying to play Tom Clancy's *The Division*.

Since these ultraportable convertibles won't primarily be used for video editing or gaming, the more important test is office work. To evaluate a device's performance during tasks like word processing, email, and web browsing, we use PCMark 8's Work Conventional benchmark.

As expected, the results confirm that with enough RAM and an adequate SSD behind them, it's hard to tell the difference between Core m and Core i7 processors in these types of tasks. I can tell the

It isn't perfect, but the Galaxy TabPro S is one heck of an impressive tablet.

difference when I drop to a more budget chip, like an Atom X7, but within the range of "Core" tablets and laptops, you'll get a similar experience in most office tasks.

Battery Life

Where the Galaxy TabPro S really knocks our socks off is battery life. (Though there's a caveat with that.) As mentioned earlier, an OLED panel doesn't backlight the entire screen—so unlike a standard LED display, a pixel won't consume power when displaying black. That means lower power consumption, and thus a much better battery life. When paired with an average-sized battery, you'll get much more longevity out of a device that uses an OLED screen instead of an LED display.

That's definitely the case for the Galaxy TabPro S, which uses a

39-watt-hour battery. In our rundown test, in which we play a 4K video repeatedly using Windows 10's Movies & TV application, the TabPro S gave us almost nine hours of playback.

For contrast, Microsoft's Surface Pro 4, which has a traditional IPS screen (and, admittedly, a more power-hungry Core i5) runs out of gas at about 6.5 hours. Dell's newest XPS 13 actually ties the TabPro S, despite its Core i5 chip. But the XPS 13 does so with a giant 57-watt-hour battery. For the TabPro S to match the Dell's battery-life performance is just phenomenal.

Admittedly, our test illustrates battery life in a scenario where there's a good amount of black on the screen, since with most movies, you have two black bars at the top and bottom of the panel that don't drain energy due to the TabPro S's OLED screen. However, if you were using the machine for tasks where the screen is almost all white, you'd consume far more power, maybe even more than a standard IPS panel.

So depending on how you use the TabPro S between charges, your battery-life mileage may vary. As more OLED displays appear in the wild, we reviewers may begin using more than one battery test. For the moment, I can definitely say that OLED kicks butt for movie runtime.

Conclusion

In the end, the Galaxy TabPro S isn't the Surface Pro killer some may expect it to be…but it's an awesome little convertible, even with the keyboard's drawbacks and the curious screen-dimming behavior. If you can look past its foibles, that OLED panel alone makes this a worthy purchase. ⏻

Dell XPS 15 Review: A great laptop gets bigger and a little better

BY GORDON MAH UNG

IT DOESN'T TAKE a genius to realize that when you hit pay dirt, you might do so again if you keep digging in the same area. That's the tack Dell takes with its redesigned XPS 15 (go.pcworld.com/xps15redesigned) laptop: It's easily summed up as a bigger, more powerful version of the super-popular XPS 13 (go.pcworld.com/skylakexps13).

Bigger isn't always better, of course, but in the case of the XPS 15, it worked out pretty well. Its body has the same aluminum top and bottom. The familiar carbon-fiber keyboard deck is there, too. Also like the XPS 13, this XPS 15 features an ultrathin "InfinityEdge" bezel around its 15.6-inch screen.

The model I reviewed is midrange. That means a 1920x1080 resolution non-touchscreen, though a 4K Ultra HD screen with touch is available. Regardless of screen type, you get that 5.5mm-skinny bezel, and it makes for an impressive presentation—for comparison, HP's Spectre X360 15T (go.pcworld.com/hpspectrex36015t) has a 15mm-wide bezel. But oddly, the XPS 15's bezel didn't wow me the same way the original XPS 13's (go.pcworld.com/XPS13rev) vdid, even though both bezels are basically the same size.

The narrow bezel looks great except from this angle

Like its sibling, that thin bezel results in the same awkward camera placement. Instead of residing at the top of the screen, the XPS 15's camera sits in the lower left side. That means people who do a lot of typing during video calls had better mind their cuticles.

The slender bezel also means Dell had to do some gymnastics to

backlight the screen properly. This isn't something you would notice under normal circumstances, especially because it's an IPS panel and has good off-axis viewing angles. However, when I placed the XPS 15, HP Spectre X360 15T, and Samsung's Book 9 Pro in a dark room and cranked up the screen brightness of each, the XPS 15 showed more backlight bleed. I'd rate the Spectre X360 15T first in quality, with the Samsung Book 9 second.

The image quality on the XPS 15 is fine, but it's worth noting that the anti-reflective screen on our test unit will, basically by definition, look duller than the glossy displays on the HP and Samsung. What you give up in eye-catching pizzazz, though, you get back in greatly reduced glare.

Ports: a note about the USB-C

For ports, you get an SD card reader, a USB 3.0 Type A port, and a Kensington lock on the left side. On the right, you'll find

Dell XPS 15

PROS
· Reasonably compact and light
· Class-leading CPU and graphics performance
· Easy to open

CONS
· Backlight bleeding
· Some models should have optional larger battery available
· Keyboard should be a little larger

$1,450

★★★★⯪

a full-size HDMI and second USB 3.0 Type A port, combination analog audio jack, and a USB 3.1 Gen 2 10Gbps Type C port with Thunderbolt 3 support. Nothing wrong with this selection, but I'd like to put in a good word for those of us with older hard drives that require dual Type A plugs to get enough power. On the XPS 15, such an accessory wouldn't work without an optional adapter cable.

After initially testing the XPS 15 with several USB Type C power bricks, I assumed there was no support for charging through the laptop's USB Type C port using USB Power Delivery. It turns out I was wrong. At least about Dell wiring the port that way. The XPS 15's USB Type C port does indeed support charging but it appears to be pretty picky about what it supports. The unit would not charge with Innergie's PowerGear USB-C nor with a 45-watt brick for the HP Spectre X2. It also understandably failed to charge (when on) with two other lower power USB Type C bricks for a Samsung Windows convertible and Google's Pixel C brick. The one brick that did run the XPS 15 was the new Google Pixel and its 60-watt power brick.

One thing to note: The XPS 15 charger is actually a 130-watt power brick and when under a heavy graphics load, would suck down 90 watts. That means when using a lower-power brick like the Google

Dell's new XPS 15 gives you a lot more screen real estate than the award-winning Dell XPS 13.

Pixel's, it will actually discharge even when plugged in.

Still, it's nifty Dell also wired its XPS 15 to charge over both plugs but the success rate with Power Delivery over USB Type C really makes me thinks it's a mess (go.pcworld.com/usbccharging).

Keyboard and trackpad

I liked the original XPS 13's trackpad, so I'm happy to report that the XPS 15's appears to be made the same way—with the same piano hinge, and the same lightly rubberized coating—but taller by about an inch.

Strangely, though, Dell didn't take advantage of the increased real estate to make the keyboard larger. One of my main complaints about the XPS 13 is its keyboard size—it's just a skootch too small. That's the scientific measurement

> Strangely, though, Dell didn't take advantage of the increased real estate to make the keyboard larger.

for something that isn't a deal-breaker, but enough to notice. The travel is good, and unless you move to a laptop with a larger keyboard, it won't bug you.

Configuration

Just like mom told you, it's what's inside that counts—and the XPS 15's specs are mostly a win.

The CPU is a Skylake quad-core Core i7-6700HQ (go.pcworld.com/corei76700HQ), which is a 45-watt chip that will run from 2.6GHz to 3.5GHz on some workloads. It and the XPS 15's GPU are quite fast when you consider the size of the laptop, but here's the bad news: The CPU's soldered down, like all Skylake mobile laptop parts, and so is the machine's Nvidia GeForce GTX 960M GPU.

Here's the better news: The XPS 15 comes with a pair of user-replaceable DDR4/2133 SO-DIMMs modules, and an M.2 slot with BIOS support for PCIe devices. That means you could easily drop in larger RAM modules or upgrade the M.2 drive to something faster or bigger.

Dell actually offers two battery options for the XPS 15. Our review

unit features the smaller standard 56 watt-hour cell, but you can also get a much larger 84 watt-hour cell in some configurations. Generally, the bigger battery comes in models with the M.2 SSD, while the lower-end hard-drive configurations get the smaller battery.

Our particular configuration straddles the fence, though. It uses an M.2 SSD and has the room to fit the larger battery, but it comes with the smaller battery. I wouldn't mind giving up that battery capacity (which spills over into the hard-drive caddy) if the XPS 15 had the user option to install a second hard drive or SSD in the bay. Dell, however, doesn't include the actual ribbon cable that connects to a drive, so phooey. I suspect you could get the ribbon cable as a replacement part, but it would be a nice inclusion for upgraders.

Getting inside this laptop is super easy. You just have to back out a few Torx screws around the perimeter and two Phillips-head screws in the center.

CPU performance

The majority of people who pay the weight and price penalty for a 15.6-inch laptop want performance—and with the Dell XPS 15, you get it.

Cinebench R13 All Threads

Laptop	Score
Dell XPS 15 (Core i7-6700HQ)	681
Samsung Book 9 Pro (Core i7-6700HQ)	644
Surface Book (Core i7-6600U)	320
Samsung TabPro S (Core i7-6500U)	318
HP Spectre X2 (Core i5-6300U)	307
Surface Pro 4 (Core i5-6200U)	290
Dell Venue 11 Pro (Core i5-6200U)	289
Samsung TabPro S (Core i5-4300U)	250
HP Spectre X2 (Core m3-6Y30)	213
Surface Pro 4 (Atom X7-8700)	124
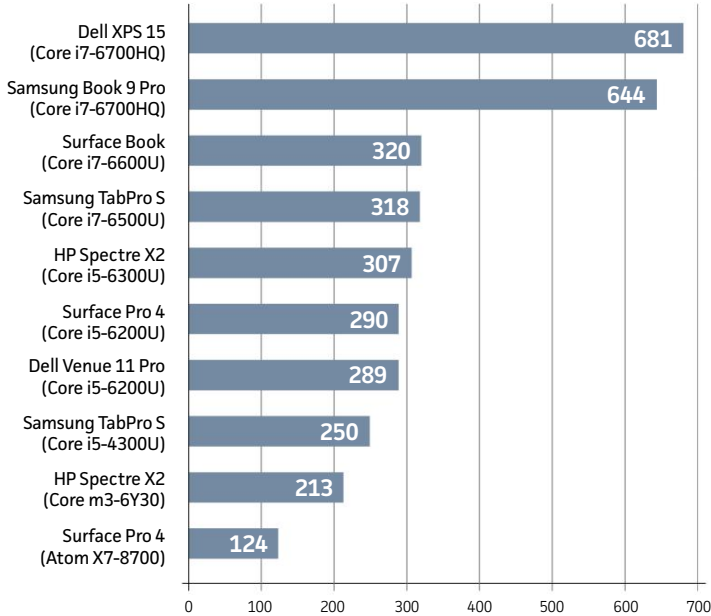
LONGER BARS INDICATE BETTER PERFORMANCE

The Dell XPS 15 destroys dual-core laptops and is a tiny bit faster than Samsung's new Book 9 Pro too in Cinebench R15.

First up is Cinebench R15, which is a benchmark based on Maxon's 3D rendering engine. It's a pure CPU benchmark and the XPS 15 leads the pack. I picked out a set of dual-core ultrabooks to compare it to, as well as the Samsung and HP's dual-core 15-inch Spectre.

Most of these laptops illustrate just what you get from a dual-core CPU versus a quad-core CPU. In a heavy-duty 3D rendering test, the quad-core shows that the price you pay for that level of processing power is worth every extra dollar gone from your wallet (and additional ounce on your back).

If you're wondering why the XPS 15 is faster than the Samsung Book

9 Pro—despite having the same chip—it's because the XPS 15 runs its CPU at a slightly higher clock speed under load.

Handbrake performance

That CPU superiority in Cinebench also shows in our Handbrake test, where we use the free program to transcode a 30GB MKV file into an Android tablet–friendly MP4. The performance in Handbrake should give a good idea of the XPS 15's video-editing performance in general. Anyone doing video editing or 3D rendering with a laptop will probably be rolling larger laptops like these quad-cores.

Handbrake 0.9.9 encode (sec)

Laptop	Seconds
Dell XPS 15 (Core i7- 6700HQ / GTX 960)	3,226
Samsung Book 9 Pro (Core i7-6700HQ / GTX 950)	3,385
Surface Book (Core i7-6600U / GT 940)	6,360
Toshiba Radius 12 (Core i7-6500U / HD 520)	6,196
Surface Pro 4 (Core i5-6300U / HD 520)	6,428
HP Spectre X360 15 (Core i5-6200U / HD 520)	6,815
Dell XPS 13 (Core i5-6200U / HD 520)	7,728
Surface Pro 3 (Core i5-4300U / HD 4400)	11,815
Asus Zenbook UX 305 (Core m3-6Y30 / HD 515	11,569
Surface 3 (Atom X7-8700 / HD)	14,400

SHORTER BARS INDICATE BETTER PERFORMANCE

No surprise: the quad-cores also smoke the dual-cores in our Handbrake transcoding test.

Office drone performance

If you just want to know if it's worth having that quad-core for office-drone work, both the long and short answer is "No."

As you can see from our PCMark 8 Work Conventional test, which simulates everyday office tasks, this Dell is ahead of the pack—but not in any exciting way. For the most part, you'll never feel the difference between a quad-core Core i7 and a low-power Core m in office tasks. If you really only do just office work, it makes more sense to buy a different laptop.

PCMark 8 Work Conventional

Laptop	Score
Dell XPS 15 (Core i7-6700HQ)	3,394
Samsung Book 9 Pro (Core i7-6700HQ)	2,939
Surface Book (Core i7-6600U)	2,744
Toshiba Radius 12 (Core i7-6500U)	3,114
Surface Pro 4 (Core i5-6300U)	2,613
HP Spectre X360 15 (Core i5-6200U)	2,913
Dell XPS 13 (Core i5-6200U)	2,887
Surface Pro 3 (Core i5-4300U)	2,810
Asus Zenbook UX305 (Core m3-6Y30)	2,672
Surface 3 (Atom X7-8700)	1,311

LONGER BARS INDICATE BETTER PERFORMANCE

The Dell XPS 15 is the fastest here, but who cares when you're doing office drone work?

Gaming performance

Besides the quad-core CPU, the other performance highlight of the XPS 15 is its GeForce GTX 960M chip. On paper, it's very similar to the Samsung Book 9 Pro's GeForce GTX 950M. Both have the same 128-bit memory 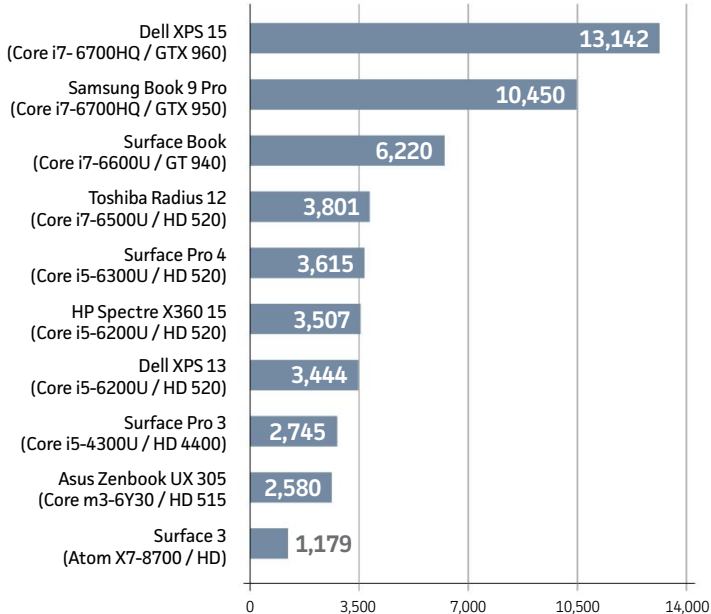bus, 80GBps of memory bandwidth, 640 shader cores, and a memory speed of 1,253MHz. The key difference between the two is clock speed: The Samsung's GPU clock is set to 915MHz with a boost speed of 928MHz. The Dell's GPU clock is rated at 1,033MHz with a boost speed of 1,098MHz.

That's the reported specifications, though. Laptop makers can tune the clock speeds to match the cooling capability, or they can choose to minimize fan noise by sacrificing speed. Running a Furmark stress test on both laptops reveals that Dell likes to push performance to the wall for as long as it can. The XPS 15 actually starts a little above its top boost speed of 1,098MHz, while the Book 9 Pro starts underclocked at 750MHz.

After five minutes of this torture test, the XPS 15 held strong with clock speeds at 1,085MHz range. After 15 minutes, it dropped down to a still very respectable 1,019MHz. As for the Samsung—I'll get into its

After 45 minutes of the Furmark stress test, the Dell XPS 15 showed no signs of throttling back on performance. I can't say the same of its competitors.

3DMark Sky Diver Overall

Laptop	Score
Dell XPS 15 (Core i7- 6700HQ / GTX 960)	13,142
Samsung Book 9 Pro (Core i7-6700HQ / GTX 950)	10,450
Surface Book (Core i7-6600U / GT 940)	6,220
Toshiba Radius 12 (Core i7-6500U / HD 520)	3,801
Surface Pro 4 (Core i5-6300U / HD 520)	3,615
HP Spectre X360 15 (Core i5-6200U / HD 520)	3,507
Dell XPS 13 (Core i5-6200U / HD 520)	3,444
Surface Pro 3 (Core i5-4300U / HD 4400)	2,745
Asus Zenbook UX 305 (Core m3-6Y30 / HD 515	2,580
Surface 3 (Atom X7-8700 / HD)	1,179

LONGER BARS INDICATE BETTER PERFORMANCE

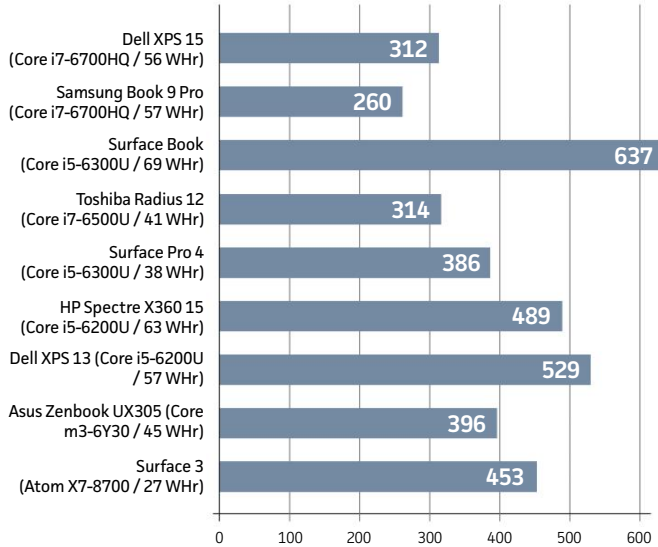**The GeForce GTX** 960M has a nice edge on the other GPUs.

performance when I write that review, but for now, let's just say its GPU clocks plummet off a cliff as time goes on. The Book 9 Pro's fans are definitely quieter, though.

Translated into gaming performance, I'd say the XPS 15 will play a lot of games set to Reasonable. No, that's not an official game setting, but it should be for people who don't have high-end graphics cards. The short of it is, the XPS 15's 960M is a decent entry-level gaming GPU.

Battery life

For our battery rundown test, we play a 4K Ultra HD video file using Windows 10's built-in media player. We set the screen brightness at

4K Video Rundown Bright Screen (min)

Laptop	Minutes
Dell XPS 15 (Core i7-6700HQ / 56 WHr)	312
Samsung Book 9 Pro (Core i7-6700HQ / 57 WHr)	260
Surface Book (Core i5-6300U / 69 WHr)	637
Toshiba Radius 12 (Core i7-6500U / 41 WHr)	314
Surface Pro 4 (Core i5-6300U / 38 WHr)	386
HP Spectre X360 15 (Core i5-6200U / 63 WHr)	489
Dell XPS 13 (Core i5-6200U / 57 WHr)	529
Asus Zenbook UX305 (Core m3-6Y30 / 45 WHr)	396
Surface 3 (Atom X7-8700 / 27 WHr)	453

LONGER BARS INDICATE BETTER PERFORMANCE

The 56 watt-hour battery gives you okay battery life, but I wish Dell offered the larger 84 watt-hour cell in this configuration too.

250 to 260 nits, which is good for watching a movie in office lighting. Considering its higher-wattage CPU and larger screen, the XPS 15 does reasonably well with just over five hours of run time.

This particular model is helped by its lack of a power-eating touchscreen and its modest, 1920x1080 display. Although it's not a true 1:1 comparison, I'd bet Samsung Book 9 Pro's briefer runtime comes from its high-resolution 4K touchscreen.

For this particular model, you can mitigate the shorter battery life with Dell's optional battery pack, which will let you run and charge the laptop from it. In higher-end configurations with the 84 watt-hour battery, I'd expect to squeeze out at least another few hours.

Here's the original Dell XPS 13 sitting on top of a MacBook Air 13. Both, by the way, feature the same size screen.

It's small but…

For its class, the redesigned XPS 15 is fairly compact and blisteringly fast. However, it's not as revolutionary as the XPS 13's overhaul. With that laptop, Dell basically crammed a 13-inch screen into a body that usually fit an 11-inch screen. Compared to the MacBook Air 13, for example, the XPS 13's extremely small footprint was game-changing.

The XPS 15 certainly has the smallest footprint of the 15.6-inch laptops we've seen, but it's not that much smaller. On the next page is a shot of the XPS 15 next to its contemporaries and an XPS 13. HP's Spectre X360 15T is almost comically wide, but that Samsung next to it is barely half an inch smaller in both directions.

The XPS 15 is very light considering what's inside it. Our scale put it at 4 pounds and 2 ounces—just half an ounce lighter than the HP Spectre X360 15T. While the glass touchscreen of the HP adds to its weight, the Dell has to keep both a discrete GeForce GTX 960M and quad-core cool. So hats off to the XPS 15. The HP does have slightly less body flex when squeezed, but neither feels hollow.

The power bricks balance out the weight issue. The Dell's is big and

heavy, bringing the total weight to 5 pounds and 7 ounces compared to the HP and its tiny brick, which total 4 pounds and 8 ounces.

Carrying the XPS 15 around in your hands is a pleasure, thanks to the rubber strips on the bottom. A lot of these metal-bodied laptops feel like they're just one slip away from disaster, but you'd have to try to drop the XPS 15 for destruction to happen.

Conclusion

The XPS 15's keyboard could be bigger. The backlight-bleeding issue could use some work. But the overwhelming amount of people interested in this size of laptop buy these machines for performance, and that's where the XPS 15 shines.

Sure, it's not quite the tiny, game-changing laptop that the XPS 13 was, but that's not entirely fair. As anyone who has suffered sibling rivalry knows, *sibling* means "sibling." Not "twin." Siblings have to find their own path forward, not just follow, and the XPS 15 does that quite well. ⏻

The XPS 15 has the smallest footprint of the 15.6-inch laptops we've seen. Clockwise from top left: Dell's XPS 13, HP's Spectre X360 15T, Samsung's Book 9 Pro, Dell's XPS 15.

Toshiba Satellite Radius E45W-C4200X: An affordable, fully reversible laptop

BY JON L. JACOBI

FOR $500 MSRP (and as low as $350 on sale), the E45W-C4200X (go. pcworld.com/E45WC4200amz) is a lot of laptop. Not many similarly priced products offer a fully reversible 14-inch touchscreen display—as a matter of fact, I can't think of one.

It's true the E45W-C4200X's display is "only" 1366x768, but to a lot of people that won't matter. Yes, 1080p video won't look as sharp, but given the laptop's price and features, it's pretty easy to overlook that.

Configuration and performance

Our test E45W-C4200X featured a Core i3-5015U CPU, 6GB of DDR3/1600 memory, and a 500GB 5400rpm HGST hard-disk drive. That storage disk isn't fast, testing at a tortoise-like 60MBps, but its performance is well within the expected range for a platter-based drive running at that speed. You also get 802.11ac Wi-Fi and Bluetooth 4.0, along with two USB 3.0 type A ports, full-size HDMI output, and an SD card slot. There's no ethernet jack, however. You'll need to carry a USB-to-ethernet adapter for a hardwire connection.

The E45W scores of 2,498 in PCMark 8's Work Conventional and 2,007 in Creative Conventional were a tad misleading. On paper, those scores indicate moderately paced performance in office and some content-creation tasks, but in practice, I experienced noticeable wait times when opening programs and booting the machine.

That's largely because of the aforementioned slothful hard drive. Upgrading the E45W with an SSD

The E45W-C4200X in "tent" mode.

Toshiba Satellite Radius 14 E45W-C4200X

AT A GLANCE

Despite the low price, the E45W's build quality holds its own against laptops and 2-in-1 machines costing several hundred dollars more. Its hard drive is slow, but overall performance is fine once Windows is fully loaded.

PROS

· Reversible touch display

· Good entry-level performance
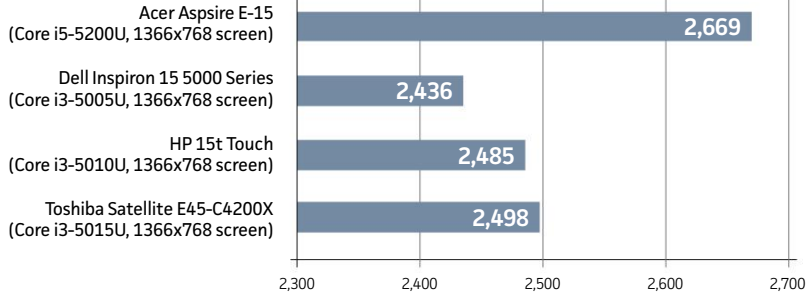
· Better than average keyboard

CONS

· Slow hard drive

$500

★★★☆☆

PCMark 8 Work Conventional (Native Resolution)

Acer Aspsire E-15 (Core i5-5200U, 1366x768 screen)	2,669
Dell Inspiron 15 5000 Series (Core i3-5005U, 1366x768 screen)	2,436
HP 15t Touch (Core i3-5010U, 1366x768 screen)	2,485
Toshiba Satellite E45-C4200X (Core i3-5015U, 1366x768 screen)	2,498

LONGER BARS INDICATE BETTER PERFORMANCE

should provide substantial improvement in performance, but it'll take a little more elbow grease than with other laptops. You'll have to remove 10 screws on the back, then apply a spudger along the seam. (You'll start at the right rear edge of the seam between the keyboard deck and the back cover.) The work is worth it, though: The battery, hard drive, and memory are in plain view once you get the back cover off. Just remember that performing such an upgrade typically voids your warranty.

Getting access to the laptop's components takes a bit of work, but it's not difficult.

During our rundown test of the E45W's battery, in which we play a 4K Ultra HD movie file using Windows 10's native video player, this 2-in-1 machine lasted for 6 hours and 20 minutes. You can't compare

that directly with most of our other laptop reviews, however, as the E45W's display hits a maximum brightness of only 205 nits. We typically test at 250 nits unless explicitly stated otherwise.

Note that with a screen that tops out at 205 nits, the E45W may have more of an issue with bright sunlight than other laptops that can fight back with some brightness of their own. In our test locations, which use typical fluorescent lighting, the screen was easy to view.

Toshiba does load a fair amount of "value-added" software on the E45W, like Wild Tangent Games, SocialSafe, Insteon, and more. There are also the usual Toshiba utilities and McAfee antivirus software. In my opinion, system performance perked up quite a bit after I removed the majority of it.

Design and Styling

Performance is all well and good, but that's not the entirety of a laptop's experience. For the most part, the E45W's non-hardware attributes can be best summed up as "very acceptable," particularly given that $500 price tag.

The E45W's dimensions are 13.3 x 9.3 x 0.85 inches, and it weighs in at a rather hefty 5 pounds, but it'd be unrealistic to expect a thin-and-light machine for this cheap. That said, I never had the feeling I was dragging around one of the anchors we had to endure a couple of decades ago.

The E45W-C4200X's keyboard and touchpad are better than you'd expect in this price range, though the latter can be a bit sensitive.

As for looks, I'm neutral about our E45W review unit's appearance. Our review unit was charcoal gray with a slate texture and a pewter-colored keyboard deck—low-key, to be sure. (Of course, beauty is in the eye of the beholder.)

I have stronger opinions about the keyboard and trackpad: I found typing on the E45W's Chiclet-style keyboard pleasant enough, though the rebound was slower than ideal. The layout was spacious, and Toshiba has nicely offset the editing and navigation keys in their own column. I don't mind a nonstandard configuration when it's easy to learn and doesn't affect the main typing layout.

The touchpad is a one-piece, piano-hinge type with integrated buttons. As expected, it's harder to press closer to the top, but overall, the tactile feedback it gives when clicked on is pleasantly solid. It seemed under-sensitive to tapping, though. Normally I have the opposite complaint and disable tapping for being too sensitive for my ham-handed ways. On the other hand, touch sensitivity on the ten-point display digitizer was nigh on perfect.

As a 2-in-1 style laptop, the E45W's fully reversible display allows you

to use it like a tablet, if you so choose, as well as in a few other configurations such as a tent-like mode. Off-axis viewing is good enough for these different positions to work, even if not what you'd experience with an IPS panel.

Conclusion

A Toshiba laptop served as my travel workhorse for several years back in the day. I liked it, but haven't since used another of the company's machines. That wasn't for any particular reason—it was just the way things worked out. However, if the E45W-C4200X is any indication of what the company is up to these days, I may have been missing out. ⏻

The E45W-C4200X in tablet mode. At 5 pounds, it's only usable as such on your lap.

Synology DiskStation DS216+ : This NAS box can stream 4K UHD movies

BY JON L. JACOBI

NAS BOXES ARE nigh on perfect devices for storing and streaming your multimedia collections—music, video, and photograph— throughout your home. Traditionally, however, that streaming hasn't included UHD/4K/2160p video, which requires a fair bit of CPU power. Enter Synology's DS216+ (the box Synology sent us for testing; go. pcworld.com/synologyDS216) and it's new DSM 6.0 operating system.

Before you get too stoked, Synology's NAS boxes can only transcode 2160p to 1080p (or a lower resolution, depending on the device receiving the stream). The same goes for Synology's chief rival QNAP. That means you can stream UHD/4K, but not at its true resolution. Note that I'm talking about using Synology's integrated Video Station player or its DLNA server. You can open any file directly and play it at full resolution if your TV or device supports network browsing and has the computational horsepower.

DS216+

The $300 (drives not included) DS216+ is one of Synology's faster consumer NAS boxes—the reason the company sent it to us to test the transcoding. It's outfitted with an Intel Celeron N3050, 1GB of memory, and with two drive bays, so you can add up to 16TB of storage. In our copy tests, writes and reads of a single 20GB file proceeded at about 109MBps, and with a more strenuous 20GB mix of smaller files and folders, at about 63MBps. That's fast for consumer-grade NAS, and it makes the DS216+ a very good repository for backups—more on that subject later.

The DS216+ has two USB 2.0 ports on the back, and a single USB 3.0 port on the front for copying files to the box. There's a dedicated copy button on the front panel: Pressing it will transfer all the files from a USB drive to the box. There's also a single gigabit ethernet port, and somewhat oddly for a small office/home box of recent vintage—an eSATA port. A full-on USB 3.x (5Mbps/10Mbps) port would be a better fit for the intended market.

To test transcoding and streaming I loaded the DS216+ with numerous test files, including about a dozen 2160p (UHD 3840x2160 and 4K 4096x2160) videos. I played files using Synology's in-browser Video

Synology DiskStation DS216+

AT A GLANCE
The ability to transcode 2160p video files in real time is this NAS box's best feature by far.

PROS
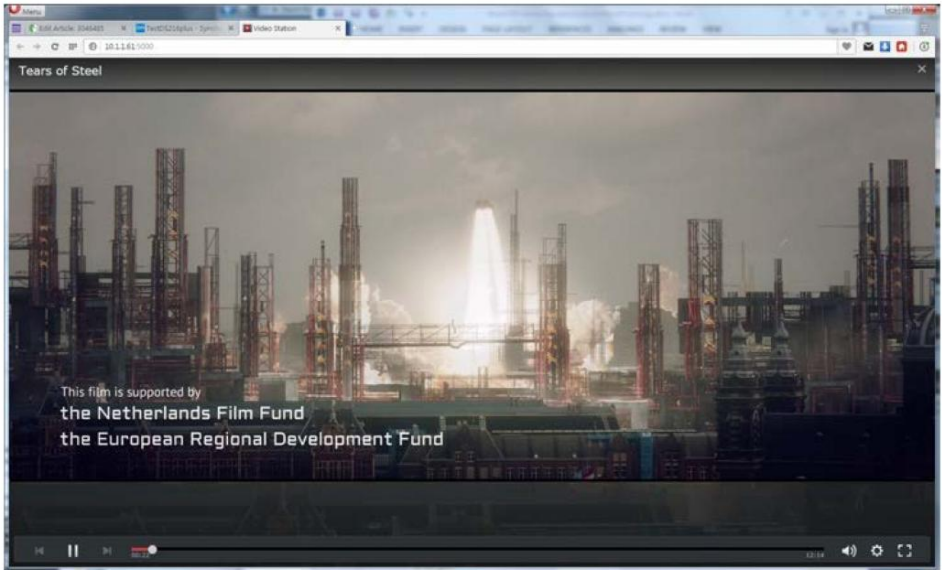· Very good performance
· Excellent multimedia streaming features
· Handles numerous small office tasks

CONS
· A bit pricey
· eSATA rather than SuperSpeed USB port for external storage

$349 ($300 online street price)

★★★★★

Station player; streamed them to Windows Media Player augmented with the LAV DirectShow filters; and as a control test, played them back directly using Media Player Classic Home Cinema, which was also set to use the latest version of the LAV filters.

Everything up to and including 1080p played or streamed fine. 2160p videos (AVC and HEVC) played well also, at least those limited to about 30 frames per second and around 6 megabits per second (HEVC) or 20Mbps (AVC). AVC is a lot easier to process than the more heavily compressed HEVC. Beyond that, both audio and video stutter began to creep in; 60fps files weren't recognized. My only other complaint is that the downscaling in Video Station could have used more antialiasing in areas with lots of fine detail.

As I mentioned up front, you can bypass the streaming and transcoding to play files directly if your device supports playing files from network locations. Doing that with MPC-HC, everything played just fine, including 20Mbps/60fps 2160p.

Synology's audio support is nothing short of fantastic. The list of

Tears of Steel playing inside Synology's browser-based Video Station. Videos up to 1080p play quite well in the app, though this 4K rendering was very jerky.

supported types includes FLAC, MP3, WMA, M4A, Ogg, Ape, both Apple and Windows lossless, as well as all wave files from 44.1kHz/16-bit to 96kHz/32-bit—including 5.1- and 7.1-channel surround types. That's everything I have in my collection of test files outside of Opus and an ancient VQF file that's long outdated. You can play any of the supported types using the included Audio Station app or streamed via DLNA.

Supported image formats include JPEG, BMP, GIF, PNG, and TIFF.

DSM 6.0

DSM, or DiskStation Manager, is the operating system for Synology's NAS boxes. As with rival QNAP's QOS, it's a full windowing system that works within your browser. Words can't do it justice. It works just like Windows, Linux (which it actually is), or OS X with clicking, dragging, lassoing, etc.

Version 6.x brings the operating system into the 64-bit world, which is of marginal value to most home users, but will allow more onboard memory in the Synology's high-end boxes. DSM 6.0 also supports Btrfs (B-tree file system) with its copy-on-write (COW) technology that allows for easy cross-device storage pools and data snapshots.

Beyond streaming multimedia, just some of the other things you can do with a Synology NAS box

The inclusion of an eSATA port on the DS216+ is a bit old-school for a modern SOHO NAS box.
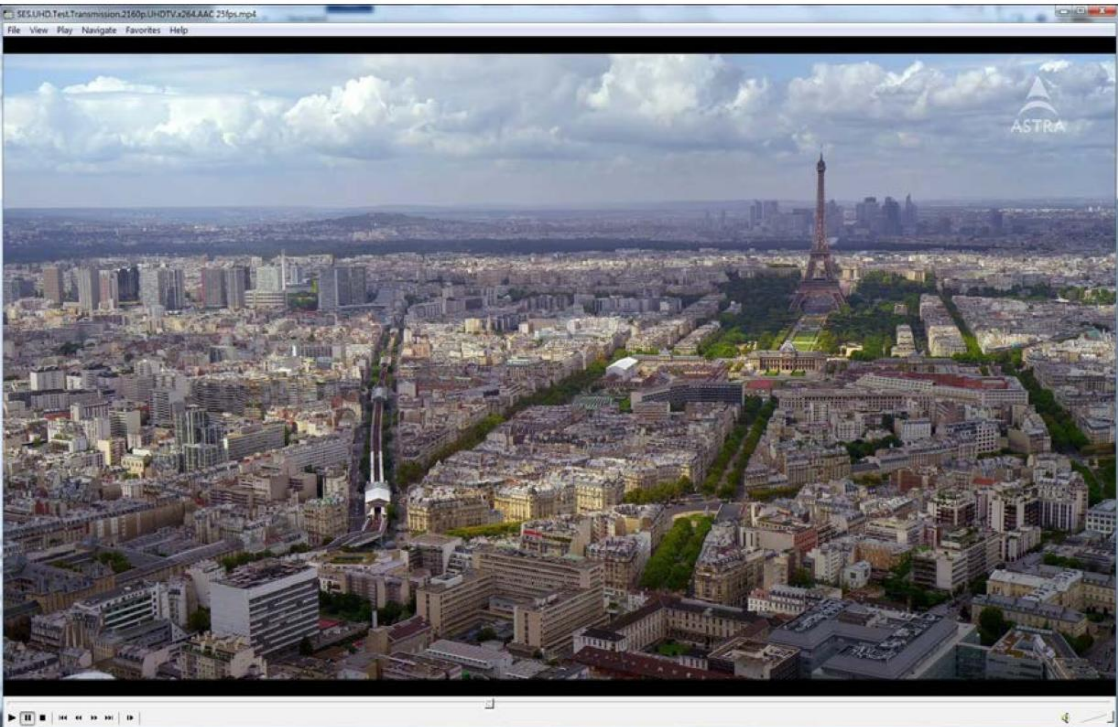
are record and browse the output of at least one Webcam, create your own email server, and—its newest feature—collaborate with other users on spreadsheets. No doubt word processing and presentations will eventually be added to the mix. Then there's the ability to watch and record TV (with a USB tuner attached), Wi-Fi connectivity (with an 802.11x dongle attached), and more.

There's also a new MailPlus app and server that supports up to five users for free. It's quite a bit slicker than the normal MailServer application and has dedicated apps for Android and iOS devices. Speaking of which, Synology provides mobile apps for viewing images, videos, etc. stored on the box. There's a lot more, but I'll have you visit Synology's website (go.pcworld.com/synologyDS216) for further details.

A 2160p video played directly, and quite smoothly, from the DS216+ using MPC-HC on a Windows PC. (Captured on a 1920x 1200 display.)

Save your stuff

Though this article is focused on multimedia serving, the DS216+ and DSM 6.0 also provide excellent backup services. In addition to Time Machine support for Macs, this Synology offers its own Cloud Station with clients for Windows, OS X, Linux, Android, and iOS. Yes, you can keep all your PCs and mobile devices backed up to the Synology box. My only issue with this was that during a rather large 400GB initial backup, the client used too much bandwidth. There's no throttle setting, so I had to pause the sync process when I needed to use another network application.

New to the mix are an improved version of the Backup & Restore app called Hyper Backup Vault, and Snapshot Replication, which leverages the new Btrfs file system's snapshot capabilities. You can also sync multiple NAS boxes (even other vendors', if they support RSync) anywhere in the world. There are also apps that back up and/or sync to S3, Glacier, DropBox and other online services.

No, that's not Linux, it's the DiskStation Manager operating system that works inside of your browser—Opera, in this case.
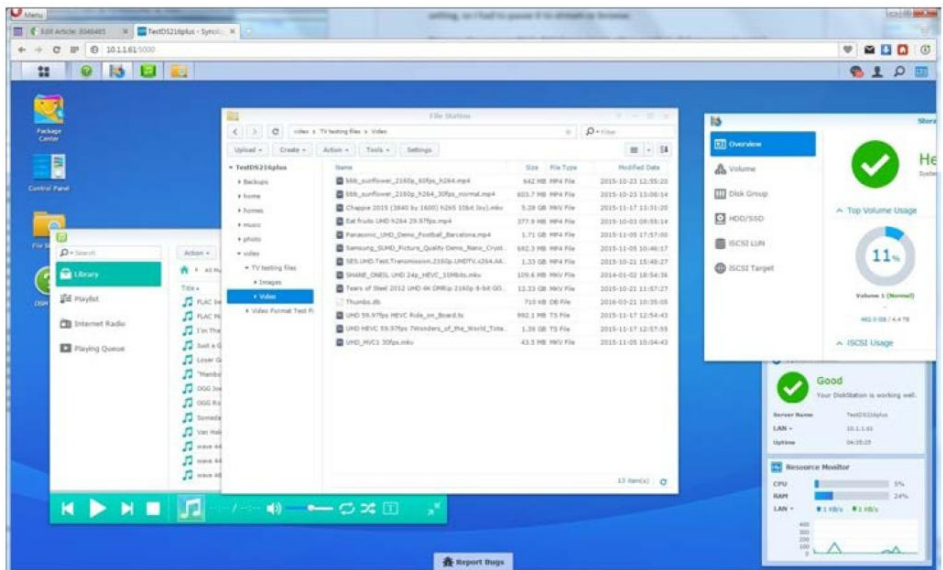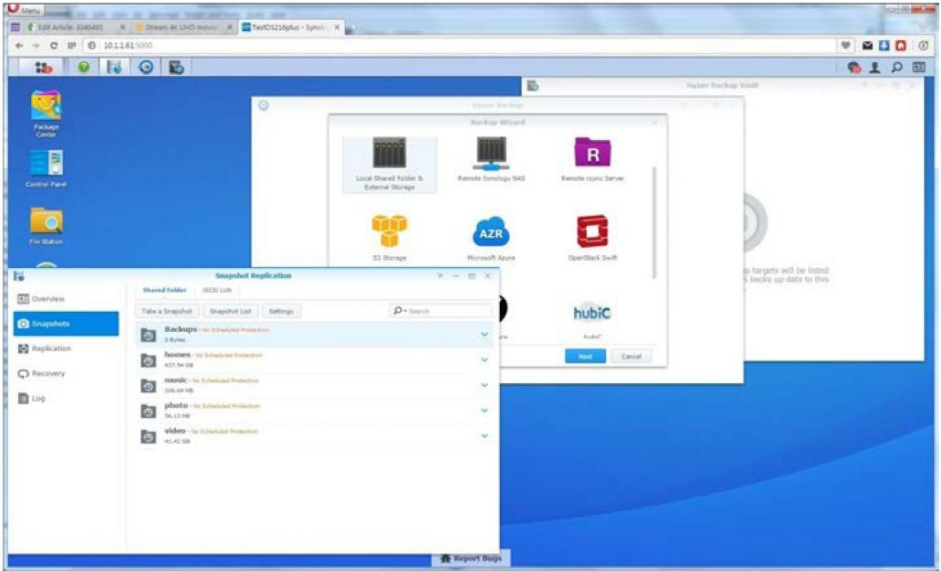
Conclusion

The Synology DS216+ is a great little box, and streams multimedia as well as any NAS box in its class. If you're looking for a central repository for your songs, photos, and movies that any device in your house can access, you could do far worse.

But if you're not dead set on the 2160p transcoding, you can get away far cheaper with other NAS boxes—including Synology's less-expensive models, of which there are many. When simply opening and playing files from a network drive, I'm able to play 4K/UHD files just fine from a far older Synology DS411 Slim.

DSM 6.0 brings Synology's boxes up to snuff in terms of backup, replication, snapshots, and spreading storage across multiple devices. Those are features more of interest to business users than multimedia mavens, but they're welcome nonetheless.

One caveat on the whole NAS for multimedia deal: Streaming and accessing files on a NAS box is simple enough for anyone, but setup requires a fair amount of tech savvy. 🔴

Synology's backup options are numerous and impressively capable.

Best AC1900 Wi-Fi router: Buffalo WXR-1900DHPD vs. Linksys EA7500

BY MICHAEL BROWN

FOR MOST PEOPLE, an AC1900 Wi-Fi router hits the sweet spot. It delivers enough speed to support media streaming, and enough features to handle the needs of most homes without blasting a hole in your pocketbook. This type of router isn't the most powerful, but it's much less expensive than higher-end routers equipped with all the latest whiz-bang features.

This review compares two of the newer contenders: the Buffalo WXR-1900DHPD (go.pcworld.com/wxr1900dhp, notable for its use of

open-source DD-WRT NXT firmware), and the somewhat more conventional Linksys EA7500 (go.pcworld.com/ea7500linksys, one of the lowest-price routers to offer MU-MIMO, go.pcworld.com/mu-mimo).

I'm not a big fan of the router industry's methodology when it comes to identifying 802.11ac router speeds. Manufacturers sum the maximum theoretical speeds available on each frequency band (often rounding up or down) and precede that with the letters AC.

The Buffalo WXR-1900DHPD and Linksys EA7500 routers reviewed here are classified as dual-band AC1900 routers because they deliver maximum throughput of 1300Mbps on the 5GHz frequency band and 600Mbps on the 2.4GHz frequency band. You will never see real-world speeds anywhere close to those numbers, because they don't take protocol overhead and other factors into consideration. But, generally speaking, an AC1900 router will be faster than an AC1300 router (867+450) and slower than an AC2400 model (1734+600).

You also need to look at more than benchmarks to determine a router's true value. If a router doesn't support all the features you need, it could deliver the fastest throughput and the longest range in the world, but not be the right solution for your needs.

Neither the USB 3.0 port on the front of the Buffalo WXR-1900DPHD Wi-Fi router nor the USB 2.0 port on the back are functional.
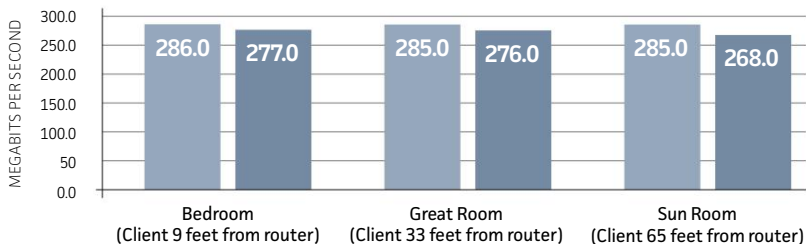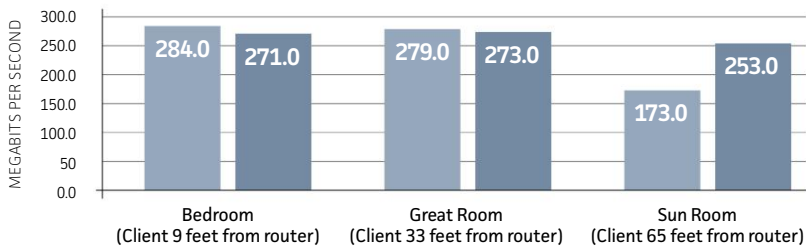
Continued: **Best AC1900 Wi-Fi router**

Buffalo WXR-1900DHPD vs. Linksys EA7500

5GHz 802.11ac Performance, Channel 153
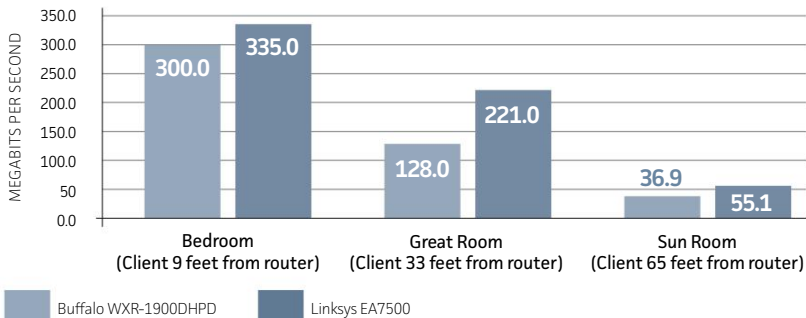(paired with 3x3 D-Link DWA-192 Wi-Fi adapter)

	Buffalo WXR-1900DHPD	Linksys EA7500
Bedroom (Client 9 feet from router)	286.0	277.0
Great Room (Client 33 feet from router)	285.0	276.0
Sun Room (Client 65 feet from router)	285.0	268.0

MEGABITS PER SECOND

Channel 36

	Buffalo WXR-1900DHPD	Linksys EA7500
Bedroom (Client 9 feet from router)	284.0	271.0
Great Room (Client 33 feet from router)	279.0	273.0
Sun Room (Client 65 feet from router)	173.0	253.0

MEGABITS PER SECOND

5GHz 802.11n Performance
(paired with a 3x3 Interl Centrino Ultimate-N 6300 Wi-Fi adapter)

	Buffalo WXR-1900DHPD	Linksys EA7500
Bedroom (Client 9 feet from router)	300.0	335.0
Great Room (Client 33 feet from router)	128.0	221.0
Sun Room (Client 65 feet from router)	36.9	55.1

MEGABITS PER SECOND

Buffalo WXR-1900DHPD   Linksys EA7500

With a Windows PC as a client, Buffalo edged out Linksys in most of my 802.11ac benchmarks, but its Wi-Fi performance doesn't make up for its lack of features.

That's particularly true of Buffalo's WXR-1900DHPD. While enthusiasts will be drawn to its DD-WRT NXT open-source firmware, that firmware in its current iteration seems half-baked in that it doesn't expose all of the router's hardware features. The router's USB 2.0 and USB 3.0 ports, for instance, are completely nonfunctional.

When I benchmarked the Buffalo WXR-1900DPHD using a Windows 10 desktop PC as a server and a Windows 10 laptop outfitted with a D-Link DWA-192 USB 3.0 Wi-Fi adapter as a client, it edged out the Linksys EA7500 at close range while using channel 36 on the 5GHz frequency band (it didn't fare as well at long range). What's more, it performed even better (including at long range) when I switched the router to operate on channel 153 on the 5GHz frequency band.

> If you're only concerned about raw performance, and you're running Windows, then Buffalo's router might better suit your needs.

When I benchmarked its performance with an 802.11n client on the 5GHz frequency band, on the other hand, the Linksys delivered the superior performance—and by much higher margins.

Wireless performance with a Windows client

Check out the benchmark charts on the previous page to see how the two routers fared against each other on Windows. If you're only concerned about raw performance, and you're running Windows, then Buffalo's router might better suit your needs.

Wireless performance with a Mac client

Interestingly enough, I had a very different experience on the Mac platform: The Linksys clobbered the Buffalo on both 802.11ac channels and at every test location (the MacBook Pro I use for benchmarking has an onboard 3x3 802.11ac adapter, so I didn't perform 802.11n benchmarks with it). Either router will deliver enough bandwidth and
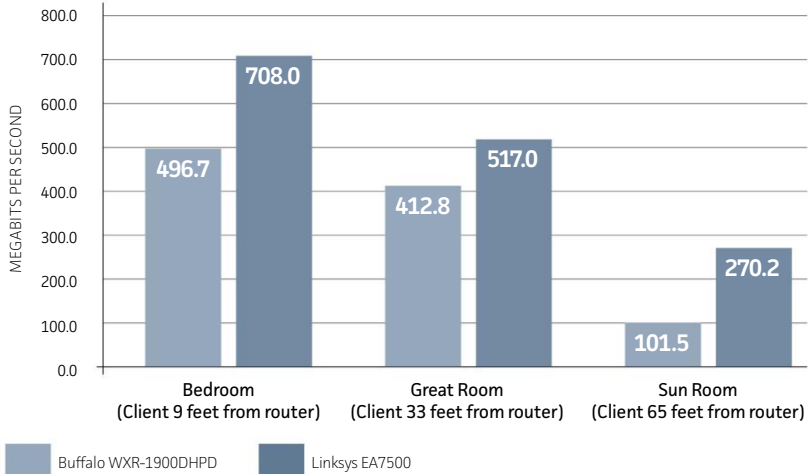
Buffalo WXR-1900DHPD vs. Linksys EA7500

5GHz 802.11ac Performance, Channel 36
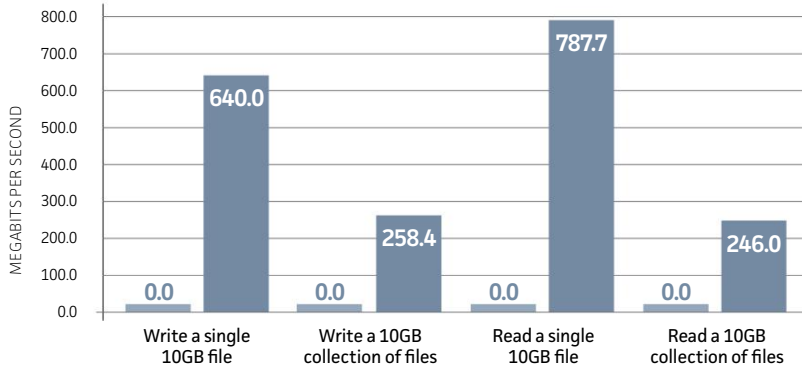(paired with a late 2013 MacBook Pro with a 3x3 802.11ac adapter)
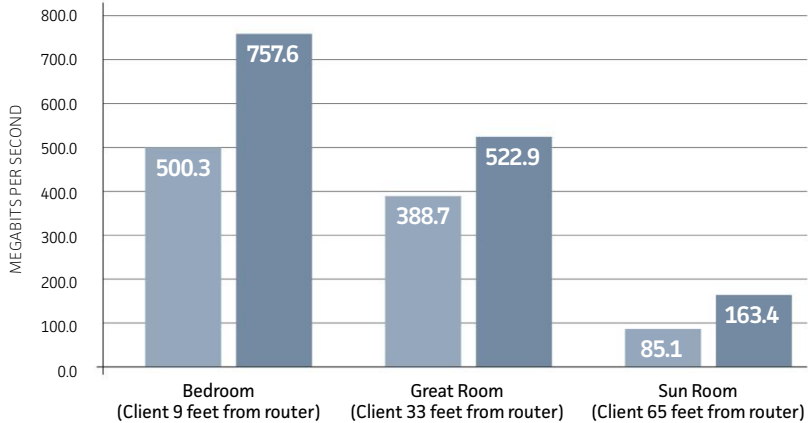
Channel 153

When using a MacBook Pro as an 802.11ac client, the Linksys EA7500 thrashed Buffalo's WXR-1900DPHD on both the low and high channels.

speed to stream 4K video, but if you have a Mac client, the Linksys
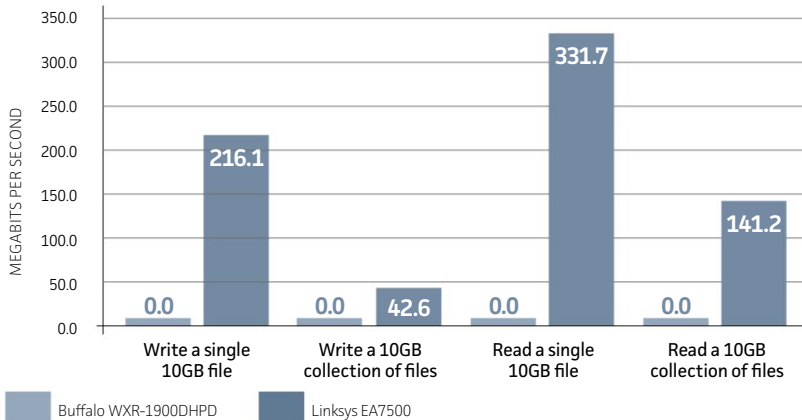EA7500 will deliver more of both—as well as better range, too. Just look
at the victories in the charts on the previous page.

Buffalo WXR-1900DHPD vs. Linksys EA7500

Read/Write NAS Performance
(file transfers between portable USB 3.0 SSD and an SSD in a networked PC)

MEGABITS PER SECOND

	Write a single 10GB file	Write a 10GB collection of files	Read a single 10GB file	Read a 10GB collection of files
Buffalo	0.0	0.0	0.0	0.0
Linksys	640.0	258.4	787.7	246.0

(file transfer between a portable USB 3.0 SSD and the mechanical hard drive in a networked mid-2011 iMac)

MEGABITS PER SECOND

	Write a single 10GB file	Write a 10GB collection of files	Read a single 10GB file	Read a 10GB collection of files
Buffalo	0.0	0.0	0.0	0.0
Linksys	216.1	42.6	331.7	141.2

Buffalo WXR-1900DHPD   Linksys EA7500

The Linksys EA7500 is very fast when it comes to network-attached storage. The USB ports on Buffalo's WXR-1900DHPD are useless.

Network-attached storage performance

If you don't want to spring for the cost of a NAS box, you can plug a USB storage device into the Linksys EA7500 and use it to share files or stream media over your network. This will work on both the Mac and PC platforms, but Mac users won't be able to use that storage for Time Machine backups.

The Linksys EA7500 is very fast when it comes to transferring files to and from a computer hardwired to the network. I'm using a hardwired connection to measure storage performance in order to remove the Wi-Fi bottleneck. But don't compare the PC numbers to the Apple numbers. I used portable SSDs with USB 3.0 ports for both tests, and the Windows PC I used has an SSD, too—the iMac, however, does not. Buffalo's router also has USB 2.0 and USB 3.0 ports, but they're not exposed in the firmware and are therefore not usable.

> If you don't want to spring for the cost of a NAS box, you can plug a USB storage device into the Linksys EA7500 and use it to share files or stream media over your network.

Which is the better router?

The Linksys EA7500 is a very good router for $200. It's easy to set up and use. It has a strong set of features (although it is missing OpenVPN and Time Machine support). And it's relatively fast. Linksys puts a lot of emphasis on the EA7500's MU-MIMO support, but that standard is just too new to be all that relevant; don't buy this router for that feature alone.

Buffalo's WXR-1900DHPD proved faster in most of my Wi-Fi benchmarks (with a PC, that is—it was slower with a Mac), and it's a little less expensive, but it falls far short on the features front. Its firmware doesn't even support all of its hardware, which is not what you expect to see from open-source firmware. It's an attractive and well-made router with a weak price/performance ratio. I can't recommend it in its current form. ⏻

Buffalo AirStation Extreme WXR-1900DHPD: Open-source firmware is supposed to be a good thing

BY MICHAEL BROWN

FANS OF OPEN-SOURCE software might initially find Buffalo's WXR-1900DPHD appealing because it uses the open-source DD-WRT firmware. This firmware is famous for unlocking hardware features that router manufacturers choose not to expose to end users for one reason or another. But that's not the case here, because Buffalo chose the underdeveloped DD-WRT NXT build, which is stable but not at all comprehensive when it comes to enabling this router's hardware features.

One of the most disconcerting omissions is the absence of support for either of the router's USB ports (there's a USB 2.0 port in back and a USB 3.0 in front). Whether you're looking for Time Machine support to back up your Mac, interested in streaming media from a shared hard drive, or intend to share a USB printer or scanner over your network, the WXR-1900DPHD's USB ports are absolutely useless with the currently available firmware.

133

Wireless performance with a Windows client

I initially thought that the router didn't offer a guest network, either, but then I realized that its user interface just doesn't label that feature as such. You can create multiple virtual access points and set up one or more of them as a guest network that will enable visitors to access the Internet, but prevent them from accessing other aspects of your network. But you have to know what you're doing to set it up correctly.

Wireless performance with a Mac client

The firmware doesn't have any parental control features, apart from turning off Wi-Fi (the entire network) and Internet access (on a per-client basis) according to a day and time schedule. But you can configure it to work with a third-party DNS (domain name server) provider. DD-WRT NXT lists several such services as preconfigured choices—including DynDNS, ChangeIP.net, and No-ip.com—but you can pick whichever service you like. Third-party DNS providers make it easier for you to reach computers, servers, and security cameras on your private network via the Internet, but some providers—such as OpenDNS—can also help prevent younger users on your home network from coming into contact with unsavory websites.

DD-WRT NXT includes support for OpenVPN and UPnP, but there is no DLNA server. Then again, its USB ports are unusable, so you can't stream media from a connected hard drive anyway. That pretty much renders the absence of a DLNA server a moot point. For all of the Buffalo WXR-1900DPHD's shortcomings,

Buffalo Technology AirStation Extreme WXR-1900DHPD

AT A GLANCE

The ability to run alternative open-source firmware is typically a plus, but the DD-WRT NXT that Buffalo chose for its WXR-1900DHPD doesn't even support all of this router's hardware.

PROS

· Fast wireless performance

· Runs open-source firmware (DD-WRT NXT)

· Attractive industrial design

CONS

· Nonfunctioning USB 2.0 and USB 3.0 ports

· Firmware is missing many common features

$162

★★☆☆☆

it isn't a terrible router—especially when operating in 802.11ac mode. When I benchmarked it using a Windows 10 desktop PC as a server and a Windows 10 laptop outfitted with a D-Link DWA-192 USB 3.0 Wi-Fi adapter, it edged out the Linksys EA7500 at close range while using channel 36 on the 5GHz frequency band (it didn't fare nearly as well at long range). It performed even better (including at long range) when I switched the router to operate on channel 153 on the 5GHz frequency band. When I benchmarked its performance with an 802.11n client on the 5GHz frequency band, on the other hand, it was its Linksys competitor that prevailed.

The WXR-1900DPHD isn't bad when it comes to wireless throughput, but this router's paucity of features leaves little else to recommend it. ⏻

Linksys EA7500 Wi-Fi router: MU-MIMO made affordable (but no more useful)

BY MICHAEL BROWN

LINKSYS THINKS MU-MIMO is the EA7500's key selling point. It's not. While this might be the least-expensive router to support MU-MIMO, that technology is just too new and under-supported on the client side to be anything other than a checklist item. Fortunately for Linksys, the EA7500 includes most of the features that do matter, and it delivers strong performance in general—particularly in the area of network-attached storage.

Linksys has been building routers in this form factor for a number of years. It's definitely a more mainstream look than the company's aggressively designed WRT series (go.pcworld.com/linksyswrt1900acs), but it doesn't go so far as to hide its antennas inside the enclosure in a futile attempt to blend into your home's decor.

The EA7500 uses Linksys' Smart Wi-Fi firmware, which has a user-friendly GUI and the option to access, configure, and manage the router from the cloud. Download the Smart Wi-Fi app to your Android or iOS device, and you can even set up the router using your smartphone or tablet—no computer required.

The EA7500 has one USB 3.0 and one USB 2.0 port, both in back, which enable you to share both USB storage and a USB printer over your network at the same time. A DLNA media server will stream audio and video files to compatible devices, ranging from a home-theater PC to an A/V receiver, on your network.

Linksys chose a Wi-Fi chipset that includes support for MU-MIMO (multiuser multiple input/multiple output), but this isn't much more than a checklist feature at this point in time. There are very few Wi-Fi client adapters that support MU-MIMO, and you need the technology at both ends of the connection for it to do any good. Go to go.pcworld.com/mumimowifi for an in-depth look at MU-MIMO.

Wireless performance with a Windows client

When I compared the Linksys EA7500 to another mid-priced AC1900 router—Buffalo's WXR-1900DHPD—the Buffalo won most of the rounds on the PC. The opposite was true, however, when I measured the two routers' 802.11n performance.

Linksys EA7500 Max-Stream AC1900 Router

AT A GLANCE
The EA7500 is a very good mid-priced router with superfast network-attached storage performance.

PROS
· Very good Wi-Fi performance
· Extremely fast NAS performance
· Very easy to set up and use

CONS
· No support for open-source alternative software (e.g., DD-WRT)
· MU-MIMO accounts for some of this router's price tag, but it's not very useful today

$200

★★★★★

Continued: **Best AC1900 Wi-Fi router**

The EA7500 has rudimentary parental controls, but they're much better than what Buffalo's router delivers. You can restrict individual network clients (up to 14 devices) from getting onto the Internet according to days and times, or you can allow every device to connect to the Internet, but block particular sites. This would be good enough to block your kids from going on Facebook when they should be doing their homework, but unless you know the URL for every objectionable website on the Internet, you'll never keep them from getting to the seamier side of the web.

Alternatively, you can use a third-party domain-name server provider, but Linksys gives you only two choices: Dyn.com or No-ip.com.

Wireless performance with a Mac client

Interestingly enough, the EA7500 beat Buffalo's router when I benchmarked its performance with a MacBook Pro, which has a 3x3 802.11ac adapter onboard.

If you don't want to spring for the cost of a NAS box, you can plug a

The Linksys EA7500's USB 2.0 and USB 3.0 ports are located on the back of the router.

USB storage device into the Linksys EA7500, and use it to share files or stream media over your network. The router supports USB hard drives formatted NTFS and FAT, for use with Windows machines, and HTFS+ for use with Macs. Unfortunately, Mac users won't be able to use that storage for Time Machine backups.

The EA7500 is very fast when it comes to file transfers over its USB 3.0 port, reading a 10GB collection of files from a portable USB 3.0 SSD attached to the router at 246Mbps on a PC and writing it back to that drive at 258Mbps. The numbers on the Apple platform are lower because the iMac I used for testing has a mechanical drive instead of an SSD. I was able to transfer the 10GB collection of files from the portable SSD to the iMac at 141Mbps, and write it back to that drive at 42.6Mbps.

> It's easy to set up and use, it has a strong set of features (although it is missing OpenVPN and Time Machine support), and it's relatively fast.

The Linksys EA7500 is a very good router for $200. It's easy to set up and use, it has a strong set of features (although it is missing OpenVPN and Time Machine support), and it's relatively fast. Linksys puts a lot of emphasis on the EA7500's MU-MIMO support, but that standard is just too new to be all that relevant; don't buy this router for that feature alone. ⏻

9.7-inch iPad Pro: Hits the sweet spot between size and price

BY SUSIE OCHS

A FUNNY THING happened while I was reviewing the 9.7-inch iPad Pro (apple.com/ipad-pro). I forgot my computer at home and only brought the iPad to work. This wasn't intentional. I'm not doing the "Can the iPad Pro replace my laptop?" challenge. I tried that (go.pcworld.com/ipadprorev) briefly with the 12.9-inch iPad Pro, and didn't have the best results, constantly running into annoying little roadblocks and workarounds that slowed down my workflow.

The reason I didn't notice that my laptop wasn't in my backpack that

Watch the video at go.pcworld. com/ipad pro97vid

morning is simple: I'm carrying two iPads right now, both the 9.7-inch iPad Pro and its big old 12.9-inch sibling, and the larger iPad Pro is almost as big as my laptop.

Yes, at 1.5 pounds, the big iPad Pro is lighter than my 2.4-pound 13-inch MacBook Air, but I didn't feel those missing ounces in the context of the rest of the junk in my bag, and the footprint of the big iPad versus my laptop is nearly the same. I find the big iPad Pro unwieldy—I'd rather just bring my computer, thanks—but the new 9.7-inch version (starting at $599 at the Apple Store: go.pcworld.com/buy97ipad) is sized just right, and with nearly all the power, it's definitely the iPad for me. (And, no, I didn't notice the difference in RAM, but more about that later.)

Size matters

Even though the 12.9-inch iPad Pro is the most powerful iPad I've ever used, after I was done reviewing it, I didn't take it anywhere. Most of the time, it just sat on my desk. The 9.7-inch iPad Pro (can we call them Lil Pro and Big Pro, please?) is sized like an iPad Air 2, and it weighs just a hair under a pound. Like the iPad mini and iPad Air 2 before it, the Lil Pro seems to disappear into my bag, and I don't mind taking it everywhere, much to the delight of my iPad-loving 4-year-old son.

One of the advantages of the Big Pro's screen size is that it gives you plenty of room to run two apps side by side in iOS 9's split-screen mode. Even with less real estate, side-by-side works great on the Lil Pro, too. With the Big Pro's 2732x2048 display, each app's half of the screen winds up being almost as big as the 2048x1536 Lil Pro held in portrait mode. But half of the Lil Pro's screen still winds up being enough space to work in,

Apple 9.7-inch iPad Pro

AT A GLANCE
The 9.7-inch iPad Pro is more portable, takes better video, adjusts your screen's color temperature to match your surroundings, and generally does everything the bigger iPad Pro can do, only for less money.

PROS
· Weighs under a pound, and smaller size is easier to use away from a table
· Supports Apple Pencil
· Shoots 4K video

CONS
· Less RAM than the bigger version, but real-world performance is barely affected

Wi-Fi only: $599 for 32GB storage; $749 for 128GB; $899 for 128GB. Add $130 for cellular.

★★★★☆

even as you use text-heavy apps like Mail and Safari.

I see a lot more webpages (including Macworld.com and even Apple.com) default to tablet or mobile views in split-screen Safari, even though they load as the full-size version when Safari has the entire screen. That's not a big deal, and even helps readability. Both sides of the screen stay active in split-screen mode—I was able to play a *Macworld* video in Safari on one half of my screen while writing this review in Byword on the other half.

True Tone

The Lil Pro has one feature its big brother doesn't, True Tone. This feature is enabled by a new ambient light sensor embedded in the Lil Pro's display. Every iOS device has these ambient light sensors, which enable the Auto Brightness feature, but in the new Lil Pro, those sensors measure the color temperature of the light in the room, not just its intensity. That way, iOS can adjust the color temperature of your display, in an attempt to match it up, so your display doesn't look more blue in some light and more yellow in others.

You can turn this off in System Preferences > Display, but it's a binary on/off switch. There's no slider to lessen the intensity of the effect—the whole idea is that it's automatically adjusted. The new Night Shift feature in iOS 9.3 (go.pcworld.com/ios93), on the other hand, isn't controlled by sensors, so it does have a slider to let you adjust the intensity. (I can't stand it at any more than about 25 percent, but your mileage may vary.) Night Shift isn't aimed at matching the color temperature of the room; rather it just shifts the temperature of your screen from blue to yellow at night, in case the reduced blue light helps you sleep better—although the research isn't so conclusive (go.pcworld.com/nightshiftsleep) that this particular feature would help. You can use both Night Shift and True Tone together on this Lil Pro, but it looks terrible, like your screen was suddenly submerged in a bucket of apple juice.

I remain ambivalent about True Tone. I don't mind keeping it on, but I wish I could tone it down just a tiny bit. Still, after a couple of days I stopped noticing it, until I had the Lil Pro side by side with a MacBook, and the MacBook screen's blueish tint was more visible than ever. Anyone who does get hooked on True Tone may start jonesing for it on

The Smart Keyboard isn't my favorite to type on, but I do like it as a slim protective cover, and its magnetic attachment is more convenient than a full case.

all their devices, and I wouldn't be surprised if Apple starts building these new light sensors into more screens. In the meantime, there's always f.lux on the Mac (justgetflux.com).

Pro features at a value price

The Lil Pro joins the Big Pro in supporting the Apple Pencil (go. pcworld.com/applepencilrev), which remains just delightful. In fact, it's even more so now, just because more apps support it. I like drawing and coloring with the Pencil to relax, but I'm even taking more meeting notes with it lately, too, just because the "infinite scroll" writing feature in GoodNotes 4 (go.pcworld.com/GoodNotes4) is so fun. The Pencil is also better with the Lil Pro because it's easier to hold the smaller iPad in one hand while you draw or write with the other. With the Big Pro, I felt like I had to be seated, preferably at a table, when I was going to do anything with the Pencil.

It's also worth pointing out that the Lil Pro starts at $200 cheaper than the Big Pro, and the Pencil is $99. The Lil Pro's Smart Keyboard is

This screen is way too nice to yellow it up by layering True Tone and Night Shift together.

$20 less too, at $149, compared to $169 for the Big Pro's Smart Keyboard. So a full setup of a 32GB Wi-Fi–only iPad Pro, Smart Keyboard, and Pencil is $847 if you choose the smaller iPad Pro, and $1,067 if you choose the larger version.

Oh, and if you use Microsoft Office, there's another bit of potential cost savings from choosing the smaller iPad. Microsoft requires an Office 365 subscription if you want to create Office documents on a tablet larger than 10.1 inches—so that rule applies to the Big Pro but not the Lil Pro (go.pcworld.com/officeontablets). If you don't already have Office 365 for your Mac, you could save $7 per month or $70 per year (the price of Office 365 Personal) by avoiding buying it for your iPad Pro.

The smaller Smart Keyboard provides almost the same typing experience as the Smart Keyboard made for the Big Pro. It has all the same keys in exactly the same places; they're just a little smaller. Both keyboards have a spill-resistant fabric coating and low-travel keys that I can't seem to type on without slamming my fingers down as hard as possible. (It's like my fingers don't believe the short-travel keys are really going down, and I formally apologize to every coworker who has discreetly slid on his or her headphones when I start up with my infernal key-pounding again.)

I really appreciate the extra speaker power on both iPad Pro models,

The camera protrudes just a bit, but the Lil Pro has a flash, for the first time on an iPad. (The iPad here is shown with the Smart Keyboard cover.)

since I watch a lot of streaming movies and TV on my iPads. The four speakers provide enough oomph for an action movie, and make music and podcasts sound better when you're listening without headphones too.

The iSight camera on the Lil Pro is even better than the Big Pro's camera, because it has a True Tone flash and supports Live Photos, which the Big Pro doesn't. Plus, it records 4K video, while the Big Pro is stuck on 1080p. Want to shoot slo-mo? The Lil Pro lets you choose 1080p at 120fps or 720p at 240fps, while the Big Pro can only handle 720p at 120fps. Again, the Lil Pro's physical size makes me more likely to use it to shoot stills or video, and even if you scoff at the very idea, don't forget that plenty of apps use the cameras for things like augmented reality or even…well, shooting video. For example, an app called Hudl Technique (hudl.com/products/technique) lets you film a baseball, tennis, or golf swing and then analyze it in slo-mo for proper form and technique. It's universal for the iPhone and iPad, but the iPad's bigger screen makes it a lot easier to use, and the camera captures enough detail that you can zoom way in on a wrist or an ankle turn during a swing.

What about the RAM?

It's true that the Lil Pro has 2GB of RAM, or half the RAM of the Big Pro, which has 4GB. But bigger screens demand more resources to power them, and in testing with Geekbench 3, the Big Pro only scored about 6 percent better overall, so I don't think many people will notice a performance hit in most tasks. Memory-specific tests show more of a discrepancy, because as it turns out, it's not just the amount of RAM that's different, but the memory bandwidth too.

In Geekbench 3's multicore memory benchmark, the Big Pro scored 4112. On the Lil Pro, the same test produced 3203, or about 28

percent worse. In most tasks, you're unlikely to see the impact of a little less memory bandwidth. Where it's more likely to manifest itself is graphics-related tasks such as gaming.

In 3DMark's Sling Shot Extreme test, for example, the Lil Pro scored 3146, about 20 percent worse than the Big Pro's score of 3787. But when the same test was set to render off screen, the Big Pro's 3794 only bested the Little Pro's 3528 by 7.5 percent. And in the AnTuTu Benchmark app, the Lil Pro scored just 11 percent worse than the Big Pro.

As a matter of policy, Apple doesn't get into the weeds on its choices for the amount of RAM or how it's configured. It could be that Apple selected slightly lower-speed RAM for the Lil Pro to save on power since the smaller unit has a smaller battery. Also, the smaller screen has a lower resolution, and Apple may have decided it didn't need the highest performance RAM.

Geekbench 3 Tests

	iPad Pro 12.9	iPad Pro 9.7
Multicore CPU test	5473	5179
Single-core CPU test	3216	3030
Single-core memory test	3622	3151
Multicore memory test	4112	3203
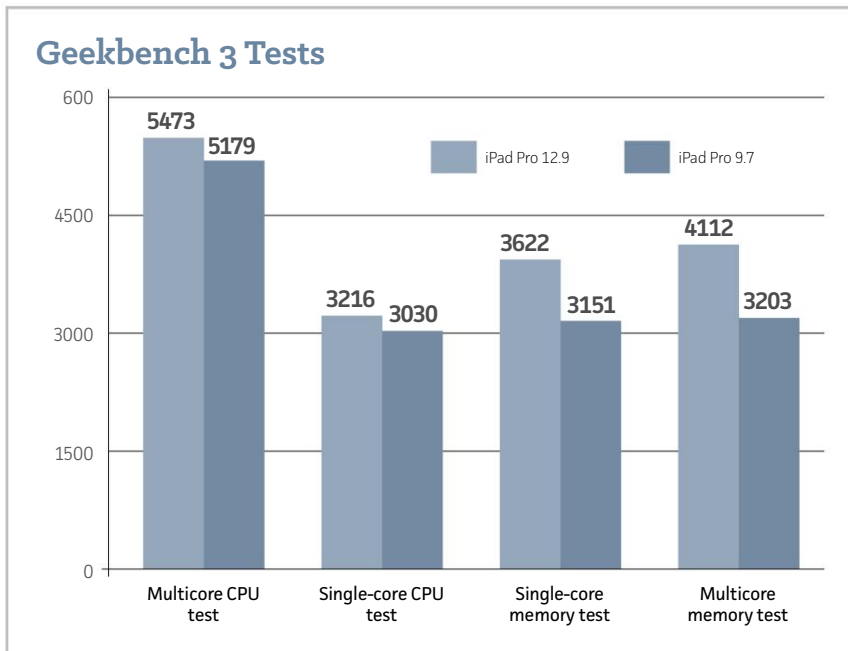
Is having half the RAM a deal breaker? I would say no.

For the most part, the amount of RAM is probably nothing to lose sleep over. There's nary a performance difference in the computing side of things and even on graphics tasks. When you consider the resolution, the difference is pretty small, as well. When buying a Mac with configurable RAM, I tend to max it out at purchase as a way of "future proofing" the machine, hoping that the more RAM I have, the longer that Mac will last before it feels obsolete. If you can't stand the thought of buying an iPad with half the maximum RAM available, you could shell out an extra $200 for the Big Pro, or wait to see what Apple does with these iPads next year. But for me, the 9.7-inch iPad Pro's performance is worth its price and then some.

Bottom line

If you're using an iPad Air or older, the 9.7-inch iPad Pro is a worthy upgrade. If you're trying to decide between a 12.9-inch iPad Pro and the smaller version, I'd go small because it's a more convenient size, and the $200 price difference is worth the minimal decrease in performance, especially if you plan to spend that difference on Apple's accessories. ⏻

Oh yeah, and as of right now, this is the only iPad that comes in Rose Gold.

Baldur's Gate: Siege of Dragonspear: A fitting end to a legendary game, 17 years later

BY HAYDEN DINGMAN

CONGRATULATIONS TO BEAMDOG. I'm pretty sure that *Baldur's Gate: Siege of Dragonspear* (siegeofdragonspear.com) now holds the record for "Longest Time Between Base Game and Expansion," at seventeen years.

Described somewhat tongue-in-cheek as Baldur's Gate 1.5, *Siege of Dragonspear* sees Beamdog move from a curatorial role (*Baldur's Gate: Enhanced Edition:* go.pcworld.com/baldursenhanced) into a more authorial role in the fabled RPG series, creating a thirty-hour

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expansion that pretty much doubles the length of the original game.

But can you really go back to 1998? I spent two weeks finding out.

More tales from the Sword Coast

I mean, I *really* went for it. Having not played the classic *Baldur's Gate* in a while, I started a party from scratch and played through the entire game—and all of the original *Tales of the Sword Coast* expansion—before starting *Siege of Dragonspear*.

For the sake of this review I'm going to assume you have some level of knowledge of *Baldur's Gate*. If not, well, you should probably go play that first. Though generally not held in the same esteem as its sequel *Baldur's Gate II*, the two are sort of a package deal of legendary isometric CRPGs.

And they can be hard as hell to get into, admittedly. RPG rulesets have come a long way from second-edition *AD&D*, with its awkward THAC0 ("To Hit Armor Class 0") combat and a health system that encouraged abuse of the rest mechanics after every combat encounter. Much of *Baldur's Gate* spiritual successor *Pillars of Eternity* (go. pcworld.com/pillarseternity)—itself one of the best PC games of 2015 (go.pcworld.com/bestpcgames15)—was seemingly designed as a direct response to problems with the old Infinity Engine games.

I did it though. I fled Candlekeep. I assembled my Good-aligned party (Minsc, Neera, Branwen, Imoen, Kivan, and myself). I sent Dynaheir on a solo journey into a pack of wolves as per usual. I uncovered the source of the iron crisis and (seventeen-year-old spoilers) slew Sarevok. Roll credits.

Except—wait, the credits aren't rolling. Welcome to *Siege of Dragonspear*. If you finish *Baldur's Gate*, the Sarevok fight now transitions straight into the

Baldur's Gate: Siege of Dragonspear

AT A GLANCE

Siege of Dragonspear is an expansion to a game seventeen years old, which invites the question: "Can you really go back to 1998?" In this case the answer is, mercifully, yes—with some small caveats.

PROS

· Skillfully bridges the gap between Baldur's Gate and its sequel

· Original voice talent bolsters some already-great dialogue

· Story Mode for those who just want to play without THAC0 worries

CONS

· It still plays like it's from 1998. THAC0 be damned.

· Missing companions are a shame

★★★★★

expansion with a new chapter heading and cinematic. (Otherwise you can import your old Enhanced Edition saves or start the expansion with a pre-created party.)

Your *Baldur's Gate* party doesn't last long though. Remember—this expansion is meant to bridge the gap between the original game and the sequel, seeing as the first ends with your triumph over Sarevok and the second opens with you in a dungeon. "What in Bhaal's name happened in between?" is a question that's plagued the series for nigh-on twenty years.

Siege of Dragonspear begins with you hunting down the last of Sarevok's old associates, and it's sort of a farewell tour. Throughout the mission your party members (all, or at least most, voiced by their original actors from seventeen years ago) drop lines about "being ready to go home." And thus it comes to pass that after slaying Sarevok's last lieutenants everyone goes their separate ways. Typical. Though they were all nice enough to drop their gear into a bottomless chest in your bedroom before taking off.

And wouldn't you know it: A few weeks later an even bigger threat

arises. A certain "Caelar Argent," also known as the Shining Lady, has gathered an army and plans to march on Dragonspear Castle. Also, she tries to kill you.

Time to get the band back together, I guess.

Or as much of the band as you can, at least. Remember: This takes place between *Baldur's Gate* and its sequel. That means at least one companion—Imoen—is too busy dual-classing into a mage to come along for the journey. Some companions (Neera in particular) aren't available until midway through the expansion. Also when she shows up she's managed to forget every spell you ever taught her and lose all her equipment.

Other companions are simply missing. Both Branwen (my go-to cleric) and Kivan (unstoppable archer madman) absconded so fast that it's apparently impossible for them to help you save the Sword Coast a second time.

Oh, and Dynaheir has somehow resurrected herself and will once again join your party alongside Minsc. Once again, I sent her on a lonesome journey into a pack of wolves. Dire wolves, this time. Though

that did make a minor Dynaheir-specific sidequest unfinishable later in the game.

But aside from my quibbles about being stuck with less-than-desirable party members as fill-in slots (Glint as cleric and Safana as thief), *Siege of Dragonspear* feels like…well, like it was built in 1998. And I mean that as a compliment.

The expansion's a bit different from the original games in that it's sort of linear. You don't just go where you want, when you want. Instead, the expansion takes the form of "an army on the march." You begin in the city of Baldur's Gate, then there are two intermediary regions, and then you eventually make it to the area around Dragonspear Castle.

Each of these regions is fairly sizable and freeform, with a handful of distinct areas to travel between and at least one dungeon per section. But once you leave a region, that's it. You can't go back. Any quests you left unfinished are unfinished forever. Don't think you can defeat an encounter at the moment? Tough, because this is your only shot, and some of those early quests have a tertiary effect on the actual "siege" part of *Siege of Dragonspear*.

It's a different approach, but it works pretty well thematically with the idea of hunting Caelar Argent's army. And you're rewarded for

exploring. Having replayed *Baldur's Gate*, there's a stark difference in density between the original game and *Siege of Dragonspear*. There's a lot of empty space in the old maps, areas with maybe one important building (the Temple map) or person. *Siege of Dragonspear* has fewer maps, but they feel better designed, more colorful, more lively.

That's also, in part, because *Siege of Dragonspear* does things that simply weren't possible in 1998. The largest enemy encounters in *Baldur's Gate* were typically six-on-six, and most of the time you were facing clones of the same enemy. A particularly crazy battle might be six-on-ten. Now take a look at the screenshot below.

This isn't a rarity in *Siege of Dragonspear*. There are at least two major battles in the expansion, each encompassing groups of maybe thirty NPCs per side. It's hectic, to the point where there's a new graphics toggle to highlight your own characters and make them stand out from the fray a bit better.

And there are actual crowd scenes. And dozens of in-engine cutscenes. It's a level of polish and spectacle that, as I said, simply wasn't possible when the original game was built—but since it's built

out using the same engine and assets, it blends (mostly) seamlessly with *Baldur's Gate* proper. If anything, it's one of those "*Siege of Dragonspear* looks like you remember the original game looking" scenarios.

Oh, and in regards to the larger encounters: They can be hard as hell, at least if you're playing on the original "Core Rules" setting. Way more difficult than normal encounters in *Baldur's Gate*. And again, I say that having literally just played through the entirety of both back-to-back.

You can duck the difficulty though, and those who just want to see what *Baldur's Gate* is all about now have access to "Story Mode," which maxes out all your stats and turns off permadeath. Then you don't even need to worry about THAC0. Other hacked-in improvements include the Bag of Holding, Potion Bags, and Ammo Belts to make inventory management a bit easier. And in case you couldn't tell from the screenshots: The entire UI received a facelift.

Bottom line

New journey, old friends. I don't know what possessed Beamdog to make *Siege of Dragonspear* an expansion to the original game, nor do I know what devil's pact coerced them into making it thirty-odd hours long. It's insanity.

But hopefully this isn't Beamdog's last bit of *Baldur's Gate* content, because they've done an incredible job. As someone who first received *Baldur's Gate* for Christmas way back in 1998 on six—*six!*—CD-ROMs, *Siege of Dragonspear* feels like a long-lost (and polished-up) chapter of the original, like it belonged from the start. That's quite a feat, given the seventeen-year spread in between.

Will it please every purist? Of course not. As with any beloved series, passions run high and nostalgia's a hell of a drug. There are bound to be those who wish Beamdog had stuck to a purely conservationist role. But *Siege of Dragonspear* won me over, and I'd like to see what the team does next. Go for the eyes, Boo. ⏻

2016 Chevy Volt: The cult hero of plug-in hybrids reaches for mainstream fame

BY MELISSA RIOFRIO

THE 2016 CHEVY Volt wants to be the Johnny Depp of hybrid vehicles: the quirky character who becomes the star of the show, like Depp playing Captain Jack Sparrow in *Pirates of the Caribbean*.

Long before Depp became a famous pirate, though, he was already a cult favorite for his unique performances in movies like *Edward Scissorhands* and *What's Eating Gilbert Grape*. In the same way, the Volt (go.pcworld.com/volt) is already a star among green-car nerds who

love how this plug-in hybrid electric vehicle combines solid electric vehicle range with convenient backup by a gasoline engine. These Volt fans bought prior generations of the car even though it looked a little weird. And now they're excited about the 2016 Volt because it promises 53 miles of EV range—a big jump from the 2015 Volt's 35 miles on electricity alone.

Weird doesn't sell as well to mainstream drivers, though, and Chevrolet wants to sell more Volts. The company has completely redesigned the 2016 model in part to make it more appealing to everyday drivers. These are people who may not know that the Volt has the best EV range of any plug-in hybrid electric vehicle, but they *may* have heard it saves a lot of gas. Plus, it looks nice.

I kept these new customers in mind during my seven days and 700 miles with the Volt. I drove long road trips and daily commutes. I put people and stuff in this car. I drove in torrential rain. I logged over 500 miles before I needed to get gas, and averaged 72 mpg.

My take: Just as we tolerate some of Depp's less-successful weirdo roles (*Mortdecai* comes to mind), mainstream drivers who buy the Volt

Watch the video at go.pcworld.com/chevyvoltvid

will have to learn how to live with a car that sacrifices some comfort and space in the name of fuel economy. The car's awesome EV range makes up for almost everything, though, and the Volt is still a PHEV I'd readily recommend.

The plug-in hybrid to beat

Before we dive into the Volt, let's establish where it dwells in the green-car universe. You probably already know that a purely electric vehicle (EV), such as Tesla's Model S or Nissan's Leaf, runs its electric motor entirely off a battery. These EVs are charged on household electricity, or, if you're lucky, at public charging stations.

And you probably know that hybrids like the Toyota Prius have a gas motor as well as an electric motor. The Prius actually uses its gas engine—as well as energy collected from "regenerative braking"—to charge the battery for its electric motor. This charging method eschews the need for public charging stations and plugging the car into wall outlets.

The Voltec Propulsion System on the 2016 Chevrolet Volt extends from the engine compartment to the battery that runs under the floor and the backseat.

IMAGE COURTESY OF CHEVROLET

The Volt sits in between EVs and gas-powered hybrids like the Prius. Its electric motor runs off an electrically charged battery, while its gas engine, of course, runs on gas. It's part gas car, and part EV, and that's why it's called a plug-in hybrid electric vehicle, or PHEV.

The problem with most PHEVs (other than the Volt) is their paltry EV range. Indeed, if you're getting just 16 electric miles from the Audi A3 Sportback e-tron (go.pcworld.com/audia3sportback), or even 27 from the Hyundai Sonata, you're not getting much EV for the money. Even the Prius Prime, announced March 23 at the New York Auto Show, will have only 22 EV miles.

So think about the 2016 Volt's 53 electric miles. If you generally drive less than that daily, you could drive and recharge a Volt many times over before needing any gas. Chevrolet expects the typical Volt owner will drive 1,000 miles between gasoline fill-ups. That's

The 2016 Chevrolet Volt can charge fully at a Level 2 station in about 4.5 hours.

Chevrolet designed the 2016 Volt to look sleeker and fancier than its predecessor.

something a regular person could appreciate.

Mainstream drivers should also appreciate the Volt's exterior, which has changed significantly in the 2016 model year both for aerodynamics and aesthetics. It doesn't look as chunky as the prior generation does. Nor does it feel as cheap: The interior's still all-plastic, but Chevy upgraded to softer textures and curvier lines. (There are some drawbacks to the design, which I'll detail later.)

One way the Volt resists blending in is with the flourish it delivers every time you open the driver's-side door. Swooshy animations play over the instrument cluster and center display, accompanied by space-agey sound effects. (You can muffle via the infotainment menus.)

Once those animations have calmed down, the digital instrument cluster and 8-inch center touchscreen offer different views to help you monitor charging status and history.

Most of the time, I let the animated Flow diagram on the center

screen give me real-time feedback on battery or gas usage.

Under the hood, you'll find the Voltec Propulsion System. Its two electric motors can work alone or in tandem. The 1.5L DOHC cast-aluminum gas motor, which plays the supporting role of "range extender," has an output of 75 kilowatts or 101 horsepower, with a top speed of 5600rpm. While the previous Volt's gas motor required premium fuel, the new one (with an 8.9-gallon tank) uses regular. It contributes to the Volt's maximum range of 420 EV and gas miles combined.

On EV or gas, in the default Normal drive mode, the Volt has a smooth, mellow feel. Because I ran down the battery every day, I

You get a wealth of charging information from the center display.

The 8-inch center touchscreen on the 2016 Chevy Volt offers, among other views, an animated illustration of the gas and electric power distribution as you drive.

experienced the switch between gas and electric motors many times. It's extremely subtle, and really only calls attention to itself when you suddenly hear the gas engine's low rumble.

You notice more of a difference in the car's Sport mode: Punching the accelerator will push you back in your seat, and you can almost

hear the battery scream as it drains precipitously. The Volt's two other drive modes are Mountain, which combines gas and electric motors for more power on slopes, and Hold mode, which prioritizes gas driving so you can reserve the battery.

The battery's the thing

The Volt's 18.4kWh lithium ion battery is its crown jewel. Chevrolet worked with LG Chem to make the new battery pack more efficient. It uses fewer cells than before (192, down from 288) to yield more power, and it weighs 20 pounds less.

Recharging is easy if you have access to 240-volt, Level 2 charging stations, taking just 4.5 hours. (DC Fast charging is not available.) Chevy expects about half of Volt owners will have access to Level 2 charging.

If, like me, you're stuck with only household AC, you'll need 19 hours on 8 amps of current, or 13 hours on 12 amps of current, to recharge the battery from zero. With the 8-amp setup at my house, I eked out only 28 to 34 miles of charging overnight.

Falling short five out of seven days is a bummer. If I owned this car, I'd probably start scouting Level 2 stations or saving up to install one at home.

This view of the engine compartment of the 2016 Chevrolet Volt shows (left of center) the motor component of the Voltec Propulsion System.

The included charging unit is an extremely useful three-headed monster. The large AC block, 25-foot cord, and sturdy plug are a challenging assemblage to wrestle in and out of the Volt's storage bin in the trunk area. Most of the time, I left it out in the trunk.

Ever in search of more battery range, I became addicted to the Regen on Demand paddle on the back of the steering wheel. It's common practice among EVs and hybrids to capture energy from the braking process and regenerate it to charge the car's battery. The Regen on Demand paddle lets you exercise this feature more frequently by slowing down the car to some degree, giving the paddle brake-like qualities (though it's not a substitute for the brake). This is obviously something you would do only when you needed to slow down anyway. It takes some finesse to avoid a slight lurching feeling when you use it, but it was worth it to get the extra juice for my battery.

The battery's positioning underneath the car's floor and backseat

The 2016 Chevrolet Volt's 18kWh battery nestles under the floor and the backseat.

The charge port is on the front driver's side; just push on the door to open.

helps lower the Volt's center of gravity, contributing to a pretty stable ride—both on the twisty roads I tried when I first drove (go.pcworld. com/2016chevyvolt) the Volt last year, and during the torrential rainstorms that blew in during my loan period. Deep puddles and heavy winds barely moved the Volt.

What the design gives, and what it takes away

Unfortunately, the combination of the battery profile and the Volt's emphatically aerodynamic design

The AC charging unit is heavy-duty and a bit awkward to handle.

impacts the car's interior layout. The long hump the battery creates forces the unlucky occupant of the center backseat to straddle a chunky console. The side backseats were snug for longer-legged
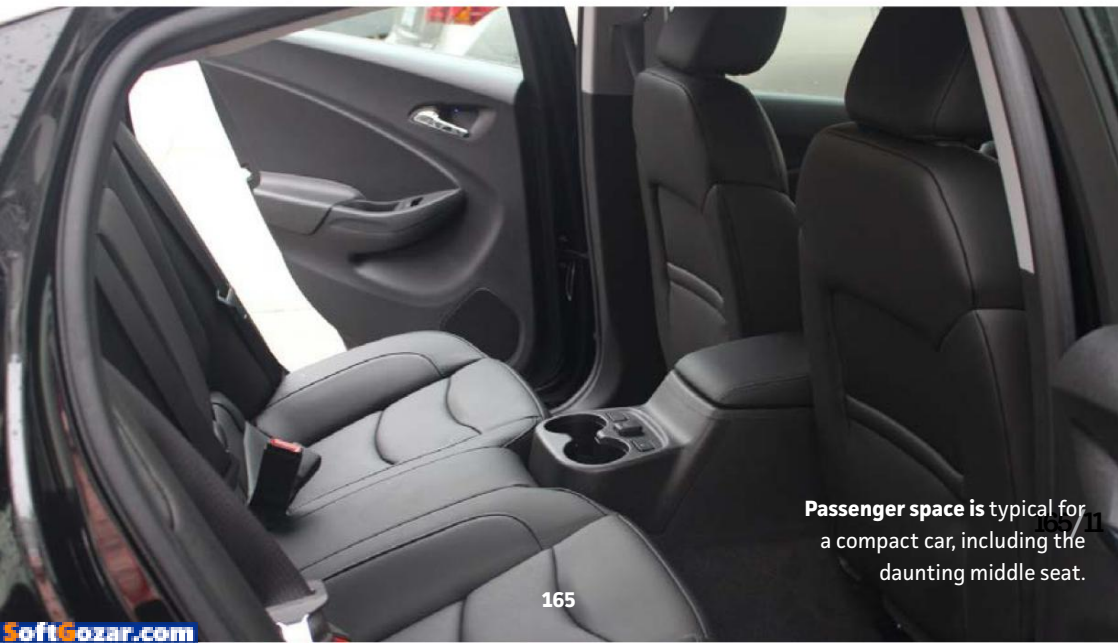
Passenger space is typical for a compact car, including the daunting middle seat.

guests, but, even worse, some of my friends had trouble getting into the car—the roof line is low, forcing difficult body contortions for taller people. In back, too, the sharply sloped rear window loomed close over their heads.

That rear window also has terrible visibility, due to its steep angle and the thick C-pillars on either side. My loaner came with blind-spot monitoring, and I needed it. The rear backup camera is standard—and essential. During one rainy day, when water droplets obscured its lens, I couldn't see anything at all in back. If I could fix one thing about the Volt's design, it would be this heavily obstructed rear view.

> **It's very hard** to see out of the steeply angled rear window on the 2016 Chevy Volt.

> For mainstream drivers, the Volt is at least worth a test drive.

The last design casualty is the trunk. With the seats up, its capacity is just 10.6 cubic feet. Deep sidewalls make it even narrower than it looks from the outside. Chevy tried to maximize space by making the floor lower, but the unfortunate side effect is a relatively high sill, forcing me to hoist things awkwardly into and out of the back.

The Volt's brush with stardom

I've detailed all these design drawbacks not to dissuade people from trying the Volt, but to manage their expectations. I think the Volt

could wield its undeniable PHEV star power best in the right roles.

For mainstream drivers, the Volt is at least worth a test drive. It's attractive, nice to drive, and useful for the groceries, dry cleaning, and occasional passengers of daily life. A PHEV is also the least-stressful introduction you could have to the new world of green cars.

What might hurt the Volt with mainstream users is its size-to-price ratio. It's as compact as Chevrolet's Cruze, but its price range is more like the larger Malibu's. (My Volt Premier's MSRP is $39,830, but federal or state incentives would knock several thousand dollars off that price.)

I also think Chevrolet should consider the Volt's other potential audience: exhausted EV drivers who want to drive green but don't want to drive themselves crazy charging all the time. I've lived that life. I like the flexibility the Volt gives me: I may want to charge, but I don't *need* to.

I actually miss the Volt now that it's gone. PHEVs seem like such a sensible choice—I keep hoping a charging port will magically appear on my traditional gas-powered car. Driving the Volt increased the likelihood my next car could be a plug-in hybrid, though I'd prefer something bigger. Right now, however, the Volt's the one PHEV I'd recommend. ⏻

It was not fun hauling heavy items over the high sill on the trunk.

HOW CPUS WORK:
A CLOSER LOOK AT EXTERIOR PROCESSOR DESIGN

BY THOMAS RYAN

WHAT'S OUTSIDE COUNTS, TOO

Processors lie at the heart of your computer. They juggle millions of instructions every second so you can watch Netflix and play *Fallout 4* (go.pcworld.com/fallout4). They throttle their clockspeeds to save power, and boost them to help you open a new tab in Chrome. But have you actually taken a good look at a processor—a really good look?

As the recent Skylake CPU-crushing debacle (go.pcworld.com/skylakecrash) has demonstrated, the physical characteristics of a chip are more important than you might think. Let's closely examine Intel's Core i7-4790K and AMD's FX-8370.

(For information on how to actually install a processor, check out this CPU installation guide: go.pcworld.com/installcpu. We also recommend this deep-level explanation of chip design—logic units, instruction cycles, etc.—on Wikipedia: go.pcworld.com/wikipediacpu.)

MIND THE TRIANGLE

Anyone who's built a PC (go.pcworld.com/diypc) can tell you that securing a CPU in its socket can be a harrowing experience—especially if it's your first time. Here's the trick for Intel (and AMD) CPUs: Line up the gold triangle on the corner of your chip with the complementary triangle on the edge of the socket.

Even with the triangle to guide you, it will feel like you're pushing too hard on the lever when you're latching down the processor. You're not.

CONTACT PATCHES

Hundreds of small electrical contact points dot the underside of modern Intel CPUs. Each one is pressed atop a small pin that's part of the Land Grid Array (en.wikipedia.org/wiki/Land_grid_array) in the socket, so the CPU can get power from the motherboard and communicate with the rest of the system.
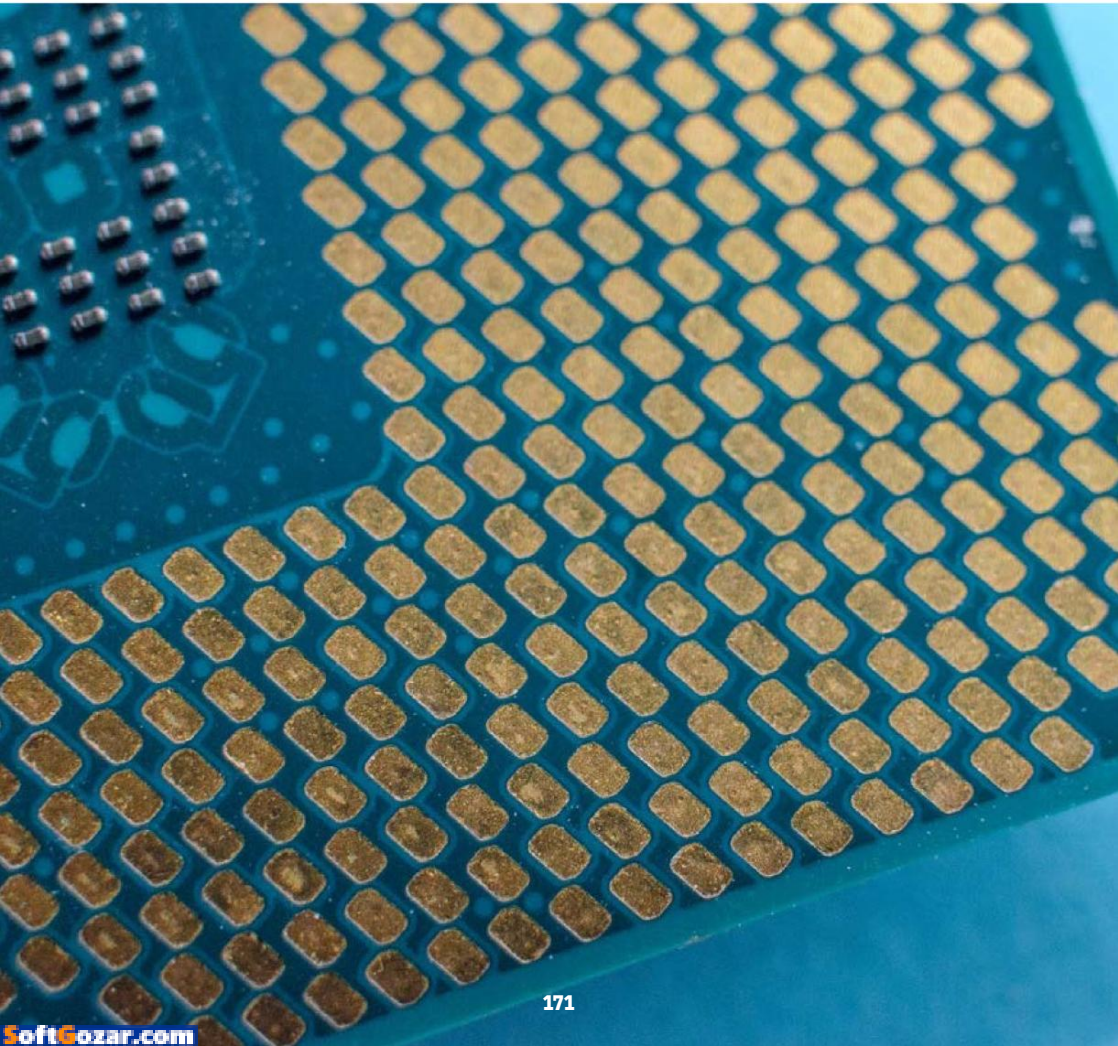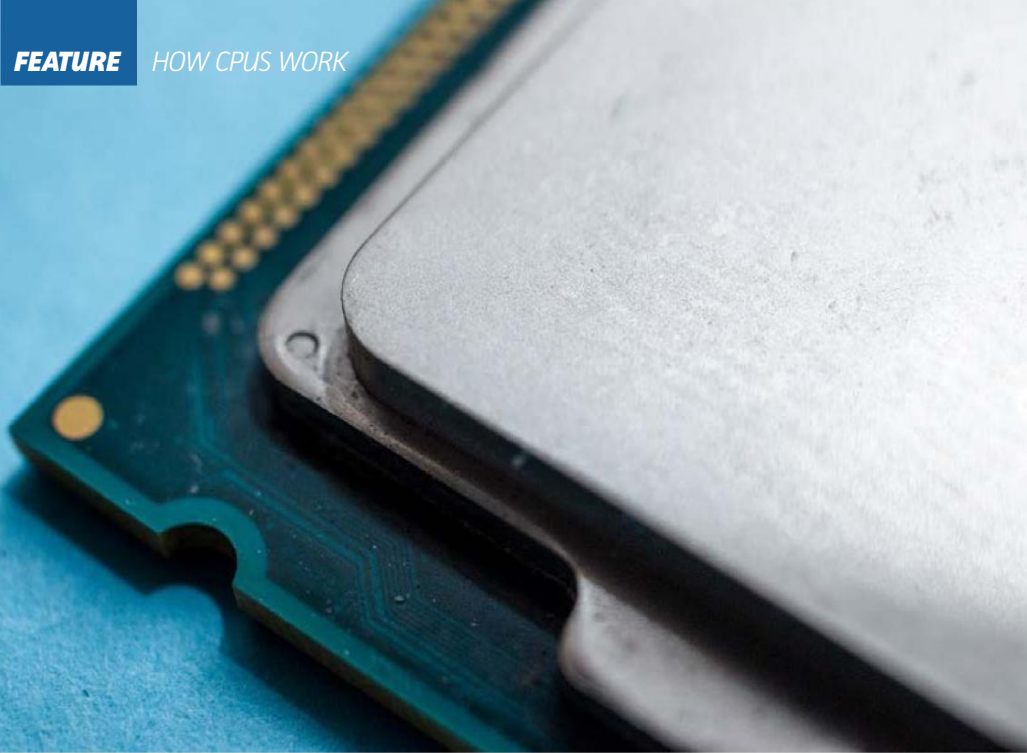
LEVEL UP

The metal heat spreader and small PCB make up the external features of an Intel CPU. You'll see they are terraced slightly to create two distinct resting areas on the CPU. The load plate, which holds the CPU in the socket, sits on the middle tier. The heat sink sits on the top tier, the CPU's heat spreader. That way, the two don't touch.

A small notch here, as well as a symmetrical notch on the other side, and the aforementioned triangle, all help you place the CPU in its socket.

TEST PADS

On the upper edge of Intel's CPUs, you can see contact patches that look similar to the contact points on the bottom of the chip. These are test pads used during the CPU's bring-up and debugging process. They're also used to help test and bin Intel's CPUs at the factory before they're sent to customers. Intel's testing process verifies that a chip is working correctly, while the binning process determines what clock speed the chip will operate at within its particular model classification.

THE UNDERSIDE

In addition to the contact pads on the underside of an Intel CPU, there's also a slate of power delivery circuits, including some capacitors—the structures in the center of the chip. This Intel Core i7-4790K packs more capacitors than the i7-4770K for smoother power delivery during overclocking attempts.

THE AMD DIFFERENCE

On AMD's CPUs, note the absence of contact pads or power delivery circuitry on the underside. While Intel's LGA design places the pins in the motherboard socket, AMD's Pin Grid Array (en.wikipedia.org/wiki/Pin_grid_array) design features a dense grid of pins that connects the CPU to the motherboard electrically.

This particular chip, the AMD FX-8370, uses AMD's socket AM3+ and has over 900 pins on its underside.
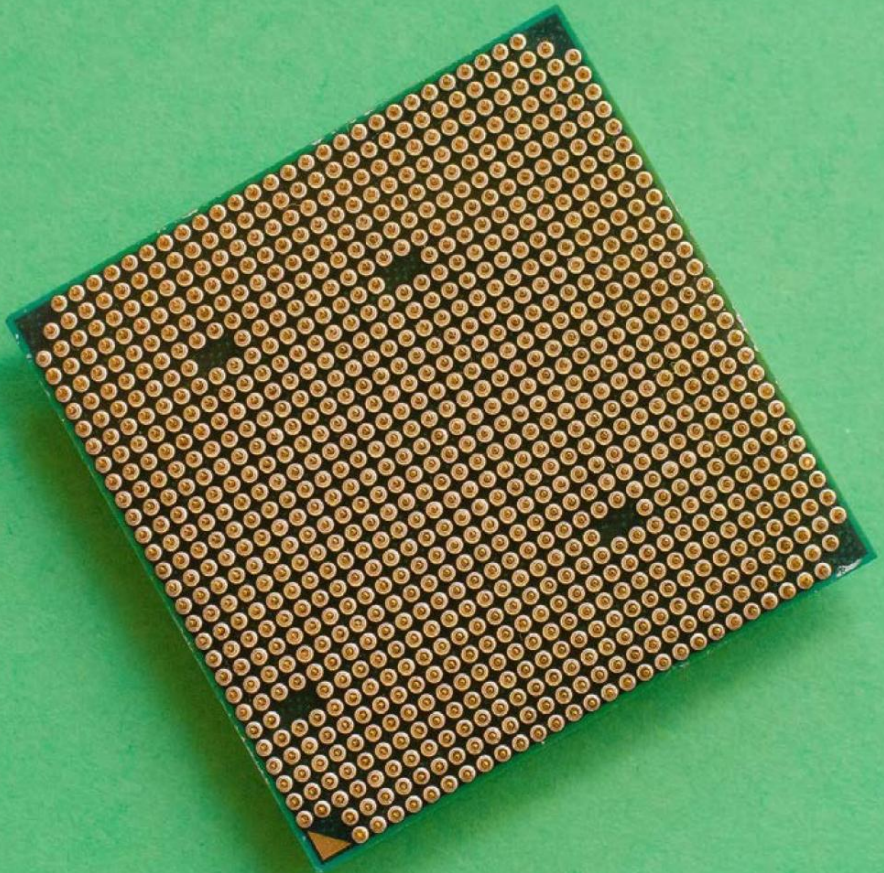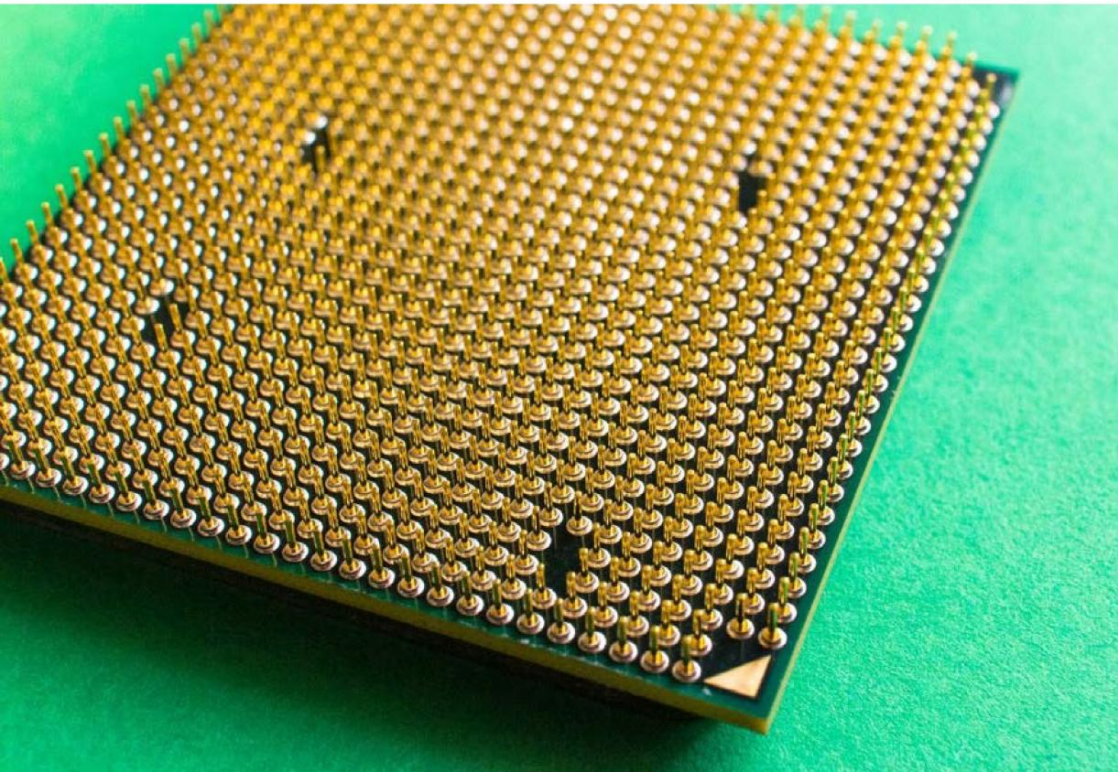
PINS AND MORE PINS

Because the pins on an AMD CPU are exposed on the chip's underside, one klutzy move can easily mean a bent pin or two. (In contrast, Intel's CPUs can be set down just about anywhere without risk). Luckily, bent pins can often be fixed by using a credit card to bend the pins back into their proper position.

KEEP IT ON THE LEVEL

There's no load plate to hold AMD's CPUs in place on the motherboard, so they lack one of the terraced steps found on Intel chips. Instead, a small lever at the edge of an AMD motherboard socket initiates tension around the pins on the bottom of the CPU to lock it in place.

The base of the heat sink sits on top of the large, flat heat spreader that covers the CPU's silicon die.
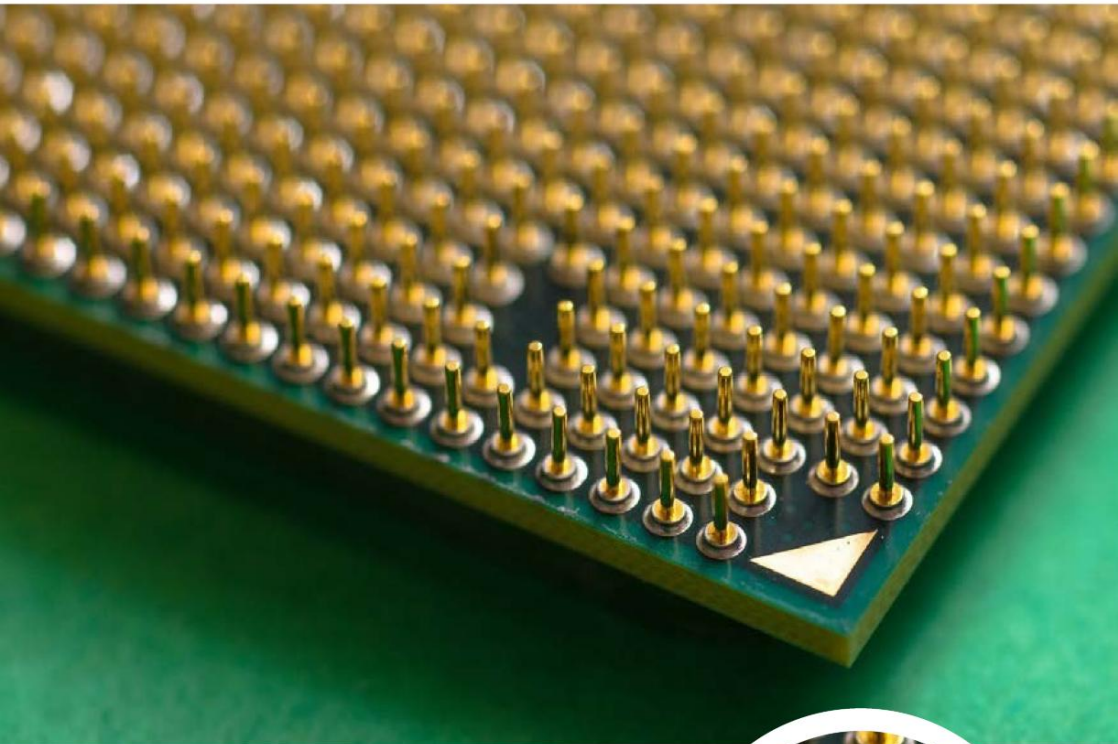
MIND THE TRIANGLE REDUX

AMD and Intel processors have one key feature in common. AMD's chips also include a small triangle marker that helps you orient the CPU in the motherboard socket. This little triangle can be found on both the top and bottom sides of the chip, and there's a complementary marker on every AMD motherboard.
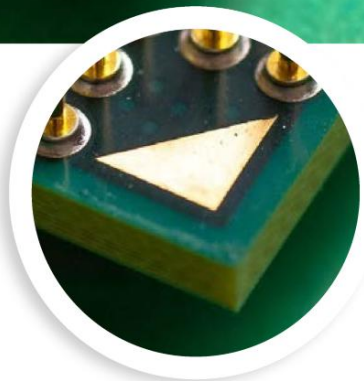
UNDER THE HOOD…ER, HEAT SPREADER

Another thing that both Intel and AMD CPUs share is the silicon die sitting inside the processor, at the center of the CPU packaging we just saw. (Pictured: a wafer of many, many Intel Haswell chip dies.)

These tiny integrated circuits are about the same length as a pin and enable your computer to calculate the pathfinding for enemy players in a game, or to display a Twitch stream of your friend making a sandwich. Whatever you use your PC for, the technology behind it is borderline magical.
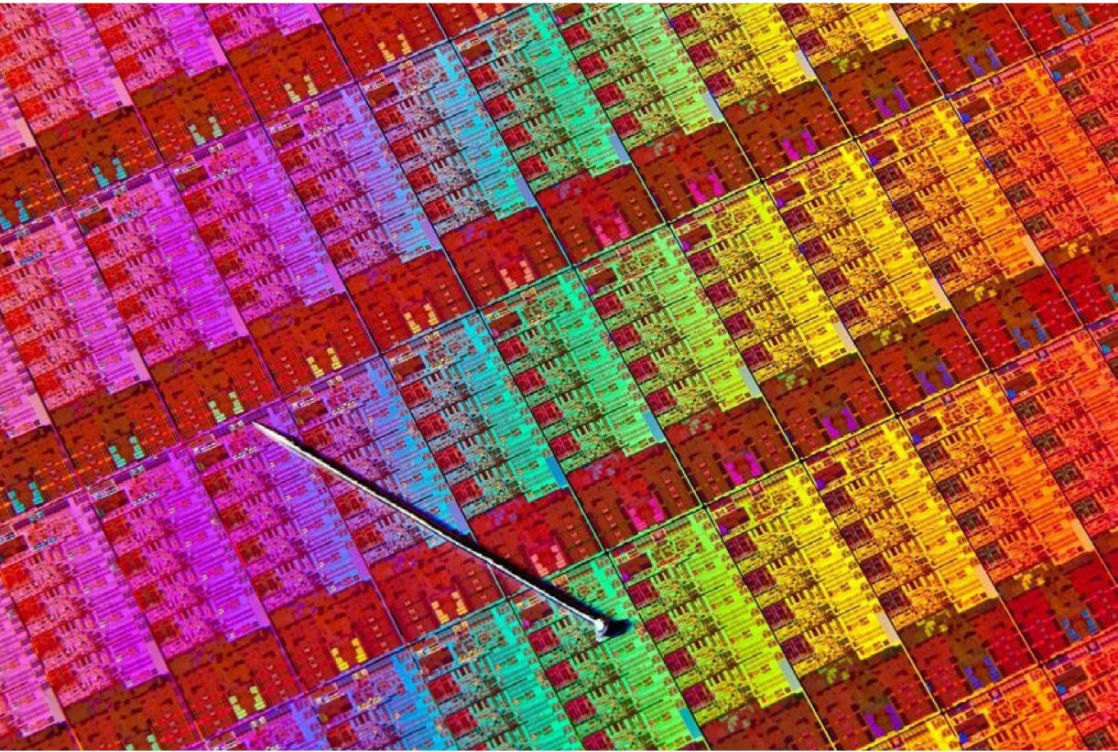
BUT WAIT, THERE'S MORE!

Interested in more deep-dives into the hardware powering your PC?
We've also chopped up RAM (go.pcworld.com/insideram) and torn
apart a motherboard (go.pcworld.com/inamotherboard) to show you
how they work. Check them out!

3 note-taking app alternatives to Evernote & OneNote

THESE SIMPLE APPS OFFER MORE PRODUCTIVITY POWER THAN YOU'D THINK.

BY MICHAEL ANSALDO

The battle for best note-taking app typically comes down to two combatants: Evernote and Microsoft's OneNote. But these two productivity titans aren't to everyone's taste. Fortunately there are some worthy alternatives—some of which may already be on your device—for collecting your task lists, ideas, and other notes. Here are three of the best.
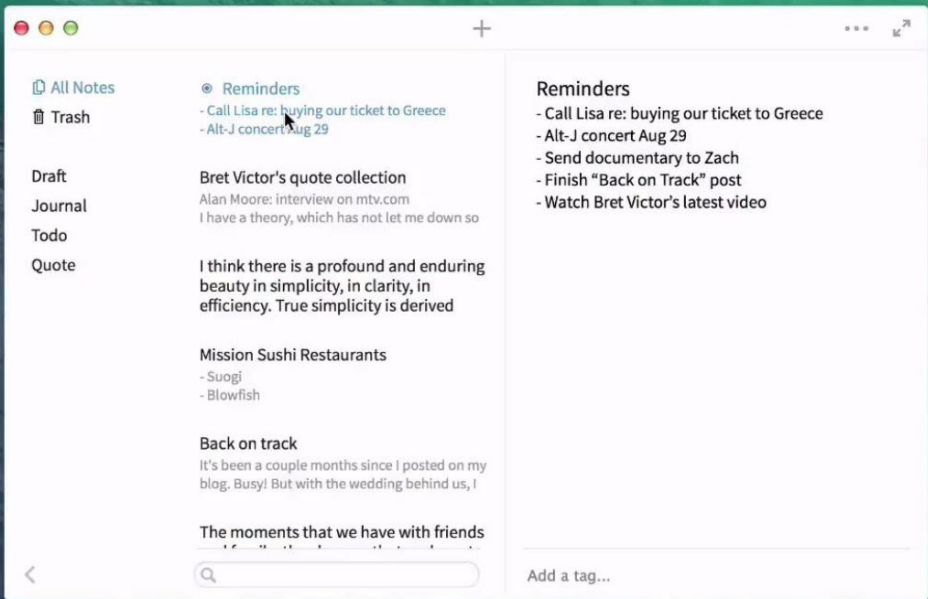
SIMPLENOTE

FREE FOR iOS, ANDROID, KINDLE, MAC, AND WEB

Simplenote (simplenote.com) is the closest an app has come to replicating the simple act of jotting notes on a blank piece of paper. As its name implies, it doesn't clutter your screen with a lot of icons or

Simplenote: no frills note taking.

buttons, nor does it allow you to attach files or add images to your note. What it does offer is a nice, clean canvas for your ideas, to-dos, and anything else you need to capture in plain text.

Simplenote lets you organize your notes with tags and also maintains version history, so you can roll back to earlier iterations when necessary. The app doesn't have any hefty collaboration features, but you can share your notes with others. All notes are backed up and synced in the cloud for access across your devices.

GOOGLE KEEP

FREE FOR iOS, ANDROID, AND WEB

This often-overlooked app (keep.google.com) in Google's productivity suite packs a lot of features behind its austere interface. Among the many tricks (go.pcworld.com/gkeep) it has up its sleeve are the ability to convert any note into a checklist, turn images into editable text, and send you reminders based on time of day or your location.

The winner, however, is its use of Google Now to enable voice-activated notes. Whenever inspiration strikes, just trigger your mic, say "OK Google—note to self," and dictate what's on your mind.
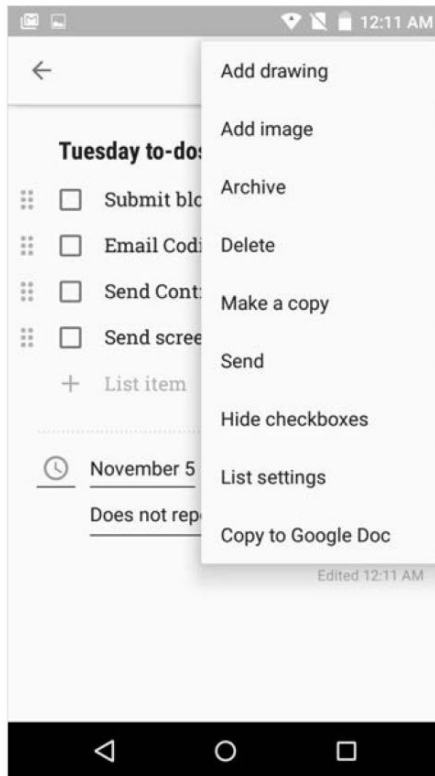
Google Keep can turn any note into a checklist.

iOS 9 tips & tricks
3:08 PM Notes attachment browser...

Paris trip prep
3:01 PM Go to passport office

Birthday list
1:49 PM This bag in either powder bl...

July 14, 2015 at 3:01 PM

Paris trip prep

✓ Go to passport office

○ Research museum admission info

Musée d'Orsay: Home
www.musee-orsay.fr

Advance Tickets | Louvre Museum | Paris
www.louvre.fr

COLLECTIONS : place, billet, ticket
www.digitick.com
Imprimez votre billet à domicile ou téléchargez-le sur
votre mobile ! Discover the rich diversity of the collec...

○ Plan itinerary of other touristy musts

[Notre-Dame de Paris] Mass and service
times
www.notredamedeparis.fr

Mass at Main Altar at noon and 6:15 pm.

Jardin du Luxembourg - Paris tourist o...
en.parisinfo.com

3 Notes

APPLE NOTES

FREE FOR iOS

Despite its appearance, the note-taking app that came with your iPhone or iPad is more than a digital legal pad. As of iOS 9, the app now supports more formatting options, so your notes can go beyond simple lists.

But Notes goes beyond text. You can also now draw sketches; take photos and video from within the app; create checklists; and insert documents, maps, and other attachments into notes. And, of course, you can sync your notes across all your Apple devices via iCloud.

Apple Notes now lets you incorporate content from other apps.

"SURE, AT FIRST I WAS A LITTLE TAKEN ABACK BY THE WHOLE PEEING STANDING UP THING. BUT I TAUGHT HIM TO THROW A STICK AND NOW HANGING OUT WITH HIM IS THE BEST PART OF MY DAY."

—EINSTEIN
adopted 12-09-10

A PERSON IS THE BEST THING TO HAPPEN TO A SHELTER PET

adopt
theshelterpetproject.org

HERE'S HOW

CONTENTS

3 fixes for a dead Windows 10 Start menu

So much for the triumphant return of the Start menu.
If it doesn't pop up for you, try these workarounds.

BY LINCOLN SPECTOR

PAT STUHLMAN WAS happy with Windows 10. Then, suddenly, the Start menu stopped working.

The return of the Start menu is probably Windows 10's most popular feature. But it doesn't work on all PCs. You can click the Start button,

or press the Window key until Apple, Google, and Microsoft all merge together and switch to Linux, but the menu just won't come up.
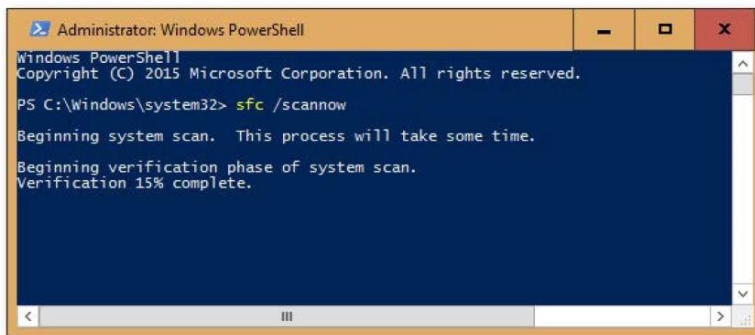
Here are three possible fixes. I can't guarantee that any of them will work, but hopefully one will.

1. Fix corrupted files

If the Search bar still works, search for **powershell**. Then right-click Windows PowerShell in the search results and select Run As Administrator.

But if the search bar doesn't work either, press WinKey-R, type **powershell**, and press Enter. Right-click the PowerShell icon on the taskbar and select Pin To taskbar. Close the PowerShell program. Hold down Shift and Ctrl while you right-click the PowerShell icon again. Then select Run As Administrator.

Once you're in the PowerShell command-line environment, type the command **sfc /scannow** and press Enter. Then wait. It can take quite a while.

Eventually, the program will tell you either that it found no corrupt Windows files, it found and fixed them, or it found some but couldn't fix them. If you get the last response, try the command:

dism /online /cleanup-image /restorehealth

This should (hopefully) download replacement files.

2. Remove and reinstall your Metro/Modern apps

Relax. This isn't as bad as it sounds. First of all, this only effects the Metro/Modern/Windows 10 apps that you get through Microsoft's Store. Old-fashioned Windows programs won't be affected.

Second, it's all automated.

Open PowerShell as an administrator as described in the previous fix. Type in the following command:

```
Get-AppXPackage -AllUsers | Foreach {Add-AppxPackage
-DisableDevelopmentMode -Register "$($_.InstallLocation)\
AppXManifest.xml"}
```

When it's done doing its job, reboot.

3. Reinstall

I hate to say it, but you just might have to reinstall Windows 10 from scratch to fix this problem.

First, make sure you've got an up-to-date backup. If not, copy the contents of your library folders to an external hard drive. You probably won't need it, but it's best to be safe.

Press WinKey-L to log out of Windows. Click the welcome screen to get to the login screen. Click the power button in the lower right corner, then hold down Shift as you select Restart.

This brings you to the Recovery environment. Select Troubleshoot > Reset This PC > Keep My Files and follow the on-screen directions.

When it's over, you'll have to reinstall all of the programs that didn't come with Windows.

12 Google Camera tips everyone can use

BY BEN PATTERSON

THERE ARE ALMOST as many Android camera apps as there are Android phones, and as of 2014 Google has its own camera app—the aptly named Google Camera.

At first glance, Google's Camera app looks surprisingly simple—nothing but a viewfinder and a shutter release. Once you start tapping and swiping, though, you'll find a bevy of hidden options, ranging from a self-timer and exposure settings to a panorama mode and even the ability to create a Street View–like "photo sphere."

Read on for 12 gotta-know Google Camera features.

Note: Not all of the following features will be available for every Android phone; for example, Android tablets without a flash won't have any flash settings, while gyroscope-less devices won't be able to create panorama shots.
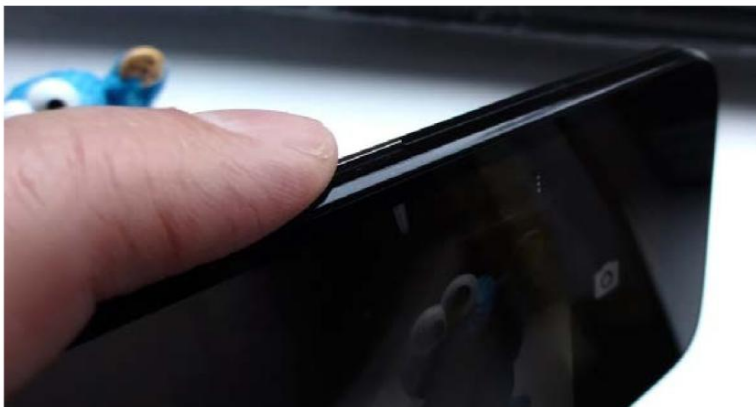
Snap photos with the volume buttons

As with iOS, tapping the (sometimes slippery) on-screen shutter release isn't the only way to take photos.

Go ahead and press a volume button—and when you do, you'll start snapping. And if you're lucky enough to own a Nexus 6P, you can hold down the shutter button to take a series of "burst" photos.

Take a selfie

You might be a bit puzzled the first time you try taking a selfie with Google Camera, given that there aren't any obvious on-screen controls

besides the shutter release.

Look closely, though, and you'll see a small, three-dot "overflow" button in the corner of the viewfinder (either the top or bottom corner, depending on how you're holding your Android device.)

Tap it, and a series of new buttons will slide into view, including one that looks like a phone with a lens and a little arrow. Tap that button to toggle between your device's rear and front-facing lenses.
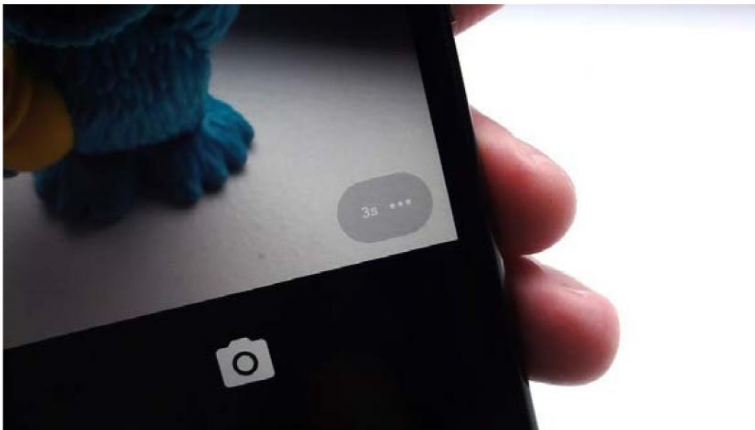
Once you pick a self-timer setting, it'll appear right next to the overflow button.

Set the self timer

Time for a group shot, including you. Never fear: Google Camera has a self-timer that'll give you up to 10 seconds to pose after you've tapped the shutter release.

Just tap the three-dot overflow button, tap the button that looks like an alarm clock with a slash through it, and then pick a timer setting— either 3 seconds or 10.

Once you've picked a self-timer setting, the interval you picked will appear right next to the overflow button.

Take charge of the flash

By default, the Google Camera app will fire off the flash whenever it thinks your shot needs a bit more light. If you like, though, you can
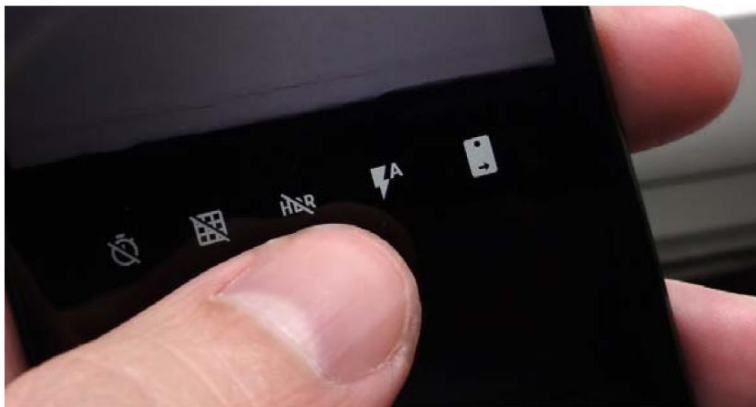
take matters into your own hands and use the flash only when you want to.

Tap the overflow button, then tap the flash button to switch between three settings: auto, on, and off.

If you've picked any flash setting besides auto, a flash icon will appear next to the overflow button.

Focus where you want to focus

Whenever you aim the lens on your Android device, the Google Camera app will automatically pick a focal point and adjust the exposure depending on the available light. If you want, though, you

can go ahead and pick your own focal point.

Just tap anywhere on the viewfinder screen to make Google Camera refocus the image and change the exposure level.

Change the exposure manually

Unlike iOS's camera app, Google Camera won't let you "lock" the focal/exposure point in place. That said, the app offers a setting that iOS doesn't: the ability to tweak the exposure setting manually.

Tap the three-dot overflow button again, then tap the two-tone square button with the plus and minus signs. When you do, Google Camera's exposure settings will appear above the shutter release; tap +1 or +2 to bump up the exposure a bit, or –1 or –2 to dial it down.

Once you adjust the exposure manually, you'll see the new setting just next to the overflow button.

Activate High Dynamic Range mode to deal with high-contrast scenes

If you're trying to capture a scene that includes areas of bright light as well as pockets of deep shadow, it may be impossible to get the exposure just right even after tweaking the manual exposure settings.

In such cases, you might be better off using Google Camera's HDR—

or "High Dynamic Range"—setting. With HDR (or HDR+, as Google calls it) switched on, the app will snap multiple shots at different exposures when you tap the shutter release. Once that's done, the camera will combine the images into a single photo that resolves (or tries to, anyway) the details in dark areas of the snapshot without overexposing the brightest areas.

To turn on HDR mode, tap the overflow button, then toggle on the HDR+ setting. If you have a newer Nexus 6, 5X, or 6P handset, you'll also have the option of an auto-HDR setting.

Take a quick look at your most recent snapshots

You can quickly review your latest Google Camera shots by swiping in from the right side of the screen.

If you want to review the photo you just snapped, tap the bubble that appears just above the overflow button; when you do, your most recent snapshot will slide into view.

No bubble? Just swipe in from the right edge of the screen to review the latest shots in your camera roll.

Add some lens blur to your shots

Now, time for the fun stuff, starting with a clever effect that'll add an artistic flourish to your photos.

Google Camera's Lens Blur feature softens the background of your images while leaving the focal point—ideally, something in the foreground—razor-sharp, giving your snapshot a greater sense of depth while focusing the eye on the subject of your image.

To get started, swipe in from the left side of the screen to open the effects drawer, then tap Lens Blur. Point the lens on your subject, tap the shutter release, and then tilt your Android device slowly, following the on-screen guide arrow.

The Google Camera app will then capture the image and process it for several seconds. Swipe in from the right side of the screen to check out the results.

Make a panoramic or fish-eye image

Sometimes, a single frame isn't enough to capture an entire landscape. Enter panorama mode, which lets you take multiple images of a scene and then stitch them together in a single, sweeping snapshot.

First, swipe in from the left edge of the display to open the feature drawer, then tap Panorama. Next, tap the three-dot overflow button to pick a format for your panoramic shot: landscape, portrait, square

or an exaggerated "fish-eye" view.

When you're ready, aim the lens and tap the shutter release. Next, you'll begin a process of making the circle in the middle of the viewfinder fit over a series of large white dots; Google Camera will snap a photo each time the circle fits over a dot.
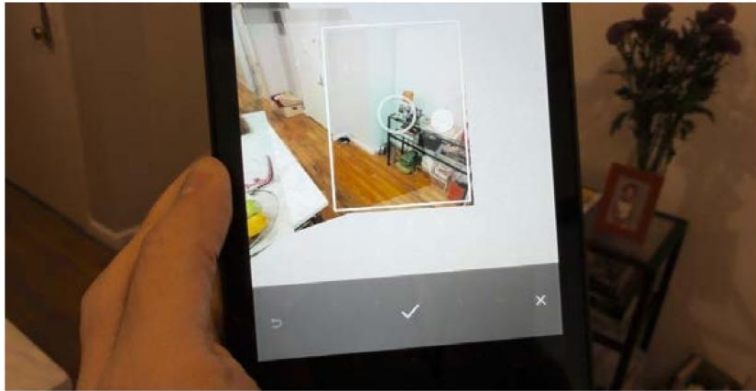
Just follow the big white dots to create a panorama shot.

Once you've completed the circle-and-dot game, the app will stitch the photos together into a single image.
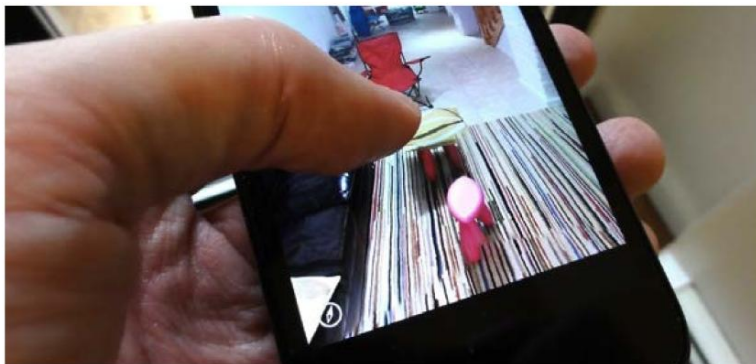
With Google Camera's Photo Sphere feature, you can create Street View–like images that you can rotate by swiping or (once you tap the compass button) by waving around your device.

Create a photo sphere

With a little help from Google Camera, you can create your very own 360-degree Street View–style images—ones that you can pan around by swiping or even by holding up your Android device and twirling around.

The process of making a so-called photo sphere is similar to that of taking a panoramic shot, except you'll have to snap a lot more photos to create the effect.

First, swipe in from the left side of the screen to reveal the feature drawer, then tap Photo Sphere. Tap the shutter release, then start aiming the viewfinder so the circle on the screen fits over the various white dots. Be prepared to (slowly) spin all the way around—up and down, left and right. When you're done, the Camera app will need anywhere from a few seconds to several minutes to stitch the images together.

Once that's done, you can swipe in from the right side of the screen to see the result. Tap the Photo Sphere button to the right of the Share button to explore the image Street View–style, then start swiping around. You can also tap the compass button in the corner of the screen to pan around by waving your Android device in the air.

Tweak your photo and video resolution settings

If space is at a premium on your Android device, you can always dial down the resolution of your snapshots and recorded video clips. Your photos and videos won't be quite as sharp, but you'll be able to shoot more images and clips before you run out of storage space.

Swipe in from the left edge of the display, then tap the settings button (the one that looks like a gear) in the corner of the screen. Next, tap Resolution & Quality, then (under the Camera And Videos heading) tap the settings for your front and rear cameras to boost or lower the resolution for stills and videos. ⏻

Note: Owners of the Nexus 5X and 6P handsets will also find settings for slow-motion video capture, a feature that most of us (including me) can't try on our devices just yet.
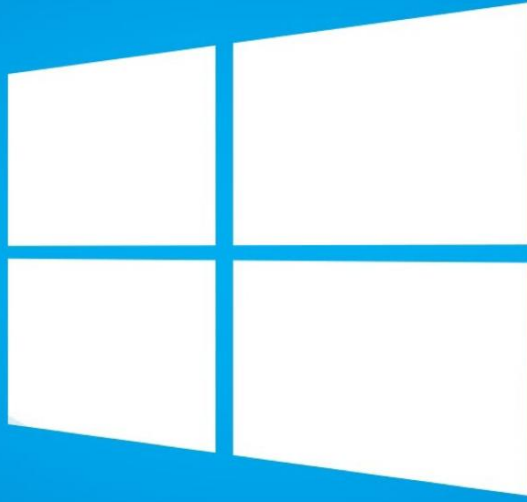
How to copy windows that weren't meant to be copied, with Textify

BY IAN PAUL

ONE OF THE great things about computers is they make it so easy to copy information. That's why there's nothing more infuriating than encountering a situation where you can't copy what you need. Windows error pop-ups are a perfect example. Not only do they have inscrutable codes that are meaningless without a Google search, you often can't copy them.

Before you bother to take a screenshot or, heaven forbid, write down the error code with pen and paper, try out Textify. This free program for Windows is an easy-to-use utility that lets you copy text from areas on your display that weren't designed with copying in mind.

There's really not much to it. You download Textify from the developer's site in a ZIP folder, extract the EXE file, and run it. Textify doesn't work like other Windows programs—the EXE file doesn't install the program. Instead it acts as a launcher for Textify. So keep that file somewhere you'll be able to find it, like your documents folder. Then when you need it, just double-click the file to launch the program.
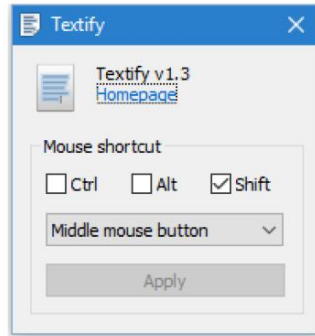
Textify's dead-simple interface.

Once you've opened it, the only decision to make is what you want Textify's shortcut to be. You can use the Ctrl, Alt, or Shift keys in combination with the right, left, or middle mouse button. By default, the key combination is Shift + middle mouse button, which works well.
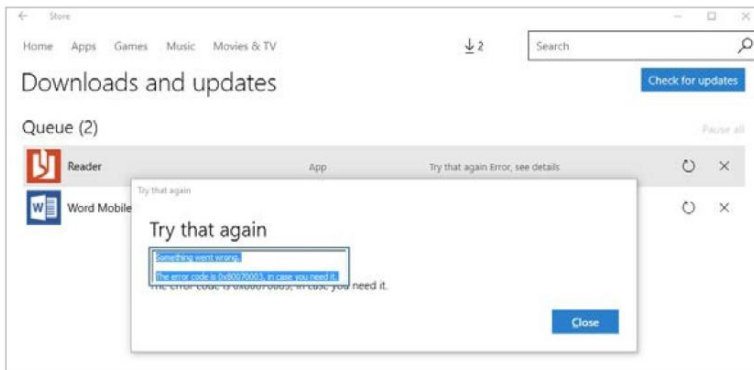
Textify in action on a Windows Store error window.

Now go to the window with text you want to copy, hover over the text you need, click the shortcut, and if Textify is running, the contents will show up in a small window that looks like a text-editing box. Copy that text with a right-click of your mouse or Ctrl + C and you're done.

Textify works great for error screens, but does have some drawbacks. Its copy box can't be enlarged. If you are trying to copy the entire contents of a window with a large amount of text split into sections, you will have to copy it line by line. ⏻

3 tips and tools for saving web content to Google Drive

BY DEREK WALTER

GOOGLE DRIVE IS one of those services that works best when you're all in. The search and productivity capabilities of Drive and its connected apps make Google's cloud storage solution an ideal place to save everything. There's no need to wonder if you saved an image to your Downloads folder or another cloud service. You know it's in Drive, and Google's search powers make it easy to find.

But there's a big sticking point to Google Drive: It can be tricky to save articles and other random bits from around the Web (which services like OneNote and Evernote excel at). Sure, there's Google Keep (go.pcworld. com/googlekeep5ways), and it's a pretty good note-taking and organization tool—but there's a lot it doesn't do. Fortunately, there are ways to supercharge Google Drive's Web-saving abilities.

How to save articles to Google Drive

There's no official extension or app to specifically clip articles into Google Drive. So here's the workaround.

If you're a Chrome user, hit Ctrl + P when you've found an article you want to save, then select Destination > Change > Save To Google Drive. This will then save the webpage to your Drive as a PDF.

If you're using Microsoft Edge or another browser, your best option is to save the page as a PDF. You can save webpages as PDFs natively in Windows 10, or use a tool like the superb CutePDF (cutepdf.com) if you're using an older version of the operating system. Once the page is captured, save it in your Drive folder
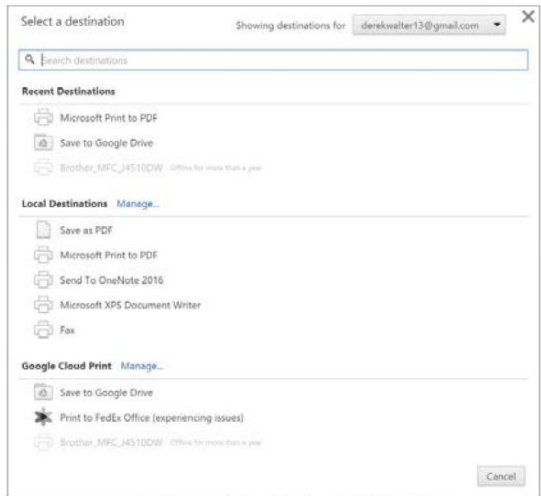
By using the Print command, you can save any webpage to Drive as a PDF.
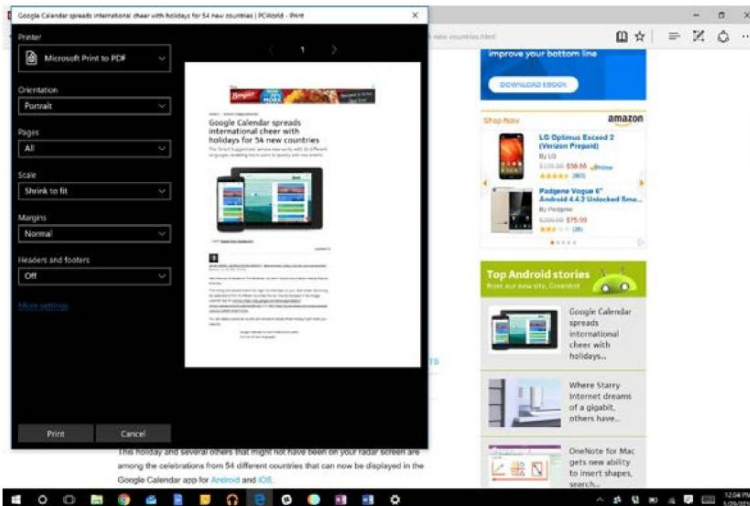
If you want to save information from another browser into Drive, your best option is to save it as a PDF.
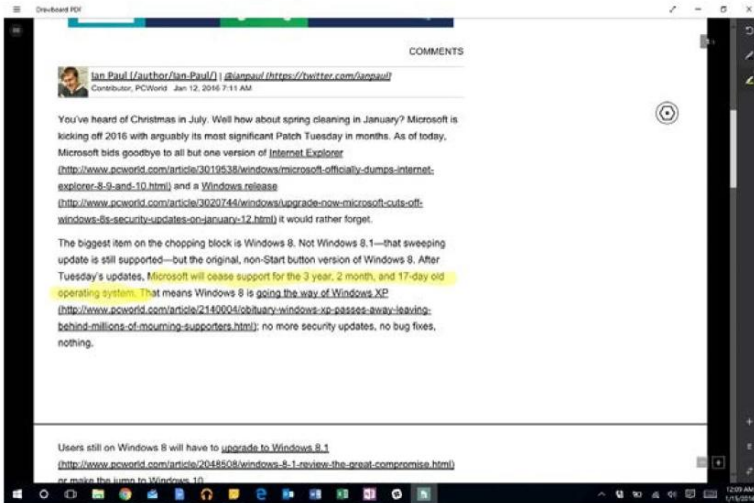
or upload it directly into the Drive website.

If you have a Surface or other Windows touchscreen device, you can then mark up the document (put that redesigned Surface Pen to use!). Your changes will sync to Drive and be available on other computers or mobile devices.

If you want to mimic a service like Pocket and save clean, ad-free versions of webpages, use a tool that strips out all the advertisements in your browser. Chrome users can install Readability (go.pcworld.com/chromereadability) or a similar extension, while Microsoft Edge (go.pcworld.com/edgereader) and Mozilla Firefox (go.pcworld.com/ffreader) natively include "reader" modes that perform the same task. Before you save an article to Drive, first click the Readability or reader-mode icon to produce a clutter-free article to add to your collection.

Save images, videos, and more

Fortunately, the method for saving most other types of content to Drive is more straightforward, thanks to the official Save to Google Drive extension (go.pcworld.com/gdrive) for Chrome. Simply right-click on the desired image, document, HTML audio link, or video and select Save To

Google Drive—it's that simple.

Note, this tool can also save an entire webpage, but only as a PNG image rather than a PDF, which isn't all that useful. There are a few other options for an HTML page as well, which you can see if you right-click on the Save to Google Drive extension and select Options.
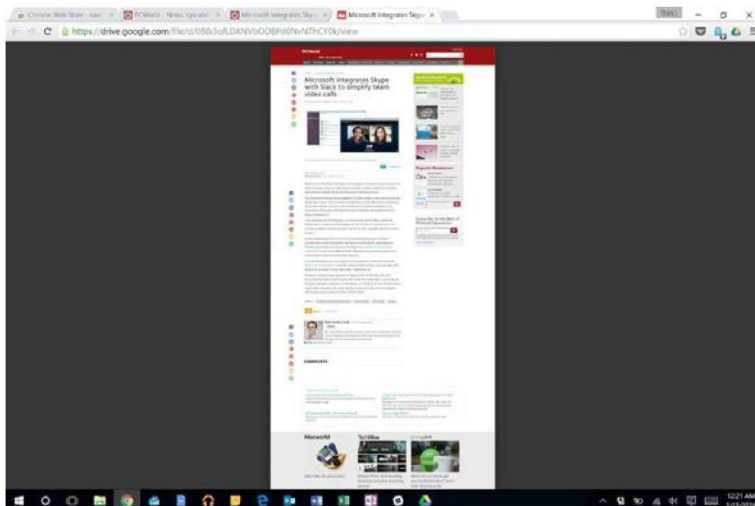
Get organized

Given Google Drive's supreme searchability, folders might seem unnecessary. But once you've begun

Right-click on any image to save it directly to Google Drive.

collecting all kinds of content from the web using these methods, Drive can become pretty cluttered.

It's a good idea to dedicate folders to separate content types. One folder for saved articles, another for audio clips, and a third for web images might be just enough to help you find what you need in a pinch.

These tips should help make Google Drive what it's intended to be: that one place where you store everything. As a result, you'll never have to wonder which cloud service is home to which of the many random items you've saved from the Web. ⏻

Google Drive can clip an entire webpage.

How to uncover Windows 10's hidden 'Applications' view in File Explorer

SAY WHAT YOU will about Windows 8 (go.pcworld.com/win8review), but the operating system's Apps screen was handy for quickly viewing all your installed programs. On Windows 10, you can scroll through the Start menu, but that isn't the same thing.

The Windows 10 full-screen Start doesn't help either since you still end up scrolling through the same single-column list just at a larger scale. Besides, who wants to use the full-screen Start full-time on a PC?

The Run window in Windows 10.

An easier option is to uncover Windows 10's all-applications view in File Explorer. Using a simple command, you can get a listing in File Explorer showing all your installed programs.

First, press WinKey + R to open the Run command window. Then type **`shell:AppsFolder`** into the text entry box and click OK, or hit Enter.

File Explorer will now open with a view to all your applications, including Windows Store apps and system utilities. To view as many applications as possible, simply hit the maximize button in the upper-right corner of the window.

Bonus tip: this command also works in Windows 8 and 8.1.

File Explorer's applications view is a little messy since it's basically showing you everything that's in your Start menu. This will include PDF documents, website links (go.pcworld.com/win10website), program-specific uninstall utilities, as well as the actual programs—although

that's really no different from the all-apps screen in Windows 8.

This little trick is a great way to see at-a-glance the programs that are on your PC or to create shortcuts for them on the desktop. What you shouldn't do from this screen is start uninstalling items with a right-click. That's better handled from the Control Panel or Settings > System > Apps & Features, otherwise you might uninstall something you're not supposed to touch. ⏻
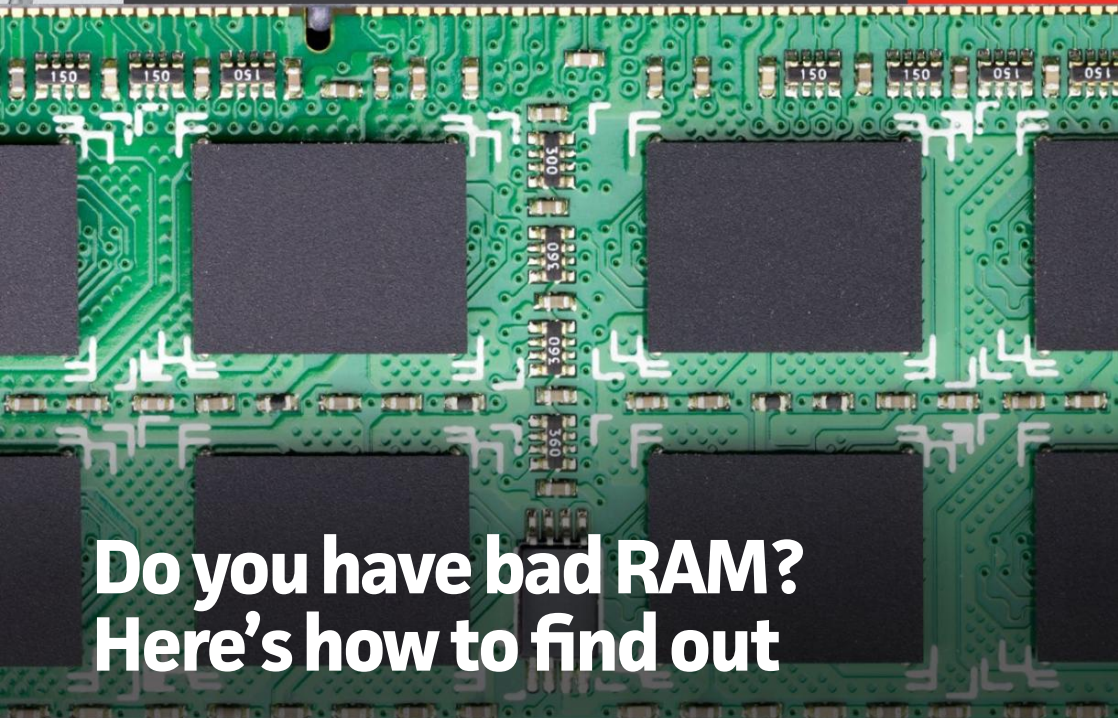
Do you have bad RAM? Here's how to find out

Defective RAM can cause all sorts of problems. If you're wondering why your PC isn't behaving, a RAM diagnosis may be in order.

Venka Tesh asked how to diagnose possible RAM problems.

Random Access Memory (RAM) wears out over time. If your PC frequently freezes, reboots, or brings up a BSOD (Blue Screen Of Death), bad RAM just might be the problem. Corrupt files can be another sign of bad RAM, especially when the corruption is found in files that you've used recently. Another possible symptom: The PC slows down considerably as you use it, but seems re-energized after a boot.

But don't just pull out and replace all of your RAM sticks. You need to

diagnose them. That way, you'll know which stick (if any) is bad. And no, don't try to replace individual chips on the stick.

Windows comes with its own memory diagnostic tool. Use the Search tool that came with your version of Windows (for instance, Start > Search in Windows 7, or the Cortana field next to the Start button in Windows 10). Search for **memory** and select Windows Memory Diagnostic.
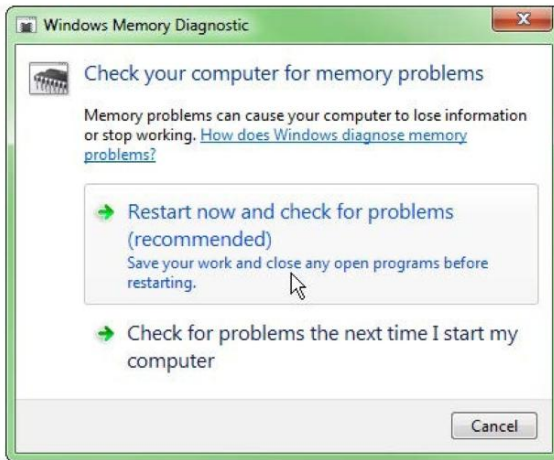

In the resulting window, click Restart Now And Check For Problems.

Windows will shut down, and your computer will reboot into the memory diagnostic program. You don't have to do anything but wait. When it's done (just a few minutes), it will boot back into Windows.

Now comes the hard part.

Search for **event** and select Event Viewer.

In the Event Viewer's left pane, expand Windows Logs and click System. Then right-click System (yes, you have to click it and then right-click it) and select Filter Current Log.
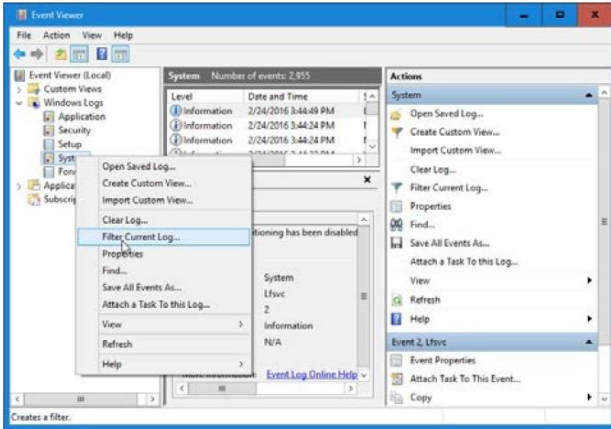
This brings up a new dialog box. Pull down the Event source menu. It's very long, so you'll have to scroll down to find and then check MemoryDiagnostics-Results. Click OK to close the dialog box.
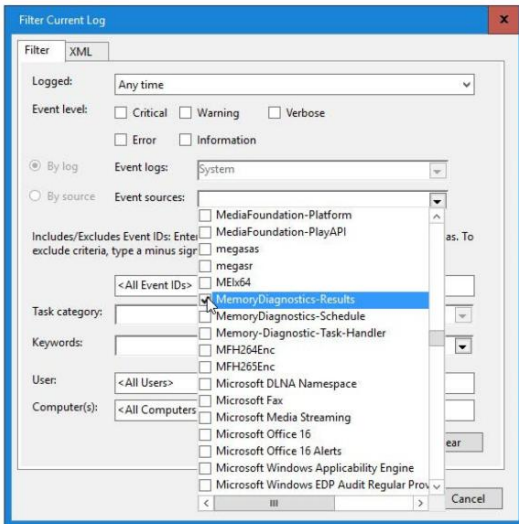
Back in the Event Viewer, note the listings in the top middle section; there will probably only be two, even if the message at the top of the pane tells you that there are thousands.
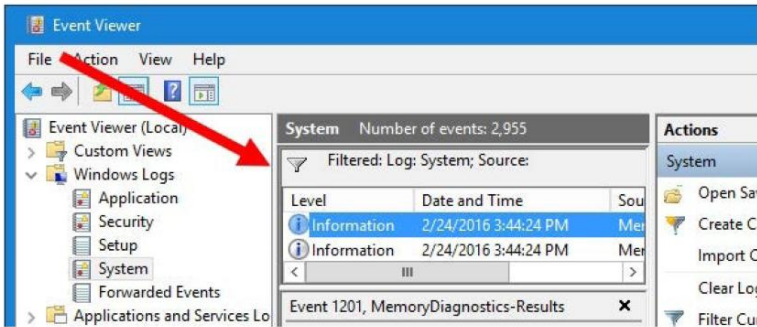
Double-click each one for information.
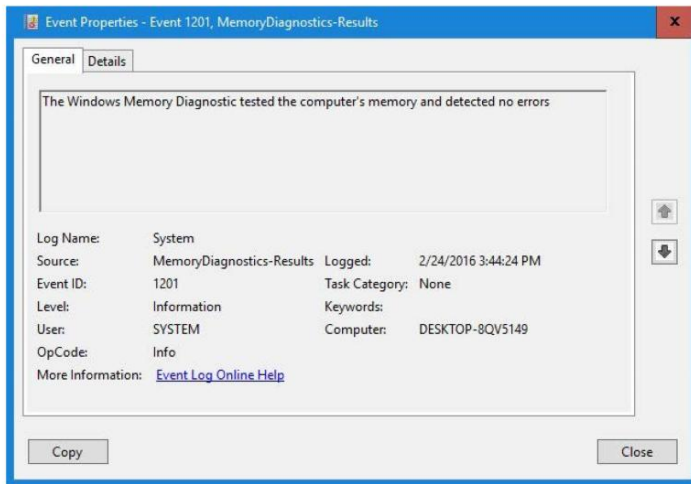
If the viewer says you have a RAM problem (I didn't), shut down your computer and remove all but one of the RAM sticks. Then reboot and repeat the testing. Repeat with each stick. That way, you'll be sure of which stick—or sticks—need to be replaced.

Then read my article on researching what kind of memory (go. pcworld.com/upgrade-ram) to buy. ⏻

Have a tech question? Ask PCWorld *Contributing Editor Lincoln Spector. Send your query to* answer@pcworld.com*.*

Female humanoid robot
Sophia is a celebrity at SXSW

>> One of the most photographed women at South By Southwest was not even human. She was Sophia, a female humanoid robot developed by Hanson Robotics. This alpha-protoype came to SXSW for the first time and became an instant sensation, drawing curious crowds wherever she went. But unlike human celebrities, Sophia seemed uncomfortable with all the attention.