PC MAGAZINE

CITIZEN SCIENCE:

DO TRY THIS AT HOME

DIGITAL EDITION
APRIL 2018

PC MAGAZINE

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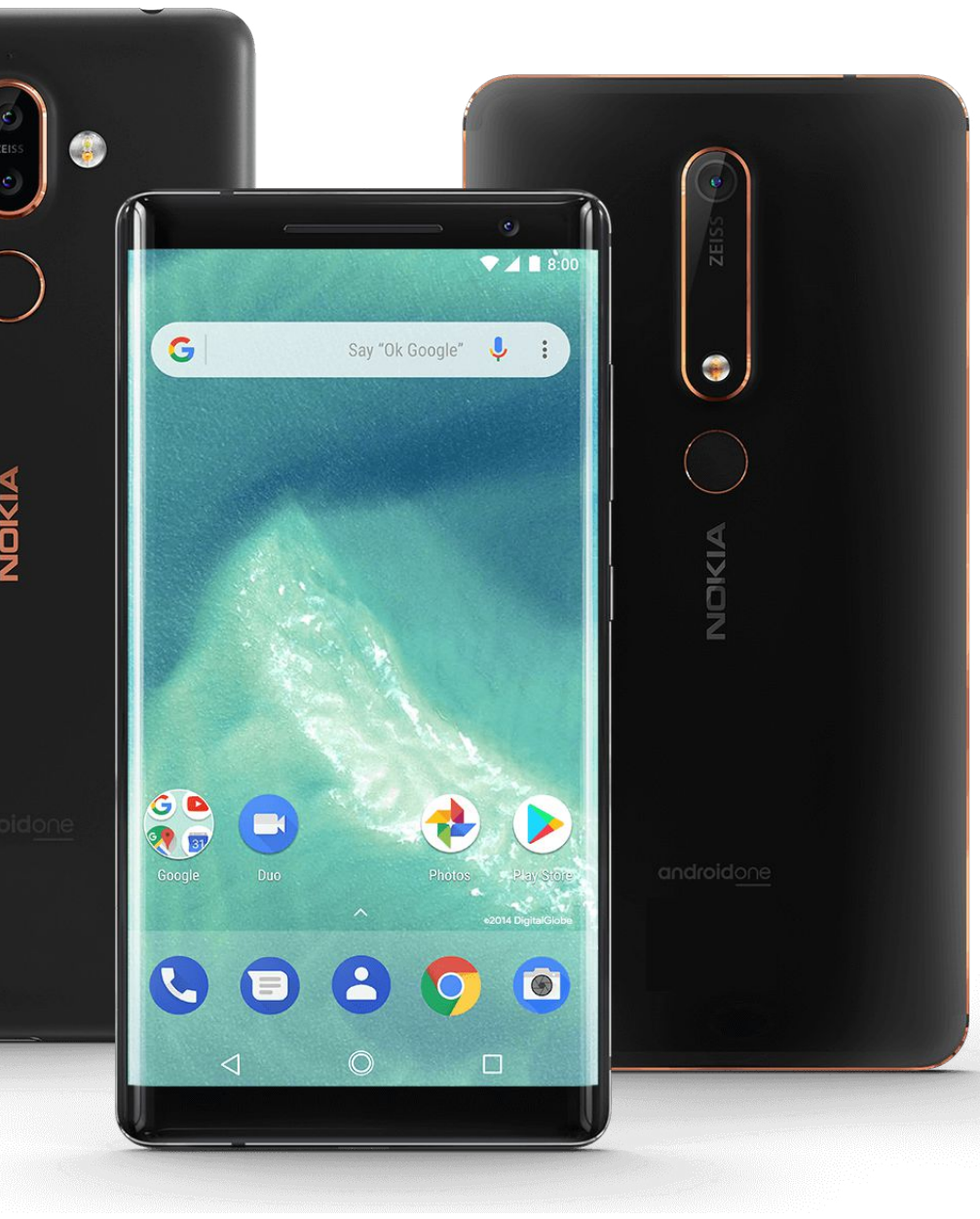

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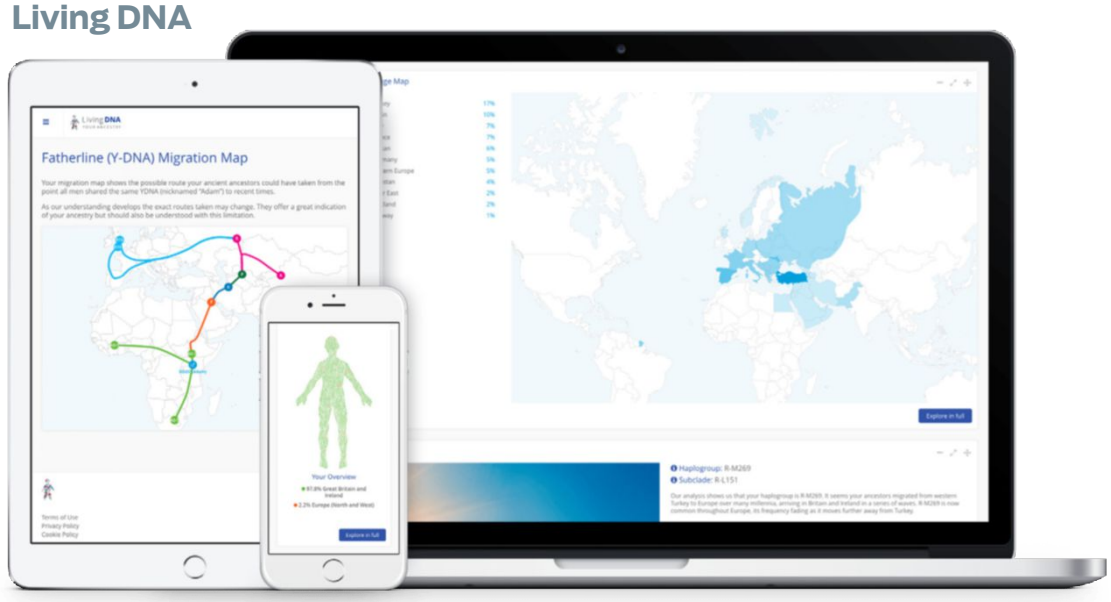

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How Tech Empowers Citizen Science

Several years ago, I met inventor James Paar at a tech event in New York City. Paar was demoing a prototype of his Open Space Agency Ultrascope, an open-source, 3D-printed telescope (powered by a smartphone!) that's intended to make astronomy feasible for interested amateurs across the globe.

Paar's concept is that a widespread community of these citizen scientists will be able to watch the sky for approaching asteroids that could be on a collision course with Earth. They'll then report their sightings to NASA, exponentially expanding the agency's ability to monitor asteroid activity and potentially, well, save the planet.

No part of this project would even be conceivable without today's technology—cloud computing, high-speed networks, low-cost, high-performance computer chips, and of course, 3D printing. Michelle Z. Donahue's cover story in this month's issue—"Citizen Science: Do Try This at Home"—showcases a dazzling amount of like-minded projects, from global efforts similar to Paar's to more local ones.

Case in point is the very local Smell Pittsburgh app, which lets residents of my hometown tag nasty odors on a virtual map that shows other smell reports from that day; the results are also reported to the local health department.

@cmangis

If you've always had a yearning to discover more about the world around you, there's an excellent chance you can find a tech-empowered citizen science endeavor to match your interests. Search online for "citizen science projects" and, say, "oceanography" or "microbiology," and you could be on your way to lab-coat country. You can add to humanity's collective knowledge and scratch your itch to learn at the same time.

At a time when some branches of science are not given the credence and support they deserve and need, it's heartening to see that technology can democratize scientific study, making it available and affordable to everyday folks with a thirst for knowledge and a desire to contribute.

I'd love to hear from you about citizen science projects that you've encountered or even participated in. Drop me an email snd tell me about it!

carol_mangis@pcmag.com

Building Your Own PC

Joel Hruska's story "How to Build a PC in 2018: Choosing the Right Components" struck a major nerd chord. Our readers were eager to chip in with their experience and expertise.

I have a problem with my current mobo [motherboard] (Gigabyte Z77X-UD3H) and was looking at upgrading. However, I want to stay with Windows 7 and was looking at not reinstalling after swapping in new mobo plus CPU. I heard newer intel CPUs officially require Windows 10, but is it actually possible to upgrade to one of these unofficially? Anyone done it? Certainly this is all an area to consider when building a new PC, and it might be worth adding a note in your article.
—Philip Meyer

I had the same feeling about Windows 10 as you, but I finally bit the bullet and upgraded. I now have two desktops and a laptop running Win10. It is not as bad as you think... A hint: If you swap the mobo, you will have to reinstall and reactivate Windows with a new key. Using a new Gen 6, 7, or 8 Intel processor or a new AMD processor will be extremely difficult with Win7 and will leave you open to problems with OS patches and fixes.
—Hunter45

Wise words about selecting power supplies from Joel. Another problem is that if a power supply can only just cope with the power demand, then all sorts of unrelated crashes can happen, and it becomes very difficult to work out what is the true problem. For example, I had a computer that would crash when starting to read a CD/DVD, as

the drive motor startup current was enough to tip the PSU over the edge. The good-quality PSUs are about three times the price of the cheapest PSUs, but should (as they are more efficient) save you that cost in electricity over the years.
—Ray54

I suspect that the sensible choice is going to be Raven Ridge (you get a powerful CPU and a good enough GPU for 1080p gaming, with the option to add a discrete GPU in the future, when the cryptocurrency madness ends). Also, Ryzen motherboards are considerable cheaper than Intel motherboards.
—Marc Guilllot

"Final point: Do not buy a generic power supply from a no-name vendor." Joel is absolutely right on this. Years ago, I bought a case with an included "500W" power supply. Being seduced by the El Cheapo angel on my shoulder and my theory that the system was a modest power draw, it'd be just "fine." About six months later, the PSU literally went up in a puff of a smoke, and worse, took out my MSI motherboard as well. Lesson learned.
— Reginald

I built my first computer in 1974, and we really did build then, not just screw readymade parts together. I had to solder parts together, and when I first switched it on, stand back and pray it didn't go up in smoke. Actually, I had to do that for its entire life!
— Marty Monroe

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.

Fast Forward: Your Sleep Is Broken—Now What?

Fast Forward is a series of conversations with tech leaders hosted by Dan Costa, PCMag's Editor-in-Chief. Dr. Chris Winter is an expert on sleep and the author of *The Sleep Solution: Why Your Sleep is Broken and How to Fix It*. Dr. Winter has helped patients including Arianna Huffington and the New York Rangers. In this interview, he and Dan discuss the increasingly complex role technology plays in our sleep.

Dan Costa: What's wrong with the way we're sleeping now?

Chris Winter: I think there is a fundamental lack of understanding about sleep that as technology comes in, it's giving us information we're not equipped to process or understand. I also think it is creating a hyper-focus in areas that don't need it. I have talked to many individuals, even writers, who use devices, who say while it started out helping them with their sleep, it started to evolve into a place where they became obsessive about it, almost like a video game where you're trying to get the higher score and do better. We want to create a situation where the technology's enhancing or augmenting our sleep, but it's not starting to pull away from it or become a distraction when it comes to getting into your bed at night.

Just from a fundamental perspective, why is sleep so important to us?

Sleep underlies everything we do. We think about pillars of our health as being nutrition or exercise, but really, underneath the pillars of those aspects…is really sleep. When we don't sleep properly, we tend to eat more poorly. We tend to gain more weight. We tend to be less motivated to exercise, and frankly, get less out of our exercise.

It's one of those things where if you made a 2018 resolution to eat better and to exercise more, [but] if you're not taking care to get better sleep, it's really kind of all for naught.

Probably the number-one thing, I think, that's affected sleep patterns in the last 10 years is that now, a large portion of the population, including myself, fall asleep with their cellphone next to the bed, and that's something that really didn't happen 10 years ago. Throughout human history, we just didn't have cell phones next to the bed. How has that changed people's sleep patterns?

It's radically changed people's sleep patterns. Taking away things like the light and the stress that these things cause, it's really creating a situation where individuals are not setting aside a time to rest. The day's work, the day's activity, the day's communication has now really bled into sleep.

People who tell me they'll watch episodes of Netflix right before they go to bed, they literally have the television screen or their phone right in the bed with them. Little alerts and chirps are happening throughout the night that may be nothing more than a two-for-one wing special at some restaurant, but there's this sort of activation of cortisol in your brain, like, "Who was that? What could that be? Is that my girlfriend?" And you look at it, and it's not.

We're having a lot more difficulty now as a society, particularly youth, disconnecting from technology, entertainment, their ways of communicating with one another.

When I was an adolescent, I would spend every night on the phone with my friends, usually one friend at a time. Now, adolescents are spending all night on the phone with all of their friends, simultaneously.

Absolutely. It only takes one person to do that. I saw a patient last week who was brought in by his family because he would have his phone on, and his girlfriend, somewhere across town, would have her phone on, and they would Skype, looking at each other in bed, all night long. They were distressed that he wasn't getting enough sleep. Well, of course he's not. He's looking at this half-dressed girlfriend. Problems we never dreamt of 10 years ago are affecting our youth now, and they're not given really good guidance on how to deal with it.

When I go to sleep at night, I have my iPad. I'm usually reading a book, but I have the screen blacked out with white text. Is that good enough? Is that going to affect my sleep?

It's much better. I think that when you look at research on e-readers, you're better off with a book, with some sort of indirect light, but there are certainly things that we can do. You can invert the text, like you've done. There are filters you can either download onto certain tablets or PCs or your phone, or a lot of them are being built in with sort of a sleep mode.

There are also glasses that we can use now that have the blue-blocker lenses. I deal with a lot of coaches who have to be on a computer at night when they're getting ready to go to bed. They're just putting those on, and actually looking at that through a filtered screen can be very helpful as well.

There are lots of brain-sensing technologies. What are some of the most interesting technologies you've seen?

I'm a huge fan of brain-sensing technology, in terms of what I do, both for elite athletes and their performance, but also the average individual who's telling me, "I can't shut my brain off to sleep at night." The idea of us being able to see what our brain or hear what our brain is doing, and learn how to better able to control it, to me, is fascinating.

I was always a big fan of the Muse brain-sensing headband. They package it now in a pair of glasses, so all the technology and the brain-sensing application is inside the actual, relatively stylish eyewear… If your Uber was delayed getting to your location, you can pull out your app and do a meditation session in the back of the car in a very easy way that doesn't require you carrying around extra baggage.

I'm really impressed with a lot of the wearable technology in terms not only of things you would wear, like a wearable watch. Nokia makes a really good sleep-sensing watch now that's actually quite attractive. They're creating sensors within the bedroom, in the bed… If you are moving, you're probably not sleeping. If you're perfectly still, you probably are. Now we're incorporating things like heart rate variability, body temperature, other things that allow us to paint a much more complete picture and really start to move towards the replication of what real scientists would consider a true sleep study.

We're getting to that place now where we can do what could only be done in a lab a few years ago in our own bedroom.

See a video of the full interview and many more at pcmag.com/podcasts/fast-forward.

Best of MWC 2018

BY SASCHA SEGAN

When it comes to trade shows dedicated to mobile devices and technologies, they don't get bigger than Mobile World Congress in Barcelona. Last year's event attracted close to 110,000 attendees; this year, Samsung returned to Spain to announce the highly anticipated Galaxy S9, and the official attendee count was very close to that number.

We saw plenty of phones to get excited about, and even a laptop or two. But although some new tablets were on display, none managed to secure a spot on this list. The same goes for wearables, which made a stronger splash on our "Best of CES 2018" list.

After a few days of pre-briefs and a couple of days on the show floor, we found eight new products and technologies that truly impressed us. We'll need to get them into the lab for testing, of course. But they represent a level of innovation that makes the year ahead look very promising.

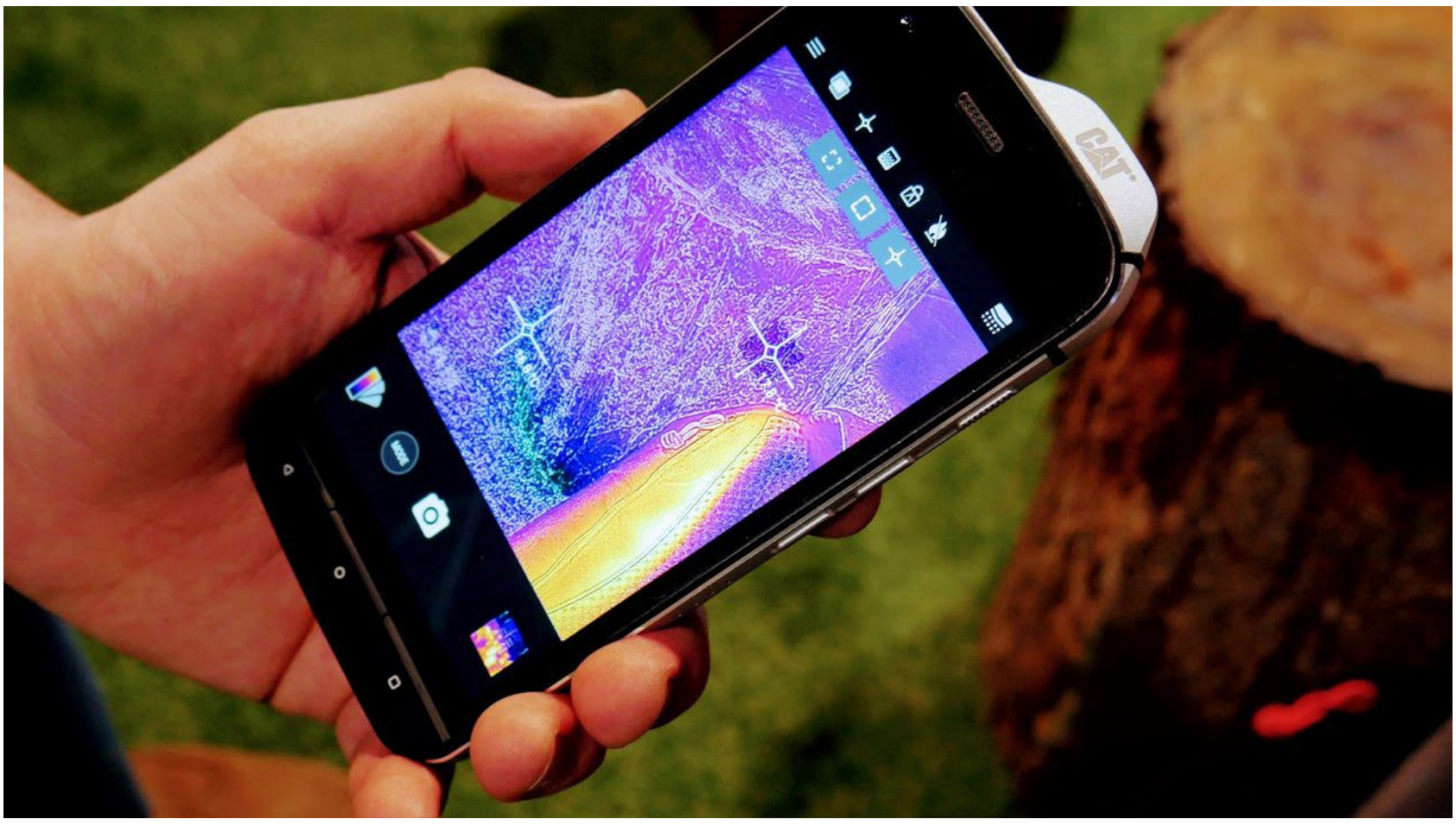
BEST PHONE: SAMSUNG GALAXY S9+

The Samsung Galaxy S9+ sets the benchmark for 2018 smartphones. While it didn't make radical changes to the S8 formula, Samsung keeps improving in every area. The Galaxy S9+ has dual cameras with optical image stabilization, one of which snaps open to a super-bright f/1.5 in low light. The X20 modem in its Snapdragon 845 chipset will outpace any other phone on US networks. Its speakers are 40 percent louder than last year's model, and its super-sharp screen is brighter. Samsung is also brave enough not to give up either the headphone jack or microSD card slot, both crowd-pleasing features. Stepping up in every way, the S9+ is the best smartphone of MWC.

BEST COMPACT PHONE: SONY XPERIA XZ2 COMPACT

The XZ2 Compact is the no-compromise smaller Android smartphone of our dreams. With a 5-inch screen and far less bezel than last year's model, it looks

updated, but the most important thing here is what's inside. Sony put a Snapdragon 845 chip into the phone's 2.55-inch-wide body, and that chip has all the fixin's, including the ability to capture 4K HDR video (which is strangely lacking from the Samsung Galaxy S9). The XZ2 Compact is like a tiny sportscar that can achieve terrifying speeds, and it's glorious.



BEST RUGGED PHONE: CAT S61

Rugged phones have been around for a while, but Bullitt Group's CAT phones have been folding in other unique features for field workers that set them apart. Of course, the CAT S61 is waterproof and built like a tank, but we're giving it a Best of MWC award for its VOC indoor-air-quality meter, humidity sensor, laser distance measure, and upgraded FLIR thermal imaging camera. These features make it a unique device for contractors, painters, energy workers, realtors, and anyone else who builds or makes things in real-world space.

Nokia’s gimmicky yellow 8110 reboot got a lot of press at MWC, but the Doro 7060 is a much better phone.

BEST SIMPLE PHONE: DORO 7060

Nokia’s gimmicky yellow 8110 reboot got a lot of press at MWC, but the Doro 7060 is a much better phone. The 7060 will run on 3G and 4G networks and has well-spaced keys, an external screen, and most important, the full capabilities of KaiOS—an HTML5-based operating system with an app store that supports Google and Facebook apps. The Doro 7060 bridges the old voice-only feature phone world and the 4G smartphone universe without adding complexity, for people who want to stay in touch but not be immersed in the internet.

BEST MOBILE OPERATING SYSTEM: GOOGLE ANDROID GO

For years now, US Android aficionados have been begging manufacturers to throw away their heavy, often-confusing Android skins and adopt clean versions of Google Android. This becomes most performance-critical on low-end phones, where additional animations tend to drag. Well, it's finally happening: At MWC, we saw low-cost phones with Google's clean, low-stress Android Go software that are coming to the US from Alcatel, Nokia, and ZTE. Users will benefit from a consistent interface and an actual update schedule—something low-cost Android phones have almost always lacked.

BEST LAPTOP: HUAWEI MATEBOOK X PRO

The MateBook X Pro is a super-slim laptop with a compelling screen design at an affordable price. Its flagship feature is the 91 percent screen-to-body ratio on its top half—the screen is so nearly bezel-less that the camera has to hide down

in a clever pop-up between the F6 and F7 keys. Huawei took a big step forward from last year's MateBook X by adding a touch screen and discrete graphics, which will improve performance. With this thin, light, and powerful laptop, Huawei really becomes a company worth watching in the Windows world.

BEST ROBOT: TEMI

Temi, "the personal robot," is ready to be your butler, boombox, and YouTube portal, and it'll even tell you the weather. Its face is a 10-inch tablet that sits atop a wheeled, motorized base so it can follow you wherever you go (except up or down stairs). You can leave your phone on its wireless charging tray and interact with it using voice commands. Temi is sort of like an Amazon Echo come to life. Out of all the robots (and voice assistants) on display at MWC, Temi has the most personality.

BEST ALEXA SKILL: MCAFEE SECURE HOME PLATFORM SKILL

Amazon Alexa and Google Home are the new operating systems of the 2010s. These new voice-based UIs are all about simplifying technical tasks—and dealing with router settings is like black magic for most average home PC users. We've never seen router management through Alexa before. Rather than typing in an obscure IP address and clicking through warning boxes—a UI that hasn't changed in a decade—you can use McAfee's Secure Home Platform skill to block devices, scan your network, run parental controls, and find insecure smart home devices by voice. That's a big step forward.

What Is Android One?

BY THOMAS NEWTON

According to Google, Android One is the "purest form of Android." Last year's HTC U11 carries the Android One designation, and Nokia (among other manufacturers) announced three new Android One phones at this year's Mobile World Congress. Unlike Android Go, which is a low-impact version of Google's mobile OS designed to run smoothly on lower-end hardware, Android One refers to a stock Android experience, similar to what you get on Google's Pixel phones.

It wasn't always like this. When Google launched the Android One initiative in 2014, it was a very different concept. As emerging markets grew and buyers' tastes shifted, Google changed Android One to reflect it. Let's look at what Android One was, how it changed, what it is today, and why you should care.

ANDROID ONE: YEARS ONE AND TWO

Android One began in 2014, when Senior Vice President of Android, Chrome, and Apps (and now CEO of Google Inc.) Sundar Pichai announced it to the world at the Google I/O conference. The plan was to reach emerging markets quickly with affordable Android phones that met a certain standard and put "the same knowledge" at everyone's fingertips. Four months after that bold claim, the first Android One phones hit the shelves in India, Pakistan, Bangladesh, Indonesia, and other South Asian markets, retailing for just over $100.

“The plan was to reach emerging markets quickly with affordable Android phones that met a certain standard.”

The plan to reach a billion extra buyers with Google devices had not paid off after just one year. Google expanded the scope of Android One in 2015 with the Infinix Hot 2 X510, which first launched in Nigeria and later arrived in Cameroon, Egypt, Ghana, Ivory Coast, Kenya, Morocco, and Uganda.

2016-2017: THE TURNING POINT

Two years after Android One launched, it started to shift. The program had, in the words of Google's Jamie Rosenberg, been "expanded" to include "new partners, geographies, and price points," including Japan and Turkey. After another year, Android One was revamped with a new set of guarantees: no bloatware, the latest Google apps, security, and a guarantee of "timely upgrades to the latest Android OS."

The latest Android One phone, the Xiaomi Mi A1, with dual cameras, USB-C, and a 5.5-inch HD display, went on sale in September 2017. And it was clear that the game was no longer about mass-market feature phones, although that strategy appeared to finally be paying off.

NOKIA 1
Nokia's own Android Oreo Go Edition phone, the Nokia 1, will be available in certain markets for around $85, and other vendors will offer their own versions, including the ZTE Tempo Go.

2018: ANDROID ONE NOW

Fabian Teichmueller, who heads up Android partnerships at Google in the UK and has been working closely with Nokia brand licensee HMD Global at a European level, explained Google's current vision for Android One: "In terms of the customer proposition, there's three key pillars of Android One. The first one is it's smart, so it'll have a really simple UI. It'll always come with the latest version of Android and have two years of updates, so it's very closely aligned to what the HMD value proposition is." He added, "It's secure, so it'll always have security updates for the first three years, it has [Google malware detection software] Play Protect, and then what we in our consumer-facing language call 'Simply Amazing'."

It's also about the hardware itself. Said Teichmueller: "We work very closely with our OEM partners to make sure that on a set of key metrics, these devices [are rated] very highly on speed, on battery performance and on storage out of the box, so that over time, Android One becomes a seal of approval for consumers, that they can trust the durability and the performance of these devices."

ANDROID ONE, ANDROID GO, AND PIXEL

Android Go, a scaled-down, less taxing version of Android 8.0 Oreo, appears to be picking up the original mantle adopted by Android One. Nokia's own Android Oreo Go Edition phone, the Nokia 1, will be available in certain markets for around $85, and other vendors will offer their own versions, including the ZTE Tempo Go.

Meanwhile, Google's own Pixel line superseded Google's Nexus range to serve as the company's flagship phones. They're first-party devices at least in name and branding, while Android One will offer Pixel-like functionality from third-party manufacturers. Jeff Yee, ZTE's vice president of product marketing and strategy, mentioned that Android One is "like Pixel but not on Pixel hardware."

By that he means you get a very similar, uncluttered UI, Google Assistant and two years' worth of guaranteed updates, along with solid battery life, durable hardware, and all those other niceties Teichmueller mentioned.

Don't expect any hard rules about what does and doesn't constitute Android One. There's no apparent spec requirement other than the phones must fit a vague definition of being good. It also appears to be more collaborative in spirit than the Nexus range was, with OEMs working with Google rather than just handing down the commandments.

"Android One is more about branding," Yee said. "Android One is a brand that means it's Google-certified Android."

If that means Android phones will receive software updates in a more timely manner, we're all for it, no matter what it's called.

"There's no apparent spec requirement other than the phones must fit wa vague definition of being good."

What Net Neutrality Really Means and How to Protect Your Business

BY WAYNE RASH

By now, you've heard the cries of anguish from all sides as the Federal Communications Commission (FCC) moves to reclassify internet service providers (ISPs) so that they fall under Title I of the Telecommunications Act. Previously, they'd been classified under Title II. One side of the discussion is claiming that the FCC repealed net neutrality while the other side is claiming that the FCC restored net neutrality. Here's what's actually going on.

Back in 2015, the FCC, acting under instructions from the White House, voted on party lines to reclassify broadband internet and the ISPs that provide it from Title I of the Telecommunications Act to Title II. Title II is the part of the Telecommunications Act that regulates phone companies, and most of its provisions are either irrelevant to the internet or would place burdens that ISPs can't meet. The FCC got around this problem by agreeing not to enforce those parts. Title I is for information services.

Under Title II, the FCC had the ability to regulate how broadband providers managed their traffic.

Under Title II, the FCC had the ability to regulate how broadband providers managed their traffic. This meant that they could prevent ISPs from placing data caps on internet users, throttling users, or charging extra for services they didn't want people to use (such as competing cloud providers), and they couldn't simply block access to sites they didn't like. It also gave the FCC the authority to enforce such actions.

Under Title I, the Federal Trade Commission (FTC) does the enforcing for what it considers unfair or deceptive practices, including data caps, throttling, or other anti-competitive behavior such as blocking or charging extra for services the ISP doesn't want you to use. The FCC still retains some control under Title I.

At the time this happened, the FCC was working with Congress to craft legislation that would provide net neutrality protections to the internet. That effort was abandoned.

In late 2017, two years after the previous action, the FCC voted, again on party lines, to rescind the reclassification to Title II, putting broadband communications back to Title I. The biggest difference between the way things were before 2015 and Title I now was that the FCC imposed a transparency requirement wherein ISPs had to disclose what they were doing. So, for example, if they were going to throttle traffic, then they had to say so before a customer signed up.

From the FCC document titled "Restoring Internet Freedom": "...the [FCC] returns to the light-touch regulatory scheme that enabled the Internet to develop and thrive for nearly two decades."

The FCC's rule change becomes effective in a couple of months now that the change has been published in the Federal Register. The result will be that the FTC goes back to enforcing unfair practices with broadband carriers.

WHAT THIS MEANS TO YOUR BUSINESS

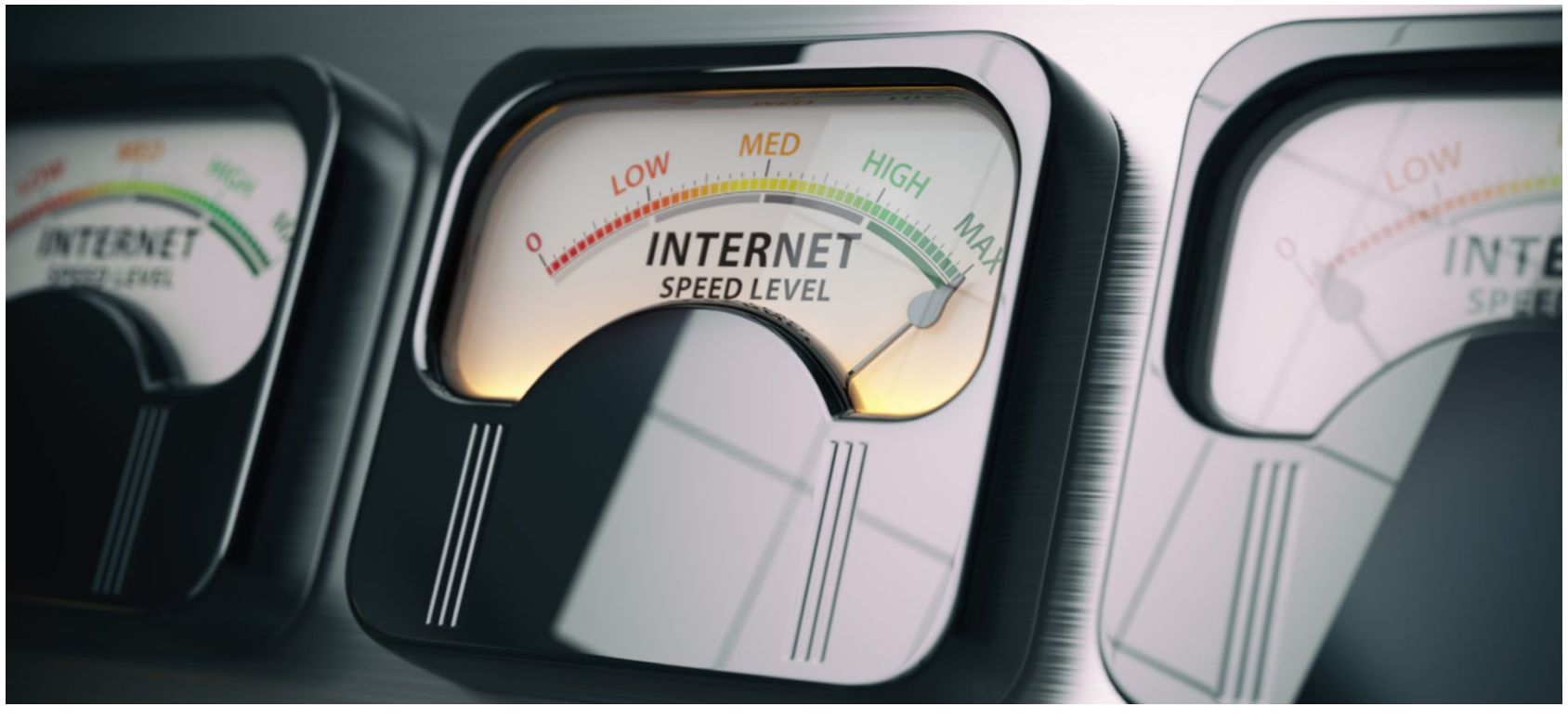
The near-term effect of the reclassification on your business is going to be minimal. ISPs have said that they have no plans to start throttling traffic, and if they do, then the FTC can take action. In terms of the so-called internet "fast lanes," nothing really changes there, either. It's worth noting that providing "fast lanes" for companies willing to pay for them isn't the same thing as creating "slow lanes." Those faster networks are private networks that exist outside of the public internet.

Despite the contention that having fast lanes also means having slow lanes, that isn't really true. What happens is that information providers that want their data to travel with less of an impediment already have those fast lanes; they had them before the first reclassification and they had them during Title II. Those fast lanes are called "Content Distribution Networks" (CDNs) and they're widely used. The largest and best-known CDN is Akamai, but there are plenty of others, including CDN.net, which is an on-demand global distribution network.

CDNs have the advantage that they get traffic with high-bandwidth demands out of the general internet traffic and, as a result, reduce congestion. So, in effect, they eliminate the slow lanes rather than creating them. This means your internet will work better.

CDNs work by geographically distributing access to your data by using their own private networks to take traffic off of the internet, and also by moving your data nearer to your users by putting it on servers that are physically located much nearer to them. To some extent, they resemble edge-computing networks, except that instead of performing compute functions, they provide faster access to data.

But what about charges that ISPs may throttle certain traffic? Well, in general, they've promised not to. But hey, they might be lying. This has happened—and the FTC ended up suing AT&T for throttling as an unfair or deceptive practice. AT&T challenged the FTC's right to do that and lost. The US Court of Appeals for the Ninth Circuit upheld the FTC's actions.

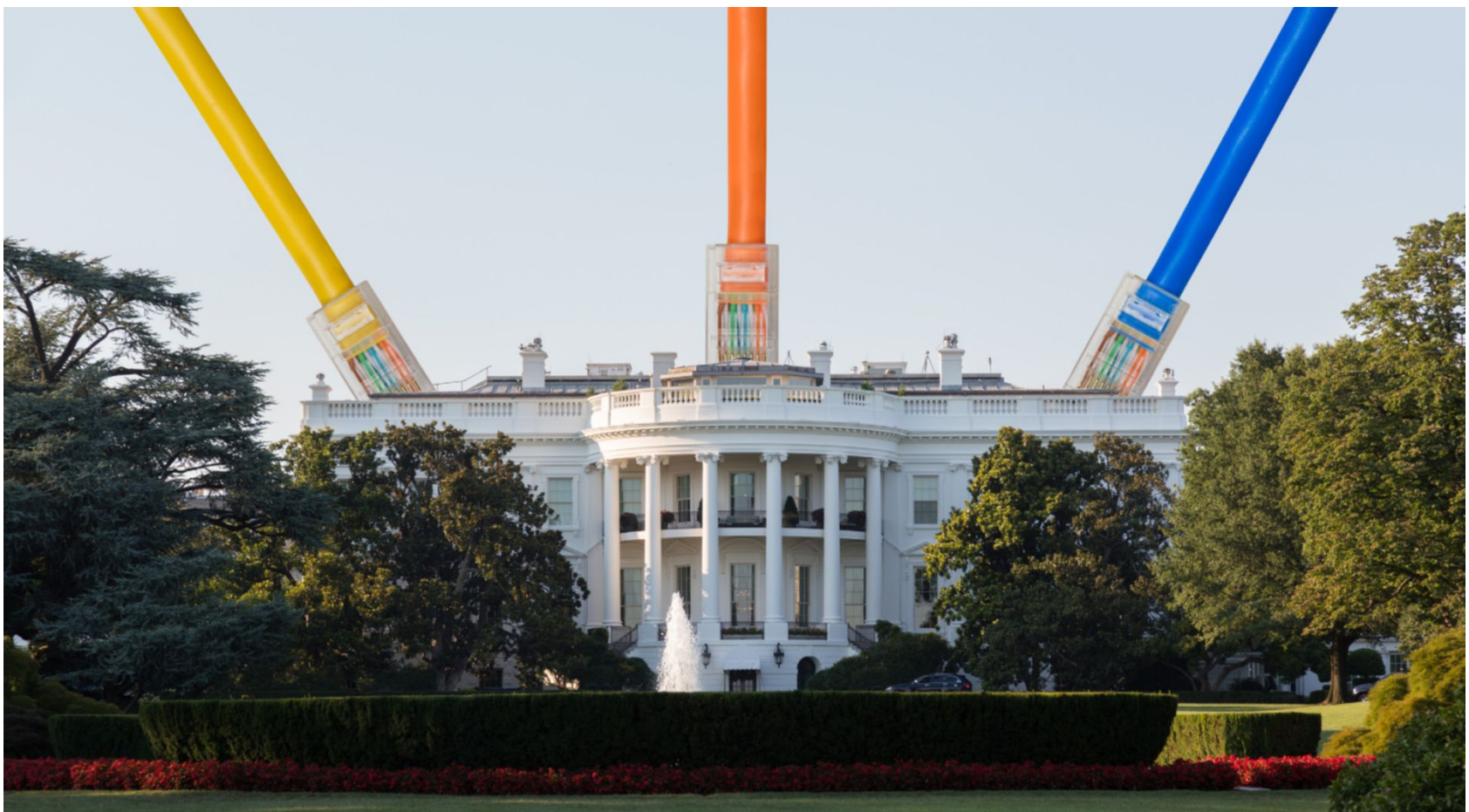


So why all the demonstrations, angst, and hype about the issue? There are several reasons, some of which are self-serving on the part of advocacy groups. Other reasons stem from not knowing what's in the FCC's order, because it's long and hard to read. And, of course, there's politics, because there are folks who can't stand anything related to the current administration in the White House, including the FCC—despite the fact that most of the commissioners were appointed by the previous administration.

Unfortunately, there's nothing to prevent a future FCC from reclassifying the current reclassification, so this whole thing could happen again. Broadband is considered to be an information service under Title I only as long as this FCC is in power. A new administration and a new FCC could change things right back, which would give you and every other internet user regulatory whiplash.

If all of this sounds insane, that's because it is. Hyper-partisan politics in Washington is one of the greater risks affecting your business over the long term, because you have no assurance that the regulations that affect you will remain stable. If a new party takes the White House in the 2020 elections, then you can expect that many of the rules you have to live by now will change again.

This long-term uncertainty can be resolved only by legislation, which is what the FCC and Congress were trying to accomplish in 2015. That legislation was a carefully crafted bipartisan effort that really would have ensured net neutrality. But the fact that it was bipartisan means that, even if it were resurrected, it would have no chance of passage in the current political climate.



PROTECTING YOUR BUSINESS

Fortunately, from an IT perspective, you can take several steps to protect your business should the worst come to pass—which, again, is by no means guaranteed. For one, you have the ability to affect your own communications environment more than consumers could. You can usually choose an ISP that will provide you the communications environment you like and that won't mess with your traffic. You can probably be your own ISP, if you're willing to go to the trouble and expense.

But you also need to worry about your customers reaching you, so if you have a lot of traffic—especially traffic that is sensitive to delays or congestion—make sure you can take advantage of CDNs. Signing up for a CDN is as easy as visiting its website, where you can see pricing and how it operates and determine whether your business can benefit. For a CDN to be effective, your site should either have a lot of users and thus create a lot of traffic, or it should have a need for reliable traffic delivery, such as a streaming service.

And if, against all sense, an ISP does decide to throttle your traffic, then you can monitor that by testing network throughput from a location on their network. But you'd probably find out through user complaints. The most likely reason for such throttling is that your company provides a service that the ISP sees as competition. If you see it happening, then your first call should be to the FTC, since that agency considers such throttling to be illegal.

Again, though, that's a worst-case scenario. The vast majority of legitimate businesses won't be blocked and are unlikely to be throttled, especially now that the FTC has the legal clout to stop it. The more likely issue is going to be network congestion, which you can fix with a CDN. Congestion isn't the same thing as blocking, and although it could be a sign of a poorly managed network, it's not illegal.

Oh, and you can make it a point to support politicians who will work for net neutrality legislation. Otherwise, uncertainty will rule, and that doesn't help you or anyone else.

US Carriers Prep ID Protection That Goes Beyond Passwords

BY MICHAEL KAN

Major US mobile carriers want to do away with using just passwords to protect online accounts. They've come up with a new "multi-factor authentication" platform that leverages your mobile phone to gain access; it's slated to arrive by the end of this year.

AT&T, Sprint, T-Mobile, and Verizon have been working on the platform since last September through a joint task force. Its overarching goal is to help prevent fraud, identity theft, and other crimes that revolve around password theft. The system will involve a "cryptographically verified phone number," the carriers said in their statement.

To further verify your identity, the system pulls data from your mobile phone, including the device's IP address, SIM card attributes, phone number tenure, phone account type, and more. "In addition, advanced analytics and machine learning capabilities will be used to help assess risk and protect customers," the carriers have said.

What this will look like for consumers is unclear. But multi-factor authentication systems work by securing your account in two or more ways. In addition to a password, you might need a special code sent to your phone, or the system might scan your fingerprint.

In addition to a password, you might need a special code sent to your phone, or the system might scan your fingerprint.

Websites such as Yahoo have done away with password-only reliance by using your phone. Yahoo uses push notifications via a mobile app as a required part of logging into your account.

The upcoming system from the US carriers may end up doing something similar. But one big challenge will be getting businesses onboard.

A website with more information on the platform and developer sign-up will launch later this year. US carriers will start the first trials in the coming weeks.

Gear Envy: What I Take to MWC

BY SASCHA SEGAN

For PCMag's mobile team, Mobile World Congress (MWC) in Barcelona is the most important show of the year; we see the debut of many hot phones and technologies. This huge event requires me to stay on my feet pretty much constantly for five days straight. Over the years, I've learned to value a lightweight kit and a bag with good back support. A trade show is a marathon, not a sprint, and I don't want to hit a wall at mile five. Here's what I took in my gear bag to Barcelona.

SASCHA'S MWC TRAVEL BAG

I go to three or four trade shows a year, and my packing trick is to balance light weight with redundancy. I always assume that I'm going to be on my feet for 12 hours a day and will have to file five stories with no Wi-Fi or power outlets. That might not be the case, but I have to be prepared. I carry everything in this shot with me all day, except for the Echo Spot alarm clock. That stays in my hotel.

BOOQ COBRA PACK

My daily bag is a backpack, because I don't want to hurt my neck and shoulders. The Booq Cobra Pack is capacious, water-resistant, tough, padded, and handsome. I've taken it for overnight trips all by itself, packing my clothes into the bottom and my gear on top of it.

$295.00, www.booqbags.com

12-INCH MACBOOK

My office laptop is a Surface Book, and I'm very happy with it. But on the road, I go as light as possible, with a laptop I just use for writing. The 12-inch MacBook has relatively long battery life and weighs almost nothing, saving my back. It's far less powerful than my Surface Book, and I would never use it as a primary computer in my day-to-day life, but it does the specific job I need on the road.

$1,229.00, www.apple.com

SAMSUNG GALAXY S8

My personal phone is a Samsung Galaxy S8 with a T-Mobile SIM. T-Mobile gives me free, slow-speed international roaming, so I get my personal texts and Hangouts messages I'm in Spain.

$720.00 and up, wwwsamsung.com

SPECK PRESIDIO GRIP CASE FOR GALAXY S8

I change up my phone case every few months, just to keep things fresh. Right now I'm enjoying this Speck Presidio Grip case because it's so grippy. Not only does that mean I'm less likely to drop my phone, it also gives me something to fiddle with in my jacket pocket when I'm antsy.

$31.96, www.speckproducts.com

APPLE iPHONE X

On trips like this, I bring a second phone; it's owned by our company and configured just with corporate apps. The iPhone X's dual cameras let me shoot product photos with bokeh, and it's set up to automatically upload those photos to our company Dropbox. I'll load it with a Vodafone Tourist Plan SIM in Spain, which will give me LTE data for high-speed uploads. (Yes, it's true, I don't bring an actual camera. I used to, but I'm not a good enough photographer to get better shots out of a "real" camera than I can with this phone.

$999.00 and up, www.apple.com

PLANTRONICS VOYAGER FOCUS UC

My absolute favorite wireless headset is supremely comfortable and platform-agnostic, and has noise cancellation, great sound quality, and a killer boom mic that slices through background noise. The Plantronics Voyager Focus UC is equally perfect for listening to music while roaming the streets of Barcelona and taking a conference call with a bus rumbling by. AirPods be damned.

$299.95, www.plantronics.com

XIAOMI MI POWER BANK PRO

At a trade show, you can't assume you will ever run into a power outlet. Xiaomi's Mi Power Bank Pro is unusually slim for its capacity and supports fast charging.

$29.99, www.xiaomi-mi.com

SKYROAM SOLIS

You may have noticed I take a belt-and-suspenders approach to connectivity and power when I'm on these trips. Having multiple backup plans on hand can mean the difference between getting a great story out of a press conference, and banging on your keyboard with rage because you can't get onto the internet. The Skyroam Solis hotspot has very long battery life and charges $9 per day for global LTE speeds, which can get my laptop hooked up wherever I need to go.

$149.99, www.skyroam.com/solis

CEPTICS 3 OUTLET POWER STRIP AND ADAPTERS

There is no such thing as too many plug adapters. This Ceptics power strip uses Wonpro-style universal sockets, which let you plug a device from anywhere into any socket, so I can mix European and US devices with abandon. The short cord lets me take it in my bag and use it in crowded press rooms, where nobody usually gets three sockets to themselves.

$17.99, www.ceptics.com

AMAZON ECHO SPOT

Hotel alarm clocks are the worst. They're difficult to set and mysterious to use. So why not just bring an Echo Spot? It's set up with my US Amazon account, so it can wake me up to music in Europe, and Alexa can be pleasant to chat with when I'm hitting that 1 a.m. writer's block in my hotel room.

$129.99, www.amazon.com/echospot

Sascha Segan

COMMENTARY

Google Can't Save ISP Competition

The Verge recently noticed that Google's wireless broadband subsidiary, Webpass, is dropping out of Boston, part of Google's general retreat from its original, ambitious, nationwide Google Fiber plans. You could say this is two steps forward, one step back, as Webpass launched in Denver and Seattle last year. But in the larger picture—which includes Verizon halting its Fios rollout years ago, and a US ISP marketplace where 37 percent of people in the 5,000 most populated ZIP codes have only one option for 25Mbps broadband—there's very little choice when it comes to affordable, quality in-home service.

Sascha Segan is the lead mobile analyst for *PC Magazine*. His commentary has also appeared on Fox News, CNBC, CNN, and various radio stations and newspapers around the world.

For a year now, I've been hoping that 5G networks would inject competition into the home ISP market, but those plans appear to be stalled. Let me note that mobile 5G appears to be going great guns; I hear 5G providers talk nonstop about sensors and the Internet of Things. But what I'm hearing about less and less is providing broad pipes at flat, affordable rates to homes with many devices in them.

AT&T has dialed back its home internet plans in favor of mobile. Verizon went from 11 test cities in 2017 to no actual 2017 commercial launches, and "3 to 5" cities in 2018. Starry says it'll be able to

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reach only two new cities in 2018. And a report in Fierce Wireless—admittedly, from a study by the cable industry—argues that there's no way 5G providers will be able to sell gigabit wireless for less than $75 a month.

That may still be less than cable companies will soon charge for it. Cable rates have been going up every year, and an October analyst's report suggests that cable broadband will soon cost $90 and up, largely because of people dropping even-more-expensive cable TV packages.

Yes, it's possible to use mobile internet as your primary home internet, but so far, mobile service providers have been unwilling to offer the gigabyte buckets that American homes generally seek. A 2016 study showed that American homes use, on average, 190GB per month. Mobile "unlimited" data plans generally de-prioritize you at 22GB or 50GB, slowing speeds and choking your connection. That may improve with 5G, but we aren't going to see broad 5G coverage for at least two more years.

With the large, for-profit companies seemingly uninterested in competing with cable, maybe the only way for Americans to get more ISP choice is to roll up their sleeves and do it themselves. A recent Motherboard story says 750 communities have gotten fed up and started to build their own networks, even though 20 states have anti-consumer laws protecting for-profit internet providers.

You don't have to be a city government to do this, either. Small, roll-your-own ISPs such as

Brooklyn Fiber have cropped up here and there throughout the country. You do have to be a network engineer and have some investment money to pull it off, but it's possible.

The cable monopolies on fast internet may not be legally mandated or an act of nature, but they may also be here to stay unless someone steps up to do something about them. And if Google, AT&T, and Verizon won't, maybe we'll have to.

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Chandra Steele

COMMENTARY

No Women Speakers at Your Conference? That's Your Fault

PCMag 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.

Women in the tech industry have spoken out about the gender pay gap, sexual harassment, and misogyny. But few voice these and other opinions onstage at major tech conferences.

April's RSA Conference has just one woman on its speaker panel. That woman, Monica Lewinsky, has a vital message about digital privacy. But the rest of the 21 speakers and moderators at the conference are men. RSA organizers say the lineup is not finalized and that it has extended invites to women, but also put some of the blame on a lack of women in cybersecurity overall.

Yet days after the RSA criticism started, Facebook Chief Security Officer Alex Stamos and Google Engineering Director Parisa Tabriz organized OUR Security Advocates, a conference with mostly female panelists.

This brings to mind the all-male keynote lineup at CES 2018 in January. After an outcry, the Consumer Technology Association (CTA), which runs the technology show, added a meager two women to an existing panel. CTA Senior Vice President Karen Chupka said the incident was

unfortunate but pointed to a “limited pool of women” who hold positions high enough to keynote CES. Never mind that the CTA itself determines those criteria. By then, the message was clear, and Twitter CMO Leslie Berland had created #HereWeAre, a panel of female keynote speakers at its own CES event.

The existence of these adjacent conference panels disproves the very claim organizers make. Yes, there is a dearth of women in tech, but those who are in it are eager to participate in panels that feature other women.

Conference organizers need to stop relying on lazy excuses and examine why women might decline to participate in their events. Such a reflection might have saved the North American Bitcoin Conference, which held its official networking event at a Miami strip club, the deserved opprobrium it received.

All tech conferences should have a code of conduct. Among the many stories of #MeToo are ones of women being sexually harassed at these events. Setting expectations for how conference participants should behave and taking action when rules are broken would go a long way toward making women feel welcome. Web animator Rachel Nabors makes it plain on her site that she will not speak at a conference that does not have one in place. CES, the largest show in the industry, has no such code.

Doing away with “booth babes” is another must. Hiring models to appear alongside a product as an accessory deters women from attending and sets up a scenario for men to eye up women while talking business. This creepy dynamic has no place in a professional environment.

By taking these steps, conference organizers would be truly listening to women, and open the door to some very worthy women to put on panels for others to listen to as well.

Jeffrey L. Wilson

COMMENTARY

How Ditching Consoles for a Gaming PC Improved My Life

Over the course of my nearly decade-long stint with PCMag, I've written numerous articles about my love for the arcade, esports, and overall video game scene, but not about how I got into those things.

For instance, I became an arcade junkie because I was too poor to own an 80s-era home computer, and my esports love grew after envy-watching various tournaments via Twitch. But how I got into PC gaming is a far simpler story, a tale that doesn't touch social-economic barriers or outright sipping from the Haterade fountain. In short, I was just tired of amassing stuff.

I began console gaming in the late 1980s, when my mother purchased a Nintendo Entertainment System as a Christmas gift. Between then and the 7th-console generation, I also owned a Sega Genesis, Super Nintendo Entertainment System, TurboGrafx-16, PC Engine, Neo Geo, PlayStation, N64, PlayStation 2, Dreamcast, Xbox, and Xbox 360. And factoring in handheld gaming, you can toss the Neo Geo Pocket, Neo Geo Pocket Color, Nintendo DS, and Nintendo 3DS into the mix. That's a lot of hardware and even more software.

Over the years, my various living spaces each quickly became less about my life and more about storing controllers, limited-edition game posters,

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video game soundtracks, cables, cartridges, and discs. I was all about that gamer life. But something had to change.

I'd been intrigued by the idea of PC gaming since discovering M.U.L.E. and Oregon Trail in my elementary-school computer classes. Initially, I was drawn to the floppy discs, mice, and keyboards—hardware that was completely foreign to me—associated with the Apple II and Commodore 64. I eventually purchased a used C64 from a computer store in Brighton Beach, Brooklyn, but sold it less than a year later, after the family encountered some money issues. But the PC gaming love still burned bright.

So when I decided to declutter my life three years ago, I knew that my console video game collection needed a Frank Grillo–style purge as I plotted a move to a gaming desktop. It was difficult. Your things become you, as the saying goes. But as I sold off a large chunk of my console collection, I realized that I had the strength to abandon other out-of-control collections. I soon dumped most of my DVD collection in favor of digital downloads and streaming services. My print comics were soon replaced with digital versions. My gaming now revolves around a single black box: my gaming PC. I haven't looked back.

PC gaming has been an unexpected personal boon. I no longer suffer the clutter associated with generations of game discs and instruction manuals in my entertainment center. And on bookshelves. And stashed away in closets. My games are all neatly sorted in my Steam account; I'm just a click away from an entertaining gameplay session—no need for multiple consoles vying for real estate or a snakepit of A/V cables.

And all that extra space in my crib? I've used it to hang art, store my bass guitar (a recent hobby I've adopted), and generally give the living area more room to breathe. With PC gaming, an inherently digital hobby, I've shattered my former collector's mentality. I'm no longer scouring eBay or video game forums or stopping in the many New York City game shops looking for a cartridge or disc to add to my collection. In that regard, PC gaming has proven incredibly freeing.

With PC gaming, an inherently digital hobby, I've shattered my former collector's mentality.

Surprisingly, the move has been far simpler than I imagined. I remember a time when PC gaming carried a stigma of being inaccessible to the average joe, but I found it in the contemporary era remarkably easy—and not just because I have tech interests and proficiencies. My Steam installation is set up so that it auto-updates itself and individual games. Likewise, the Nvidia GeForce Experience desktop app always keep my graphics card drivers up to date. In fact, Nvidia often releases fresh Game Ready drivers before a high-profile game hits the digital marketplaces, so I never need to hunt down the appropriate software.

I miss a few console games by being a PC gamer. I won't be getting Pokemon Ultra Sun/Ultra Moon, the Shadow of the Colossus remake, or the new God of War. I'm perfectly fine with that, as those aren't exactly my bags (the Yakuza series, on the other hand, very much is). But I do have Dragon Ball FighterZ's true-to-anime fighting, multiple Ys adventures, Fire Pro Wrestling World's strategy and theatrics, and Out of the Park Baseball's mega-addictive sports simulations, just to name a few. And Microsoft's brilliant Play Anywhere initiative ensures that Xbox One exclusives, such as the marvelous Cuphead and Forza Horizon 3, are

available for play on Windows 10 desktops and laptops. I'm really not missing much. And I'm collecting even less.

That ethos has carried over to my Steam purchases. Many PC gamers lament their Steam backlogs, the tons of unplayed or underplayed games that get lost in the shuffle when players load up on new titles during the seasonal Steam sales. I very briefly suffered that ill, too. Thankfully, learning to let go of my physical console collection instilled within me the will not to give Valve full access to my bank account; I've been thoroughly enjoying playing through games without that backlog ghost haunting me.

All that said, I must admit that I dropped 300 bones on a Nintendo Switch last March. How could I resist? The Switch's library and home-and-away functionality is a one-two combo that cannot be duplicated. Hypocritical? Not at all. It's a relatively small device (it fits in my jacket pocket!), and most of my purchases have been digital joints from the Nintendo eShop. Besides, playing Switch exclusives such as Super Bomberman R, Breath of the Wild, and Splatoon 2 on the go is quite appealing. After all, I can't lug my Origin PC onto the Q train. Still, PC gaming is my preferred platform; my "main," if I were to use FGC vernacular.

So thank you, consoles. You were gateways to many adventures in my younger days; in recent times, the catalyst to living a far more streamlined existence.

"I must admit that I dropped 300 bones on a Nintendo Switch last March. How could I resist?"

Samsung Galaxy S9+ Sets the Bar for Smartphones

PC MAGAZINE EDITORS' CHOICE

The Samsung Galaxy S9+ is the best phone on the market. It hasn't been reinvented from last year's model, and there's no radical new feature that will send you running to the store, no change in the game or shift in paradigm. But it has the best screen, the best connectivity, the best speaker, and three of the best cameras available. There's no reason to cast aside your year-old smartphone for an S9+, but if you're shopping for a new phone, this is the one to get and our Editors' Choice.

Samsung Galaxy S9+

$839.99 as tested

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Please note that this is a review of the Galaxy S9+, which we think edges out the Galaxy S9 because it gives you dual rear cameras, more RAM, and a bigger battery. That's a switch from last year, when we preferred the smaller S8 because we didn't feel the S8+ differentiated itself enough.

A LITTLE BETTER EVERY DAY

The Galaxy S9+ looks a lot like the Galaxy S8+, to the point that it's difficult to tell them apart. Like the S8+, the S9+ is a smooth phone with curved edges and a screen cascading down both sides of the curved glass. There's a little bit less top and bottom bezel than there was on the previous model. It still has a dedicated Bixby button on the left, ready to launch you into a secondary home screen. Turn the phone over, and you'll see a difference: two cameras instead of one and a fingerprint scanner below the cameras rather than next to it.

That fingerprint-scanner location is a little bit of a middle finger to those who complained about the S8's scanner, because it's not an improvement. The S8's scanner required you to feel around the back of the phone, possibly putting your finger over the camera lens, and that's still the case. The solution now is just to slide your finger up from the bottom rather than in from the side.

Samsung Galaxy S9+

PROS Gorgeous screen. Beautiful body. Spectacular network performance. Dual main cameras with excellent low-light capture. Loud audio.

CONS Camera software oversharpens images. AR Emoji and Bixby disappoint.

The two cameras are both 12MP shooters, which are optically stabilized and can vary from f/1.5 to f/2.4 aperture.

The Galaxy S9 measures 5.8 by 2.7 by 0.3 inches (HWD) and weighs 5.8 ounces, while the Galaxy S9+ measures 6.2 by 2.9 by 0.3 inches and weighs 6.7 ounces. Both are slightly shorter, wider, and heavier than their predecessors (respectively 5.9 by 2.7 by 0.3 and 5.5 ounces, and 6.3 by 2.9 by 0.3 inches and 6.1 ounces), but not so much that you notice. The S9+ is, obviously, larger than the S9, but it's narrower than the iPhone 8 Plus (3.1 inches), making it easier to hold. The phones come in black, blue, or purple.

On the bottom are the same USB-C port and traditional 3.5mm headphone jack as on the S8+. The phone comes in 64GB, 128GB, and 256GB versions and also has a microSD card slot. It supports both fast and wireless charging, and it's IP68-certified water resistant. So far, so much like last year's phone.

That fingerprint-scanner location is a little bit of a middle finger to those who complained about the S8's scanner.

The Samsung Galaxy S9+ looks a lot like last year's Galaxy S8+, but it's been upgraded from top to bottom.

Ultimately, though, everything's a little better. Start with that screen, 6.2 inches on the S9+ and 5.8 inches on the S9. According to Ray Soneira of DisplayMate Labs, it's a little brighter, has better automatic brightness settings, and has better colors than last year's phones. The most dramatic new feature is a user-settable white point—if you think the screen is too blue, you can adjust that.

The phone's dual speakers, one in the earpiece and one on the bottom, pump out sound that's noticeably louder and more full than that of the Galaxy S8+. We got 90db of pink noise at a 6-inch distance as opposed to 83db on a Galaxy S8+. That affects not only media playback but also the speakerphone. The Galaxy S8+ boasted the best call quality in the business; the Galaxy S9+ is just as good—and louder.

The phone supports both voice-over-LTE and Wi-Fi calling, although you may need a carrier-specific unit to get those features. The unlocked model supports Wi-Fi calling on T-Mobile and Sprint, but you'll need a carrier-branded unit for Wi-Fi calling on AT&T and Verizon.

HOT CHIPS

The Galaxy S9+ runs Android 8.0 Oreo on the first Snapdragon 845 processor we've seen on a US phone. This model has 6GB of RAM, while the smaller S9 has 4GB. The Snapdragon 845 has four cores running at 2.8GHz and four at 1.7GHz. This doesn't appear to bring massively more CPU power to the table, but the improvements on graphics, LTE, and Wi-Fi are quite noticeable.

The Snapdragon 845 benchmarks better than any other Android phone; how it compares with the iPhone depends on which benchmark you're using. On Geekbench, which focuses on CPU performance, the iPhone X beats the S9+ with scores of 4269 single-core and 10403 multi-core, compared with the S9+'s 2278 and 8379. But Antutu shows the opposite result: The Galaxy S9+ got 267,233 compared with the iPhone X's 233,592 largely because of a better 3D performance score. Cross-platform benchmarks are not terribly useful. And on PCMark, our score of 7273 is similar to those of the Pixel 2 phones, although it's noticeably higher than the 6800 we got on the Galaxy S8.

The high screen-to-body ratio means that the 6.2-inch Galaxy S9+ is the best large phone for people with smaller hands.

Browser benchmarks show a modest improvement over Snapdragon 835-based phones. Those usually get about 63 to 65 on the Jetstream Javascript benchmark and 250 or so on Browsermark; with the 9S+, we got 69.97 on Jetstream and 270 on Browsermark.

Graphics benchmarks comparing the S9+ with other Android phones, though, are heartening. On the GFXBench Car Crash test, the S9+ got 35fps offscreen, and Snapdragon 835 phones only get 24 to 25 fps. That's a really nice performance bump.

The phone has a Category 18 LTE modem that can hit maximum theoretical speeds of 1.2Gbps, 20 percent faster than the previous generation of high-end phones. We tested the unlocked variant and were happy to see that it has all the bands used by each of the US carriers, including (for AT&T, T-Mobile, and Verizon) the new 5GHz LAA band that recently gave us speeds of over 500Mbps on T-Mobile. The phone has 4x4 MIMO antennas on bands 2, 4, 7, 30, 41, and 66. (If you're curious about the full LTE band list, including roaming bands used mostly in other countries, it's 1, 2, 3, 4, 5, 7, 8, 12,13, 18, 19, 20, 25, 26, 38, 39, 40, 41, 46, 66, 71.)

“The Galaxy S9+ runs Android 8.0 Oreo on the first Snapdragon 845 processor we've seen on a US phone.”

There's good news here for all carriers. The phone can support 12 streams of data to previous devices' 10 and can do 4x4 MIMO on three bands simultaneously, compared with the previous devices' two bands. That means more flexibility to squeeze greater speeds out of each cell site on every carrier.

On AT&T, 4x4 MIMO on Band 30 is new. On Sprint, the S8+ lacks 4x4 MIMO on the critical Band 41, so you'll see much faster speeds on an S9+. On T-Mobile, the S9+ brings in the new rural Band 71 for extended coverage, which isn't on the S8+. The S7 doesn't have either of these features, and no iPhone has them, either.

The Galaxy S9+ can support 12 streams of data and can do 4x4 MIMO on three bands simultaneously. That means more flexibility to squeeze greater speeds out of each cell site on every carrier.

When a carrier SIM is put in the unlocked phone, the phone adapts to whatever that carrier's bands and aggregation strategies are.

To test RF, we brought the S9+ and a Galaxy Note 8 to a T-Mobile cell site of verified quality. We got slightly better signal and latency on the S9+ than on the Note 8. Now, that could be because of hardware or software, and we plan to look into this further, but there's no question that we're talking top-of-the-line LTE performance.

We were also very pleasantly surprised by the S9+'s stellar Wi-Fi performance when compared with the S8+ on the 5GHz band. In good signal conditions on a 150Mbps symmetrical connection, we got 130 to 150Mbps down on the S8+, but only 70 to 80Mbps up. On the S9+, we got 135 to 150Mbps up. And as we went farther from the router and through walls, the S8+'s connection decayed before the S9+'s did: With a middling link, we got 77Mbps down and 40Mbps up on the S8+, but still a solid 154Mbps down and 130Mbps up on the S9+.

As far as battery goes, the S9+ has a 3,500mAh cell. It outran our 10-hour streaming YouTube video, with 5 percent life, which bodes very well for battery life. Android-wise, Samsung's extensions to Google's operating system here are identical to those from last year. Beyond the camera modes, the S9+ has Samsung's "edge" functionality to drag in widgets from the side of the screen, and the phone supports Samsung's DeX docking stations to turn it into a desktop PC. Both features are useful but probably won't be used as often as Samsung would like.

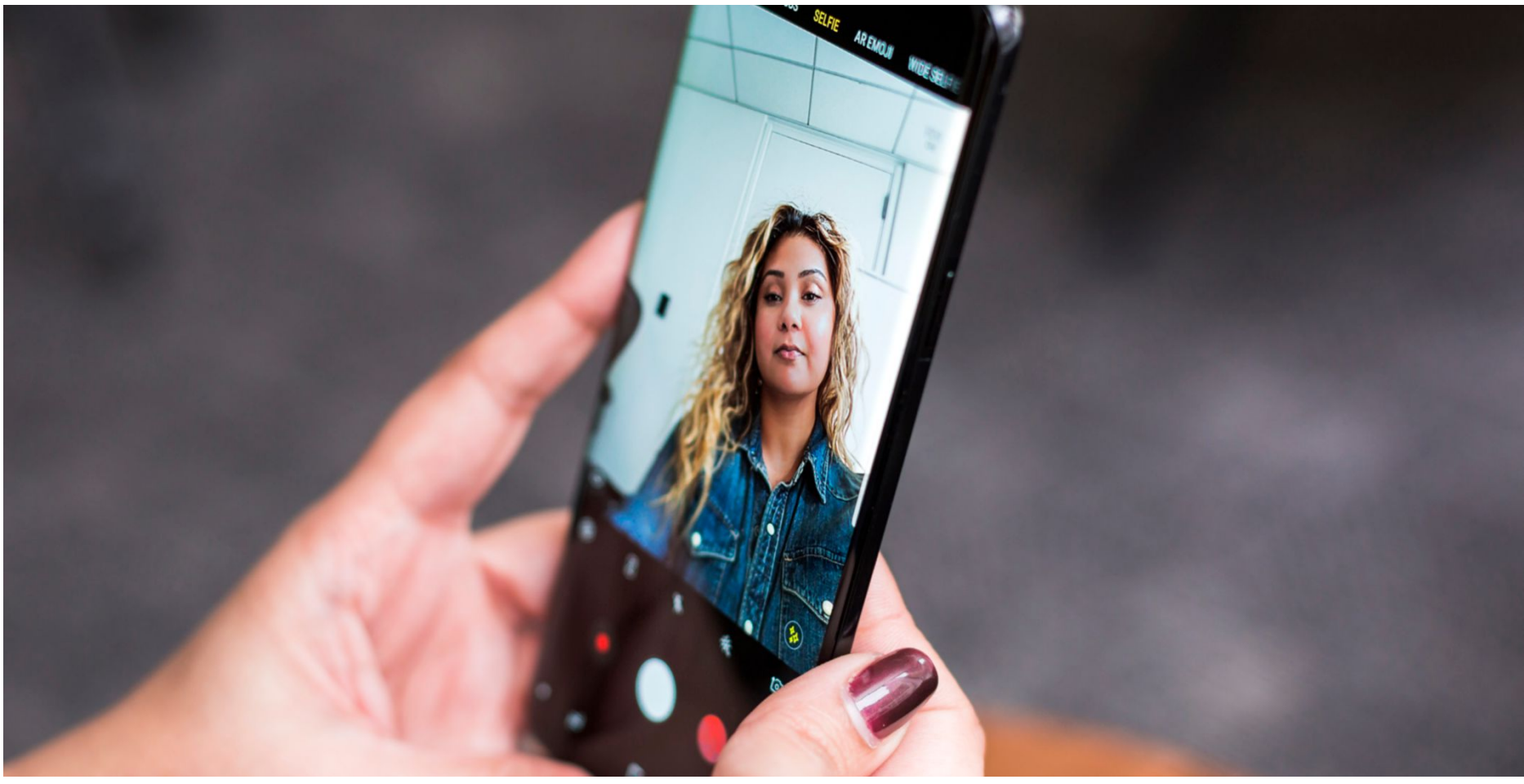
BRIGHTER VISION

The Galaxy S9+ has two primary 12MP cameras stacked on top of one another on the back. Both the S9 and S9+ have new, dual-aperture lenses that snap from f/2.4 or f/1.5 depending on lighting conditions. At light levels under 100 lux—basically, indoor lighting—they pop open to f/1.5, letting more light in. You can also control the change manually in the camera's Pro mode. You can actually see the iris open up when you look closely at the camera.

The front-facing f/1.7, 8MP camera is identical to the Galaxy S8's in our testing. But it has a new wide-selfie mode that combines selfie with a partial panorama and a software-operated selfie bokeh mode.

“It has a new wide-selfie mode that combines selfie with a partial panorama and a software-operated selfie bokeh mode.”

From a hardware perspective, the S9+ delivers on its promises. Its bright lens and sensor deliver images that exceed other smartphones in dim light, and on-sensor autofocus locks onto subjects very quickly. But the software employs some very aggressive sharpening that we're not big fans of.



On the S9+, the dual-aperture lens is the top one. The bottom one is an f/2.4 lens at 2x zoom. Both have optical image stabilization. The camera UI is a little slippery and sticky. I'm confident this will get worked out in a firmware update, but scrolling across the different camera modes—Pro, Auto, Slow-mo, and so on—sometimes jumped ahead and sometimes felt stilted, which is frustrating.

The idea behind the dual-aperture camera option is simple: crisper images when shooting in bright light with an f/2.4 prime and lower ISOs in very dim conditions with f/1.5. An f/1.5 lens captures about 2.6 times the light as an f/2.4.

Of course, you'll likely compare the S9+ with other handsets as opposed to dedicated cameras. The Note 8 has an f/1.7 prime, giving the S9+ a more modest 30 percent advantage in gathering light. The iPhone 8, 8 Plus, and X have an f/1.8 main lens, which means the S9+ gobbles up about 45 percent more light. This translates into either a shorter shutter speed, lower ISO, or a combination of both when you're working in dim light. Smartphone camera image quality suffers at high ISO settings, so this is a definite plus.

“Scrolling across the different camera modes—Pro, Auto, Slow-mo, and so on—sometimes jumped ahead and sometimes felt stilted.”

A brighter lens is great, but because of some software choices by Samsung, the results are mixed. At its default JPG output setting, images are significantly oversharpened. Close examination shows odd artifacts, especially in high-contrast areas—say, a dark object against a bright sky, a common situation in landscape and architectural photography. Even when viewed at screen resolution, modest halos are visible in these areas. This is fixable in software.

It's not a problem with the sensor. We looked at Raw photos, too, and they look great. You can definitely get more natural photos with crisp lines and without the too-sharp look, with a little bit of processing.

The effect is more pronounced at lower ISO settings. As we move to the high ISO range—the S9+ can be set manually up to ISO 800—the sharpened images, coupled with improvements in the underlying sensor technology, actually deliver more detail than the cameras from the S8+/Note 8 and iPhone 8/Plus/X. But it's not just the JPG engine that's doing it. The Raw sensor output from the S9+ shows more detail and less noise at ISO 800 than the Note 8 or iPhone 8 Plus main cameras, which means it's also better than those phones in dim light.

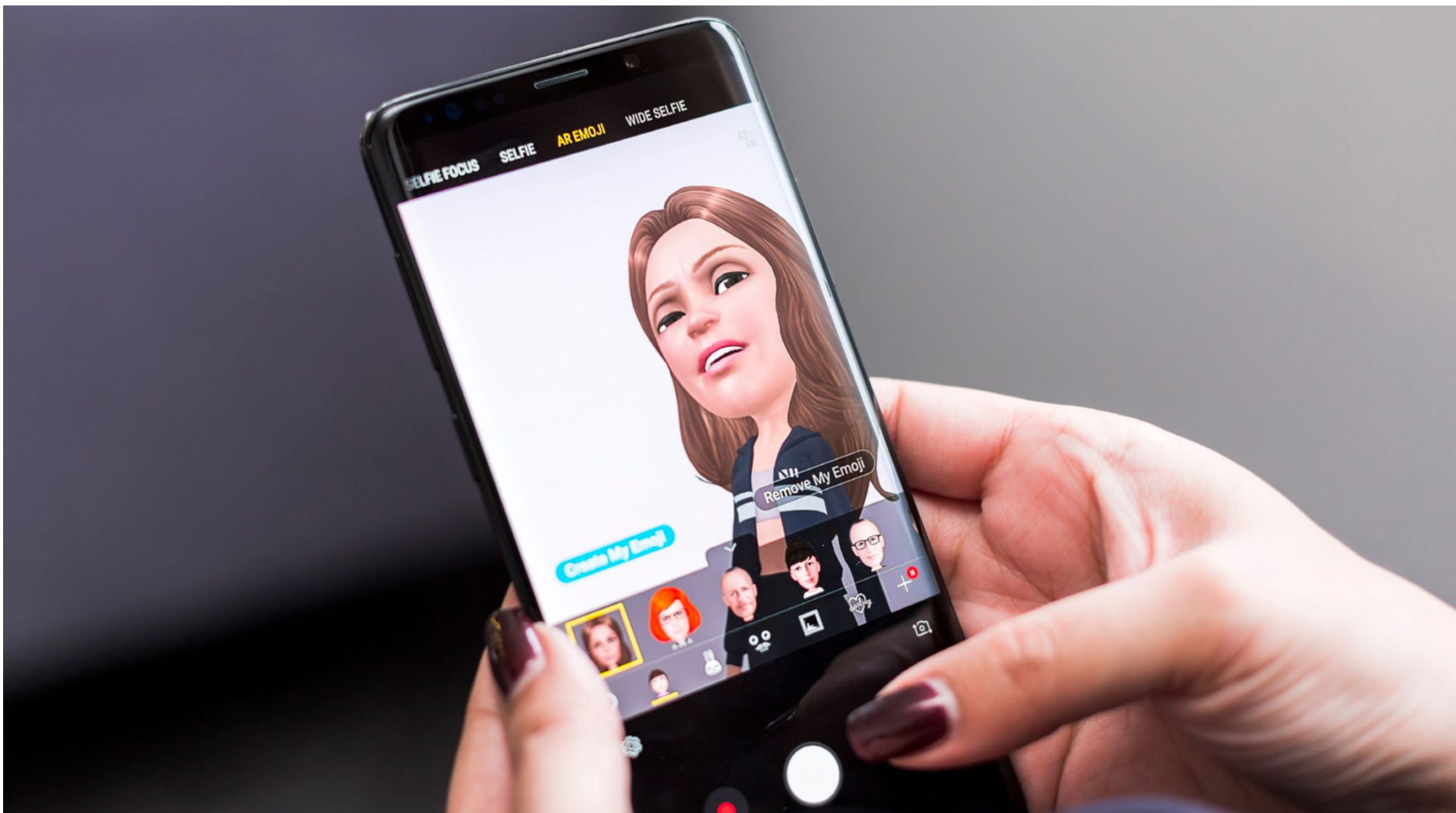
Videos are nicely optically stabilized, both at 1x and 2x, in up to 4K at 60 frames per second. The S9+ doesn't capture 4K HDR, though, and 4K60 capture is limited to five minutes per video.

Samsung also put memory right under the image sensor, the same way Sony has, to enable 960fps slow-motion. The GS9+ can capture up to 20, 0.2-second clips at that super-slow-mo level; it needs a moment to flush the memory buffer out after each clip. Because it's really difficult to guess which 0.2-second clip you're going to want, the camera has an auto-detect mode in which it starts recording normal video and then kicks into super-slow-mo when it detects motion in the frame. The super-slo-mo clip becomes a short video, but the GS9 also creates three 4MB highlight GIFs that have much smaller file sizes than the video, and are easier to share. That's some pretty great handholding for anyone who wants to post their slow-mo quickly to social networks.

I popped some balloons in slow-mo, and it worked fine. One thing to be aware of, though, is that the super-slow-mo mode records only at 720p, and the images can be very soft in indoor lighting. The more light you have at this speed, the better.

THE UNCANNY EMOJI VALLEY

Samsung's AR Emoji are a cross between Apple's animoji, which I haven't seen in the wild for months, and the cartoonish Bitmoji, which are a hideous plague on the internet. The concept: They construct a custom cartoon character from your face that can match your facial movements for photos and videos. The characters, though, live firmly in the uncanny valley, that land of somewhat-realistic dolls and zombie creatures that make you wince instead of laugh.



When I created a character for myself, it initially didn't look at all like me, because it had the wrong hair and no glasses. Tweaking the hair color, skin tone, and glasses helped a lot, but the animation still floated in that creepy realm between cartoonish and photorealistic. After thinking on it for a while, the problem wasn't that the face didn't look like me—the slight slackness and lag of the motion capture created the problem. That's part of why Apple's Animoji are cartoon characters, which you don't expect human expressions from.

After getting over the initial shock, I realized that the AR Emoji aren't bad at all when they're turned into GIF stickers. The phone autogenerates a range of GIFs from your image, and while they're ridiculous, they aren't disturbing.

You can also use the S9's motion-capture prowess with three cartoon characters and a variety of Snapchat-like masks for your selfies. They all move a little stiffly, because the S9 doesn't have the 3D face-tracking camera the iPhone X has on its front. Branded Disney characters are coming, Samsung says, but the animations will have to get more fluid and mobile to be compelling.

Samsung's software story continues in the S9's new Bixby camera modes. Bixby is Samsung's catch-all term for AI software features. It's a voice assistant, an extra home screen with informational widgets, and a bunch of intelligent camera modes. On the S8+, Bixby's camera modes identifies wine bottles and other products, reads QR codes, and translates languages. On the S9+, you can count the calories in food and shop for makeup by putting it on your face as a Snapchat-style filter.

The camera modes' quality varies, but they all feel like gimmicks you'll quickly forget about. Unfortunately, the most useful one, language translation, doesn't work well for many languages. It gave me a sense of Spanish and French in tests but totally failed with Bengali, Hebrew, and Russian, even though it says it supports those languages. The calorie counter mode is an awesome party trick and works surprisingly well, but it's of limited utility. Ultimately, nothing in Bixby would make you buy a phone and little that is better than a combination of Google Assistant and some third-party apps such as Microsoft Translate and Bitesnap.

COMPARISONS AND CONCLUSIONS

I don't think the past 12 months were a great innovation year for smartphones. That doesn't mean we're seeing bad phones; it means we aren't seeing game-changing phones. With in-display fingerprint sensors coming at the end of 2018 and 5G networks at the beginning of 2019, we're going to see some real innovation soon. For now, the S9+ just makes everything a little bit better.

It brings you dual cameras, a big battery, and lots of memory for $839.99 unlocked. We think that's worth paying $120 more than you would for the smaller S9, and it's less than you'd pay for the Galaxy Note 8 or the iPhone X. Wireless carriers are charging more for this phone, but unless you need Wi-Fi calling on AT&T or Verizon, you should get the unlocked model—it has no bloatware, has better resale value, and supports all US carrier bands.

This is an excellent phone, if an emotionally unexciting one. It's our Editors' Choice because it's the best at almost everything that other Android phones do, and it's not far from the best at the rest (mostly, camera JPEG encoding).

“Wireless carriers are charging more, but unless you need Wi-Fi calling on AT&T or Verizon, you should get the unlocked model.”

If you have a Galaxy S8, it's hard for me to argue that you toss away it away for a collection of meaningful but largely incremental improvements. If you have a Galaxy S7 or S6, on the other hand, this is a major upgrade, especially in terms of connecting to your carrier's fastest network. Compared with the Note 8, get the Note if you're going to use the pen. Get an S9+ if you aren't.

The S9+ doesn't change the "iPhone or Android?" calculus much. It puts the Galaxy line on a par with the iPhone 8 Plus in terms of having dual cameras, but the song remains the same. I prefer the Galaxy line over iPhones right now, because they have better radios, a real headphone jack, and what I think is a more attractive design, and the more I look at the iPhone X notch, the more I don't like it. A lot of people love iOS for its elegant third-party applications and Apple's absolutely unmatched network of high-quality service and support. They're not wrong.

Other Android smartphones can bring a quality experience for less money—they're also not quite as good. The Google Pixel 2 XL, for instance, lacks the GS9+'s secondary camera, has a slightly slower processor and a slower modem, and doesn't have as gorgeous a screen. It does, however, encode better JPEGs.

The Galaxy S9+ is the pinnacle of smartphone innovation right now. Like the Galaxy S8 did last year, it sets the bar for smartphone quality, and it's going to make life difficult for companies such as Motorola and Sony that are also trying to sell $700-plus smartphones. If price is no object, you aren't going to use a pen, and you aren't set on an iPhone, this is the one for you.

Jim Fisher contributed to this review.

SASCHA SEGAN

Ecovacs Deebot R95: A Solid, Versatile Robot Vacuum

Ecovacs Deebot R95

$549.00

The Ecovacs Deebot R95 does a lot more than your typical robot vacuum. For starters, it can also mop your floors. You can control it via app or Amazon Alexa, and it supports virtual boundaries you can draw right in the app. At $549.99, the Deebo R95 is on the pricier side, and it's held back slightly by its smaller-than-average dustbin and slightly bulky form factor. It's a solid choice for a robo-vac that can do it all, though the Roomba 690 offers comparable performance (minus mopping) for significantly less.

DESIGN

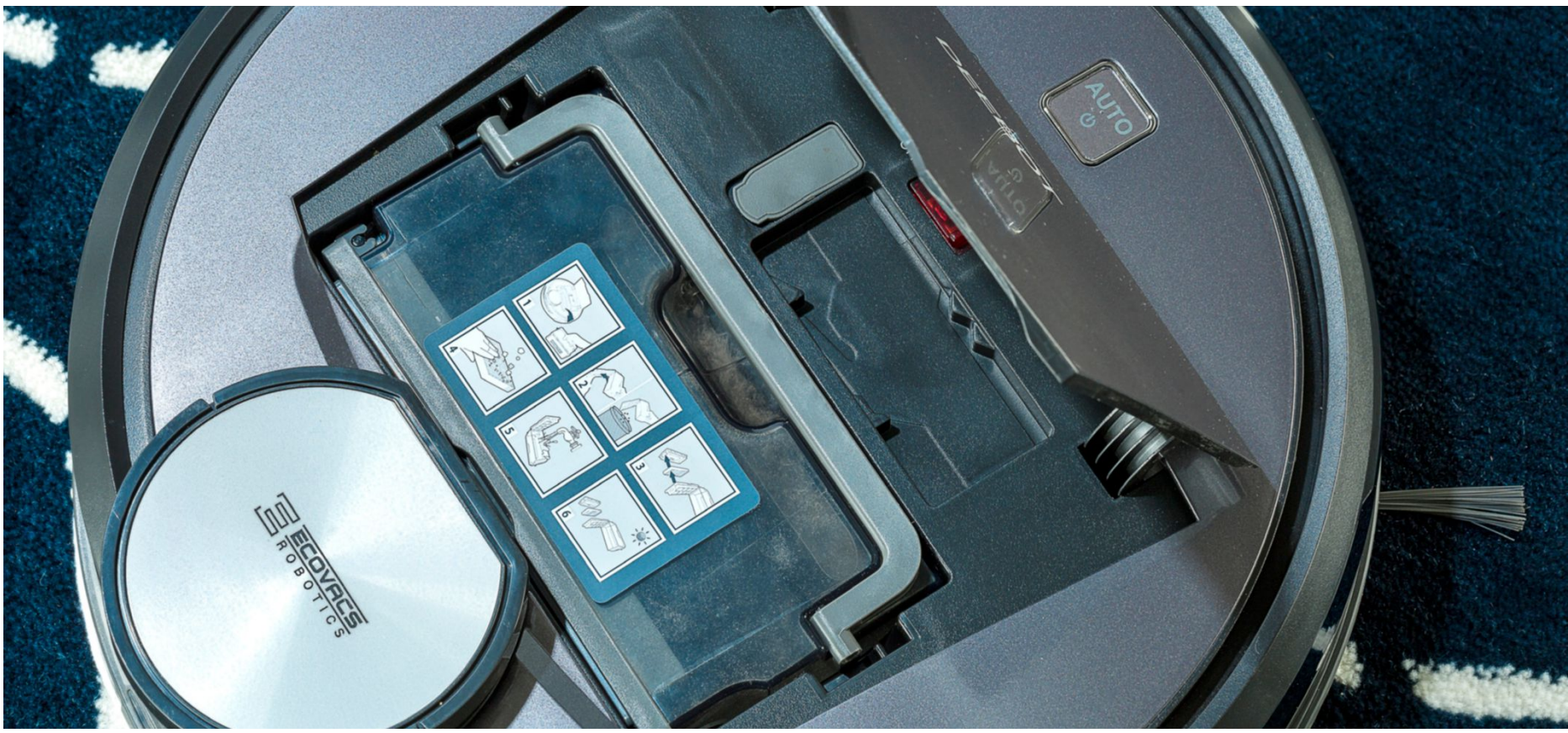
The Deebot R95 is large for a robot vacuum. It measures 13.9 inches in diameter and stands 4 inches tall. Compared with the 3.7-inch-tall Roomba 690, it's not as well-suited for low-clearance furniture.

The bot's body is gunmetal gray, and there's a fairly discreet lid on the top panel. When you flip it open, it gives you access to the dustbin and power switch. The dustbin is a bit smaller than usual, so you'll likely need to empty it out after each cleaning session. Also on top you'll find four indicator lights for Wi-Fi, Scheduling, Spot Cleaning, and Charging. A circular navigation sensor is on the side.

Ecovacs Deebot R95

PROS Comes with mop attachment. Good navigation capabilities with virtual boundaries. Works with phone app and Amazon Alexa.

CONS Small dustbin. Loud. May not fit under low-clearance furniture.



Turn the Deebot over, and you'll find two main treads, drop sensors, the brush compartment, charging contacts, and a swivel wheel. The mop attachment slots in easily down here; I'll discuss this more in a bit.

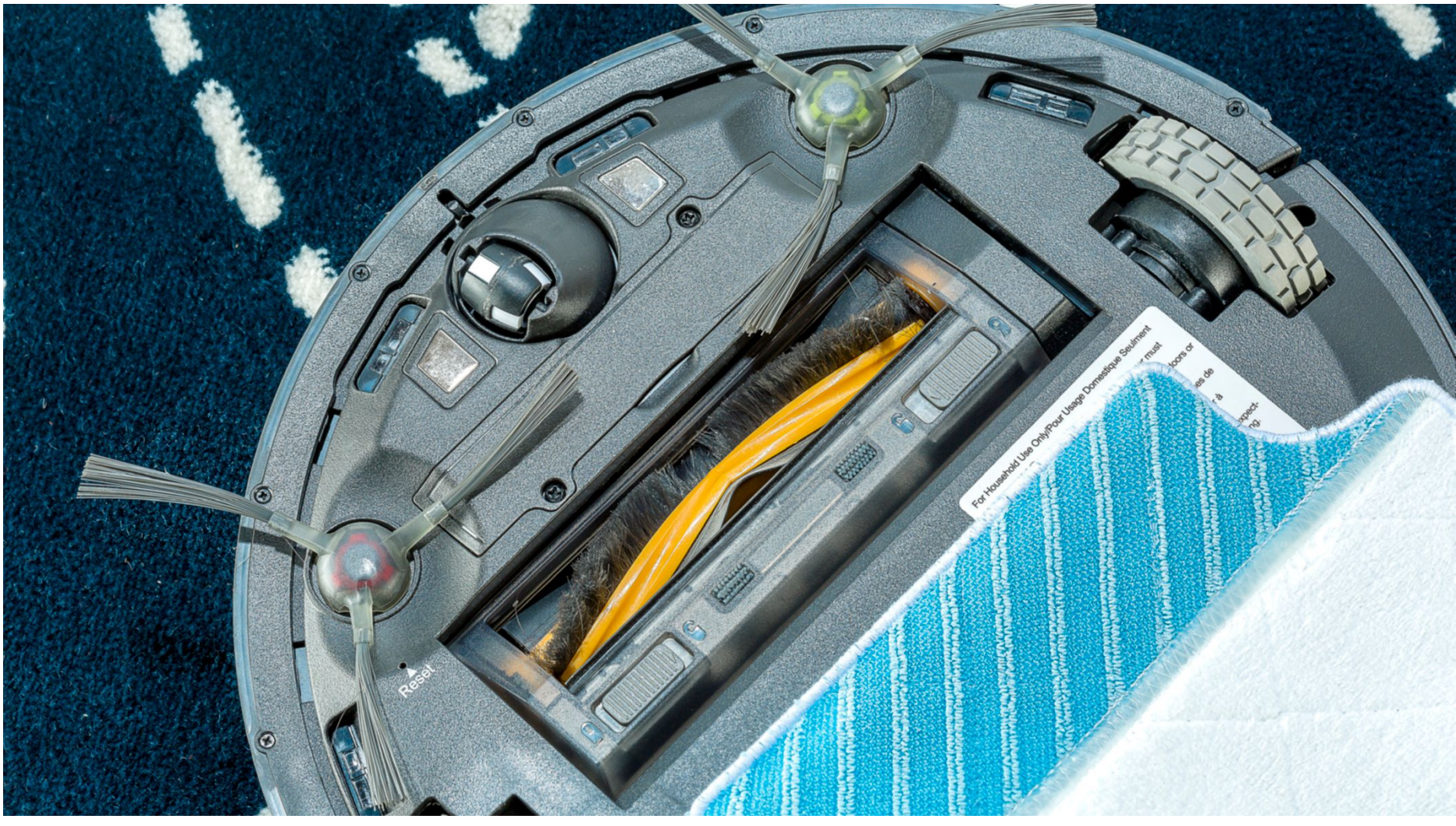
You get an assortment of accessories in the box. Along with the mop attachment and a charging dock are an extra brush, a water cup, a cleaning brush, a filter, an additional mop cloth, and two extra spin brushes.

SETUP, ALEXA, AND APP

The first step in setting up the R95 is to charge its battery by placing it on the dock. Then you download the Ecovacs app (Android or iOS). You'll be prompted to create an account, then select your bot from a list of models. Flip the Deebot R95 onto its back, locate and press the pinhole Reset button, and wait until you hear a beep. Once this is done, you can connect the R95 to Wi-Fi. Make sure your phone is connected to a 2.4GHz network, as the app doesn't let you select manually, and 5GHz isn't supported.

The app is easy to navigate: It has a clean and simple design, with the main screen divided into a map of your home and stats on the robot. You can start cleaning by tapping the Auto button at the bottom of the screen or send the vacuum to its dock by pressing Charge. To access more advanced features, tap the icon in the upper-right corner. This brings you to a menu where you can set schedules, toggle voice notifications, and view a work log.

The mop attachment slots in easily at the bottom of the Deebot R95.



Setting up Alexa is also easy. Just enable the Ecovacs skill in the Amazon Alexa app. Once that's done, you're prompted to enter your Ecovacs account information to link the Deebot R95. Using Alexa (via a device such as the Amazon Echo), you can ask the R95 to start or stop cleaning or to return to its dock.

PERFORMANCE

In testing, the Deebot R95 was able to easily pick up hair, debris, and other bits and bobs lying around my apartment floor. As with any robot vacuum, you have to take care to clear the floor of any loose cords, unless you want to untangle them later.

The R95 stands out when it comes to navigation. It scans your home, maps it, then follows a methodical back-and-forth cleaning pattern. In testing, it maneuvered around obstacles with little trouble. It was also able to traverse different floor types, including carpet, tile, hardwood, and even ridges without needing human assistance. You can toggle between different cleaning modes in case you need to take care of a specific mess.

I was also impressed with the R95's mapping ability. The first time you use it, the app tells you to run a diagnostic clean in order to access more advanced features. Of these features, the virtual boundaries are the most interesting. Basically, you draw a line or a block on the map demarcating areas you don't want the robot to enter. In testing, I used virtual boundaries to block off my roommate's bedroom and the Deebot avoided it accordingly. I also like that you can send it to a specific area of the house for cleaning. If you want to steer the bot yourself, however, you're out of luck. It doesn't come with a remote control, and the app doesn't have a drive function.

The R95 scans your home, maps it, then follows a back-and-forth pattern to clean your floors methodically.

Mopping performance isn't as strong. Unlike the iRobot Braava Jet 240 or Braava 380t, the R95 doesn't have a water tank. It's closer in function to the Bobsweep Pethair Plus: You have to manually wet the mop attachment cloth with soap and water. I found it was successful at making my kitchen floor damp, but it wasn't good at lifting tough stains. Ultimately, you'll get a deeper clean with a Swiffer and some elbow grease.

Noise-wise, the Deebot R95 is... loud. When it was cleaning my bedroom, I could hear it pretty clearly from the living room. On the plus side, its voice updates are pretty loud as well, and a female voice tells you exactly what's wrong when the robot encounters an issue.

As for battery life, the Deebot R95 is on a par with most other robot vacuums. It was cleaned my entire apartment in about 90 minutes before it needed a charge.

I found the Deebot R95 was successful at making my kitchen floor damp, but it wasn't good at lifting tough stains.

CONCLUSIONS

The Ecovacs Deebot R95 offers more features than you find in most robot vacuums, and most of those features work quite well. It's not the best at mopping, however, so it's hard to recommend over the Roomba 690, which doesn't mop at all but sells for nearly $200 less. If you want a robot vacuum that can do it all, the Deebot R95 is worth a look. If you want to save some money, the Roomba 690 is a better bet.

VICTORIA SONG

Sony Cyber-shot DSC-RX10 IV: Finest Bridge Camera Money Can Buy

Sony Cyber-shot
DSC-RX10 IV
$1,699.99
●●●●○

Since its introduction, Sony's RX10 series has delivered premium image quality in a fixed-lens bridge camera design (bridge cameras are styled like SLRs but feature fixed long zoom lenses). The fourth-edition RX10 IV upgrades the image sensor to include phase detection focus, so it can shoot at up to 24fps while tracking subjects. That's a big plus for sports and wildlife photographers who want to pack light—the camera has 600mm reach. It delivers better image quality than superzooms with small sensors, and it also offers best-in-class capture speed and autofocus. Not everyone needs this type of power, and you can save a few hundred dollars without sacrificing image quality by choosing the RX10 III, an Editors' Choice. But for those who don't mind paying some extra money for additional speed, the RX10 IV is worth the premium.

DESIGN

The RX10 IV is nearly identical to the RX10 III. The body is similar in size and shape to an SLR, but the lens is integral to the design rather than interchangeable. It measures 3.7 by 5.2 by 5.7 inches and weighs 2.4 pounds. The body is black with a mixed polycarbonate, rubber, and metal exterior and an internal magnesium alloy chassis. It's a weather-sealed design with enough protection to use in rainy or dusty environments.

The fixed lens is the same 8.8-220mm (24-600mm equivalent) f/2.4-4 design used by the RX10 III. It's tied for the longest in the class—the RX10 III uses the same lens, and the Canon PowerShot G3 X has a 24-600mm f/2.8-5.6 zoom, which is dimmer and slower to focus than the RX10 IV.

Other superzooms have longer designs, including the 65x Canon PowerShot SX60 HS. But they use smaller image sensors and narrower apertures. The RX10 IV uses a 1-inch sensor design with a surface area that's four times that of the 1/2.3-inch designs used in more affordable bridge models.

Sony Cyber-shot
DSC-RX10 IV

PROS 25x zoom lens. Large 1-inch sensor. Phase detect autofocus. 24fps Raw capture with tracking. Dust- and splash-resistant design. Touch LCD and EVF. Top info LCD. Wi-Fi. 4K video and 1080p slow-motion.

CONS Very expensive. No in-lens neutral density filter. Hood blocks flash at wide angles. Can't start a video when still buffer is in use.

In addition to the 25x zoom ratio, the lens doubles as a capable macro. It focuses to 1.2 inches at the wide angle and to 2.4 feet when zoomed all the way in, good enough for 1:2 magnification. There's a focus limiter switch on the barrel; when turned on, it disables macro capture, focusing only on subjects farther than 10 feet (3 meters) away. It speeds focus when you're photographing distant subjects.

Optical stabilization is rated to 4.5 stops by CIPA, and I found it worked a little bit better than that. I was able to capture consistently crisp images at 1/13-second when shooting at 600mm, better than 5 stops of compensation. The lens doesn't have an integrated neutral density filter (included in the shorter zooming RX10 and RX10 II). If you're a fan of long exposure photograph or want to keep your video shutter speed lower to maintain a traditional shutter angle, you'll want to invest in a set of 72mm ND filters.

It delivers better image quality than superzooms with small sensors, and it also offers best-in-class capture speed and autofocus.

Along with the limiter switch, the barrel has a focus hold button that prevents autofocus from activating. The lens has a physical aperture ring that can be set from f/2.4 through f/16 in third-stop increments or turn freely without detents. Knurled metal zoom and manual focus rings are also on the barrel.

On top of the camera, the lens barrel has markings to show at which focal length it's set.

The focus adjustment toggle rounds out the front controls. It can be set to AF-S (Single), AF-A (Auto), AF-C (Continuous), or DMF (Direct Manual Focus) modes. AF-A switches between single and continuous focus based on the scene, and DMF lets you override autofocus at any time using the manual focus ring.

The LCD is a 3-inch 1,440k-dot panel with touch support. It's bright and sharp and tilts up or down, but it doesn't swing out from the body or face all the way forward. That's a shame, considering how good a video camera the RX10 IV is.

Touch functionality is also limited. You can tap to set a focus point, but you can't navigate menus via touch. Sony does include Touch Pad focus adjustment, though. When the camera is to your eye, you can slide your finger across the LCD to move the active focus point. It works—but not as well as a dedicated focus control.

The electronic viewfinder is big, bright, and sharp. It has a 0.7x magnification factor, an OLED design, and a 2,359k-dot resolution. Its eye sensor turns on and off automatically as you bring the camera to your eye, and Sony has eliminated the sensitivity issue that plagued the first two RX10 models; it's difficult to accidentally trigger the eye sensor with your body, and it doesn't work at all when the screen is tilted out.

CONNECTIVITY AND POWER

The RX10 IV includes Bluetooth, NFC, and Wi-Fi. It can pair with Android and iOS devices to transfer images or videos or for remote control. Image transfers are quick—the camera resizes images to 2MP to speed things up—but video transfer, especially when you're shooting at 4K, can take a while.

Physical connections include the multi-interface hot shoe, which can accommodate an external flash or Sony's XLR audio adapter, 3.5mm headphone and microphone jacks, micro HDMI, and micro USB. The battery charges in-camera via USB; Sony doesn't include an external charger with the RX10, just a cable and a USB-to-AC adapter.

The included battery is good for about 400 shots using the rear LCD, 370 shots with the EVF, or up to 75 minutes of video per CIPA standards, which should get you through a full day of shooting.

The RX10 IV includes two rear control wheels and customizable button controls. The LCD is a 3-inch 1,440k-dot panel with touch support. It's bright and sharp and tilts up or down, but it doesn't swing out from the body.

The single memory card slot is on the right side, separate from the bottom-accessible battery compartment. It supports SD, SDHC, SDXC, and Memory Stick Duo formats. Its speed rating tops out at UHS-I, so you can't take advantage of the speed offered by the latest ultra-fast UHS-II SD cards.

PERFORMANCE AND AUTOFOCUS

Because its lens has to extend to start shooting, the RX10 IV is a little slow to power on, focus, and capture an image—it takes about 2.3 seconds to do so. That's par for the course for a superzoom camera. But its autofocus system is very speedy, locking on almost instantly when you're shooting in bright light and managing a 0.4-second focus lock in very dim conditions.

And it's the autofocus system and burst rate that really set the IV apart from the RX10 III. Though you can shoot JPGs at 14fps and Raw images at 8fps with the III, the IV ups the burst rate to a staggering 24fps, even in Raw format, and adds on-sensor phase detection for better subject tracking.

Shooting fast-moving action—a soccer match, for example—is something you can do more effectively with the RX10 IV than with the III, even though shooting at 24fps is an overkill for many subjects and can fill up your memory card quickly. You can still take advantage of the faster focus system when dialing the burst rate down to a more reasonable 10fps by setting it to medium instead of high.

The shooting buffer is large enough to hold 105 Raw+JPG, 106 Raw, or 228 JPG shots when shooting at 24fps. Clearing it to a memory card does take some time—70, 50, and 75 seconds respectively, when paired with the fastest UHS-I card we had, rated at 95MBps. I'd prefer the slot was UHS-II, which could cut buffer clear times by a third, as you can't start recording a video when there are any images left in the still buffer.

You have some different options in terms of focus area. The default setting is Wide, which covers about 65 percent of the sensor with phase and contrast detection points. You can couple this with EyeAF for the best results when photographing people. It will try to detect and focus on your subject's eyes and falls back to standard face detection when it can't identify an eye.

You can override the Wide area by tapping on the rear screen; that changes the focus mode to Flexible Spot, which looks for focus in only a small area of the frame. You can also set the camera to use the Flexible Spot at all times (with Small, Medium, and Large options available for the spot size), Center point only focus, or Lock On Flexible Spot. The latter is available only in Continuous focus mode; it identifies the subject under the spot you select and tracks it as it moves through the frame. In any focus mode, small green dots dance in the viewfinder to let you know what the camera is focusing on.

I tend to use the Wide focus area when shooting with the RX10 IV, in combination with EyeAF when photographing people. The camera does a good job of picking the focus point, but there are times when you want to control it completely. Using the Touch Pad AF function to move the focus area around works, but I don't think it's as responsive as it should be. It can take a few swipes to move the point from the right to left side of the frame. You can opt to set it Absolute positioning, which means that tapping to the left of the touch area (configurable via the menu) moves the point to the left immediately, but I found that even more frustrating to use than the default Relative mode.

I'd love to see Sony add a dedicated focus joystick control to the body, as it has with its latest full-frame mirrorless cameras. That would go a long way toward improving this one aspect of operation. Perhaps we'll see it in the inevitable Cyber-shot RX10 V.

IMAGE QUALITY

The 20MP 1-inch image sensor is about four times the size of the sensors used by most superzoom cameras. It measures 13.2 by 8.8mm, for a surface area of 116mm2; that's about a third of the size of the APS-C sensor you find in consumer SLRs.

I used Imatest to analyze its performance when capturing images at various ISO settings. The RX10 IV has a native range of ISO 100 through 12800, with low extended settings available at ISO 64 and 80. ISO 25600 is supported, but only when using Multi-Frame capture and blending.

When shooting JPGs at default settings, the camera keeps noise under 1.5 percent through ISO 3200, about what we expect from this sensor type—the 20MP 1-inch design is used in many premium compact models, including competing options from Canon and Panasonic. But only Sony has this stacked design with on-sensor phase detection.

The RX10 IV's body design mimics that of an SLR, but the lens isn't removable, and the camera uses an EVF rather than an optical viewfinder.

There is certainly some noise reduction going on to net these results. To my eye, images shot through ISO 800 are perfectly crisp, with no evidence of noise reduction or grain. At ISO 1600, the very tiniest details of our test image lose some crispness, but are still distinct. There's some visible smudging at ISO 3200, so these lines start to run together a bit. The smudge effect is more pronounced at ISO 6400, but still fine for web resolution and smaller prints. It gives way to a more blurred look at the top standard setting, ISO 12800.

Shooting in Raw format, you can squeeze more clarity out of photos at higher ISOs. There's more grain in shots captured at ISO 1600 than with a JPG, but details are clearer. That holds true as speed ramps up; details are notably crisper in the ISO 3200 Raw image. Noise cuts into image quality at ISO 6400, so you get a grainier image with a little bit more detail than the JPG, as is the case at ISO 12800.

“To my eye, images shot through ISO 800 are perfectly crisp, with no evidence of noise reduction or grain.”

The RX10 IV has a brighter lens than many other superzooms. It captures more light at every equivalent angle of view when compared with the Canon G3 X (f/2.8-5.6) and small-sensor SX60 HS (f/3.4-6.5). But the lens isn't just bright, it's also really sharp.

At 24mm f/2.4, it scores 2,362 lines per picture height on a center-weighted sharpness test. Most of the frame meets or exceeds the average score, although edges (1,809 lines) fall behind. They still match the 1,800 lines we want to see at a minimum from a 20MP camera, however. Narrowing the aperture improves edge quality—they show 1,986 lines at f/2.8 and 2,345 lines at f/4. The average also improves—2,601 lines at f/2.8, 2,925 lines at f/4, and 2,856 lines at f/5.6. After that diffraction sets in and limits image quality; you should avoid shooting at f/11 (1,852 lines) and f/16 (1,215 lines) when possible.

By 100mm the lens has narrowed to f/4, but image quality doesn't take a step back. We see 2,839 lines on average, with excellent performance from center to edge (2,632 lines). There's not much change at f/5.6 (2,843 lines) or f/8 (2,573 lines), but we see a big drop at f/11 (1,768 lines) and f/16 (1,203 lines). Zooming all the way in to 600mm takes a toll. At f/4 the lens scores 2,121 lines on average, but edges are weak (1,480 lines).

You don't have to worry about distortion or darkened corners. The RX10 IV applies corrections to both Raw and JPG images to remove both. Most Raw converters will recognize the corrections, although you may be forced to make them yourself if you stray too far from Lightroom or Capture One.

Overall, the lens is an excellent performer, better than one with a bright design and 25x zoom power has any right to be. But that's what you expect from a camera that costs this much. You can get the Canon G3 X for a lot less money, but its lens doesn't hold up as well when zoomed all the way in, nor does it capture as much light. (And the G3 X is plagued by slower autofocus, making action shots difficult.)

VIDEO

The RX10 series has always been capable for video, even with the first model that was released in the 1080p era. Every iteration since then has supported 4K capture. The IV captures 4K footage at 24 or 30fps, with your choice of 60 or 100Mbps XAVC S compression. If you're happy with 1080p, you can capture video at 24, 30, 60, or 120fps at bit rates ranging from 16Mbps (to save space on the card) through 100Mbps (for best quality), also in XAVC S.

It's not just about resolution. The RX10 IV adds SLog3 to its laundry list of picture profiles (the RX10 III supports SLog2). Shooting in a log format reduces contrast, so more dynamic range is preserved in your video. But it requires you to apply a color grade using software to make the footage look good—if you're a pro who knows how to color correct, you're familiar with the process.

In addition to pro-level video profiles, the RX10 IV supports an external microphone. Vloggers and travel videographers will be happy with an on-camera shotgun microphone connected via 3.5mm. But for more serious work you can buy Sony's $499 XLR add-on and connect a balanced microphone.

The camera can also go beyond 120fps if you need slower slow-motion. It has an HFR setting on the Mode dial—High Frame Rate. You can set it to record footage at 240fps, 480fps, or 960fps and to play back at 24fps, 30fps, or 60fps, giving you a varying range of slowdown. I'm a big fan of 240fps at 24fps, a 10x effect. There are a bevy of options for HFR, including when to start the clip and the quality of the capture—the high quality mode captures four seconds of real life, and the lower quality option extends that to seven seconds.

All HFR is output at 1080p quality, but not all 1080p is created equal. The 240fps looks the sharpest, and the 960fps is a bit soft and also cropped. You also need a ton of light to shoot at 960fps—the camera needs to use at least a 1/960-second exposure for each frame in order to reach that speed.

There are a couple of caveats for using HFR. First, the camera has to buffer footage before it can start recording. You can start the buffering process well in advance of starting the video, but focus and zoom are locked once the buffering starts. Second, and more annoying, is the amount of time that it takes to render the video. When you are shooting at 240fps and playing back at 24fps, a full clip takes about 45 seconds to render—which is how long it takes to save the movie file to the card. When you're shooting at 960fps in high-quality mode, you can wait for more than two and a half minutes for the video to be ready. While the video is processing, you can't use the camera for anything else, although you can cancel at any time.

But for the right scene, the effect is worth the wait. And you can always shoot at 120fps 1080p in standard mode for a more modest slow-motion effect without the stringent requirements of HFR capture.

CONCLUSIONS

The Sony Cyber-shot DSC-RX10 IV is the most feature-filled—and most expensive—model yet. It keeps the same 24-600mm f/2.4-4 lens as the RX10 III (now around $1,400) but adds on-sensor phase detection for quicker focus and a staggering 24fps burst capture rate, even in Raw mode. It goes beyond what other bridge cameras can do, delivering a zoom range that covers all but extreme telephoto shooting, 20MP of resolution, and the image quality of a 1-inch sensor, which is beyond what smaller-sensor cameras can deliver.

It wraps it all up in a tough, weather-sealed body, with a crisp EVF and tilting touch LCD. Video features are also strong, with both crisp 4K capture and extreme slow-motion at 1080p available. The RX10 IV is the finest bridge camera money can buy.

But it takes a lot of money to buy it. There's no doubt it is more full featured than the RX10 III, but it doesn't replace that model in Sony's lineup. We continue to recommend the RX10 III to most photographers searching for a high-end bridge model. It is more than enough camera for most purposes and costs $300 less. But if you're not as sensitive to price, or if you shoot subjects where an improved burst rate and focus system will come in handy—typically sports and wildlife—then spend the extra money on the RX10 IV.

JIM FISHER

"There are a couple of caveats for using HFR. First, the camera has to buffer footage before it can start recording."

Lenovo ThinkPad X1 Carbon: Premium Features in an Attractive Package

PC MAGAZINE EDITORS' CHOICE

The sixth-generation Lenovo ThinkPad X1 Carbon is more of a status symbol than the workhorse ThinkPad that business users know and love. But incredible battery life and a pleasingly premium soft-touch chassis, among other features, make this ultraportable laptop far more than a gimmick. It even brings back a few things that Lenovo had removed from last year's model. All told, the X1 Carbon delivers most of what we love about the ThinkPad T470 in a much smaller package, which makes it the best high-end laptop you can buy for your business.

Lenovo ThinkPad X1 Carbon
(2018)

Starts at $1,369.00

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FAMILIAR LOOKS

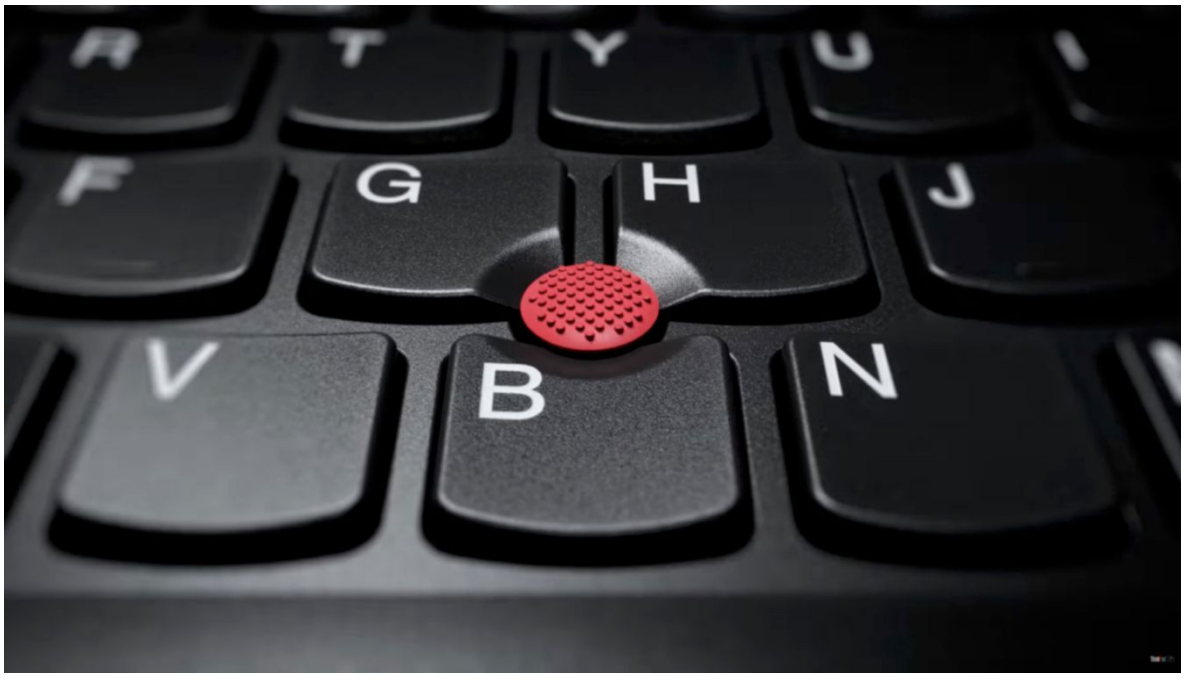
The consumer ultraportable laptop market is flooded with head-turning designs (see, for instance, the vanishingly thin bezels on the Dell XPS 13 or the snow-white expanses that adorn the HP Spectre 13), but ultraportables meant for business can be far more stodgy. Lenovo is somewhat responsible for this trend, since its chunky black ThinkPad notebooks have been the gold standard in enterprise mobile computing for years.

With the newest X1 Carbon, however, Lenovo fuses a traditional black aesthetic—complete with a slightly soft exterior of carbon fiber and magnesium alloy that makes it feel premium—with a thin screen bezel and a light weight. The result is an ultraportable that weighs just 2.49 pounds, measures 0.63 by 12.74 by 8.55 inches (HWD), and still manages to fit in legendary ThinkPad characteristics such as a comfortable keyboard, long battery life, and a semi-rugged enclosure. The ThinkPad T470, by contrast, is 0.79 by 13.25 by 9.15 inches and weighs 3.74 pounds.

Lenovo ThinkPad X1 Carbon (2018)

PROS Premium build quality. Thin and light. Very good battery life. Quick charging.

CONS Expensive. Finicky touch screen. Anemic speakers. No Ethernet port.



And in case you're wondering, Lenovo throws in a red pointing stick to please the most discerning ThinkPad purists. Why you'd still use one is a bit of a mystery, though, since Lenovo has also brought back a touch display, which was missing from the last generation of the X1 Carbon.

Lenovo throws in a red pointing stick to please the most discerning ThinkPad purists.

You can upgrade to either a glossy or matte QHD (2,560-by-1440) display that lacks touch capability. This high-end screen is targeted at well-heeled enthusiasts rather than corporate IT departments, Lenovo said at CES this year when it unveiled the new X1 Carbon. The glossy version promises to be the first HDR laptop screen once an update is rolled out this spring to unlock the Dolby Vision functionality on the software side. You'll likely take a battery-life hit by choosing this configuration, though.

The 14-inch full HD (1,920-by-1,080) touch screen on our base model Carbon X1 is still unique, in both good and bad ways. Instead of adding weight and complexity to the screen by enabling touch the old-fashioned way, with a protective layer on top of the display, Lenovo added capacitors directly into the screen. The result is a matte, anti-glare touch display that's perfect for bright office environments and easy on the battery but also includes touch for when you need it.

Ideally you won't need it too often, though, because the unconventional integrated capacitors are much less precise than you might expect. The X1 Carbon's screen isn't very responsive; whether that's a worthy sacrifice for an anti-glare screen is a matter of personal preference.

Along with the screen, you can also upgrade the memory, storage, and hard drive (which will increase the price to more than $2,000). You can also choose a silver version that ThinkPad purists will likely scoff at. This entry-level model is equipped with an eighth-generation Intel Core i5 processor, 8GB of RAM, and a 512GB SSD. The processor and memory might initially seem a bit anemic for a laptop that costs more than $1,700, but they can handle most common computing tasks with aplomb.

LUXURIOUS KEYBOARD

When you're not tapping, you'll be luxuriating in the X1 Carbon's backlit island-style keyboard, which boasts excellent travel and supremely sturdy, sculpted keys. This is largely the same board we loved on the ThinkPad T470, and the fact that Lenovo manages to stuff it into a much thinner chassis is impressive. I appreciate that the Fn and Control keys are swappable using the Lenovo settings app, which means you can decide if you'd like the outermost key to perform the Control function as it would on a standalone keyboard.

The clickable touchpad is better than you'd expect for a Windows laptop, but it's rather small and can't match the excellent Force Touch capabilities nor the gargantuan size of the one on the MacBook Pro. Next to the pad is a fingerprint reader with its own processing chip: This lets it verify your prints on the chip without Windows having access to them, a new security enhancement on this year's X1 Carbon that's sure to please wary security managers. Other corporate-friendly features include Intel's vPro management and an integrated cover for the webcam when you're not using it, but the laptop has no keycard functionality like you'll find on a business workstation.

“The clickable touchpad is better than you'd expect for a Windows laptop, but it's rather small.”

The port selection is excellent for such a thin machine. Unlike Apple, which equips the MacBook Pro solely with USB-C ports, Lenovo gives business users several more options. The X1 Carbon has two USB-C ports with Thunderbolt 3 support that are also used for charging, as well two USB 3.0 ports and an HDMI-out port. The left edge features a dock connector for the new ThinkPad dock (old ones that connect to the bottom of the laptop won't work), and a Kensington lock slot is on the right. A microSD card slot is on the back of the laptop, in the same enclosure that houses the SIM card for cellular-equipped models.

Your only disappointment will be if, like us, you expect to find an Ethernet port on your business laptop, which can make your life much easier when you encounter poor Wi-Fi in a hotel or crowded banquet hall but manage to find a wired connection. At least there's 802.11ac Wi-Fi and Bluetooth 4.2 to help you stay connected.

Impressive audio isn't expected on an ultraportable, and the X1 Carbon didn't surprise us. It offers present if not startling bass and treble, but the downward-firing speakers aim directly at your desk or lap, resulting in an anemic sound.

Instead of adding weight and complexity by enabling touch with a protective layer on top of the display, Lenovo engineers instead added capacitors directly into the screen. The result is a matte, anti-glare display that is perfect for bright office environments.

Lenovo includes a one-year warranty with mail-in hardware support for the X1 Carbon laptop.

POWER ON THE GO

Let's face it: You're not buying ultraportables for the multimedia content creators, programmers, and data scientists in your company. You're buying them for workers whose jobs entail word processing, email checking, and maybe some light Excel work. The Intel Core i5-8250U processor running at 1.6GHz with integrated graphics should be more than adequate for these tasks, even though you can find more powerful processors for less money in consumer ultraportables.

As proof, the X1 Carbon turned in a respectable score of 3,363 on the proprietary PCMark 8 benchmark test, which is within a few hundred points of its competitors—even within striking distance of the HP EliteBook 1040 G4 and its more powerful Intel Core i7. Any PCMark 8 score above 3,000 indicates more than enough juice for basic computing tasks. On a more anecdotal level, app loading was snappy, and startup times were lightning fast—less than 10 seconds—over several days of heavy use.

Tasks such as rendering video footage and editing photos are better suited to laptops with discrete graphics cards and CPUs with more processing cores. Still, note that X1 Carbon was faster than the MacBook Pro on our Handbrake video-encoding test, our Cinebench 3D-rendering benchmark, and our series of Photoshop editing tasks.

Gaming performance is predictably subpar, with neither the X1 Carbon nor any of its Windows competitors turning in frame rates higher than 30 frames per second, which we consider to be the absolute minimum threshold for enjoyable gaming. Thanks to its superior Intel Iris Plus graphics card, the MacBook Pro offers slightly better frame rates, but it's still not a substitute for a machine with a dedicated graphics card.

The X1 Carbon's fans spooled up during the benchmark tests, producing audible exhaust noise, but they were silent during a weekend of mixed regular use, including web browsing and Netflix-watching. That's a huge benefit that this laptop shares with the MacBook Pro over similar consumer ultraportables, such as the Asus ZenBook UX430U, which produces audible fan noise even during casual tasks like web browsing.

Battery life is excellent, as you'd expect from a Lenovo laptop. I was on the edge of my seat during our battery rundown test, wondering if the X1 Carbon would outlast the ThinkPad T470's excellent result of 17 hours and 36 minutes. Alas, it did not, coming in just a few minutes short at 17:26. That is still very impressive—even more so when you consider that the T470 requires two batteries to last that long. No other business ultraportable comes close.

When charging, you can fill up the battery from empty in less than an hour and a half, thanks to Lenovo's quick-charging technology.

EVERYTHING EXCELLENT IN A SMALLER PACKAGE

For road warriors who value portability and are blessed with generous IT budgets, it doesn't get much better than the Lenovo ThinkPad X1 Carbon. This ultraportable takes nearly everything there is to love about full-size ThinkPads and puts it in a much smaller but just-as-good-looking, package. From all-day battery life to a wonderfully comfortable keyboard, the X1 Carbon's features list is made for business and will please even enthusiasts, with cutting-edge options including an HDR display. For all these reasons, it's our Editors' Choice for business ultraportables.

TOM BRANT

HP Omen X Compact Desktop and VR Backpack

PC-tethered virtual reality systems offer the most compelling VR experience and the best control options. The tether is always inconvenient, though, and wandering around a virtual space is hazardous when you're dragging a cable that's connected to a PC on a desk. HP offers a wearable solution: the Omen X Compact Desktop. This system is a small-form-factor gaming PC designed to be worn on your back with the optional VR Backpack ($499.99). It's a capable PC in its own right, but it's an awkward solution to a problem that can be solved more elegantly with wireless adapters and standalone headsets. The combo works as advertised, and the Omen X desktop on its own may be worth your consideration, but you can spend your money more practically.

HP Omen X Compact Desktop and VR Backpack

$2,499.00

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COMPACT DESKTOP DESIGN

The Omen X Compact Desktop is a flat, irregular black-plastic octagon with red backlit highlights on one panel. It's comparable to a high-end gaming notebook in size, measuring 13.1 by 2.4 by 9 inches (HWD) and weighing 5.5 pounds. The top edge holds most of the system's connectors, including two USB-A ports, a USB-C port, an HDMI port, a Mini DisplayPort, a 3.5mm headphone jack, and a power connector. The power button sits to the right of these ports, on the top-right corner.

The bottom edge of the Omen X Compact Desktop holds a wide, proprietary data connector; two large, two-pin power connectors; and two physical mount holes for use with the included dock. The back panel features a series of flat mounting brackets built into the computer's plastic body for use with the optional backpack kit, which we'll detail shortly.

HP Omen X Compact Desktop and VR Backpack

PROS Fast gaming performance in small form factor. Enables desk-free VR experience. Easy to dock. Many ports. Hot-swappable batteries for long sessions.

CONS Expensive. VR experience is clumsy. Many parts to set up and store. Individual batteries don't last long.

You can use the Omen X Compact Desktop by simply laying it down flat on a desk like a laptop and plugging in a display, mouse, and keyboard. The PC has relatively few ports, and when lying flat, it takes up a fair amount of table space—you can't stack anything on top of it. But you also get a desktop dock, which holds the system upright to save space and, thankfully, adds several additional ports.

The Omen X docked in its base, with the power brick on the left and the battery charging base on the right.

The front of the dock holds two more USB-A ports and a USB-C port. The back adds three more USB-A ports, an HDMI port, an Ethernet port, a full-size DisplayPort, two power connectors, and a Kensington lock slot. Also, the ports on the top of the Omen X Compact Desktop are exposed in this orientation, so you can still use them as well.

The dock is an 11.9-by-5.1-by-4.9-inch trapezoidal ingot with a wide slot at the top where you can insert the desktop. The aforementioned data and power connectors lock into the dock, and the two mount points attach to metal pins that hold the system in place. The dock mechanically locks when the PC is inserted, preventing you from accidentally pulling it out; a button to the right of the slot releases the PC.

When the desktop is standing in the dock, it measures 14.96 by 6.9 by 7.87 inches and is similar to the size of some of the best small-form-factor gaming desktops, such as the Falcon Northwest Tiki and the Corsair One Pro. Inside, the Omen X is pretty well equipped. Only one configuration is available, which includes a 2.9GHz Intel Core i7-7820HK processor, 16GB of memory, and the mobile version of Nvidia's GeForce GTX 1080 graphics card. As the benchmark results below demonstrate, it's a solid gaming system built into a small body.

“You can use the Omen X by laying it down flat on a desk like a laptop and plugging in a display, mouse, and keyboard.”

VR BACKPACK

The Omen X Compact Desktop is oddly shaped to make it a potentially wearable computer, but you can't wear it out of the box. The optional VR Backpack lets you mount the computer on your back for VR gaming or simple PC transport. But since so much of the desktop's design is built around—or at least made to work with—the VR Backpack, it strikes us as odd that they aren't always sold together. The desktop is functional in its own right, though it's safe to say the market for the backpack add-on is pretty limited.

The name “VR Backpack” is a misnomer; it’s actually a padded harness with no pockets. A raised, sturdy plastic surface with mounting points extends a few inches off of the back of the harness for holding the Omen X Compact Desktop. The computer locks securely onto the mounting points and stays in place until you press a small tab on the top of the plate. It’s very easy to slide the computer into the harness, it locks in on its own, and it never felt like it was going to fall off during testing.

The wearable part of the harness consists of two large padded shoulder straps attached to a padded belt with a plastic buckle in the front. A smaller, unpadded nylon strap extends from the shoulder straps to buckle around your chest. The result is a comfortable, well-balanced fit that feels similar to a camper’s pack. It’s safe to say you’re not going to look like the coolest person in town wearing it, but you’re not trying to win any fashion contests while playing at home. The price seems steep for what amounts to a harness, two sets of batteries, and charging dock, though.

The Omen X desktop has an internal battery so it can work outside the dock, but the backpack comes with hot-swappable batteries that provide the main juice. The backpack has battery holsters on either side, with power cables that screw into the bottom of the desktop while it’s in the backpack. It’s a little finicky to set up, but straightforward enough. The backpack comes with a charging base for the hot swappable batteries, which you power through a connection on the Omen X Compact Desktop’s dock. The batteries have power indicators, so you can see their status, and since there are four of them, you can always have a pair charging while the other is in use.

The optional VR Backpack allows you to take the Omen X desktop on the go—or at least away from your desk.

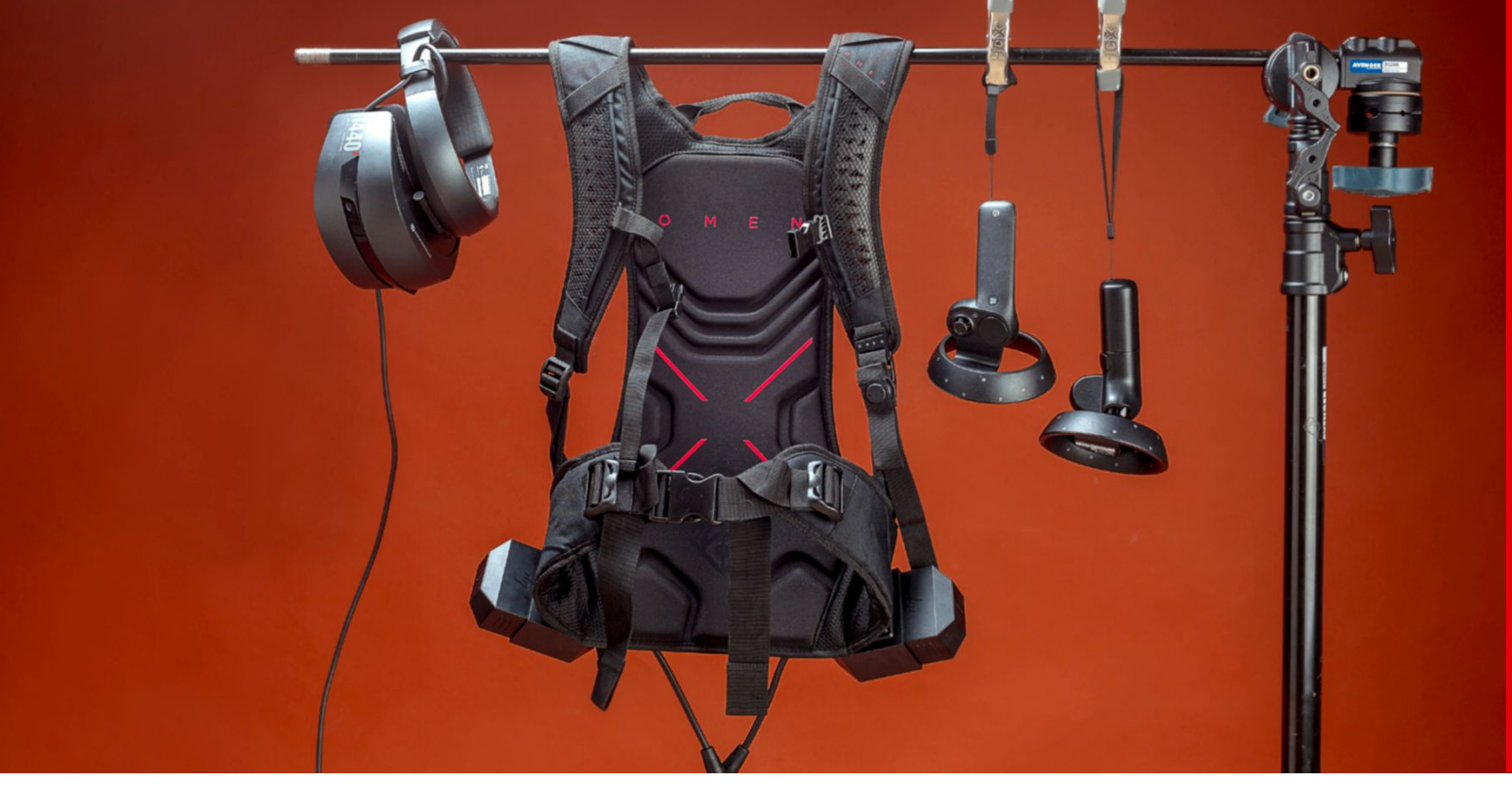
Many parts are involved here, and it's not the most elegant design. The desktop and dock on their own don't take up much room, but the power brick, battery-charging base, and harness together lead to desk sprawl pretty quickly. Add to that the mixed-reality headset and VR controllers, and you'll end up needing a lot of space to store the entire setup.

PERFORMANCE AND BATTERY LIFE

As a general-use desktop, the Omen X impresses. The i7-7820HK processor and 16GB of memory led to good benchmark scores. Its PCMark score isn't chart-topping, but it establishes the Omen X as a speedy system for everyday use. The multimedia test scores also support its aptitude apart from gaming: The PC made quick work of the Handbrake encoding test, and its Photoshop time was admirable. Other systems in this price range offer faster performance, but a certain amount of the Omen X's cost can be linked to the work that goes into making it so small. Still, if the size and functionality are enough to get you on board, know that it's a fast desktop, too.

> **You're not going to look like the coolest person in town wearing it, but you're not trying to win any fashion contests.**

Powered by a GTX 1080, the Omen has solid 3D and gaming scores. On the Heaven and Valley gaming tests at 1080p and Ultra-quality settings, the Omen X averaged 124 frames per second (fps) and 115fps, respectively. That's well above the target 60fps and scales well when you bump up the resolution further. 4K is a bit of a reach, but it's capable of 30fps, averaging 30fps and 39fps on the same test at 3,840-by-2,160 resolution. Again, some other systems in this price range will get more power, but they're larger, more traditional desktops. The Omen doesn't reach quite the same highs as some of its small-form-factor competition, with the Origin PC Chronos, the Tiki, and the Corsair One pushing out higher frame rates, but there's not a big gap between the HP and these non-portable desktops.



The wearable part of the harness consists of two large padded shoulder straps attached to a padded belt with a plastic buckle in the front. A smaller, unpadded nylon strap extends from the shoulder straps to buckle around your chest.

Battery life isn't something we typically discuss with desktops, but given the Omen X's unique portability, it's important here. The system's internal battery ran for 2 hours and 32 minutes on our rundown test, but the hot swap batteries mean it's not something you'd need to worry about. With the Omen X in the backpack with a pair of batteries connected, you have theoretically unlimited play time away from the dock, so long as you keep throwing the unused pair into the charging base.

If you're someone who'd spend hours at a time wearing a headset, the Omen X and backpack allow you to do so untethered. From full charge, the batteries died in about 45 minutes of play time while the internal battery prevented the system from shutting off. You'll have to keep an eye on battery life and swap the set somewhat often, but you do have the internal battery to fall back on, at least until you can change in the other pair.

THE UNTETHERED GAMING EXPERIENCE

To remove the desktop from its dock and use it with the VR Backpack, some setup is involved. You need to place the two batteries into the holsters (make sure they're charged), connect the headset to the ports as you would on any PC, strap on the VR backpack, toss the wires out of your way behind your back, and grab your VR controllers.

The backpack fits securely, and its 10-pound weight with the computer and batteries doesn't feel heavy or uncomfortable. Once the battery packs are screwed into the bottom of the PC, switching batteries is a matter of pressing a button on the side of each compartment to release them and inserting charged ones that click into place.

Adding the headset to the mix is another story. Though the backpack comes with a shortened 3-in-1 cable, HP's own Windows Mixed Reality headset uses a proprietary connector with its much longer 2-in-1 cable. This requires using the longer cable with the backpack, because the shorter cable won't plug into the headset. The included cable could conceivably work with other VR headsets, but not HP's.

Once we made sure the longer cord wasn't dragging, having free movement with no cables connecting to a separate computer or console let us walk freely without tripping. We spent several hours in total strapped into the VR Backpack with the Omen X Compact Desktop locked onto it, wearing the HP Windows Mixed Reality Headset, and trying out titles including Rick & Morty: Virtual Rick-ality, Minecraft VR, and the LEGO Batman Batmersive VR Experience. Of course, because Windows Mixed Reality offers no way of seeing out of the headset's front-facing cameras, we still had to be careful and move within a certain area to avoid bumping into things.

“Having free movement with no cables connecting to a computer or console let us walk freely without tripping.”

The good news is that it works as intended, allowing some freedom of movement away from a stationary PC. And our testing showed no performance drop when we ran the system on batteries and out of the dock, so you won't be taking a frame-rate hit if you decide to step away from your seat while playing.

The bad news is that it isn't any more of a compelling VR experience than traditional setups and ultimately has most of the same limitations as a desk-bound VR solution. You need to have a good amount of open space to get any benefit, and you can't see with the headset on. You won't trip over wires, but that's no use if you can't move around freely without falling over your chair or stubbing your toe—movement is still pretty limited. Even with two pairs of batteries, we're struggling to find a justification for the $500 price tag of the backpack. Tether-free VR is a minor convenience that doesn't justify spending as much on a harness as you would on a VR headset itself.

TECHNICALLY FUNCTIONAL, PRACTICALLY QUESTIONABLE

While the product pair succeeds in its design goal, the Omen X Compact Desktop and VR Backpack combination is a lot of (expensive) equipment with a fussy setup process for a very simple task. You have to really want to play VR, and to play it in this untraditional way, for the investment to be worthwhile. Being totally freed from a desk is neat, but you still need a lot of space to store and use the system. The VR Backpack also seems redundant, considering alternatives. Mobile-based VR platforms such as Google Daydream View and Samsung Gear VR are functional, even though they can't offer the graphical fidelity or processing power of tethered VR systems. More notably, standalone VR headsets are in production, and even HTC is cutting the cable without a backpack with its upcoming Vive Wireless Adapter.

Considering all of these solutions, an expensive harness with a computer on your back seems a bit silly. It's not especially quick to set up, either, and you're still draped with plugs and wires when you're ready to go. Add in the cost, the need to monitor your battery life, and the hardware you have to keep track of, and we question whether it's worthwhile. The HP Omen X Compact Desktop and VR Backpack feels more like a tech demo than a truly useful innovation.

MATT BUZZI, WILL GREENWALD

Microsoft Surface Pro With LTE Advanced: Travel-Friendly Tablet

PC MAGAZINE EDITORS' CHOICE

The new Microsoft Surface Pro with LTE Advanced includes a feature that the Editors' Choice model we reviewed last year lacks: LTE connectivity. This means you can stay online anywhere with this 2-in-1 hybrid tablet. Pairing 4G with some of the best hardware on the market could make this a game-changer for professionals who need to take their internet-based work on the go.

Microsoft Surface Pro
With LTE Advanced

Starts at $1,149.00

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PROVEN PEDIGREE

This 1.79-pound Surface Pro is pretty much identical to the non-LTE model and shares the same dimensions, measuring a slim 0.33 by 11.5 by 7.9 inches (HWD). The one exterior change required for the LTE version of the Surface Pro is a SIM card slot, which is located on the rear panel beneath the kickstand. With the kickstand extended, you can access the slot and eject the tray by poking into a pinhole using the provided tool. To install a SIM card, simply pop it into the tray and push it back into the slot.

The LTE model also has an embedded SIM card, an alternative to standalone SIM cards. The integrated SIM option allows you to use a pay-as-you-go plan through the Windows Store. LTE eSIM service in the US will be provided by French company Transatel, with several plans available: You can buy 200MB for one day ($4.99), 1GB for 15 days ($13.99), and 3GB for 30 days ($29.99). The Apple iPad Pro also has an eSIM, but, unlike the Surface Pro's, it works with all four major US carriers and most international carriers.

Microsoft Surface Pro
With LTE Advanced

PROS Speedy 4G LTE service from major wireless carriers. SIM and eSIM card support. Sleek, portable design. Top-notch display. Well-designed kickstand and keyboard.

CONS Type Cover and Pen sold separately. Not as many configuration options as the non-LTE version.

The design of the LTE version is the same as that of the non-LTE model, but the internal components we're testing this time around are different. The $2,199 Surface Pro we reviewed last year packed a Core i7 processor, 16GB of memory, and a 512GB SSD, while the model we tested for this review is configured with a Core i5-7300U, 8GB of memory, and a 256GB SSD and rings up at a more modest $1,449. Only one other configuration of the LTE version is available: a base model with a 128GB SSD and 4GB of memory for $1,149. A much wider range of options is available for the non-LTE Surface Pro, starting at $799 for the base model and up to a $2,699 top-of-the-line version. As with the non-LTE Surface Pro, the Signature Type Cover ($159.99) and Surface Pen ($99.99) are sold separately.

> **The integrated SIM option allows you to use a pay-as-you-go plan through the Windows Store.**

KEEP COMPUTING, ANYWHERE

This Surface Pro supports connectivity on 20 LTE bands for service in nearly any country. That's combined with dual-band Wi-Fi and the Surface Pro's ability to seamlessly switch between the two when you move out of range or your connection drops.

I didn't get to take the Surface Pro country-hopping, but I did put the LTE connection through its paces in PC Labs and throughout New York City using both T-Mobile and Verizon SIM cards. When disconnected from Wi-Fi, the Surface Pro immediately switched over to cellular data without a hitch. Just like with a smartphone, speeds are connection-dependent. My area of the office has weak connectivity, but the same is true for my Galaxy Note 8. Elsewhere in the office and in other parts of New York, the signal was strong; sites and videos loaded quickly.

Using Ookla Speedtest in our office to gather results, the Surface Pro with LTE Advanced averaged 46.81Mbps up and 22.22Mbps down on Verizon's network, while my Galaxy Note 8 averaged 54.6Mbps up and 10.12 down on Verizon. Results of these tests will vary based on time and location, but the Surface Pro's speed consistently fell at or near other efficient LTE devices when tested in the same conditions. (Note: Ookla is owned by Ziff Davis LLC, PCMag.com's parent company.)

PROFICIENT PERFORMANCE

Since this configuration is different from the model we previously reviewed, I also put the Surface Pro's components through our standard PC benchmarks. Though it's not on a par with the speedier Core i7 model, the CPU still produced a solid score on the PCMark 8 Work Conventional test. The non-LTE Surface Pro scored higher, but not substantially so, and the HP Spectre X2 was in the same ballpark. The less expensive Lenovo IdeaPad Miix 520 scored higher, but resolution impacts PCMark scores, and the IdeaPad's HD resolution isn't nearly as demanding as the Pro's high-res 2,736-by-1,824 screen. That said, multimedia test results weren't as impressive; landing the Surface Pro at the back of the pack.

At0.33 by 11.5 by 7.9 inches (HWD), this is a thin, sleek device. It weighs 1.79 pounds and is made of a silver magnesium alloy with a reflective Windows logo on the rear.

Given the lack of a discrete graphics card in most 2-in-1s, we don't expect high frame rates, and that's the case with the Surface Pro. Professionals who work in 3D, animation, and modeling will be happier with the Microsoft Surface Book 2, as it's still thin and light, but is powered by a discrete Nvidia graphics card.

At 13 hours and 15 minutes on our rundown test, battery life results are very similar to the non-LTE model's 13:54. It handily beats the Spectre X2, the IdeaPad Miix 520, and the Dell Inspiron 13 7000 (7378). If you rely heavily on cellular data while off the charger, though, don't expect it to last as long—you will likely shave a couple of hours off that time with heavy use.

POWERFUL, VERSATILE, AND WELL CONNECTED

The Surface Pro with LTE Advanced isn't as powerful as the high-end configuration of the non-LTE model we previously tested, but it costs significantly less. While the maximum performance potential for the LTE version is lower, given the available configurations, adding cellular data is potentially invaluable for professionals who need to take their work away from working Wi-Fi. Slimmer and quicker convertibles or ultraportables may be out there, but if you need LTE, the excellent hardware of the Surface Pro makes it a very attractive option.

If you can do without the LTE service and are looking to save some cash, the Editors' Choice–winning Dell Inspiron 13 7000 (7378) is a sound alternative. And for those who really want to slash prices, the Acer Switch 3 is an excellent, affordable detachable 2-in-1. But keep in mind that other "always-on" alternatives are hitting the market, including LTE-enabled laptops and convertibles armed with Qualcomm's Snapdragon processors, including the HP Envy x2 and Asus NovaGo. These notebooks not only offer cellular connectivity but also promise battery life of 20 hours or longer. We haven't reviewed any of those models yet, but we're anxious to put that battery-life boast to the test.

MATTHEW BUZZI

AgileBits 1Password Is Slick & Easy to Use

AgileBits 1Password

$3.99 per month or $35.88 per year

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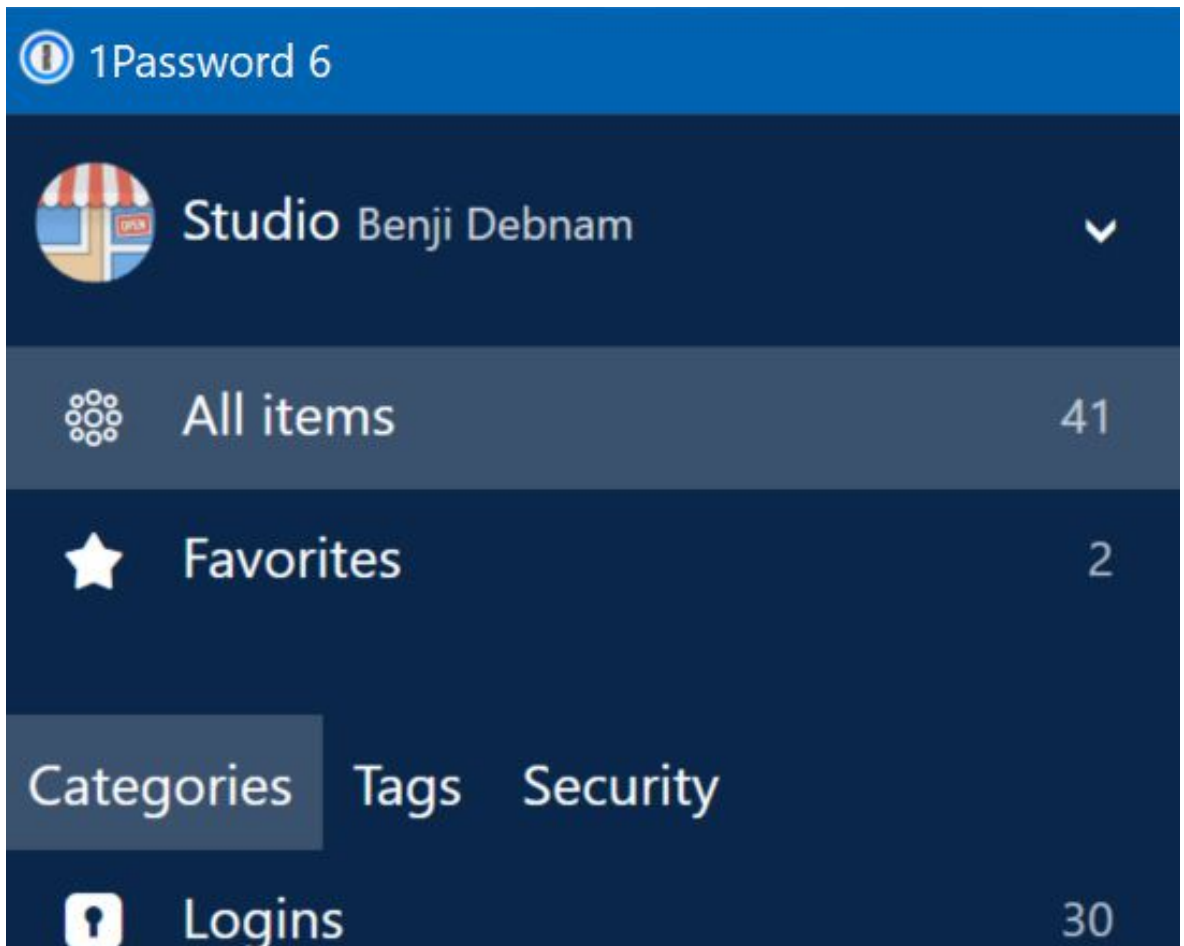
For most people, a password manager that's limited to Windows isn't good enough. It's important to have password access on all your devices. AgileBits 1Password has you covered, with apps for Windows, macOS, Android, and iOS, and browser extensions for Chrome, Edge, Firefox, Opera, and Safari. A new and somewhat experimental Chrome-only add-on extends the product's reach to Linux. However, it's not as automated as most, and it lacks high-end features such as password inheritance and automated password updates.

Pricing for password managers varies more than for many other categories of security software. You can get Zoho Vault for just $12 per year, Dashlane costs $39.99 per year, and most of the rest fall within that range. With 1Password, you pay $3.99 per month or $2.99 per month ($35.88 per year) when you pay a year at a time. You can use the product on all your devices, and syncing is instant and automatic.

1Password also offers a family plan, at $5.99 per month or $59.88 per year. This gets you five licenses, along with the ability to share passwords within your family. For business, you can set up a team account, at $3.99 per user per year.

I reviewed Version 6 of 1Password a year ago. The current version, 6.8, shows that the app has evolved quite a bit. The most noticeable difference is the redesigned user interface. The left-rail menu is now blue, and it displays your own thumbnail image at the top. A column next to the menu displays saved items of the type you've selected, and the remainder of the window shows details for the selected item. It now grabs icons from the websites you save, making it easy to find what you want.



AgileBits 1Password

PROS Apps for Windows, macOS, Android, and iOS. Secure yet simple authentication when adding new devices. Extensions for most browsers. New all-platform Chrome extension.

CONS Not compatible with Internet Explorer. Limited import options.

GETTING STARTED

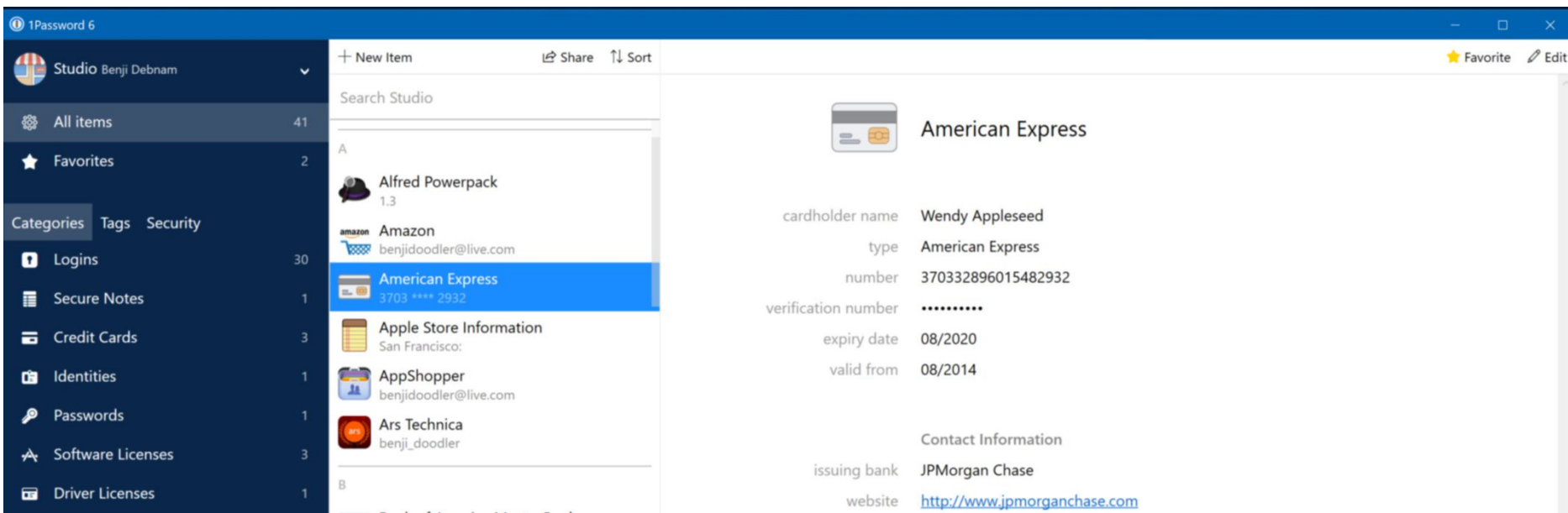
Launch Chrome, Firefox, Opera, or Safari, and navigate to the 1Password website. (1Password doesn't support Internet Explorer.) Sign up for an account, and you get 30 days for free; entering your credit card info is optional. During setup you enter your name, and you have the option to add a photo.

The next step is somewhat unusual. 1Password generates what it calls an Account Key, a massive string of 34 letters and digits that are separated by hyphens into seven blocks of varying sizes. Each time you add a new device or browser extension, you need this key.

Next, you create a strong master password. As always, this should be something you can remember, but nobody else would guess. As for that monster account key, the wizard creates what it calls an "emergency kit." This is a PDF file containing your email address and account key, with a space to write down your master password. Print it off, fill in the master password, and stick it in your fireproof lockbox, or somewhere else secure.

With your account finalized, it's time to set up your apps for Windows, Mac, Android, and iOS. You do need that monster account key for each installation, but you don't necessarily have to type it. After installing the app on an Android or iOS device, you can use it to snap a QR code that fills in all your information except the master password. If you're installing on a desktop device, you can copy that QR code to the clipboard for import. You won't often need to type in the Account Key.

Even if your activated device is lost or stolen, a thief would still need your master password. But for total security, you can log into the web console, click My Profile, and deactivate the device. Now that thief would need both your master password and Account Key to gain access.



For full functionality, you also must add the 1Password extension to your browsers. The first time you open a supported browser, 1Password should offer its extension. In my hands-on testing, that didn't happen, but it's easy enough to grab the necessary extension from the AgileBits website. To add the Edge extension, you install it from the app store and then log in with your account information.

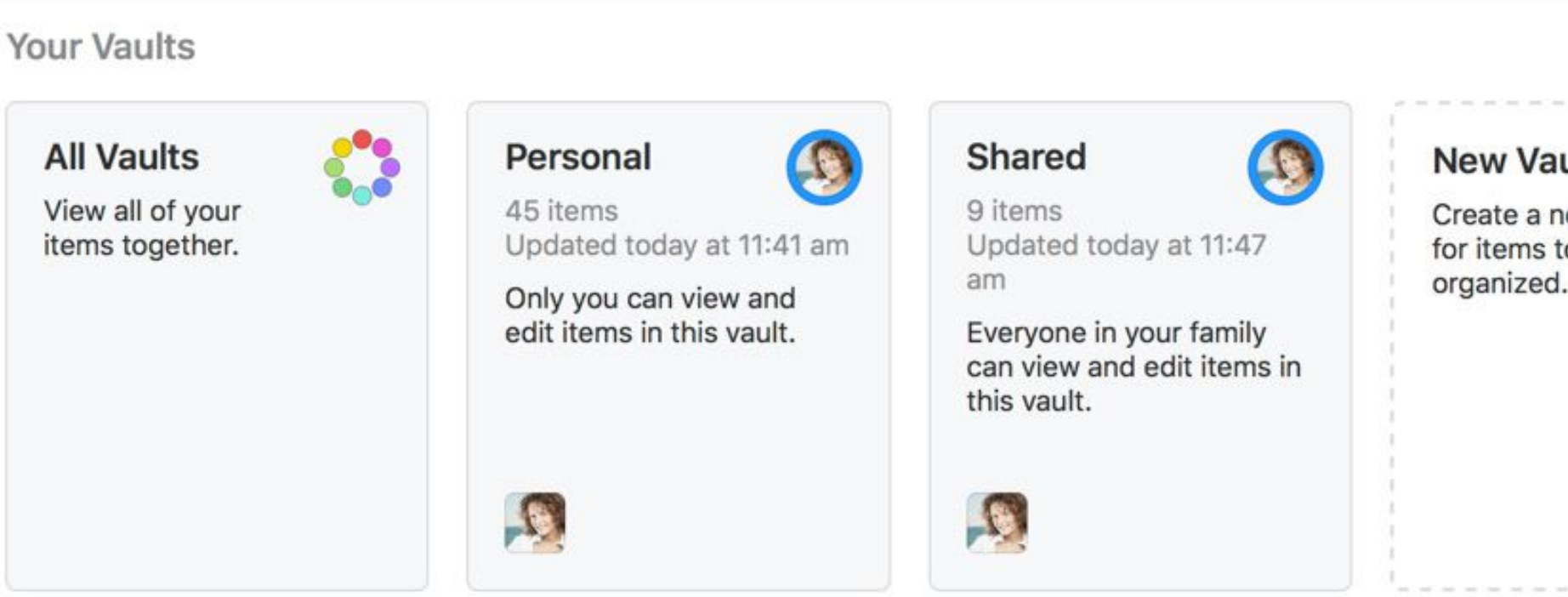
The easiest way to switch from one password manager to another is to import the existing product's passwords. 1Password can import from LastPass, Dashlane, and RoboForm, and it can pull in a correctly formatted CSV file, but that's it. LastPass, by contrast, can import from over 30 competing products, and KeePass imports from almost 40. Note that to use the import feature, you must log into your 1Password account online. The app can only import 1Password files exported from another installation.

The easiest way to switch from one password manager to another is to import the existing product's passwords.

You do have another option for importing: The 1Password Utilities collection includes community-created scripts to convert data exported from 35 other products into 1Password's own format. Note, though, that using these scripts is definitely a hands-on proposition.

PASSWORD CAPTURE AND REPLAY

1Password's browser extension watches as you enter your credentials on secure websites and offers to save what you've entered. In the password capture dialog, you can enter a friendly name for the login and also add one or more tags. By default, all passwords go into your personal password vault. If you need to keep multiple sets of passwords, perhaps personal and work collections, you can define additional vaults and choose which to use at capture time.



Password replay with 1Password isn't quite as automated as it is with most competing products. When you revisit a site for which you've saved login credentials, it doesn't do anything right away. Clicking the toolbar button displays available logins for the site, and you can click one to fill in your credentials. When you know you have a password saved, press Ctrl+\ to fill in the site's credentials. In the event you have more than one login, that keystroke pops up a window with the available logins.

Password replay with 1Password isn't quite as automated as it is with most competing products.

My AgileBits contact pointed out that requiring user interaction to fill passwords is a deliberate, security-related decision. It eliminates the chance of a website snagging your credentials using invisible login forms.

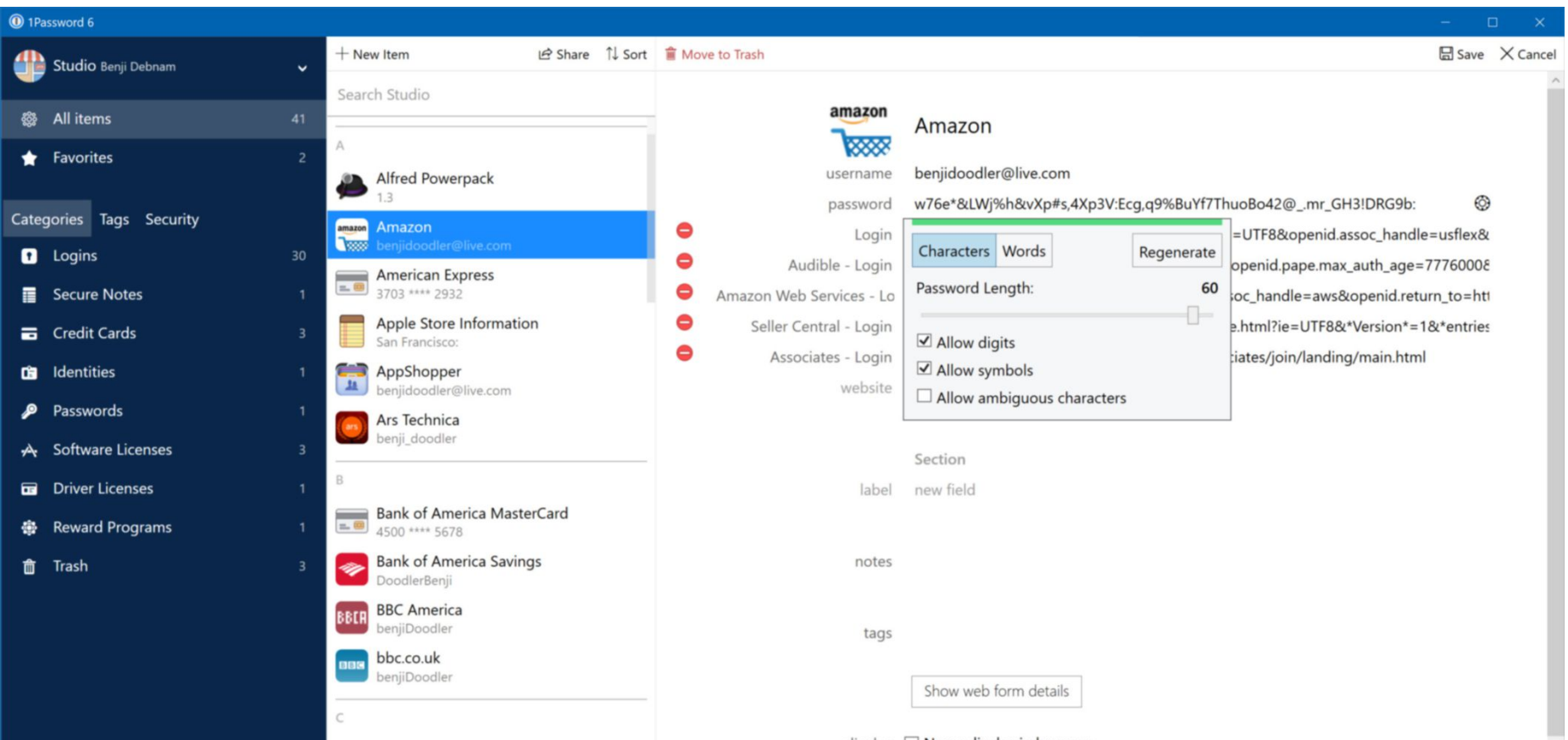
RoboForm, LogMeOnce, Password Boss Premium, and most of the other products of this type offer another handy way to use your saved logins. Clicking the toolbar button displays a list of your saved sites, and clicking one of them first navigates to the site and then logs in. 1Password now does this as well, showing an alphabetical list of logins. You can scroll down the list or just start typing the name of the login you want. The list narrows to match what you've typed. Just click to visit and log into the desired site.

There are always some nonstandard logins that confuse password managers. LastPass Premium, Sticky Password, Keeper, and a few others get around this problem with a manual capture feature. You enter all the necessary data, then click to save all data fields. An older version of 1Password used to do this as well, but that feature isn't in the current version.

PASSWORD GENERATOR

Just storing all your existing passwords in 1Password isn't enough. You need to find those old, weak passwords and update them to something strong and unguessable. 1Password deliberately doesn't attempt to automate the process of changing passwords, for a variety of reasons. Chief among these, according to my company contact, is the worry that a failure of automatic password updating, perhaps due to a change in the website, could result in locking you out of your account. Keeper's developers avoid this automation for the same reason, though Keeper Password Manager & Digital Vault offers one-click filling of standard password-change forms.

1Password does offer a password generator to help you create a strong password when signing up for a new site or updating an existing one. The password generator, whether in the Windows app or the browser extension, defaults to 24 characters. I approve of long generated passwords—after all, you don't have to remember them. Not every product reflects this fact, though. RoboForm, Trend Micro Password Manager, and Ascendo DataVault default to just eight characters; I worry that users won't know to change this. At the other end of the spectrum, the free MyKi generates 30-character passwords by default.



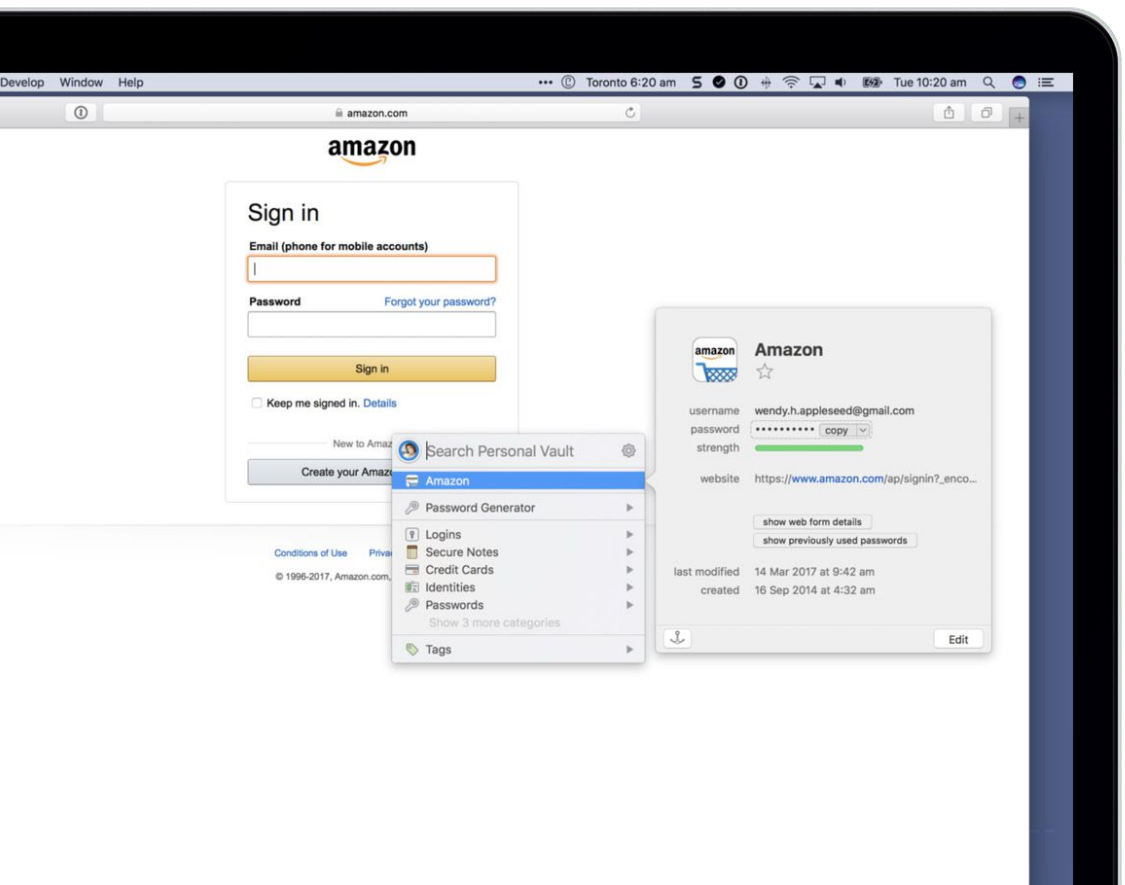
By default, 1Password generates passwords that include capital and lowercase letters, digits, and symbols. You can disable use of digits and symbols when you hit a website that doesn't accept them, but the letters are always there. By default, 1Password suppresses ambiguous characters such as the digit 0 and capital letter O. And changes you make to the defaults affect both the extension and the app.

Using a random collection of characters makes a password strong, meaning it's extremely hard to crack. Another way to make a password strong is to make it long. 1Password's generator can churn out random collections of words, separated by a hyphen, space, period, comma, or underscore. By default, it offers four-word phrases like "maxilla hound bisexual perspire" and "spake anarchy opal hysteric." The main use I see for this feature is when you must memorize the password, like the famed "correct horse battery staple" example.

FORM-FILLING IDENTITIES

Like Dashlane, LastPass, and most other commercial password managers, 1Password lets you store personal information for use in filling Web forms. You can create any number of identities, each of which includes personal data, address information, and a variety of internet contact details. 1Password also stores credit card information separately from the personal identity.

Some fields, like name, address, and telephone, always appear. You can click the red-circled minus icon in front of optional fields to remove them, if you're sure you'll never use them. With the demise of AOL Instant Messenger there's no point in storing an AIM screen name, for example, and few people still use ICQ.



RoboForm Everywhere is the long-time master of form-filling, and includes uncommon options such as the ability to have multiple instances of any data field. 1Password doesn't do that, but it does let you add custom fields.

When you navigate to a Web form, most products offer to fill in your personal data. As with password replay, 1Password is a bit more hands-on—you click Ctrl+\ for a menu of available identities. I found that it did an OK job of filling in my stored data. I entered phone numbers for home, work, fax, and cell; it filled in the Fax field with the home number, leaving the rest blank. It also filled in the CCV code for my imaginary credit card in the SSN field. Still, every field filled by 1Password is a field you don't have to fill yourself.

ORGANIZING AND EDITING

Whether in the Windows application or the browser extension, you can view and edit all of your saved logins and other stored data. Many password managers let you organize your saved items into folders. LastPass, Sticky Password Premium, and a few others even support nested folders. 1Password instead uses a tag system, allowing multiple tags for each login.

In addition to passwords, identities, and credit cards, you can add a wide variety of other data items, and access them from any of your devices. Among the many choices are driver's license, passport, and social security number.

There aren't many configuration options to worry about. Chief among these is the security option to log out after 10 minutes of inactivity. You can change the idle time to various choices from 30 seconds to 12 hours. 1Password also automatically locks if you switch away from your Windows user account.

SOME ADVANCED FEATURES

In previous editions, 1Password could display a list of saved passwords with a color-coded strength rating for each. It wasn't quite the actionable password strength report found in LastPass, Dashlane, and a few other competitors, but you could sort the list by strength and use it to focus on fixing the weakest passwords. The current version displays password strength in the browser but not in the application, and you can't sort by strength.

1Password doesn't precisely have the two-factor authentication that's such a major feature of True Key. But its system of validating new devices using the Account Key is a form of two-factor authentication. You can get that key from your emergency kit, or from any of your existing devices.

Password sharing is available only in the Family and Team editions. You can't share a password with just any fellow user, the way you can with Intuitive Password, LastPass, and many others. In addition, 1Password does not include a mechanism for passing on your account to your heirs after your demise.

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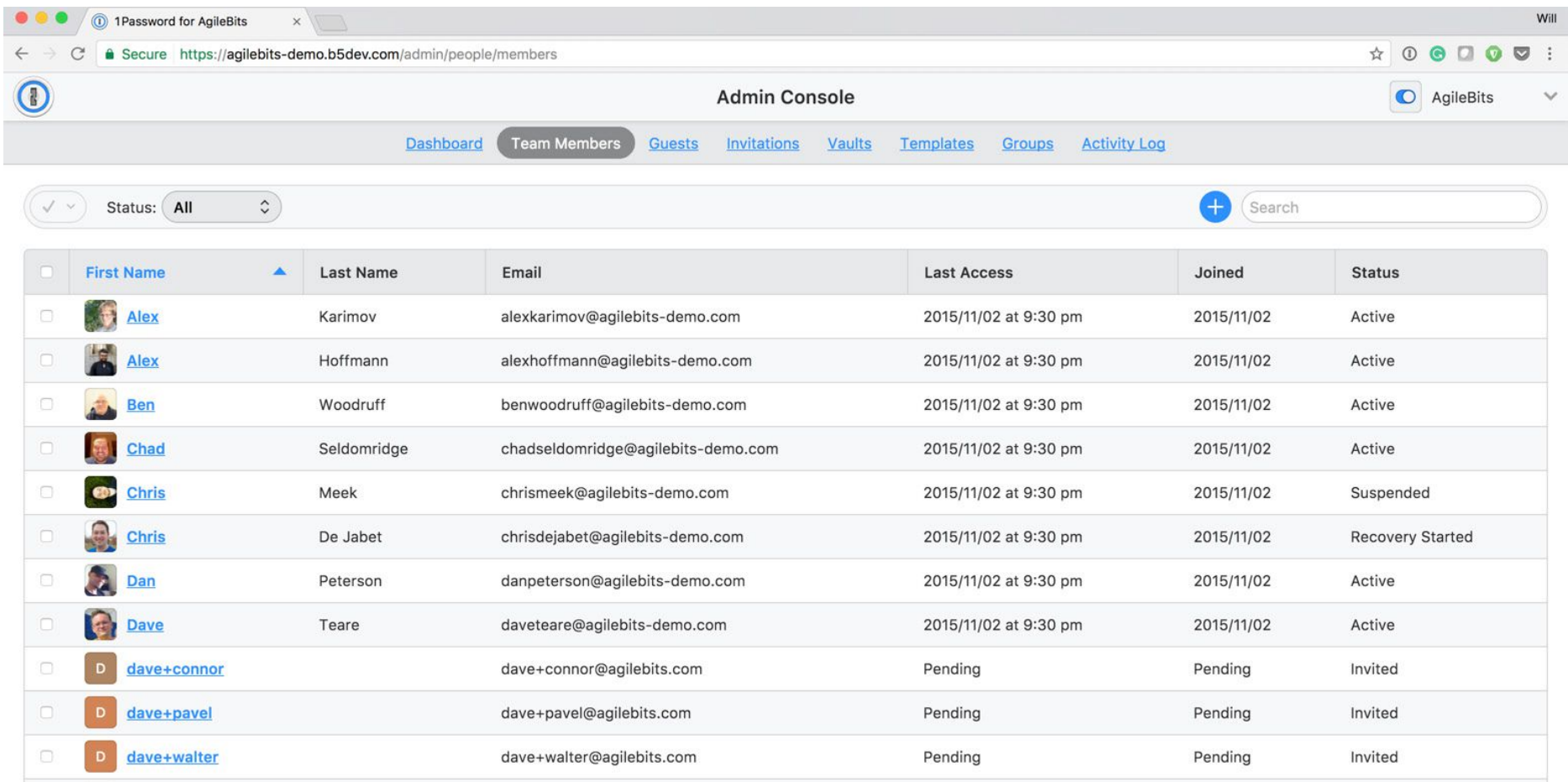
You can configure many websites to use time-based one-time password (TOTP) apps such as Google Authenticator, Twilio Authy, and Duo MobileFree at iTunes Store for smartphone-based two-factor authentication. In addition to the password, you must enter a time-sensitive code returned by the app. 1Password has that sort of authentication built in. You register it as an authenticator, just as with any of the others. Thereafter, the site's entry in the password list always shows the latest code. That means you need just one app to log in, not two. When you log in to the site, 1Password puts the current code in the clipboard, so all you need do is Ctrl+V after Ctrl+\.

As the name suggests, Myki Password Manager & Authenticator also packs this ability, without need for pasting from the clipboard. Dashlane, too, can replace Google Authenticator.



New since my previous review, the Watchtower service warns you of possible compromised passwords. Keeper and Dashlane offer similar reporting of passwords that may have been compromised by a data breach. Of course, I couldn't test this feature, but it seems like a good idea.

OTHER PLATFORMS

Installed on a Mac, 1Password has all the same features and then some. As expected, its browser extension lets you capture and replay passwords in Chrome and Safari. But it expands on the Watchtower concept with a full Security Audit. In addition to reporting potentially compromised passwords, the full audit reports weak, duplicate, and old passwords. This isn't the fully actionable security report that you get with Dashlane, Password Boss, and a few others. Nor does 1Password include automatic password changing the way LogMeOnce Password Management Suite Ultimate, LastPass, and Dashlane do. But it's useful.

In addition to reporting potentially compromised passwords, the full audit reports weak, duplicate, and old passwords.

On an iPhone or iPad, you get full access to all your logins and other saved data. Launching a site opens it inside 1Password's proprietary browser. To use it with Safari you must copy and paste, but the Quick Copy feature automatically copies the next field after you fill one. TouchID support is available, and FaceID for the newest devices, and you can use your iOS device to enable 1Password's TOTP authentication feature.

Fingerprint authentication is also available in the Android version, with the added ability to set a PIN code for devices without a fingerprint reader. As on iOS, logins open in the proprietary browser by default, but you can enable autofill in other browsers as long as you're using Android 8 (Oreo) or later.

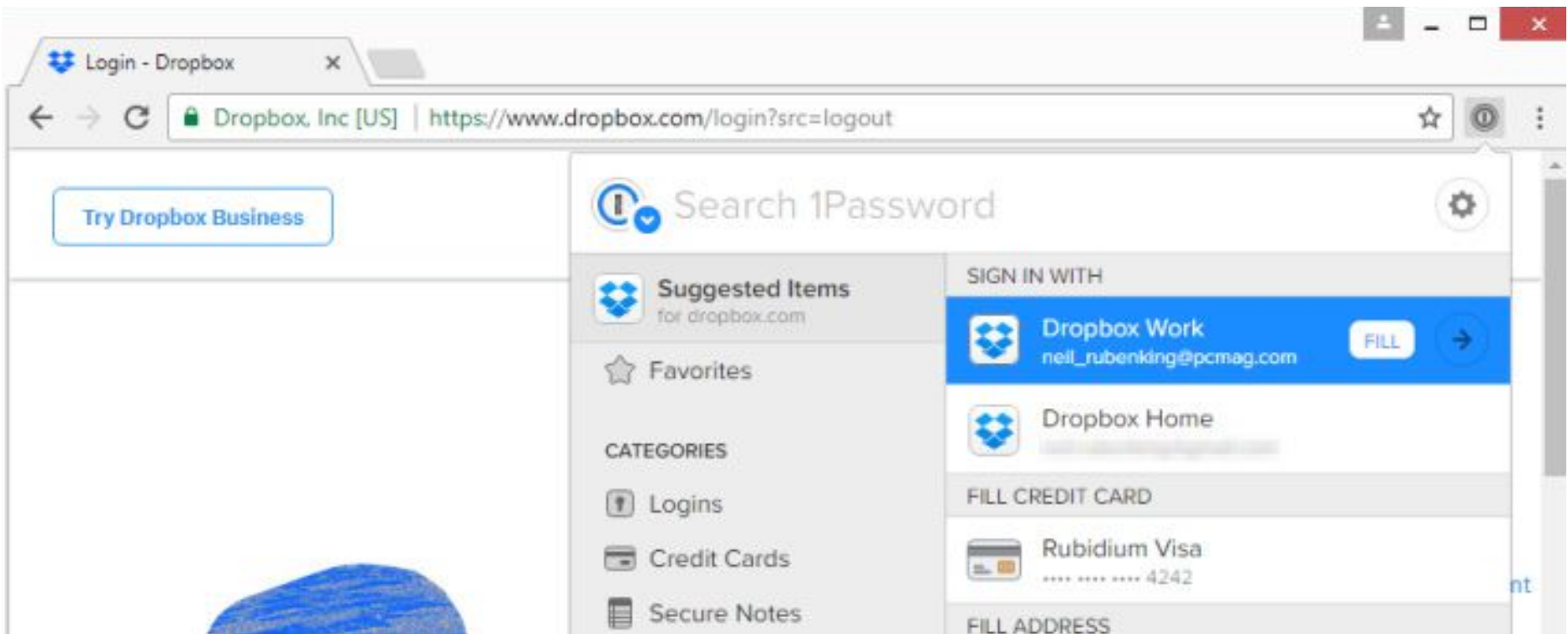
1PASSWORD X

The browser extensions I've mentioned thus far work by communicating with the 1Password app. 1Password X is a standalone Chrome extension. That means you can use it on any platform that supports Chrome, including Linux. It encapsulates most of the app's functionality, with a few exceptions.

Password capture and replay don't require any special keystrokes. When you enter a username and password, 1Password X displays a popup offering to save your credentials. Like Dashlane and Keeper, it puts this offer right below the password field, which is convenient. In a similar fashion, when you revisit a page that has one or more saved logins, it displays the choices right under the login fields. I did find that it failed to capture two-page logins like EventBrite and Amazon. However, it managed to log into them using credentials already in the system.

When you enter a username and password, 1Password X displays a popup offering to save your credentials.

If 1Password X detects that you're creating a new account, it offers a suggested password from the password generator. However, I didn't find any way to configure the length or characters used. By observation, it defaults to 30 characters using letters and digits, but no symbols. The password generators in the app and in the app-reliant extensions share the same settings, but 1Password X doesn't.



I thought at first that 1Password X didn't support time-sensitive passcodes. Pressing Ctrl+V didn't paste in the code, the way it did with the regular extensions. I found that you must click the toolbar button, select the site from the list, and click a Copy button next to the code.

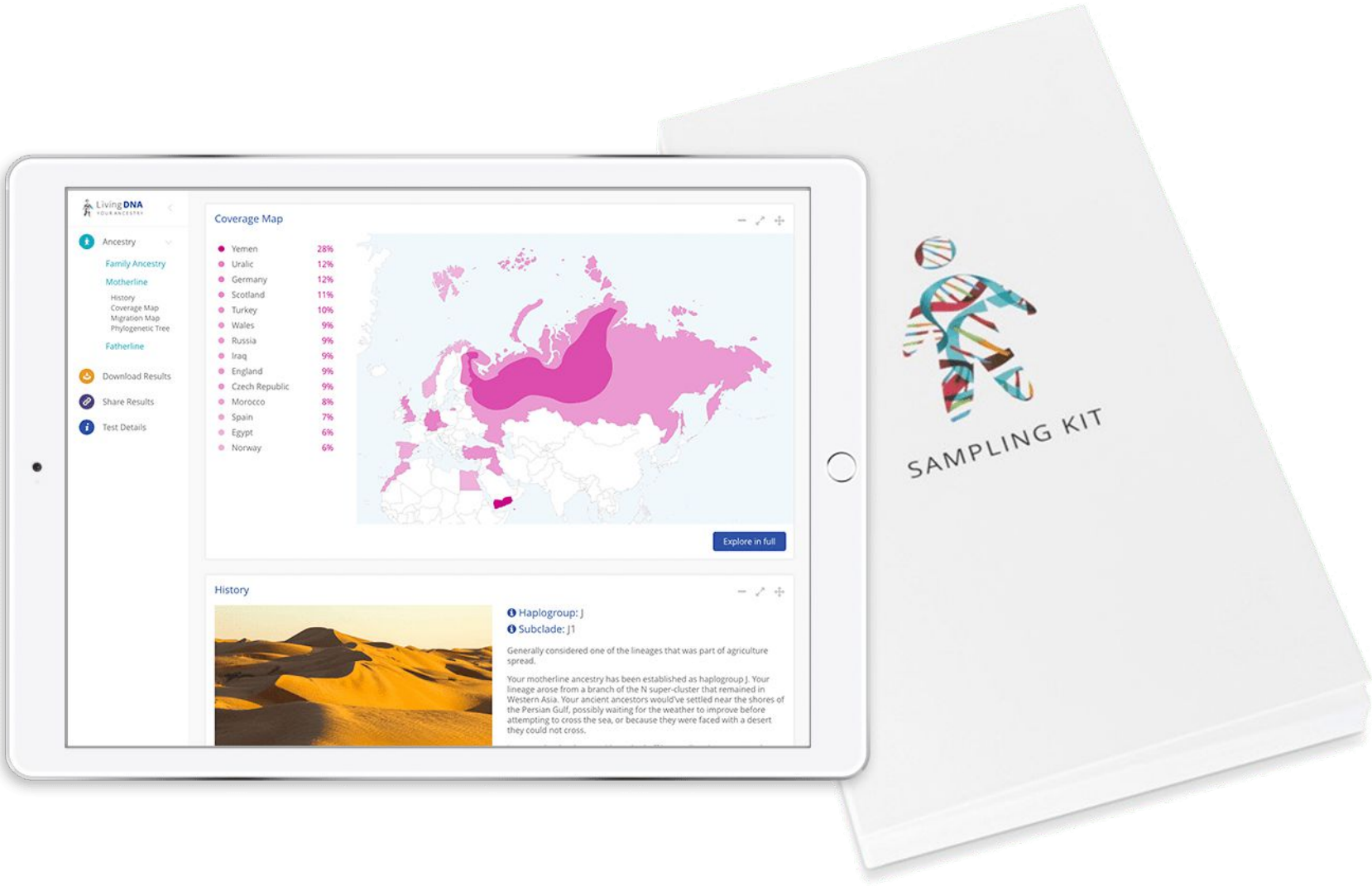
This extension is definitely a work in progress. I couldn't get it to fill personal data in web forms. I didn't find any way to search the saved items, or filter by tags. But the fact that you can use it on absolutely any platform that supports Chrome will make it ever so useful.

WORTH A LOOK

You can try AgileBits 1Password for 30 days at no cost, so if it sounds interesting to you, give it a whirl. It smoothly syncs your passwords and personal data across all your Windows, macOS, Android, and iOS devices, and handles all the expected tasks of a password manager. And the new 1Password X extension brings your passwords to any platform that supports Chrome. True, password replay and form filling aren't as automated as in competing products, but during the trial period you'll learn whether that limitation bothers you. Don't want to continue? There's a handy option to delete your account completely.

If you find that you want more than what 1Password offers, consider the product's we've identified as Editors' Choice in the commercial password manager arena. LastPass Premium offers a range of features well beyond most of its competition. Dashlane and Keeper both offer a wonderfully smooth user experience, along with a significant collection of advanced features. LogMeOnce Password Management Suite Ultimate and Sticky Password Premium are also in the Editors' Choice Group, though I've begun to feel that they may be over-complex; I'll evaluate them again soon.

NEIL J. RUBENKING



Living DNA: Solid Ancestry Discovery

Living DNA

$99.00

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Living DNA launched in 2016, so it is relatively new to the genetic-testing scene, but its parent company, DNA Worldwide Group, dates back to 2004. The London-based company is made up of more than 100 scientists, academic researchers, and genetic experts around the world and collaborates with universities, testing services, and genomics experts to refine its DNA results and migration routes. Living DNA is a good value and offers solid ancestry discovery and family tree-building features, even if it does take a while to complete your DNA profile.

DNA DISCOVERY

Living DNA's test traces your family ancestry and takes you backward in time to show how your ancestors got from Africa to Europe, Asia, and the rest of the world. Like Ancestry DNA, Living DNA also has family tree tools. One of these is DNA matching with Family Networks, which Living DNA recently introduced, helps you build your family tree using machine learning rather than relying on time-consuming manual work.

DNA tests are skewed toward US users; as a nation of immigrants, many of us have a need to discover or confirm our origins. This need isn't as present in Europe, where many families can trace their roots back hundreds of years. Living DNA encourages Europeans to take the tests as well, even if they know their origins, to connect with distant relatives on other continents. Since DNA tests compare your DNA with populations in different countries, the more in-country data available, the more accurate your results.

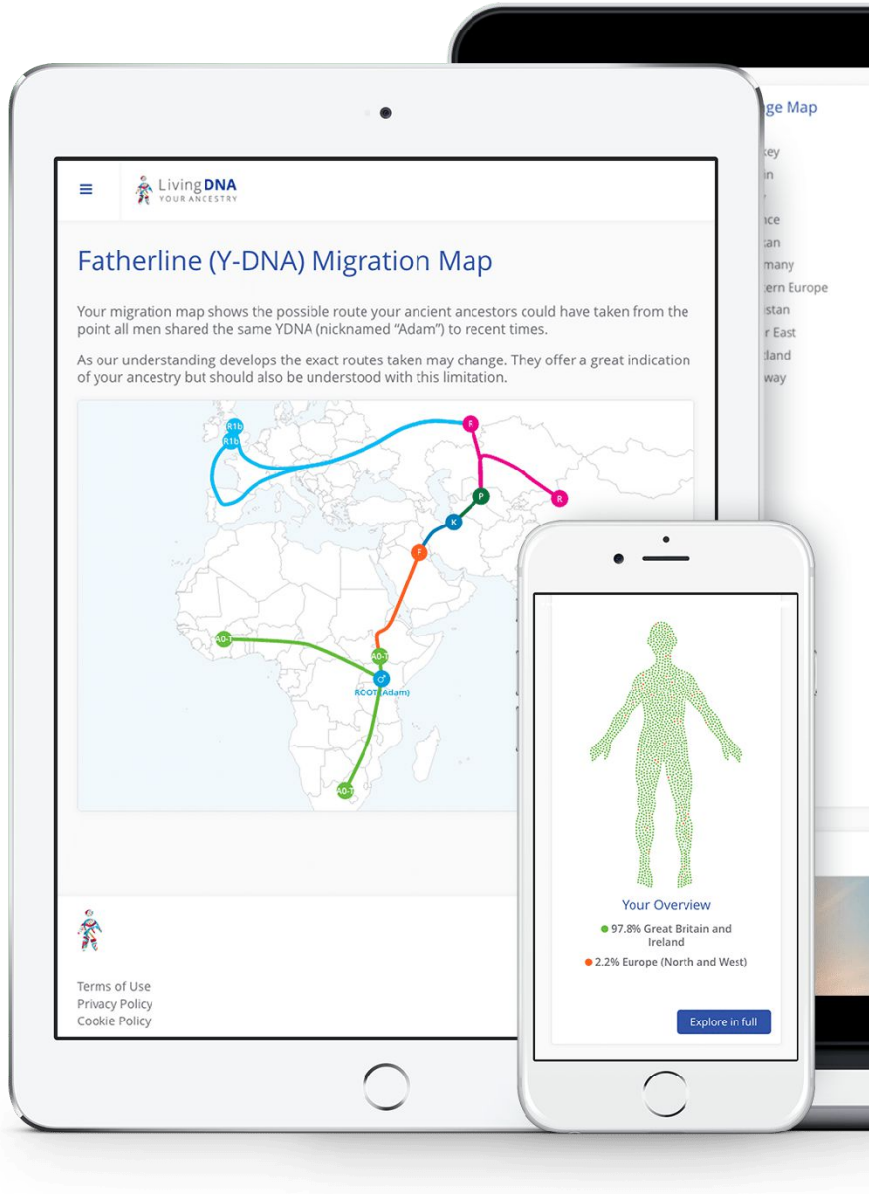
SETUP AND INTERFACE

The first step, as with all DNA test kits, is to activate it. First, you input a unique 12-digit code. (All DNA kits have unique codes that connect your sample to your account; your name or other identifying information are omitted to preserve your privacy.) After that, Living DNA asks for your name, email address, date of birth, and sex. All DNA testing services ask for your gender; this is because samples from females (XX chromosome) only have mitochondrial DNA (mtDNA), while males (XY chromosomes) have both mitochondrial and Y-DNA results. Mitochondrial DNA passes from mothers to children, but males do not pass on mtDNA.

Living DNA

PROS Covers 80 worldwide regions—more than competitors. Family Networks feature makes building family trees less labor-intensive.

CONS Constructing DNA profile can take between 10 and 12 weeks.



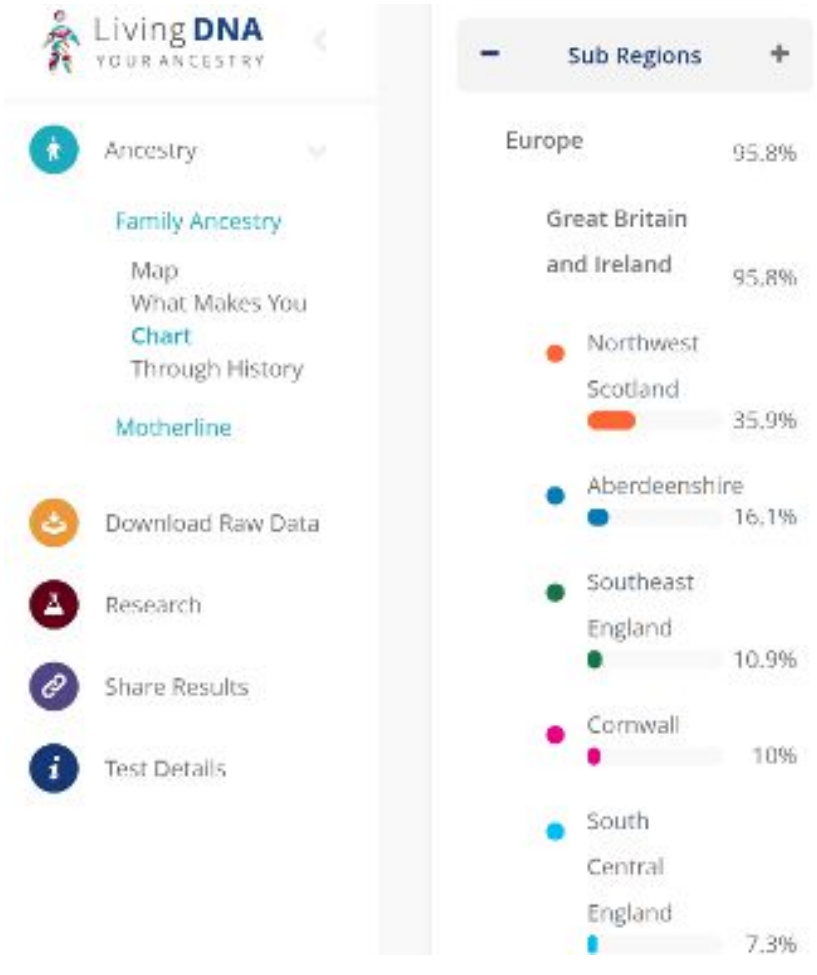
Before taking the test, it's best to avoid drinking, eating, or smoking for at least a half hour, to ensure a clean sample. You extract DNA using the provided cheek swabs and place them in the included vials. Then you send the vials to their labs in a prepaid envelope. Results take about 10 to 12 weeks to process.

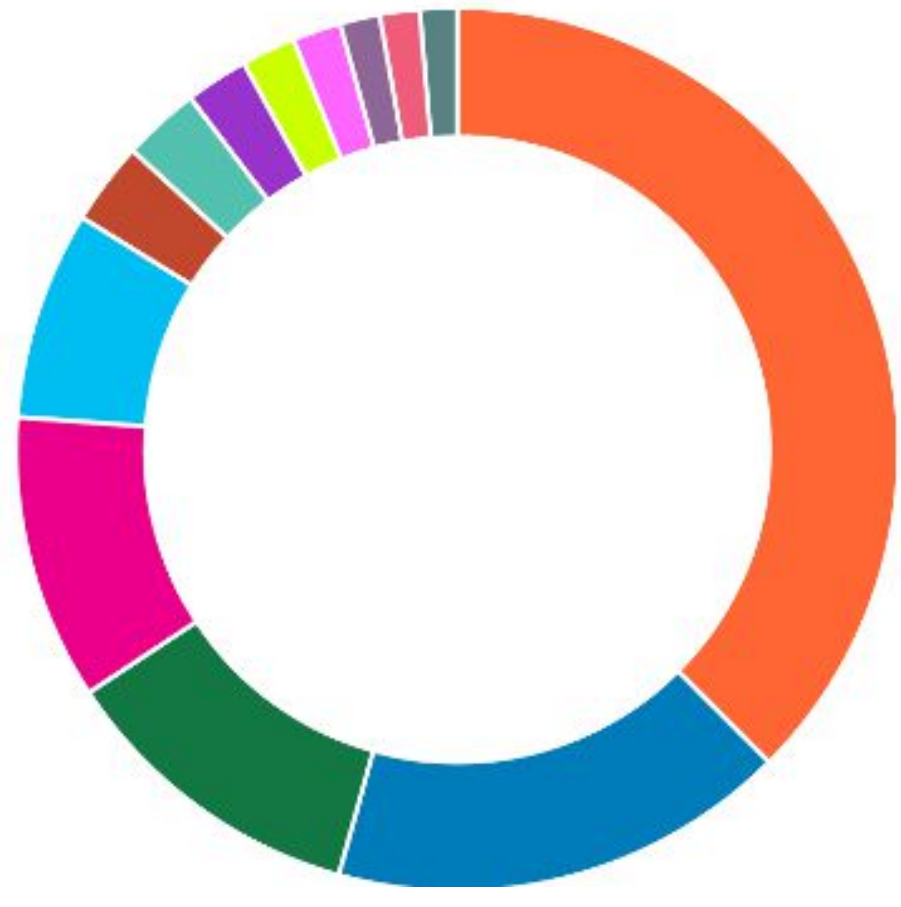
Before taking the test, it's best to avoid drinking, eating, or smoking for at least a half hour, to ensure a clean sample.

DNA REPORTS AND FAMILY NETWORKS

When I first viewed my data, Living DNA informed me that I was one of the first people to receive DNA results from the company. It says it will continually update results based on new research and is rolling out a host of features in the coming months. Living DNA does not conduct health testing, as 23andMe does; it only looks at ancestry. You can choose whether you want to let Living DNA use your results in future research projects; the first project is mapping the world's genetic history.

Living DNA looks at 80 worldwide regions to determine your ancestors' origins. The company says this is more than double the number of regions that other companies offer. Your DNA results are available online, but the company also gives you the option to order a personalized book with illustrations.





The three main sections of your results are Family Ancestry, Motherline, and Fatherline. The fatherline (Y-DNA) data is available only if you have a Y chromosome; since I have two X chromosomes, I could see only my motherline. Women can convince a male relative, a father or brother, to take the test and then get fatherline data too.

The Family Ancestry page shows an overview of your geographical origins—in my case, about 96 percent Europe and about 4 percent Central Asia. Tap on Explore in Full to see an explanation of how the service determined your DNA results, followed by a map of your ancestry. Click that to see a visualization of your DNA mix in the last ten generations.

The plus button reveals more migratory detail—from Europe to Great Britain and Ireland to regions of England, Scotland, and Ireland, in my case. You can view this information in a human avatar, which uses colored dots to illustrate different regions that make up your ancestry. Alternatively, you can view it in a color-coded, donut-shaped chart.

Finally, you can see your ancestry in a video visualization that goes back 60,000 to 80,000 years. While viewing, you can pause the video and learn more about each era.

The motherline and fatherline results are similarly laid out with a history section coverage map, migration map, and phylogenetic tree. Since my results included only motherline data, I'll discuss that, but it presents both types of results in much the same way.

The coverage map shows the current common locations of your motherline haplogroup; in my case, Brazil, Portugal, and the United Kingdom were my top three results (good thing I speak Portuguese.) A haplogroup is a group of people who share a common ancestor on their motherline or fatherline. The migration map shows how ancient ancestors in your haplogroup moved around the world. Finally, the phylogenetic tree starts with the genetic group that contains every living person today and traces down through haplogroups to your subtype. It's a cool way to put your results in context with the rest of the human genetic world.

At RootsTech in February 2018, Living DNA previewed Family Networks (currently in beta), which uses machine learning technology to scan its database and build your family tree. You can verify relatives you know and have Living DNA check your guesses. Family Networks can go back 13 generations to find potential relatives based on your DNA results, sex, and age. This feature is a boon to those who want to build a family tree but don't have the time or the interest to conduct months of research.

USE TECHNOLOGY TO DISCOVER YOUR PAST

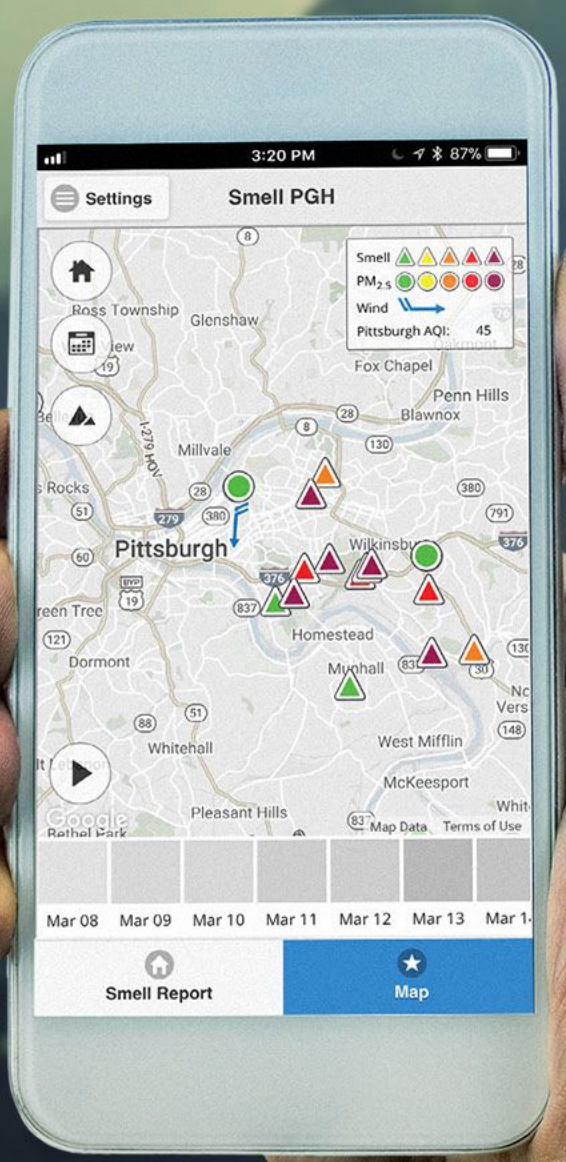
Living DNA offers an interactive look at your ancestors and your DNA composition. If you're not interested in health-related DNA testing, it's a great choice. Otherwise, you should give 23andMe, our Editors' Choice in this category, a try. For those more interested in tracing their ancestry and building a family tree, Living DNA offers the full package, including Family Networks, an intriguing new feature that takes the manual research and guesswork out finding distant relatives.

MOLLY K. MCLAUGHLIN

CITIZEN SCIENCE:

DO TRY THIS AT HOME

BY MICHELLE Z. DONAHUE



In November 2015, several hundred people gathered for a meeting in Ben Avon, a neighborhood of around 2,000 people nestled along the Ohio River northwest of Pittsburgh. As with previous assemblies of this kind, residents had come to learn the latest about an unwelcome neighbor.

That neighbor was the Shenango Coke Works, a coal processing plant straddling one end of an island directly opposite Ben Avon. Residents had long suspected the plant's emissions were regularly polluting the air to such a degree that living there was a hazard. They blamed the bad air for asthma, nausea, headaches, and myriad other illnesses they and their families had suffered. But in the past, they had lacked definitive evidence, outside of their own experiences.

So, they found some.

Not long after the meeting began, with a representative from the US Environmental Protection Agency sitting in the front row, Carnegie Mellon University computer scientist Randy Sargent got up and started reeling through time-lapse videos from cameras he'd helped the neighborhood point toward Shenango. Taking frames every 5 seconds, 24 hours a day, the cameras made it easier to do what the community had been trying to do over the years: to watch the smoke.

Distinguishing toxic clouds from mere steam is tricky business, so the community had turned to Sargent, who works out of CMU's CREATE Lab (Community Robotics, Education, and Technology Empowerment). He and colleague Yen-Chia Hsu developed a computer-vision algorithm to pick out bad smoke types in each picture.

Stitched together from hundreds of frames, the resulting video showed a looping reel of black, brown, blue, and orange clouds from a single month. Paired with federal, local, and community sensor data gathered from corresponding days, Ben Avon's suspicions finally seemed to find some footing: Shenango was releasing permit-busting amounts of toxic substances into the air five out of every seven days.

One month later, DTE Energy announced it would close its Shenango facility, citing a weak steel market and lack of customers. By January, the plant had baked its last batch of coal and is slated for demolition.

“They said it was economic issues, but I wonder if the timeline changed because of the pressure from the community,” said Bea Dias, project director for CREATE Lab. “The algorithm was a tool that gave their voices more weight, an extra leg to make a case. But the tech wouldn’t have worked if it didn’t have an active community to use it, people to put it in front of the decision-makers constantly.”

Dias’ group is charged with engaging directly with communities to provide them with hardware, software, and other solutions to address their concerns. The computer-vision algorithm turned out to be a particularly powerful realization of that mandate. But it’s just one example in a field that’s experienced astounding growth in recent years: high-tech tools for citizen science.

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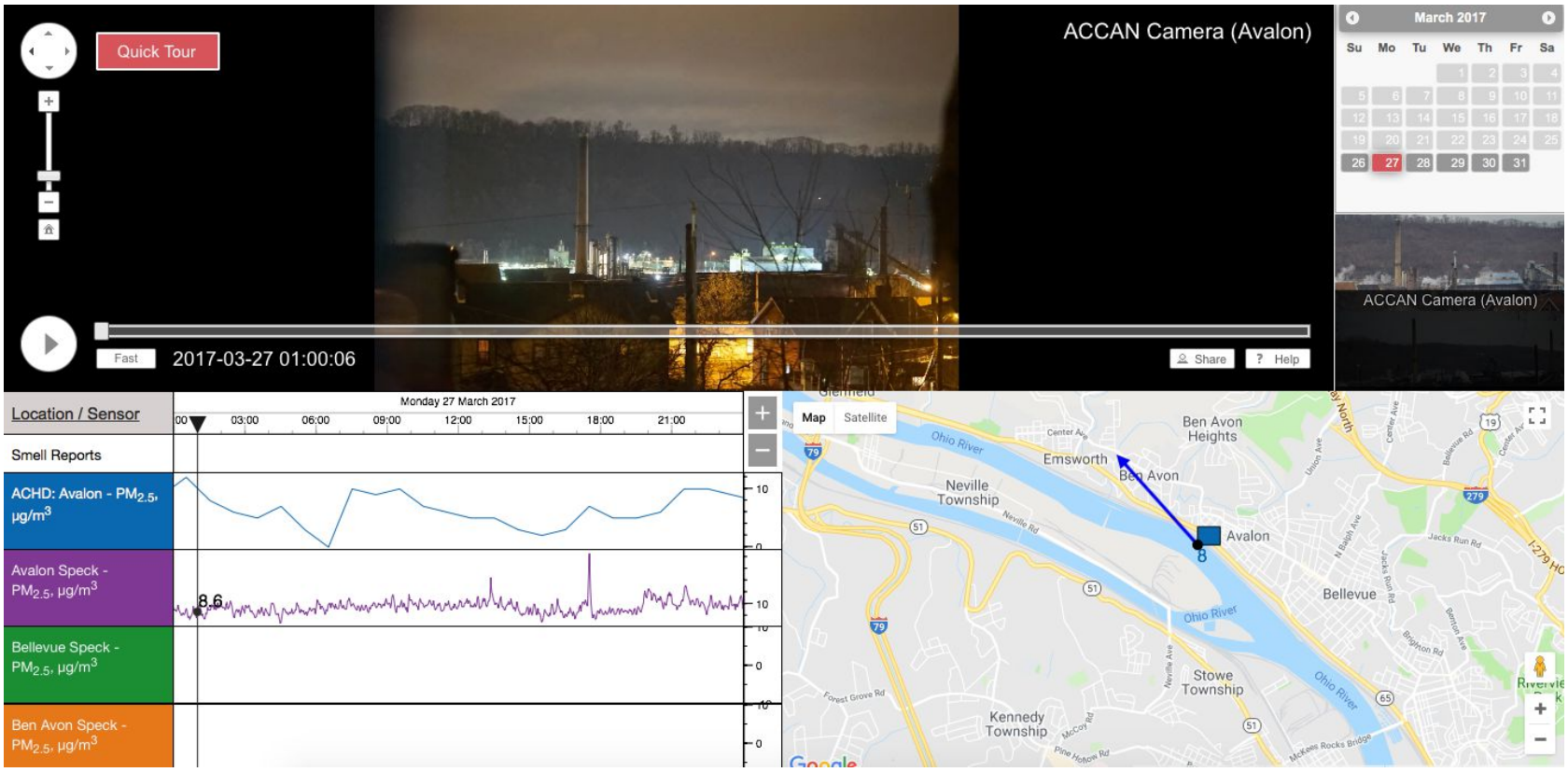


ALL-ACCESS PASS

Even if you don’t have a factory pumping out bad air in your backyard, you might still want to get involved in some kind of citizen science—which is research conducted by enthusiastic amateurs, either alone or in concert with professional scientists. Luckily for you, there’s something for everyone.

While the Shenango Coke Works in Pittsburgh was still active, Carnegie Mellon University helped put together a public dashboard called the Shenango Channel.

Want to help pick through terabytes of space telescope data to find exoplanets and quasars? Head over to Zooniverse. Or maybe you have a laboratory project in mind, but you can't afford the equipment. No problem; print out the parts from a blueprint on Appropedia's Open-source Lab.

How about some DIY biology? Local biospaces, such as BioCurious in Santa Clara, CA, or the Baltimore Underground Science Space in Maryland, can advise and assist with projects ranging from DNA extraction to printing cell cultures.

Tinkering with projects and crowd-sourcing data are two of the main occupations of citizen science, and a major stimulus for it is empowerment.

"This recent era of federal deregulation shines a spotlight on the insufficiencies and gaps in oversight, and when we can't rely on government intervention, we must rely on ourselves," said Gretchen Gehrke, data and advocacy steward with Public Lab. But access to the necessary tools to do that work can be a challenge, she added.

"Access" often simply translates to "making things cheaper." Thanks to the ever-plunging cost of sensors and microcontrollers, access to satellite data and the willingness of others to share technical expertise, sophisticated tools once available only to institutional researchers are now in the hands of anyone who wants them.

Marine researcher Kersey Sturdivant prepares to test an OpenCTD along a tidal creek in Virginia in 2016. (Photo courtesy of Andrew Thaler)

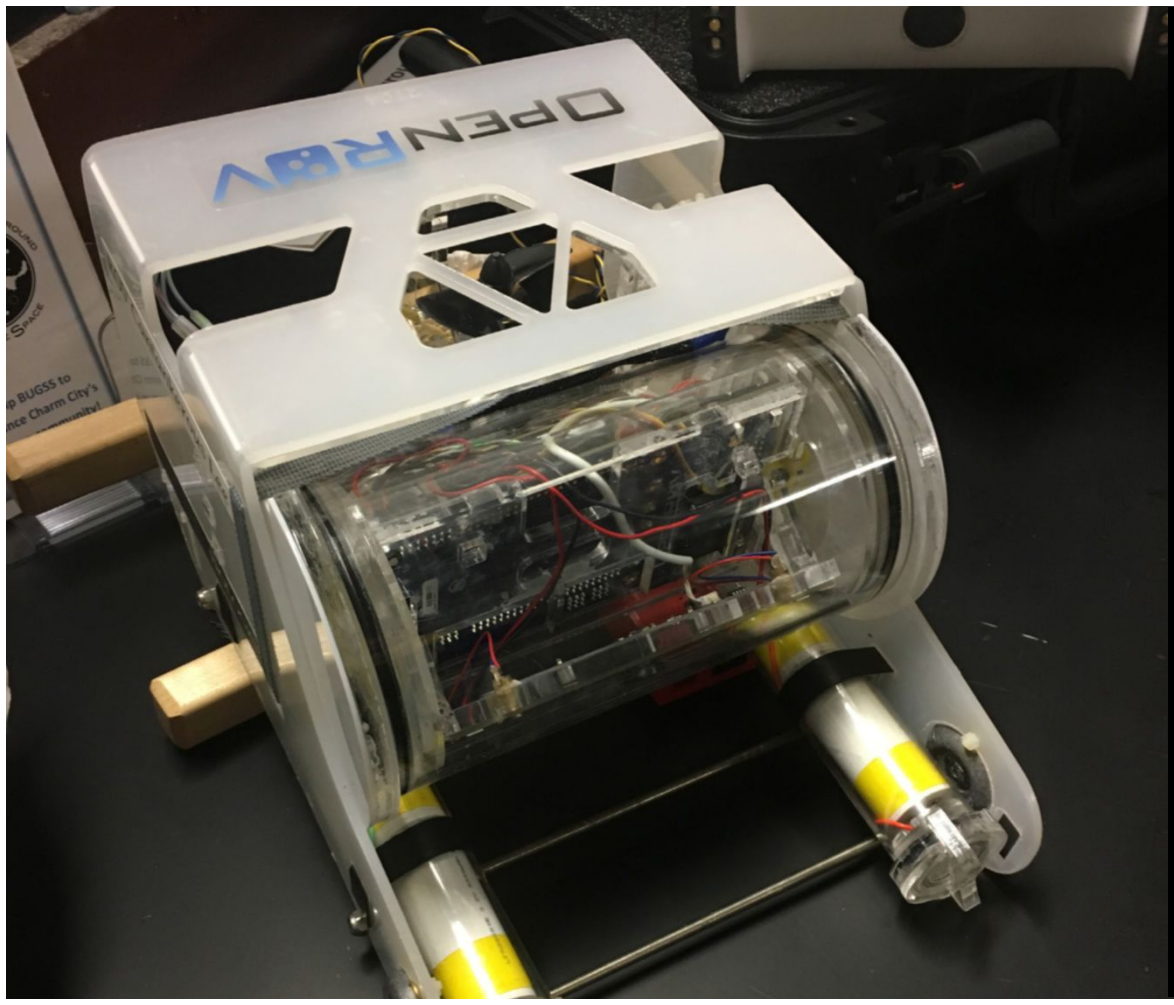
Consider the Raspberry Pi–based spectrometer designs hosted by Public Lab's community pages. Spectrometers are used to determine information about an object or substances through the analysis of its light properties. A commercial handheld version runs about $1,500; a bulky lab workhorse is five times that. Or with a little guidance, you can build one for yourself for about $70.

Another citizen-science pioneer is Andrew Thaler, a deep-sea researcher and marine ecology consultant who started Oceanography for Everyone because of barriers to access. The organization's stated goal: "Empowering researchers, educators, and citizen scientists through low-cost, open-source hardware."

The main tool Thaler worked on developing was a CTD, used in oceanography to measure conductivity (salinity), temperature, and pressure. It's an essential tool for studying and understanding an aquatic environment—but if you want one, get ready to fork over $6,000 at a minimum, up to the tens of thousands.

Andrew Thaler is a deep-sea researcher and marine ecology consultant who started Oceanography for Everyone.

Ecologist and open-source developer Andrew Thaler prepares to test an instrument of his own design on Lake Superior in 2015. His OpenCTD is the small white pipe strapped to the side of the much larger commercial version of the instrument. (Photo courtesy of Andrew Thaler)



Thaler has used the open-source OpenROV aquatic robot in community workshops designed to equip people with the knowledge, skills and tools to monitor the health of their own local waters. (Photo: Michelle Z. Donahue)

With a lot of patience and collaboration with friends and colleagues, Thaler developed a CDT for $300. The most expensive component is the sensor itself, which runs nearly $200. Yet tested alongside a device that cost 200 times more, Thaler's CTD returned data within a 2 percent margin of error of the more expensive unit.

"There is an increasingly relevant need to remind scientists that they're also citizens," Thaler said. "Sure, you might have access to a massive research grant, and you can buy a $60,000 commercial unit. But that's a huge barrier for entry for community groups who want to monitor their own waterways. If [scientists] also start supporting programs that make that same piece of equipment cheaper, a lot more science gets done."

Access to monitoring and robotics tools has helped at least one marine community accomplish a major goal. In Mexico, several fishing villages used Open ROV, the same open-source robotics platform Thaler uses in his training programs, to conduct surveys of Nassau grouper spawning aggregations. The grouper is a key reef fish as well as a vitally important commercial species, and the community established a marine protected area to shield it from being wiped out by poachers.

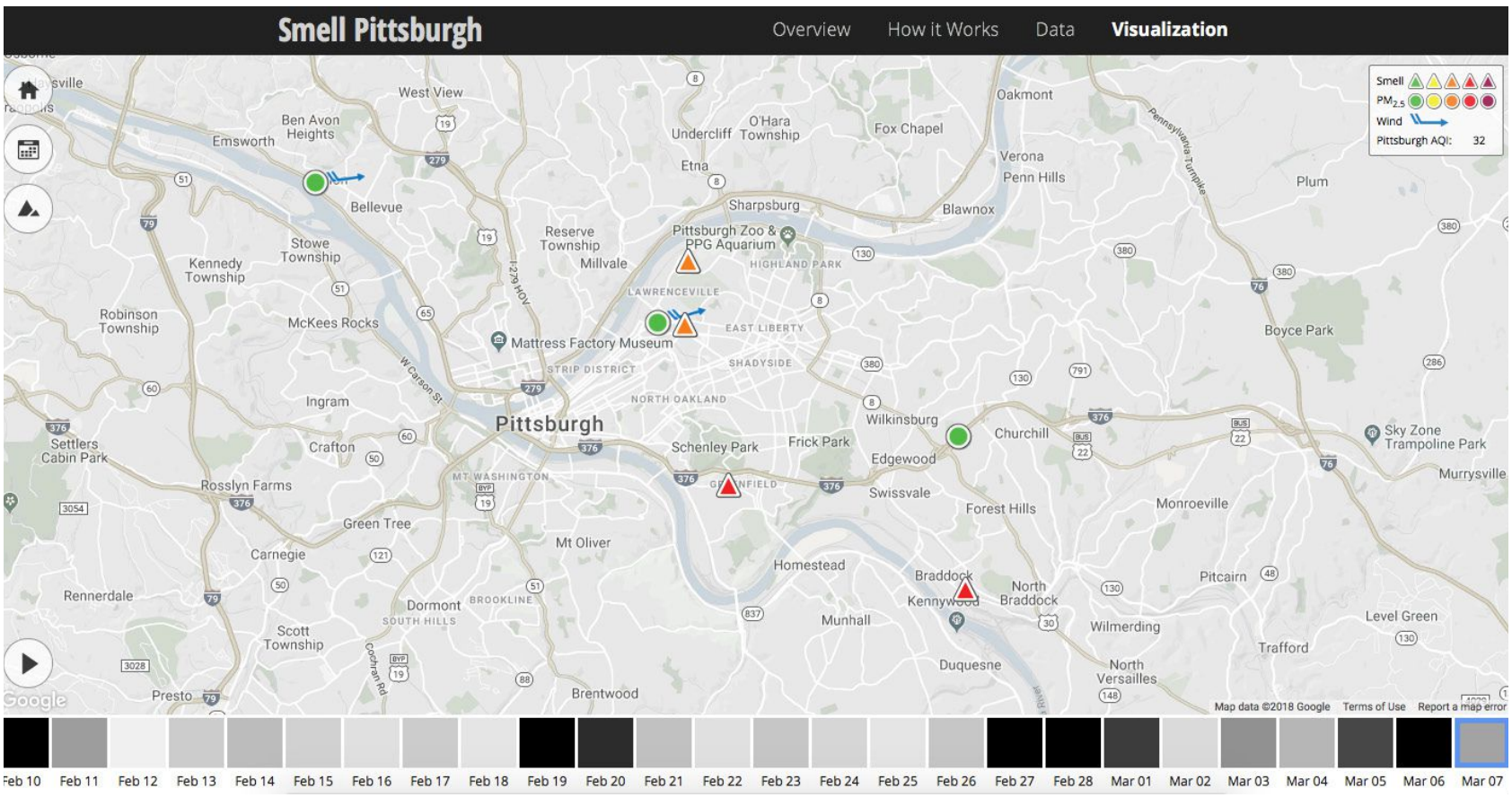
PREDICTING PROBLEMS

In Pittsburgh, CREATE Lab didn't stop with Shenango. Another prong of its mission is to help communities build on the knowledge and tools they gain through working with CMU scientists. And Pittsburgh being what it is, still somewhat in the grip of its steel-age legacies, Shenango isn't the only thing making a stench.

Enter Smell Pittsburgh, an app that came directly out of CREATE Lab's Shenango work. Still under development and envisioned as a tool that could eventually be used in any city in the nation, the app lets residents tag offensive environmental odors, which are logged in the app as well as reported to the local health department. After logging, the app displays a map that shows any other smell reports from the same day and time.

Mark Dixon, a Pittsburgh-based documentarian and industrial engineer, described the app as a way to motivate people to be engaged with something they'd like to change about their environment.

"There's this 'valley of malaise' that occurs when you report problems and nothing happens," Dixon said. "This app accelerates people through that valley—and the first thing they see is that they're not alone. Plus they can really see the scope of the problem."



Dixon is working toward building on the usability of the app. One project involved developing an algorithm that combines Smell Pittsburg reports and National Weather Service data to try and predict upcoming #Stinkburgh days, as they're tagged on Twitter. After achieving a roughly 75 percent success rate over a 10-day test period, Dixon shared his information with a group of local data geeks, including a Smell Pittsburgh developer. As a result, the ability to more reliably predict bad air days may be forthcoming in future versions of the app.

Prediction is also one goal of a different kind of app, the Mosquito Habitat Mapper. Launched in June 2017 by the Institute for Global Environmental Strategies (IGES) in partnership with NASA, the app aims to identify and eliminate dangerous mosquito habitat.

Already tested in Barbuda, Peru, and Chile, the app trains people to identify mosquito larvae they find, snap a picture, and eliminate standing water, and also to log time, location, date, and local environmental conditions into the app's database. To date, the project has accumulated around 1,500 data points—not yet enough to make any meaningful predictions. But the hope is that in the long term, an accumulation of better data from the ground in places where mosquito-borne disease is a serious public-health issue can help refine prediction models, which are currently based on weather and climate data gathered by satellites.

“The app trains people to identify mosquito larvae they find, snap a picture, and eliminate standing water.”

“There's a lot we don't know about how mosquitoes respond to microclimates,” said Rusty Low, a senior scientist at IGES who spearheaded the app's development. “We're looking for subregional, subseasonal tools that can be used by public health workers and communities to better understand their risk for disease.”

In Baltimore, Johns Hopkins doctoral student Anna Scott's Weather Cubes could also give urban planners more to work with when it comes to planning for healthy cities in a warmer future. Scott's cubes, which came about as an outgrowth of her studies on urban heat, are outfitted with Arduino-based sensors to measure temperature, humidity, ozone, nitrogen dioxide, sulfur dioxide, and hydrogen sulfide. Fifty cubes are deployed at 25 sites around the city, and Scott hopes to put more of them out this summer.

> **Weather Cubes could give urban planners more to work with when planning for healthy cities in a warmer future.**

Anna Scott's WeatherCubes are calibrated against EPA air monitoring stations. (Photo courtesy of Anna Scott)

Early monitoring data revealed that a greater number of small green spaces, like pocket parks, could be better for lowering temperatures across the city than several large parks, according to Kristin Baja, a former Baltimore climate resilience planner. That information could shift the perception of the city's 16,000 vacant lots from blight to beneficial.

In Baltimore's Turner Station neighborhood, Larry Bannerman hosts two of Scott's cubes. His predominantly African-American community has experience battling local polluters and agitating for protection. He said he's happy to have an additional card in his deck, should he need it.

“We’ll have a crystal clear picture of what’s in our air,” he said. “That knowledge in our pocket will be our biggest asset if we need to make some changes.”

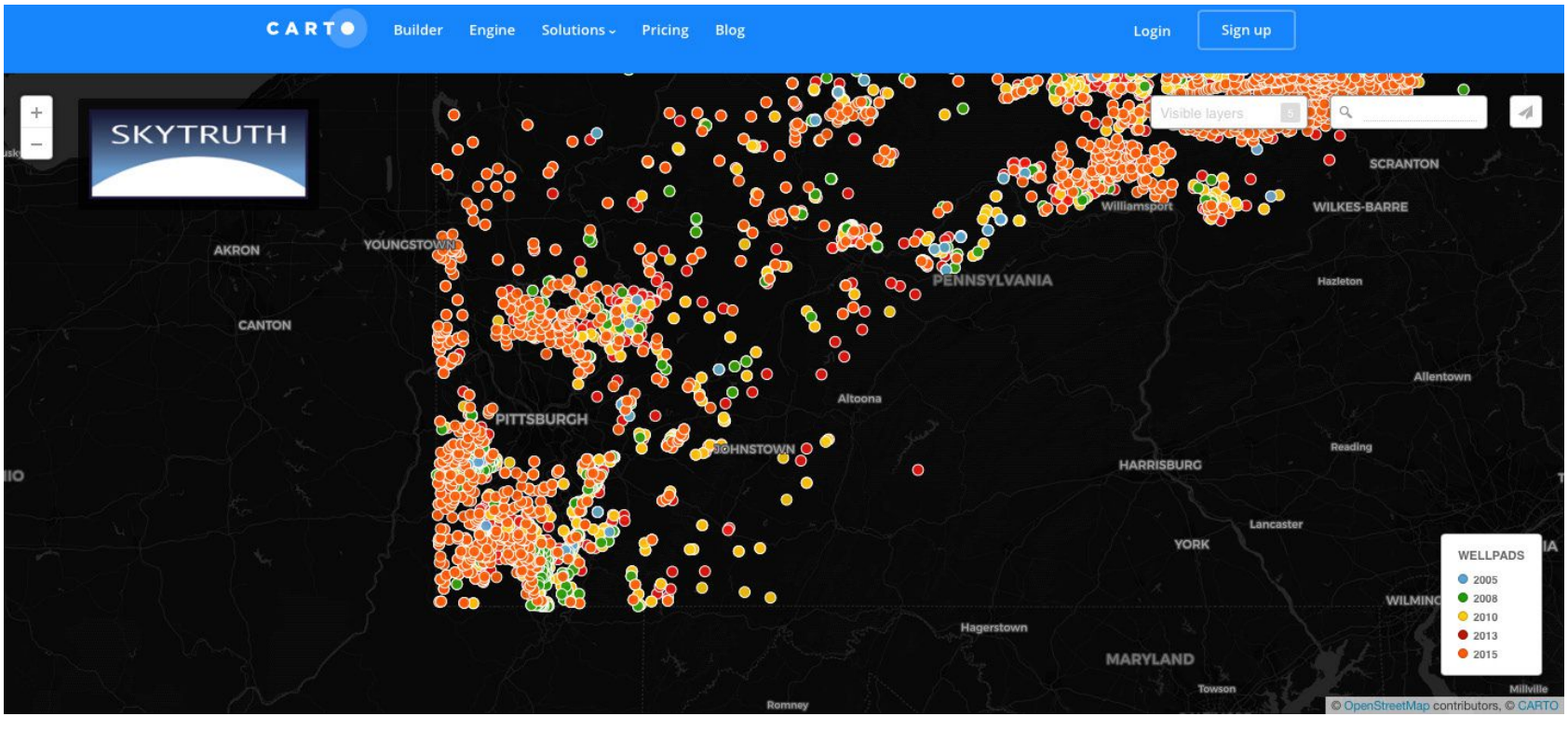
A VIEW FROM SPACE

In John Amos’ view, citizen contributors are going to be key to tackling a problem that’s often on his mind: making massive amounts of visual data more usable.

The non-profit he founded, SkyTruth, used satellite imagery analysis to show that the Deepwater Horizon oil spill in 2010 was larger than BP’s publicly stated estimates. Though the group continues to use human eyes to monitor satellite imagery for environmental impacts from spills, surface mining, and other industrial activity, SkyTruth is currently working toward adding artificial intelligence, machine learning, and big data into the mix.

SkyTruth Alerts is a service users can sign up for to be notified of certain environmental changes in a particular area—say a new gas drilling permit, a violation of a permit, or the report of a chemical spill or natural gas leak. Initially developed as an in-house tool, the alerts are currently scrape from Coast Guard and state-environmental-department reporting sites. Around 3,000 people are current users of this tool.

The evolution of the service aims to include more and more data sources and tools, and use AI and machine learning systems to compare new satellite imagery alongside historic imagery. With those kinds of references, analysis can detect changes even before they are reported through official channels.



The holy grail is to allow users to share their own observations and alerts, thereby creating a range of communities with shared concerns.

In fact, crowd-sourced data contributed by SkyTruth users for a separate project, FrackFinder, resulted in several studies that pushed Maryland to ban fracking in 2017. Johns Hopkins public health researcher Brian Schwartz looked at several health implications of living near fracking wells, including asthma and premature birth rates. Though he drew upon many data sources for the studies, there were "no alternatives" to the type of data that SkyTruth's users contributed, he said.

"We met with state elected officials several times and presented our findings and answered all their questions," Schwartz told us. "Some of them were reported, in newspaper stories and elsewhere, to have said that the 'Johns Hopkins health studies' finally persuaded them to vote for the ban. Those are our studies."

The power of local, on-the-ground human observation, combined with the data-crunching abilities of cloud computing, makes it possible to see potential problems unfold in real time, Amos noted.

"It's not just about things that have already happened, but also things that are happening in the environment before know anything about it, to be made aware that something is happening that we should be paying attention to," Amos said. "To me, that's a tech-driven, grass-roots revitalization of environmentalism."

And interest in harnessing emerging technology to simply be curious will only grow from here, added CREATE Lab's Dias.

With those references, analysis can detect changes even before they are reported through official channels.

COSMIC WATCH
Nuclear physicists Spencer Axani and Kasia Frankiwicz's clever, inexpensive tool visualizes actual cosmic particles. The box contains a strip of plastic called a scintillator, which emits a photon when a charged particle, like a muon, passes through it.

"These kinds of technologies shouldn't just be in labs or higher-ed spaces only," Dias said. "They should be accessible to everyday people, to create, and not just consume.

"And the idea is that once people are more fluent in technology, that they can take everyday things off the shelf and hack something together that works for them."

A.I. COMES TO EDGE COMPUTING

BY BEN DICKSON

Along the coastline of Australia's New South Wales (NSW) state hovers a fleet of drones, helping to keep the waters safe. Earlier this year, the drones helped lifeguards at the state's Far North Coast rescue two teenagers who were struggling in heavy surf.

The drones are powered by artificial-intelligence (AI) and machine-vision algorithms that constantly analyze their video feeds and highlight items that need attention: say, sharks, or stray swimmers. This is the same kind of technology that enables Google Photos to sort pictures, a smart home camera to detect strangers, and a smart fridge to warn you when your perishables are close to their expiration dates.

But while those services and devices need a constant connection to the cloud for their AI functions, the NSW drones can perform their image-detection tasks with or without a solid internet connection, thanks to neural compute chips that let them perform deep-learning calculations locally.

These chips are part of a growing trend of edge-computing innovations that enable our software-powered devices to perform at least some critical functions without a constant link to the cloud. The rise of edge computing is helping us to solve problems new and old and pave the way for the next generation of smart devices.

UNBURDENING THE CLOUD

In the past two decades, the cloud has become the defacto way of hosting applications, with good reason.

“The thing that makes the cloud so attractive is that it tends to offload the cost of starting up any activity you want to perform,” says Rob High, CTO of IBM Watson. “The cloud… allows people to… solve real problems today without having to go through the cost of infrastructure creation.”

With ubiquitous internet connectivity and near-countless cloud applications, services, and development platforms, the barriers to creating and deploying applications have lessened considerably. The vast resources of cloud providers such as IBM, Google, and Amazon have boosted the development not only of trivial business applications but also of complex software that require vast amounts of computation and storage—AI and machine learning algorithms as well as streaming and AR (augmented reality) applications.

“The thing that makes the cloud so attractive is that it tends to offload the cost of starting up any activity you want to perform.”

But these advances have also created a challenge: Most of the applications we use can’t function unless they are connected to the cloud. This includes most of the applications that run on computers and phones as well as the software in fridges, thermostats, door locks, surveillance cameras, cars, drones, weather sensors, and so on.

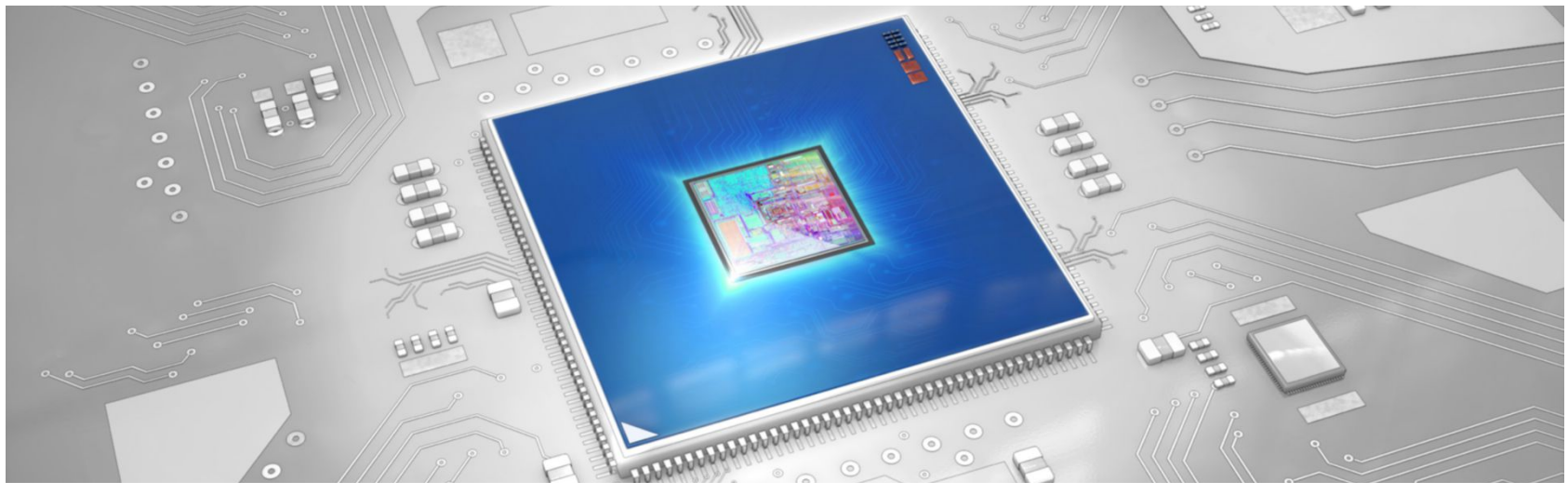
With the advent of the Internet of Things (IoT), an increasing number of devices are running software and generating data, and most of them will require a link to the cloud to store and process that data. The amount of power and bandwidth required to send that data to the cloud is immense, and the space needed to store the data will challenge the resources of even the most powerful cloud behemoths.

“There’s a lot of data that we’re collecting in these systems, whether it’s at the edge, or it’s an IoT device, or any other place, that you could almost decide not to care about,” High says. But if every decision must take place in the cloud, all that data will have to be sent across the network to cloud servers to be scrubbed and filtered.

As an example, High names modern airplanes, which contain hundreds of sensors that monitor jet engines and collect hundreds of gigabytes of status and performance data during each flight. “How much of that data really matters if you want to analyze it over an aggregate? Probably only a fraction of it,” High says. “Why not just get rid of it at the source when it’s not necessary for anything else you’re doing?”

Doing what High suggests outside the cloud was previously all but impossible, but advances in low-power, low-cost System-on-Chip (SoC) processors have given edge devices more computing power and let them shoulder some of the computational burden of their ecosystems, such as performing real-time analytics or filtering data. “There’s so much data in the edge environment, it makes sense to bring some of the cloud computing capabilities into the computational capacity of the edge device,” says High.

But the benefits of edge computing aren’t limited to freeing up cloud resources.



PRIVACY CONCERNS

Remi El-Ouazzane, New Technology Group and General Manager at Movidius (Intel), cites commercial security cameras as another example of when edge computing can make a huge difference. You see these cameras at traffic lights, in airports, and at the entrance of buildings, recording and streaming high-quality video across the network around the clock.

“The less data you need to haul back into a server or data center, the more scrubbing and finessing you can do locally, the better your overall cost of ownership will be from a storage and transfer perspective,” El-Ouazzane says. This means providing cameras with the power to analyze their own video feeds, determine which frames or lengths of video require attention, and send only that data to the server.

When those cameras are installed in your home, your office, or any private location, the connection to the cloud also becomes a potential security concern. Hackers and security researchers have been able to compromise the connection between home appliances and their cloud servers to intercept sensitive video feeds. Parsing the data locally obviates the need to have a video conduit between your home, your private life, and a service provider.

Movidius, which was acquired by Intel in 2016, is one of several startups that make computer chips specialized for AI tasks such as speech recognition and computer vision. The company manufactures Vision Processing Units (VPUs)—low-power processors running neural networks that analyze and “understand” the context of digital images without the need to send them back to the cloud.

“When the camera understands the semantics of what it’s looking at, then the ability to impose rules as to what the camera can do or cannot do is becoming a very easy task,” El-Ouazzane says. “You do not need to actually capture your living room for the next twelve hours just to know that, at a given time, your dog crossed the carpet in front of the sofa.”

The Movidius Myriad 2 reference board is an always-on vision processor made for power-constrained environments.

Other companies are exploring the use of specialized AI-powered edge computing to preserve user privacy. The Apple iPhone X, for example, is powered by the A11 Bionic chip, which can run AI tasks locally, allowing it to perform complicated facial recognition without sending the user's mugshot to the cloud.

More AI processing at the edge can pave the way for decentralized artificial intelligence, where users have to share less data with big companies to use AI applications.

More AI processing at the edge can pave the way for decentralized artificial intelligence.

REDUCING LATENCY

Another problem with big cloud providers is that their data centers are located outside big cities, placing them hundreds and thousands of miles away from the users and devices that are using their applications. In many cases, the latency caused from data traveling to and from the cloud can yield poor performance, or worse, fatal results. This can be a drone trying to avoid collisions or landing on uneven ground, or a self-driving car trying to decide whether its running into an obstacle or a pedestrian.

Movidius's lightweight implementation of deep neural networks and computer vision makes its chips suitable for mobile edge devices such as drones, for which power-consuming hardware such as GPUs are not feasible. Drones are a particularly interesting study, because they need low-latency access to AI computation and must keep functioning in offline settings.

El-Ouazzane points to gesture detection as another area where edge computing is helping to improve the drone experience. "The goal is to make drones accessible for many people, and gesture seems to be a nice way for people to use them. Latency matters when you gesture the drone to perform some task," he says.

For startups such as Skylift Global, which provides heavyweight drone services to rescue workers and first responders, low-latency access to AI and compute resources can save money and lives. “It will significantly cut data ingestion costs, reduce network latency, increase security, and help turn streaming data into real-time decisions,” says Amir Emadi, the CEO and founder of Skylift.

For startups such as Skylift Global, low-latency access to AI and compute resources can save money and lives.

Delivering supplies to first responders, because of the significance of requires split-second decisions. “The more time that passes, for instance in fighting a wildfire, the costlier it becomes to remedy the situation. As our drones become capable of making real-time decisions at the edge even when they lose connectivity, we will be able to save more lives, money, and time,” Emadi says.

Other domains in need of near-real-time computation are augmented- and virtual-reality applications and autonomous vehicles. “These are all experience-based computing environments. They’re going to happen around the people,” says Zachary Smith, CEO of Packet, a New York–based startup focused on enabling developers to access highly distributed hardware.

An AR or VR application that can’t keep up with the movements of the user will either cause dizziness or prevent the experience from becoming immersive and real. And latency will be even more of a problem when self-driving cars, which rely heavily on computer vision and machine learning algorithms, become mainstream. “A 30-millisecond latency will not matter for loading your webpage but will really matter for a car to determine at 60mph if it should turn left or right to avoid crashing into a little girl,” Smith says.

MEETING THE CHALLENGES OF THE EDGE

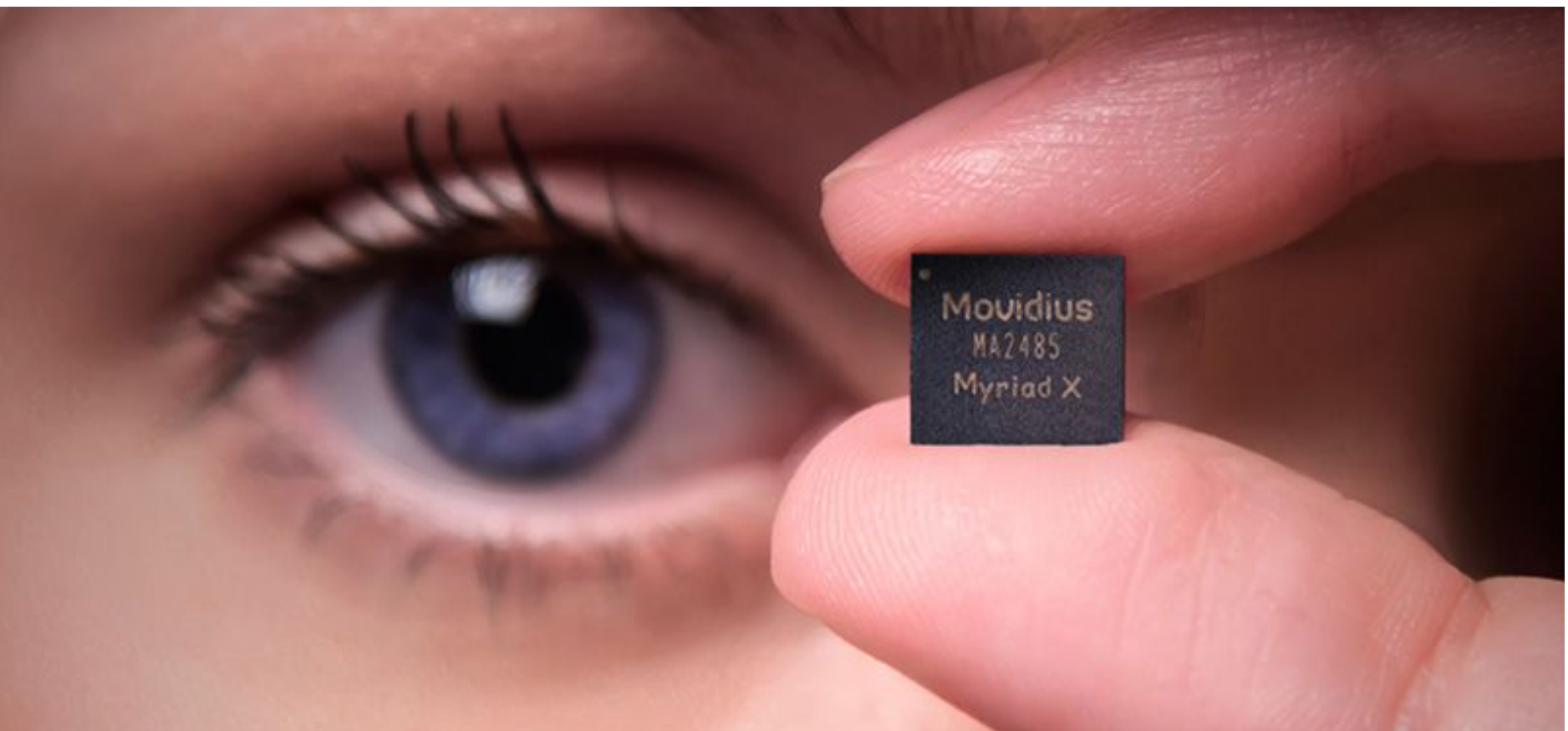
Despite the need to bring computing closer to the edge, putting specialized hardware into every device might not be the final answer, Smith acknowledges. “Why not just put all the computers in the car? I think it really has to do with the evolution of how fast you can control the lifecycle of that,” he says.

“When you put hardware into the world, it usually stays there for five to ten years,” Smith says, while the tech powering these experience-based use cases are evolving every 6 to 12 months.

Even very large companies with complicated supply chains often struggle with updating their hardware. In 2015, GM had to recall 1.4 million vehicles to fix a security vulnerability that was exposed five years earlier. And giant chipmaker Intel is still scrambling to deal with a design flaw that is exposing hundreds of millions of devices to hackers.

Movidius’s El-Ouazzane acknowledges these challenges. “We know that every year we’re going to have to change a range of products, because every year we’re going to bring more intelligence at the edge, and we’ll ask our customers to upgrade,” he says.

To avoid constant recalls and to let customers make long-term use of their edge hardware, Movidius packs its processors with extra resources and capacity. “We need the ability for the next few years to perform upgrades on those products,” El-Ouazzane says.



Packet, Smith's company, uses a different approach: It creates micro data centers that can be deployed in cities, closer to users. The company can then provide developers with very low-latency computational resources—as close as you can get to users without putting actual hardware at the edge.

"It is our belief that there will be a need for an infrastructure delivery mechanism to put hardware that can be accessed by developers in every city in the whole world," Smith says. The company already operates in 15 locations and plans to eventually expand to hundreds of cities.

But Packet's ambitions go further than creating miniature versions of the sprawling facilities operated by the likes of Google and Amazon. As Smith explains, deploying and updating specialized hardware isn't feasible with the public cloud. In Packet's business model, manufacturers and developers deploy specialized hardware at the company's edge data centers, where they can quickly update and refresh it when the need arises, while also making sure their users get superfast access to computing resources.

Hatch, one of Packet's customers, is a spin-off from Rovio, the mobile gaming company that created Angry Birds. The company runs Android on edge-computing servers to provide low-latency multiplayer-gaming streaming services to users with low-end Android devices.

"[Hatch] needs fairly specialized ARM servers in all these markets around the world," Smith says. "They have customized configurations of our server offering, and we put it in eight global markets across Europe, and soon it will be 20 or 25 markets. It feels like Amazon to them, but they get to run customized hardware in every market in Europe."

Theoretically, Hatch could do the same thing in the public cloud, but the costs would make it an inefficient business. "The difference is between putting a hundred users per CPU versus putting 10 thousand users per CPU," Smith says.

Smith believes this model will appeal to the developer generation that will be driving the next software innovations. "What we're focused on is how to connect the software generation, people who grew up in the cloud, with specialized hardware primitives," Smith says. "We're talking about users who can't even open their MacBook to look inside, and that's the person who's going to innovate on the hardware/software stack."

WILL THE CLOUDS DISSIPATE?

With edge devices becoming capable of performing complicated computational tasks, is the future of the cloud in danger?

“To me, edge computing is a natural and logical next progression of cloud computing,” says IBM Watson’s High.

In fact, in 2016, IBM rolled out a set of tools that let developers seamlessly distribute tasks between the edge and the cloud, especially in IoT ecosystems, where edge devices already collect a lot of data about their immediate environment. And in late 2016, Amazon Web Services, another major cloud development platform, announced Greengrass, a service that enables IoT developers to run parts of their cloud applications on their edge devices.

None of this means the cloud is going away. “There’s just a lot of things that are better done in the cloud, even when a lot of work is still being done on the edge,” High says. This includes tasks such as aggregating data from many different sources and doing large-scale analytics with huge datasets.

“If we need to create models in the AI algorithms that we use in these edge devices, creating and training these models still is a very massive computational-intensive problem and oftentimes requires computational capacity that far exceeds what’s available on these edge devices,” High says.

El-Ouzzane agrees. “The ability to train AI models locally is extremely limited,” he says. “From a deep learning standpoint, the training has only one place to sit, and it’s in the cloud, where you get enough compute resources and enough storage to be able deal with large datasets.”

El-Ouazzane also provisions use cases where edge devices are assigned with mission- and time-critical tasks, while the cloud takes care of the more advanced inferencing that is not latency-dependent. “We’re living in a world of continuity between the cloud and the edge.”

“There’s a very symbiotic and synergistic relationship between edge computing and cloud computing,” High says.

AFTER THE HURRICANES, PUERTO RICO EYES A FUTURE AS A TECH HUB

BY ROB MARVIN

Late on a Sunday evening in Puerto Rico weeks ago, a breaker exploded at a power station. After a fraught five-month recovery effort following Hurricanes Irma and Maria, parts of the island were plunged once more into darkness.

A few days later, Governor Ricardo Rosselló Nevares stood onstage at a Puerto Rico economic forum in New York City, asking and answering his own rhetorical question: If he had known he'd have to deal with not one but two Category 4 hurricanes, would he still have taken the job?

Rosselló's answer (obviously) was yes. Power has been restored to more than 79 percent of homes, and the governor had hoped to reach 90 percent by March. Unfortunately, outages continue to plague Puerto Rico, as the island's overmatched energy company struggles to fix outdated infrastructure.

Financial challenges also remain: Puerto Rico asked for $94.4 billion from Congress to rebuild the island's infrastructure. It got about $16 billion, with $6.8 billion in disaster relief aid split between Puerto Rico and the US Virgin Islands and another $2 billion toward Puerto Rico's energy grid.

“Outages plague Puerto Rico, as the island's energy company struggles to fix outdated infrastructure.”

Restoring the electrical grid falls on the Puerto Rico Electric Power Authority (PREPA), which itself is bankrupt and struggling to get the lights back on for its almost 500,000 customers. Due to inefficient and outdated machinery, the governor said, PREPA currently spends around 60 percent of its budget maintaining inefficient generators and power plants. This includes the two on the north end of the island, where explosions and fires led to the fresh blackout. A federal judge recently approved a $300 million loan to keep PREPA afloat, but that's more or less a Band-Aid. The governor's office is hoping to reduce the energy debt and modernize the grid by reforming and privatizing the energy sector.

"You become a pseudo-expert on energy after going through a hurricane," Rosselló said.

The island has also received around $37 billion in FEMA recovery dollars. Yet with fiascos such as the Whitefish Energy contract, the US territory's massive pre-hurricane debt, and disparity between the aid given to both Florida and Texas, Rosselló addressed the elephant in the room: Puerto Rico has no voting power in Congress.

"If Maria and these disasters showed anything, it's that the response to Puerto Rico and the actions that needed to be taken were always harder for us. Nothing was given. Nothing was assumed. Everything has to be battled through, and it's because we don't have political power," said Rosselló. "Why is there a difference in program funding relative to the states and citizens? Puerto Rico is a remnant of a colonial world. We're the oldest, most populated colonial territory in the world. How can you preach democracy if it's not being addressed in your own backyard?"

“PREPA currently spends around 60 percent of its budget maintaining inefficient generators and power plants.”

That separation from US political influence may be a major funding disadvantage, but as Puerto Rico looks toward the future, it also affords the island the freedom to innovate. Puerto Rico's power plants are outdated; the machinery is more than half a century old. Telecommunications and internet grids were wiped out along with power. How often is an entire populace forced to rebuild its infrastructure from scratch?

"The infrastructure overhaul Puerto Rico faces is unprecedented, and so is its economic and technological push to rebuild."

The infrastructure overhaul Puerto Rico faces is unprecedented, and so is its two-pronged economic and technological push to rebuild. Puerto Rico is working with companies including Tesla to build island-wide renewable energy grids, with AT&T and other telcos on IoT-enabled 5G networks and smart cities. San Juan is also becoming an attractive destination for startups, particularly in the blockchain and cryptocurrency space, and Puerto Rico is in the process of crafting a landmark regulatory bill to catalyze the industry.

PCMag spoke to Manuel Laboy, Puerto Rico's Secretary of Economic Development and Commerce, and Omar Marrero, Executive Director of the Puerto Rico Public-Private Partnerships Authority (P3A), about rebuilding the island's infrastructure and fostering economic growth. There are still massive challenges ahead, but Puerto Rico's future is bright.

BUILDING THE CITIES OF THE FUTURE

The catastrophic damage wrought upon Puerto Rico by Hurricanes Irma and Maria resulted in the largest blackout in US history. Cellular networks were crippled as well. Once you lose power, the rest of the technologies powering modern civilization collapse.

“Energy had a domino effect across all infrastructure sectors. We didn’t have water, because we didn’t have energy. We didn’t have communication, because we didn’t have energy,” Marrero said. “When the next hurricane comes—and it will come—we have to make sure we are ready.”

Priority number one is getting the existing energy grid back up to 100 percent and running reliably. But looking forward, even the president of the US Federal Reserve said Puerto Rico should rebuild its energy infrastructure from scratch. For starters, that means turning Puerto Rico into a testbed for widespread renewable energy, given its equatorial location and high frequency of sunny days. On that front, it’s Tesla to the rescue.

A consequential Twitter exchange between Elon Musk and Governor Rosselló led to quick action: Tesla installed a pilot project of 500kW Powerpack batteries at the Hospital del Niño (children’s hospital) in San Juan, with enough solar panels to keep the array charged. Musk also donated his own money to recovery efforts and provided Powerpacks for free, but Tesla is angling to make things official and greatly expand its solar efforts on the island to power smart microgrids with renewable energy.

“[Tesla] submitted a proposal we are evaluating right now to build a virtual plant across Puerto Rico with energy storage similar to what they’re doing in Australia,” said Marrero. “The virtual plant would help Puerto Rico to lower the cost not only from a resiliency perspective and to help us to comply with the max requirement for the EPA, but also to lower the cost of energy. This is a great opportunity not only to rebuild, but also to rebuild with the best partners that we can get.

“The hurricanes have put a spotlight in Puerto Rico, and companies like Google, Tesla, even Virgin Atlantic are talking about how they can revitalize locations like the Luis Muñoz airport and others all across Puerto Rico.”

Marrero said Puerto Rico is working on finalizing its Integrated Resources Plan. The government wants more than 30 percent of the energy sector to be renewables at first, with that figure growing over time as the island takes advantage of wind and solar elements.

Next to energy and vital utilities like water, the next most important infrastructure priority is telecommunications. Puerto Rico's blackout underscored the need for new telco infrastructure and communications networks; telephone lines and cellular sites were decimated during the storms.

AT&T, Sprint, and T-Mobile, as well as networking hardware companies like Cisco deployed large ground crews in the aftermath of the hurricane to patch and rebuild. Silicon Valley came through as well, with Facebook sending its connectivity team and Google sending in its balloon-powered Project Loon internet project, which brought LTE service back to more than 100,000 AT&T and T-Mobile customers in the two months following the hurricanes.

Marrero said Puerto Rico was already considering implementing more intelligent infrastructure, but the natural disasters pushed the government and tech companies into action.

> **"The government wants more than 30 percent of the energy sector to be renewables at first."**

“This is an opportunity that allowed Google and other companies to deploy their technology and see if it works… and it worked,” he said. “We want to harden communications infrastructure and deploy better technology to make it more resilient, to make sure it can withstand [future catastrophes]. We want to expand access to broadband.

“We were already considering a product similar to KentuckyWire, a broadband product essentially allowing the private sector to build the infrastructure and then get their own investments through user fees. Now our need has further sparked that interest.”

Because Puerto Rico has to rebuild from scratch, Marrero hopes the island can serve as a testbed of sorts for what the cities of the future might look like. He said that part of the aid package approved by Congress, upward of $11 billion, has to be used within two years. The government has a specific timeframe in which it needs to deploy and use the technology to rebuild Puerto Rico. The P3A is exploring investments and partnerships not only in energy and communications but also toward loftier goals, including 5G networks and smart cities. That, in turn, is an investment in attracting more startups, tech companies, and corporations to the island to help revitalize the economy.

“It’s not just about substituting the bulbs we have now with LED light bulbs or embedding them into Wi-Fi and broadband,” said Marrero. “We are going to be as aggressive as we can. We’re preparing what I call our ‘moonshot’ recovery plan. We have a Smart Cities Council helping us develop innovative ideas, and both the Rockefeller Foundation and MIT have committed to help us. We submitted an application for a grant so Puerto Rico can train local leaders, both public and private, in how they can formulate smarter projects and build smarter cities.”

“Marrero hopes the island can serve as a testbed of sorts for what the cities of the future might look like.”

A BLOCKCHAIN-FUELED STARTUP BOOM

Puerto Rico's infrastructure rebuild is only half the story. The island has long been a quiet home for tech companies and multinational corporations: GE, Google, Honeywell, HP, Microsoft, Pfizer, Tesla, and others have outposts in Puerto Rico for everything from manufacturing to software development. Over the past several years, the government has unveiled a number of economic and tax incentives to attract large companies and to entice a larger crop of startups and entrepreneurs.

2012's Act 20 includes tax incentives to promote export services, including a maximum 4 percent corporate tax rate and no minimum job-creation requirement. Act 73 adds economic incentives, including a 4 percent income tax rate specifically for manufacturing, technology, and software development, as well as a 50 percent tax credit for research and development.

Manuel Laboy, Puerto Rico's Secretary of Economic Development and Commerce, said the island has benefitted from a combination of its tropical locale, economic incentives, and highly skilled workforce.

“Puerto Rico's infrastructure rebuild is only half the story. The island has long been a quiet home for tech companies.”

“Puerto Rico has mostly been dominated by big corporations. There was a boom in the seventies that brought pharmaceutical and electronic giants to the island, like Intel, looking for good local incentives,” said Laboy. “The second wave was biotechnology companies and pharmaceutical groups, and a third wave was aerospace, and at that point the companies began transferring knowledge to the people. The last 10 years have been more technology-driven, with companies like Microsoft. Now everyone is starting to see the island as a place to do business.

“We still want Microsoft, Honeywell. We want all those guys on the island,” he continued. “We also now have a Google X presence through Project Loon, and Tesla’s work with solar and battery packs. But the perception we’re seeking is in addition to those guys. We want to attract technology entrepreneurs and startup companies.”

PROJECT LOON IN PUERTO RICO

Startup accelerators such as Parallel18 are looking to attract international companies and talent and turn Puerto Rico into a hub of the Americas. Other prominent startups include Abartys Health, which won the 2017 Release IT competition at the South by Southwest (SXSW) conference. Abartys is building cloud-based platforms meant to disrupt and simplify the healthcare and insurance landscape.

The real boon for startups is Act 22, which has helped establish Puerto Rico as an attractive tropical destination for blockchain and cryptocurrency companies over the past several years. Act 22 gives a 100 percent income tax exemption to new residents for their first six years living on the island, along with no capital gains tax, while they still maintain US citizenship. Combined with no minimum job creation requirement and the R&D tax credit, these incentives are a major factor in creating what The New York Times recently dubbed a “Crypto Utopia.”

Dozens of entrepreneurs and startups including Block.One, BlockV, and Videocoin are flocking to the island. A more mature company with its sights set on Puerto Rico is Blockchain Industries, a fintech firm specializing in digital assets and virtual currencies, which also offers cloud-based cryptocurrency mining services. Those operations are currently located in California but are expanding to Puerto Rico and Singapore this year.

Blockchain Industries is also sponsoring the Blockchain Unbound conference (formerly called the Puerto Crypto conference) with the Puerto Rican government. Taking place in San Juan in mid-March, Blockchain Unbound is a singular indication of the growing mainstream fervor around Puerto Rico’s crypto potential. Speakers to appear at the high-profile event include Olympic gold medalist and aspiring crypto entrepreneur Apolo Ohno and Overstock CEO Patrick Byrne, as well as Laboy and Governor Rosselló.

Blockchain Industries is also making an even bigger, more audacious bet on Puerto Rico: The company is forming a state-chartered bank to hold, convert, and lend against digital and virtual assets. How that plays out, however, is tied to the Puerto Rican government’s ambitious plans for the space.

Laboy and Governor Rosselló's administration were not exactly thrilled with the New York Times article's characterization of Puerto Rico as a lawless crypto haven. Long before the article ran, the government had begun working on a first-of-its-kind regulatory framework to turn the island's blockchain and cryptocurrency activity into a quantifiable industry.

"This view of a cryptopia tax haven promoting illegal activities and fraud portrays a completely distorted view of what we think this could be for Puerto Rico," said Laboy. "We want to craft a bill that is going to establish a necessary framework to both safeguard the interest of Puerto Rico and at the same time achieve the goal to be a major jurisdiction for blockchain and cryptocurrency."

The administration has been working on the regulatory proposal for several months and hopes to make it a reality by the end of summer. They're looking to create a friendly framework for attracting blockchain and cryptocurrency innovation, but with a clear set of rules to avoid illicit activities. Laboy wouldn't divulge many technical specifics of the potential legislation, but said he sent representatives to events such as the North American Bitcoin Conference in Miami this past January to talk to industry stakeholders.

"We want to achieve two goals. We want to validate that this is the right direction, and number two, we want to get the details right. The [representative] put together a great scouting report about the [Bitcoin conference] and submitted it to the governor, who has been very interested in this since last year," said Laboy. "I'd like to have something submitted before June 30. That's my goal, which is very aggressive, but certainly we would like to have something before the end of the year."

"They're looking to create a friendly framework for attracting blockchain and crypto-currency innovation."

Puerto Rico has an opportunity to become a real player in a number of different emerging spaces—not only the blockchain and cryptocurrency but renewable energy as well, Laboy said. He pointed to the Integrated Resources Plan and how the governor is looking to leverage the island's recovery efforts and funding to rebuild, and also to leapfrog the competition on renewable energy with an ambitious infrastructure plan.

He sees the same sort of opportunity for blockchain. Countries around the world, including the US, Russia, the Philippines, and South Korea, are beginning to regulate cryptocurrencies and initial coin offerings (ICOs). Puerto Rico hopes to pass regulation that—thanks to the island's accelerated economic plans tied to recovery—could help set precedents for the emerging space.

"Not only do we want to be a player and be relevant, we want to be a pioneer. We know that Wyoming, Nevada, and other states are trying to do the same thing, and that countries like Japan, Singapore, and South Korea are putting similar things in place," said Laboy. "Blockchain technology is going to revolutionize all transactions through decentralized networks. It's more effective, more efficient, and more transparent. If we don't get into this within the next five years or ten years, we are going to become irrelevant. That's why I would like to use the word 'pioneer.'"

Puerto Rico is still deep into the recovery process from an unprecedented scale of widespread natural devastation. Yet Puerto Rico pushes forward. As the island rebuilds its homes, power grid, and telecommunications infrastructure, there is much hope to be found. The government and the tech and startup ecosystem helping to revitalize Puerto Rico's economy envision an island of the future dominated by renewable energy, smart cities, and tech-driven prosperity. As Laboy put it in his presentation at the New York economic forum, he wants entrepreneurs and innovators to help Puerto Rico rebuild and to come "live and work in a tropical paradise."

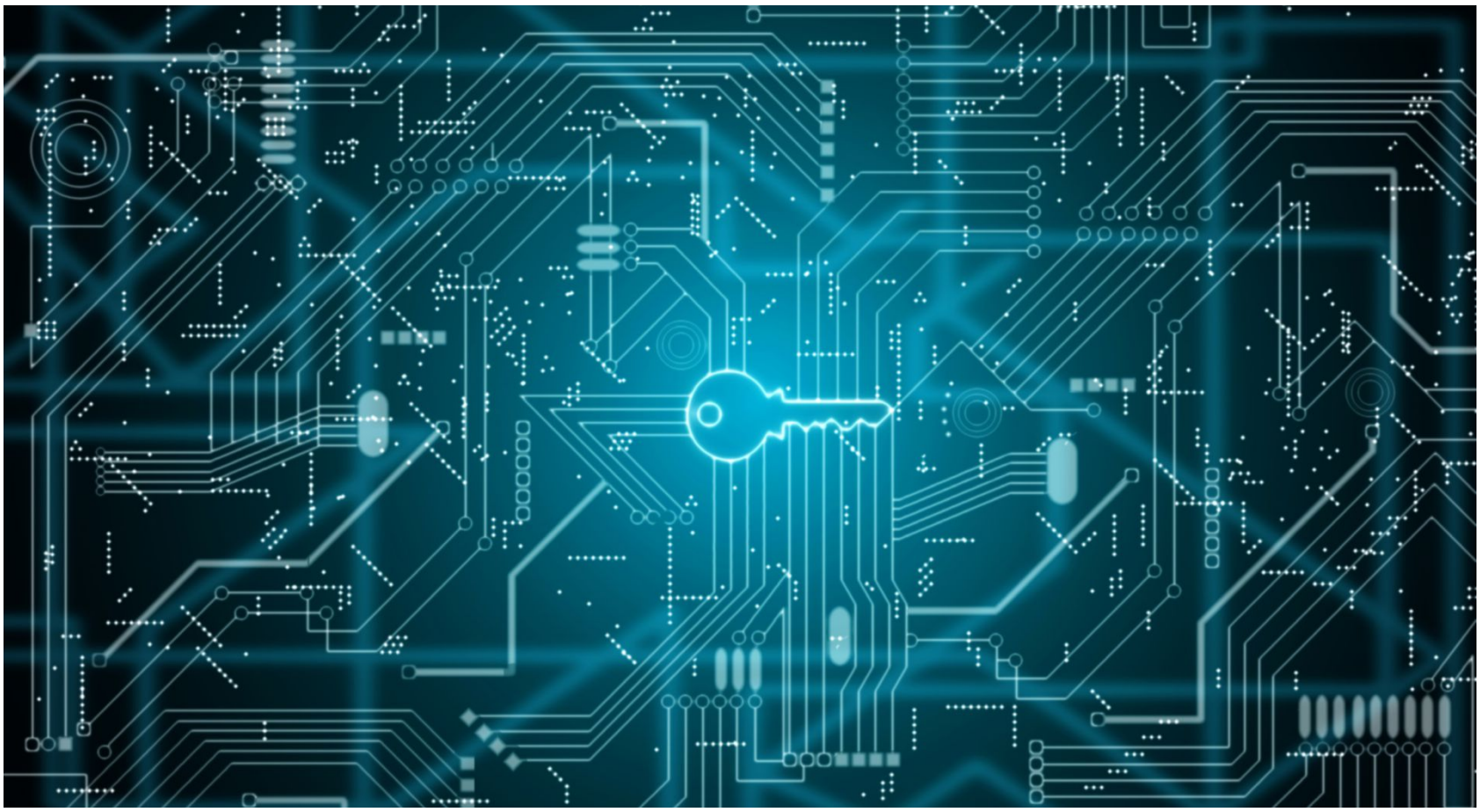
How to Set Up and Use a VPN

BY MAX EDDY

You should be using a virtual private network, or VPN, whether you're connecting to the internet on your computer or your smartphone. That may sound paranoid, but real threats exist, and they're only getting worse. On Wi-Fi networks, unscrupulous individuals can attempt to intercept your information. And whenever you connect to the internet, your internet service provider (ISP) has access to everything you send and has been given the green light from Congress to sell your anonymized information to advertisers. Out on the wide open internet, advertisers and spies can track your movements among websites and discern your location by peeking at your IP address.

The fact is, the internet was not designed to protect your privacy. It was created for easy information exchange, not for user privacy, anonymization, or encrypted communication. Although HTTPS goes a long way toward protecting your information, it doesn't guard against ISP snooping or local network attacks—a major problem when you use a connection that isn't yours, such as one at a hotel or a coffee shop.

So until a new, more private internet comes together (probably never), using a VPN is the easiest way to make sure that you're sharing as little information as possible. Make no mistake: You need a VPN.



WHAT A VPN DOES AND DOES NOT DO

As with any security tool, it's important to understand the limitations of a VPN. After all, you wouldn't expect a Kevlar vest to save you from falling out of an airplane, or a parachute to stop a bullet.

When you switch on a VPN, your traffic is routed through an encrypted tunnel to a server operated by the VPN company. That means that your ISP and anything (or anyone) connected to your router won't be able to see your web traffic. From the VPN server, your traffic exits onto the public internet. Unless you're headed to a site that uses HTTPS, your traffic is no longer encrypted.

Because your traffic appears to come from the VPN's server, your actual IP address is effectively hidden. That's important, because IP addresses are distributed geographically and can be used to infer someone's location. If someone checks your IP address, they'll see the IP address of the VPN server. This can come in handy if you want to spoof your location: By, say, connecting to a VPN server in London, you can make it appear as though you are accessing the internet from the UK.

What a VPN won't do is completely anonymize your traffic. To do that, you'll want to use a service such as Tor. This excellent anonymization service is easily accessed through a special version of the Firefox browser. Instead of just piping your data through a single intermediary (that is, a VPN server) Tor bounces your data through several different volunteer computers. This makes it much harder for someone trying to track your activities to see what you're up to.

Additionally, websites can track your movements through cookies, browser fingerprinting, online trackers, and other tricky tools. Using an ad-blocker such as Privacy Badger helps suppress these ever watchful nasties and can make it much harder for advertisers to follow your movements across the web.

Finally, just because you have a VPN doesn't mean you can forget about the security basics. Though some VPN services claim they can block malware, we recommend standalone antivirus software for your computer, because those tools are designed specifically to protect your computer from malicious software. You should also use a password manager, because recycled passwords are a major point of failure. Another precaution is to use common sense when clicking on links or opening email attachments. Phishing attacks—when an attacker uses a bogus website that mimics a familiar one to trick you into entering your login credentials—are so common as to almost be mundane, so stay alert.

HOW TO CHOOSE A VPN

When we review VPNs, we look for a few key metrics. One is that the VPN service should allow you to connect at least five devices at a time. Another is whether the VPN service allows BitTorrent traffic on its servers. Some do, some do not, and you don't want to run afoul of the company you're paying a monthly fee to.

Speaking of fees, the average cost of a VPN service is $10.53 per month. A VPN service that charges more isn't necessarily ripping you off, but it should offer something significant, such as a great interface or lots of server locations to sweeten the deal. You can usually get a discount when you buy longer-term contracts, but we recommend avoiding those until you're certain that you're happy with the service.

Before you sign up with a VPN, be sure to read its terms of service. This document will outline what information the VPN collects and what it does with that information. Most companies say that they don't log traffic, which is great. Others go further, saying that they do not monitor user activity at all. This is important, because a VPN has access to all the information you're trying to protect from others. The best terms of service make all these issues clear, while the worst are opaque on the details and written in legalese. If reading one of these documents feels like trying to translate the Dead Sea Scrolls, consider trying another service. TunnelBear, for example, clearly outlines its operation in easy-to-understand language.

It's also useful to see where the VPN company is based. Keep in mind that this isn't always the physical location of the business but a legal distinction that outlines what jurisdiction the company operates under. NordVPN, for example, is in Panama, while ProtonVPN is in Switzerland. That means that these companies are not beholden to data retention laws, which would require them to hold on to certain information that could be obtained by law enforcement. Hide My Ass VPN, on the other hand, is based in the UK, which has more intrusive laws.

The most important thing about a VPN is trust. If the location, pricing, or terms of service don't fill you with confidence, try another service.

FREE OR PAID VPNS?

We at PCMag recently conducted a survey of 1,000 people, asking questions about VPN use. According to our results, 62.9 percent said they didn't want to pay more than $5, and 47.1 percent said they want to use a free VPN.

Unfortunately, most VPNs are a far cry from free—or even from $5. But you don't need to break the bank to get protected. If you're sold after trying out a service for a month or two, you can save money by purchasing long-term contracts. And Private Internet Access is an excellent and affordable service that costs just $6.95 per month for an albeit no-frills experience.

Many VPN services offer a free trial, but usually for a limited time. Others, like TunnelBear and AnchorFree Hotspot Shield Elite, have totally free versions but may limit some features to paid users. TunnelBear, for example, has a data allowance for free users. Hotspot Shield, on the other hand, has an ad-supported free version. ProtonVPN, from the creators of the secure email service ProtonMail, has a limited free version of its VPN, too.

The browser Opera has a free VPN baked in and charges nothing for its use. Opera separately offers excellent VPN apps for Android and iOS, also completely free, extending protection wherever you go.

GETTING STARTED

Once you've settled on a service, the first thing to do is to download the company's app. There's usually a downloads page for this on the VPN service's website. Go ahead and download the apps for your mobile devices as well; you'll want to protect as many as you can. Generally, you pay one subscription fee for a certain number of licenses (usually five), and then you can use the service on any device for which it provides apps.

We've found that when they release VPNs for Mac, companies sometimes have different versions in the Mac App Store than on the company website. This seems to be in order to comply with Apple's restrictions. Figuring out which will work for you can be tricky, but we break down the differences in our reviews.

Once you've installed the apps, you're prompted to enter your login information. In most cases, this is the username and password you created when you signed up for the service. Some companies, such as Private Internet Access, assign you a username that's different from your billing credentials, to provide customers with more privacy.

Once you're logged in, your VPN app usually connects to the VPN server closest to your current location. That's done to provide better speeds with a VPN, as latency and speed reductions increase the farther the VPN server is from your actual location. That's it: Your information is now being securely tunneled to the VPN server.

Latency and speed reductions increase the farther the VPN server is from your actual location.

Note that you do not have to install the VPN company's app. Instead, you can configure your device's network settings to connect directly to the VPN service. If you're concerned about the potential for surveillance within app ecosystems, this might be a good option for you. Most VPN services will have documentation on how to configure your device.

CHOOSING A SERVER

Sometimes you might not want to be connected to the server the VPN app recommends. Perhaps you want to spoof your location, use BitTorrent via VPN, or take advantage of some of the custom servers your VPN company has provided.

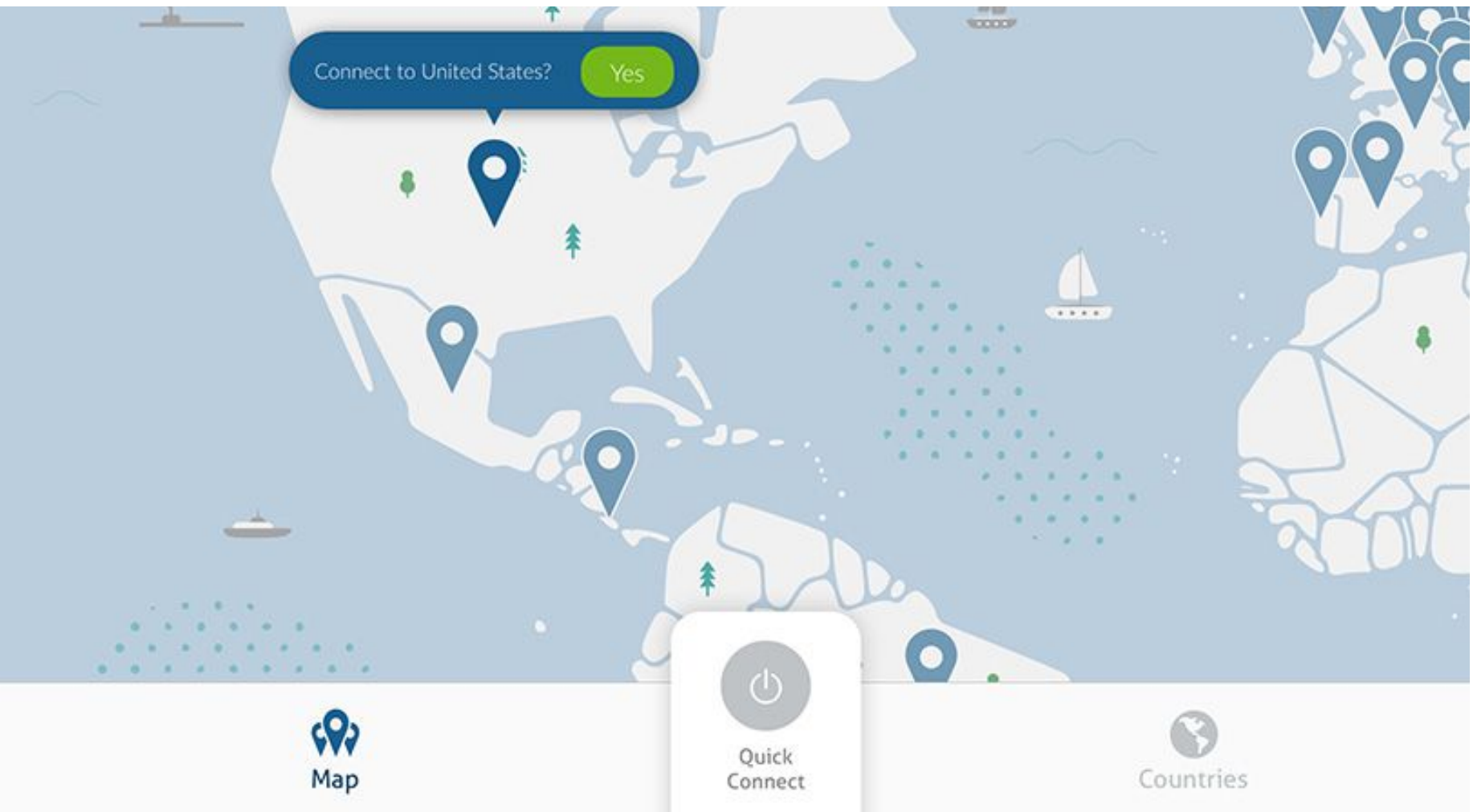
Many VPN companies include an interactive map as part of their app. NordVPN, for example, lets you click on countries to connect to those servers. It's a useful way to understand where your information is going, but there's probably a list of servers you can select from.

Choosing a server depends entirely on what you want to accomplish. For security and speed, you should choose a server that's close by. To access region-locked content, you'll want a server that's local to content you want to watch. If you're trying to watch the BBC, you'll want to tunnel to the UK. Some VPN companies, such as KeepSolid VPN Unlimited and NordVPN, have specialized servers for streaming video.

These specialized servers are useful, because streaming services such as Netflix block VPNs. At issue are the licensing deals Netflix secures with studios. For example, Netflix has the rights to provide Star Trek: Discovery outside the US, but within the US, you have to pay for CBS's All Access service.

It's also a good idea to check whether your VPN service allows BitTorrent traffic on any server or just specific ones. NordVPN clearly marks the servers cleared for torrenting, and others do the same. TorGuard, on the other hand, is all about torrenting and allows its use on all the company's servers.

Other services, such as NordVPN and ProtonVPN, have enhanced security options, including access to Tor or multihop VPNs. Tor, as mentioned, is a way to better protect your privacy and lets you access hidden websites on the so-called Dark Web. Multihop VPN is similar: Instead of routing your traffic through just a single VPN server, a multihop connection tunnels you to one server and then another. Both offerings trade speed for enhanced privacy.



If you've opted to ignore first-party apps and configure your network settings manually, you will probably have to enter the information for each VPN server individually.

ADVANCED SETTINGS

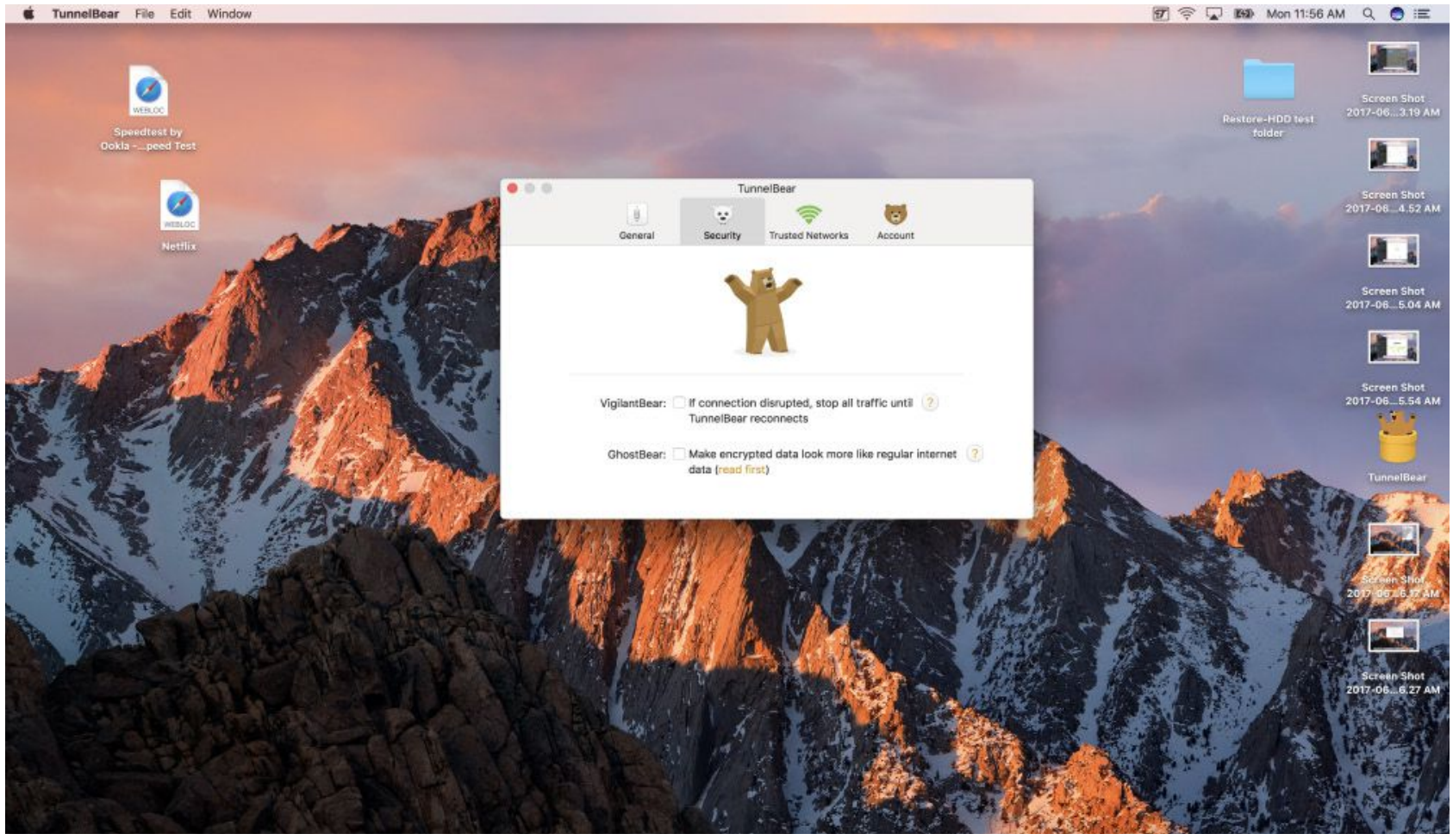
The set of features in each VPN varies from service to service, so we can only generalize about what you may see when you open the Settings pane. But we encourage you to read through the documentation and try clicking some buttons. The best way to learn how to use a tool is to try, after all.

Most VPN services include some kind of Kill-Switch feature. Once engaged, this option prevents your computer from transmitting or receiving information over the internet unless the VPN is engaged. It's useful for times when your computer disconnects from the VPN, and it can prevent little bits of data sneaking through unencrypted.

> **The Kill Switch prevents your computer from transmitting or receiving information unless the VPN is engaged.**

Most services offer an option to select a VPN protocol. This can be intimidating, since they have weird names, and companies rarely provide information about what these are and what changing the protocol will do. In general, this is something you can leave alone.

But if you're interested, the protocol we recommend is OpenVPN. It's open-source, so it has been picked over by many eyes for any potential vulnerabilities. IKEv2 is also a good, secure option if OpenVPN is not available. Note that on some platforms, such as macOS and iPhone, OpenVPN is not always available, because of additional restrictions placed on developers. The best VPNS for iPhone give you access to the latest and greatest protocols available on that platform.



WHEN SHOULD I USE A VPN?

For the best security, you should use a VPN as often as possible—ideally, all the time. At minimum, use a VPN whenever you're using a network that's not one you control, especially if it's a public Wi-Fi network. We recommend that users set the default on their VPN apps to be connected as much as possible. You can always disconnect if it's causing a problem.

VPNs for Android and other mobile devices are a little trickier, particularly if you frequently move in and out of cellphone coverage. Each time you lose and regain data connectivity, the VPN has to reconnect, which adds a frustrating wait. It's also just less likely that your cell traffic can be intercepted, but researchers have shown that it can be done. And considering that law enforcement and intelligence agencies have effectively unfettered access to telecom data, it's a good idea to use a VPN even over cellular connections. Also, most mobile devices can automatically connect to any familiar-looking Wi-Fi network. At minimum, you should use a VPN when connecting via Wi-Fi, because it's trivially simple to impersonate a Wi-Fi network.

Many VPNs have settings for how and under what circumstances they should reconnect if they become disrupted. We honestly cannot think of a reason you wouldn't want your VPN to try reconnecting and encourage everyone to make sure their settings reflect this.

If you're concerned about VPNs slowing your connections or blocking important traffic, you should take a look at split-tunneling options. Again, different companies give this feature different names, but the gist is that you can decide which apps will use the VPN for their traffic and which apps can transmit without the VPN. TunnelBear, for example, includes an option not to tunnel any Apple apps, to ensure they function properly on a Mac. Frequent video streamers and gamers in need of a VPN may want to look into this.

HOW TO USE A VPN FOR STREAMING WITH CHROMECAST OR AIRPLAY

Chromecast and AirPlay let you share music and video from your computer or mobile device to speakers, TVs, and streaming boxes. But all of them require Wi-Fi, which can be a problem when you're using a VPN.

When a VPN is engaged, your traffic is moving through an encrypted tunnel, which prevents the devices from finding one another other on the same Wi-Fi network. That's as it should be, since you don't want someone snooping around a network to see what you're up to. But it means that Chromecast and AirPlay won't work when you have a VPN active.

The simplest solution is to switch off your VPN, but that's not your only option. You can use split-tunneling, as mentioned above, to route only the traffic you want secured through the VPN. You can use a VPN browser plugin, which encrypts only your browser traffic and nothing else.

Alternatively, you can install a VPN on your router. Doing so means that all the devices connected to your router—from your phone to your smart juicer—have their traffic encrypted. That's a great option for a heavily wired smart home.

VPNS AREN'T ROCKET SCIENCE

While VPNs might seem like arcane security tools, many companies have worked hard to make them friendly and easy to use. Most are now set-and-forget, as they should be. And though opening your wallet to guard against potential threats is always annoying, buying a VPN is one of the best and easiest ways to guard your web traffic from, well, just about everything.

How to Use Your Amazon Echo to Get in Shape

BY LANCE WHITNEY

You can laze around, asking your Echo to play music and keep you entertained with quizzes and games. But you can also use it to help you get in shape. Among Alexa's many skills are ones that can shout out exercises like a disembodied personal trainer.

Ask Alexa to start a five-minute plank, start a new workout for abs, talk you through a chest workout, or launch into a seven-minute routine. Your Echo can even personalize and keep track of your workouts, so you can simply tell Alexa, "Open my workouts," and it'll know just what to do. In some cases, you may have to enable an exercise first before you can perform it, which you can do in the Alexa app.

To browse through all of Alexa's workout skills, open the Alexa app, tap on the hamburger icon, and select Skills. Tap on the Categories button, then tap on the Health & Fitness category. Hunt around to discover the various exercise and fitness skills. To save you time, here are some skills that will get you started on your road to better health and fitness.

QUICK START

Say, "Alexa, open Random Workout." In response, Alexa conjures up a random exercise for you to perform and also tells you the number of times you must perform it, such as 15 crunches, 20 sit-ups, or 10 push-ups. It's then up to you to do that exercise.

HIFIT

Say: "Alexa, open HiFit." Alexa launches the HiFit high-intensity workout route. Through this skill, you can work out your entire body or just certain muscle groups, such as your abs or chest. Alexa even volunteers to play some music while you work out. Your workout kicks off with a specific exercise, such as a certain number of pushups. Alexa then gives you time to cool down and recover before launching into the next exercise. Keep this up until the program finishes or you're too pooped to continue.

7-MINUTE WORKOUT

Say: "Alexa, start 7-Minute Workout." Alexa describes the workout and then gives you an exercise to perform, such as jumping jacks or push-ups, and a certain amount of time to complete it. She then moves onto the next exercise, keeping that up until you're done. Alexa can even keep track of the number of workouts you perform and then pick up where you left off at a later time.

BOXING

Want to box? Say: “Alexa, open My Boxing Coach.” Alexa then takes you through however many three-minute rounds you want to try, giving you the punches to do, such as a jab, a cross, and an uppercut.

YOGA GURU

Interested in trying some yoga? Say: “Alexa, ask Yoga Guru to teach me a yoga pose.” You can then ask how to do a certain pose, such as a Cobra pose, and Alexa describes the pose to you.

YOGA STUDIO

You can also say: “Alexa, open Yoga Studio and start for ten minutes.” Alexa serves up a class by a yoga teacher who takes you through each pose.

MY WORKOUTS

Finally, say: “Alexa, open My Workouts.” Alexa asks your name and offers to create your own personalized workout profile and program. She asks for your height, weight, gender, age, fitness goal, how often you exercise, and what exercises you can do. Alexa then gives you an exercise and tells you how long you have to complete it.

Once you’re done, Alexa gives you the next exercise in the program. You do each exercise while Alexa plays music in the background. After you stop, you can then go back to your program at another time, telling Alexa to resume your previous workout or start a new one.

How to Take Great Photos With the Apple iPhone X

BY LANCE WHITNEY

With superior cameras on the front and back, the iPhone X takes high-quality snapshots and selfies. But there are a few tricks to picture-taking with Apple's newest smartphone.

First, some technical specs: The iPhone X boasts rear 12-megapixel wide-angle and telephoto lenses. The wide-angle lens has an f/1.8 aperture and the telephoto lens an f/2.4 aperture. The wider aperture on the telephoto lens helps take photos in low-light conditions. The telephoto lens offers an optical zoom of 2x and a digital zoom of up to 10x. Both lenses come with optical image stabilization to steady handheld video. The 7-megapixel camera in front uses an f/2.2 aperture and can take shots using Portrait mode.

Many of the features, such as the high-quality dual cameras and Portrait mode, are available with the iPhone 7 Plus and iPhone 8 Plus as well as the iPhone X. So some of what I cover here applies to all three phones. But I'll use an iPhone X as the test subject, and review the other photo options for those of you who may not be familiar with them. Let's check out how to take photos with the iPhone X.

UPDATE TO IOS 11: First, make sure you've updated your phone to the latest iOS version. To do this, go to Settings > General > Software Update. Your phone will either tell you that your software is up to date or download the latest version.

CAMERA APP OPTIONS: Open the Camera app to see several options for photos and videos: Time-Lapse, Slow-Mo, Video, Photo, Portrait, Square, and Pano. To take a regular snapshot, select Photo, and tap on the Shutter button. Hold down the Shutter button to take multiple shots in burst mode. Tap on the 1x button to zoom in. To use the digital zoom to get even closer, hold down the 1x or 2x button. Move your finger along the curved line until you reach the zoom number that you want. You can also simply pinch on the screen to zoom in or out. (Note that digital zoom can reduce resolution and quality.)

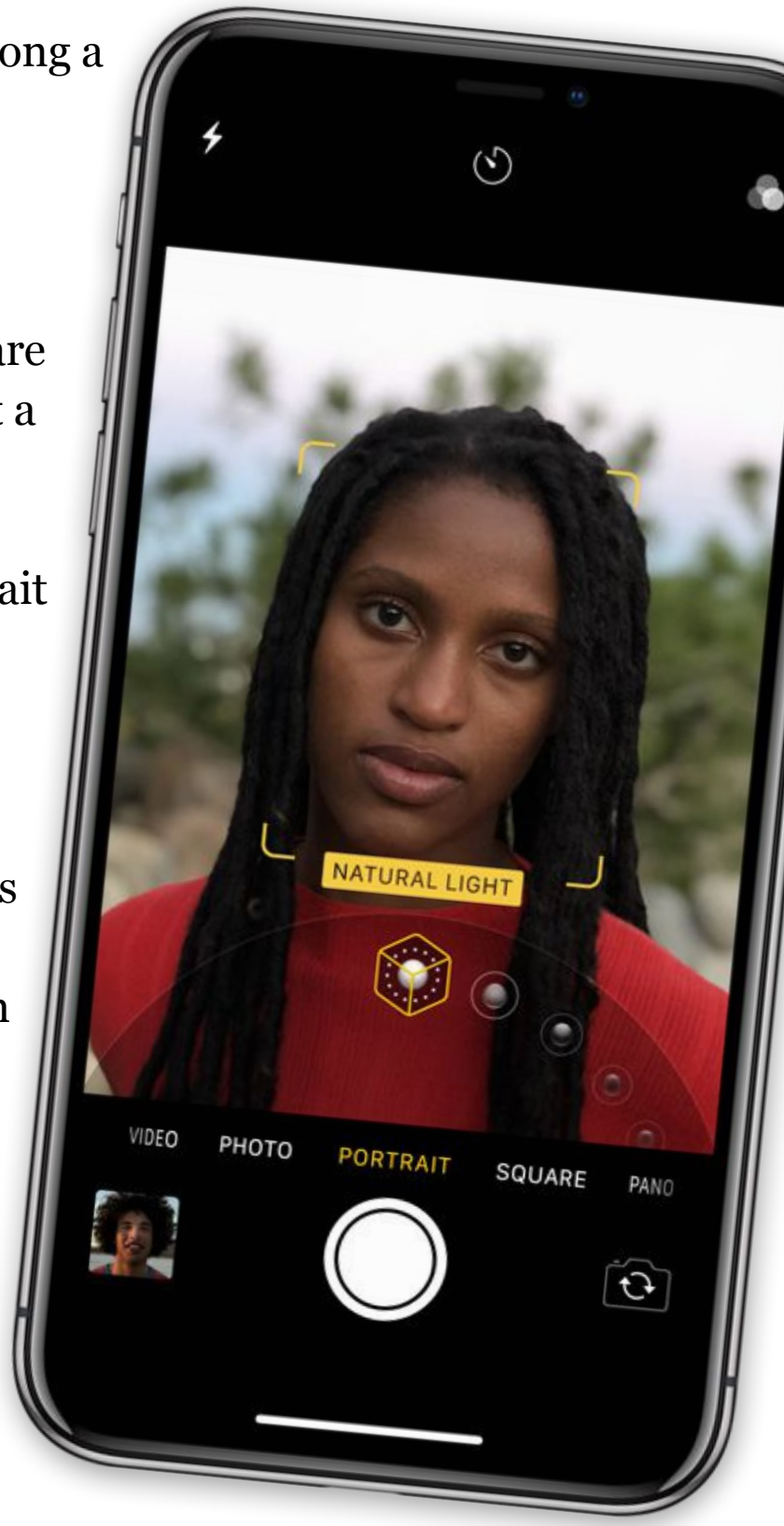
VIDEO OPTIONS: Time-Lapse lets you shoot a short video. When you view it, the action speeds up. You can use the wide-angle or optical zoom for time-lapse but not the digital zoom. Slow-Mo also lets you shoot a video, and when viewed, the action slows down. You can use the wide-angle, optical, and digital zoom with a slow-mo video.

ADJUST RESOLUTION AND FRAME RATE: Video, of course, also lets you shoot a normal video using the wide-angle, optical zoom, and digital zoom. You can adjust the resolution and frame rate of the video from the Settings screen. Open Settings > Camera. Tap on the Record Video setting, and you can opt to shoot 720p, 1080p, or 4K video at different frame rates–24, 30, or 60 frames per second. You can lock the camera so your phone doesn't switch between the wide-angle and telephoto lenses, ensuring a smoother video. From the Camera Settings screen, you can also select the frame rate for slow-mo video, either 120 or 240fps.

PANO: Pano lets you slowly move your phone along a wide scene to capture everything in one shot, producing a panoramic image. You can shoot the panoramic image at 1x or 2x.

SQUARE: Square resizes your image into a square as opposed to a rectangular photo. You can shoot a square photo at up to 10x via the digital zoom.

PORTRAIT MODE: And that brings us to Portrait mode, which you'll find on the iPhone 7 Plus, the iPhone 8 Plus, and the iPhone X. When you first use Portrait mode, your phone displays a screen explaining what it does. Tap Continue. As you frame your subject, your phone offers suggestions to help you take a better shot, such as move closer, move farther away, or place subject within 8 feet. With the iPhone 8 Plus or iPhone X, you can also choose from among different Portrait Lighting effects, including Natural Light, Studio Light, Contour Light, Stage Light, and Stage Light Mono. Check out each of the lighting effects to see which one best suits your subject and your photo.



FRONT CAMERA: You can snap a shot using the front camera in Photo, Time-Lapse, Video, and Square modes. The front camera can also jazz up your selfies when you're in Portrait mode by letting you experiment with the various Portrait Lighting effects.

PORTRAIT LIGHTING: With the iPhone 8 Plus or iPhone X, you can apply one of the Portrait Lighting effects to photos you've already taken in Portrait mode. From the Camera app, tap on the thumbnail icon in the lower left to segue to your library. Swipe through your photos until you find the one you want to tweak. The photo will display the word Portrait at the top to indicate that you shot it in Portrait mode. Tap Edit. The icons for Portrait Lighting appear at the bottom of the photo. Swipe through them until you find the effect you want. Tap Done.

CUSTOMIZE: You can take advantage of other options when you snap a photo, which you can access at the top of the Camera app screen. Tap on the Flash icon to set the flash to go off automatically when needed, to turn it on, or to turn it off. Available on the iPhone 6s and later, Live Photos captures the moments just before and just after a snapshot and is enabled by default. You can tap on the Live Photos button to turn the feature on or off. Tap on the Timer icon to set a timer for 3 seconds or 10 seconds.

FILTERS: Tap on the Filter icon and swipe through the different color filters to pick one you like.

HDR: HDR (High Dynamic Range) takes three photos in one shot at different exposures and tries to create a single photo combining the best elements of the three. HDR is automatically enabled on the iPhone X and other iPhone models. An HDR image does take up more space on your phone than a standard image. If you want to turn off Auto HDR and control it on a shot-by-shot basis, go to Settings > Camera. In the HDR section, turn off Auto HDR. Return to the Camera app. You'll now see a setting for HDR so you can set it to Auto, turn it on, or turn it off.

JOHN C. DVORAK

The Old Man and the Smartphone

The smartphone is under intense scrutiny as a disruptive device that causes depression in teens and has resulted in a noteworthy increase in pedestrian deaths. People walk into poles because they are looking at the screen or get into car accidents because they are texting while driving. It's ridiculous.

I've been ridiculed in the past for recommending (on national TV) that Apple stop developing and marketing the iPhone. In hindsight, I was right, but not about Apple—just about the smartphone in general. It's a genuine plague. That said, it's too late now to do anything about it.

I'd love to see Hieronymus Bosch's painting "The Garden of Earthly Delights," a masterpiece done around the year 1500, updated to a modern scene with everyone holding a phone in one of the two positions—talking or texting. In fact, look at any painting done before 2007 and add the reality of the smartphone. Take any photo from the turn of the century where every male in the crowd is wearing a straw at and add the smartphone.

Why do we need to feel so plugged in and connected that we have to have this phone in our pocket or by our bedsides at night?

I've always related this connectivity to the heyday of the pager—generally referred to as a "beeper"—in the years between 1970 and 2000. These devices were first used by doctors on call and drug dealers.

@ THErealDVORAK

To me, they were the ultimate ball and chain. I was always stunned when people who didn't need them had them anyway. I'd ask, "What do you need a pager for?" and always got some bogus answer that translated to, "So I can feel important and needed."

This got out of control with the BlackBerry, the pager on steroids—nicknamed the CrackBerry. People would constantly be checking their email for an important, life-changing message.

I think the phone fulfills our need to constantly be fiddling with something. It's part of the human (and primate) condition. It's no coincidence that the decline in cigarette smoking marked the increase in smartphone usage to the point of it being dangerous. Cigarette smoking was also an intensive ritual using hands and fingers.

Visit the mountain villages of the Andes, and you'll find every old woman talking to her friends and slowly hand-spinning a huge ball of wool. In Eastern Europe, you'll find people fingering rosary beads for no particular reason. Chimps and other primates spend a lot of time grooming each other and literally nit-picking. It's no coincidence that people do virtual nitpicking by looking up wiki articles on the phone while in a discussion around the dinner table to clarify some fact. Nitpicking, same as a monkey.

People who are constantly knitting or those who crochet: I'd bet money that they spend less time on a smartphone than most of us. Same goes for whittling, scrimshaw, basket-weaving, and painting. My thesis would indicate that taking up the guitar or the piano—where you use the fingers

> **It's no coincidence that people do virtual nitpicking by looking up wiki articles on the phone around the dinner table.**

constantly—would just as well take care of this need to fiddle around with something.

Recent indicators that heavy smartphone use causes depression may have it backward. The depression comes from lack of doing things with our hands, which is compensated for by heavy phone use. But unlike the wool spinners or knitters, nothing comes of it. There is no fruit of any labor, just time-wasting.

So my recommendation is obvious: Get a piano, knitting needles, or a paint-by-number kit. Get off the phone. Most of you are not doctors on call. Nothing is so important that it can't wait.

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