

PC MAGAZINE



Who's Hacking Your Vote?



DIGITAL EDITION
NOVEMBER 2016





COVER STORY

WHO'S HACKING THE VOTE?

2016 is no ordinary election year, and cyber attacks reportedly linked to the Russian government have put officials on high alert.

FEATURES

SMART FARMS: BIG DATA MEETS BIG AG

The dream of big data in agriculture promises to improve efficiency and yields. But we're not quite there.

SNAPCHAT SPECTACLES

The rebranded Snap Inc. is "a camera company" that sells "toys" to the connected generation.

REVIEWS

CONSUMER ELECTRONICS

Logitech G231 Prodigy Gaming Headset

Pebble 2 Plus Heart Rate

DJI Mavic Pro

Sony PlayStation VR



Sony PlayStation VR

HARDWARE

Origin EON17-X 10 Series

Top 5 Gaming Mice

Asus ZenBook 3

Razer Blade Stealth (late 2016)



Asus ZenBook 3

SOFTWARE & APPS

McAfee AntiVirus Plus

Duolingo (for iPhone)

Duolingo (for iPhone)



WHAT'S NEW NOW



THE LARGE HADRON COLLIDER IS RUNNING OUT OF DISK SPACE

It's too efficient.

YOUR NEXT BANK CARD MAY CHANGE NUMBERS EVERY HOUR

Foil those ID thieves!

GOOGLE PATENT TIPS IMPLANTABLE HEALTH DEVICE

But will the company actually build one?

BMW'S SMART MOTORCYCLE WON'T TIP OR CRASH

It's part of the company's 100-year vision.

TOP GEAR

The products we love most this month.



OPINIONS

DAN COSTA

First Word

READER INPUT

CHANDRA STEELE

Fighting Sexism in Silicon Valley: You're Doing It Wrong

MAX EDDY

Elon, Don't Make Me Spend 30 Years in a Pizza Hut on Mars

TIM BAJARIN

Voters Should Reject Tech-Illiterate Candidates

“

Even the thought of Andromeda is too little, too late; it promises to be another Nexus Q.

”

JOHN C. DVORAK

Last Word

DIGITAL LIFE



GET ORGANIZED

Make Your Old iPhone Feel New Again

HOW TO

Use and Tweak Your Windows 10 Lock Screen

TIPS

9 Ways to Help Your Laptop Battery Last Longer

WORK SMART

Find Your Own Best Personal Productivity Tricks With Exist.io



Election Time

When I started in journalism, I wanted to cover politics. I got a degree in political science, volunteered on some campaigns, and applied for jobs at the *New Republic*, the *National Review*, *The New Yorker*, *The Nation*, even the *Village Voice*. None of them hired me. So I took a job with *Mobile Computing* magazine, which led me, eventually, to *PC Magazine*. The tech beat has worked out pretty well for me, but sometimes I still miss being part of our civic conversations. Fortunately, the worlds of technology and politics are always running into each other.

In September, we dug into the self-driving car revolution, a development that will profoundly reshape our cities, our economy, and our lives. Then last month, we explored how important encryption technology is to the modern digital world—a reality that is in direct conflict with law enforcement priorities. We've even covered how robots will put us all out of work. The common thread running through all these stories is that technology is transforming our world.

For those of us who earn our livings in comfortable offices commenting on the transition, these are fascinating, exciting times. The old world is dying. But it's not at all happy about that. If you want to see the old world in its death throes, look at the crowd at a Donald Trump rally. There are no policy positions: The crowd is shouting because our country looks, works, and acts differently from when they were kids. Some old-worlders voted for

Bernie Sanders, because he acknowledged that the raising minimum wage was more important than lowering capital gains taxes. And the old world is terrified of Hillary Clinton (in part, anyway), because she represents more of the same—“the same” being more change.

One thing we won't be doing in this issue is endorsing a candidate. It's tempting, and there are lots of technology issues we could touch on to justify the coverage: cyber defense, WikiLeaks, email servers, and more. It could be fun, but it wouldn't tell you anything you don't already know. And it wouldn't change anyone's mind.

Instead, in this month's cover story, Chloe Albanesius digs into who is trying to rig the 2016 presidential election, how they're doing it, and thankfully, why it's destined to fail. There are two theories: One involves a conspiracy between the mainstream media, urban voters, and thousands of local electoral commissions across the country, and the other suggests a foreign autocrat with a personal vendetta. We chose to follow that story.

I'll end by saying that I've been a fan of electronic voting, but I'm a little relieved that no voting booths are hooked up to the Internet.

A handwritten signature in black ink, appearing to read 'Dan Costa', with a stylized, cursive script.

dan_costa@pcmag.com



Dvorak's Long, Strange Tech Trip

John C. Dvorak's reminiscences of the past three decades triggered a lot of readers' memories, especially of the exciting early days of personal computing. And some of the responses demonstrated that he's not the only cranky geek around!



"MY 30 YEARS AT PCMAG: A BRIEF HISTORY OF PERSONAL COMPUTING"

I have very fond memories of those early years of the computing industry. As a child of the 80s, I gobbled up every copy of *PC Magazine* that my father subscribed to, and after he ended that, I'd go to the library and devour its copy as soon as it became available. I especially liked the technical columns, which delved into arcane commands and techniques, something which one doesn't see that much of these days in mainstream publications. ([I] also always enjoyed your "Inside Track" column.) When I was around 15, I even sent in an entry to "Abort, Retry, Fail" and won \$50! (And an ugly-ass *PC Magazine* t-shirt.)

—Avi Burstein

John, I remember reading your articles starting around 1990 as I went from hobbying with computers to pursuing them for a career. Glad you've stuck around, "Cranky Geeks" and all. [I] don't always agree with your views, but always a pleasure to read.

—ncgmac

Thanks for reminding me just how friggin' old I am! I can remember your *InfoWorld* days, and *MacUser* as well. S100 boards bring back a lot of memories, as I started an Alpha Microsystems dealership in 1981. By 1991 we had an office wallpapered with S100 boards. Several hundred thousands of dollars in original retail value! Keep

up the good work. The world needs us
old men yelling at clouds!

—*cecil77*

My first PC was a Kaypro passive back plane machine that I thought was incredible. I bought the 8088 model with a 30MB hard drive and one 3.5-inch drive and one 5 1/4-inch. I imagined buying the 286 plug in card to boost my processing speed. I needed it for Wordstar! That computer (with a monitor and amber colored screen) came home with me in March 1987 with a dot matrix printer. I caught the fever. That's about the time I became obsessed with OS/2. Within two years I had set up an OS/2 database server running a version of Oracle SQL. I was on my way.

—*Thomas Gentry-Funk*

Oh please, Dvorak, get your head out of where your coccyx should be. In 1998, my team isolated a major system for our company and advanced the date to 1/2/2000. We did this as a demonstration for the board when they balked at spending money to fix this problem. Chaos ensued when the system no longer collected money nor paid vendors. We got the funding and Y2K passed without a hitch. Had the board spent the money when the systems were developed in the first place... Well, you know the rest. As for COBOL, billions of lines of COBOL code still is in use every day, providing

tens of thousands of jobs.

—*Gerry Allen*

Thanks for this great series, John. I've enjoyed it tremendously, since I lived it along with you. You placed things in perspective for me and at the same time saddened me. Anyone who was part of the beginning of the Personal Computer age knows the special excitement that was in the air during those years. Breaking free of the "men in white lab coats" was a mantra, and we revolutionaries were relentless in our pursuit of that goal. It was a time of freedom and a chance for the individual to have control. If you didn't live through those years, you simply can't imagine the excitement. Now, as you beautifully wrote... it has come to a close. The same corporate chains we fought so hard to break have recaptured our dream and killed it. I'm glad I lived it, aren't you?

—*RKflorida*

Ask us a question

Have a question about a story in *PC Magazine*, one of the products we cover, or how to better use a tech product you own? Email us at letters@pcmag.com and we'll respond to your question here. Questions may be edited slightly for content and clarity.

The Large Hadron Collider is Running Out of Disk Space

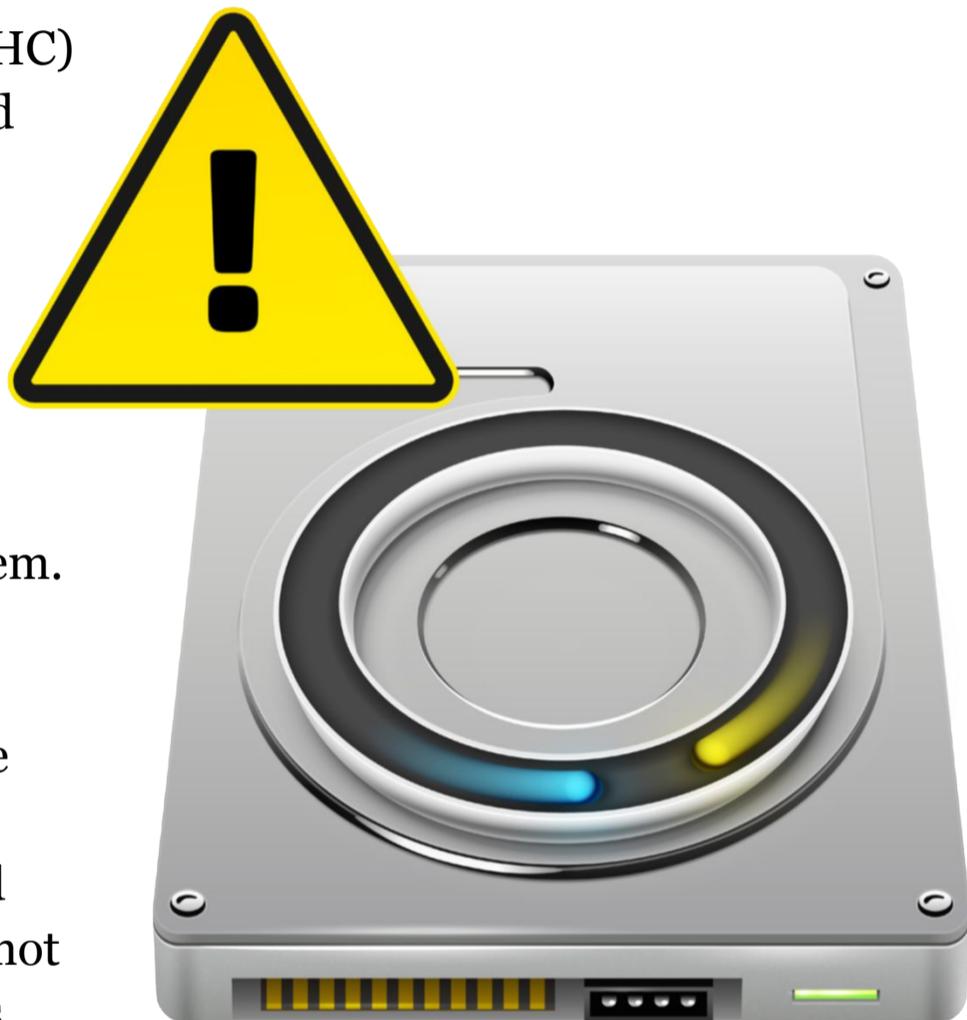
BY JESSICA HALL

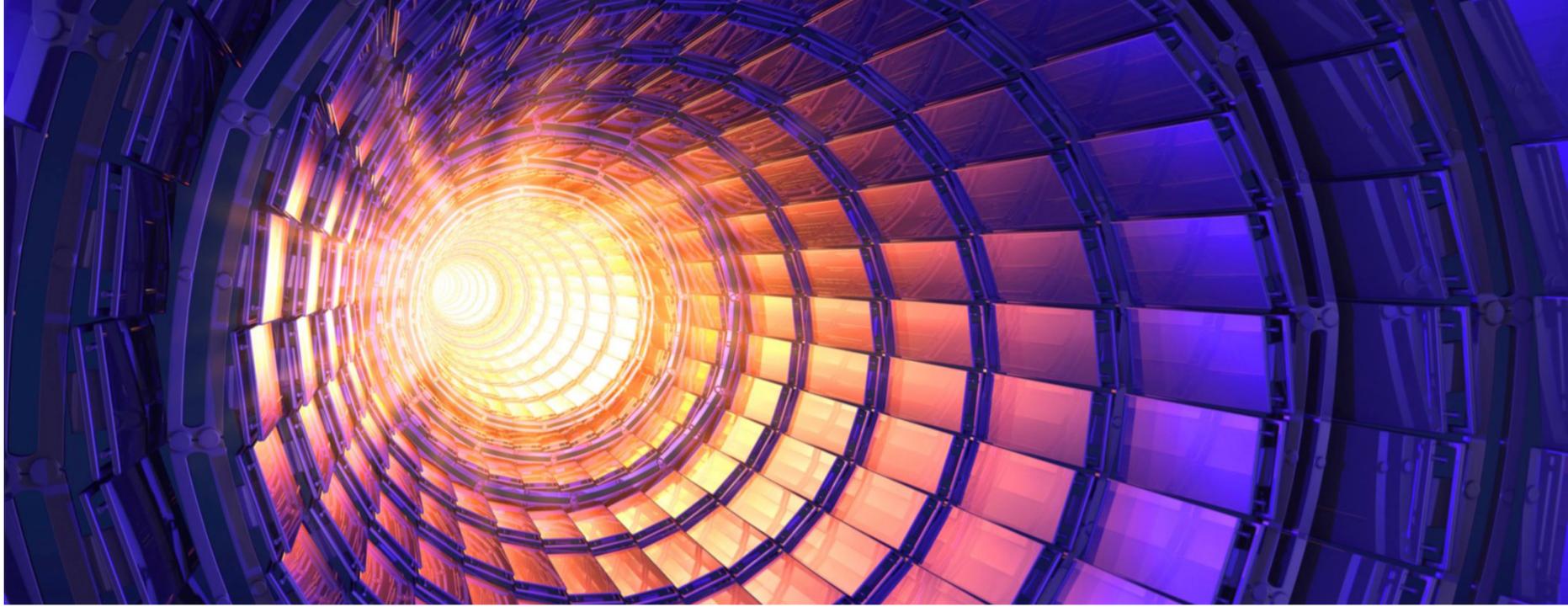
The Large Hadron Collider (LHC) has run into an unanticipated problem: It's running out of disk space. "This year the LHC is stable and reliable," says Jorg Wenninger, head of operations at the LHC. "It is working like clockwork. We don't have much downtime." That's actually the problem.

When the collider was planned out, scientists expected that it would be running about a third of the time. The rest of the time would be used for maintenance, refilling, rebooting, and other such logistical tasks. But that's not how it seems to work in practice. This may be the first time in history when technicians have made a bad estimate about uptime and had that result in success. The LHC is actually doing collisions about 70 percent of the time, more than double its expected rate.

This faster collision rate lets scientists learn more about rare processes and particles such as the Higgs boson, which the LHC produces about once per billion collisions. It's also filling up their data storage.

"The number of hard drives that we buy and store the data on is determined years before we take the data, and it's based on the projected LHC uptime and luminosity," says Jim Olsen, a physics professor working on the CMS project. "Because the LHC is outperforming all estimates and even the best rosy scenarios, we started to run out of disk space. We had to quickly consolidate the old simulations and data to make room for the new collisions."

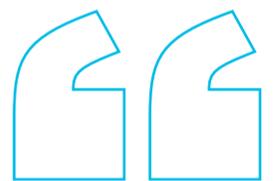




One reason for the huge glut of data is the number of different experiments going on at CERN. They all have to jockey for time.

The most recent experiment taking up collider time is on the ATLAS hardware — and instead of focusing on the maximum number of collisions possible (this is typically referred to as “luminosity”), the team is prepping for some low-speed, low-energy collisions. The type of scattering they want to study is known as “elastic scattering,” which occurs when two protons survive their encounter with each other in the detector. Instead of smashing protons together to see what happens when they collide, the goal is to bounce them off each other and measure what happens after that. The long-term goal is to better model cosmic rays and understand why cosmic rays that hit our atmosphere split into an array of secondary particles. By watching what happens to protons when they “bounce,” scientists hope to better understand why cosmic rays split into secondary particles when they strike Earth’s atmosphere.

One of the other goals of these upcoming experiments is to measure the probability that two protons could pass directly through each other without interacting at all. This is only possible because, like other atoms (which are mostly made up of empty space), protons are themselves composed of particles. In theory, it may be possible for one proton to pass through another. How often this happens is what we’re hoping to discover.



This may be the first time in history when technicians have made a bad estimate about uptime and had that result in success.



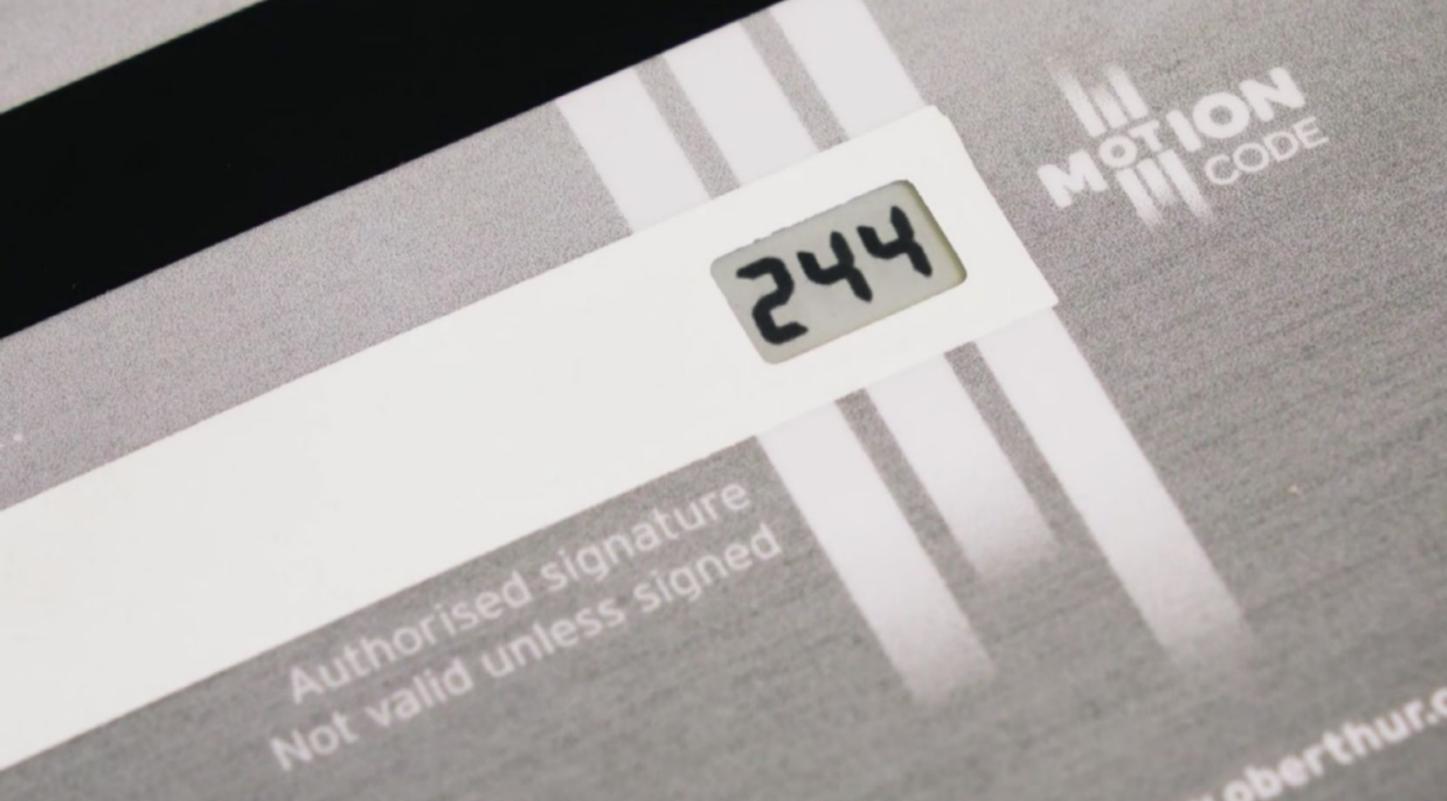
Your Next Bank Card May Change Numbers Every Hour

BY MATTHEW HUMPHRIES



Bank and credit cards are the gatekeepers to our funds, offering access to ATMs, a way to quickly pay for goods over the counter or online, and an essential part of actually dealing with your bank. But they are also the target of fraudsters who have many methods of stealing or copying their details and spending your cash for you.

Soon, though, stealing your card details may end up being completely pointless —because an hour after they are stolen, they'll stop working. Bank cards may become a little bit more intelligent by switching the three-digit card security code (CSC) found next to your signature every 60 minutes.



A MOVING TARGET

The MotionCode display changes the CSC (card security code) on the back of your bank card every hour, making it more difficult for thieves to use stolen card numbers.

Until now, the CSC has been a permanent printed code on the back of a bank card. You typically have to enter it during online checkout to help confirm the card is valid and in your possession. But it's just as easy for a fraudster to steal this number along with those on the front of the card. So French digital security company Oberthur Technologies came up with a solution it calls MotionCode.

MotionCode replaces the permanent CSC with a tiny display. Once every hour the 3 digits on the display change, rendering the old set useless. In effect, a fraudster would have at most 60 minutes to steal your card details and use them, which pretty much renders the stolen card useless. They certainly can't sell the details on to someone else, and as an added bonus you won't need to go through the hassle of replacing your card.

This clever tweak to the bank card (and eventually, to credit cards) is still in its infancy, but two French banks (Société Générale and Groupe BPCE) are set to introduce it for their customers. If no problems present themselves, and with card fraud being such an expensive problem for banks, we can expect MotionCode to be used by a growing number of banks in the next few years.

A card using MotionCode looks and acts exactly the same as the cards we use today—they just have a changeable display on the back. You also don't have to worry about the battery running out as it's guaranteed to last beyond the expiry date of the card.

Google Patent Tips Implantable Health Device

BY DON REISINGER

Google is looking to patent an implantable device that would keep tabs on a person's health.

As first noted by PatentYogi, the patent application describes a method by which a doctor or other healthcare provider would inject a that person with a small chip that would analyze fluids in the skin. Data could then be sent to a reader device so doctors could analyze blood and other fluids.

Armed with that knowledge, doctors could make determinations on a person's blood sugar levels and find out how a diabetic's level are fluctuating throughout the day. In addition, Google says, the technology could be used to detect heart rates and even body temperatures.

Of course, patents don't always translate into actual products.

Google has been working on health-related issues for some time, including its smart contact lenses and needle-free blood draws. More recently, Alphabet's Verily Life Sciences (formerly known as Google Life Sciences) said it would team up with French pharmaceutical firm Sanofi to create a new company known as Onduo, which will help those living with diabetes manage the disease via data-driven solutions.

Rivals technology firms are also tackling health-related products and services, including Apple with HomeKit and Samsung with S Health.



BMW's 100-Year Vision: A Smart Motorcycle That Won't Tip or Crash

BY BILL HOWARD



Looking ahead to its second century, BMW recently completed the vision for its four groups: BMW, BMW Motorrad (motorcycles), Mini, and Rolls-Royce. It's now BMW Motorrad's turn, and the company showed a conceptual bike called the Vision Next 100 that keeps itself upright while driving or standing.

Although the BMW concept motorcycle of the future isn't self-driving, it comes close. The Vision Next 100 helps the rider stay upright and constantly adjusts to road conditions. It's so safe, BMW says, that the rider doesn't need a helmet or protective clothing.

When the driver turns the handlebar, the frame itself flexes and changes shape, allowing the bike to go left or right. It takes more effort to turn the bike at higher speeds, improving stability. With the Flexframe (BMW's term), there is also no suspension—no springs, no shock absorbers, no swingarm. Instead, the two wheels absorb the bumps. (BMW's future vision apparently envisions an end to potholes.)

“

The Motorrad Vision Next 100 is so safe, BMW says, that the rider doesn't need a helmet or protective clothing.

”



EASY RIDER

Via its self-balancing system, which includes gyroscopes, the motorcycle remains upright; the visor has a virtual display that shows the ideal riding line.



A technology suite of stability control, traction control, and anti-lock brakes mean the bike should stay up at all times. It won't, BMW believes, ever fall over. That makes this an ideal bike for beginning riders and adds a measure of safety for long-term riders.

The powerplant has the look of BMW's classic opposed-cylinder design, but it will be built with some non-polluting, zero-emissions technology.

FREE WHEELING

“Freedom means experiencing the environment with all your senses, and feeling centrifugal forces, acceleration and the wind,” says BMW.

BMW'S DIGITAL COMPANION FOR THE RIDER

The bike won't tip over. It won't crash. So there's no need for a helmet or protective leathers (in theory). The rider will wear special gear, a sleek body suit (so long as the rider inside is sleek), and a data-display visor. BMW calls it the Digital Companion. Different data appears when the driver looks and looks down; information shuts off completely when the driver looks straight ahead.

What can the Digital Companion do? Suggest ideal lines and banking angles going through a turn, or advise of road hazards ahead. If the rider doesn't position the bike properly, the display suggests a better angle, and if the rider fails to respond, the bike corrects itself.

Looking upward brings a rear view camera into play. The bike has no instrument panel to speak of other than a red throttle grip on the right.

The rider's gear warms or cools the rider. The flexible, banded suit provides support for the body for long or grueling rides. Navigation instructions are transmitted as vibrations to the left or right arm and on the smart visor.

BMW'S AUTOMOTIVE VISION

As a group, the BMW Vision Next 100 vehicles embrace zero emissions and alternative energy: electric vehicles for sure, and possibly hydrogen-fuel-cell vehicles (that generate electricity). Although the quartet of concepts was rolled out beginning in early 2016, they seem to have anticipated Germany's legislative push to end internal combustion-engine vehicles by 2030.

The BMW Vision Next 100 Bimmer, the concept representing the core brand, features a shape-shifting body and flexible skin sections. Hundreds of "Alive Geometry" triangles on the body can pop up and turn red. The pop-ups might indicate a road hazard, the path through a corner, or where you turn on your route. Fabric panels cover the wheels to improve aerodynamics, borrowing from BMW's 2008 GINA ("Geometry and functions In 'N' Adaptations").



Navigation instructions are transmitted as vibrations to the left or right arm and on the smart visor.



BMW VISION NEXT 100 BIMMER

The car's Companion feature helps the car get to know its driver and offers advice. The dynamic display on the car's windscreen recommends points of interest, when it's in Ease (autonomous) mode.

This is the BMW concept most certain to have a steering wheel into the future. In Boost mode, the driver drives, aided by driver assists to make sure the car stays in lane and at a safe following distance. The entire windshield would be an information display. In Ease mode, the steering wheels retracts into the dash. The driver and passenger seats angle slightly toward each other for better conversation.

MINI'S AUTOMOTIVE VISION: THE SHARED CAR

BMW has shaped Mini since 1994 and shares some common designs and components, such as the front-drive chassis also found on the BMW X1. This future Mini could well be a shared-ownership vehicle or an on-demand rental. Driver/renters would maintain a profile in the cloud that adjusts his/her preferences to the current vehicle, making the current Mini be “my Mini.”

The Mini Vision Next 100 Concept would be autonomous-drive and it would be battery powered. The roof and doors can display colors and messages. Although it's autonomous, there would be a steering wheel and it could be removed and reinstalled to switch from right- to left-hand drive.

ROLLS-ROYCE'S AUTOMOTIVE VISION: TOTALLY AUTONOMOUS

In the Rolls-Royce Vision 100 concept, the spacious back seat is the only seat, or sofa. The car is fully automated: no steering wheel, no instrument panel. The motorcar will interact via the web to book hotels, suggest preferred routes, maybe even arrange tickets to “Hamilton.”

Fitted luggage slides out of custom holders just aft of the shrouded front wheels. A furled umbrella pulls from the side of the body when the upswinging doors are raised.

Despite the single seat, the 103EX (this one has a name) measures almost 20 feet bow to stern. Propulsion would be zero-emissions, most likely electric.



What We Love Most This Month

BY STEPHANIE MLOT



NIKE HYPERADAPT 1.0

This is heavy: Nike is finally launching a pair of self-lacing sneakers. Not exactly the flashy kicks Marty McFly donned in 1989's *Back to the Future II*, the HyperAdapt 1.0 are the company's first attempt at adaptive lacing. When you step into the sneaker, your heel hits a sensor and—great Scott!—the system automatically constricts; two buttons on the side let you tighten or loosen the fit. The shoes, first envisioned nearly 30 years ago, are available for “experience and purchase” at select Nike retail locations.

Price TBA (probably very expensive) news.nike.com



What We Love Most This Month

BY STEPHANIE MLOT



NIXON MISSION

Whether you're ripping up the slopes, catching some waves, or just giving the dog a bath, you need a tough smartwatch—and the Nixon Mission was built tough. Water- and shock-resistant, the Android Wear timepiece comes with real-time snow and surf alerts; pair it with a compatible iPhone or Android device for GPS and map support, voice commands, music control, weather updates, and more. The customizable Mission has the Qualcomm Snapdragon Wear 2100 processor inside and comes with a carrying case and charging cable.

\$\$400-\$450 nixon.com



What We Love Most This Month

BY STEPHANIE MLOT



RINGLY ARIES

Ringly has taken a different approach to wearables, first with its Bluetooth-connected rings and now with the Aries bracelet collection. Available in two finishes with your choice of six semiprecious gems, the bangles vibrate and light up to signify incoming calls, texts, and other notifications. The Aries has more than 100 iOS and Android apps as well as new step tracking. The smart jewelry lasts 24 to 48 hours on a charge and works up to 30 feet away from your phone—ideal for yoga class and staff meetings.

[\\$245-\\$265](#) ringly.com



What We Love Most This Month

BY STEPHANIE MLOT



BEDJET CLIMATE COMFORT SYSTEM

Relationship battles can be won or lost in bed—and that has (almost) everything to do with temperature. Some like it hot; others prefer it cool. And while the BedJet may look like an industrial vacuum hoovering your comforter, it actually sends a stream of air into the bed for a cooling or warming effect. Clamped onto one side of the mattress, the machine ventilates and removes body heat and moisture along with arguments over climate control. A wireless remote and mobile app make it easy to regulate.

\$369.00 bedjet.com



What We Love Most This Month

BY STEPHANIE MLOT



EMOTIV EPOC+ 14-CHANNEL MOBILE EEG

The future is here, and it's another wearable accessory. Strap the Emotiv EPOC+ to your head to record your brain activity for research, self-assessment, and training—or to control things with your mind. Unlike conventional electroencephalogram (EEG) systems that use sticky gels, this gadget employs saline-based wet sensors, then transmits data wirelessly via Bluetooth. The headset is little more than a battery-powered dog toy, though, without the accompanying software (available online for a monthly or annual subscription fee).

\$799.00 emotiv.com



Fighting Sexism in Silicon Valley: You're Doing It Wrong

Women in tech face an incredible number of challenges that their male counterparts do not. So they may have felt hopeful and expected some useful advice from an op-ed in the *Wall Street Journal* that directly addressed them and was written by someone with power and influence in the industry: John Greathouse, who is both a partner at VC firm Rincon Venture Partners and a professor at the University of California at Santa Barbara. What they found instead was a template for sexism and a call for women to shape themselves to it.

After the outcry that followed the op-ed, “Why Women in Tech Might Consider Just Using Their Initials Online,” Greathouse issued an apology for it on his Twitter page. He admits, “I utterly failed to help.” But in the way that we have seen Donald Trump and Billy Bush’s casual promotion and acceptance of sexual assault start a national conversation about that, Greathouse’s editorial should serve to highlight exactly what has to change in Silicon Valley. In that way, maybe Greathouse can help after all.

To start, we must stop blaming women for the lack of success they may face in getting hired or obtaining funding. Greathouse begins his piece with: “Professional women, are you properly



PC Magazine Senior Features Editor Chandra Steele got her tech journalism start at CMP/United Business Media. She also writes fiction and has been published in McSweeney's Internet Tendency.

curating your online first impression?” That is the tech equivalent of asking a woman what she was wearing when she was attacked. It’s particularly insulting because female entrepreneurs are so skilled at building businesses via social media.

In his argument for why women should cloak themselves in anonymity online, Greathouse cites evolution, which he says has rewarded the ability to make snap judgments about others. But blaming biology is far easier than setting up standards, systems, and practices that encourage girls to participate in STEM from an early age and make life for women in the industry viable.

Curiosity is the natural state of children, and we should presume girls possess an interest in science and technology rather than defaulting to the assumption that they don’t. Their natural inclination can be encouraged by visits to museums, quality time with informative YouTube videos, and extra-curricular programs.

Higher education is where a sustained love of STEM is turned into a career. But it’s also where a tremendous drop-off in STEM education for women occurs. From 2000 to 2013, women, particularly minority women, enrolled in engineering and computer science at disproportionately low rates, according to the National Science Foundation’s 2016 report on science and engineering indicators. The NSF tasked the American Association of University Women (AAUW) with investigating why there is such disparity in the numbers of men and women who work in STEM fields.

The AAUW found a distinct lack of female instructors and mentors at a university level and that introductory classes are not broad enough to encompass all that women may not have learned because of gender discrimination earlier in life.

With easy adjustments in faculty hiring and curriculum development, schools can make a huge difference in how many women pursue and stay with STEM majors. There are some schools, such as University of California, Davis, that do a good job of recruiting and retaining women.

When these women have conquered the hurdle of education, they will face further tests in the professional world—all the usual ones that accompany the transition from the Platonic ideal of learning to the practicalities of a work environment, as well as some harsher ones. Getting catcalled at conferences, work environments that epitomize the worst of frat-boy behavior, outright sexism, and dealing with societal expectations regarding child care are among them. There are stark differences in how women and men are treated in Silicon Valley and the industry. Much of the correction has to do with those in charge owning up to and changing their behavior, practices, and policies.

Which brings us to Greathouse's assertion that the idea of likability is working against women. Citing "persuasion guru" Robert Cialdini, Greenhouse states that "liking is accentuated when the persuader has a name that is similar to the person being persuaded."

This is reminiscent of the discrimination software engineer Isis Wenger faced in August, when an ad featuring her image caused a tremendous uproar that she did not, somehow, look like an engineer and therefore could not be one. This ouroboros of logic is truly a feat. If women must hide their gender to participate in the tech industry, how will they ever surmount this likability gap? Men would continue to be the accepted face of technology and women would be relegated to genderless avatars.

That might sound like hyperbole. Yet



There are stark differences in how women and men are treated in Silicon Valley and the industry.



Greathouse's advice is for women to wipe their visages from their LinkedIn, Twitter, and other social media profiles and to use only their initials in all forms of media and communication. In other words, become an egg so that men don't think of you as just the sum of your eggs. "[W]omen in today's tech world should create an online presence that obscures their gender" is a base sentiment.

In the op-ed, Greathouse adopts the tone of someone who cannot believe that anyone would harbor such biases against women. But he has put (or not put, as it were) his money where his mouth is. Rincon Venture Partners has investments in 34 tech companies, only three of which are cofounded by women (each is a founder team comprising two men and a woman).

Greathouse passes off misogyny as if it is an insurmountable, inherent, biological characteristic of men that women will have to literally work around. Disrupting such notions is an idea that the technology industry needs to put some funding behind. And if Greathouse has truly seen the error of his ways, then he will be doing just that.

Chandra_Steele@pcmag.com



In other words, become an egg so that men don't think of you as just the sum of your eggs.



Hey Elon, Don't Make Me Spend 30 Years in a Pizza Hut on Mars

Popular rocket man Elon Musk recently unveiled his plan to make humanity a multi-planet species. It is among the boldest, most audacious plans in recent memory. And unlike NASA or other space agencies's programs, Musk's Mars mission doesn't hinge on a single journey but on a constant stream of massive ships between our home world and the Red Planet.

A NEW LIFE AWAITS IN THE OFF-WORLD COLONIES

I worry because in the United States, the vast majority of people purchase a home by taking out a mortgage. Debt in the U.S. is the way nearly everything works. We use it to buy houses, cars, and even college educations. Credit cards let us sink into debt over sticks of gum or microtransactions in iPhone games. And debt seems like what most people will use to buy their way to Mars. But who will own that debt, and how will it be paid?

The story of Europeans crossing the Atlantic Ocean to settle North and South America is often cited as an analogy for future space settlement. This was, as history teaches, a bloody, brutal affair. During the early days of European colonization of the Americas, immigrants would



PC Magazine Software Analyst Max Eddy has also written for publications such as International Digital Times, International Science Times, and The Mary Sue.

occasionally fund their journey by entering into labor contracts: Just sign on the line, and you'll be given free passage to America, along with clothing and lodging once you arrive. All you have to do in return is work for the owner of the contract for a set period of time. The term for this was *indentured servitude*.

This practice waned over the years for many reasons (particularly the growth of the slave trade; the 13th Amendment finally ended both in this country). But the concept of extracting wage-free labor didn't go away. In West Virginia coal towns, for example, you signed up with the local coal company and got a job that paid, but the cost of your housing and the leasing of your tools were extracted from your paycheck. Some coal towns even operated on scrip—company-issued funny money that was exchanged for goods at company-owned stores. This system ensured a captive, economically dependent workforce.

We would like to believe that we're a bit better than the people of 100 or 500 years prior. But we are less than a decade past a worldwide banking crisis, much of which was caused by predatory loans that put people in homes they couldn't possibly afford. Even more recently, Uber has begun targeting low-income individuals who want to work for Uber but have no car, via subprime loans. And Amazon has taken flak for dangerous working conditions in its fulfillment centers. Apple supplier Foxconn faces similar criticism; workers there live in company dormitories, reminiscent of coal towns.

Musk mentioned corporate partners who may help finance SpaceX's Mars-bound vehicles. When he joked about "who will be the first person to build a pizza shop on Mars," I couldn't help but wonder how the people working in that pizza

place would be paid. While taking money in exchange for tickets is quite neat and tidy, debt allows you to extract labor directly in exchange for a service. Why pay the woman behind the counter of the Famous Original Rays on Olympus Mons when you could pay her fare to the Red Planet and then have her work unpaid or underpaid for 30 years?

In America, bankruptcy is a difficult but powerful option that gives individuals a path out of unpayable debt. How would that work, in a context where individuals' continued existence may rely on the private corporations that produce the breathable air, the drinkable water, and the only protection against the radioactive vacuum of space?

GET MY ASS TO MARS

I do not believe that Elon Musk is hatching an evil scheme to become a space dictator. Nor do I believe that going to Mars en masse is a bad idea. I do agree with Musk that to increase the chance of humanity's survival, we must become multi-planetary. Moreover, I think Musk's is the first plan that has the money and the will to actually work, and the only one I can think of that is for permanent settlement.

To his credit, Musk has already considered at least some of the problems of ferrying a species between worlds. He mentioned that a ticket to Mars with SpaceX would include a free return trip. That's great. I would also like to see serious work put not only into rockets, but funding to ensure that not just the desperate and the wealthy are sent off-world. We have full-ride scholarships for college—we need full rides to Mars if we're headed that way. I would also like to see worker and individual protection for Mars colonists codified in law before rockets ignite. These people will be operating with limited resources and far from outside help. Proactive protection is really our only choice.

Musk's attention seems to be solely on the technical issues, which is fair. He's got rockets and spacecraft to build, and those are kind of hard. But before a single foot lands on the Red Planet, we should think seriously about what we are willing to accept to make that happen.

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Voters: Reject Tech-Illiterate Candidates

With the election just around the corner, I'm concerned that very few of those running discuss or understand the importance of technology in our future. In a recent column, I laid out seven areas where tech is about to explode and have a major impact on our country and world. Yet I hear very little about tech growth on the campaign trail.

One of the more interesting aspects of my 35 years of covering high tech has been to chronicle its role and impact on our world. It has also allowed me to see firsthand the various nuances between the worlds of tech, big business, and the U.S. government and the changing role tech has had on the latter two.

For the first 50 years of the tech explosion, dating back to the early 1940s, Silicon Valley was quite happy to avoid the U.S. government unless it was handing out lucrative contracts. And the feds were seemingly fine with turning a blind eye; the less the government knew about what tech companies were doing, the fewer legal and legislative issues it would have to address.

But in the mid 1990s, a group of technology heavyweights led by Cisco CEO John Chambers and investor John Doerr realized that technology would permeate every aspect of business, education, and consumers' lives. And they needed the help of the U.S. government if they were to have the kind of impact they envisioned.



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Even then, Chambers, Doerr, and key leaders from Intel and other tech companies saw the benefits of mobile, connected cities, and the Internet of Things (IoT). They lobbied the Clinton administration and governmental agencies under him to help officials understand tech and its eventual role in our country.

To Clinton's credit, he and Vice President Al Gore opened a lot of doors to the tech industry in Washington. Then when George W. Bush became president, he created a special nonpartisan tech advisory council at the urging of Chambers, Doerr and Michael Dell. I was invited to join that council, and our first meeting with President Bush was very promising. He seemed to understand how important technology would be for the future of the country, and I know he spent many hours with tech leaders before the election to get a grasp on their vision.

But five months after our first tech council meeting at the White House, the September 11, 2001 terrorist attacks shook the nation. The Bush administration's focus shifted to fighting terrorism, and the tech council was put on the back burner and never revived. While key tech leaders tried to get their message heard in a broader way in Washington, the wars in Iraq and Afghanistan and the fight against terrorism took up much of the White House's mindshare. Any real focus on helping to expand a tech agenda during Bush's years in office was minimal.

When President Obama entered the White House, many of these same tech leaders, along with new and younger tech visionaries, pushed him and his administration to become more focused on the role of technology at all levels of business. He and his administration have done so and have made an effort to understand things

such as the maker movement, the IoT and its role in cities, and issues related to telecom spectrum. During his presidency, we have seen the Internet and the cloud become core components of government, business, education, and consumer programs.

We're now at another presidential transition point, and given the recent advancements in tech, whoever is elected president or to serve in Congress needs to be more tech-savvy than ever. During his keynote at Intel's Developer Forum this week, CEO Brian Krzanich invited Jeffrey Immelt, the CEO of GE, to the stage to talk about the various things GE is doing to make cities more intelligent. He also had an executive from BMW share its vision for autonomous vehicles. Both emphasized the role legislators will play in the success of these programs.

For smart cities and smart cars to succeed, laws will need to be changed or written to make it possible for autonomous cars to drive safely within city limits. Lawmakers will have to approve the placement of new sensors and smart cameras to enhance accident avoidance. State officials will have to understand how technology will impact every corner as gadgets are added to streets, light poles, and intersections. Unless our elected officials understand this, they will only slow down the expansion.

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Whoever is elected president or to serve in Congress needs to be more tech-savvy than ever.





A Low-Price Gaming Headset With Excellent Audio



Logitech's new Prodigy line of peripherals is aimed at gamers who are looking to get started with dedicated accessories but daunted by the price of high-end equipment. The G231 Prodigy wired gaming headset doesn't have the luxe feel or superb audio quality of the Turtle Beach Elite Pro and is less fully featured than the wireless G933 Artemis Spectrum, but it costs less than half of either of those headsets and still offers a solid build and excellent performance. If you want a dedicated gaming headset with a lot of bang for not much buck, the G231 Prodigy should be high on your list, and it earns our Editors' Choice.

**Logitech
G231 Prodigy
Gaming Headset**

\$69.99



The G231 is mostly dark-gray plastic with bright-orange highlights on the outside of the earcups, just above the earpads, and over the padding under the headband. The headband and earcup padding is fairly thin and springy, and it's covered in a breathable mesh fabric. The flip-down boom mic sits on the left earcup, along with the connection point for the attached, fabric-wrapped cable, which terminates in a single four-pole 3.5mm connector.

The headset is light and comfortable. It doesn't press down on your head, and the vaguely trapezoidal earpads are large enough that they didn't crush my ears.

An inline remote sits surprisingly low on the headset cable, a good 2 feet down from the headset itself. The remote has a small volume wheel and a microphone mute switch, and the enclosure features a clip to secure it to your shirt (though you still have to deal with some cable slack).

As a wired headset with a 3.5mm connector, the G231 can work with any modern game system. You can plug it directly into any PlayStation 4, Wii U, or Xbox One S (or Xbox One with Stereo Headset Adapter) gamepad or any smartphone or tablet, through its single 3.5mm connector, and the included Y-connector has you covered if your PC has separate headphone and microphone ports.

GAME PERFORMANCE

Games sound very good on the G231. The audio for Gears of War: Ultimate Edition comes through cleanly and powerfully. The in-game dialogue can be heard clearly over the forceful thumping of gunfire and explosions, which receive plenty of low-end response through the headset. The balance can feel a bit bass-heavy at higher volumes, but the mid-highs and highs necessary for voice communication are easily discernible.

ReCore has much less ballistic oomph to its

Logitech G231 Prodigy Gaming Headset

PROS Excellent sound for the price. Solid build. Includes a 3.5mm splitter.

CONS Not particularly plush or snug. In-line remote sits oddly low on the cable.



WIRED REMOTE

Use the G23's inline remote for volume control and muting.

soundtrack, and comes through very well balanced. Joule's chatty narration and the sci-fi blaster sounds of the various weapons and robots all sound crisp and clean without any noticeable dips or spikes in the frequency range.

MUSIC PERFORMANCE

The G231 is quite capable for music as well. It handles our bass test track, The Knife's "Silent Shout," at top volume without a hint of distortion. The force of the bass from the synth notes and kick drum hits can be felt clearly, but the deep low end isn't overwhelmingly powerful, even at its loudest.

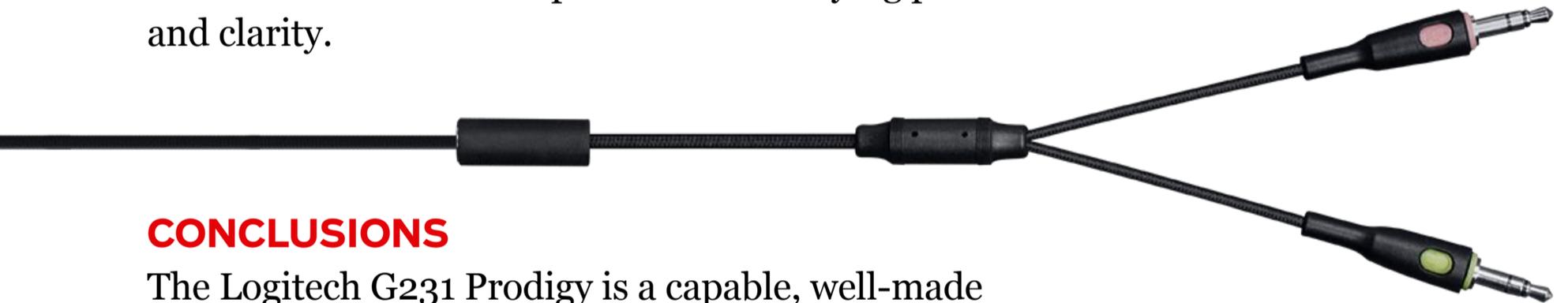
The opening to Yes's "Roundabout" sounds clear and detailed across the board, even though it's lacking a bit of subtle finesse in the high-end to really bring out the texture of the acoustic strings that more expensive, dedicated headphones can produce. Still, for a \$70 gaming headset, the G231 delivers both the acoustic elements and electric slap bass with satisfying power and clarity.

CONCLUSIONS

The Logitech G231 Prodigy is a capable, well-made gaming headset at a very reasonable price. You can find headsets that feel more plush or offer a bit more crispness in the high-end, but you'll spend two or three times as much for those luxuries. If you're looking for a sub-\$100 headset that offers satisfying performance, the G231 is an excellent pick, and it's our Editors' Choice for budget-friendly wired headsets. If you want to spend even less, the Tritton Kama is available for around half as much as the G231, but its build quality and performance aren't quite as strong.

WILL GREENWALD

“
The G231 handles our bass test track, The Knife's "Silent Shout," at top volume without a hint of distortion.
”





Pebble's Fitness Smartwatch Has Potential, Not Quite There

Hot on Apple's heels, Pebble is updating its smartwatch lineup with a lot of some the fitness-tracking functionality you'll find in the Apple Watch Series 2 or a dedicated fitness tracker. The Pebble 2 + Heart Rate is the first out of the gate, with a lighter, slimmer design than the original Pebble Classic, along with an accelerometer and an optical heart rate monitor to track your workouts and sleep. But heart-rate and sleep results were inconsistent in testing, so you're better off with a fitness tracker such as the Fitbit Charge 2. If the fitness features don't hold much appeal, the Pebble Classic can be had for about half the price and remains an Editors' Choice.

**Pebble 2
+ Heart Rate**

\$129.99



DESIGN AND DISPLAY

The Pebble 2 is available in five colors: black, white, aqua/white, charcoal/flame, and charcoal/lime (we received the charcoal/lime version, shown at right, for our review). The watch weighs 1.1 ounces including the band, and the face measures 1.5 by 1.2 inches (HW). That makes it both lighter and slimmer than the Pebble Classic (2.0 by 1.4 by 0.5 inches, 1.5 ounces) and the Pebble Time (1.6 by 1.5 by 0.4 inches, 1.5 ounces). Pebble is working on a new version of the Pebble Time, the Pebble Time 2 + Heart Rate, which should be available in January 2017.

The polycarbonate case looks very similar to those of previous Pebbles. It has four plastic buttons for navigating menu screens—three on the right side, one on the left—along with a microphone on the right for voice replies. A magnetic charging port on the back fits the included proprietary charging cable.

You need to install the included 22mm silicone strap when you first get the watch; it uses quick-release pins, so you can swap it out for any standard 22mm band. The strap is soft and smooth to the touch, similar to the Sport band on the Apple Watch Series 2. I kept the Pebble 2 on for several days and nights without it ever feeling uncomfortable or in the way.

The watch face is slightly curved, so it contours to your wrist. The display is an always-on 1.26-inch, 144-by-168-pixel monochrome e-paper panel with LED backlighting. It's the same as you'll find on the Pebble Classic, but it's covered with Gorilla Glass 3 for an extra layer of scratch resistance. The screen is crisp and easy to see indoors and out, even under direct sunlight. The backlight turns on automatically when you lift your wrist, and you can adjust how long it stays on. The fact that it's always on is definitely a plus, as most smartwatch and fitness tracker displays automatically turn off after just a few seconds.

Pebble 2 + Heart Rate

PROS Excellent battery life. Always-on display. Solid voice-to-text functionality. Android and iOS compatible. Instant notifications. Lots of apps. Comfortable.

CONS Inconsistent heart rate monitoring and sleep tracking in testing.



EPAPER DISPLAY

As with previous Pebble models, the 2 + Heart Rate uses a backlit display that's easy to read in nearly any lighting situation.

The Pebble 2 is waterproof to 98 feet, which means you can shower, bathe, and go in the pool or ocean with it. But you can't take it diving or snorkeling, and you need to clean it with fresh water afterward. I wore it in the shower and in the rain with no problem. There's no built-in swim-tracking mode, but you can download third-party apps that count laps and intervals. It should be noted that the Pebble Classic is waterproof to 164 feet.

Battery life remains one of the main reasons to get a Pebble. The Pebble 2 lasts up to seven days, just like previous models. The Apple Watch Series 2 and Android Wear watches like the Huawei Watch typically last little more than a day, if that. Even fitness trackers such as the Charge 2 and the Fitbit Blaze last only about five days on a full charge.

PAIRING AND FEATURES

The Pebble 2 works with Bluetooth devices that run Android or iOS. I downloaded the Pebble app and paired it with a Samsung Galaxy S6 after following some simple onscreen instructions. One firmware update later, I was ready to go. The whole process took around 5 minutes.

Navigating the Pebble 2's interface is nearly the exact experience as it is with previous Pebble watches, which is a good thing. The aforementioned buttons on either side of the case toggle back and forth between menus, which in turn activates charming animated screen transitions with star-shaped happy faces and smiling cartoon suns. You can view a timeline of your Google Calendar appointments and weather reports using the top and bottom buttons on the right, while the middle button brings up your music, notifications, settings, watch faces, and installed apps. For speedier access, you can map certain apps to the right buttons. Pressing the left button brings you back one step.



FAMILIAR FACE
Pebble used nearly the same interface for the 2 + Heart Rate as it has on previous models—and that's a good thing.



Smartphone notifications are accompanied by a gentle vibration and appear at the exact same time as they do on your phone. You can get notifications for most apps and features, including calls, emails, texts, calendar events, Google Hangouts, and even Snapchat. You can also mute specific apps or turn off notifications altogether by holding down the left button to activate the Pebble 2's Mute command.

To respond to messages, the watch offers canned responses, emojis, or voice replies. As with previous Pebbles, the microphone is accurate and responsive; I was able to dictate full sentences while walking down busy city blocks or standing in noisy crowds.

Pebble says it has more than 10,000 apps and watch faces in its app store. The store is easier to navigate than it was the last time I visited. A slider up top recommends specific categories for watch faces (Halloween, for example) and apps (such as fitness). You'll find lots of the usual app suspects here, including ESPN, Evernote, Jawbone, Misfit, Pandora, Runkeeper, Whatsapp, and Yelp.

As far as watch faces go, my favorite is a downloadable one based on the Seiko watch from Metal Gear Solid V. You'll have numerous Star Wars-related faces to choose from as well. A Heartbeat face is another cool option that shows an animated heart and an EKG-style pulse line that responds to your actual heartbeat. The Apple Watch Series 2, by comparison, has even more in the way of apps (a strength of Apple's across all its platforms), but just a handful of built-in watch faces to choose from.

PERFORMANCE AND FITNESS TRACKING

The Pebble 2 uses the same ARM Cortex M4 processor found in the Pebble Time. That's a step above the Cortex M3 in the slightly slower Pebble Classic. Equipped with an accelerometer, an optical heart-rate sensor, and a built-in fitness app, the watch can track your active minutes, calories, distance, heart rate, and sleep. Trackable activities include running, walking, and generic workouts. There's no built-in GPS or altimeter, so you're not getting the same level of self-quantification as you do with the Apple Watch Series 2 or the TomTom Spark Cardio + Music.

To access the Pebble 2's fitness features, press the upper right button to get to the Pebble Health screen and cycle through your steps, heart rate, and sleep stats. Pressing the middle button on any of these screens will give you a deeper dive into the information gathered, such as a daily breakdown of the number of hours you've slept per day. You can view even more detailed information in the Pebble app on your phone, which lets you drag your finger across graphs to view hourly data.

To test accuracy, I wore the Pebble 2 and the very accurate Fitbit Charge 2 for several walks and bike rides. Sometimes they returned similar results—distance and steps were mostly comparable, for instance. But the Pebble's heart-rate monitoring was all over the map. At times the Pebble 2 would report the same numbers as the Charge 2, but other times it reported numbers far too high or low to be accurate. For example, I would be walking at a normal gait, and the Pebble 2 showed my heart rate at close to 200 beats per minute—way off the mark. The Charge 2, meanwhile, posted much more credible numbers in the 80s and 90s. Sitting still would often result in BPMs in the 40s, which is very low. The Charge 2 reported a more accurate low-to mid-60s. In addition, the heart-rate monitor reported random numbers when I wasn't even wearing the watch, and the app would record these readings, throwing off my data.

I contacted Pebble about this, and a spokesperson for the company said it's a known issue that it's working to resolve in a coming update. We'll revisit this review when the update is available.

Sleep tracking was similarly inconsistent. Once again, the Pebble 2 was right on the mark some nights, and off by 4 or 5 hours on other nights, while the Charge 2 remained consistent with my actual sleep and awake times. And just like the heart-rate sensor, the Pebble recorded ghost readings when I wasn't wearing it. For instance, it detected that I napped for 2 hours, even though I wasn't wearing the watch at the time.



ASLEEP AT THE WHEEL

Our tests of the Pebble 2 + Heart Rate's sleep tracking produced inconsistent results, including ghost readings.



The 2 + Heart Rate's fitness capabilities just aren't on par with the Apple Watch Series 2 or a dedicated tracker.



COMPARISONS AND CONCLUSIONS

With an update to fine-tune its fitness-tracking capabilities, the Pebble 2 + Heart Rate has the potential to win over smartwatch fans with an interest in fitness, and vice versa. As it stands, however, its fitness capabilities just aren't on par with the Apple Watch Series 2 or a dedicated tracker.

The Apple Watch Series 2 is far more expensive, and it's for iPhone users only, so its potential audience is a lot more limited than Pebble's. But Apple offers the best selection of smartwatch apps out there, and built-in GPS makes the watch a compelling alternative to a dedicated fitness tracker. The Fitbit Charge 2, meanwhile, costs the same as the Pebble 2 and offers more accurate fitness metrics and a thriving social community. But if it's just smartwatch functionality you're after, the Pebble Classic offers all of the same features and functionality, minus the fitness focus, for considerably less.

TIM TORRES



DJI's Little Drone Has a Lot of Firsts

Small drones are the next big thing. The DJI Mavic Pro joins the GoPro Karma, the Vantage Robotics Snap, and the Yuneec Breeze as the latest downsized model. It's twice the price of the Breeze but delivers almost all of the features of DJI's top-end consumer drone, the Phantom 4. If you're looking for a small quadcopter that doesn't compromise on functionality, the Mavic Pro is worth considering. Our Editors' Choice honors remain with the Phantom 4, which is larger but also more powerful, so it can fly faster and stay stable on windy days.

DJI Mavic Pro

\$999.00



DESIGN

I was shocked to see just how small the Mavic Pro really is. DJI describes it as about the size of a water bottle when folded, and that's not far off. It measures 3.3 by 3.3 by 7.8 inches (HWD)—if you're making room in your camera bag, it can slide into the same slot that you'd normally use for a modest telezoom such as the AF-S Nikkor 80-400mm f/4.5-5.6G ED VR.

The Mavic weighs in at 1.6 pounds when ready to fly with a microSD memory card installed. You'll have to spend a few bucks to register with the FAA before flying, if you don't already have an identification number, and make sure the aircraft itself is marked with that number. First-time pilots should familiarize themselves with drone-flying rules and regulations before taking flight. The DJI Go smartphone app, which is required to pilot the Mavic, includes a flight simulator to help you get used to the controls.

The drone is finished in gray with yellow accents. You unfold its arms before flight, first pulling the front rotors out and away from the body and locking them into the forward position, then pulling the rear struts down and back into their locked setting. The rotors, which fold in half, don't have to be removed between flights, but they have a push and twist design for installation and removal. A clear dome protects the camera—you can fly without it, but you'll need to remove the gimbal clamp, a small piece of plastic that locks the camera into place during transport, before flight.

DJI Mavic Pro

PROS Small, foldable design. Obstacle avoidance system. Sharp, distortion-free stabilized 4K video camera. 12MP Raw and JPG stills. Records in portrait or landscape mode. Compact remote control. 23-minute flight time. Strong operating range. Orbit, follow, and other intelligent flight modes.

CONS Requires a smartphone to operate. Unable to take off from grass in testing. Not as steady in strong wind as Phantom models.



The battery snaps in and out of the top. DJI claims it can power the Mavic for up to 27 minutes under ideal conditions. In my field tests, which comprised high-altitude flying on a breezy day, low-altitude testing of the obstacle-avoidance system, and a few jaunts across a football field in the high-speed Sport mode, all while shooting footage at 4K resolution, I netted 23 minutes of flight time by using 90 percent of a fully charged battery. Recharging takes about an hour, and spare batteries cost \$89. If you plan to get a couple of spares, consider the Fly More bundle— at \$1,299, it includes two extra batteries, ten propellers, and a carrying case.

REMOTE CONTROL AND OPERATING RANGE

I reviewed the Mavic Pro, which ships with six propellers, one battery, and no carrying case. One other option, the Mavic (\$749), is the same as the Pro edition minus the dedicated remote control. If you plan on flying exclusively with your smartphone as the controller, it's a solid way to save some money, but it cuts the maximum operating range to about a 0.6 miles (1km) and throttles down the top speed to 9mph. I recommend you spend the extra money on the remote. It's small—smaller than an Xbox controller when folded—and flying a drone with joysticks offers more control.

DJI states that you can fly up to 4.3 miles, but that's under absolutely ideal conditions. In real-life testing, I was able to fly about 2,000 feet from home base in a suburban setting before communication became spotty. In a rural environment, I flew a full mile (5,280 feet) without any sort of hiccups or stutters in the video feed. I chose to turn the drone around and bring it home at that point, rather than trying to get more distance out of it. But that's enough to tell me you don't need to worry about limited operating distance.

You'll also enjoy fast flight with the remote. The top speed (with obstacle avoidance enabled) jumps to 22mph, and you can enable Sport mode to achieve 40mph flight. With obstacle avoidance disabled but not flying in Sport mode, I got the Mavic up to about 33mph when flying at 240 feet.

The controller features dual joysticks. The left controls altitude and spins the Mavic about its axis, and the right moves it in the direction you push the stick. It also has two control wheels: The left adjusts the gimbal tilt, and the right brightens or darkens video. Also on the controller are buttons that take a picture, start and stop video recording, activate Return to Home mode, and pause automated flight. Two rear buttons launch the the app's camera menu by default but can be customized. Likewise, any of the four directional presses of the small joypad that sits at the right of the monochrome information LCD can be customized.

Two antennas sit atop the controller, folding down for storage. The clip to hold a smartphone sits at the bottom; it had no problem accommodating a phablet. Cables are included for Lightning and micro USB connections, but for a phone with USB-C, you'll need to buy an \$8 accessory cable.

APP AND FLIGHT MODES

Your phone runs the DJI Go app, which allows you to change camera settings, view live video from the Mavic's camera, and see where the drone is on a world map—useful if you've lost track of it in the sky.

The app really lets you take control of the 4K camera. You can adjust the color balance, capturing video that's more vividly saturated or with a flat color profile that can be graded in post-production. You can also filter JPG photos or set the camera to capture Raw images in DNG format.

The app is also where the Mavic's Intelligent Flight Modes live. As with the Phantom 4, you can set the drone to orbit a point in space (Point of Interest), repeat flights along a preset path (Waypoints), follow you (Follow Me), and change the way it responds to joystick control (Home Lock and Course Lock). TapFly allows you to control the drone's path in the air simply by tapping on a portion of the screen. A generation raised on smartphones may find this to be more intuitive than flying via a joystick, but it's not my favorite way to pilot. And ActiveTrack can recognize and follow a moving target. Both of these work with the obstacle avoidance system, which reduces the chance of an accident.

New to the Mavic is the Terrain Follow mode, which uses its downward-facing obstacle sensors to maintain a constant altitude above the ground. It's a solid choice for low tracking shots when flying over uneven terrain. And Gesture snaps your picture when you wave at the Mavic. We'll call the resulting shot a “dronie.”



UNDER CONTROL
The small remote control has a clip that's big enough to house a phablet. Two antennas on top can fold down for storage.

The app also displays important telemetry information: current altitude, distance from the home point, speed, and orientation. You can swap the full-screen live view feed with the embedded area map, a big plus in locating the Mavic in the air when it's flown a good distance from its takeoff point.

VIDEO QUALITY AND PERFORMANCE

The Mavic's camera is a new design, smaller than the 4K unit used by the Phantom 4 but matching it in video modes and bit rate (60Mbps). Its field of view is slightly narrower, closer to a 25mm full-frame lens than the wider 20mm optic on the larger Phantom. Landscapes won't appear quite as wide, but you still get solid coverage for aerial video.

In a first for a drone, the camera module can rotate from the standard landscape orientation to a vertical portrait orientation. This works for both stills and videos, and though it is my strong belief that shooting vertical video is a cardinal sin, shooting a vertical 4:3 photo is often preferable for a portrait.

The camera is also the first I've seen attached to a drone that supports focus adjustment. Most are fixed-focus designs that capture everything from a certain distance to infinity in crisp detail. The Mavic can focus closer—to 19 inches (half a meter)—but locking in close means that distant objects will appear blurred. You aren't likely to use the close-focus ability for aerial shots, as the obstacle avoidance system will stop you from getting 19 inches away from your subject, but the Mavic is tiny enough that I can see it being used as a handheld camera. Just make sure you don't start the motors when doing so.

The Mavic supports 4K DCI recording at 24fps, the more common 16:9 4K UHD format at 24 or 30fps, 1080p at standard frame rates up to 60fps, as well as at 96fps for smooth slow-motion playback, and 720p at the standard rates up to 60fps, with 120 and 180fps available for a more extreme slow-motion effect. Video is silent—not a bad thing, as the only audio you get from an aerial camera is propeller and wind noise.



In a first for a drone, the camera can rotate from the standard landscape orientation to a vertical orientation.



The 4K footage captured by the Mavic is just as crisp and detailed as that of the Phantom 4. The lens doesn't show any noticeable barrel distortion, and video is steadied by a 3-axis gimbal. I took my first test flight on a breezy day and did notice the occasional wobble when a gust hit the drone as well as jitter when I brought it to an abrupt stop. But for the most part, video is silky smooth and steady, even when the drone is flying in the high-speed Sport mode: The extra distance that the Mavic needs to go from full speed to stop actually helps reduce the jitter you get from abrupt stops and turns at lower speeds.



Photos are captured at 12MP resolution in JPG or Raw DNG format. Image quality is what you'd expect from a point-and-shoot camera, which is typical for most drones. If you want to get more than that, you'll need to go with a copter with a Micro Four Thirds camera, such as the Yuneec Tornado H920 or the DJI Inspire 1 Pro. Still shooters will appreciate the new Tripod mode, which slows the maximum speed considerably, making it easier to make very precise adjustments to the drone's position so you can set up the perfect shot.

READY FOR TAKEOFF

Once the four arms are swung out, the Mavic is ready to fly. You can leave the clear dome attached to protect the lens, or remove it to maintain the highest level of video quality.

The Mavic Pro includes forward and downward obstacle-avoidance detection, as well as downward Vision Positioning, which has been a staple of the Phantom series since the introduction of the Phantom 3 Professional. The systems do a solid job of preventing the aircraft from flying into objects, bringing it to a halt a few feet away.

As a smaller drone, the Mavic Pro doesn't handle as well in high wind as the Phantom, which has stronger motors and a higher top speed. I flew in wind varying from 5mph up to around 12mph, and the aircraft was steady in the air. At a high altitude, about 280 feet, the app warned me that the wind was on the strong side, after a gust. But I had no problems controlling the Mavic and was able to bring it back home and to a lower altitude with no problems.

There's one notable drawback to the low-profile design. I was unable to get the Mavic to take off from a neatly trimmed athletic field, as even short grass stopped it from taking off. Stone and gravel parking areas are also a concern, as the Mavic sits unevenly, which can cause the gimbal to not properly align with the horizon. In both cases I was able to use a large backpack as a takeoff area, but you may want to consider adding a small piece of cardboard or something equally light and flat to your portable kit to give you more versatility in launch points.

CONCLUSIONS

The DJI Mavic Pro is a prime example of just how quickly the drone market is evolving. A few months ago a small drone, even one with GPS stabilization like the Parrot Bebop, was underpowered and less than capable, compared with larger models. The Mavic Pro changes that. When folded, it stows easily in a smaller bag, and though it's not quite as quick or as powerful as the larger Phantom 4, it can fly high, move through the air at a solid pace, and capture 4K video that's just as detailed.

I'm not naming the Mavic Pro our Editors' Choice, as that honor remains with the superb Phantom 4, which is now around the same price as the Mavic Pro. But it's a strong option for the right pilot, who doesn't mind spending a good amount of money on a drone and places a high value on a portable design. If you've coveted the Phantom 4, but think it's just too big to carry with you to exotic locales to capture stunning aerial footage, the Mavic Pro is the way to go.

JIM FISHER



**Sony
PlayStation VR**

\$399.99



Sony PS VR: Best Balance of Price, Power, Features



Sony's virtual reality headset is finally here. The PlayStation VR is a system designed for use with the PlayStation 4 and the upcoming PS4 Pro. It's a powerful accessory that lags only a hair behind the PC-powered HTC Vive and Oculus Rift in specs, and it's far less expensive, especially when you put the required PlayStation up against the pricier VR-ready PCs the Vive and Rift require. In addition, its graphical capabilities and motion tracking far exceed smartphone-based VR headsets such as the Samsung Gear VR. Virtual reality is still a technical novelty you have to commit to before you spend the cash, but the PlayStation VR offers the best combination of accessibility, content, and power, and it earns our Editors' Choice.

REQUIREMENTS AND DESIGN

In addition to a PlayStation 4 or the more powerful PS4 Pro, you need a PlayStation Camera to use the PS VR, though one isn't included with the headset. The \$499.99 PlayStation VR Launch Bundle includes a PlayStation Camera and two optional PlayStation Move motion controllers, so we recommend that version over the base kit unless you already have PlayStation Move set up with your PS4. Otherwise, expect to spend another \$60 on the camera, and \$100 for a pair of PlayStation Move controllers.



The headset is made mostly of curved white plastic with a prominent visor that holds most of the electronics and a single thick headband that runs around the back of your head. It weighs 1.3 pounds, making it a bit heavier but not particularly bulkier than the Oculus Rift (1 pound) and the HTC Vive (1.2 pounds). The headband is supported by a plastic crosspiece with an adjustment wheel and button, and sturdy elastic is hidden where it connects to the visor. Gray panels around the front, with a few scattered over the back, hide multicolored lights that come on when you use the headset; they're used in tandem with the

Sony Playstation VR

PROS Immersive VR experience. Works with non-VR apps and games. Motion control support. Low cost of entry compared with PC-based headsets.

CONS Requires PlayStation Camera, which is not included. Slightly less powerful than its main competitors. Some motion-tracking hiccups when playing in brightly lit rooms.

SONY'S VR HEADSET IS HERE

The PlayStation VR is a powerful accessory that lags only a hair behind the PC-powered HTC Vive and Oculus Rift in specs—and is far less expensive.



PlayStation Camera to track the headset's location. A wire runs from the left side of the visor and partly along the headband before dropping down to connect to the PS VR processor box with the included cable.

It almost looks like a Microsoft HoloLens, with its huge face mask of a visor and the various whites, grays, and silvers of its design. Of course, the HoloLens is a completely different beast, an augmented reality device that project images on what you actually see rather than completely replacing your sight with a computer-generated image, as the PS VR does.

To put the headset on, you just place the visor over your eyes and pull the headband back, stretching the elastic until the crosspiece fits against the back of your head. Turning the wheel tightens and locks the headband, thus keeping the headset in place while you use it. The button releases the headband so you can adjust it or pull it off. This is a notable departure from the Vive and Rift, both of which use a T-shaped harness with a strap that runs over the top of your head. The fit is very secure even without a strap over your head to keep it in place.

VIRTUAL REALITY CHECK

The PS VR differs from the Microsoft HoloLens; the latter is an AR device, so it projects images on what's actually visible.

SONY PLAYSTATION VR

An inline remote sits about a foot down the wire from the headset and contains a 3.5mm headphone jack for use with the included earphones, volume up/down and mic mute buttons, and a power button that turns the headset on and off. The cable terminates in two HDMI connectors; one is a standard HDMI plug and the other has a bump over the top, giving it a proprietary shape. They both plug into the VR connector cable, which in turn plugs into the processor box with another pair of the same HDMI plugs. If the different shape of the connectors isn't enough for you to keep track of which plugs into which port, they're also marked with pairs of PlayStation face button icons (Triangle/Circle and X/Square) that match the correct ports on both the female end of the connector cable and the processor box.

The VR processor box looks like a miniature PlayStation 4, only with a rectangular profile instead of parallelogram. It measures 5.6 by 5.6 by 1.4 inches (HWD) and weighs 12.9 ounces, making it notably larger and heavier than the HTC Vive Link Box but still dwarfed by the PlayStation 4 next to which you'll be placing it. The front holds an indicator light on the left two-thirds of the box and a pair of connectors for the headset on the right third. The VR connectors sit recessed in a plastic sleeve, which slides back to let you plug the cable in before returning to its original position to hold the cable slightly more securely. The back holds a connector for the included power brick, a micro USB port for connecting directly to the PlayStation 4, an HDMI input to connect to the PS4's video output, and an HDMI output to connect to your television.



NECESSARY ACCESSORIES
The PlayStation VR Launch Bundle includes a PlayStation Camera and two optional PlayStation Move motion controllers.

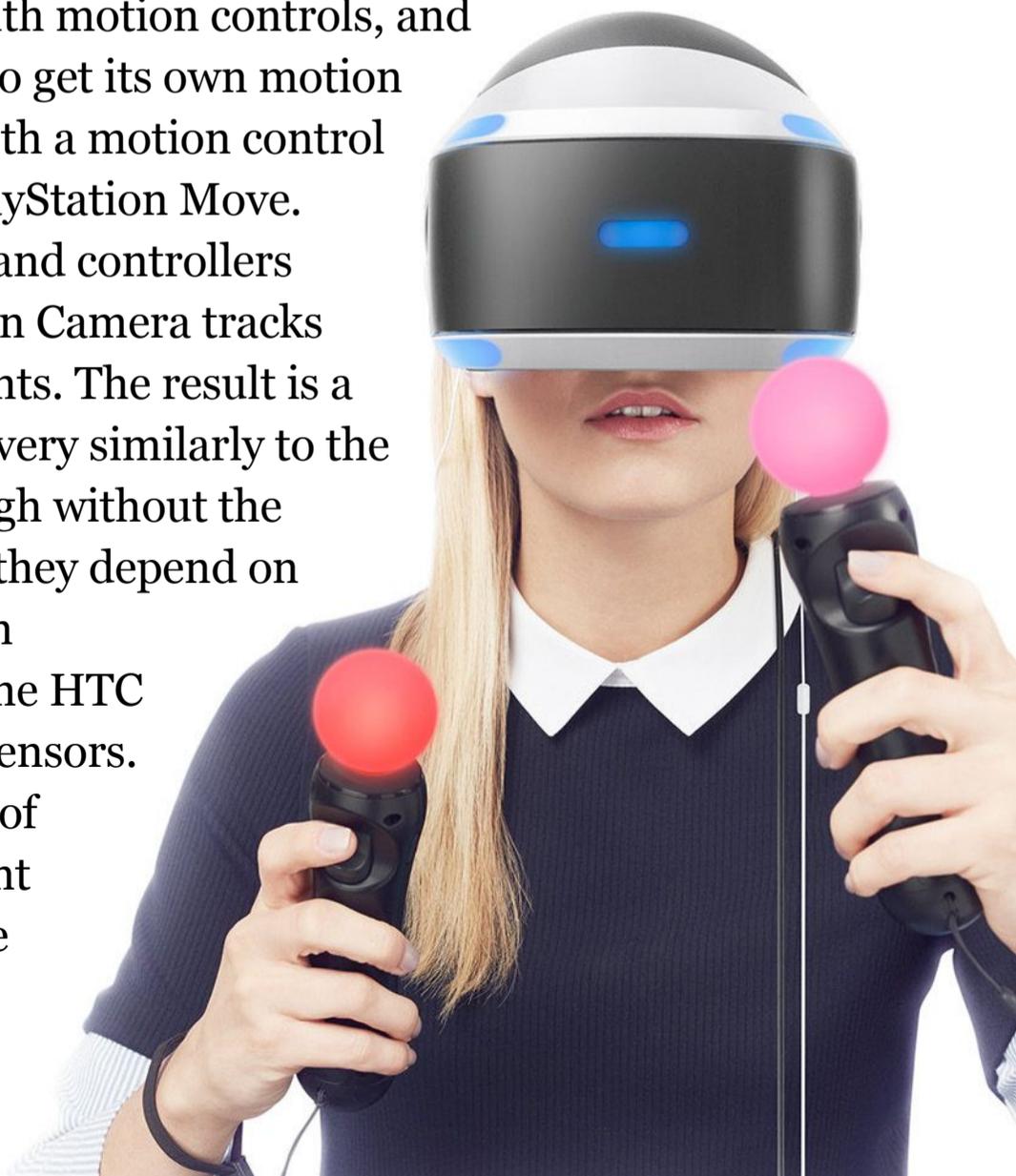
SETUP AND DISPLAY

Hooking everything up is a fairly direct process, but it produces a nest of cables. You need to plug the processor box into the front of the PS4 with the included USB cable, into the back of the PS4 with an HDMI cable, and into your television with another HDMI cable. Then plug the PS VR headset into the processor box with the VR connector cable, and plug the power brick into the processor box. Finally, plug the PlayStation Camera into the back of the PS4. Once connected, turn on the PS4 and you're ready to go. Press the power button on the inline remote of the headset. It will turn on and display the PS4's main menu as a large screen projected in front of you, using the headset's lights and the PlayStation Camera to track your position.

The PS VR uses a 1,920-by-1,080 OLED panel split into 960-by-1,080 images for each eye, which is lower resolution than the 2,160-by-1,200 panels (1,080-by-1,200 for each eye) used in the Rift and Vive. This means the PS VR's picture is just slightly grainier, but aside from some minor pixelation with small text, it isn't very noticeable. The PS VR's panel also has a 120Hz refresh rate, which means the headset has the capability of smoother motion than the 90Hz Rift and Vive. Ultimately, it looks crisp and smooth, and stands solidly alongside the other two headsets in picture quality.

CONTROLS AND MOTION TRACKING

Like the HTC Vive, which launched with motion controls, and unlike the Oculus Rift, which has yet to get its own motion controls, the PS VR hits the market with a motion control scheme in the form of the optional PlayStation Move. The Move uses two motion-sensing wand controllers with glowing bulbs that the PlayStation Camera tracks along with the PS VR's positioning lights. The result is a motion-control system that performs very similarly to the HTC Vive's in terms of accuracy, though without the Vive's controller's touchpad. Because they depend on the PlayStation Camera, you can't turn completely around like you can with the HTC Vive and its two spread-out tracking sensors. If you stay sitting or standing in front of your television (or wherever you mount the PlayStation Camera), however, the controls are very reliable.



While the PS VR doesn't support whole-room motion tracking as does the HTC Vive, it still demands a fair bit of space. I had to sit several feet back from by the screen on which I mounted the PlayStation Camera for the headset to track reliably, which is a significant departure from the performance of the Vive (which uses two wall-mounted sensors that covered me in nearly all locations in our test room) and the Rift (which uses a desk-mounted camera that functions very well close-up). Your PlayStation 4 is likely connected to a television for couch-bound use rather than a monitor for desk use, so the need for distance is understandable. But it's something to note if your PS4 is hooked up to a monitor or if you plan to use the PS VR in a cramped area.

Because the PS VR relies on visual tracking with colored lights rather than infrared tracking, it seems to be more vulnerable to disruptions from ambient light and reflections. With the lights on in our test room, I noticed some tracking drift that made the view of the headset gradually float to the left, and some hiccups and other tracking disruptions occasionally crept in while I played. Batman: Arkham VR demanded the most movement of the PS VR software I tried, and because of that, it brought out quirks in the PS VR's motion tracking more than other games.

GAMES

Of the three major virtual reality headsets to come out this year, the PlayStation VR has the best signal-to-noise ratio of fully formed games rather than small-scale experiences that serve as tech demos. It doesn't launch with any single killer app, but it has enough complete games to provide several hours of entertainment, so that it feels like more than just a demo.

Sony includes a disc filled with software to get you started—mostly trial versions of retail VR software of varying scopes and prices, such as Driveclub VR, Rigs, and Thumper. I tried several of the demos, along with some full versions of PS VR software provided by Sony for the review, including Batman: Arkham VR, Battlezone, and Until Dawn: Rush of Blood.



- **Rigs** is a mech action game where you play the pilot of a giant robot in a combat sports league. It uses the DualShock 4 controller, relying on the analog sticks for controlling mech movement and PS VR head tracking for aiming weapons. Aiming feels incredibly natural using head movements, letting you simply look directly at enemy mechs to shoot them while dodging and maneuvering separately from your weapons. The graphics are impressive. It's a short demo that shows a lot of potential for the full game, and demonstrates that VR can produce some compelling gameplay.

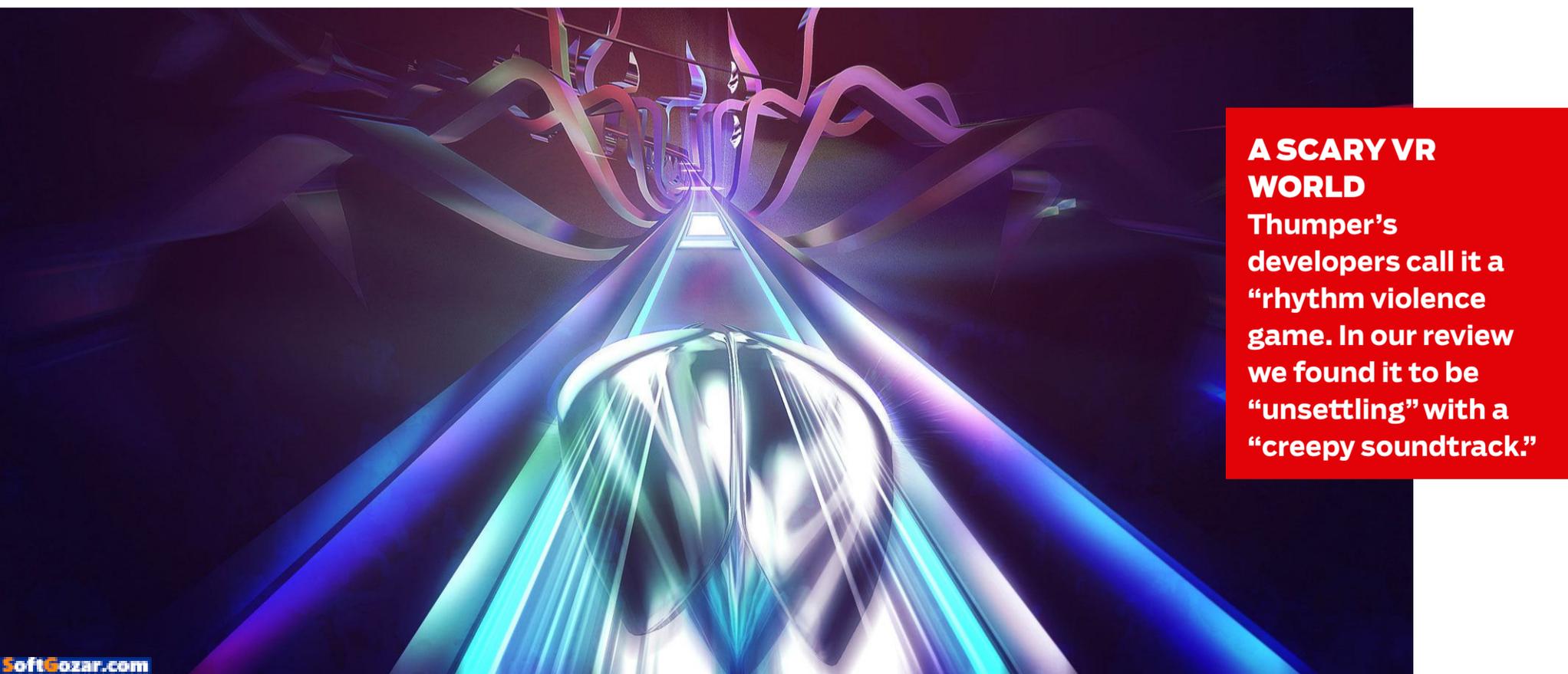
- **Battlezone** is a modern take on the classic arcade tank-combat game. Head movement is relegated entirely to looking around and finding targets, which makes the VR implementation seem much less necessary than it does with Rigs. But the weapons reticule moves intentionally slowly because you're in a tank rather than a more agile mech, and instant aiming through motion tracking would ruin that effect and unbalance the game. The graphics are slightly less impressive than Rigs, but it's still a fun action game that feels fully fleshed out.

READY TO GAME

The PlayStation VR has the best signal-to-noise ratio of fully formed games rather than small-scale experiences that serve as tech demos.



- **Driveclub VR** is a virtual reality-enabled version of the Driveclub racing game already released for the PlayStation 4. It puts you in the driver's seat of one of three cars on a single three-lap street race. The big VR hook is that, because your view is completely covered by the game and the camera tracks your head movements, you can look around the car while you drive. This sounds like a gimmick unless you consider just how much you move your head when you actually drive. The ability to look left and right when passing, to tilt your head up to see the rearview mirror, or to look directly over your shoulder for a better view behind you is extremely useful, and it enhances the Driveclub experience.
- **Thumper** is the most sinister rhythm game I've ever played. You control a scarab-like vehicle running down a set track in a featureless void, using the X button and left analog stick on the DualShock 4 to respond to glowing bars and sharp curves on the track. A creepy, thumping soundtrack builds up as you play while a series of strange, tendril-filled geometric portals appear on the track, warping it and adding obstacles. It's a simple but fun and unsettling experience. But of all of the demos on the PS VR disc, this has the least justification for VR. The use of a headset makes the void appear stranger and more immersive, but it doesn't actually improve the gameplay.
- **Batman: Arkham VR** is based on the Arkham games and uses many of the same graphical assets as Arkham City and Arkham Knight. It's a technically impressive though fairly short demo that puts you in Batman's boots, using the PlayStation Move motion controllers as Batman's hands to solve a series of puzzles to get to the bottom of a violent crime. Each Move



A SCARY VR WORLD
Thumper's developers call it a "rhythm violence game. In our review we found it to be "unsettling" with a "creepy soundtrack."

controller works as one of Batman's hands, which I used to both interact with the environment and use Batman's gadgets. To use the tools, I physically reached down to each one as if it were on my body and pulled the trigger on the Move controller to grab it. I couldn't actually move smoothly around my environments; instead, I jumped between set points by pointing at them and pressing the Move button on the Move controller or took out my grappling gun and aimed it at objects to pull myself up to them. Despite the movement limitations, Batman: Arkham VR is a fun little jump back into the world of the Arkham games.

- **Until Dawn: Rush of Blood** is the PS VR--specific standalone successor to the horror adventure game Until Dawn. You play an unnamed individual dropped into a slow-moving roller coaster that rolls through a dilapidated amusement park; you must shoot violent murderers before they can attack you. The PS VR head tracking also comes into play, following your movements and forcing you to lean and duck to avoid dangers as the roller coaster goes through the tracks. It's an over-the-top blast filled with surreal and bloody imagery. While it clearly takes a lot of assets from Until Dawn, it remixes them into a new, fresh, and thematically different experience. The PlayStation Move controls for the guns make the shooting feel very immersive. But after about 20 minutes the orientation of the controllers started to tilt and drift. This forced me to aim my pistols at increasingly uncomfortable angles before I recalibrated them. It's a minor annoyance.

NON-VR SOFTWARE

The PlayStation VR displays all non--PS VR software as a giant screen floating in front of your face, similar to the Virtual Desktop software available for the HTC Vive. Motion controls are disabled when you're playing non-VR games, but the system still tracks your head movement to give the impression that you're sitting in front of a big screen. If you want to turn and use the view from another position, a prompt appears to tell you to hold the options button on the DualShock 4 down for two seconds to reset the screen to whatever direction you're currently facing.

This is a very helpful feature that gives the PS VR some purpose beyond the games and tech demos designed specifically for it. It effectively gives you a virtual big-screen television that only you can see, with which you can enjoy any PlayStation 4 content. Since it's still a virtual reality experience, you need to be wary of eye and neck strain from long-term use, and it's simply not as

comfortable to use as sitting in front of your television. It's a fantastic option to have, though.

AN ACCESSIBLE INTRO TO HIGH-END VR

Graphics-intensive, device-tethered virtual reality is still in its infancy, and so far it's a very expensive proposition. That said, the PlayStation VR offers the best balance of price, power, and features we've seen in the category yet. At \$900 including a PS4, the total cost of entry is significantly less than that of the Oculus Rift and the HTC

Vive (\$1,500 to \$2,000 each, including the necessary VR-ready PC), and it supports motion controls that the Oculus Rift still lacks. It also packs far more graphical power than any of the phone-based VR headsets, including the Samsung Gear VR. And the headset is launching with a fairly strong collection of interesting games and VR experiences, making a better case for use of the technology than the competition.

WILL GREENWALD





The Best-Performing High-End Gaming Laptop



The Origin EON17-X 10 Series is the most powerful gaming laptop we've reviewed, boasting an overclocked Intel Core i7 processor and a Nvidia GeForce GTX 1080 graphics card. It's big and heavy, but the performance is unmatched by anything we've tested, and the speed justifies the price in this already expensive category. It costs more than its predecessor, the Origin EON17-X (\$1,716), but for the extra money, you get that additional speed, a 4K display, and a ton of storage. For that reason, it's our top recommendation and Editors' Choice for high-end gaming laptops.

Origin EON17-X 10 Series

Starts at \$1,858;
\$3,567 as tested



DESIGN AND FEATURES

The new Origin EON17-X 10 Series looks a lot like the previous version, but the chassis is different in a few ways, the most obvious being that the white lid now has a glossy finish. Other panel colors, designs, and paint jobs are available for configuring the laptop, but only the plastic black and red don't add to the price. The rear design and port offerings are also different from those on the 9 Series model, but the rest of the black plastic body looks similar.

The new EON17-X measures 1.6 by 16.4 by 11.6 inches (HWD) and weighs 9.91 pounds, and its power brick is also quite large. That makes it one of the heaviest contemporary laptops we've tested, even beefier than the previous EON17-X (1.53 by 16.46 by 11.1 inches, 8.6 pounds), though there are still some even larger 17-inch gaming notebooks. The Asus ROG G752VS-XB78K Overclocked Edition is very slightly bigger and heavier (1.5 by 16.4 by 12.7 inches, 9.92 pounds) and the Acer Predator 17 X (GX-791-758V) is lighter but has a bigger body (1.77 by 16.65 by 12.66 inches, 9.67 pounds).

As on the last EON17-X, the keyboard is non-chiclet, but it is spacious and backlit with room for a number pad. Typing feels pretty good; unless you greatly prefer chiclet, using the keyboard is satisfying once you adjust to the spacing. The backlighting is customizable across four zones (not quite the per-key backlighting of the super-thin 2016 Razer Blade but one more zone than the previous model had), and you can change the lighting color and effects through free software.

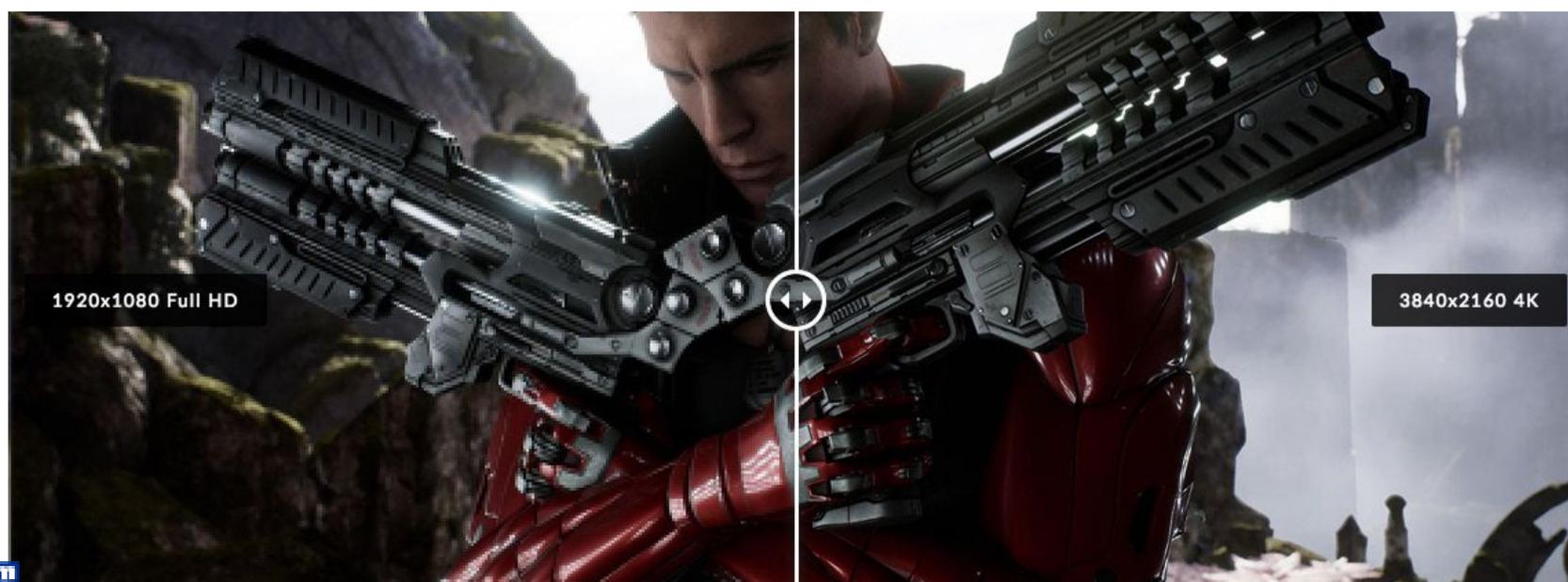
Origin EON17-X 10 Series

PROS Best-in-class gaming performance. Equipped with 4K display. High storage capacity. Includes a USB-C port with Thunderbolt 3.

CONS Expensive. Short battery life. Loud fans under heavy load.

FUTURE-PROOF DISPLAY

The EON17-X's 4K (3,840-by-2,160) resolution elevates the 17.3-inch display beyond most of the competition.



The laptop's 4K resolution elevates the 17.3-inch display beyond most of the competition. The screen is matte, so no annoying reflections to worry about—though as with most matte screens, the picture doesn't seem quite as stunning as that of glass displays. The resolution is extremely sharp, though, adding even more virtual real estate to an already-large screen. Remember that 4K is more demanding, so keeping it at that resolution while gaming will reduce your frame rates—1080p is generally used for gaming laptops since the hardware is generally less powerful than you'll find on desktops, but the top-of-the-line components in the EON17-X still make 4K viable, as you'll see on the test results below. You can always lower the resolution to get a game to run more smoothly, but you can't add 4K to systems that don't have it, which makes this screen invaluable for increasingly common 4K content.



You can lower the resolution to get a game to run more smoothly, but you can't add 4K to systems that don't have it.



As mentioned, the port inclusions are different this time around, with a lot of variety offered. On the left side are two USB 3.0 ports and two USB-C ports—one with Thunderbolt 3. You'll also find an Ethernet jack and an SD card slot. On the right flank are two more USB 3.0 ports and four audio lines for microphone,

PORT CHOICES

On the right of the EON17-X are two more USB 3.0 ports and four audio lines for microphone, headphones, and speakers.

headphones, and speakers. Finally, an indent in the rear holds the power jack, an HDMI port, and two Mini DisplayPort connectors.

This laptop has a ton of storage available, with a 1TB SSHD and dual 256GB solid-state drives in a RAID Level 0 array. For comparison, the Velocity Micro Signature 17 is on the low side with just a 512GB SSD, and most high-end gaming laptops are similar to the previous EON17-X (a 1TB hard drive and a single 256GB boot drive). Origin includes a one-year part replacement warranty with lifetime support and free labor.

PERFORMANCE

With an Intel Core i7-6700K processor overclocked to 4.5GHz, an Nvidia GeForce GTX 1080, and 16GB of memory, this is a blazing-fast laptop. The one area this didn't show was on the on the PCMark 8 Work Conventional test, which is greatly affected by the demanding 4K resolution. It scored 3,262 points, but the Signature 17 and the previous EON17-X, with the same processor but no 4K, scored 4,815 and 3,936, respectively. Those results are more a product of this specific test than any sign that the new EON17-X isn't powerful: It outperformed the Signature 17 on all three multimedia tests and showed no signs of slowdown or issues with normal use.

No such caveats exist for the 3D and gaming tests: These results are the best we've recorded for a laptop. On the 3DMark Cloud Gate and Fire Strike Extreme benchmark tests, the new EON17-X scored 33,646 points and 9,709, respectively, which crushes the previous EON17-X (27,630 on Cloud Gate, 4,395 on Fire Strike Extreme). The Signature 17, given that it's also a newer release boasting a GTX 1080, came the closest with 32,482 points on Cloud Gate and 9,323 points on Fire Strike Extreme.



KEY TO SUCCESS
As on its predecessor, the keyboard is non-chiclet, but it is spacious and backlit with room for a number pad.

The 1080p Heaven and Valley gaming tests (with high details) followed the same pattern. This system averaged 133 frames per second (fps) on Heaven and 128fps on Valley. That's a huge improvement over the previous EON17-X (54fps on Heaven, 60fps on Valley), and better than the ROG G752VS-XB78K Overclocked Edition (103fps on Heaven, 105fps on Valley) and the Signature 17 (118fps on both Heaven and Valley). Turned up to 4K, it still managed more than 30fps on both tests—a big drop in performance but still representative of smooth 4K gaming. The most demanding modern titles may force you to turn down a few visual options to maintain 30fps at 4K, but the EON17-X is more than capable, in my experience. Note that the laptop gets pretty loud, sometimes even while it's idle, since the processor is overclocked. Heat wasn't an issue during testing, but you can definitely hear the fans under load.

Battery life, on the other hand, leaves something to be desired—the laptop lasted just 2 hours, 7 minutes, on our rundown test. Gaming laptops generally don't have long-lasting batteries, as they're power hungry and meant to be used plugged in, and the 4K screen only shortened this time. The previous EON17-X lasted 2:49, the Signature 17 ran for 2:38, and the ROG G752VS-XB78K Overclocked Edition for 3:48.

CONCLUSION

To put it simply, the EON17-X 10 Series is the most powerful gaming laptop we've tested. Of course, it's incredibly expensive, but on the high end of an inherently pricey category, it delivers precisely what it should and is a much better value than the Signature 17, which has less storage, slightly lower performance, and an inferior display. The EON17-X is far from the most mobile laptop at this size and weight—cue suggestions that you might as well get a desktop—but it is portable if you need to bring it with you on a trip, and it has a built-in 4K display. Given its blistering performance, 4K screen, high storage capacity, and a wide selection of ports, the Origin EON17-X 10 Series is our new Editors' Choice for high-end gaming laptops.

MATTHEW BUZZI



Super-Thin Laptop, Outstanding Performance



The design of the Asus ZenBook 3 is as close as you can get to that of the Apple MacBook without laser-cutting an Apple logo into its slick aerospace-grade aluminum body. This ZenBook is less than half an inch thick, but it doesn't skimp on computing power: It features an Intel 7th Generation Intel Core i7 processor (the first we've seen). You'll need to make a few feature concessions with an ultraportable laptop that's this thin and light, but the result is worth it.

Asus ZenBook 3 (UX390UA)

Starts at \$1,099;
\$1,599 as tested



DESIGN AND FEATURES

The ZenBook 3 is available in two colors: a traditional grayish silver and an avant-garde blue with gold accents (as on our review unit). The aluminum body feels just as sturdy as those on thicker laptops such as the Editors' Choice ultraportable Dell XPS 13 Touch, and it's more substantial than on some competitors—the LG gram-14Z950, for example.

The laptop's dimensions are 0.47 by 11.65 by 7.53 inches (HWD), and it weighs only 1.97 pounds. That means you can stow it in just about any bag or folio, and it will fit neatly on an airline tray table. That's also the case for the HP Spectre 13, which is a millimeter thinner. For a Windows PC that's even lighter and thinner, you'd have to trade in for a tablet such as the Huawei MateBook or the Microsoft Surface Pro 4. The ZenBook 3 is more portable than the Dell XPS 13 Touch and thinner and lighter than the Apple MacBook or Apple MacBook Air 13-inch.

The 12.5-inch full HD (1,920-by-1,080) screen is one of the highlights of this laptop. It's bright and colorful but not quite as high-resolution as the screens on the MacBook (2,304 by 1,440) or the XPS 13 Touch (3,200 by 1,800), but it's certainly enough for most day-to-day situations. You may want a higher-resolution screen for photo and video editing, tasks at which the XPS 13 Touch, the 4K version of the Razer Blade Stealth, and the 13-inch Apple MacBook Pro excel.

The backlit keyboard has alphanumeric keys that are a little wider than they are tall, and the function keys along the top are on the small side (similar to the Apple MacBook's). They're chiclet-style but have a relatively shallow travel that can take some getting used to for those transitioning from a traditional laptop keyboard. They travel deeper and are much more comfortable to use than the keys that barely move on the 12-inch MacBook, though we'd still recommend the Dell XPS 13 Touch to anyone who types for a living.

Asus ZenBook 3 (UX390UA)

PROS One of the thinnest laptops on the market. Excellent performance and battery life. Strong speakers. Fingerprint reader. Windows 10 Pro.

CONS Single integrated USB-C port. Internal fans run often. Display is limited to full HD panel. No Thunderbolt 3 support. Slippery touchpad.

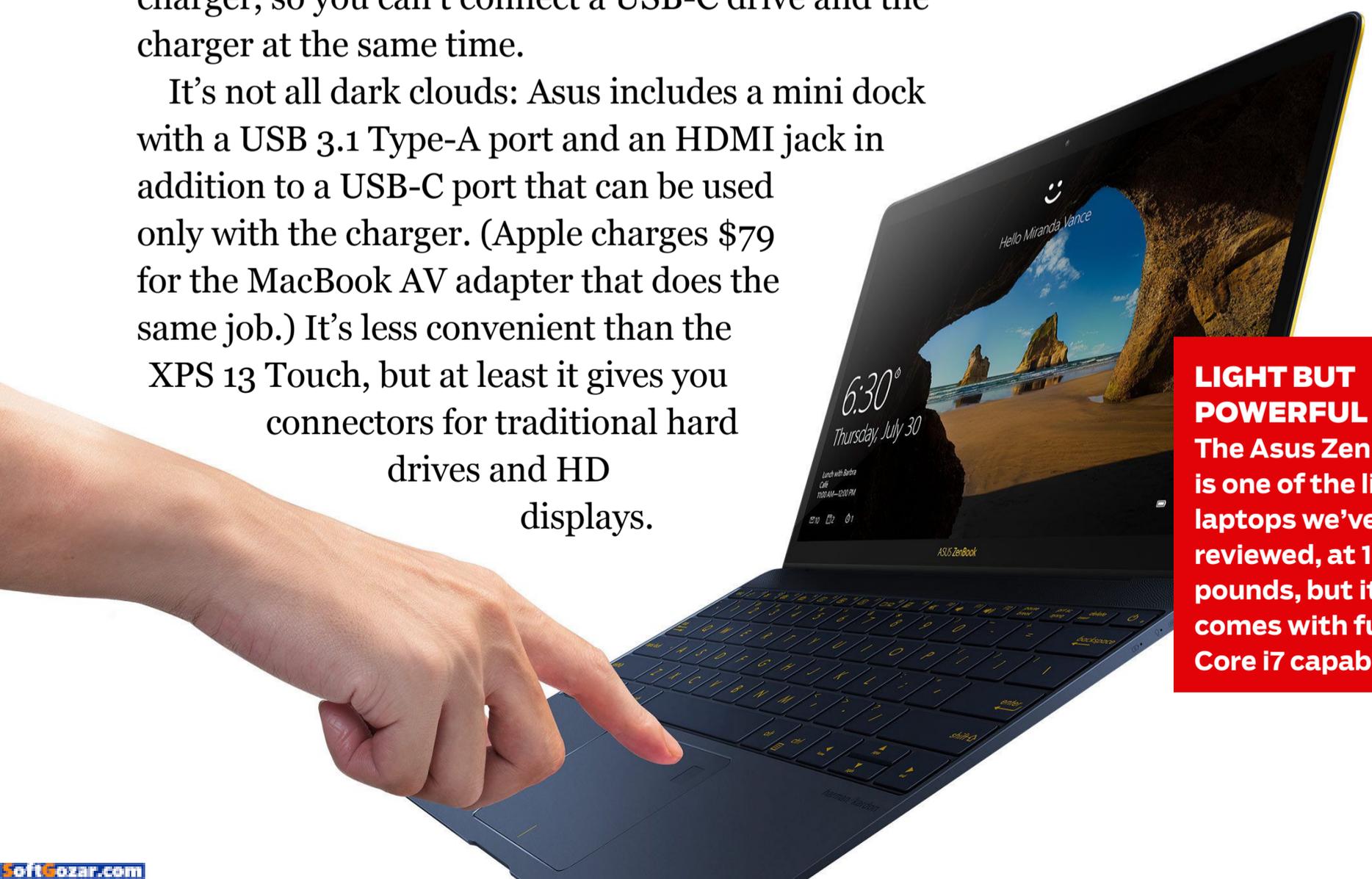


The one-piece touchpad has a fingerprint reader embedded in its upper-right corner, and it works with Windows Hello logins. The touchpad surface is a little slick; it took me some time to get used to it, during testing. The four Harman Kardon–branded speakers are clear and able to fill a medium-size room. You’ll hear a little fan noise from time to time, something you won’t experience with Core M systems like the MacBook. But even during our benchmark test runs, the noise was never overbearing.

Like the 12-inch MacBook, the ZenBook 3 has only a single USB-C port on the right side and a headset jack on the left. There seemingly isn’t a lot of space for much else, though the HP Spectre 13 has three USB-C ports—and it’s even slimmer. One other technology that’s missing from the ZenBook 3 is Thunderbolt 3, which both the HP Spectre 13 and the Dell XPS 13 Touch include. Thunderbolt 3 is far from a requirement, but it’s nice to have, particularly if you’re going to be transferring large files such as Raw photos or 4K videos. The single USB-C port is also the port for the included charger, so you can’t connect a USB-C drive and the charger at the same time.

It’s not all dark clouds: Asus includes a mini dock with a USB 3.1 Type-A port and an HDMI jack in addition to a USB-C port that can be used only with the charger. (Apple charges \$79 for the MacBook AV adapter that does the same job.) It’s less convenient than the XPS 13 Touch, but at least it gives you connectors for traditional hard drives and HD displays.

“
The 12.5-inch full HD (1,920-by-1,080) screen is one of the highlights of this laptop.
”



LIGHT BUT POWERFUL
The Asus ZenBook 3 is one of the lightest laptops we’ve reviewed, at 1.97 pounds, but it still comes with full Intel Core i7 capabilities.

The 512GB SSD and 16GB of RAM are both generous and should serve you well for several years. That large amount of memory is beneficial for multitasking and working on multimedia projects, and after all, that's why you'd consider a Core i7 machine over one running a Core i3 or i5. This configuration comes with Windows 10 Pro, so it works well as an executive's laptop, since it will easily interface with your company's file and login servers. The ZenBook 3 comes with a one-year warranty.

PERFORMANCE

The ZenBook 3 is the first system we've tested equipped with a processor from Intel's 7th Generation Core ("Kaby Lake") family: a Core i7-7500U with integrated Intel HD Graphics 620. This combo leads to a class-leading score of 3,228 on the PCMark 8 Work Conventional test, which measures a PC's prowess with day-to-day tasks such as document editing, Web browsing, and video conferencing. It also helps the ZenBook 3 outperform systems including the Apple MacBook, Dell XPS 13 Touch, and HP Spectre 13 at the Handbrake (2:13) and CineBench (332) tests, while remaining competitive though a few seconds behind the average time among the high-end ultraportables at the Adobe Photoshop test (4:48). 3D performance is passable, which is to say that you'll probably be able to play Minecraft and even Diablo III at low quality settings, but don't expect to boot up Grand Theft Auto V or the new Doom. The Core i7 version of the Dell XPS 13 Touch (Gold Edition) was the best 3D performer in the ultraportable category, though you shouldn't play Doom on that, either.



A BACKLIT KEYBOARD
Though its key stroke is shallow, the keyboard is still comfortable to type on. The touchpad has an embedded fingerprint reader.

Battery life, on the other hand, is spectacular. The ZenBook 3 was able to last 12 hours, 7 minutes, on our rundown test. Our test measures video playback, which is one of the major targets of optimization in the latest Core processors. The system outlasted the MacBook Pro (11:10) and 12-inch MacBook (11:37), our former champs. That's surprising for such a compact system. Like the MacBook, the ZenBook 3 uses a group of separate flat battery packs shaped to fit inside the contours of the laptop case. These give the system the stamina to outlast other Windows laptops, such as the XPS 13 Touch (9:02), HP Spectre 13 (8:36), and Razer Blade Stealth (6:25).

CONCLUSIONS

With the ZenBook 3, Asus has shrunk the Core i7 laptop to amazingly slender proportions—only the HP Spectre 13 is thinner. Though the ZenBook 3 costs a few hundred dollars more than the Spectre, it bests it on every spec and performance measure except port selection. It's certainly faster and more comfortable to type on than the Apple MacBook, and it lasts longer on a battery charge, though the MacBook has a higher-resolution screen. The Dell XPS 13 Touch is a different animal, as it has a closer price, a much higher-resolution touch screen, and better connectivity (two USB 3.0 ports, a USB-C port with Thunderbolt, and an SD card reader); but it also has a lower-performing processor, less storage, and less memory. The Gold edition of the XPS 13 Touch carries a \$150 price premium over the ZenBook 3, but the former's Core i7 processor and integrated graphics are the only improvements over the silver model. The ZenBook 3 meets or exceeds our expectations for premium ultraportables: speed, endurance, thinness, light weight, advanced technology, a beautiful screen, comfortable typing, visual presence/aesthetics, and build quality. That's plenty of reason to award the ZenBook 3 our latest Editors' Choice for premium ultraportable laptops.

JOEL SANTO DOMINGO



Razer Blade Stealth (Late 2016)

Starts at \$999.99;
\$1,249.99 as tested



The New Blade Stealth: Even Better Than the Original



The original Blade Stealth, released earlier this year, was Razer's foray into the mainstream laptop space, an ultraportable without discrete graphics despite the company's firm roots in the gaming market. The ultra-thin-and-light impressed us as an excellent general-use ultraportable, with top-notch build quality, a sharp 2,560-by-1,440 (QHD) touch screen, and cool extras, such as the world's first keyboard with individually backlit keys. The latest Blade Stealth features almost exactly the same body and physical design—plus a couple of beneficial additions. With a fresh Kaby Lake processor (the newest generation from Intel) for markedly improved performance, and longer battery life, the new Blade Stealth manages to earn our highest recommendation, even over its excellent Editors' Choice-winning predecessor.

DESIGN AND FEATURES

By looks alone, you can't tell the new Blade Stealth apart from the original. It features the same 12-inch, high-end, black machined aluminum body; green Razer logo on the lid; and keyboard with per-key backlighting. Two rubber strips are on the bottom for grip, along with the fan vents.

The new model measures 0.52 by 12.6 by 8.1 inches (HWD) and weighs 2.9 pounds, slightly deeper and heavier than the previous version (0.52 by 12.6 by 6.1 inches, 2.81 pounds) to make room for a larger battery, though the difference isn't noticeable. It is something of a case of diminishing returns when a laptop is already this slim, but there are thinner and lighter ultraportables, including the new Asus ZenBook 3 (reviewed in this issue) and HP Spectre 13.

Again, the display is a standout on this system: Our unit boasts a QHD touch display with Indium-Gallium-Zinc-Oxide (IGZO) technology for brighter, more vibrant colors. It's an attractive screen, and that high resolution gives you extra room to work—especially useful for a 12.5-inch notebook with a bezel this wide (about 0.75 inch, versus just over 0.25 inch for the ZenBook 3). As you could with the last-generation Stealth, you can also choose a 4K display when ordering, but that option is also tied to larger storage amounts, so the price will jump to at least \$1,599.99. QHD still gives you a really sharp picture, though, and is a higher resolution than you'll find on many 1080p ultraportables (including the 13-inch Apple MacBook Air) and even the more expensive ZenBook 3 and Spectre 13.

Razer Blade Stealth (Late 2016)

PROS Sleek design with premium materials. New Intel Kaby Lake processor for class-leading performance. Vibrant high-resolution touch display. Improved battery life over previous Stealth.

CONS Key travel is a bit shallow.

BATTERY SPACE

The new model measures 0.52 by 12.6 by 8.1 inches (HWD) and weighs 2.9 pounds, slightly deeper and heavier than the previous version.





Individual key backlighting is not a must-have, but there's no denying it looks excellent and is another feature to separate this laptop from the pack. Through Razer's Synapse software and Chroma lighting technology, you can change the light effects and colors. If you don't want anything flashy, just set the lights to one static color or turn them off. I suspect most will like how it looks, though—it helps that the lighting is crisp and bright, unlike on some keyboards where light bleeds through the keycaps. With the ability to change the color of each key independently and with extra effects in the software, such as matching the lighting to music, the Chroma keyboard is a definite plus.

The keys themselves are good quality; there isn't much travel to them, which may irritate some users, but they're generally fine. The touchpad, as on all previous Blade systems I've used, is one of the best: sturdy, super smooth, and responsive. The two speakers, one on either side of the keyboard, are capable of getting quite loud for such a small system. The sound quality at lower volumes is fine, but there is some distortion when you dial up to maximum.

NEW AND IMPROVED

With a fresh Kaby Lake processor—the newest generation from Intel—for markedly improved performance, a sharp 2,560-by-1,440 screen, and longer battery life, the Razer Blade Stealth is one of the best ultraportables on the market.

Slim laptops don't tend to offer many ports, but one upside to not being the on the super-thin end of the spectrum is the inclusion of more than just USB-C. On the left is the USB-C charging port with Thunderbolt 3, a USB 3.0 port, and the headphone jack. On the right is another USB 3.0 port and an HDMI port. This is not a large suite of port options, and it's the same group as on the original Stealth, but the essentials are there. Also included are dual-band 802.11ac Wi-Fi, Bluetooth 4.1, a TPM security chip, and a 2-megapixel webcam.

For storage, our model comes with a 256GB solid-state drive (SSD) with Windows 10 installed, but 128GB and 512GB options are available as well with the QHD screen. Alternatively, you can order a 4K model with a 512GB or 1TB SSD. Changing the storage model alters the laptop's price fairly significantly, so it's up to you to decide how important that is—the 1TB maximum limit is new compared with the previous Stealth. Razer offers a one-year warranty on its laptops.

PERFORMANCE

The Kaby Lake generation of processors is one of the main upgrades driving this Stealth—every new configuration, regardless of resolution or storage capacity, includes a 2.7GHz Core i7-7500U CPU. That and the 16GB of memory helped this system provide strong performance scores across the board. On the PCMark 8 Work Conventional test for measuring general productivity, the new Stealth scored 3,032 points. This beats the previous Stealth (2,764) and falls slightly behind the more expensive Spectre 13 (3,069) and ZenBook 3 (3,228). These results might seem like a discrepancy given the Stealth's faster processor, but the PCMark 8 results reflect the higher demands of the QHD resolution compared with 1080p on those two systems—there realistically isn't much of a difference in day-to-day use.



**Individual
key
backlighting
is not a
must-have,
but there's
no denying it
looks
excellent.**



Multimedia test results better demonstrate the Kaby Lake processor's speed upgrade, in spite of the more demanding resolution. The new Stealth beat all comers—including the Gold Edition Dell XPS 13 Touch and the 13-inch Apple MacBook Pro—on the Handbrake encoding test with a time of 2 minutes 3 seconds, the next-closest competitor being the ZenBook 3 at 2:13. It also posted the fastest Photoshop time (3:41) and the highest CineBench score (354) of any ultraportable.

As with the other ultraportable systems regardless of price tier, the Stealth includes integrated Intel graphics. A discrete graphics card adds quite a bit to the price, and more important for this category, requires much more physical room than a super-slim laptop affords. With Intel HD Graphics 620, the new Stealth was able to post so-so results of 21 frames per second (fps) and 25fps on the 1,366-by-768-resolution Heaven and Valley with medium details. Considering 30fps is the minimum target for smooth gameplay, most modern games are a bridge too far for the Stealth and other ultraportables—these frame rates exactly match the Spectre 13's and beat out the ZenBook's. With these tests set to Ultra graphics quality and 1080p, performance slowed to a crawl. You can get away with playing simple games and maybe some less strenuous titles on low settings, but don't expect to do heavy gaming on this system, despite the Razer name.

Note that the Razer Core external graphics card enclosure is designed to allow thin Razer laptops like the Stealth access to more powerful desktop graphics processing. It costs \$499 and must be purchased separately, though you get a \$100 discount if you buy it with a Stealth. The enclosure uses the USB-C port, which further diminishes connectivity, and supplies seem limited—it may take a few weeks to receive one after you place your order.



**MORE THAN JUST
USB-C**

On the left of the ultraportable are a USB-C charging port with Thunderbolt 3, a USB 3.0 port, and a headphone jack.

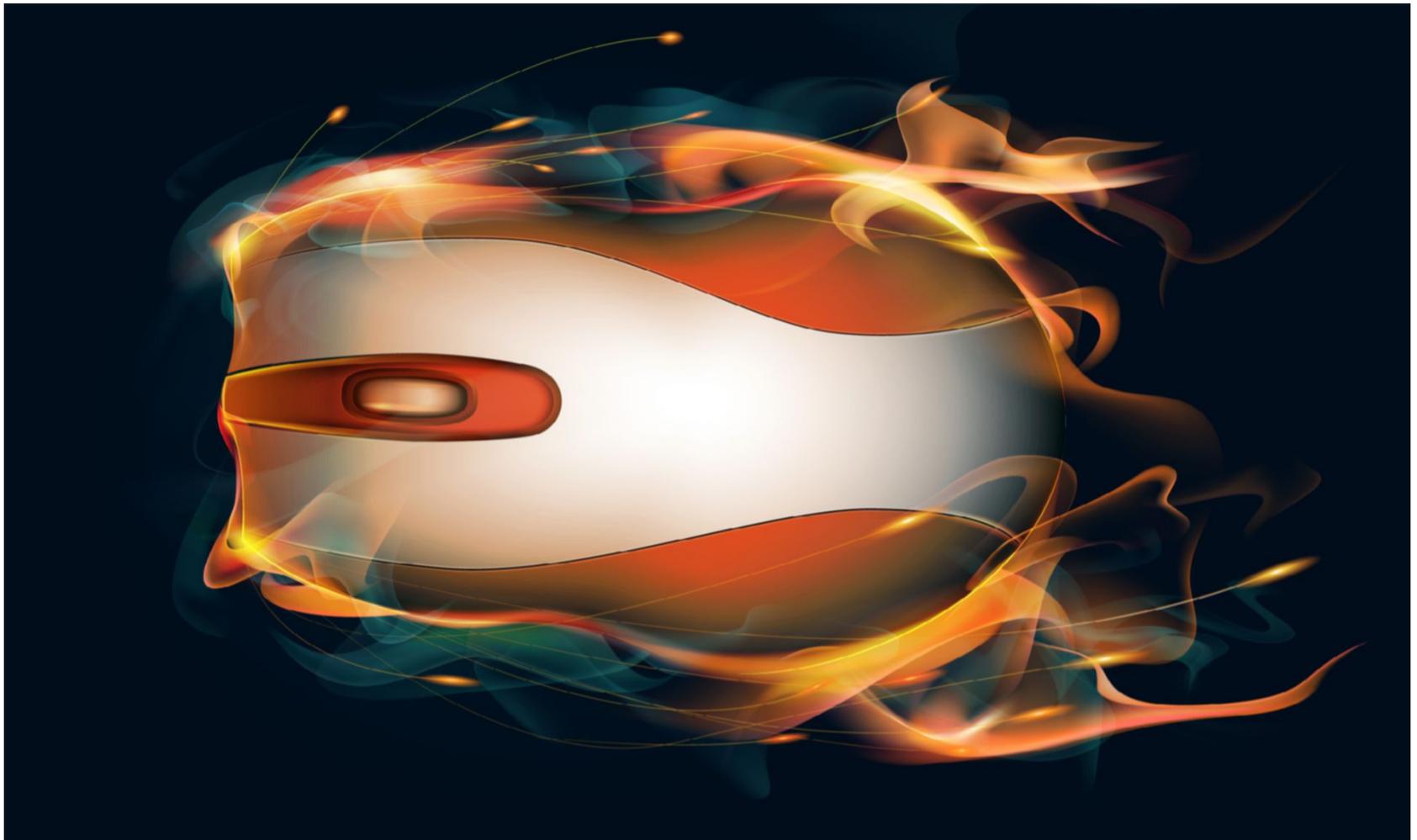
Finally, the extra room added in the back of the system means good things for battery life when combined with the more power-efficient processor. The Stealth lasted 9 hours 20 minutes on our rundown test, a nearly 2-hour improvement over the previous Stealth (7:36). The QHD resolution definitely plays a part in draining power, though, since the ZenBook 3 lasted 12:07 and the MacBook Air 13-inch ran for 17:36 on the same test, but 9 hours is still a good time, and it's more than we saw from the Spectre 13 (8:36).

CONCLUSION

The New Razer Blade Stealth is stylish, thin, and faster than its predecessor, with a measurably longer battery life. It's an all-around upgrade—there's no reason to buy the previous model now, except perhaps for a slashed price—and more configuration options are available for those who want a ton of storage and a 4K display. If you want something that's thinner and more elegant, and you don't mind paying more money, the Asus ZenBook 3 is gorgeous and about as powerful as the Stealth, though it lacks the higher screen resolution and “fun” additions. Between the sleek look, fast performance, features including USB-C with Thunderbolt 3, and higher-than-average resolution, the New Razer Blade Stealth is our new Editors' Choice for midrange ultraportables. And it's one of the best in any price tier.

MATTHEW BUZZI





Top 5 Gaming Mice

Aiming, targeting, slashing, attacking: Some of the most important actions you take in a PC game happen with the click of a mouse. Any gaming mouse you buy will offer reliable connectivity, smooth and responsive tracking, and basic click and scroll functions. But it takes more than basic functionality to make a good gaming mouse.

A high-quality sensor is the first step toward precision and accuracy. Less expensive mice usually have optical (or LED) sensors, which offer fairly good tracking sensitivity but do particularly well when lifted slightly from the tracking surface. Laser sensors, on the other hand, may be a bit more finicky in the heat of battle but offer much better tracking. And you can get the best of both worlds, using the two sensors in tandem to provide the high-accuracy tracking of a laser with the less delicate tracking of an optical sensor.

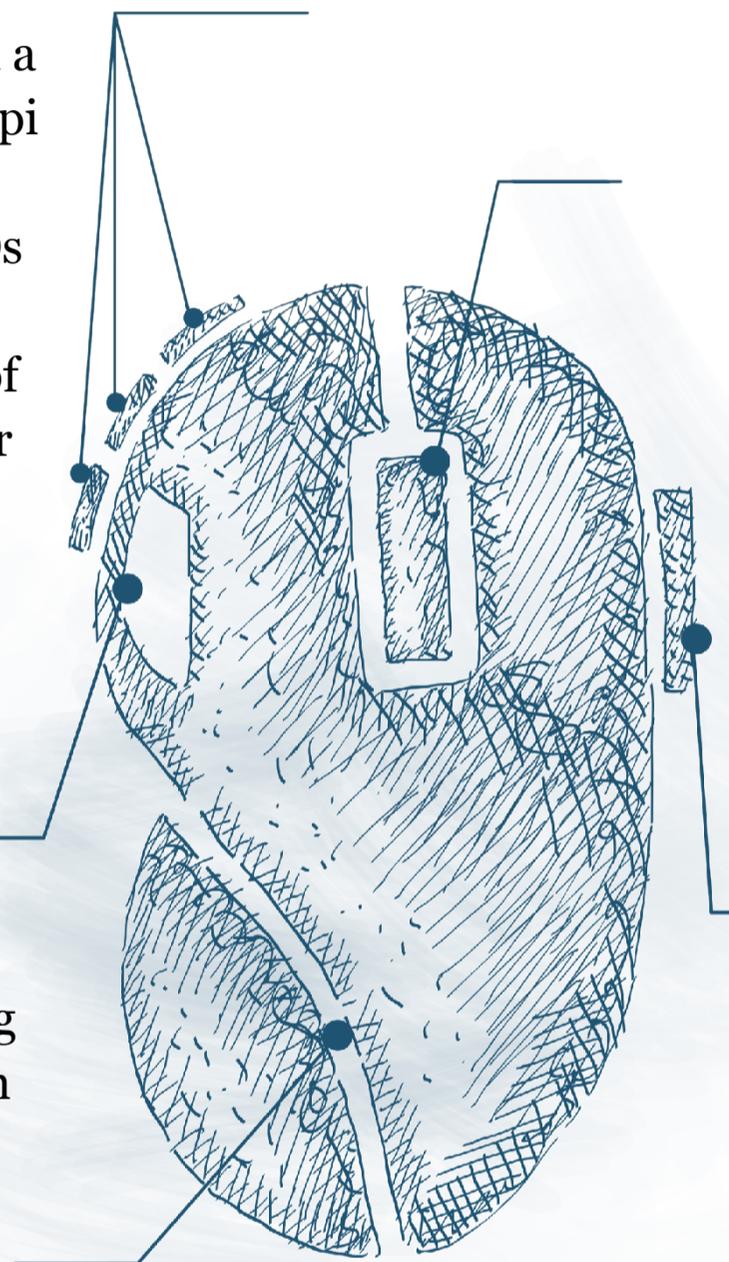
The best gaming mice offer comfort and customization. Features match the unique needs of your preferred games, whether you're dealing with a firefight or staving off an advancing horde. Mice aimed at first-person shooters feature ratcheting scroll-wheels—which let you cycle through your arsenal without selecting the wrong weapon—and on-the-fly dpi adjustment for switching between the fast low-dpi tracking needed in a frantic firefight and the more tightly controlled high dpi needed for lining up a sniper's shot.

Mice designed for real-time strategy games and MMOs are often outfitted with an array of six to 12 programmable macro buttons. Set just under the tip of the thumb, these can either be used as number keys or programmed to execute longer macro commands.

All of the gaming mice currently available are made with some customization in mind, even if it's just tweaking the tracking speed. Each gaming-gear manufacturer has developed its own customization software, which often includes advanced macro programming. In addition to recording macro commands, these dashboards will also let you swap preset profiles, and many offer presets for non-gaming use, letting you leverage your programmable mouse in programs such as Excel and Photoshop.

For maximum comfort, many gaming mice can also be customized physically. Removable weights are common, letting you tweak the total weight one way or the other. Some models take this even further, letting you shift the center of balance, or adjust the height and pitch of the palm rest.

Finding the best gaming mouse for you comes down to knowing your own preferred style of game, determining whether or not you will take advantage of more complex functions, and then tweaking the chosen mouse to your specific tastes.



MATTHEW MURRAY



RAZER MAMBA (2015)

\$149.99



The versatile Razer Mamba is an excellent gaming mouse that offers unparalleled features and customization, including adjustable click feedback, 16.8 million lighting colors, 10 programmable buttons, and wired or wireless operation. The price tag may be too high for some, and the unique features driving up the cost might appeal only to serious gamers. The Razer DeathAdder Chroma (\$70) is much more affordable—but if you're going for the ultimate gaming mouse, you can't beat the Mamba. With its adjustable click feedback, wireless functionality, solid design, and high level of customizability, the Razer Mamba deserves our Editors' Choice.



CORSAIR M65 RGB LASER GAMING MOUSE

\$74.99



The Corsair M65 RGB Laser Gaming Mouse offers a killer design and lethal accuracy, and it comes in a rainbow of colors. This mouse has everything you could ask for, with excellent construction, several customizable features, and rock-solid performance. It's a small update from the previous top pick in the category, the Corsair Vengeance M65, but it's enough of one to earn the M65 RGB our nod as an Editors' Choice gaming mouse.



LOGITECH G PRO GAMING MOUSE

\$69.99



Simple, comfortable, and practical, the Logitech G Pro Gaming Mouse is ideal for the professional gamer and anyone who wants to be one someday. Free of unnecessary accoutrements such as stepped mouse buttons and asymmetrical wiring points, the Logitech G Pro Gaming Mouse is simply a responsive and (mostly) ambidextrous input device that solves the problems of traveling gamers. It's attractive, customizable, light, and reasonably priced. This makes it a top pick for gaming mice.



RAZER DEATHADDER CHROMA

\$69.99



The Razer DeathAdder Chroma gaming mouse serves up an ergonomic design, lots of customization possibilities, and excellent performance. It's a top-notch gaming mouse with a very ergonomic design and numerous options for lighting and performance via the included software. While you can't adjust the weight of the mouse, as you can with the Corsair M65 RGB, it has a better feel and a stronger sensor, making it a new Editors' Choice for gaming mice.



COUGAR 300M GAMING MOUSE

\$39.99



The Cougar 300M is an adept entry-level gaming mouse, with smooth performance, seven customizable buttons, and onboard memory. It doesn't have the same easy-to-use software experience, thumb grip, or neat look of the Razer Mamba, but for the price, it's a good choice for first-time gamers, and its dpi-switching button is much more usable than the one on the Cougar 550M.



The Best Free Language-Learning App Adds Bot Chats



If you're studying a language, no doubt you've heard of Duolingo, which is the best free program you'll find. The fantastic Web app comes with equally free mobile apps that let you practice your language on the go, and the iPhone app is the best free language-learning app.

A new feature, which is exclusive to the iPhone app at the time we reviewed it, gives language learners a fresh way to practice their skills—by having in-app chats with a bot. The conversations are tightly scripted, and you can't openly converse the way you might with a real-life human, but it's refreshing to see something novel in a language-learning app.

The rest of the content, which mirrors what's on the Duolingo website, remains very high quality. With excellent exercises and wonderful interface, the Duolingo iPhone app earns a rare five-star rating.

Duolingo
(for iPhone)

Free

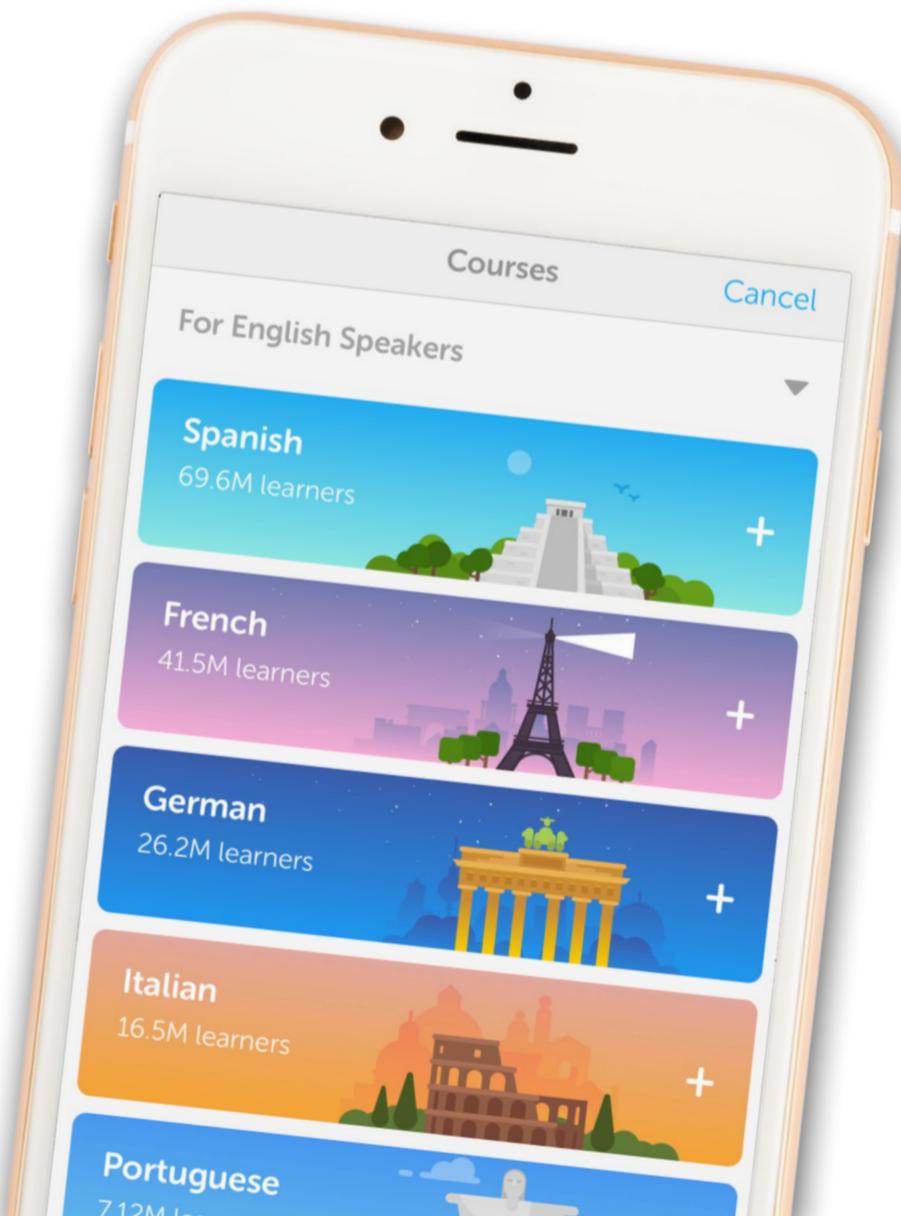


SUPPORTED LANGUAGES

English speakers, the Duolingo iPhone app offers 19 languages for you to learn: Danish, Dutch, Esperanto, French, German, Hebrew, Hungarian, Irish, Italian, Norwegian, Polish, Portuguese, Russian, Spanish, Swedish, Turkish, Ukrainian, Vietnamese, and Welsh. When we wrote this, Hebrew, Hungarian, and Vietnamese were listed as still being in beta on the full Duolingo website.

Additional language-learning programs are available for speakers of other languages, so if you have a Spanish-speaking friend who wants to practice English, Duolingo has a program for him or her, too.

Duolingo's list of supported languages has grown quickly over the years, but at least one in-demand language is still missing: Mandarin. Duolingo has a language incubator project (<https://incubator.duolingo.com>) where you can see new languages on the roadmap for rollout. You can also see the full list of available languages and those in beta by going to Duolingo's Courses page.



Duolingo (for iPhone)

PROS Free language learning. Can learn more than one language. Lessons available offline. Well-structured content. Good activity pace. Fun exercises.

CONS Not available in many languages. May contain some inaccuracies because of crowd-sourced information, especially at higher levels.

SPEAKING IN TONGUES

These are just a few of the 19 languages the Duolingo iPhone app can help you to learn.

For those looking to learn a language that isn't on Duolingo's list, I would recommend paying for a different program. I've tried many other free mobile language-learning apps, but none are as good as Duolingo. One option to try is Pimsleur Comprehensive, which offers around 50 languages, including many that are harder to find, such as Ojibwe, Twi, and Icelandic. Pimsleur is almost exclusively audio-based and not as interactive in the technological sense, but it's reasonably affordable and is excellent for learning on the go. You can install Pimsleur's MP3 files on your iPhone in the same way that you'd upload other kinds of music.

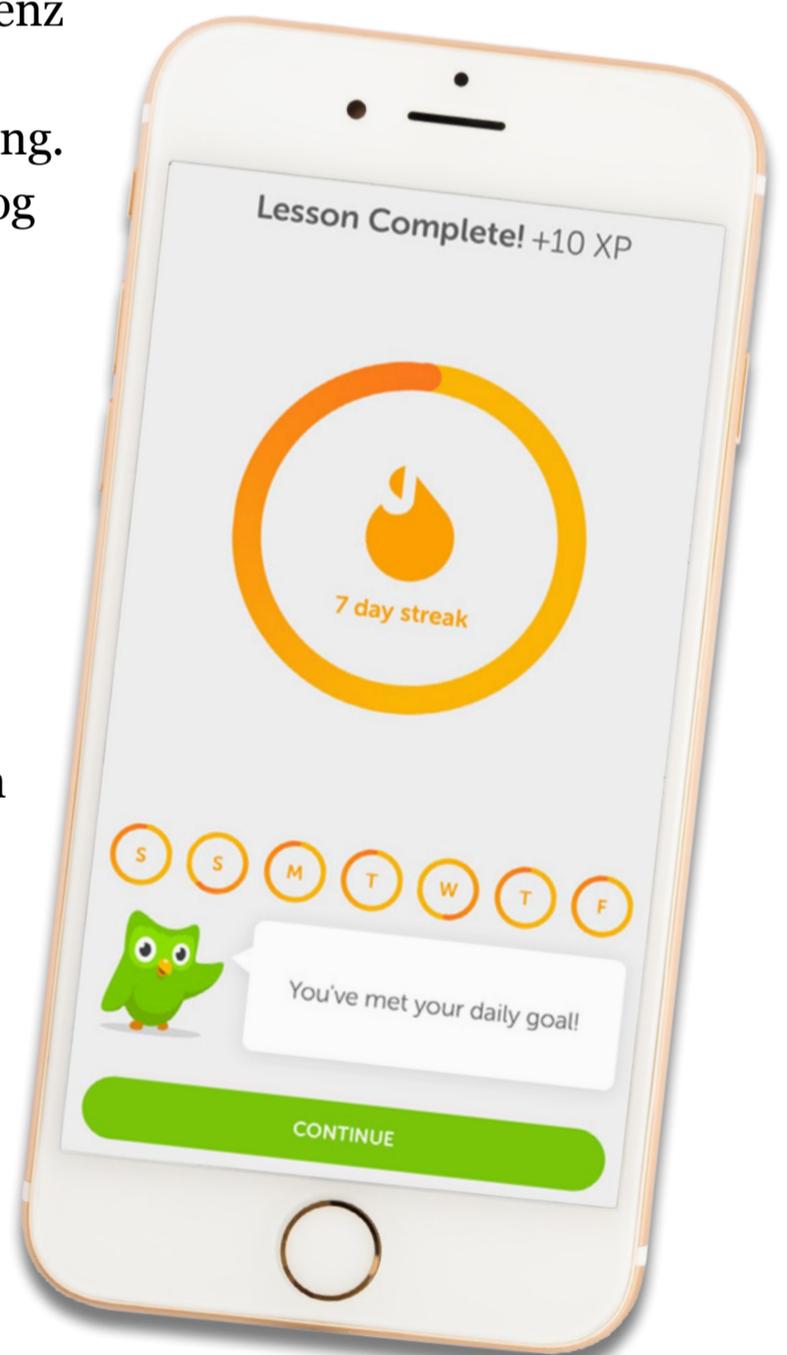
If you want more interactive language-learning software and don't mind paying for it, I'd encourage you to move to a full-size computer or laptop and try Rosetta Stone, an Editors' Choice, or Fluenz, another very good program. Both Rosetta Stone and Fluenz have Mandarin programs. They both also have mobile apps where you can continue your learning. Once you have a subscription, you'll be able to log into the iPhone app for either one.

HOW DUOLINGO WORKS

From a user's perspective, Duolingo works like most other language-learning programs. You complete exercises or activities to get to new lessons, which are part of larger units. The structure is clear and shown on a dashboard. Icons and short descriptions of the lessons, such as "Gerunds," guide you along your language-learning journey. Fully completed sections turn gold, and they stay gold as long as the content is still likely to be fresh in your mind. Sections that you have passed but are no longer gold appear in color, with a progress bar beneath them. Sections that are currently locked to you because you don't have the skills yet to do them are gray.



A new feature gives language learners a fresh way to practice their skills—by having in-app chats with a bot.



The apps sync to keep track of your progress across both on your iPhone and in the Web app. So you can practice conjugating verbs in German at home and pick up where you left off in the iPhone app during your commute.

A placement test lets new users who are familiar with a language jump ahead to a point in the program that's right for them. Equally helpful is an option to test out of a section—so if you know adverbs really well, you can skip them, so long as you pass the test.

One thing about Duolingo that's different from many other language-learning apps is that you must move through the material sequentially and unlock sections to progress. Other language-learning programs, including Rosetta Stone, Fluenz, and Transparent Language Online, let you bounce around at will.

The core learning is extremely clear to see and work through. The language-learning parts are solid and replicate some of the typical drills you'll find in more well-known language software. Duolingo works your reading, writing, listening, and speaking skills, though you can disable anything that requires your voice input, in case you are in a place where talking aloud in a language you don't actually speak might be uncomfortable.

Exercises build on one another, so that you're introduced to words and concepts at the right point in the learning schedule. Typical lessons have multiple choice questions, listen-and-write exercises, and translation exercises. In some exercises, you listen to a sentence and write it in the new language. In others, you translate a written sentence from English to the new language, or vice versa. In the multiple choice questions, I really like that sometimes there can be more than one right answer—you tap checkmark boxes next to whichever correct answers you see.

The Duolingo service does rely on crowd-sourced information to power its language learning, and occasionally, especially at the higher levels, you might find incorrect information. The errors are few, however, and they occur much less frequently than in any other crowd-sourced language learning program I've encountered.

No matter how you start learning and practicing with Duolingo, you can do so with multiple languages. In other words, for the low, low price of nothing, you can start programs in Dutch, Swedish, and Portuguese if you like, whereas many language-learning programs lock you down to just one language. That's pretty incredible.

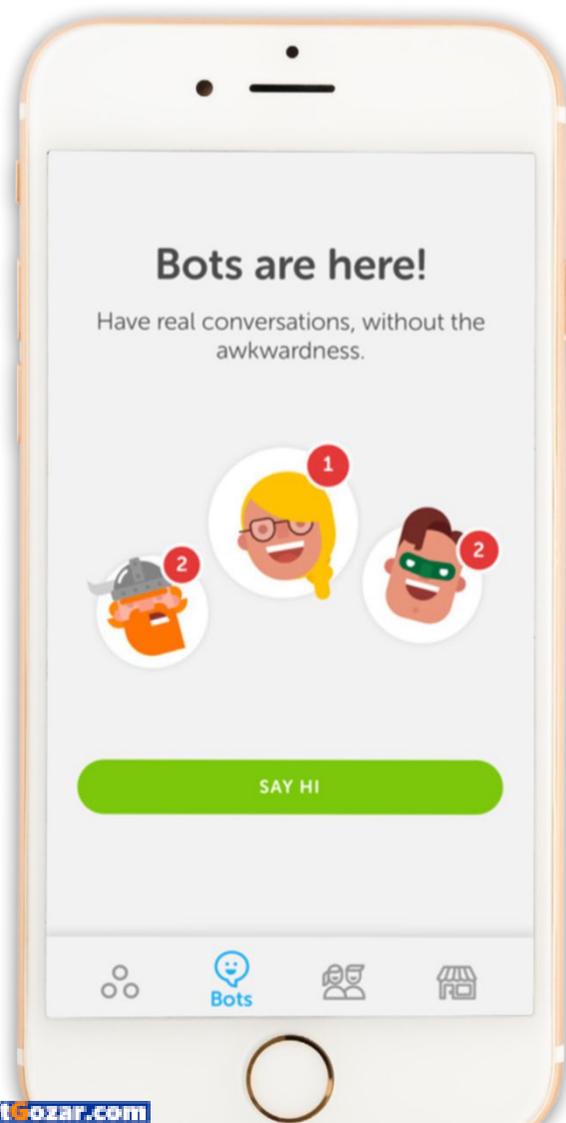
DUOLINGO BOTS

Duolingo's iPhone app recently received a facelift, and to be honest, I'm not crazy about it. The biggest change is that people (or rather, flat images of cartoonish human figures) now appear in most of the exercises. These figures are meant to be speaking to you some of the time, but I find that they take up space unnecessarily.

As mentioned earlier, a new Bots feature lets you hold in-app chats with robots. The Bots area appears to be the source of the new flat family of characters. When you start a chat, a little face appears as if you are messaging with the person. She or he typically asks you a question or tells you in the language you're learning to do something, like "Say hi to my friend, Roberto," and you have to take appropriate action. You can't type anything at will. Only certain answers will be accepted as correct. And you can't type an infinite number of characters either.

The Bots conversation remind me a little of middle school Spanish oral exams, where you are expected to answer a certain way, repeating back key information ("What does Robert eat?" "Robert eats pizza.") or further the conversation in a specific way ("How are you, Jill?" "I'm well, thank you. And you? How are you?").

You aren't required to use the Bots section, but you will earn points for conversations that go toward your daily and weekly goals. Since I can take them or leave them, I appreciate that they're optional.



MOBILE DESIGN

The exercises in the Duolingo mobile app are very similar to those on the website, but they have a few adaptations that make them easier to complete on a tiny mobile one exercise, for example, the app shows you a sentence, you must translate it and type it in the language you're learning. On the iPhone, instead of typing each word verbatim, sometimes you'll see a bank of words from which you choose the correct ones and put them into the correct order.

Duolingo is forgiving of minor typos, which is excellent, especially on an iPhone where the small screen makes it harder to type accurately. The iPhone also makes it easy to insert special characters by pressing and holding any key for options that use that letter as its base.



You've met your daily goal!

In the Duolingo iPhone app settings, you can disable sound effects, speaking exercises, and listening exercises, which again is tremendously helpful for a mobile app. You can also dismiss speaking exercises as they come up, without visiting the settings. These kinds of design choices are what make Duolingo exceptional.

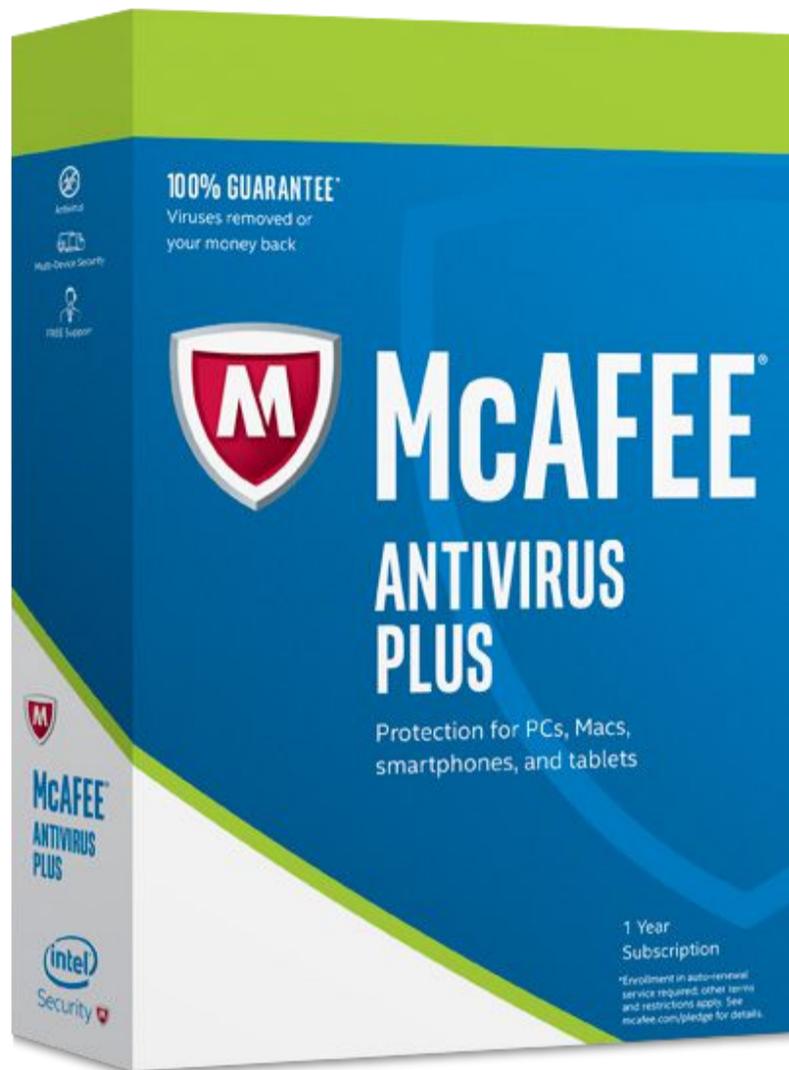
SCORE SOME POINTS

In Duolingo, you earn points for studying and practicing a language. You can set a goal for how many points you'd like to try to earn each day.

PRACTICE AND LEARN WITH DUOLINGO

I've been a Duolingo user off and on since the very beginning, and the app has really grown quite a bit with solid content and language-building exercises effectively packaged in bite-size chunks. I can easily say that Duolingo is the best free tool for learning a language. The iPhone app works well, handling special characters and some translations with greater ease than even the full Web version. It's an ideal way to practice another language anywhere you have a few minutes on your hands. Additionally, it doesn't have to be used exclusively on its own. Duolingo makes for a great companion app to other kinds of language study, whether it's in a classroom or with another piece of software.

JILL DUFFY



Multi-Platform Virus Protection for All Your Devices



It used to be easier to distinguish between antivirus software and security suites, but these days the lines are blurry. Not only does McAfee AntiVirus Plus (2017) include firewall protection and a veritable host of additional security features, but it also allows unlimited installations on all of your Windows, macOS, iOS, and Android devices. That sort of multi-platform protection used to be something you'd get only with a suite. McAfee doesn't necessarily score at the top in our tests or independent lab tests, but it's uniquely capable of protecting every device you own.

**McAfee
AntiVirus Plus
(2017)**

\$59.95



A subscription price of \$39.99 per year for one license seems to be the going rate for antivirus tools.

Bitdefender Antivirus Plus 2017, Kaspersky, Norton, and Webroot are among the many that sell for about that price. At \$59.95 a year, McAfee might seem more expensive, but this subscription lets you install protection on every single device in your household, including Windows, macOS, iOS, and Android devices. Far from being more expensive, it's a fantastic bargain.

That multi-device mode influences the way you install the product. You start by redeeming your 25-digit product key online and either adding it to your McAfee account or creating a new McAfee account. After logging into your account, you can either download the software locally or send an email with a download link to another device.

New with this year's product line, McAfee offers a Virus Protection Pledge. If the product can't remove a virus (or any other kind of malware), tech support will do everything they can, including remote diagnosis and remediation. If they can't fix it, you get your money back. Enabling the pledge requires you to sign up for automatic renewal, but that's not unreasonable. Norton's similar promise requires either direct purchase or automatic renewal and applies only to the Norton suites, not to Symantec Norton AntiVirus Basic. Check Point also has a guarantee but only for the top-of-the-line ZoneAlarm Extreme Security.

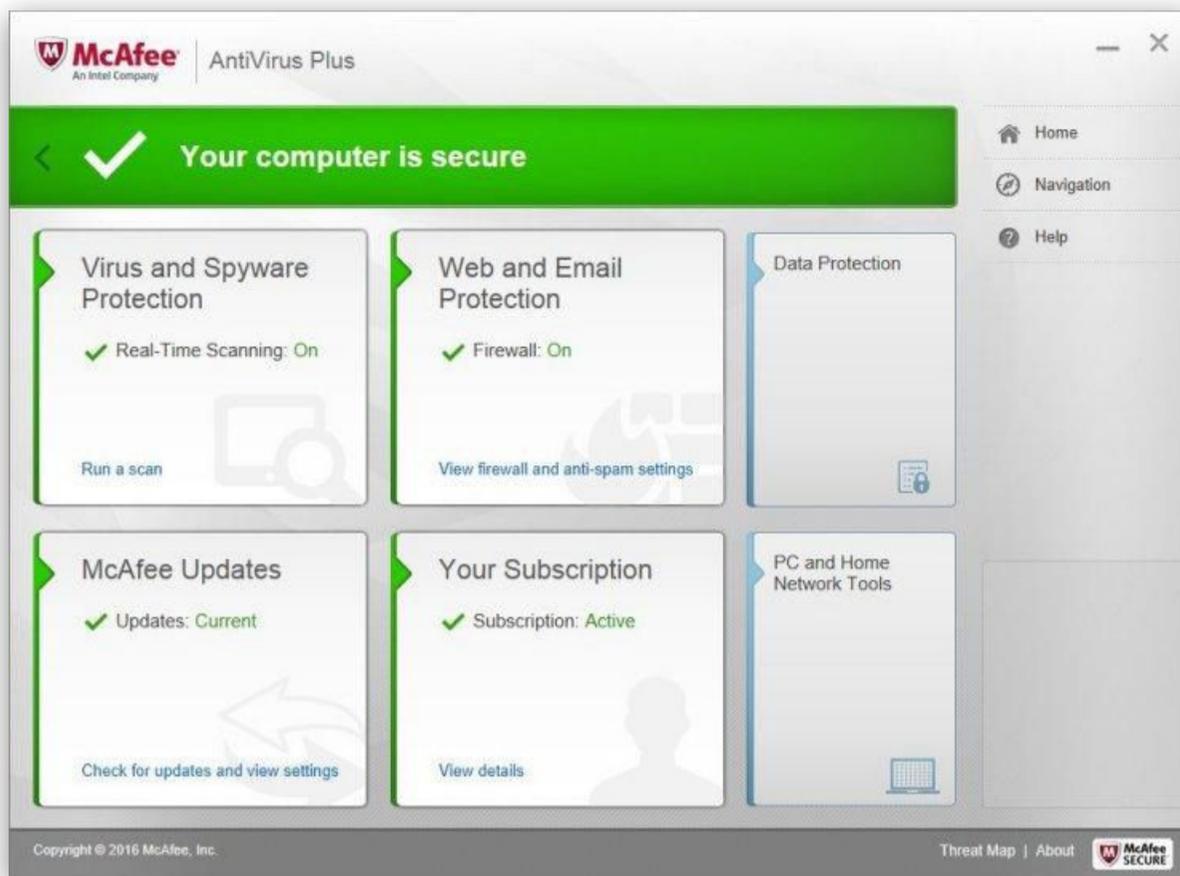
The installation process has been streamlined, requiring hardly any user interaction. Once the product has installed and updated, you're ready to go. You won't see any significant difference in the user interface. The layout and the gray-green-blue color scheme haven't changed. And as before, you can click the Navigation link to get an alternate main page that offers direct access to all program features.

McAfee AntiVirus Plus (2017)

PROS Unlimited protection for Windows, Android, macOS, and iOS devices. New behavior-centric antivirus engine. Good scores in our hands-on malware blocking and malicious URL blocking tests. Numerous bonus features.

CONS So-so scores from independent labs. Mediocre antiphishing score in our testing. Protection on macOS and iOS not as full-featured as on Windows and Android.





PROTECT AND SAVE
McAfee AntiVirus Plus offers firewall protection and a veritable host of additional security features.

REAL PROTECT

The real difference is underneath the hood. The latest McAfee product line uses a completely new virus-detection and remediation engine called Real Protect. This engine relies strongly on behavior-based detection to minimize the local signature database and catch zero-day malware. Like Webroot SecureAnywhere AntiVirus, when McAfee encounters a suspicious unknown program, it sends behavioral data to the cloud for analysis, journals the program's behavior, and rolls back all the malware activity if the cloud component decides the program is malicious.

My McAfee contacts supplied the results of an independent performance test comparing last year's edition with the current edition across many different metrics. The tests ran on both a high-performance machine and a relative clunker. It's worth noting that on the clunker, a full system scan and a repeat scan both took longer with the current edition. That matches my experience, since my virtual machine test systems aren't terribly resource-rich. A full scan took almost an hour and a half, nearly twice the current average. Scan speed isn't all that important, though, since you can continue using your PC during the scan. And a second scan finished in just 35 minutes.

SO-SO LAB SCORES, BUT...

Because I review antivirus products shortly after release, the independent lab test results that I report are always slightly dated. That's usually not a problem, because the vendors keep their antivirus definitions up to date in between major revisions. But McAfee gradually phased in the new antivirus engine over the past few months, so it's not clear to what extent the labs have tested this engine.

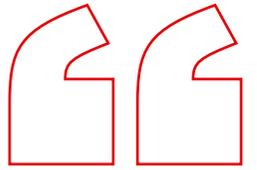
Results may change in the next round of testing. And that's a good thing, because the results aren't all great.

The research experts at AV-Comparatives perform a wide variety of tests on antivirus and other security products; I follow five of these. Products that pass a test receive a Standard rating. Those that do more than the minimum needed to pass can earn an Advanced or Advanced+ rating. McAfee participates in three of these five tests and received one Standard and two Advanced ratings. Bitdefender and Kaspersky both swept the field with five Advanced+ ratings.

For a multifaceted look at antivirus capability, AV-Test Institute scores products on protection, performance, and usability, assigning up to six points for each. McAfee aced the usability test, meaning it marked few or no legitimate programs and websites as malicious. A minor performance impact earned it 5.5 points in that test. But in the all-important protection test, it managed only 4.5 points, for a total of 16. Trend Micro Antivirus+ Security, Kaspersky, and Bitdefender each scored a perfect 18 in this test.

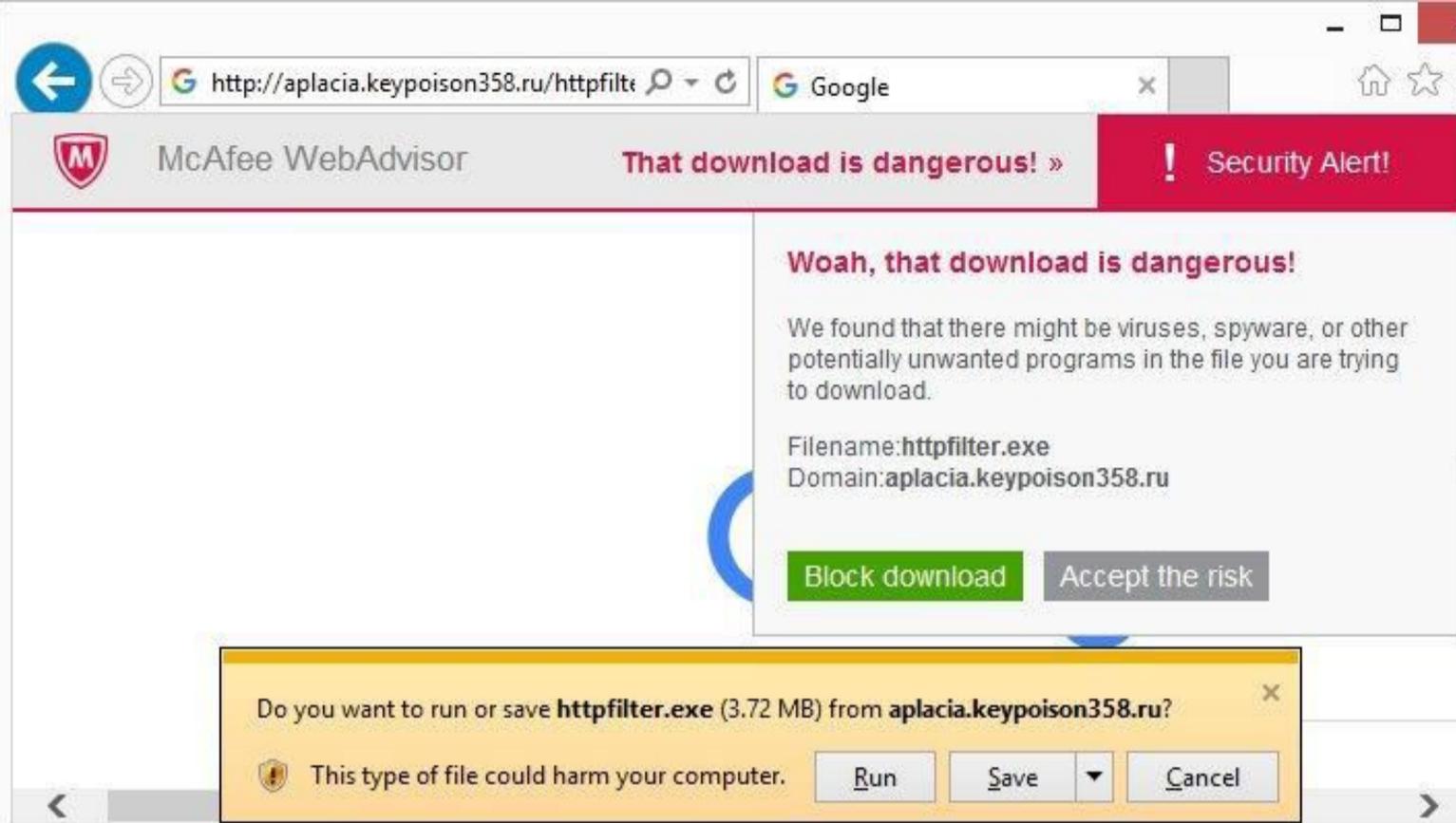
To imitate real-world protection as closely as possible, the team at Simon Edwards Labs captures Web-based attacks and uses a replay system to hit each product with the exact same attack. This lab certifies products at five levels, AAA, AA, A, B, and C. McAfee earned certification at the middle-of-the-road A level.

Earlier this year, I added a pair of tests by MRG-Effitas to my list. One very specifically measures protection against banking Trojans, while the other attempts a comprehensive selection of active malware types. Where most of the other labs offer a range of scores, this one basically tags protection as perfect, near-perfect, or failed. Like many other products, McAfee failed both of these tests. Because of their pass-fail nature, I've reduced the impact of these tests in my lab score aggregate calculation.



**The latest
McAfee
product line
uses a
completely
new virus-
detection and
remediation
engine.**





PLAYING IT SAFER
McAfee's WebAdvisor browser extension proved quite impressive in our tests. In most cases, it first displayed a banner stating that it was examining the download and then warned that the file was dangerous.

For McAfee, that calculation yielded 7.9 of 10 possible points, which isn't so good. Kaspersky Anti-Virus managed a perfect 10, Norton took 9.7 points, and Bitdefender got 9.4. Once again, though, McAfee's scores don't reflect the brand-new antivirus engine.

MIXED MALWARE BLOCKING

McAfee fared quite a bit better in my own hands-on malware-blocking test but had a couple of odd hiccups. With the advent of the new behavior-focused engine, McAfee no longer scans files on access. Rather, it waits for launch and then either whacks the file immediately if it's a known threat or tracks its behavior and rolls back malicious actions as necessary. In testing, I saw several samples whose description indicated that they'd been blocked by Real Protect.

McAfee detected 94 percent of my samples and earned 9.2 of 10 possible points, which is pretty good. But among those it missed were two rather virulent ransomware specimens. One is so nasty I have to cut off the Internet before launching it or risk a nasty note from my ISP. As for the other, I launched it and watched as it encrypted files in my documents folder and displayed its ransom demand with no reaction from McAfee. You'd think that kind of behavior would have been noticed.

All the samples mentioned above are far from zero-day. To get a feel for how antivirus products handle up-to-the-minute threats, I start with a list of very recent malware-hosting URLs supplied by MRG-Effitas, each of which points directly to a malicious executable. I navigate to each URL in turn, discarding any that are already non-functional, and record whether the antivirus blocks the URL completely, destroys the downloaded payload, or sits idly by.

McAfee's WebAdvisor browser extension proved quite impressive. In most cases, it first displayed a banner stating that it was examining the download and then warned that the file was dangerous. A few times the warning didn't appear, the download proceeded, and the real-time protection system scanned and eliminated it. Just once, the WebAdvisor scanned and greenlighted a file, after which the real-time scanner marked it as suspicious. The two protection layers aren't identical, and that's just fine.

Once I got to 100 samples, I quit and ran the numbers. McAfee blocked 85 percent of the malware downloads, the vast majority of them in the browser. That's better than the current average of 70 percent, but quite a few products have done better. When I tested Avira Antivirus Pro 2016, it blocked 99 percent of the URLs completely. Norton's protection rate came in at 98 percent.

SO-SO PHISHING PROTECTION

All the malware protection in the world won't help if you get tricked into giving away your security credentials to a fraudulent (phishing) website. Like most modern antivirus products, McAfee includes a component to detect and block phishing sites. But its accuracy in my hands-on antiphishing test took a nose-dive this time around.

For this test, I scrape data from a number of antiphishing websites, specifically going for URLs that have been reported as fraudulent but not yet classified and blacklisted. I launch each URL simultaneously on a test system protected by the product under test, in another protected by long-time antiphishing champion Norton, and in three others using the protection built into Chrome, Firefox, and Internet Explorer.

Last year, McAfee's detection rate was just 2 percentage points behind Norton's, and it did a better job than all three of the browsers. That's quite good. The only recent products to actually beat Norton are Bitdefender, Kaspersky, and Webroot.

This time around, though, McAfee lagged a full 44 percentage points behind Norton, 40 percent behind Chrome, and 24 percent behind Internet Explorer. It did beat Firefox, but lately Firefox has made a very poor showing in this test.

The lesson here is simple. Don't turn off your browser's phishing protection. McAfee can still make a contribution any time it catches a fraudster that the browser missed.

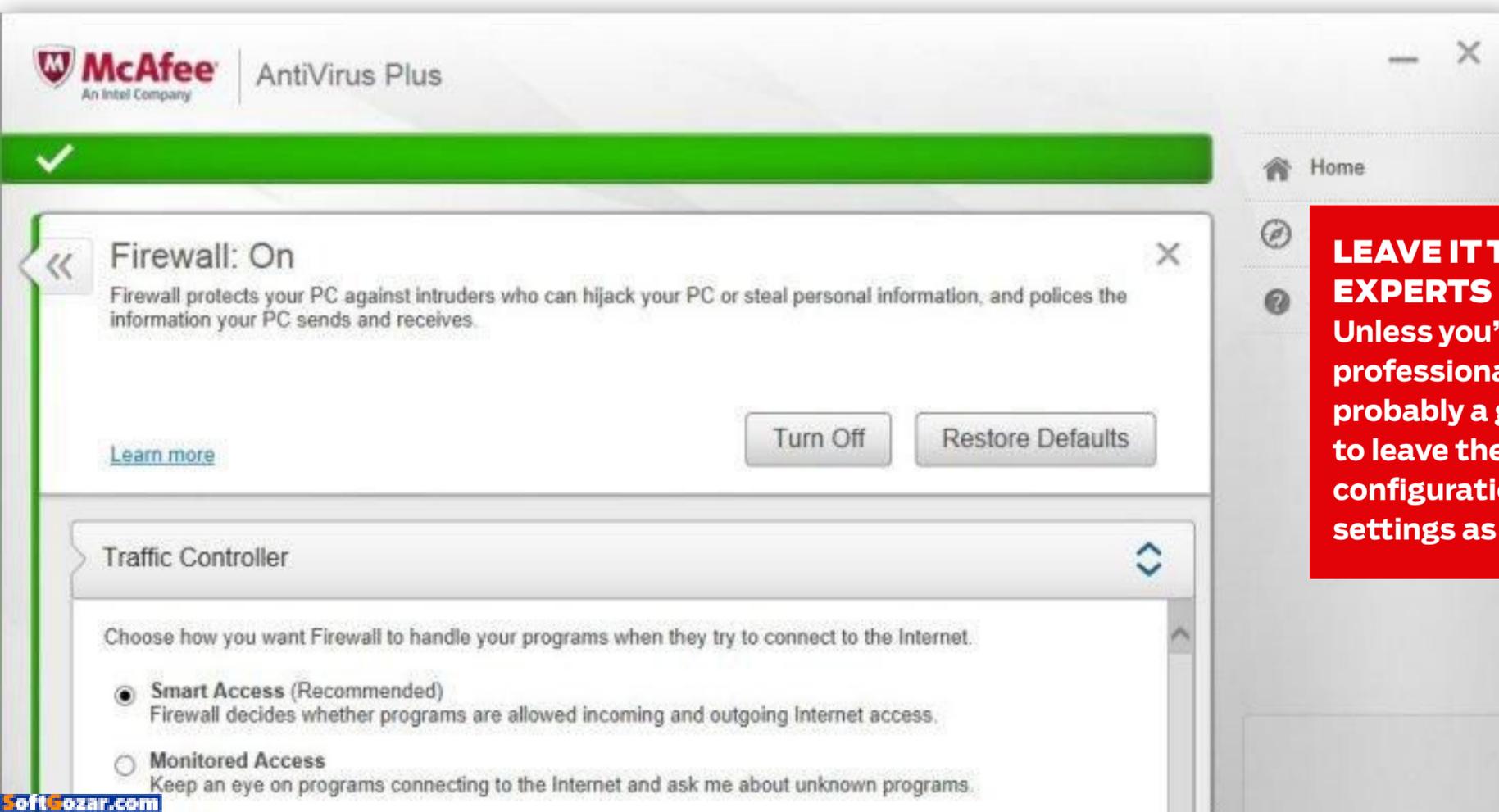
FIREWALL INCLUDED

The earliest personal firewalls were famous for bombarding users with incomprehensible security questions. Putting the decision of whether to allow an unknown program Internet access in the hands of the user turned out to be a bad idea. Most people either always clicked Allow or always clicked Block until they broke something important, then switched to Allow.

Like Symantec Norton Security Premium, Bitdefender Internet Security, and other similar programs, McAfee automatically assigns network permissions to known good programs and keeps an eye on the behavior of unknowns, ready to shut them down if they abuse the network connection. You won't see any sign of program control unless you open Firewall settings and change the Traffic Controller setting from Smart Access to Monitored Access. When I did so, it correctly identified my tiny hand-coded browser as an unknown and asked me whether to allow it online. Most users should leave this setting at its default value, though.

The firewall built into Windows handles such tasks as blocking port scans and putting all ports in stealth mode, so any firewall that aims to replace it must take over those tasks. McAfee correctly stealthed the ports and defended against the Web-based attacks I threw at it.

If you dig into the firewall settings, you'll find a ton of configuration settings. You can turn on Intrusion Detection, view and modify program permissions, open ports, and more. But unless you're a network expert, you should take a strict hands-off approach. Likewise, without that expertise, you probably won't get much out of the Traffic Monitor.



Norton is one of the few products with an intrusion detection system that blocks exploit attacks at the network level. In many products, though, the antivirus component whacks some of the executable payloads. In last year's test, McAfee caught a third of the exploits I hit it with. The change in the antivirus engine cut that detection rate way back. When I hit McAfee with 30 exploits generated by the CORE Impact penetration tool, it actively blocked just two of them. Another two seemed to be blocked when I enabled the Intrusion Detection System. At least, the browser displayed an error message. But since these didn't show up in the log, I can't be sure.

I always check for weaknesses that would allow a malware coder to programmatically disable firewall protection. To start, I comb the Registry to see if there's a simple off switch. Poring through McAfee's more than 750 Registry keys and more than 2,800 registry values, I did find what seemed to be such a switch. But changing it externally had no effect; it's just an indicator of the current on/off state, not a control.

Out of the 14 McAfee processes I found running, the only one I could kill was the WebAdvisor; all the rest were properly armored. As has happened before, though, I managed to stop and disable eight of McAfee's Windows services. Admittedly these weren't the most essential ones, but it surprised me to see the big green "Your computer is secure" message with so many components disabled.

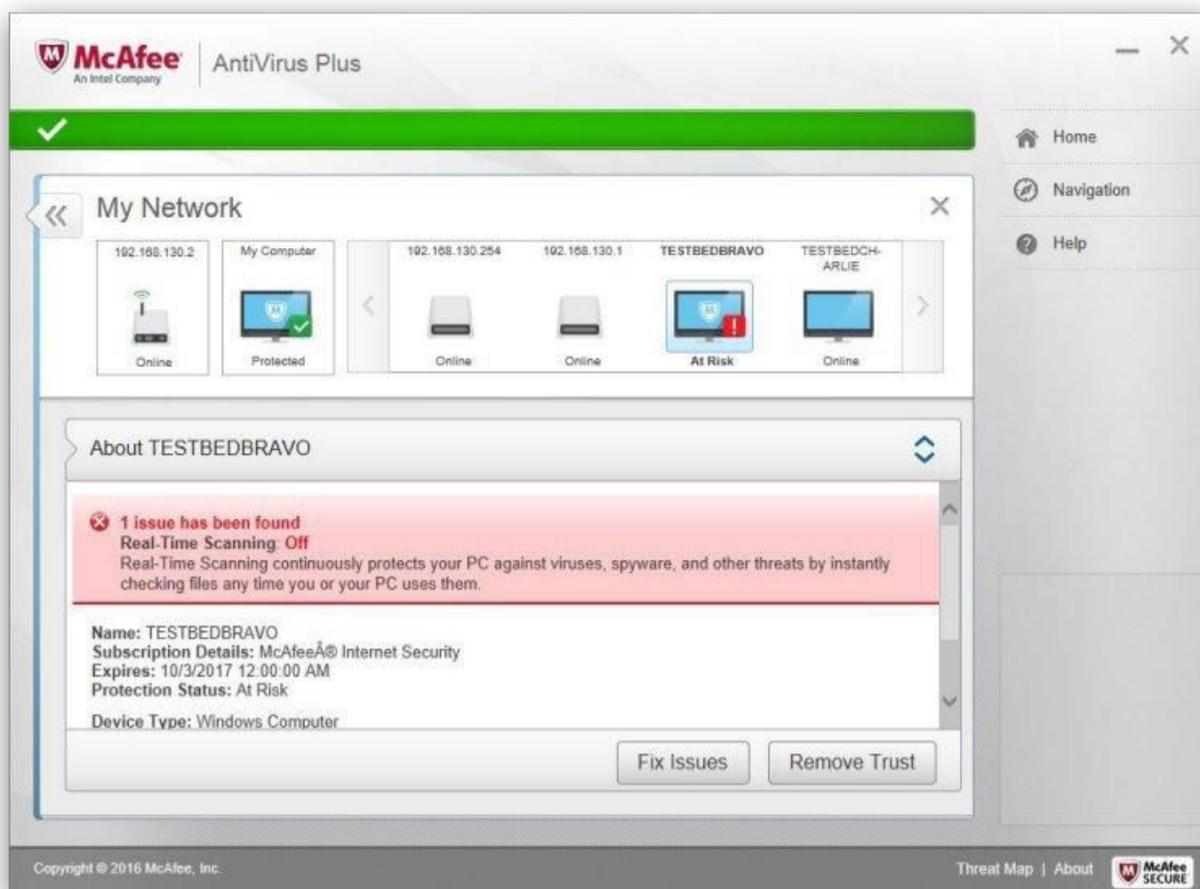
WEBADVISOR

I've mentioned the WebAdvisor component's ability to head off dangerous downloads and identify malicious or fraudulent websites. It can also mark search results, flagging sites as safe, iffy, or dangerous using green, yellow, or red icons. Sites that have been actively vetted by McAfee and found super-safe get a special McAfee Secure marker; Norton's SafeWeb does something



I always check for weaknesses that would allow a malware coder to programmatically disable firewall protection.





MY HOME NETWORK

Open this component and you'll see all of the devices on your home network with the computer name for each.

similar. Note that by default WebAdvisor marks up results only in McAfee's own Secure Search. I advise configuring it to mark results in any search engine.

When you point the mouse cursor at a site-rating icon, you'll see a popup with a brief explanation. You can also click a link to get a full report on the site. I observed that the full report seemed less detailed than what used to appear for McAfee SiteAdvisor.

A new feature in this edition actively attempts to defend you against typosquatting sites. These sites are deliberately named with slightly misspelled versions of popular websites, in hopes that users will accidentally land on them. For example, when I typed www.paypla.com, it popped up asking if I actually meant PayPal.

MY HOME NETWORK

As noted, you can install McAfee on all the devices in your network. If your PC is in the office and your kids have their own laptops or PCs, you can use My Home Network to monitor their protection. When you open this component, it shows all the devices on your network along with the computer name for each or the IP address for other devices. PCs with McAfee installed display a McAfee shield logo. To set up trust between two PCs, you enter a passphrase on one, submit it, and then go enter the same phrase on the other.

Once the trust relationship is established, you can view the other system's status in the network map. If there's anything wrong with the configuration, perhaps because your teen turned off antivirus during an online fighting game, you can remotely fix the configuration. It's a useful feature.

NUMEROUS BONUS FEATURES

For a nominally standalone antivirus, this product looks remarkably like a suite. I'll briefly describe its remaining bonus features.

The QuickClean component scans your system for junk files such as broken shortcuts, file fragments, and temporary files, by default. You can add a few more abstruse categories such as thumbnail caches and memory image files, and you can have it scan the Registry. It also wipes cookies, cache files, and history in all of your browsers. You can launch it at will, or schedule it to clean up at regular intervals.

A lot of the data breaches you read about happen because the company or institution failed to keep their systems fully patched. McAfee's Vulnerability Scan seeks out missing security updates for Windows and popular programs. By default, it scans once per week and awaits your permission to install any found updates. You can tweak the schedule if you like, and can also set it to automatically install updates.

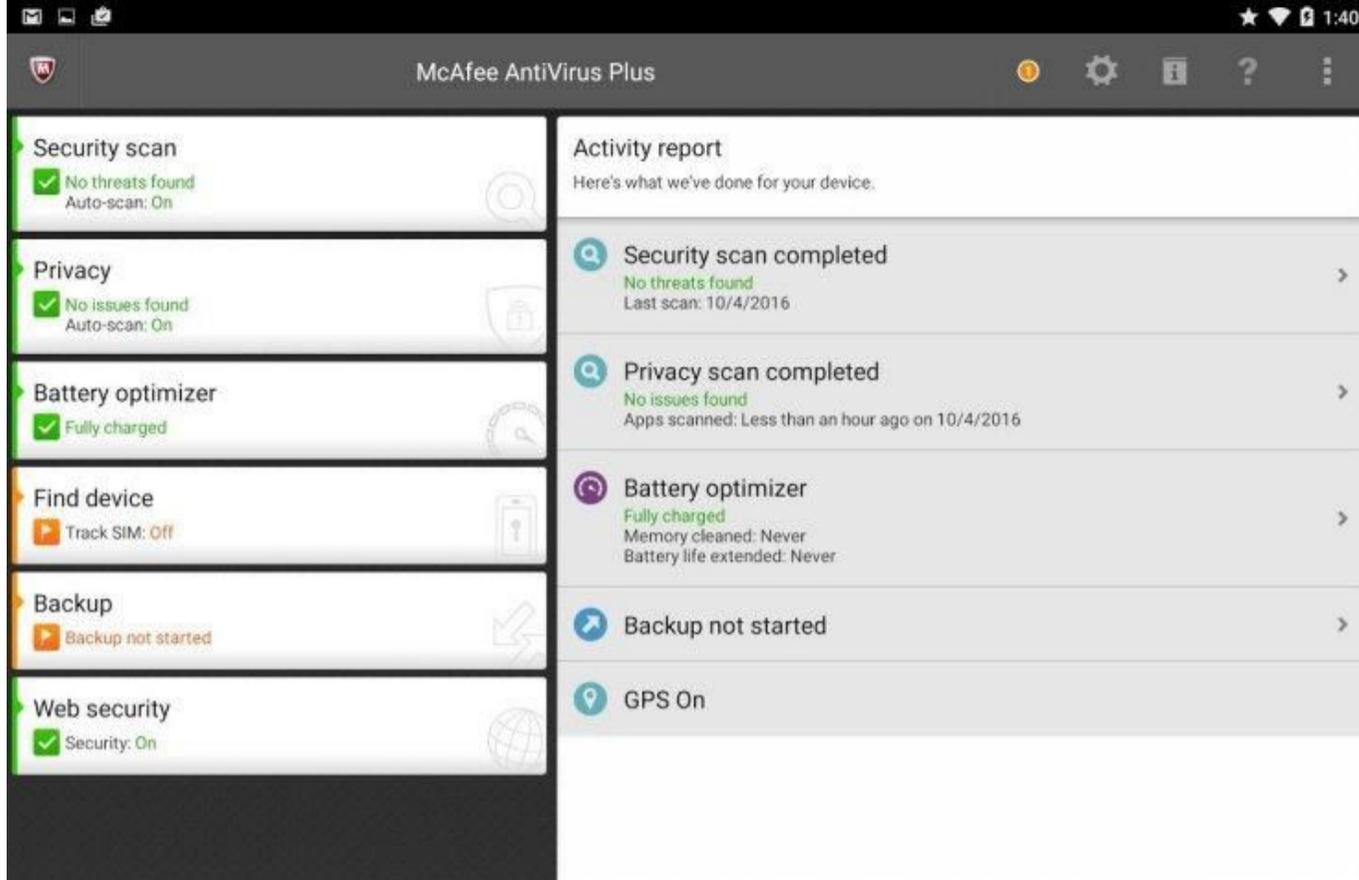
You know by now that deleting a file in Windows merely sends it to the Recycle Bin. Even if you skip the Recycle Bin, or empty it, the data for deleted files remains on disk until another file overwrites it. McAfee's file shredder offers four levels of security, Basic, Safe, Comprehensive, and Complete, ranging from a single overwrite before deletion at the Basic level up to 10 overwrites at the complete level. You can shred the Recycle Bin, Temporary Internet Files, or any files of your choice. It also adds a Shred option to the right-click menu for files and folders.

From the Navigation page, you can access a number of online resources. McAfee's Threat Map indicates hotspots for malware and spam using color codes. Connect with the Virus Information Library if you want to learn what threats are prevalent or get more detail about something the antivirus found. The HackerWatch site is a community for sharing information about the



A lot of the data breaches you read about happen because the company or institution failed to keep their systems fully patched.





LIMITED MAC PROTECTION
For Macs, McAfee AntiVirus Plus includes a firewall and protection against the small (but growing) number of macOS malware attacks. It also steers your browser away from dangerous sites and marks up search results.

latest Internet threats. If you have a deep and abiding interest in all things security-related, these three tools should prove interesting. If not, well, the map is pretty!

MAC AND MOBILE

This review focuses on the Windows version of McAfee AntiVirus Plus, but I'll run through what you get for your macOS, iOS, and Android devices too. Note that Mac and mobile support is the same across the entire McAfee product line.

McAfee really wants you to make use of your subscription across all your devices. To that end, the device management screen includes a button that scans the network and reports on devices that could have McAfee installed but don't yet. To manually extend protection to another device, you log into your McAfee account and either download the installer for the current device or send a link in an email message. The link automatically ties the new installation to your account.

Protection on a Mac is quite limited compared to what you get on a PC. It does include a firewall and protection against the small but growing number of macOS malware attacks. It scans email and IM attachments for malware. As on the PC, WebAdvisor steers your browser away from dangerous sites and marks up search results. That's about it.

Android devices get a good deal more than Mac in terms of protective features. In addition to antivirus and WebAdvisor, you can remotely locate, track, lock, and wipe your device, with the option to do a remote backup before wiping. You can also back up your data at any time and restore to the same device or a different device.

If it's just about to run out of power, your Android device transmits its

location using the S.O.S. feature. Android security products from Lookout and Bitdefender do something similar. App protection points out too-broad permissions for apps on your device and ranks them by level of privacy sensitivity. McAfee can filter unwanted calls and texts, and its CaptureCam silently snaps a photo of someone who has found (or stolen) your device. Wi-Fi security warns when you connect to an unsecured hotspot and actively cuts the connection if it detects shenanigans. A battery optimizer ekes out more screen time. It can send notifications to your Android Wear watch and pair it with another device so you don't leave either behind. The feature set is extensive.

Those installing McAfee on iOS devices don't get quite as much: no antivirus, for starters, which makes sense given the dearth of iOS malware. Wi-Fi security, battery optimization, app protection, WebAdvisor, and call/text filtering are absent. You can locate and wipe the device but can't lock it or track it in real time. And the backup feature handles contacts only.

On the plus side, the S.O.S. feature works on iOS devices, as does CaptureCam. And you can pair your Apple Watch with an iOS device to get notifications and keep from losing either.

CONCLUSIONS

McAfee AntiVirus Plus doesn't always get the best marks from the independent labs. That honor goes to Bitdefender and Kaspersky. It scored high in some of my own hands-on tests but lower than last year in others. This product's claim to fame is twofold. It has a huge feature set when installed on Windows, and you get unlimited licenses to install protection on your Windows, macOS, iOS, and Android devices. It's that amazingly broad protection that earns McAfee an Editors' Choice for commercial antivirus.

If your main aim is to install antivirus on a fairly limited number of PCs, though, you may do better with one of our other Editors' Choice products. As noted, Bitdefender Antivirus Plus and Kaspersky Anti-Virus are the darlings of the labs. Norton Antivirus Basic extends excellent antivirus protection with a powerful Intrusion Detection System. And Webroot SecureAnywhere AntiVirus is the tiniest antivirus around. Your choice will depend on exactly what you want to protect.

NEIL J. RUBENKING



SMART FARMS: BIG DATA MEETS BIG AG

BY MICHELLE Z. DONAHUE



The dream of big data in agriculture promises to improve efficiency and yields. But the components have yet to become a cohesive whole.

BY MICHELLE Z. DONAHUE

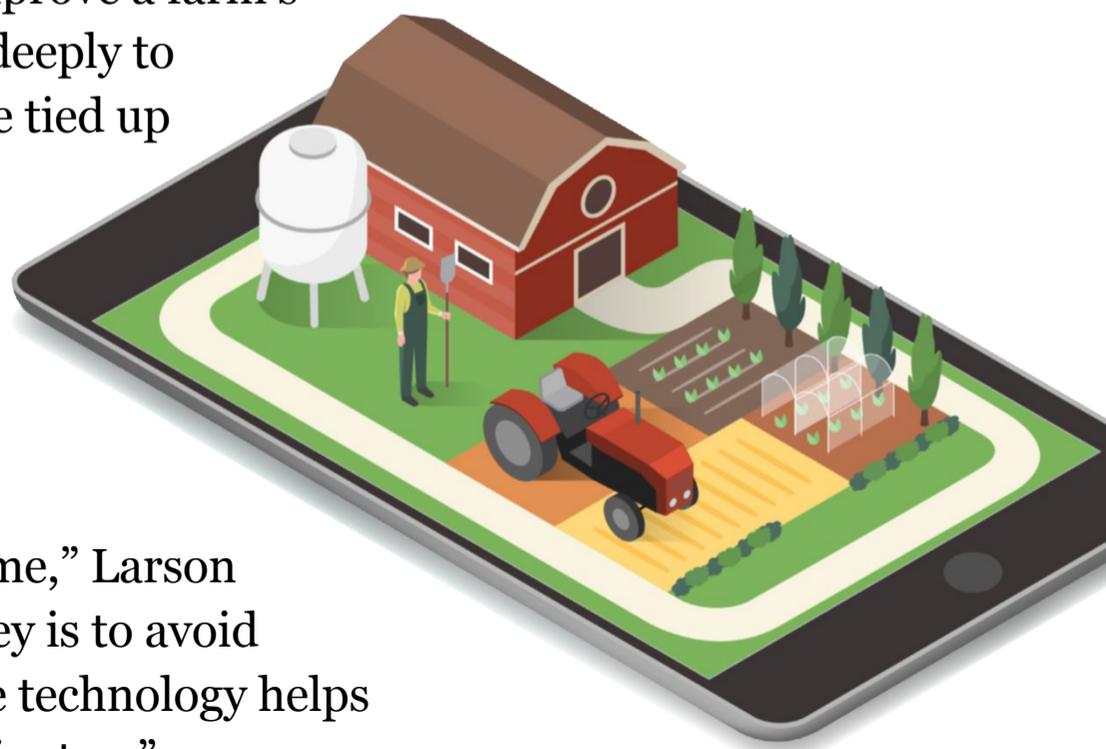
Like much of the American heartland, the summertime landscape in Iowa's Webster County is dominated by several immutable features. Hot sun, and lots of it. A ruler-straight grid of byways that bend only at old property boundaries and upon encountering water. Shining grain silos towering above the plains. Farmhouses surrounded by fields of soybeans, alfalfa, and hay.

And, of course, corn. Hundreds of thousands of acres of it, a sweeping, shimmering sea of green, towering well over even a tall man's hat by July in a good year. In 2013, just over 200,000 acres, fully 50 percent of Webster County's farm acreage, was given over to *Zea mays*.

Brent Larson is part of this economy, farming around 400 acres along with his father and brother. They run their farms primarily in the evenings and on weekends, their workday filled with assisting the hundred or so clients they serve through Sunderman Farm Management, their consulting and brokerage firm. Farming alone is a difficult way to make a living.

So technology that promises to improve a farm's yields while lowering costs appeals deeply to Larson. Large amounts of capital are tied up in seed, fertilizers, water costs, and equipment, and predicting the impacts of weather and market timing is an annual wrangle if he hopes to make some green of the spendable type.

"People are interested in net income," Larson said. "The easiest way to make money is to avoid spending it in the first place. If more technology helps avoid additional expenses, that ties in, too."



He, his family and his agricultural peers are no strangers to technology. GPS-guided tractors are the norm, helping farmers navigate perfectly straight rows and plot optimal routes over uneven terrain to maximize rows planted per acre. Larson can call upon several drone companies to do periodic imagery of a field. And along with 100,000 other farming operations on 92 million acres of fields, Larson uses FieldView, a subscription-based data analysis platform created by Monsanto subsidiary Climate Corporation. Connected to data-gathering equipment on their planters and tractors, farmers can view real-time weather data, see historic field and yield data, and capture crop and soil information from a tractor as it passes through a field.

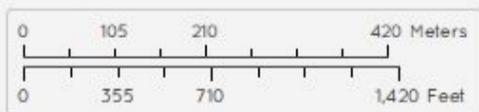
Larson said he is intrigued by what the recent proliferation of agriculture-targeted Internet- and cloud-connected sensors might be able to do for him, as well as farming as a whole. But whatever he invests in has to work reliably. The optimal windows for tilling, weeding, seeding, fertilizing, and harvest are all incredibly small, whether for row crops such as corn and soy, vegetables such as lettuce, or perennial crops such as grapes, nuts, and fruit.

“GPS-guided tractors are the norm, helping farmers navigate perfectly straight rows and plot optimal routes.”



ScoutView Report

Survey Name Napa_Demo_ortho
 Survey Date 20 April 2016
 Report Date 03 May 2016
 Location Napa County, California
 Lat / Lon 38.42900, -122.40930
 Map Projection WGS 84 / UTM zone 10N
 Image Resolution 0.51 in | 1.30 cm
 Survey Area 68.84 ac | 27.86 ha



SCOUTVIEW
 Precision Hawk’s DataMapper service provides an instant snapshot of a client’s aerial field surveys. Each report captures weather information, location, average crop height and volume across a plot, soil type and more. (Photo: Precision Hawk)



20 April 2016



2.0 mph

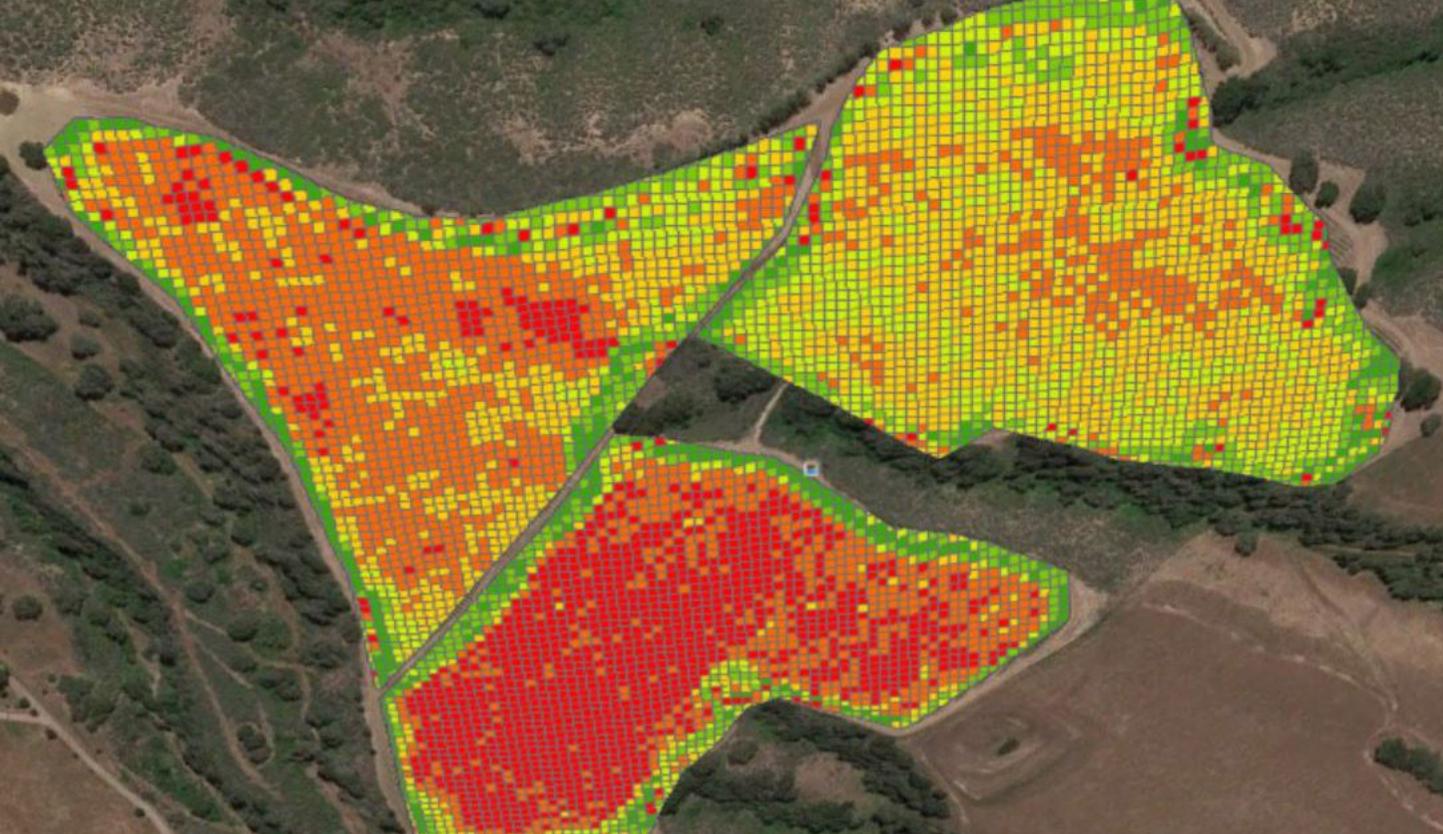
7 Days: 0.06"



Legend
 Survey Boundary



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HOT ZONES

Precision Hawk's scanning tools include a variety of vegetation algorithms to analyze how vigorous and robust plants are. (Photo: Precision Hawk)

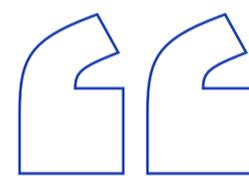
“One of the hardest things to figure out is where to spend your time, energy and effort,” Larson said. “Some of these technologies are great, but to learn them, and keep them up to date, and then throw them away when the next best widget comes out in three years—I don’t want to buy another \$5,000 device that will just be a paperweight in a couple of years.”

He envisions a time when his farm and others like it, as well as the huge Big Ag plantations, can all harness the promise of Big Data for highly targeted plant management: applying fertilizer only where the soil is starved, watering only where plants are thirsty, and spraying for pests and diseases before they become a plague. But as it has been for as long as we’ve farmed, many of those decisions made today are heavily dependent upon an expert eye and the many layers of intuition of accumulated seasons. The idea of getting the right mix of hardware and software deployed in his fields to assist with those goals still smacks of science fiction for Larson.

But it’s not as far off as he might imagine.

GADGETS IN THE FIELD

In 2015, nearly 500 ag-tech companies drew \$4.6 billion in investments, double the previous year’s figure, according to agriculture investment platform AgFunder.



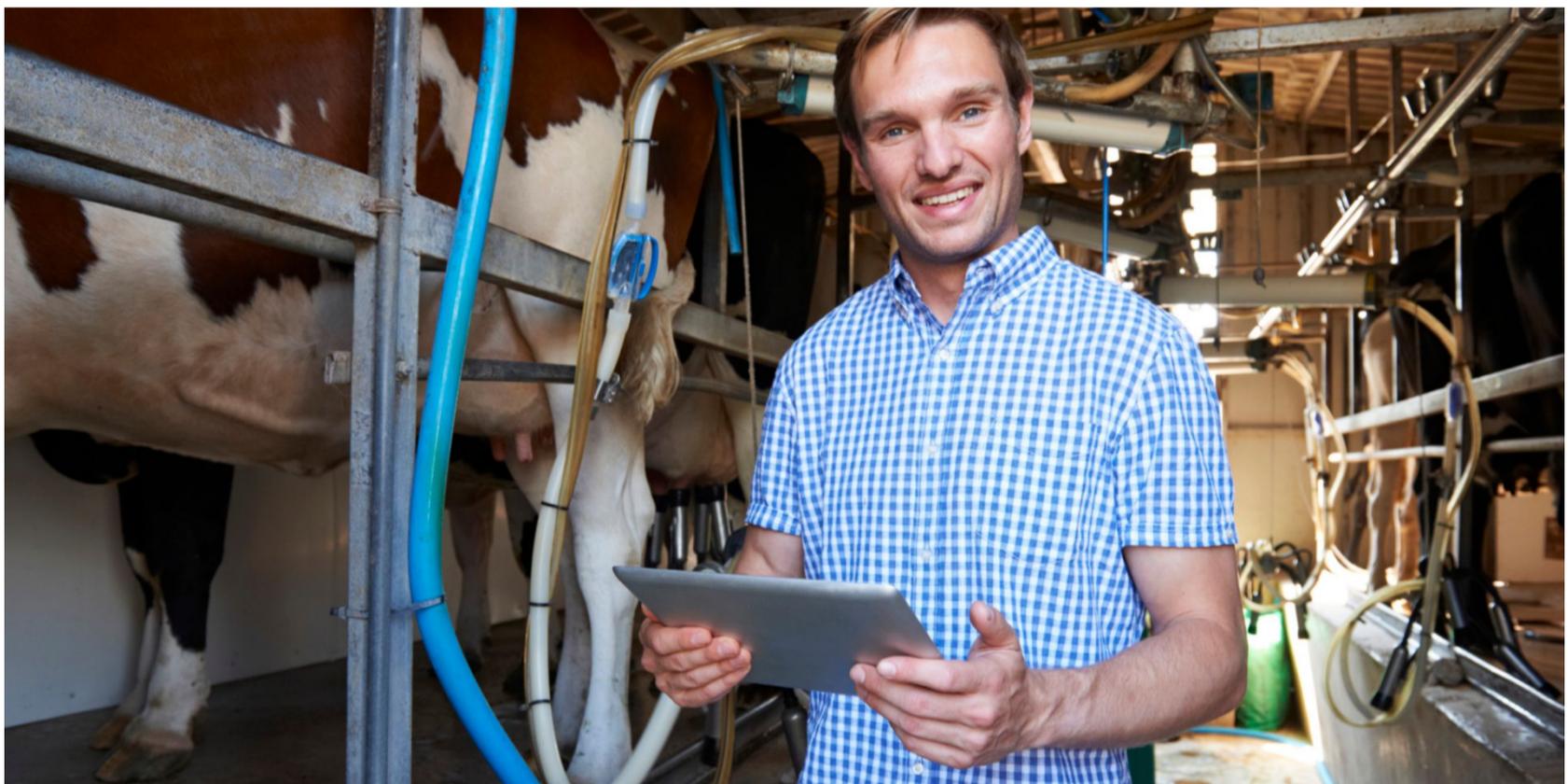
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This year has been slower—only \$1.75 billion went to ag tech in the first half of 2016, a 20 percent reduction over the same time last year. AgFunder CEO Rob Leclerc said that’s probably because companies now are putting prior investments to good use.

Still, the ways in which companies and start-ups are getting into the ag space vary wildly.

Hardware abounds, as you might expect. Startup Cowlar is helping dairy farmers optimize milk production by outfitting their herds with smart collars—essentially activity trackers that send alerts when cows are “exhibiting abnormal behavior or unusual temperature levels are detected” or when they wander off the farm. Other companies are making Wi-Fi-enabled ear tags and embedded chips that send data to farmers on an animal’s movement, temperature, and gestation cycle.



Sensors for grain elevators track humidity and temperature gradients throughout a silo, feeding into automated climate control systems to keep grain from fermenting. SWIIM worked with the U.S. Department of Agriculture to develop a complete sensor-software system for monitoring precipitation and water usage, so a farmer can not only conserve more water but could also profit from leasing out any leftover portions of his or her water rights.

And there are plenty of DIY tinkerers in the field, working to make devices for their own farming operations. One such community, known collectively as Farm Hack, has been concerned with the potential for tech to enable data gathering and automation from its very inception.



Dorn Cox, a co-founder of Farm Hack, runs the 300-acre Tuckaway Farm in Lee, NH. The farm raises organic specialty crops primarily for restaurant clients, including blueberries, mushrooms, vegetables, maple syrup, sunflower oil, and baked goods made from farm-grown grains. In 2011, when the open-source FarmHack community first started, one of the very first problems members discussed was how to remotely detect dangerously high temperatures in greenhouses. Using a basic Arduino system, a modified GSM cellular signal, and a cell phone, the project created a temperature sensor that sends text alerts when temps got too high in the operator's greenhouse.

More and better-quality off-the-shelf devices are available now for members to use or tweak for their own purposes. Cox himself has developed a dashboard dubbed FarmOS that lets users collect, centralize, and manage their remotely collected data. He also has a number of sensors deployed around his farm—primarily in the greenhouses—that help him and his small staff prioritize their tasks. He predicted he won't be able to grow economically without the help of a larger sensor and data-collecting scheme.

“Our mushroom operation, for instance, is really sensitive to environmental conditions,” he explained. “The risk is so high when things get out of range that we won't be able to expand without adding those kinds of alerts. I think we're all heading toward being dependent on that kind of capability.”

Cox is concerned by the sheer abundance of devices on the market, though, and said that there's little assurance for any interested party that the hardware is collecting robust data. He and other Farm Hack collaborators worked recently at a U.S. Environmental Protection Agency and U.S. Department of Agriculture air quality and climate station in Maine to install, calibrate, and run comparisons of the performance of low-cost sensors alongside their powerful—and much more expensive—science-grade counterparts.

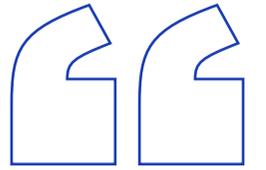
“As we add more and more sensors to our fields, they’re important not only for farm management and environmental compliance but also to a research audience,” Cox said. “These are people building models about how carbon, water, and nitrogen cycle through an agricultural system, and those models are used to project the effect of agriculture on climate change. That feedback from agriculture systems is so important to validate. Policy is made based on that.”

STITCHING THINGS TOGETHER

As it affects their crop yields, farmers are primarily concerned with two things: climate and chemicals. How much water is available? How fertile is the soil? How much will I need to allot for insect and disease sprays? Sensors and data-gathering devices can provide actionable information on each of these concerns. But what if you wanted data streams on all of them, all at once, every day? Or more specialized information based on your particular crop or location?

Break out your password keeper: For the most part, it’s very much a disjointed jumble of objects, ideas, and processes. There is hope, though: “Integration” is the new buzzword in the IoAg. Think platforms.

“Our average subscriber has 160 data streams, but we have some farms with over 1,000,” said Lance Donny, founder and CEO of OnFarm. “That’s a lot of data for a grower to manage, especially if it’s reporting to you all the time.”



‘Integration’ is the new buzzword in the Internet of Agriculture. Think platforms.

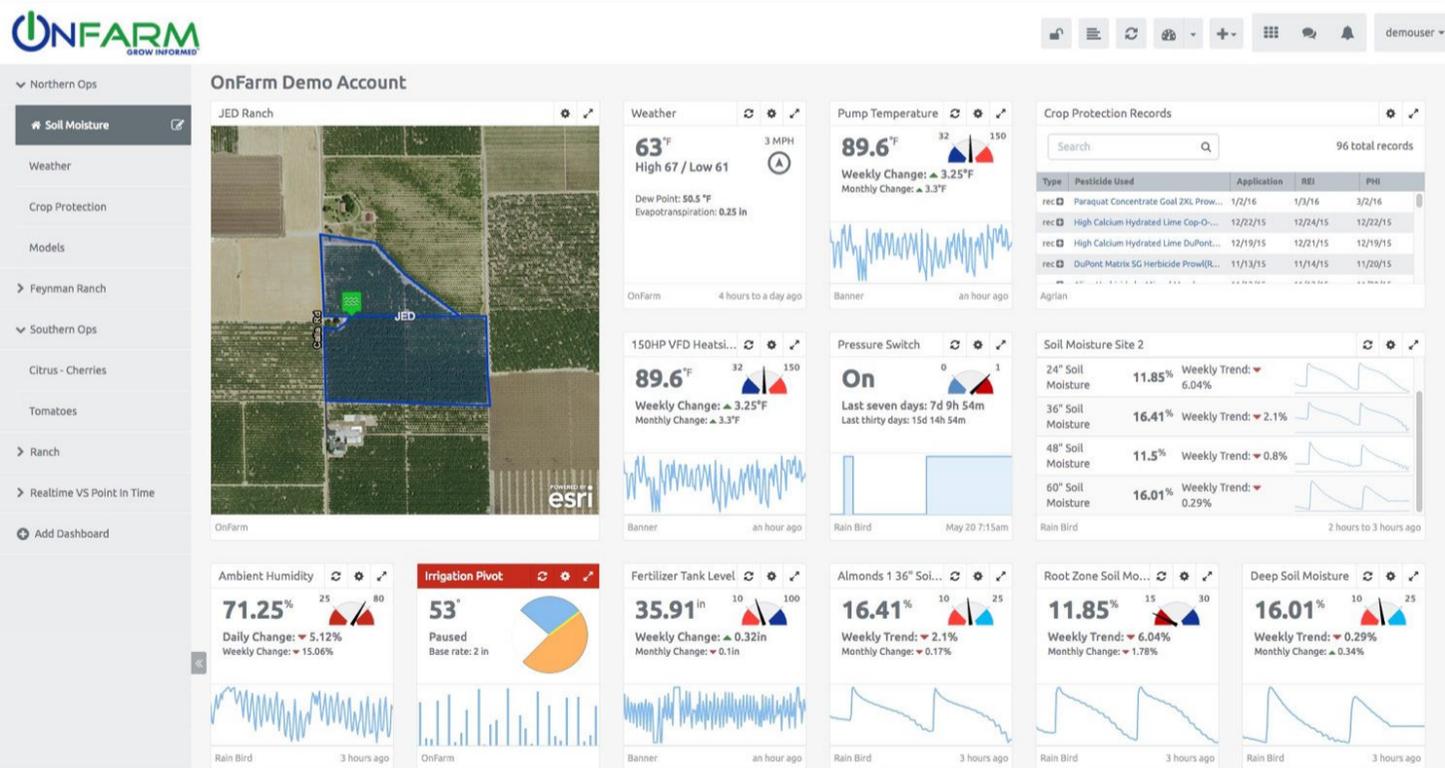


TABLET FARMING
OnFarm’s platform allows farmers to create a customized control panel for any array of sensors and devices they have deployed on their operation. (Photo: OnFarm)

OnFarm provides a central nervous system, accessed via smartphone, tablet, or computer, through which farmers can route all or some of their sensor data for analysis. On the tech side, hardware and software developers can add their services to the OnFarm network to reach the company's subscribers. Though OnFarm boasts partnerships with big-name companies such as John Deere, Davis Instruments, and Campbell Scientific, Donny asserted he's agnostic about who joins the ecosystem.

"We're supporting any data, coming out of any device," Donny said. "There have been so many IoT-based solutions giving growers so much information about lots of different things, but all that information was siloed, and there were no data standards for interoperability amid all that data. So it was hard for growers to make a determination of what to use, how to use it, and how to get the best return on that investment."

“**OnFarm receives 70 million readings per month from 71,000 sensors spread over half a million acres.**”



FRIEND OF A FARMER

The customizable OnFarm interface lets farmers check such things as weather, ambient humidity, root zone soil moisture, and fertilizer tank levels.

Focused primarily on growers of specialty crops—nuts, fruits, berries, and vegetables—Donny said OnFarm receives 70 million readings per month from 71,000 sensors spread over half a million acres in 32 U.S. states and Canada.

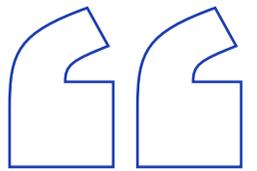
“Data management systems have almost become a requirement in order to quantify it and boil it down,” he said. “You just can’t juggle that information in your head.”

Climate Corporation, also primarily concerned with vending data-analysis services, is working toward integrating more types of high-resolution data layers from more sources for its FieldView products. It aims to accomplish this in large part by partnering with numerous third-party providers, such as Kansas-based Veris Technologies, which has developed a series of tractor-mounted sensors to map individual fields’ organic matter content, pH, electrical conductivity, and soil texture.

Climate Corporation’s chief innovation officer, Mark Young, said that by stirring up conversations with other innovators of all sizes, Climate Corporation hopes do for farming what Google did for Web search or Amazon for the digital marketplace: Make it simple and make it bulletproof.

“When your ag software is down and it’s stopping you from planting or harvesting, that’s not an option,” Young said. “It’s a little more rigorous than what most Silicon Valley tech companies are used to focusing on. These are multimillion dollar operations, and it cannot go wrong. If the code running your pacemaker has a bug, that’s a bad day for everyone, and where we’re getting to, the software has to have that same level of redundancy.”

Princeton, NJ-based Arable is taking a somewhat more global approach to integration. Subscription-based data management and analysis is also key to its process, but instead of solely cobbling together a network of thousands of third-party providers, founder Adam Wolf decided that packaging several dozen commonly used sensors into an attractive, easy-to-deploy design would be most beneficial to a broader array of growers.



**Climate Corp.
hopes do for
farming what
Google did for
Web search
or Amazon for
the digital
market-place:
Make it simple
and make it
bulletproof.**





STRAWBERRY FIELDS

Strawberries ripen in one of Driscoll's commercial growing fields in Monterey County, CA (Photo: Driscoll's)

Wolf was first spurred to the idea as an agronomy grad student lugging around hundreds of thousands of dollars' worth of weather-monitoring equipment for research in Kazakhstan. In his experience, growers everywhere want the same basic abilities: soil moisture and fertility tracking, intensity and hours of sunlight available, correlation of crop yields with weather trends, and the ability to quickly assess foliage for problems.

“You shouldn't have to send a grad student with a pickup truck to wire this stuff up,” Wolf laughed. He worked with Nest and GoPro designer Fred Bould to package an array of sensors into a compact disc-shaped housing. The Pulsepod contains, among other things, net radiometers for measuring absorption of shortwave and longwave solar radiation; tilt and orientation sensors; spectrometers to reveal foliage in different wavelengths for measuring plant stress, growth rate, and chlorophyll content; and cameras. The pod can be mounted on a pole at any height and customized with additional hardware on external ports.

“The big opportunity that has never really existed in ag IoT is measuring and connecting the predictors with their outcomes,” Wolf said. “It's supply chain optimization. If you look at what's valuable, 30 percent of all food is lost before it reaches the consumer. That's money left on the table, and all the irrigation, fuel, people hours, land value—all that was wasted. In the larger context, there are bigger fish to fry than just irrigation or applying pesticides.”

For large international companies such as berry producer Driscoll's, which partners with around 700 strawberry growers around the world, IoT technology like Arable's also represents the ability to make sensor data more detailed. Where previously growers might deploy one sensor per 100-acre field, smaller, more affordable units that provide more information from a single data stream makes it easier to justify 10 to 20 times the number of sensors per field. Driscoll's is currently beta-testing Pulsepods in two fields in California.

“You get this closed feedback loop where you really trust that the sensor data are representative of what’s happening in the field, and that provides the grower with information to make better decisions,” said Michael Christensen, Driscoll’s director of forecasting for the Americas. “And in the future, if growers can act on individual plants instead of spraying an entire 100-acre field, there are big ramifications for pesticide, fertilizer, and water use. If someone can unlock the ability not only to sense but also to act on that data, there’s a lot of value in that.”

Growers of another high-value crop, wine grapes, are eager to employ forecasting methods based on tightly knitted datasets: multifunction platforms or devices give them the ability to tie microclimate variances to yield predictions by responding to real-time conditions in the field as they unfold.

“Being able to pinpoint what past seasons have done to predict your current season before you get there really can help turn things around,” said Will Drayton, director of technical viticulture and research winemaking for Australia-based Treasury Wine Estates. “As soon as I have an inkling there may be some shatter in the merlot, I can start speaking to growers across the state to pick up additional contracts and buy early while we still have a good price. But it also goes to the level of ordering corks, casks, employee hours, harvest interns, everything.”



KEEPING AN EYE ON THINGS

A Washington State orchard manager checks data-overlay images of his fields, captured by a drone-mounted field-mapping tool by Precision Hawk.

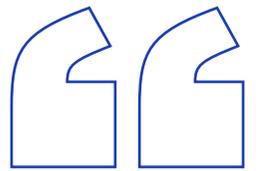
FEEDING THE FUTURE

In the United States, the ability for growers to collect more data essentially amounts to better profits, and perhaps more consistent prices for consumers at the grocery. But in places in the rest of the world where one daily meal, let alone three, are far from assured, more data from IoT devices may mean the difference between subsistence and success.

Assume that the ongoing problem of cellular access, wireless or other internet connectivity is solved in developing nations. The question companies like Arable and Climate Corporation are asking becomes , how can we make farmers in countries like Zambia, Brazil, and India as productive as American farmers, with enough surplus to feed not only themselves but also their community and even country?

“The issues that affect the smallholder are different from those that affect the guy in Iowa,” Climate’s Young said. “They’re light on agronomic advice, commodity prices, and microcredit to run their operation. A lot of them are planting the same seeds as we are and getting only 60 or 70 bushels per acre, while we’re getting 100 bushels per acre. How we get them to be better farmers, and put them in better touch with neighbor farmers?”

Climate Corporation is working to answer this question by adapting its large-scale grower platform for use by smallholders as well. It has already signed up 3.5 million users in India to receive text messages with market and agronomy information based on their regional crops and conditions.



How can we make farmers in countries like Zambia, Brazil, and India as productive as American farmers?



OUT HERE IN THE FIELDS

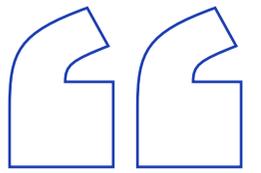
Chris Fastie, left, of the open-source testing community Public Lab, and Dorn Cox, Farm Hack co-founder, test a Photosynq leaf tissue analyzer to compare photosynthetic rates of Austrian winter pea planted with winter rye in three different fields at Cox’s Tuckaway Farm in New Hampshire in 2015. (Photo courtesy of Dorn Cox)

Arable's Wolf added that giving farmers in developing nations—as well as government entities such as the U.S. Agency for International Development—a better understanding of what big data can do can help give farmers more confidence in their assessment of seasonal risks and yields.

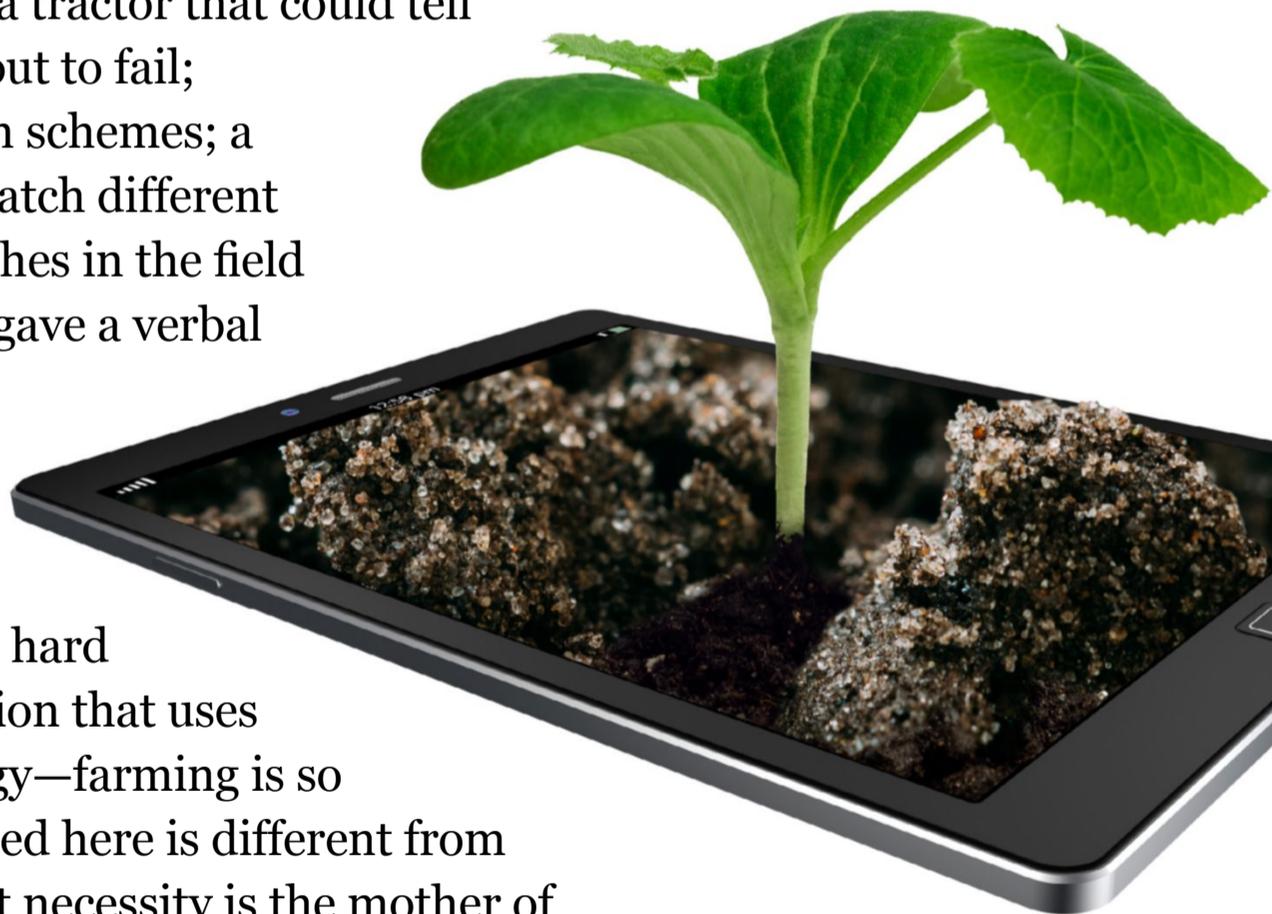
“How do you feed the future?” Wolf mused. “One meme is ‘climate smart agriculture,’ measuring conditions that allow you to predict whether the conditions that support [disease development] are happening, as well as the conditions of a particular microclimate in order to give periodic advice to farmers. Having a system or device that’s able to measure that gives basic value around taking action in response.”

In Iowa, Brent Larson considered the plethora of offerings on tap to help farmers make more by growing more. His wish list of all the connected things that would help him personally: a tractor that could tell him when a bearing was about to fail; customized spot-fertilization schemes; a planter with the ability to match different hybrid corn varieties to patches in the field where they’d grow best. He gave a verbal shrug.

“Ultimately, everyone uses what is appropriate for their operation,” he concluded. “I think you’d be hard pressed to find an organization that uses all of the available technology—farming is so localized. The technology used here is different from 500 miles west or south. But necessity is the mother of invention, and there will be different inventions for every need.”



‘The issues that affect the smallholder are different from those that affect the guy in Iowa,’ Climate’s Young said.





WHO'S HACKING THE VOTE?

BY CHLOE ALBANESIUS

Rigged elections are usually the stuff of spy movies and corrupt regimes. A shadowy figure in a dark room directs henchmen to crack heads or make ballots disappear, lest an undesirable candidate gain power.

But 2016 is no ordinary election year, and cyber attacks reportedly linked to the Russian government have put U.S. officials on high alert for those who might seek to influence our politics from behind a computer screen in Moscow.

“In recent months, malicious cyber actors have been scanning a large number of state systems, which could be a preamble to attempted intrusions,” Homeland Security Secretary Jeh Johnson said in an October 1 statement. “In a few cases, we have determined that malicious actors gained access to state voting-related systems. However, we are not aware at this time of any manipulation of data.”

Hackers have targeted databases in 20 states, according to *Politico*, and two states—Arizona and Illinois—have each confirmed a breach.

The Illinois State Board of Elections said hackers breached its system in late June and stole “various” Illinois Voter Registration System (IVRS) passwords, including those of election authorities, their staffs, internal election board users, vendors, and Web services. In response, Illinois officials reset all passwords, encrypted those passwords, and started requiring two-factor authentication for logins.

“We can confirm that no voting history information and no voter signature images were captured. We are highly confident that no data in the IVRS database was added, changed, or deleted, although the investigation is not yet complete,” the board said in an August 26 statement.

According to the McLean County Clerk, who posted on Facebook a note sent to all Election Authorities in Illinois, hackers got in via “a vulnerability on our public Web page that an applicant may use to check the status of their online voter registration application.”

The resulting SQL injection hit election board IP addresses five times per second, 24 hours per day between June 23 and July 13, when the board’s website and database were taken offline to thwart further intrusion. Attacks continued, however, until August 12, when they “abruptly ceased.”

“This was a highly sophisticated attack most likely from a foreign (international) entity,” the note published by the county clerk reads.



A spokesman for Arizona Secretary of State Michele Reagan, meanwhile, told the *Washington Post* that the hack of its database was an “eight on a scale of one to 10,” and prompted a temporary shutdown. Ultimately, the hackers stole only a username and password for one election official in Gila County, the *Post* reported.

DON'T FREAK OUT

While that sounds bad, officials emphasize that election databases and actual election systems that tabulate votes are two different beasts.

“There have been a lot of press reporting about attempts to intrude into voter registration databases,” FBI Director James Comey told the House Judiciary Committee in September. “Those [databases] are connected to the Internet. That’s very different than the electoral mechanism in this country.”

In the U.S., votes are tabulated by local election officials in counties, parishes, and independent cities or townships, and then certified and handed over to state officials.

“The vote counting process in the United States is highly decentralized,” according to the Election Assistance Commission. “This structure serves to compartmentalize the election process so that the effects of inadvertent errors or mismanagement are more or less contained. Furthermore, decentralization limits the opportunities for fraud or corruption, by making it extremely difficult to accomplish on a scale grand enough to be decisive without being detected.”

But while voting machines are not connected to the Web, many of them are electronic, and some do not produce paper receipts. The issue is not new, but it has been revived in the wake of the database hacks. Rep. Hank Johnson, a Georgia Democrat, introduced legislation in late September that would allow states only to purchase voting systems that produce paper receipts, which can be manually tabulated if necessary.

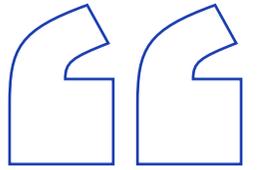
“We cannot afford to be reactive; we must invest now in clear, tough, and verifiable ways to protect everyone’s vote,” said Rep. Johnson, who also expressed concern about voter suppression and intimidation in his home state of Georgia.

SO WHAT GIVES?

The larger issue here is the perception that the U.S. election system is vulnerable. Even if the Russians aren’t virtually pulling any levers on November 8, creating the illusion of chaos ahead of Election Day may be enough of a result for the Kremlin.

It's about "undermining faith in Western institutions [and] democratic institutions," journalist Julia Ioffe told ABC's George Stephanopoulos in October. "You don't have to do all that much to project a lot of power for Americans to start thinking, wow, [Vladimir Putin] has the power to swing a whole election."

Democratic lawmakers agree. "Based on briefings we have received, we have concluded that the Russian intelligence agencies are making a serious and concerted effort to influence the U.S. election," Sen. Dianne Feinstein and Rep. Adam Schiff of California said in a joint statement issued on September 22.



The larger issue here is the perception that the U.S. election system is vulnerable.



RUSSIAN TO JUDGMENT

Two separate hacking cells with known ties to the Russian government compromised the DNC's systems, according to CrowdStrike, the security firm that investigated the attack.

"At the least, this effort is intended to sow doubt about the security of our election and may well be intended to influence the outcomes of the election—we can see no other rationale for the behavior of the Russians," they said. "We believe that orders for the Russian intelligence agencies to conduct such actions could come only from very senior levels of the Russian government."

"We have never in the history of our country been in a situation where an adversary, a foreign power, is working so hard to influence the outcome of the election," Hillary Clinton said at the second presidential

debate. “And believe me, they’re not doing it to get me elected. They’re doing it to try to influence the election for Donald Trump.”

PUTIN VS. THE DEMOCRATS

Russian Prime Minister Vladimir Putin’s alleged involvement in the 2016 election first emerged earlier this summer, when the Democratic National Committee revealed a hack of its system.

Two separate hacking cells with known ties to the Russian government compromised the DNC’s systems, according to CrowdStrike, the security firm that investigated the attack. One cell, known in the security community as Cozy Bear, had access to the DNC since last summer; the other, Fancy Bear, breached the network in April.

That was followed by a hack of the Democratic Congressional Campaign Committee (DCCC), which serves as the official campaign arm of the Democrats in the House of Representatives. According to *Reuters*, the IP address associated with the DNC hack is similar to one used for the DCCC hack. Clinton’s campaign systems were also targeted but not breached.

Then, on the eve of the Democratic National Convention, Wikileaks posted emails obtained via the hack of the DNC. Wikileaks founder Julian Assange refused to divulge who provided the emails, but Russia was the prime suspect from the jump, at least according to Clinton staffers. The campaign pointed the finger at the Russians, arguing that intelligence officials there are trying to

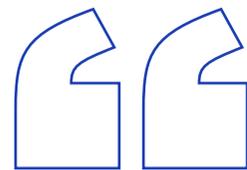


smear Clinton in an effort to elect Donald Trump, who has had an interesting relationship with Putin over the years and is seen as more sympathetic to issues important to Russia. Republican Rep. Michael McCaul said in September that the Republican National Committee had also been hacked, but a spokesman denied it, and McCaul later said he had misspoken.

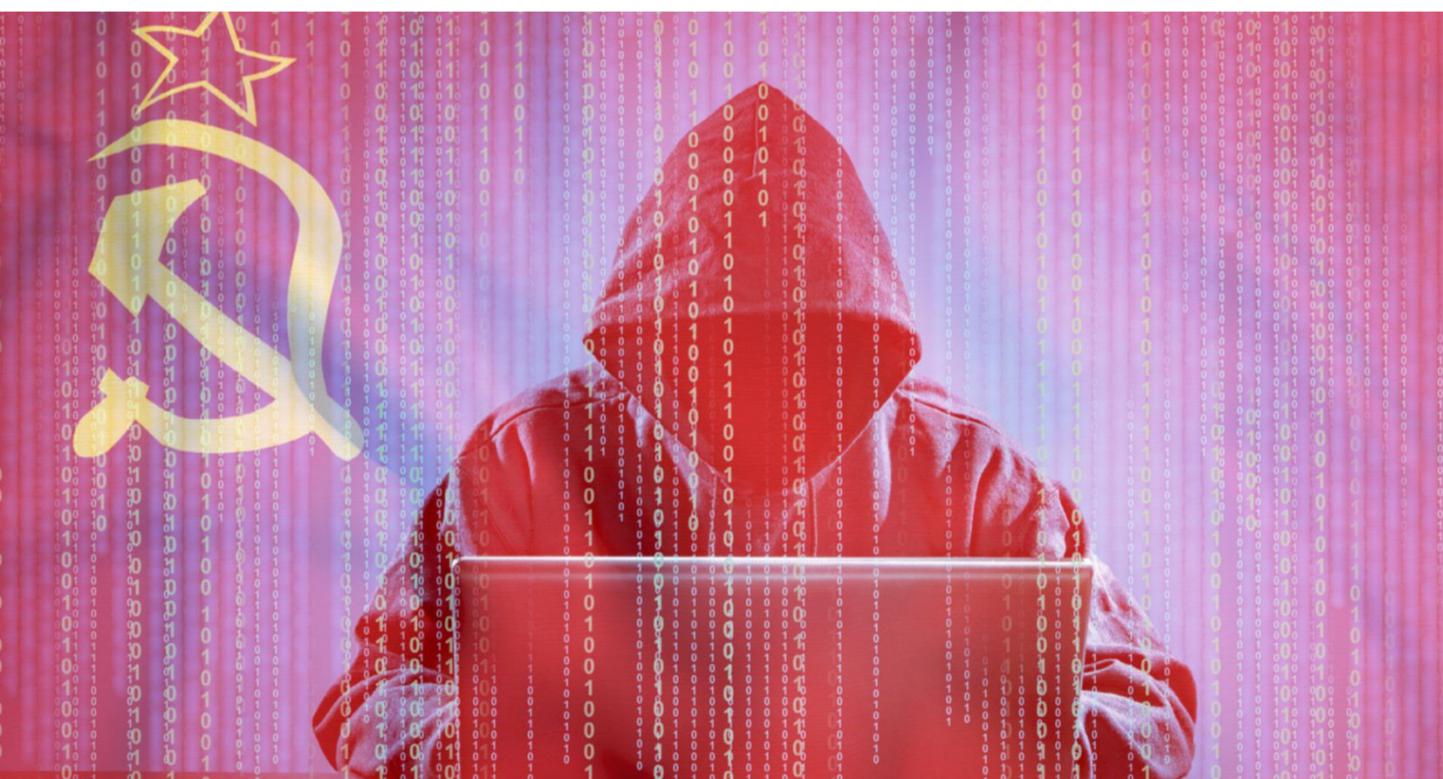
When asked by *Bloomberg* last month whether Russia was behind the DNC hack, Putin denied it. “I don’t know anything about that,” he said in a translated statement. Skilled hackers can hide “their activity as that of some other hackers from other territories or countries. It’s an extremely difficult thing to check, if it’s even possible to check.”

Putin, however, slyly questioned why people were up in arms. “Does it even matter who hacked this data from the campaign headquarters of Mrs. Clinton? Is that really important? The important thing is the content that was given to the public,” he suggested.

When asked who he’d like to see in the Oval Office, Putin was coy. “I would like to work with a person who can make responsible decisions and implement any agreements that we reach. Of course, it’s necessary for that person to enjoy the trust of the American people,” Putin asserted. “That’s why we never interfered, don’t



When asked by *Bloomberg* last month whether Russia was behind the DNC hack, Putin denied it.



MORE ATTACKS

Adding fuel to the fire, *Newsweek*’s website was recently hit with a huge DDoS attack after publishing a story about Trump’s alleged violation of the Cuban embargo.

intervene and try not to intervene in domestic political processes.”

U.S. officials don't buy it. “We're doing an awful lot of work through our counterintelligence investigators to understand just what mischief is Russia up to in connection with our election,” FBI Director Comey told Congress. At the very least, hackers are “poking around,” he said.

Trump, meanwhile, is not ready to place the blame on Russia—at least not for the DNC hacks. “I don't think anybody knows it was Russia who broke into the DNC,” he said at the first debate “She's saying Russia, Russia, Russia but I don't ... maybe it was. I mean, it could be Russia. But it could also be China. It could also be lots of other people. It could be someone sitting on their bed that weighs 400 pounds, okay? You don't know who broke into DNC.”

And at the second debate, Trump questioned whether the breaches even took place. “She doesn't know if it's the Russians doing the hacking,” Trump said of Clinton. “Maybe there is no hacking.”

In an October 3 speech to retired military personnel, however, Trump acknowledged that “cyber attacks from foreign governments, especially China, Russia, North Korea, along with non-state terrorist actors and organized criminal groups, constitute one of our most critical national security concerns.

Trump's reluctance to place blame is not surprising; why would he want to stop the release of potentially damaging documents about his opponent? But he's also not doing himself any favors by praising Putin (“he is really very much of a leader”) or hiring campaign staffers and experts with ties to Russia.

Adding fuel to the fire, *Newsweek's* website was recently hit with a huge DDoS attack after publishing a story about Trump's alleged violation of the Cuban embargo. The investigation is ongoing, but an editor says the attack may be linked to a Russian IP address.

We'll see what happens come November 8. Until then, the Department of Homeland Security is encouraging state election officials to contact the agency if they want a cyber-security checkup ahead of Election Day. As of October 1, 21 states had taken the offer.



CLINTON VS. TRUMP

WHERE THEY STAND ON TECHNOLOGY

The two major-party candidates for the U.S. presidency have made clear their stands on our country's major issues. We pulled together synopses of how each intends to deal with current matters in **technology**. BY CHLOE ALBANESIUS



INTERNET GOVERNANCE

Clinton supports handing over control of the Web's governing body to the nonprofit Internet Corporation for Assigned Names and Numbers (ICANN). The transition, which occurred on October 1, ends Commerce Department oversight that was intended to be temporary but has dragged on for years. Clinton says she views the transition "as a critical step towards safeguarding the Internet's openness for future generations."

"Internet freedom will be lost for good" if the transition happens, Trump argued prior to the switch. "There will be no way to make [the Internet] great again once it is lost," according to a spokesman, who pushed Congress to intervene.



CYBER-SECURITY

Clinton wants to expand on President Obama's Cybersecurity National Action Plan. She supports having a federal Chief Information Security Advisor, the modernization of federal IT systems, and upgrades to government-wide cybersecurity. That includes multi-factor authentication for federal systems, the use of tools such as government bug bounties, and "government red teams" that will work to identify and fix bugs before hackers exploit them. Clinton "supports expanded investment in cybersecurity technologies, as well as public-private collaboration on cybersecurity innovation, responsible information sharing on cyber threats, and accelerated adoption of best practices."

Trump says "improving cyber security will be an immediate and top priority for my administration." He will direct the Justice Department to "create a joint task force" with federal, state, and local law enforcement "to crush this still-developing area of crime." A "cyber-review team" will also audit existing government IT systems and establish a training program for government employees.



CYBER WARFARE

“We need to make it very clear, whether it’s Russia, China, Iran, or anybody else, the United States has much greater capacity, and we are not going to sit idly by and permit state actors to go after our information; our private sector information or our public sector information,” Clinton said at the first presidential debate. “We don’t want to engage in a different kind of warfare, but we will defend the citizens of this country.” Clinton’s ISIS attack plan “does involve going after them online,” she said. “I think we need to do much more with our tech companies to prevent ISIS and their operatives from being able to use the Internet to radicalize, even direct people in our country and Europe and elsewhere.”

Trump supports the U.S. having the “unquestioned capacity to launch crippling cyber counter attacks” and calls on the U.S. to “turn cyber warfare into one of our greatest weapons against the terrorists.” He will also direct his Secretary of Defense and Joint Chiefs “to present recommendations for strengthening and augmenting our Cyber Command.”



VISAS FOR SKILLED WORKERS

“Far too often, we require talented persons from other countries who are trained in U.S. universities to return home, rather than stay in here and continue to contribute to our economy,” Clinton says on her campaign website. She’s in favor of giving green cards to those who earn STEM masters and PhDs from accredited institutions. She would also issue startup visas to international entrepreneurs who start businesses in the U.S., provided they get financial backing from U.S. VCs and create a certain number of jobs. She has voiced concern, however, about U.S. companies that hire foreign workers just to save money, even if a U.S. worker is available.

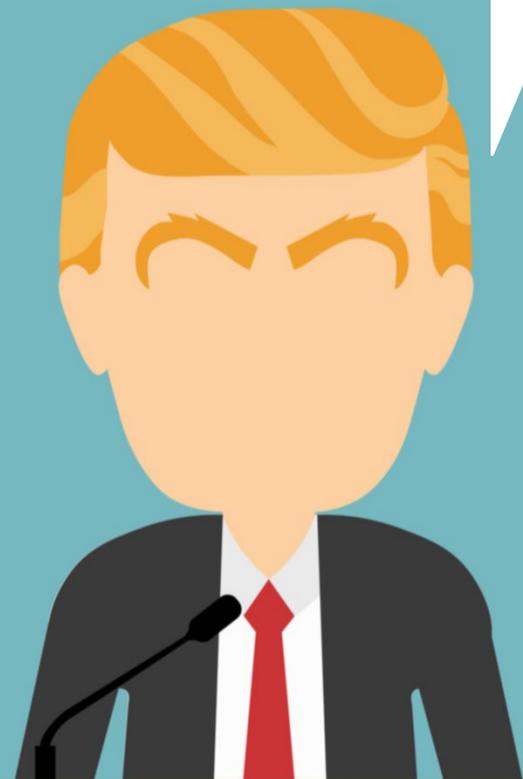
In a March 3 debate Trump said, “We absolutely have to be able to keep the brain power in this country,” when asked about the H-1B visa program for highly skilled workers. He later said that “the H-1B program is neither high-skilled nor immigration,” but serves to import foreign workers who can be paid less. “I remain totally committed to eliminating rampant, widespread H-1B abuse.” U.S. companies should be required “to hire American workers first for every visa and immigration program,” he said.



INTERNET FREEDOM

As Secretary of State, Clinton identified Internet freedom as a major policy principle for the U.S. As president, “she will oppose efforts to block or degrade Internet access or to shut down social media, and she will stand with like-minded countries against efforts by countries like China or Russia to create a balkanized Internet run by governments.”

During a December debate, Trump said he was open to closing parts of the Internet. “I would certainly be open to closing areas where we are at war with somebody. I sure as hell don’t want to let people who want to kill us and kill our nation use our Internet,” Trump said. “ISIS is using the Internet better than we are using the Internet and it was our idea.”



NET NEUTRALITY

Like President Obama, Clinton has been a strong supporter of net neutrality. “The government has an obligation to protect the open Internet,” she says. Clinton vows to defend the FCC’s rules in court and continue to enforce them.

Like many of his fellow Republicans, Trump is not a fan of the FCC’s net neutrality rules. After President Obama pushed the agency to reclassify broadband as a telecom service in November 2014, Trump tweeted that the move was “another top-down power grab.”



COMPUTER SCIENCE EDUCATION

Clinton backs President Obama's push to offer more computer science classes in U.S. schools and wants to train an additional 50,000 computer science teachers in the next 10 years. She also supports grants that would allow for innovative approaches to STEM education, such as maker spaces, robotics competitions, and after-school programs.

When asked by ScienceDebate.org how we prepare students for 21st century jobs, particularly those in STEM, Trump did not directly answer the question, instead arguing that control of schools should be at the state and federal level, not in the hands of the Education Department.



FEATURES



BY ROB MARVIN

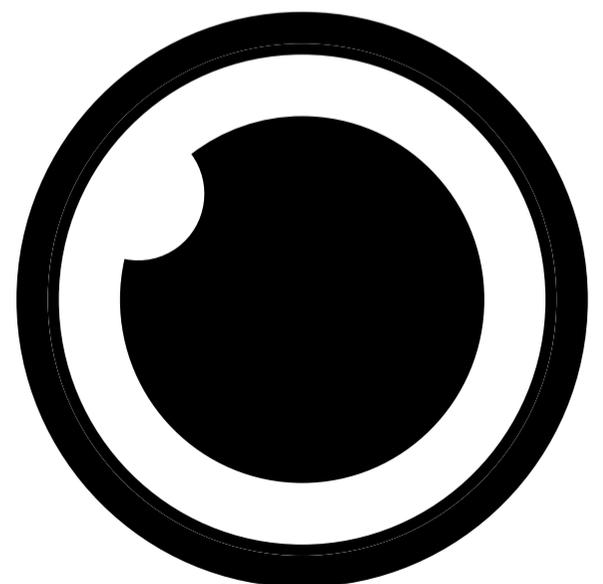
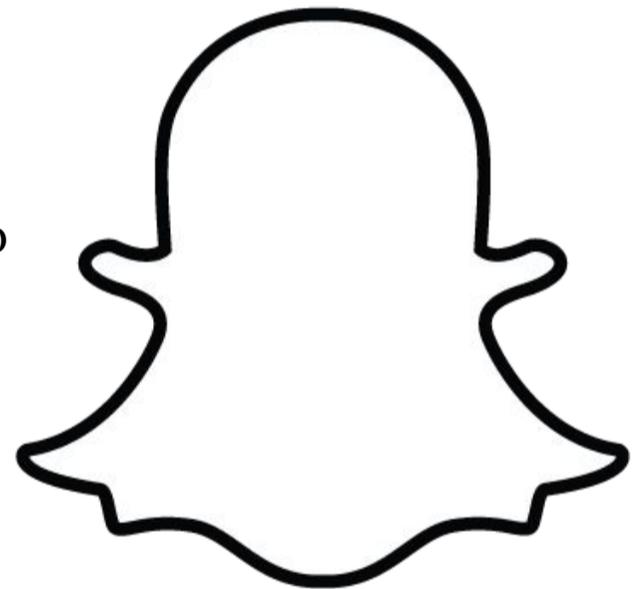
Snapchat is no longer just an app. In fact, the company isn't even called Snapchat anymore. The newly rebranded Snap Inc. has officially moved into the hardware business, announcing its \$130 Spectacles, a pair of colorful sunglasses with a built-in camera for recording 10-second, first-person videos with the tap of a button.

The Snap portfolio now includes two products: Snapchat and the Spectacles wearable, broadening the startup's marketability beyond the traditional software-only definition of social media. But after years of user growth and much trial and error, a long-term business model is finally coming into focus while Snap's user base continues to expand. In a keynote during Advertising Week in New York in October, Snap Chief Strategy Officer (CSO) Imran Khan stated that the company now has more than 60 million daily active users in the U.S. and Canada, about a third of the 175 million counted by Facebook in the region.

Snap plans to generate revenue through a three-pronged strategy: native advertising with between-snap ads and sponsored geofilters; content generation through My Story, Live Stories, and its news-focused Discover tab; and now, hardware sales with the Spectacles. When you look at the rebranded Snap Inc. website, the first description you see is: "Snap Inc. is a camera company."

SPECTACLES: THE NEXT BIG-KIDS TOY CRAZE?

Snap Spectacles are coming sometime this fall, according to *The Wall Street Journal*, and the smart money would be on a launch right around the holiday season. Snap CEO Evan Spiegel referred to Spectacles as a "toy," and that's no accident. The moment I saw them, I thought, every kid will be wearing one of these next summer.

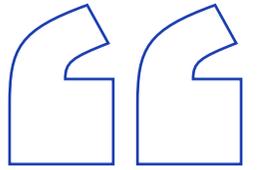


Spectacles are coming to market at the right place, time, and price to make for an ideal viral toy geared at the connected-kids generation. At \$129.99, they're priced more similarly to the Sphero BB-8 App-Enabled Droid than to other AR headsets, such as the failed \$1,500 Google Glass. Rather than starting top-down with a complex, expensive piece of hardware, Snap is starting with the basics: cheap glasses with one simple feature (for now).

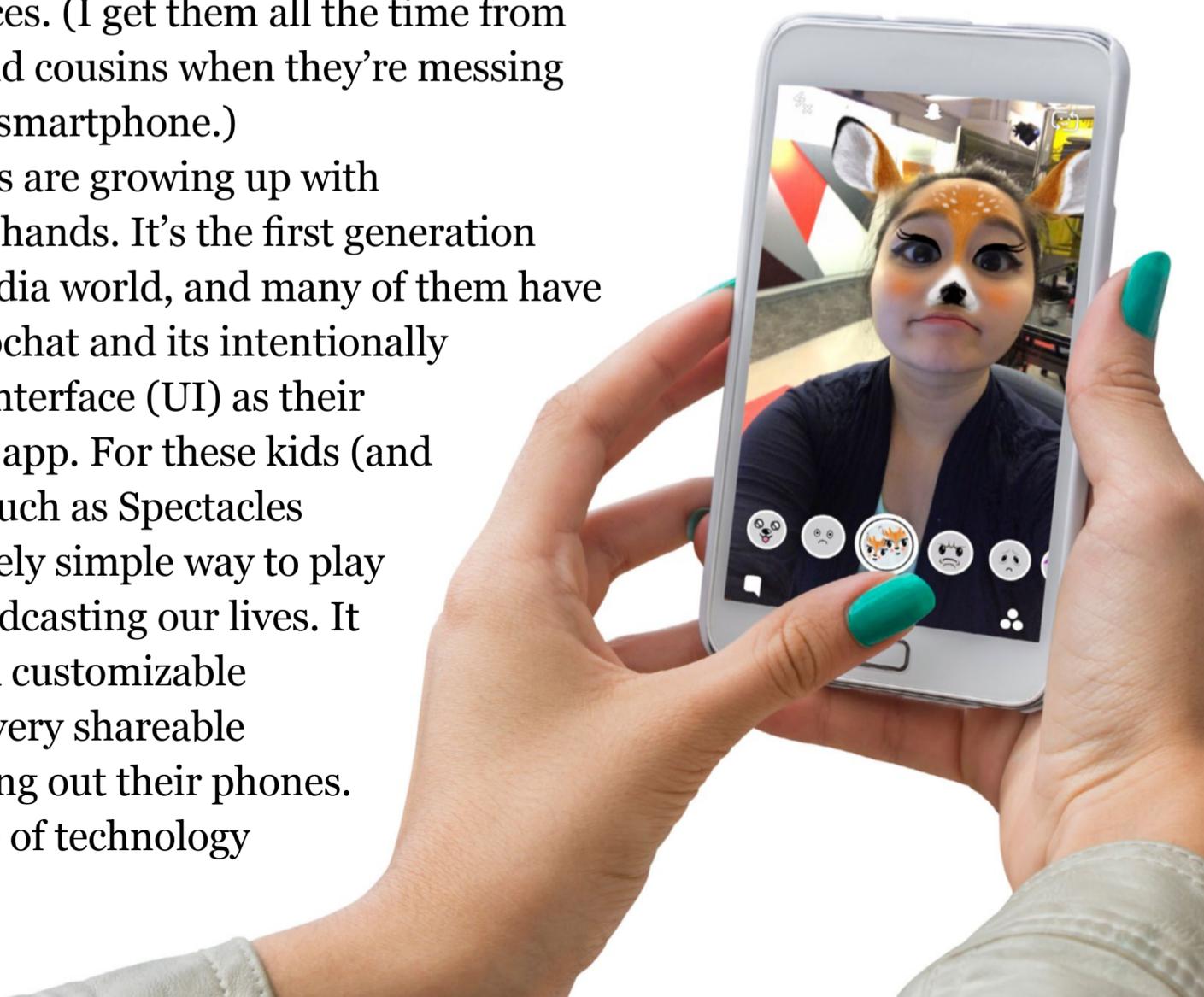
The company has long recognized that its key audience is in its teens or even younger. Snapchat owns that coveted advertising and marketing demographic, with 23 percent of the company's more than 150 million users between ages 13 and 17, 37 percent between ages 18 and 24, and 26 percent between ages 25 and 34, according to Statista.

Those numbers don't even count children younger than 13, a segment the company targets with a program called Snapkidz that allows children to record and save their own snaps to a sandbox without the ability to send. Kids are also spending plenty of time on their parents' Snapchats, swiping through animated filters and making funny faces. (I get them all the time from my 10- and 11-year-old cousins when they're messing around on my aunt's smartphone.)

More and more kids are growing up with smartphones in their hands. It's the first generation born into a social-media world, and many of them have already taken to Snapchat and its intentionally difficult-to-use user interface (UI) as their primary social media app. For these kids (and their parents), a toy such as Spectacles represents a deceptively simple way to play into the trend of broadcasting our lives. It gives kids and teens a customizable accessory to record every shareable moment without taking out their phones. Spectacles are a piece of technology



Spectacles are coming to market at the right place, time, and price to make for an ideal viral toy.



designed expressly for our “pics or it didn’t happen” culture.

The other part of the product’s marketability, particularly for the children and teen toy market, is customization. To start, the glasses will be offered in black, teal, or coral. But if Spectacles take off, the company will likely expand the color and style catalog to something resembling Warby Parker’s. Accessorizing is a tried-and-tested aspect of the toy market, from action figures to dolls. Kids want to customize their toys and then show them off to their friends.

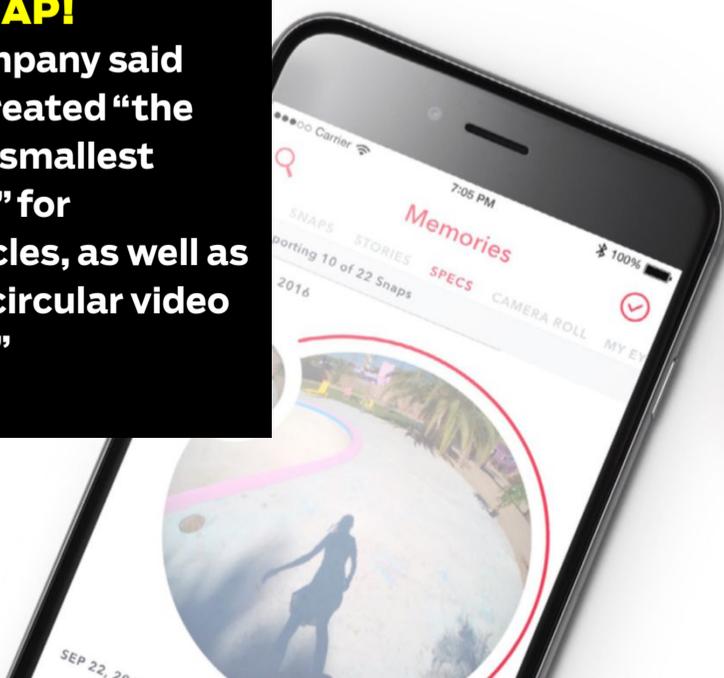
A bigger question about what Spiegel called a “slow approach to rolling [Spectacles] out” is whether we might see the glasses in stores, in addition to online sales. To really appeal to the children’s toy market, kids need to see them on shelves and bug their parents to buy them until they relent. The parents who ultimately buy a pair of Spectacles get to hand their kids a memory-capturing machine. Kids aren’t the only ones who want to document their lives, and the glasses capture Snapchat Memories in “circular video format” with a 115-degree field of view, connected back to the Snapchat app via Bluetooth or Wi-Fi.

Will adults wear them? In the “capture every moment” action-camera space, one player already owns the lion’s share of the market, and its name is GoPro. Snapchat’s hardware didn’t come out of nowhere, because GoPro already set the precedent for creating social-focused video content. Snapchat is undercutting GoPro on price—GoPro’s main camera starts at \$199 but other models go well north of \$399. Still, facing off with GoPro in the wearable action-camera market will be a far tougher obstacle than entering the kids’ toy market market, where the company’s target audience is already using its platform.

Don’t be surprised if we begin to see commercials on both TV and Snapchat itself around the holidays, with some of the app’s mega-stars, maybe DJ Khaled or Kim Kardashian, sporting decked-out pairs of Spectacles. But even if I’m wrong and the glasses bomb, this is only the first connected hardware product for Snap Inc. as the startup transitions away from being just an app.

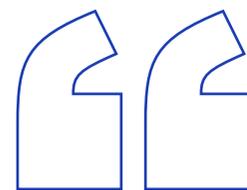
OH, SNAP!

The company said it has created “the world’s smallest camera” for Spectacles, as well as a new “circular video format.”



GEOFILTERS AND SNAPCHAT'S QUESTIONABLE DECISION-MAKING

Snap Inc. is diversifying its product portfolio with Spectacles. This is a major gamble, and hardware production in particular is fraught with obstacles, from manufacturing to shipping, for startups that have never done it before—not to mention taking on an established competitor like GoPro. But if the product turns out to be a hit, it could position Snap as a startup-turned-tech-giant success story along the lines of its one-time suitor, Facebook. The company is finally figuring out how to make money with its coveted millennial demographic in a multitude of ways that, for the most part, don't turn off its user base.



The company is finally figuring out how to make money with its coveted millennial demographic in a multitude of ways.



SPECTACULAR

Snapchat's first hardware product, spectacles, are action-camera eyewear.

Snapchat's growth hasn't come without controversy. Beyond whether Snap Inc. will make the successful transition into consumer hardware and augmented reality (AR), the company also needs to prove it won't alienate its user base. After it released a string of controversial geofilters over the past few months, a question remained about how Snapchat will handle the responsibility borne by the growing sway its platform holds over culture at large.

Geofilters are another major pillar of Snapchat's monetization strategy, and regional geofilters have

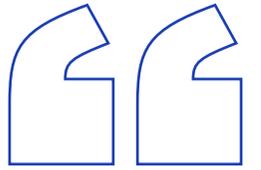
become a popular advertising tool in the past year. For an active user, geofilters are one of the most enjoyable features of Snapchat. They give you that exclusive feeling of showing people that you're in a particular place or at an exclusive event.

Geofilters are available on a number of levels, from user-submitted “community” geofilters for cities and neighborhoods to custom geo-fenced filters people pay for during parties, events, and weddings. Aside from brands, the primary election season was rife with candidates—among them, Hillary Clinton, Bernie Sanders, and Ted Cruz—buying regional filters for specific campaign stops and events. Geofilters are becoming a preferred form of Snapchat-native advertising, often adding dynamic effects and even music to entice users to choose that filter and send that brand's logo to everyone in their Snap stories.

Then Donald Trump's campaign released a national “Crooked Hillary” geofilter ahead of the first presidential debate. The first-ever national geofilter, a milestone for Snapchat's advertising efforts, was a Trump attack ad. This is one of those “with great power comes great responsibility” moments for Snap Inc.

The more success the company finds, particularly with the millennial demographic and younger generations to come, the more responsibility the company holds for how its business and technology decisions impact culture. After its Bob Marley 4/20 filter inadvertently promoted blackface, and its “yellowface filter” brought another wave of well-deserved criticism this past August, choosing a Trump ad as the first national filter could have been perceived as an ugly third strike. Spectacles and the Snap Inc. rebrand represent Snapchat finally figuring out the kind of business and technology company it wants to be and revealing the first steps on its roadmap to get there.

At the same time, the company with the number-one app for millennials also needs to decide on the kind of



The first-ever national geofilter, a milestone for Snapchat's advertising efforts, was a Trump attack ad.



message it wants to send. By approving Trump's ad as the first national filter, Snapchat gave a direct platform outlet to a candidate who has publicly promoted bigoted and racist views. Is that the message Snapchat wants to send to those 60 million daily active users?

A DIFFERENT KIND OF SILICON VALLEY BUSINESS MODEL

In the context of the Snap Inc. rebrand, Spectacles show how Snapchat is doing things differently. Snapchat didn't take the \$3 billion Facebook buyout it was offered in 2013, risking Facebook's wrath and now a string of feature ripoffs on Facebook and Instagram. The startup also didn't go for an initial public offering (IPO) before its products and monetization strategy were ready (I'm lookin' at you, Twitter). Instead, Snapchat recently closed on a massive Series F funding round of \$1.8 billion. The startup has thus far raised \$2.3 billion in venture capital (VC) funding and was valued at more than \$20 billion even before announcing Spectacles.

Spiegel spoke about Snapchat's three-pronged business model at Recode's Code Conference last year. The part that sticks out in retrospect is his focus on the camera as Snapchat's core business: "Content is one part of the three businesses that comprise Snapchat," said Spiegel. "If we take a step back and look at what Snapchat is, it all starts with the camera."

Lately, most of the cogs in Snapchat's business model have begun to churn. The company has begun making more and more money from traditional



streams such as native advertising in between stories, with users spending an average of 25 to 30 minutes in the app. Aside from the growing ad revenue and content revenue from Snapchat's Discover tab, which displays dedicated channels with stories from partnered media brands, the Snapchat Partners program is turning geofilters into the other huge revenue driver for Snapchat.

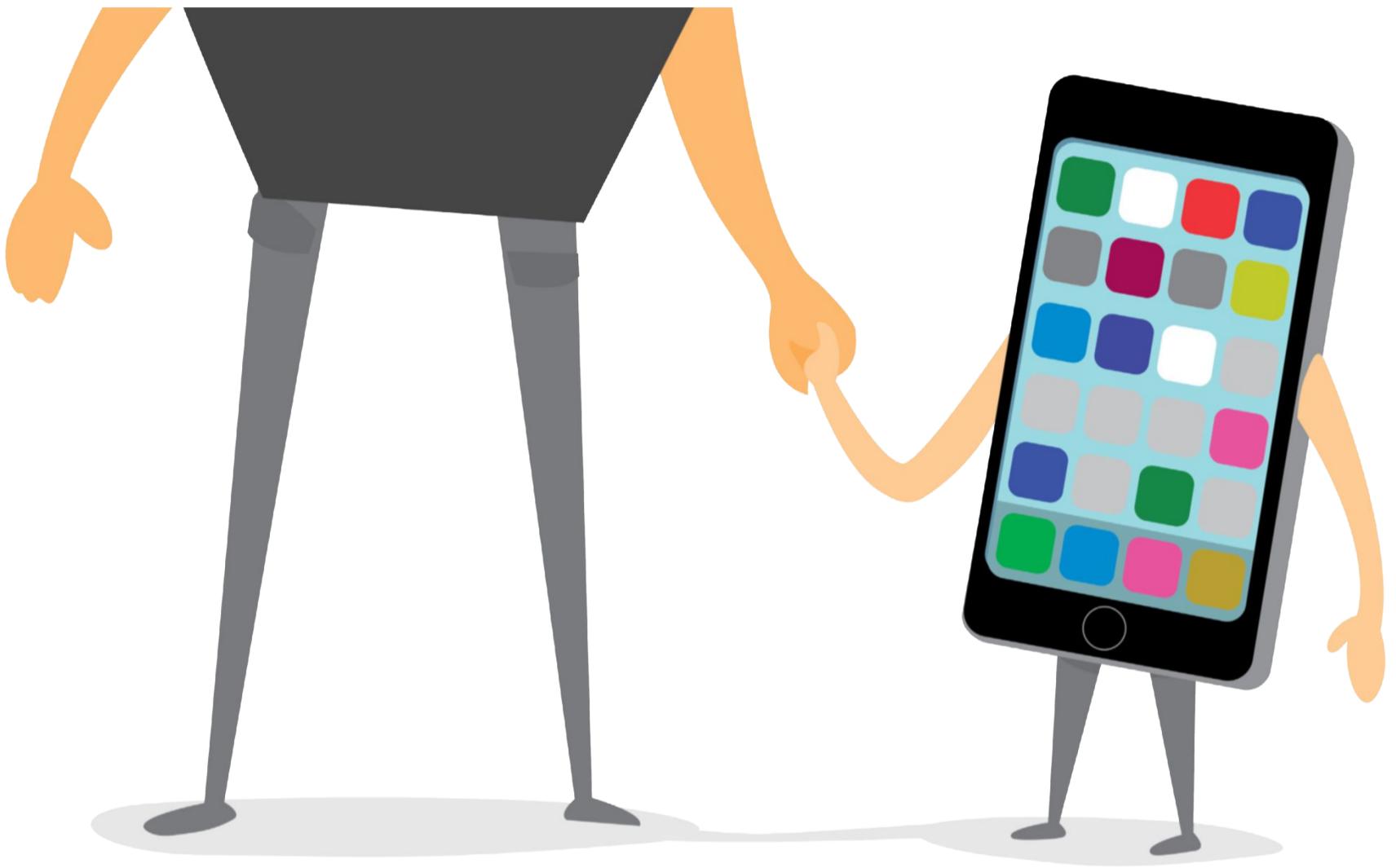
On-demand geofilters, particularly at the regional and now national level, are core to turning the native advertising arm of Snap's business model into the consistent profit generator to complement its ambitious AR hardware play. Geofilters have also become a necessary lens through which to examine Snap Inc.'s judgment, and the image it wants to put forth as a startup with a rapidly rising profile.

The business question around Snapchat has always been how, when, and if it could build a profitable business with its young user base and ephemeral experience. The announcement of Spectacles and Snap Inc. as "a camera company" is Spiegel finally showing his hand. If Snap Inc. does look at putting forth an IPO sooner rather than later, then the startup is positioning itself with three strong pillars of revenue on which to stand.



Make Your Old iPhone Feel New Again

BY JILL DUFFY



Upgrading is tempting. A new phone promises more than just a shiny new gadget: It's a do-over moment. With a new phone, we tell ourselves, we will take better photos, have more storage space, and from that moment forward, be more organized with the device. Sometimes, though, we get distracted by what's new and forget to focus on what we need.

Apple iPhone owners who are considering jumping to the iPhone 7 or 7 Plus might first ask themselves whether they're making the most of the phones they have now. Does your current phone already meet your needs? Are you getting out of it what you thought you would when it was the shiny new upgrade model? And what about all you people who got the 6s and 6s Plus, who aren't due for upgrades? How can you recapture that sense of excitement about your no-longer cutting-edge handset?

Extending the life of your current phone may buy you some time, help you reach the end of your contract, and even save you some money. It might also extend the life of those nice headphones you purchased. I'm (half) joking about the new iPhone models' lack of a standard headphone jack.

If you think your current phone might have a little life left in it, here are some ways to help extend that life by doing some minor cleanup and restoration work.

FREE UP STORAGE SPACE

If your iPhone's tight on space, check your storage space to first figure out if there are any unnecessary hogs. Often the culprits are photos, videos, and music. Chances are good that you'll need to do this anyhow before you upgrade to iOS 10—and it might alone help make your older phone feel new again.



The easiest way to free up space taken by photos and videos is to offload them to a cloud storage service, such as Dropbox. When you move your photos to Dropbox or some other provider, be sure to install that company's app on your phone so that you can still get to your pictures easily. Once you've moved the photos to a new location, you can delete them from your phone.



How can you recapture that sense of excitement about your no-longer cutting-edge handset?



PERSONAL SPACE

Offload some of those many photos and videos to a cloud storage service and delete them from your phone.

Important: Be sure to empty the Recently Deleted folder in the Photos app. A lot of people miss this step and don't see any gains in their space for a month!

Music is a little bit trickier to handle, although with such good music streaming services available now, there's less of a need to keep music files on the phone. If you move your music files to a cloud storage service, you'll still be able to download them or stream them when you want to hear those tracks.

TRY NEW APPS

Now that you've freed up some storage space by deleting old stuff, maybe it's time to fill at least some of it back up again with new stuff. Have you just been sticking with the same old apps for the past year or two? There are many thousands of new ones for you to try. You can teach your old phone some new tricks with a fresh app or two.

Delete apps you don't use, too. That's easier said than done, I know, but think of it as phone hygiene.

TAKE BETTER IPHONE PHOTOS

A better camera has long been one of the most attractive reasons to upgrade from one iPhone to the next. But before you blame the camera for your poor photos, ask whether you know all the ins and outs of taking a decent shot in the first place. Here are some very simple tricks to learn with the iPhone camera that will help you take better pictures.

The simplest one—and forgive me for how simple it is, but some people might not yet know—is to tell the camera where to focus before taking a photo. Press your finger on the screen where you want the point of focus to be. In many cases, the exposure will change as you move the focus, too. Try it out a few times before snapping the pictures.



FOCUS ON THIS

Before you take a photo, make sure you focus on your subject—don't just trust the phone to know what it is!

Another easy way to take better photos is to use the HDR setting. It's right at the top of the interface when you open the camera app. HDR stands for high dynamic range. It balances out the shadows and highlights of a photo by taking three pictures in quick succession and then merging them into one. It's really important to hold still while taking HDR photos.

Last, you may need to clean the camera lens. You can use compressed air and a microfiber cloth to clean off the exterior lens casing. If that doesn't help, you might need to take your phone apart to clean the inside. You'll need a Pentalobe screwdriver, two suction cups, some compressed air, and a lens-cleaning device that's small enough for a smartphone (Lenspen makes one).

If taking apart your phone sounds scary, ask a mobile phone repair shop to do this task for you. Paying someone a few bucks to clean your phone's camera lens is still several hundred dollars cheaper than what it would cost to get a new phone. Make sure to consider the state of your warranty, of course, but that probably isn't an issue for older phones.

MINOR MAINTENANCE

Other small matters of maintenance can bring back some life to your phone. For example, I keep a microfiber cloth in my bag so that I can wipe my phone screen clean often.

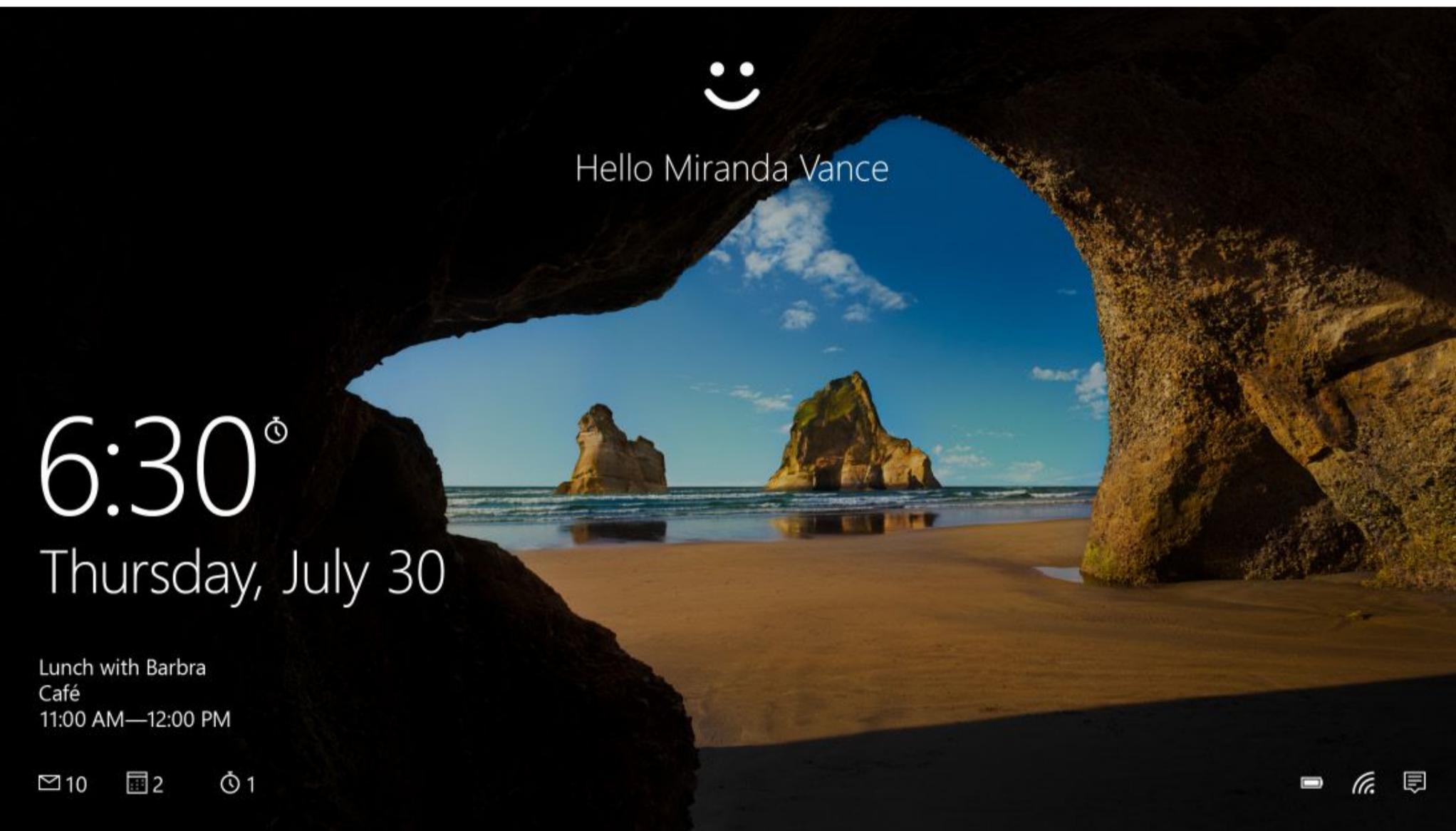
You can also clean the headphone jack and Lightning connection jack by pulling off most of the cotton from a cotton swab (to make it smaller) and putting a tiny dab of rubbing alcohol on what's left of it. Roll that around inside the connection points to help clear out any lint that may have become lodged inside. Do not use alcohol anywhere on the screen, though.

Finally, treat yourself to a new case and screen protector. Those will also help extend the life of your phone by minimizing damage.



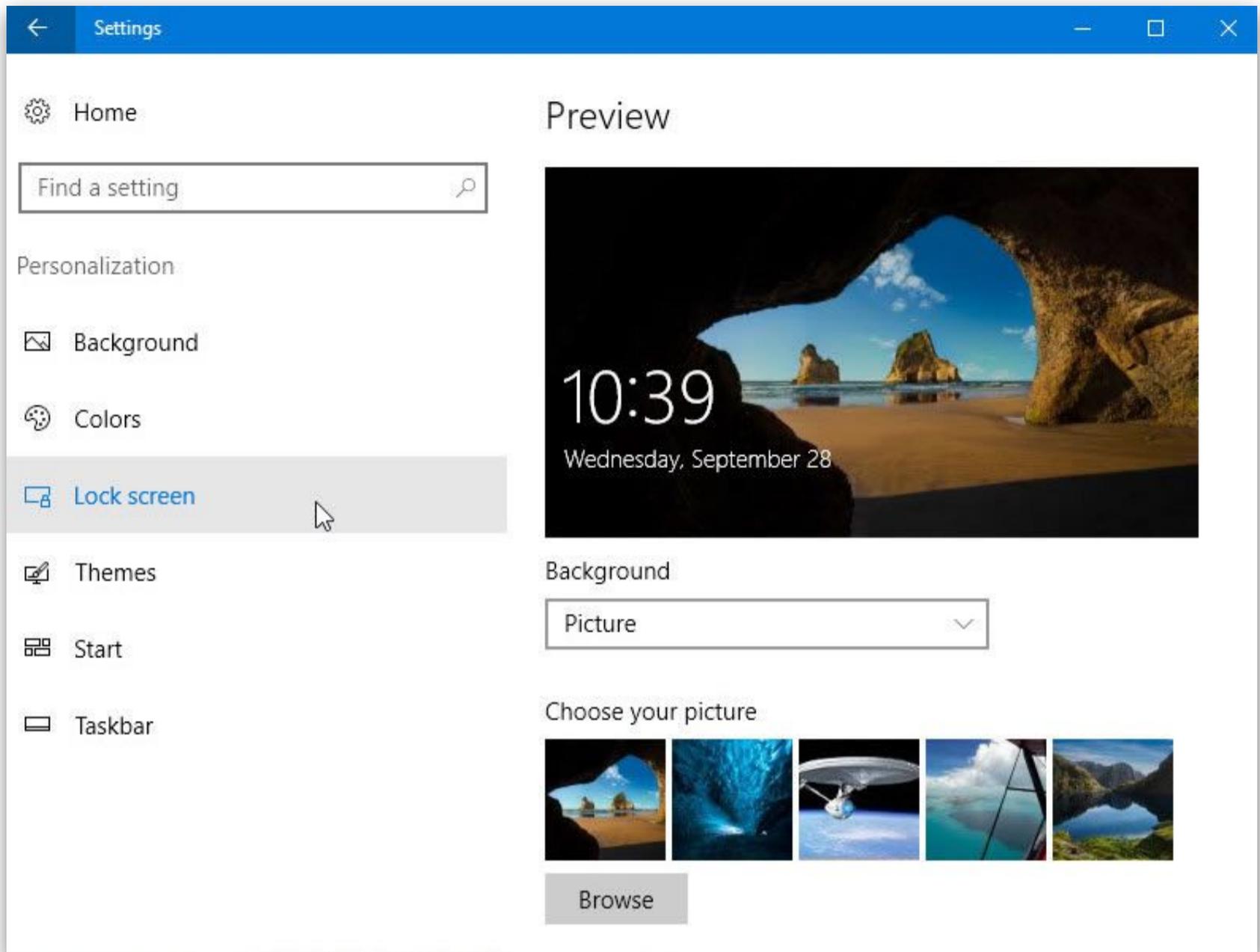
Use and Tweak Your Windows 10 Lock Screen

BY LANCE WHITNEY



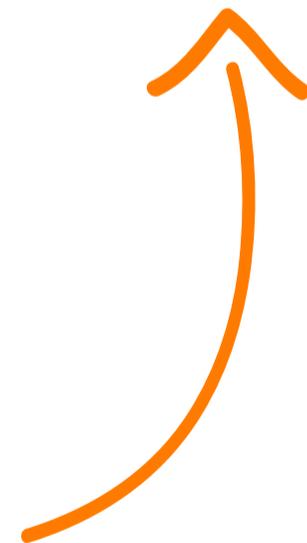
The first item that greets you when you fire up Windows 10 is the Lock screen. Clicking or tapping on it brings you to the sign-in screen, where you log into Windows. The Lock screen might seem unnecessary, but it offers some tidbits that can be useful before you even launch Windows.

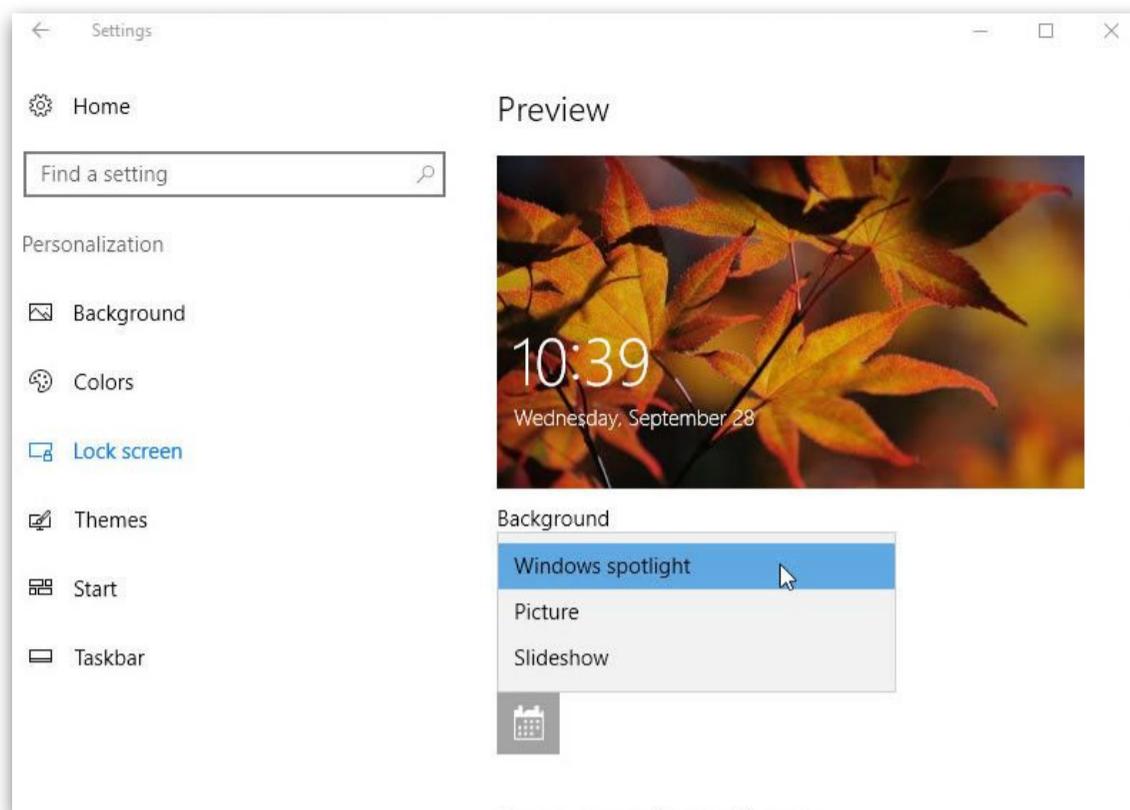
From the Lock screen, you can view information from certain apps. You can also chat with Cortana, if you've installed the new Windows 10 Anniversary update. And you can customize the screen with your favorite background image or slideshow.



To tweak the Lock screen within Windows 10, click the Start button, then click on the Settings icon. (For those of you who've installed the Windows 10 Anniversary update, the Settings icon looks like a small gear.) From the Settings screen, click on the category for Personalization, then click on the setting for Lock screen.

The first thing to do is pick a background image for the Lock screen. Click on the drop-down menu under Background. Let's choose Windows Spotlight.

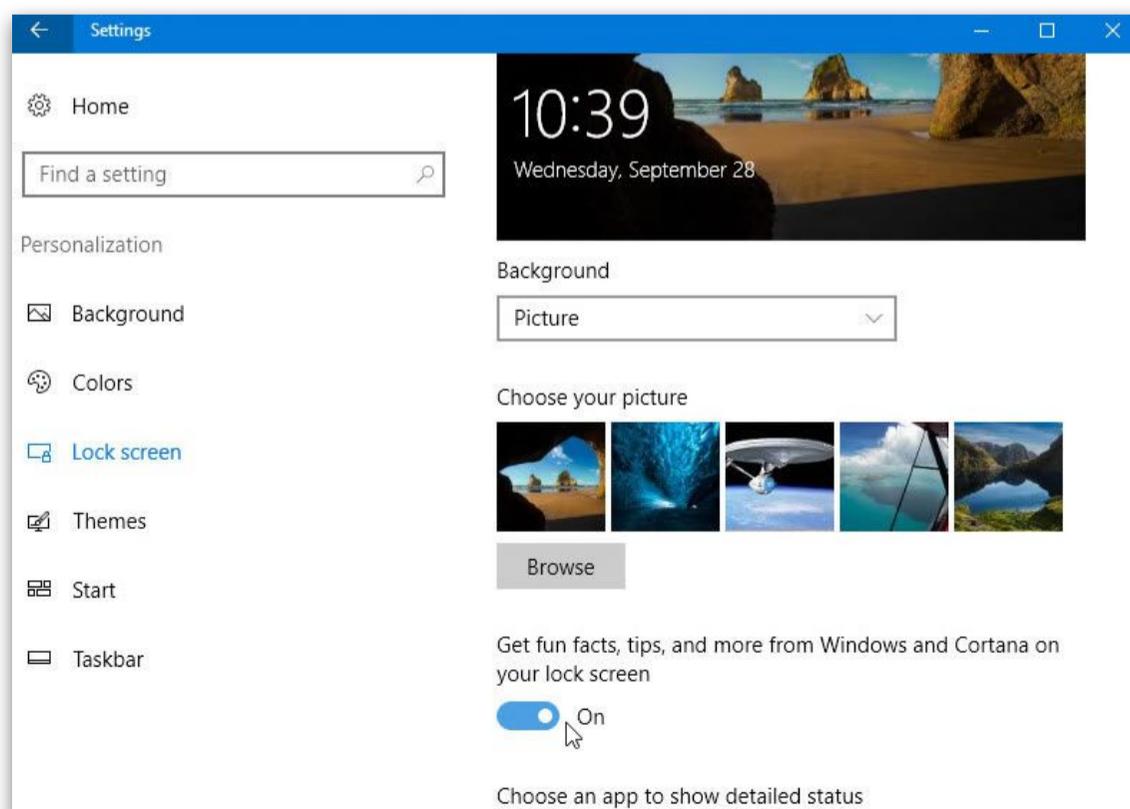


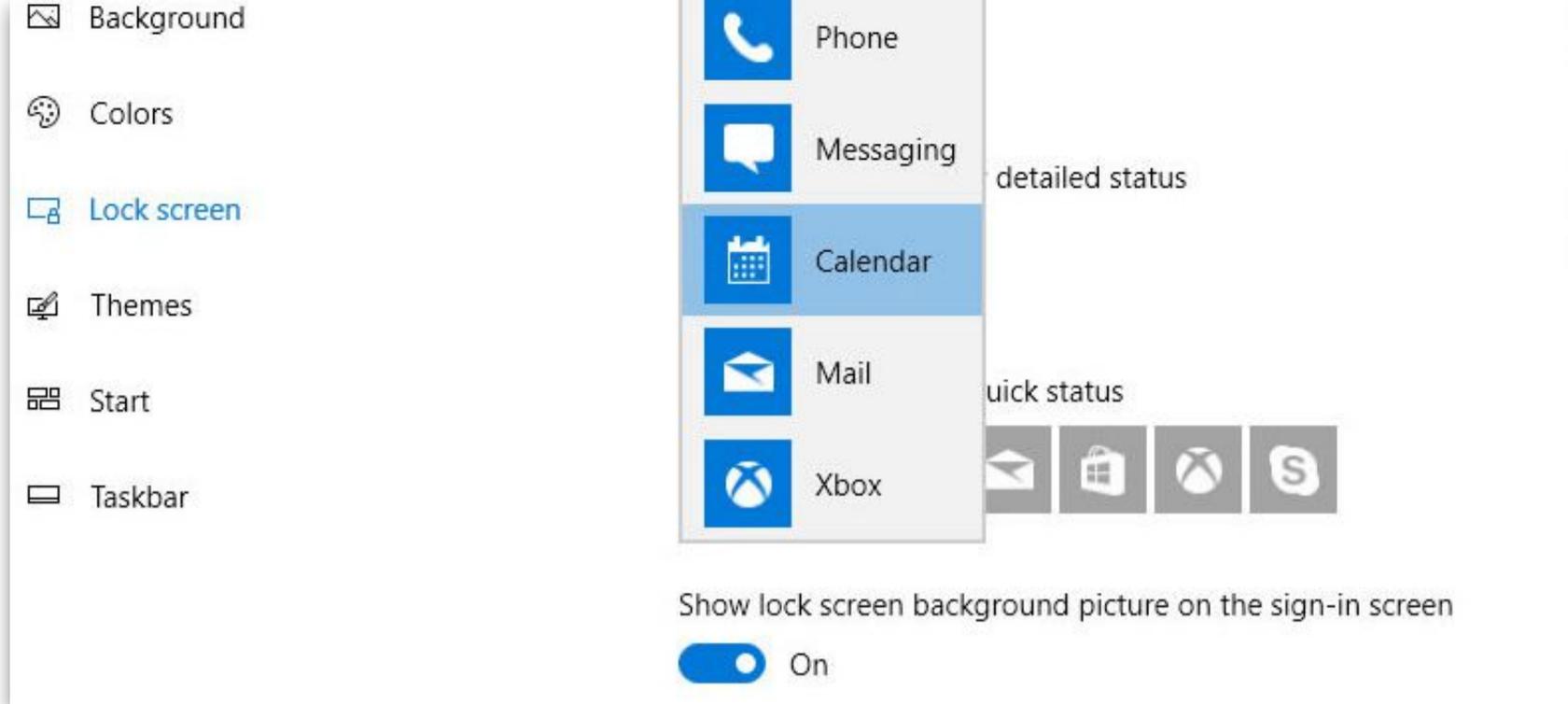


The spotlight option displays a different image periodically, and you get to vote on which images you like. Windows asks if you like or dislike a certain image to try to learn your preferences, and it then displays images that might strike your fancy.

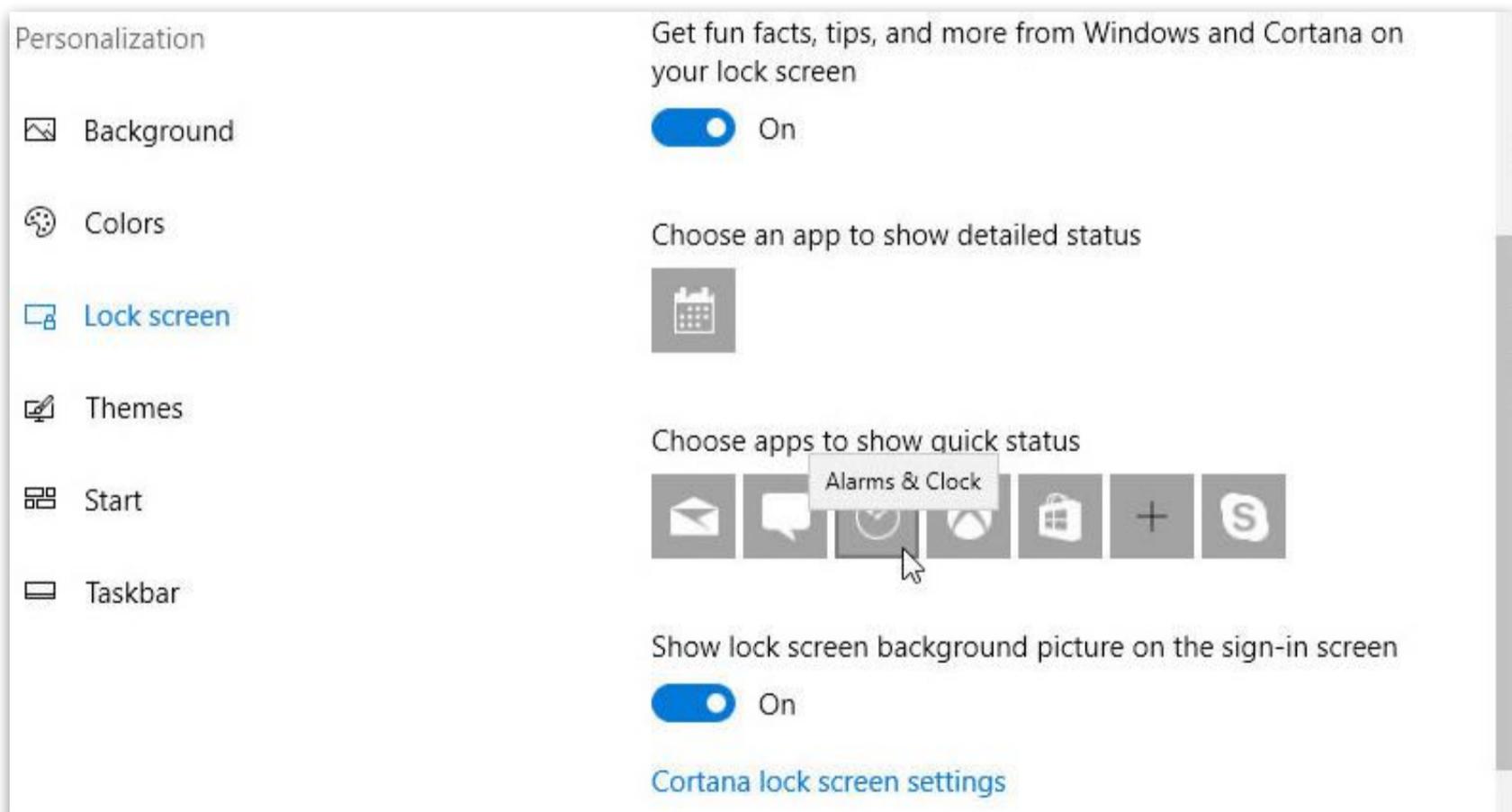
The second option for Picture lets you choose a picture from one of the thumbnail images displayed. Or you can click on the Browse button to choose an image of your own. And the third option for Slideshow lets you choose multiple images that segue from one to another, to play a slideshow on your Lock screen.

The next option lets you display tips and other information about Windows and Cortana on your Lock screen. This option is available only when you set your background image as a picture.

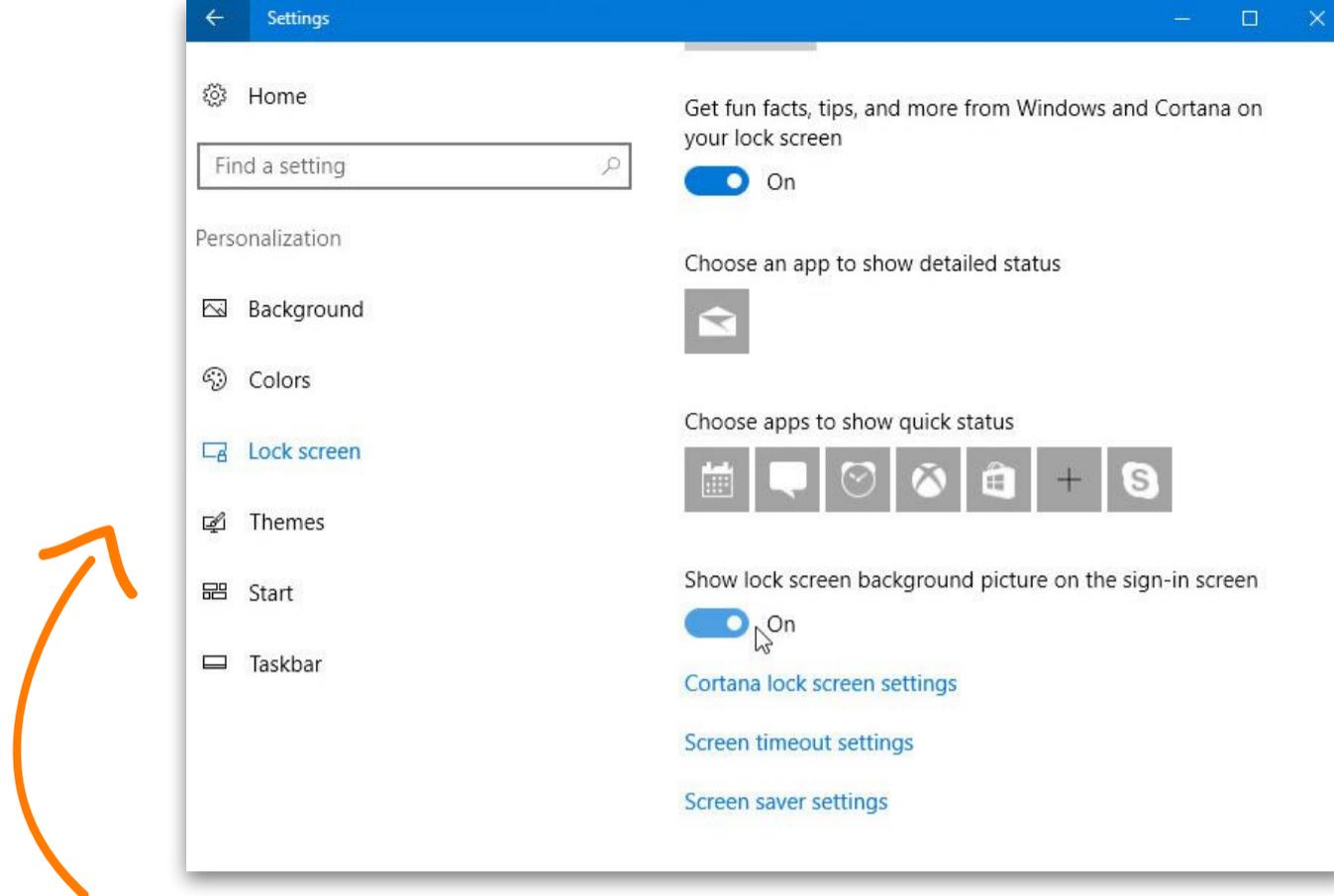




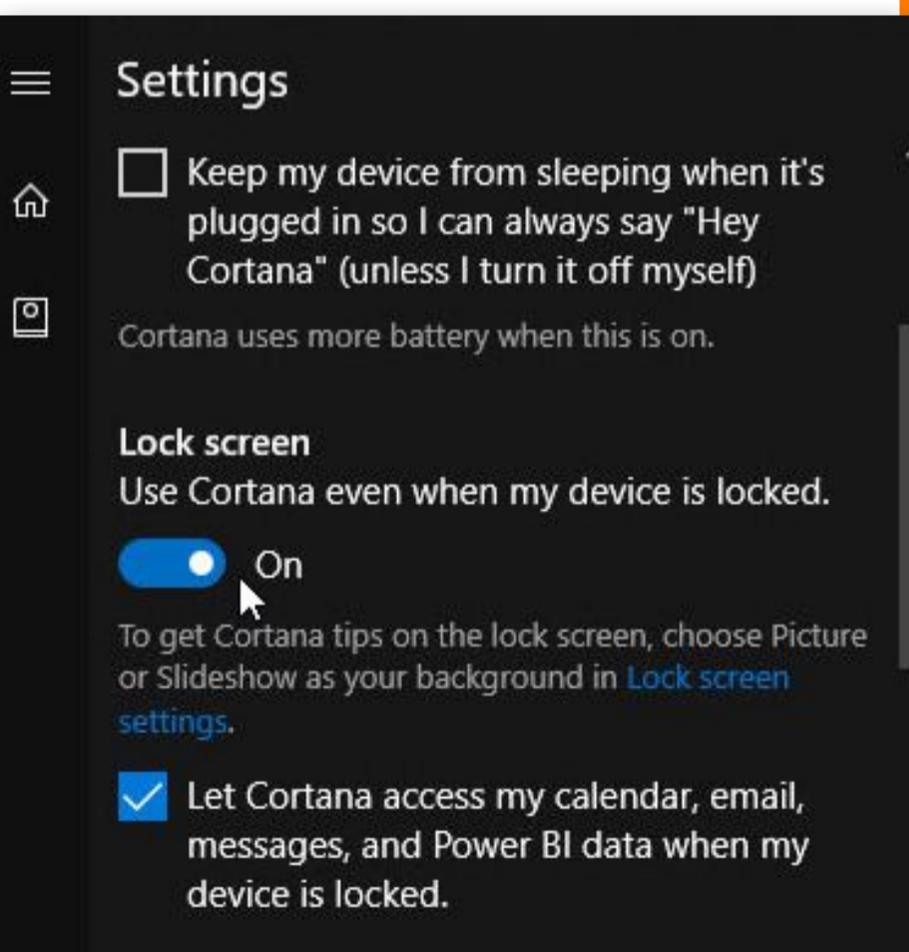
Next, you can choose an app to see specific details from it on the Lock screen. Click on the icon under the phrase “Choose an app to show detailed status.” You can opt to see details from Weather, Messaging, Calendar, and Mail, among other apps. For example, choosing Calendar might show you an appointment scheduled today, and choosing Weather might display the current temperature.



You can also choose several apps to display a quick status, which simply means fewer details. Click on each icon under the phrase “Choose apps to show quick status.” Select such apps as Weather, Messaging, and Calendar as well as Alarms & Clock, Mail, and Windows Store.



The next time the Lock screen pops up, you should see information from the apps you chose. When you're happy with your Lock screen image, you can keep the same one for your sign-in screen. Just turn on the next option to "Show lock screen background picture on the sign-in screen."

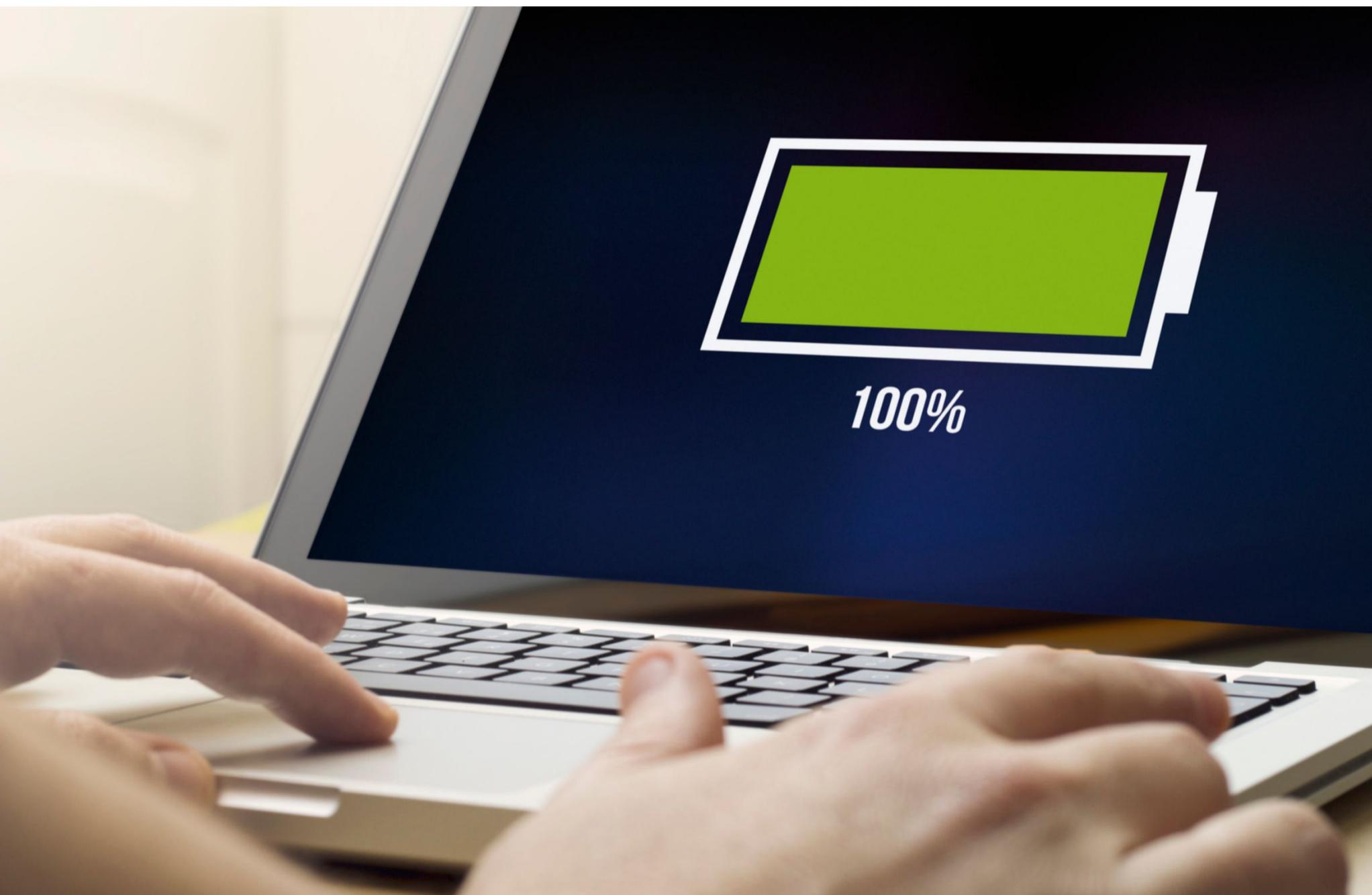


Finally, the coolest option of all may be the ability to chat with Cortana at the Lock screen without having to log in. Just click on the link labeled "Cortana lock screen settings." The Cortana settings pane appears, displaying this option: "Use Cortana even when my device is locked." Make sure that setting is enabled, and you'll be able to say, "Hey Cortana" and ask a question or issue a command to Microsoft's voice assistant right from the Lock screen. This option is available only if you've installed the Windows 10 Anniversary update.

Scroll down a bit farther, and you can also turn on an option to "Let Cortana manage my calendar, email, messages, and Power BI data when my device is locked."

9 Ways to Help Your Laptop Battery Last Longer

BY MATTHEW MURRAY, BRIAN WESTOVER



We've all been there. You're in a meeting, or on the road, or in a classroom, and you find, to your horror, that your laptop is nearly dead. But don't despair: You can buy more time on that almost-dead battery to meet a deadline or respond to an important email. Some of these techniques are for when you need to stretch your battery at that very moment; others are preventive measures, best implemented before your battery life comes up short.

SHORT-TERM BATTERY-STRETCHING STRATEGIES

If you're in a tough spot right now, you can extend battery life immediately. None of these actions will actually increase the amount of power left in the battery but instead will reduce the amount of power the laptop is using, letting you squeeze in a few more precious minutes before the battery goes kaput. The name of the game in these instances is power consumption, and you need to reduce yours to as little as possible.

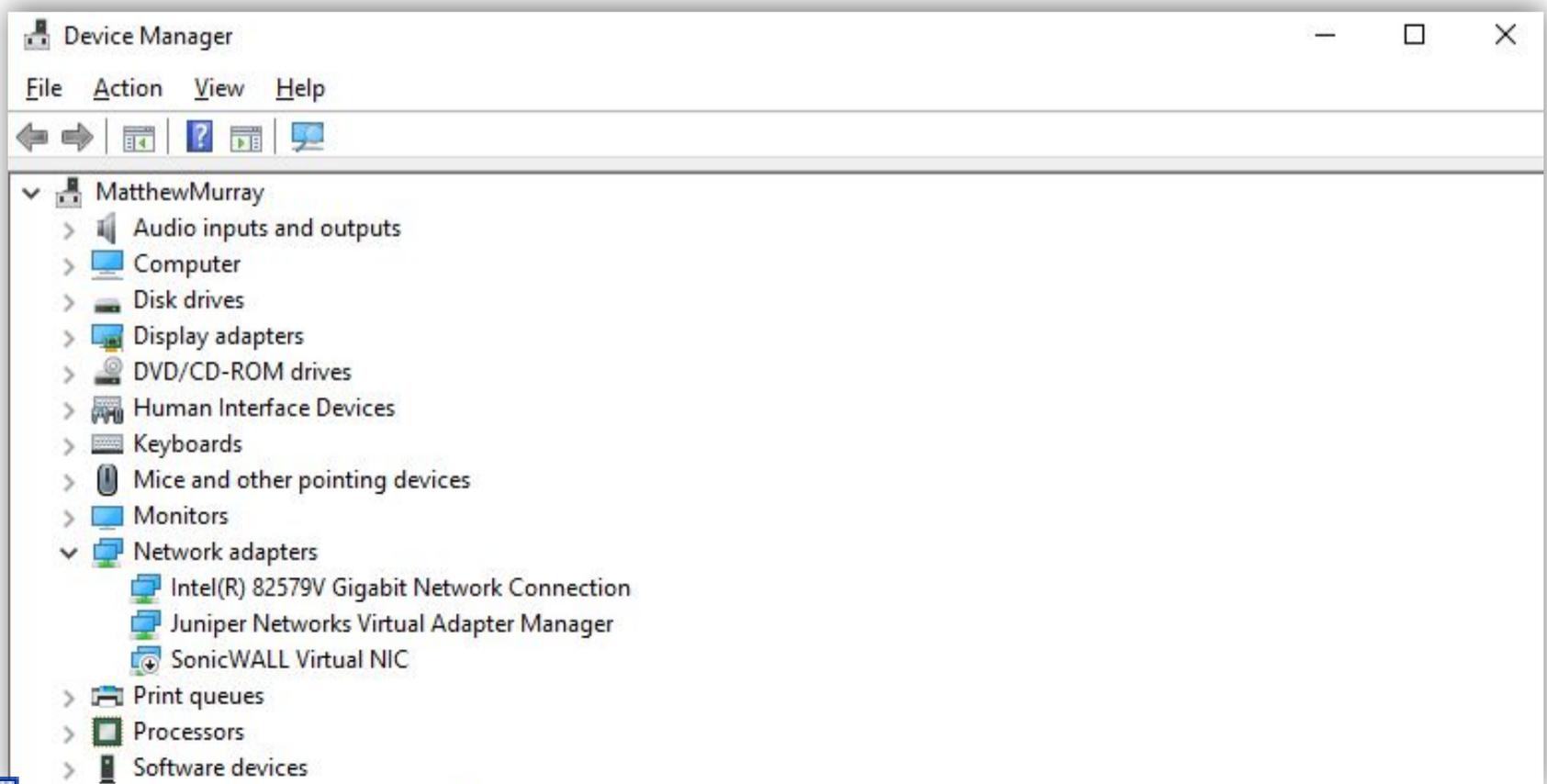
1. Activate your laptop's Battery Saver Mode or Eco Mode

Most Battery-Saver or Eco modes will engage a number of automatic changes to lengthen usable battery life—many of the same changes we'll be making here. This saved profile will adjust your laptop's settings and shift components into low-power states to help you ration your remaining juice a bit longer.

Once you've turned on the battery-saver tool, you can still take plenty of steps to eke out even better efficiency. Try turning off unnecessary devices, adjusting settings to reduce power consumption, shutting down unwanted apps and processes, and adjusting your activities to use less power.



Most Battery-Saver or Eco modes will engage a number of automatic changes to lengthen usable battery life.



2. Disable Unused Devices and Ports

The easiest way to reduce power consumption is to simply turn stuff off. Every component in your laptop needs power to function, but that doesn't mean you need to power all of those components all the time. Start by disconnecting any unneeded peripherals (say, a USB mouse or external drive) and turning off the biggest power hogs, such as Wi-Fi and Bluetooth radios, graphics processors, and unused optical drives.

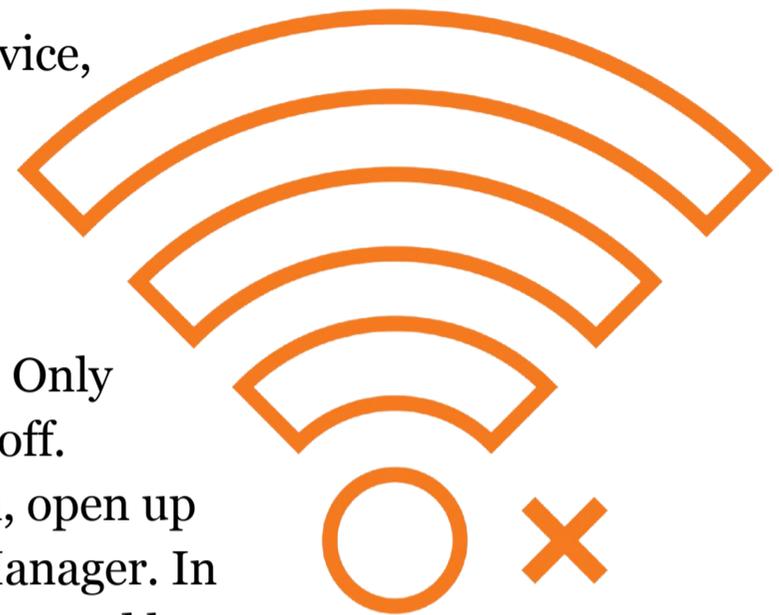
Warning: Before disabling any component or device, stop and make sure that the device is not in use and that it is not essential to continuing operation of the laptop. For example, you do not want to disable the hard drive that houses the operating system or the processor that runs the entire laptop. Only disable those devices you are comfortable turning off.

To disable unused devices on a Windows system, open up your system's Control Panel and find the Device Manager. In the Device Manager, individual components are grouped by category. For example, Network Adapters will often include both the LAN adapter, which provides Ethernet connectivity, and Wi-Fi, for wireless networking.

The four standard candidates for saving power are the graphics card (found under Display Adapters), the optical drive (found under DVD/CD-ROM Drives), and the Ethernet and Wi-Fi adapters (under Network Adapters). Find the device you want to shut down within the relevant category. Right click on the device name, and select "Disable" from the drop down menu.

While you're in the Device Manager, you can also turn off any unused ports. Just like an extension cord left plugged into an outlet, these unused plugs still have power going through them and are losing some in the process. The actual impact on battery life will be minimal, but if you need to eke out another minute or two of life, this will help. Take a quick glance at your ports, and turn off anything that's not being used, such as USB ports with nothing connected to them.

While you can disable USB ports on a Mac using the terminal program, it's something that IT administrators would use to lock down Macs for security purposes. We don't recommend doing it as an end user because it may make your system act up. You can, however, disable Bluetooth and Wi-Fi from the Menu bar at the top of the screen.



3. Adjust Your Settings

Although you'll still have to use the display and the keyboard, you can adjust the settings for each to reduce power consumption. One often-overlooked power drain is keyboard backlighting. Unless you're in the dark and need the backlight to see your keys, turn it off entirely. You can typically assign a hotkey for this function.

The next power drain is your screen. You need to keep it up and running to use the laptop, but you don't necessarily need it running at 100 percent brightness or full resolution. Many laptops have hotkeys for increasing and decreasing the screen brightness, but yours doesn't, it can be adjusted in the control panel. Reducing the display to 50 percent when you're running on battery power can add a significant amount of time.

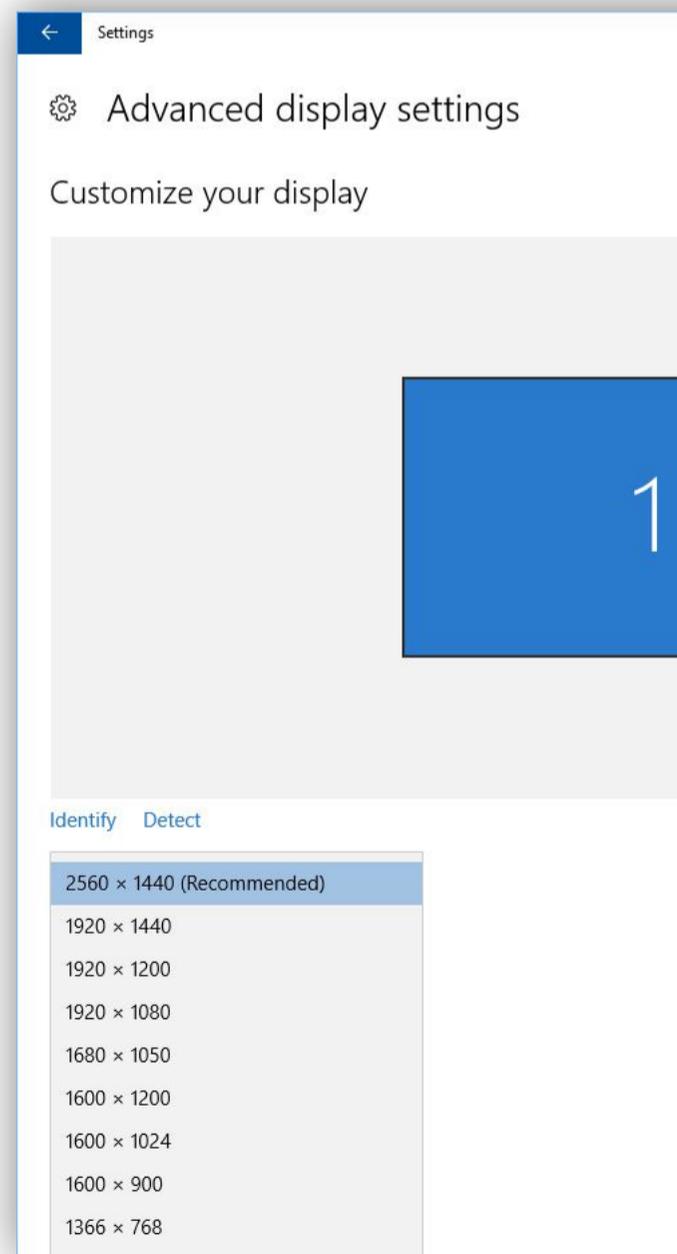
If you're simply typing up a document, you don't need all the detail offered by a 1080p or higher display. Dialing down the screen resolution to a basic 1,366-by-768 resolution or lower reduces the amount of power used in graphics processing without negatively impacting your ability to work.

Finally, turn off or turn down the sound. If you need to hear, drop the sound down as low as you can and consider switching from the laptop's larger speakers to a set of tiny earbuds to get the audio piped right to your ears. Whenever possible, mute the laptop altogether. That way, the speakers won't be getting any power, and you'll buy yourself some more precious time.

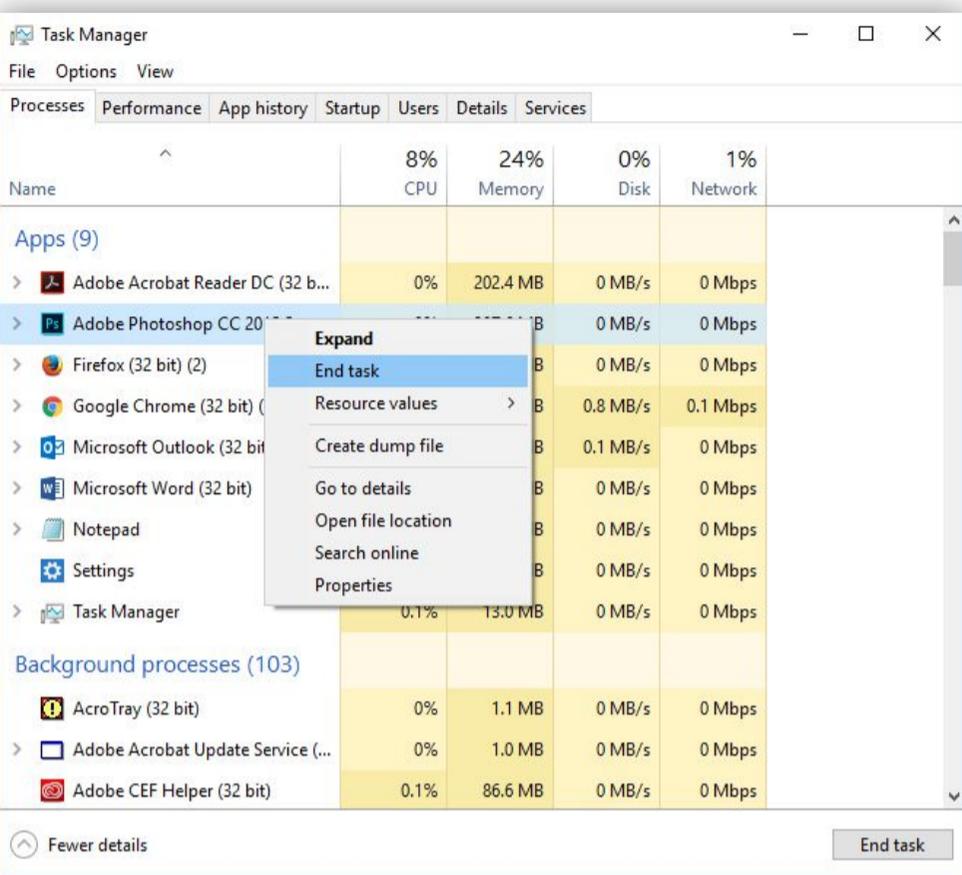
4. Turn Off Apps and Processes

It's not just the hardware that's stealing your battery juice. Multiple apps and processes running on your system will also chew through battery life more quickly. As with the hardware, start by turning off anything that isn't being used.

In Windows, start by taking a look in your System Tray, the collection of icons in the lower right corner



of the desktop, next to the clock. On the left end of the System Tray, select the icon to display hidden icons. Take note of which apps are running in the background.



Open up the Task Manager by pressing Ctrl+Shift+Esc, or use Ctrl+Alt+Del and select Task Manager from the menu. Once in the Task Manager, look at the open apps—you may find that programs have been left running simply because you forgot to close windows instead of minimizing them.

Next, go to the Processes tab. This shows you which processes are currently running on your machine. Some of these are needed, but some, like those associated with music and video players or cloud storage services (Dropbox or Google Drive, for example) can be disabled without causing any problems.

For MacBooks, the process is a little different. Take a look at System Preferences > Users&Groups for a menu called Login Items. Delete any power-hungry programs that you don't need anymore and disable activities such as a browser's automatic launch at startup. You can also see programs that are using a lot of power at any given moment by holding down the Option key and then clicking on the battery indicator in the Menu bar.

Open the Activity Monitor utility to see a list of all the programs and processes currently open and which of these are using the most power. Stop these processes by selecting the program and then clicking the Stop icon. Power Nap is an Apple OS X feature that checks your email and Twitter feeds for activity while the system is asleep. When you are trying to maximize battery life, it would be wise to turn that feature off.

5. Simplify

Stretch your battery life by simplifying your own activities. Multitasking is nice when you have full power, but running several programs at once puts a greater load on the processor and draws more power. Adjust your computer use by sticking to one application at a time and avoiding resource-intensive programs.

Start by single-tasking—when you need to type up a document, close any additional programs. You'll get longer battery life by not running Spotify in the background. When you need to keep some tunes going, switch from streaming media to locally stored songs—you'll still be using some extra power to play them, but streaming media over Wi-Fi also uses the laptop's wireless radio.

You might also benefit from switching to simpler tools for the same tasks, like opting for a simple text file instead of a Word document. With fewer features and none of Word's automatic actions (like Spell Check and Autosave), you can do all the writing you need without using quite so much power. Some activities you'll want to avoid entirely, like photo and video editing tools, which place a significant load on the processor and graphics card, and are real power hogs.

By eliminating unnecessary power uses, you should be able to extend the life of your battery in those moments that you find yourself high and dry.

LONG-TERM STRATEGIES

These tweaks will help turn your system into a lean, mean energy-efficient machine, adding to the useful time you get out of a single charge and extending the lifespan of the battery.

6. Care and Feeding of Batteries

Start with taking care of the battery. If your system has a removable battery, take care not to damage the battery contacts—they connect the laptop to the battery, and when the contacts get dirty or damaged, that can reduce and disrupt the flow of power. Clean the contacts with a cotton swab and rubbing alcohol, but bear in mind that damaged contacts might need to be professionally repaired. This doesn't apply to laptops that seal the battery into the chassis.

You may have heard old tips about charging your battery to only 80 percent, and not leaving it on the charger all the time. But most of that advice is outdated and applies to older nickel metal hydride batteries but not the lithium-ion and lithium-polymer batteries used today. Though modern laptop batteries don't require you to be as conscientious about how and when you charge your battery, you should occasionally take the opportunity to let the battery drain completely through normal use.

Finally, keep things cool. Heat will shorten the long-term life of the battery, so take steps to provide optimal airflow and cooling. The biggest problems come from physical obstruction of the ventilation ports. Dust buildup is one problem, which you can take care of by cleaning the laptop's vents and fan. A can of compressed air can be used to blow out some of the dust. And if you use the

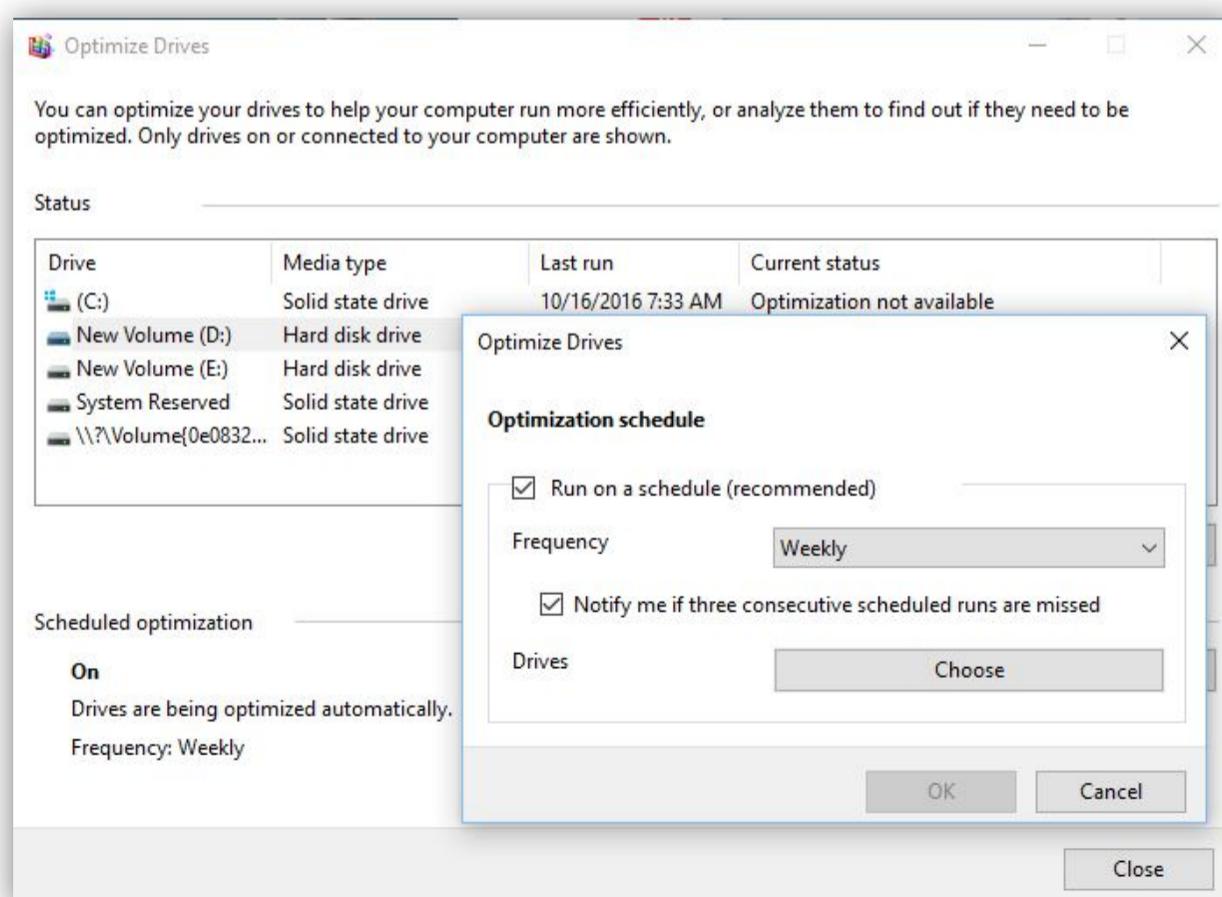
laptop on a pillow or blanket, that can both obstruct the ventilation fan and retain the heat coming off of the system. Use your laptop only on surfaces such as a table or desk. And a lapdesk will make a big difference when you use a laptop in bed.

7. Tune-Up

The next step is keep your laptop tuned up for more efficient use of power. A few simple maintenance tasks and upgrades will not only help your battery last longer but will also result in a faster system.

For starters, regularly defragment your hard drive to make data retrieval more efficient. (Note: Do not try to defrag a solid-state drive, as it will reduce the usable life of the drive.) An active drive uses more energy than an idle one, and defragging your hard drive reduces the amount of active drive time needed to access data. Over time, as you add and remove files from your system, data is haphazardly recorded to the hard drive, scattered in different portions of the drive. Accessing this disorderly (or fragmented) data requires additional time and energy in the course of regular use. Newer versions of Windows have automatic tools that defragment your drive regularly, but you should at least check to be sure that this is enabled and running properly.

Decluttering your drive will also make it more efficient. Practice good computer hygiene and regularly remove unwanted programs, clean out cobwebbed files, and ditch any bloatware that came with your system. Clean out the cache on your Web browser and delete old files from your downloads folder.





8. Upgrade Components

Another option is to ditch the hard drive entirely and upgrade to a solid-state drive (SSD). Solid-state drives use flash memory instead of a spinning disk, so they have no moving parts, which creates more energy efficiency. It also removes the problems associated with fragmentation, which is a larger problem with hard drives. Upgrading to an SSD will both improve your battery life and put some pep in your system, as SSDs offer faster performance and boot times than their traditional counterparts.

Finally, add more RAM to your system. RAM stores data for short-term use in flash modules, much like an SSD. The more data that can be put into RAM, the less reliant the system will be on pulling that data afresh from the hard drive. So adding RAM also has performance benefits you'll notice immediately.

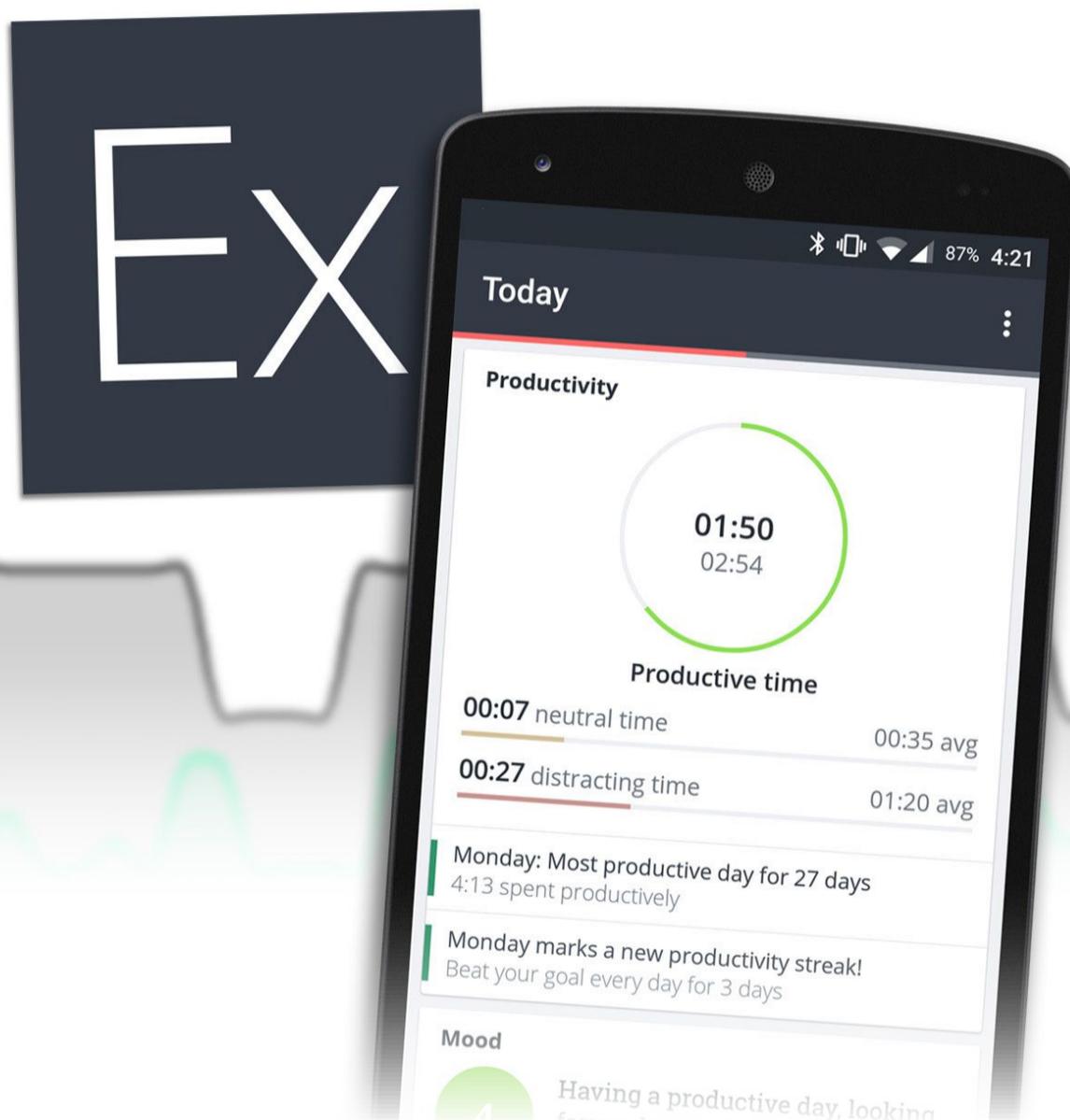
9. Battery Backup

Finally, the easiest way to ensure that you always have enough battery power is to bring along either a spare battery or an external battery pack. For laptops with a removable battery, the simplest option is a second battery. These can either be ordered directly from the manufacturer or purchased from a third-party company, usually for less than \$100. Simply swap the old battery for the new once in a while when charging, and bring along the charged-up spare whenever you expect to be away from a power outlet.

A similar option is an external power pack. These are technically batteries, but they plug into your laptop just like your charger does. They come with adapters for use with many different laptop models and can be reused on more than one system and even for other devices, such as your phone and tablet.

Discover Personal Productivity Strategies With Exist.io

BY JILL DUFFY



Productivity hacks can be fun to read about, but they never carry much weight for me. They're usually made up or based on what some successful CEO does, as if what works for someone who is already successful would also work for the rest of us.

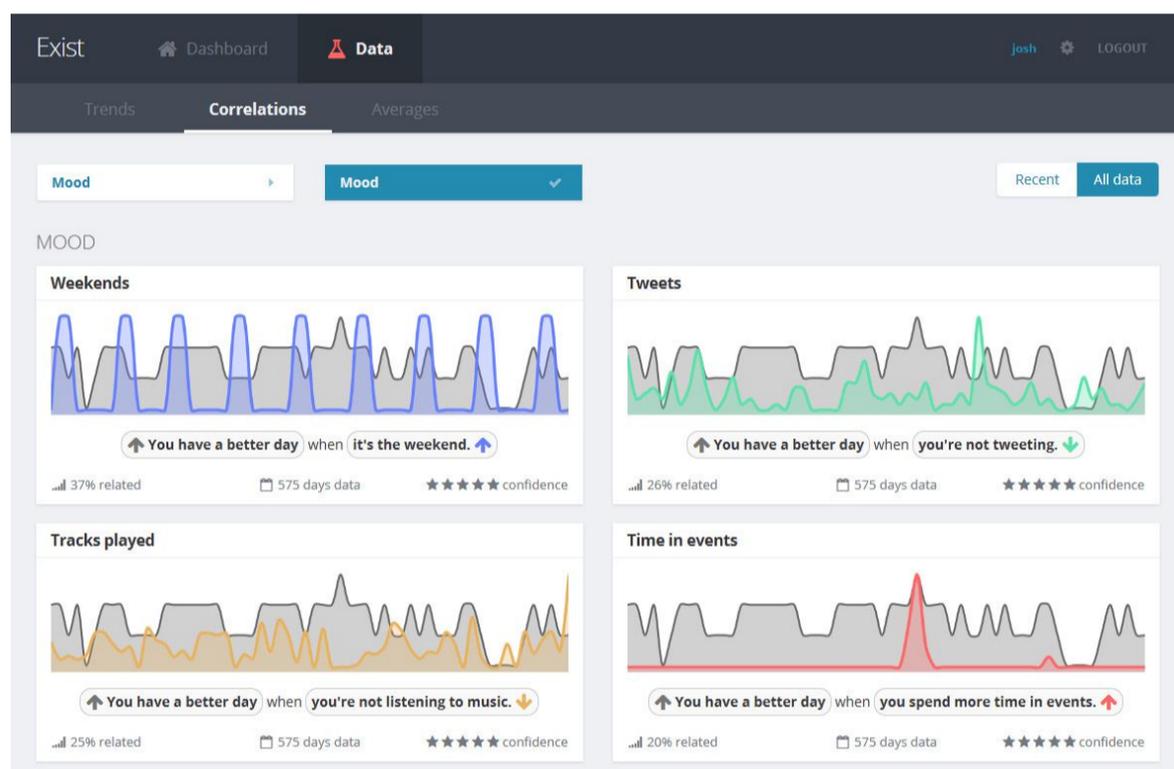
Instead, I advocate looking to two places for productivity tips: first, peer-reviewed research on large numbers of people, and second, personal insights that come from your own data.

IT'S ALL ABOUT YOU

This app makes correlations among things such as your fitness-tracker data and the music you listen to, by looking for correlations between your productivity and things that increase it.

To that second point, an app called Exist.io (a.k.a. Exist) finds patterns in your data for you. The app compiles information you collect about yourself from a variety of sources, such as a fitness tracker and time-tracking software RescueTime, and identifies correlations, trends, and insights. For example, it might tell you, based on RescueTime and other productivity apps, that you get more done when you sleep eight hours the night before.

Exist, which has been around since 2013, supports a decent network of services, so you can find possible links between your productivity and all kinds of other things going on in your life: what kind of music you listen to while working, your weight, and places you go.



WHAT CAN YOU LEARN ABOUT YOUR PRODUCTIVITY?

Josh Sharp, one of Exist's cofounders, has been using the app much longer than I have, and he was kind enough to share a few things he's learned about himself and his cofounder, Belle Beth Cooper, through their data. Sharp is more productive when he listens to music, as tracked by Last.fm. More specifically, he tends to get more done when he listens to Radiohead or Ryan Adams. Cooper completes more tasks when she goes to bed earlier the night before, and she also completes more tasks when she wakes fewer times during the night.



It might tell you, based on RescueTime and other apps, that you get more done when you sleep eight hours the night before.



IN THE MOOD

Exist.io determines correlations among various factors in play when you're feeling good about life.

“We started off thinking that it’s too hard to do all this stuff yourself,” Sharp told me. “We should take advantage of the fact that we can pull all this information together without any effort,” he said, referring to the passive nature of the apps, gadgets, and services used to collect the data.

BUILDING SUPPORT FOR YOUR DATA

Some of these insights are easy to act on. Sharp can make sure to turn on Radiohead when he has a big project that needs to get done, but Cooper might have a harder time figuring out how to sleep soundly through the night, because that’s a tougher change to make.

There’s also a chicken-and-egg issue going on here. Does Sharp tend to turn on Radiohead when he’s about to buckle down and get work done, or is the music what’s causing him to focus on his tasks? With Exist, it’s hard, and in some cases impossible, to isolate factors. That’s something we give up when we use consumer devices that passively collect data and seamlessly fit into our lives. Controlled experiments are very good at isolating factors, but they’re often bad at replicating a natural setting.

In the case of music and productivity, we can turn to peer-reviewed research and find that in controlled settings, listening to music can cause an increase in productivity. So Sharp has more evidence to support the correlation he sees in his own data.

WHAT EXIST.IO TRACKS

Exist tracks more than just productivity and music. Here’s the full list of what’s supported to date:

- Steps, activity, sleep, and weight from fitness trackers: Fitbit, Misfit, Jawbone UP, Withings, Apple Watch
- Activity from other apps: Moves, Runkeeper, Strava, Apple Health, Google Fit
- Productivity: RescueTime, Github (commits), Todoist (tasks completed)
- Events: Google Calendar, iCal
- Location: Swarm by Foursquare
- Weather: Forecast.io, DarkSky
- Music: Last.fm, plus Spotify, Deezer, Apple Music connected via Last.fm
- Social media interactions and activity: Instagram, Twitter

One more type of data you can track is manual rather than collected automatically from a connected source, and that's mood. Sharp told me he initially believed Exist members would not want to rate their mood daily and type a few words about it, but it has turned out to be one of the most used features. To keep tabs on a kind of information that's not supported, such as daily pain for chronic pain sufferers, you could co-opt the mood rating (you can't rename it, though) or type a few notes about your pain into the mood log.

ACTIONABLE INFORMATION

My Exist tracking is still in its early stages, and I probably need a few more weeks of data before I can see true patterns. But already, Exist is confirming some things that I already know about myself, or that are common sense. For example, I spend more time in email when I have fewer events (because when I'm at an event, I'm away from my desk).

I asked Sharp whether he could share any trends that he's seen in aggregate across the Exist community. "Monday is the least productive day of the week," he told me. "In terms of things that make people more productive, music is the biggest one."

He also noted that weather affects productivity: Good weather, meaning clear skies and moderate temperatures, makes people less productive. That correlation has also been supported by peer-reviewed research, where it was found that workers get distracted thinking about all the activities they could be doing outside when the weather is pleasant.

"Our users are also slightly more productive after a better night's sleep," Sharp later told me. "Again, not a groundbreaking discovery," he added.

Even if Exist merely confirms things we already assume to be true, seeing the data can be powerful. This is hard evidence rather than just a hunch, and it's quantified, so you can see whether the results are moderate or strong. It can also guide people with clear and concrete actions they can take to make their day more productive.





Why Google Andromeda Might Be Too Little, Too Late

Recent rumors suggest that Google is working on a new OS, dubbed Andromeda, that will be compatible with Chrome and Android apps. On the surface, it seems like that OS should become a universal replacement for macOS, Windows, Chrome OS, Android, Windows Phone 10, iOS, Linux, and so on. I'm skeptical, though; just look at Google Glass or the screwball (pun intended) Nexus Q.

Here's the Google problem. The company's main revenue stream is advertising generated via search, the success of which allows other departments to fiddle around with so-called moonshots. This makes Google a great place to work—as long as the cash cow keeps generating cash.

Very few moonshots become cash cows. But Google continues to pursue some remarkable inventions and ideas. These include scanning the world's libraries, the ongoing development of Google Maps and Street View, the autonomous car, Google Fiber, and the Android phone OS.

If there were a serious economic downturn, though, I wonder what Google would do to these expensive projects—and to its workforce, to refocus them on the search-engine cash cow. My guess is that this would not be fun to watch.

This exposure is compounded by the company's overall secretiveness. Ian Thompson of *The Register*, for example, mentioned on a podcast that Google would let him ride in an autonomous vehicle but that he couldn't write about it. It's all very Steve Jobs and does prevent competitors from poaching employees. But it can also result in

bungles, because an objective third eye can catch blunders missed by rank-and-file employees who are often afraid to rock the boat.

I'm reminded of Texas Instruments and the 1979 episode involving the rollout of the TI 99/4 Home Computer. In short: The company decided it was going into the home computer business. Rumors about its new killer computer were rampant, but nobody knew anything, because TI kept everything under wraps. That included the media, many of whom were also hobbyists.

When it arrived, TI's machine had no control key, slash key, or question mark key. The company had to dump millions of machines at \$99 to get rid of them. The entire thing was a fiasco.

Google has similar tendencies. I've been advocating for a new OS for a decade or more, but I lost faith in the company when it developed its cloud-based Chrome OS.

Google was active in 1998 and grew during the eras of Windows 98, Windows ME, and then Windows 2000. It had all the time in the world to take on Windows in a real way, but what did we get? Chrome OS—something that relies on an Internet connection and is essentially smart-terminal software circa 1970.

Even the thought of Andromeda is too little, too late; it promises to be another Nexus Q.

A handwritten signature in black ink that reads "John Dvorak". The signature is fluid and cursive, with the first letter of each word being significantly larger and more stylized than the others.

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