PC MAGAZINE

FASTEST MOBILE NETWORKS 2018

DIGITAL EDITION
JULY 2018

PC MAGAZINE

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CAROL MANGIS

Driving Toward 5G

I'm writing this on the first full day of summer—officially road-trip season. But PCMag drivers have already hit the road this year, testing phone-carrier signals across the country. Welcome to our Fastest Mobile Networks 2018 issue.

As always, we checked for data speeds and reliability on the top four networks—AT&T, Sprint, T-Mobile, and Verizon Wireless—in and around 30 US cities. We did regional drives as well to get a sense of how well carriers perform outside urban areas; read our cover story to see the winners.

The bottom line, though? Everything is getting speedier. As PCMag's Lead Mobile Analyst Sascha Segan wrote: "Compared with 2017, we're seeing faster, more consistent LTE connections on all four major US wireless networks. Peak speeds have jumped from the 200Mbps range to the 300Mbps range, average download speeds have bumped up by 10Mbps or more, and latency has dropped by 10ms."

That's pretty exciting stuff for smartphone users. But in 2019, we expect the news to be even better: For the first time, we'll be testing the carriers' nascent 5G offerings. The wireless industry came up with the first official 5G standard last year. AT&T plans to launch mobile 5G in the US this year. Verizon is starting out with a fixed 5G home internet service launching in three to five cities in mid-2018. And both T-Mobile and Sprint say that they're launching 5G phones early in 2019.

@cmangis

How will 5G impact users and the market? Joel Hruska on our sister site, ExtremeTech, sums it up this way: “5G is being treated as a game-changer for wireless networks. Not only is it expected to be the network of choice for billions of IoT and IIoT (Industrial Internet of Thing) devices, it’s designed to offer a greater degree of implementation flexibility than LTE did.”

Look for 5G to enable myriad other new capabilities. At a 5G hackathon in Oulu, Finland, last year (see our September 2017 issue), Segan saw developers working on projects including stroke rehabilitation through VR, smart bandages that track healing, and a method for parents to interact with babies in incubators. He wrote, “All of these ideas require the high bandwidth, low latency, or low power and low cost of 5G.”

I think we’ll have many more happy surprises in store as this new standard takes off and enables more innovation. Watch for PCMag’s updates and reviews as 5G arrives.

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Is a VPN a Must?

For PCMag Software Analyst Max Eddy, the answer is an emphatic yes—but not all of our readers agree.

Surprising to hear that only 29% of readers use VPNs. I've been trying (and failing) to recruit my friends for years.
—Henry

It's having one more frigging bill to pay that keeps me and many others from using a VPN. I don't want more bills. Also, I've been online for 20 years without one. Why start now? I have only one thing I care to protect, and that is my bank account password. Anyone can steal my family pictures, music, and game saves. Have at it! My computer would bore a hacker to death.
—Chris Terry

I recommend using a VPN on the router level, so that you can encrypt your entire network—even devices that have no native VPN support, like a Playstation or smart TV. You will need to flash your router with DD-WRT in order to do this. Flash your router yourself, or buy a preconfigured one from FlashRouters.
—Ed Gallagher

[Using a] VPN is important if you are a road warrior jumping onto a questionable Wi-Fi [connection] or untrusted network. If you're working off your own router (with a secure WPA connection), there really is no point.
—Dan

I frequently find myself toggling and forgetting to turn my VPN on. My internet provider provides me with a DVR-type outlet where I can watch television shows and movies. When I'm home, I get full access; when I'm not, I get limited access. Well, using a VPN gives my ISP the idea I'm attempting to watch the content elsewhere, which is quite annoying. So anytime I stream a show, I typically have to disable my VPN.
—Buster

If you don't use a VPN, the gummint will harass you.
—PhlatBatturee

CORRECTION: In our June cover story, "WIreless Power Is Coming," we stated that Ossia has FCC certification for its Cota Transmitter; we should have said that Ossia has passed key tests for FCC approval of the Cota Transmitter, and approval is expected shortly. In the same story, we also stated incorrectly that both Energous and Ossia partner with Dialog Semiconductors. Ossia is actually working with large electronics manufacturers Motherson and Molex.

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.

Mozilla: Facebook Data Leak Is Like a 'Nuclear Waste Spill'

BY DAN COSTA

Mozilla is best known as the maker of web browser Firefox, but the organization also has a philanthropic function. As part of that function, Mozilla has compiled a massive, graphic-laden assessment of the internet itself, dubbed the Internet Health Report 2018.

I sat down with Mozilla's Executive Director Mark Surman to discuss some of the report's key findings, including the scourge of fake news, consolidation of industry power, and how leaked data should be treated a "nuclear waste."

“If you look at the headlines, it looks like we are having a pretty bad year for the internet,” Surman says. “On the question of data protection and the problem with the centralization of power in the hands of just a few tech companies, this is not a healthy place.”

Most consumers don’t understand the nuances of what Cambridge Analytica did. In a nutshell, a lot of data was collected using survey tools that were valid at the time, Surman explains.

Approximately 270,000 took the survey in question, and their responses were sold to Cambridge Analytica, in violation of Facebook’s rules. Compounding the issue was the fact that before 2014, when this survey was administered, Facebook allowed app developers to collect not just the survey taker’s data but also data from all of their friends. So that 270,000 actually affected an estimated 87 million people.

“Facebook ended the policy of sharing friends’ data in 2014, but that didn’t stop Cambridge Analytica from holding on to what it had.”

“Cambridge Analytica took all that data, put it in a database, and connected it to a bunch of other data sets,” Surman explains. “Then they sold that off as a way to target advertising.”

Is that a data leak? Surman has a better analogy. “It is not so much a data leak so much as it is a nuclear waste spill,” he says. “Something they didn’t want to have out in the environment got out in the environment.”

The nuclear waste example also reflects how irrevocable these data spills are. Facebook ended the policy of sharing friends’ data in 2014, but that didn’t stop Cambridge Analytica from holding on to what it had for at least another year—and possibly to this day.

“Nuclear waste also has a half-life,” Surman says. “A lot of user data is out there.”

The current reckoning is forcing companies to reevaluate their role in the data economy. We simply collect too much data, Surman says. Many companies collect and store data on their customers by default and often don't even know what they will do with it. Hopefully, companies are starting to recognize that is a risky proposition, Surman says. He hopes we move to an age of "lean data" collection.

Another thing the Internet Health Report Makes clear is that health of the internet varies greatly across the globe. Connection speed, data costs, and basic freedoms shift from country to country, and some countries are starting to pull ahead of the US. India passed net neutrality protections at about the same time the FCC rolled them back here, he says, so the internet may be healthier abroad.

India passed net neutrality protections at about the same time the FCC rolled them back here.

Fast Forward is a series of conversations with tech leaders hosted by Dan Costa, PCMag's Editor-in-Chief. You can see a video of the full interview and many more at pcmag.com/podcasts/fast-forward.

The Coolest Things in iOS 12

BY CHLOE ALBANESIUS

Apple's Worldwide Developer Conference keynote in June was all about software; those hoping for updated MacBooks were likely disappointed. This was truly an event just for Apple developers, a group now 20 million strong, CEO Tim Cook announced.

Though we heard about updates coming to watchOS and macOS, iOS 12 was top of mind for many developers (and iPhone/iPad owners). New features coming to Apple's mobile operating system this fall range from serious to silly. Here are some of the most interesting announcements.

GROUP FACETIME

In iOS 12, you will no longer be limited to one-on-one FaceTime chats. With Group FaceTime, you'll be able to talk to up to 32 people at once—which might seem excessive, unless Apple is planning for enterprise users to pick it up.

During a chat, your image will appear in small boxes on the screen; as people speak, their images will bubble up and appear more prominently. But if you want to see only a certain person, you can just tap on their video.

If you're having a group chat on Messages, you can turn the discussion into a Group FaceTime chat at any time, and drop in and out of the conversation as needed. And with Memoji, you can turn your mug into a cartoon version of yourself.

If you're having a group chat on Messages, you can turn the discussion into a Group FaceTime chat at any time.

MEMOJI

What is Memoji, you ask? It's an update to Apple's Animoji that lets you create a lifelike avatar of yourself on your iPhone X. For those who would prefer to look like an animal, Apple is adding a ghost, koala, tiger, and T. rex as Animoji options in iOS 12.

SCREEN TIME

Tech addiction is a hot topic lately. At I/O, Google showed off "well being" features coming to Android P; Apple's version is Screen Time, which will debut in iOS 12. You'll get an overview of how much time you spend on your iOS devices and which apps suck up most of your time. You can set limits, and iOS 12 will warn you when it's time to sign off.

If you tend to get inundated with notifications during the night, you can stop them from showing up on your screen until a certain time, and you can group discussions so the alerts don't get out of control. Parents can do the same for their kids, limiting access to iOS at certain times of the day (like bedtime) or to certain apps, such as Snapchat.

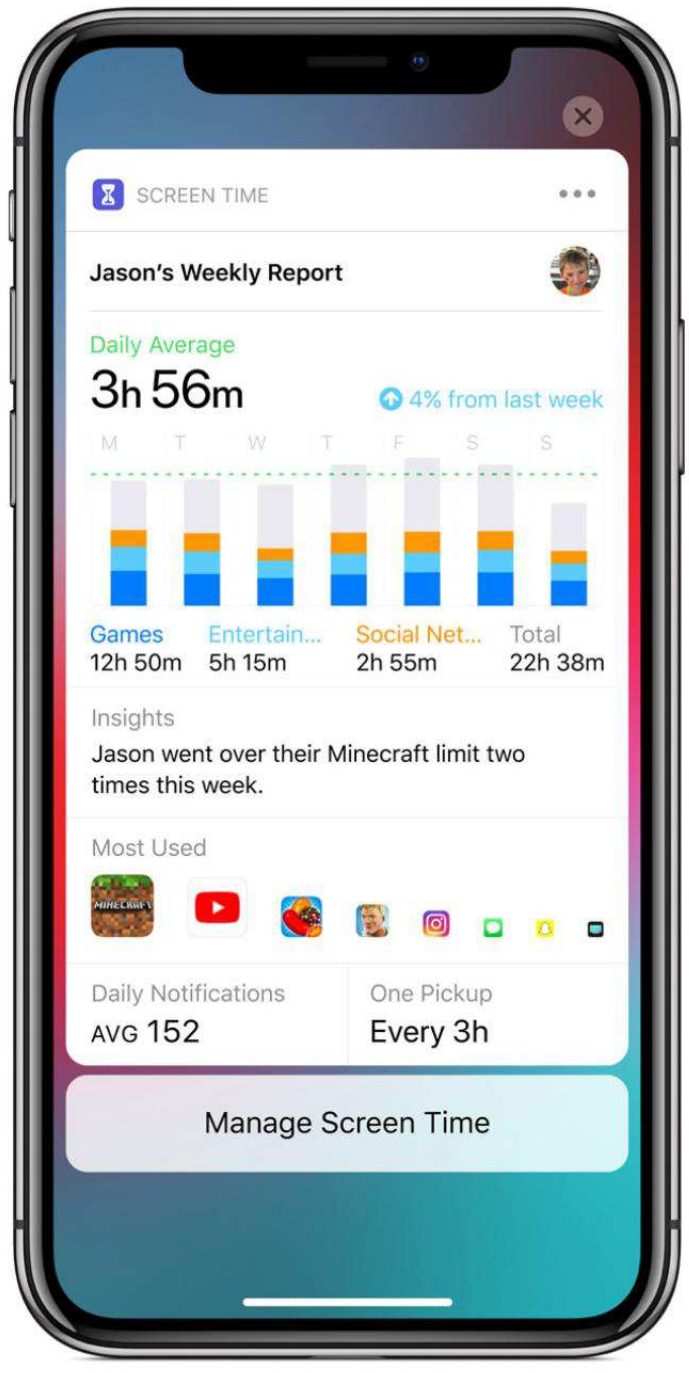
You'll get an overview of how much time you spend on your iOS devices and which apps suck up most of your time.

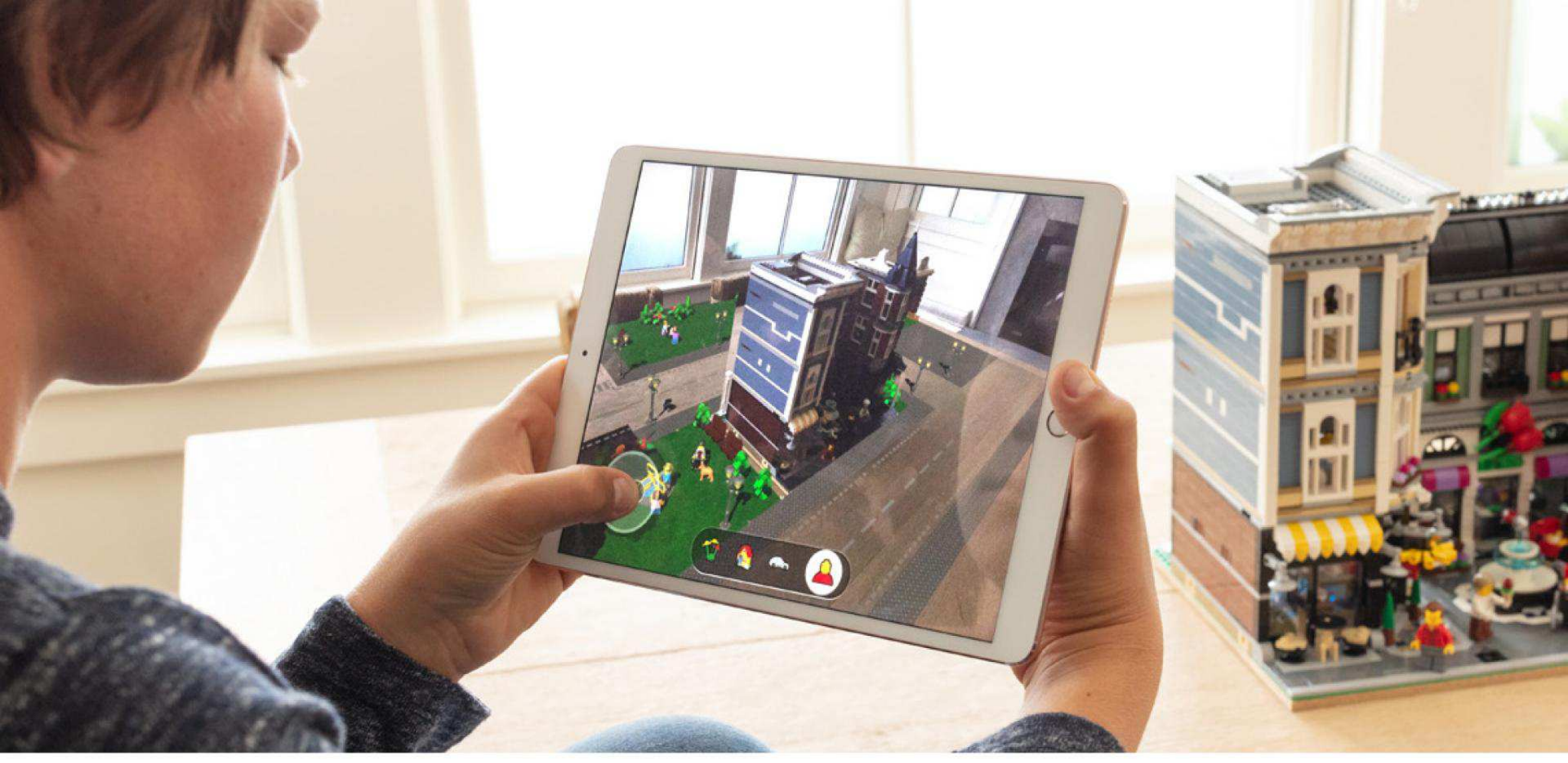
If you think you're being clever by swapping the iPhone for the iPad for a few more minutes of screen time, don't bother. Activity is synced across devices.

SIRI SHORTCUTS

Siri has fallen behind Amazon's Alexa and the Google Assistant when it comes to the smart home, but Cupertino is not giving up. With Shortcuts, you can create a phrase that will be Siri's cue to perform a series of tasks, much like routines for Alexa or Google. "Heading home," for example, could alert Siri to map your commute, turn on the A/C at home, and start playing a podcast.

"Users can customize Shortcuts by creating a simple voice command to kick off the task or download the new Shortcuts app to create a series of actions from different apps that can be carried out with a simple tap or customized voice command," Apple says.





ARKIT 2

With iOS 12, you get support for ARKit 2 and a new open file format, usdz, which will bring augmented reality to apps including Messages, Safari, Mail, Files, and News. Onstage at WWDC, Craig Federighi, Apple's SVP of Software Engineering, navigated to the Fender website, where he selected a guitar and then "placed" it on the table in front of him to see what it would look like in his house. On Apple News, images in news stories will come alive with an AR boost.

PHOTOS

In iOS 12, Apple will play catch-up somewhat with Google Photos; it will offer features such as sharing suggestions, which will recommend that you send certain shots to friends and vice-versa. You'll also be able to search by Events, People, Places, Groups, Categories, and recent searches and include multiple terms in a search.

The Best of Computex 2018

BY TOM BRANT

Computex, the giant annual electronics trade show in Taipei, Taiwan, was full of eye-opening, future-looking announcements this year. A 32-core mega-CPU, a laptop with a touchpad that doubles as a second display, a PC case with lighting you control via voice: We saw a ton of technology to look forward to, and much of it will be available before the end of 2018.

We roamed the halls of the Nangang Expo Center, took a trip to the Asus world headquarters on the outskirts of the city, and looked everywhere in between for the best of what Computex had to offer.

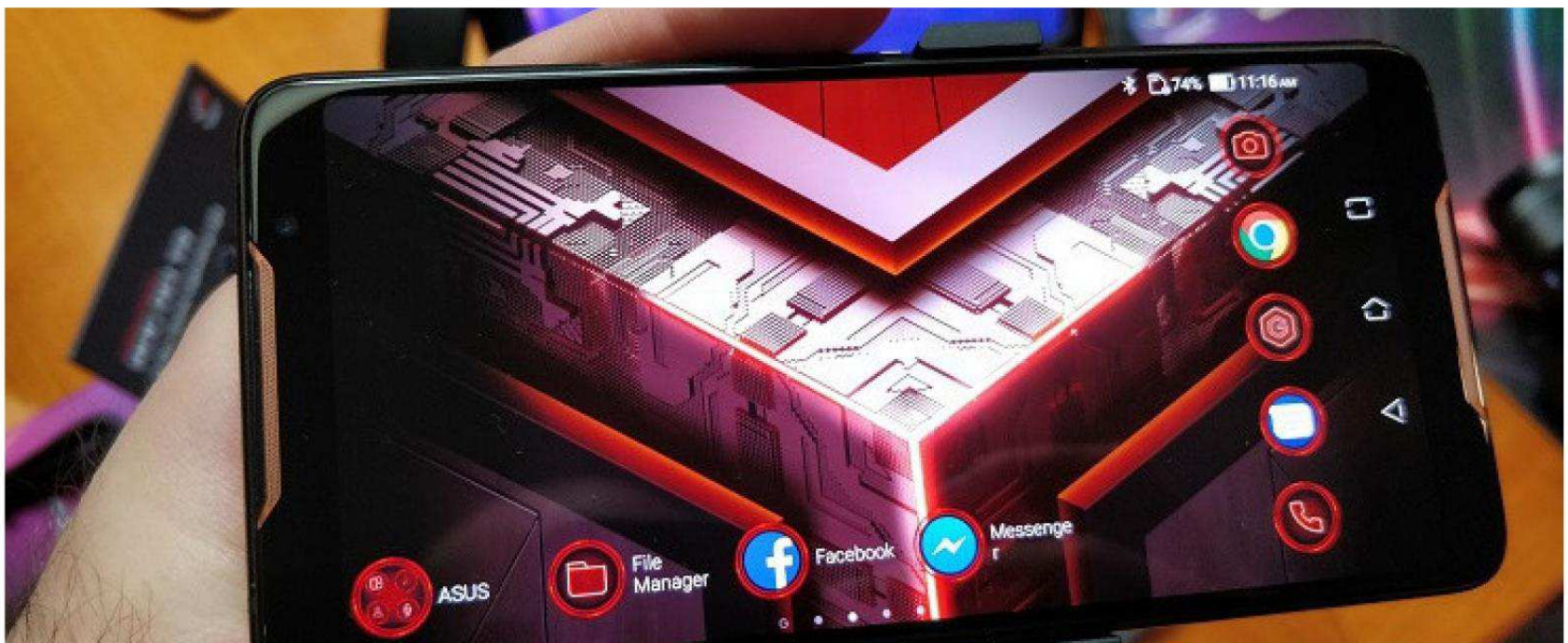
BEST LAPTOP: ASUS ZENBOOK PRO 15

A touchpad that moonlights as a 5.5-inch full HD display will grace the 2018 version of the Asus ZenBook Pro 15 laptop. Dubbed the ScreenPad, this funky hybrid display/pointer joins other alternative input methods such as the Logitech Craft keyboard, the Microsoft Surface Dial, and the Apple Touch Bar as a means other than the keyboard and cursor for controlling specialized apps.

While some of those input methods are useful only for graphic designers, video editors, and other multimedia professionals, the ScreenPad has broader user appeal, because it can function as an additional display for watching videos or making calculations, in addition to app-specific controls. You can even turn it off entirely—and when you do, it's nearly indistinguishable from an ordinary touchpad.

BEST SMARTPHONE: ASUS ROG PHONE

The new Asus ROG Phone is the fastest smartphone in the world, according to the company's internal benchmark testing. The Qualcomm Snapdragon 845 system-on-a-chip (SoC) in the ROG Phone runs at 2.96GHz instead of the normal 2.8GHz. It's not overclocked, but rather Qualcomm has supplied Asus with "speed-binned" versions of the chip, meaning that they're tested for the ability to maintain higher speeds than otherwise-identical chips. Couple that



with attractive styling and some wild accessories, such as a snap-on cooling fan, and you get one of the most intriguing Android phones we've seen in a long time.

BEST DESKTOP PC: MSI PRO 24X

Computex is a sea of tricked-out desktop gaming PCs, both concept designs and ones you can actually buy. There were a handful of models announced from the likes of Acer, Asus, and MSI in all price ranges that will hit the US market in time for the holiday shopping season. But one brand-new, very svelte mainstream all-in-one stood out above the rest, fulfilling a role that is perhaps the essence of the family computer: a good-looking all-in-one for your kitchen.

The fact that the Pro 24X comes from MSI, a company that's known for its gaming prowess, is even more remarkable. Unlike several existing thin-bezel AIOs that are currently on the market, the Pro 24X manages to fit all its components behind the 24-inch IPS display rather than in a bulky stand. The Pro 24X features up to an Intel Core i5-7200U processor, Intel Optane memory, an NVMe PCIe M.2 SSD, and easy access for component upgrades.

Computex is a sea of tricked-out desktop gaming PCs, both concept designs and ones you can actually buy.

BEST PC INNOVATION: INTEL'S SINGLE-WATT LAPTOP PROTOTYPE

The best PC display we saw at Computex was not a stand-alone monitor but was built into a laptop. It was actually a prototype from Intel that uses just a single watt of power, eliminating the second-largest energy hog in a typical ultraportable after the CPU.

Shown here integrated into a Dell XPS 13, the reference design has a brightness of just 150 nits, but it still appeared plenty bright enough in the well-lit demo room. It works in concert with Intel chipset and driver infrastructure as part of an initiative dubbed Intel Low Power Display. Assuming manufacturers get on board, this could revolutionize laptop battery life; Intel claims to have achieved more than 28 hours with its prototype.

BEST DISPLAY: ASUS VG49V

With a resolution of 3,840 by 1,080 pixels, the 49-inch Asus VG49V is essentially two full HD displays fused into a single giant monitor. It's not the first 49-inch monitor on the market, but it's notable because it adds AMD's FreeSync technology to synchronize the frame rates between the display and a compatible graphics card so that screen tearing is greatly reduced. It also has a unique "Picture-by-Picture" feature, which lets you display feeds from multiple inputs side by side when you're not gaming.

That Picture-by-Picture mode and a superior refresh rate of just 1ms gives the Asus a slight leg up on the otherwise similarly excellent MSI Optix MAG491C, a 49-incher that was also announced and shown at Computex.

BEST CPU: AMD'S SECOND-GENERATION THREADRIPPER

AMD and Intel each surprised Computex attendees this year with monstrous CPU offerings. AMD showed off the second generation of its beastly Threadripper CPUs for high-end desktops, which will have up to a whopping 32 cores and 64 threads. Meanwhile, Intel demoed a 28-core prototype processor that it intends to put into production by the end of the year.

These CPUs are far from mainstream. They will be relevant mostly for extremely tricked-out gaming rigs or multimedia workstations that enthusiasts build themselves (though the first-gen Threadripper is available in some off-the-shelf desktops, such as the Alienware Area-51 Threadripper Edition). Still, boosting thread and core counts is where much of the innovation lies in the CPU market today, as opposed to increasing clock speeds. So we expect that the more mainstream Intel Core and AMD Ryzen lineups will receive trickle-down benefits from these vanguard chips. We give the upcoming second-gen Threadrippers the edge, though, because they'll work with existing X399 infrastructure, are closer to market, and win the raw-cores race for the moment.

BEST FORWARD-LOOKING RETRO TECH: INTEL CORE I7-8086K

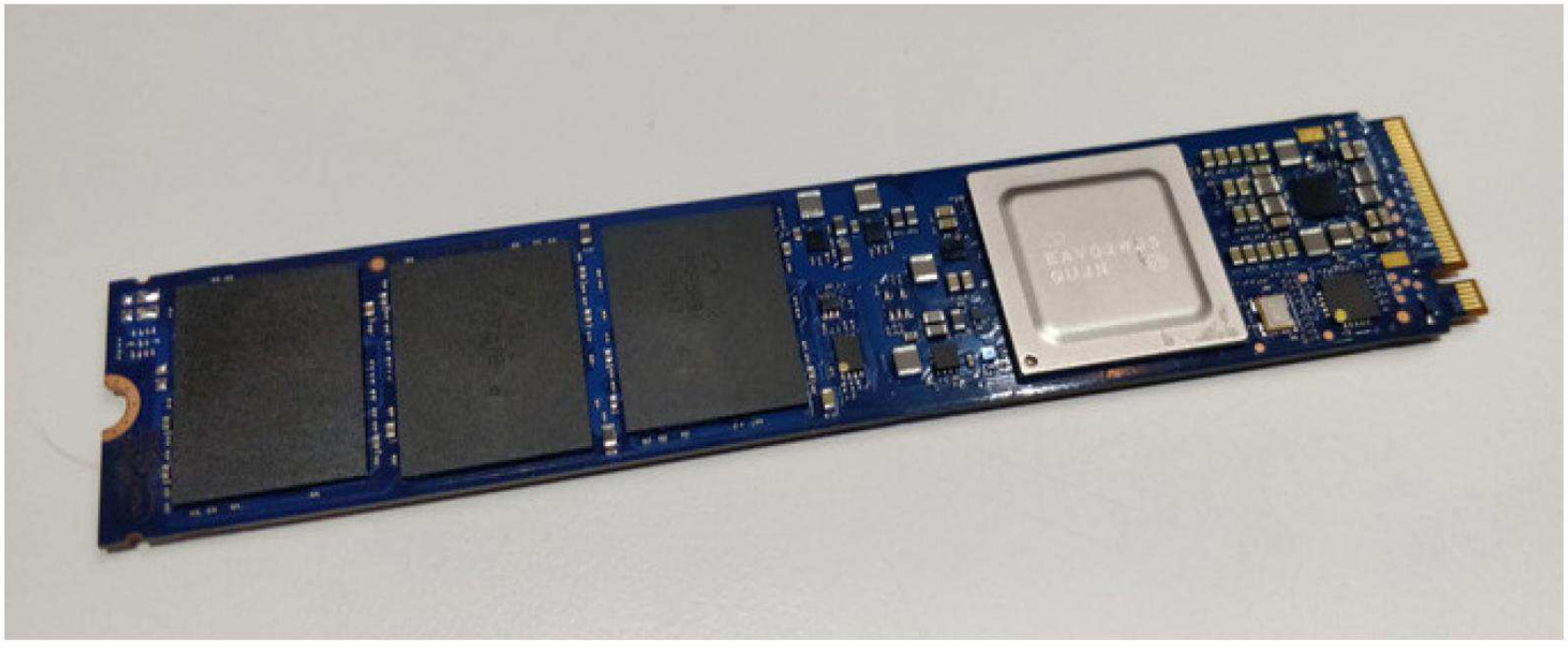
This year, Intel is celebrating its 50th anniversary in addition to the 40th anniversary of the x86 architecture and 8086 microprocessor. Intel thinks that's a milestone worth marking with hardware, so we're getting a limited-edition 8th Gen Core i7-8086K processor. It's the first chip with a 5GHz single-core turbo frequency. Yes, it has "only" six cores and 12 threads, and it's basically a "binned" version of the flagship "Coffee Lake" Core i7-8700K. But this CPU begs to be overclocked to the limit, so it could be even more appealing to enthusiasts than the Threadripper and Intel's existing Core X-Series.

BEST GRAPHICS CARD: POWERCOLOR RADEON RX VEGA 56 NANO

There were no major graphics-card announcements from either AMD or Nvidia at Computex this year. Although the rumor mill posited that Nvidia might announce a new generation of its GeForce GTX cards, CEO Jensen Huang instead said that generation won't be coming for "a long time." AMD was a bit more forthcoming on a new 7nm RX Vega architecture, explaining that it will arrive first in data center and enterprise computing formats in the second half of the year, but offered few details.

So the only real GPU of note at the show this year was a new, smaller single-fan version of the existing Radeon RX Vega 56, manufactured by third-party card

maker PowerColor. (Such a card was teased by AMD last summer at Siggraph 2017.) If you've been itching to put AMD's high-end GPU in a small-form-factor PC build, this is the card for you. It's already for sale online, though predictably hard to find since it's in high demand from cryptocurrency miners.



BEST STORAGE: INTEL OPTANE 905P M.2

Intel's Optane SSDs offer exceptional read and write performance, but they are limited to relatively low capacities. One of the few models that is available in sizes greater than 200GB is the Optane 905P, which until now was only available in a PCI Express-card form factor. The new M.2 version means that you can add one of these to a desktop with an M.2 slot or several at once to a desktop in a RAID array, potentially with a motherboard that has multiple M.2 slots or using a specialized M.2 RAID card. In a striped array, you could attain a maximum capacity of 1.2TB.

Like the 32-core second-generation Threadripper, a RAID array of Optane SSDs is extreme hardware for professional-level or fringe use cases. But if you have a late-model gaming or desktop-replacement laptop, the M.2 version of the Optane SSD might let you benefit from the exceptional performance that previously required a full-size PCI Express slot, and thus was limited to desktops only. Intel says that the Optane 905P's power and cooling requirements limit it to large M.2-equipped laptops, but we expect that future versions will be more power-efficient and eventually could show up even in ultraportables.

BEST PC CASE: IN WIN 300 SERIES (WITH VOICE CONTROL)

Static PC-case RGB lighting is so 2017. Case maker In Win seldom disappoints at Computex, and its updated 300 Series takes the standard RGB-lighting concept and elevates it with a whopping 144 individual RGB LEDs that cover the front of the chassis, programmable to display patterns or even run basic games.

You can control this case via In Win's software, and it also joins the voice-activated revolution by allowing you to change the lights based on spoken commands. It comes in a striking white color that gives the RGB lights added clarity and makes the case stand out from the legions of black or dark-grey gaming cases on the market.

Its updated 300 Series takes the standard RGB-lighting concept and elevates it with a whopping 144 individual RGB LEDs

Sascha Segan

COMMENTARY

Apple Ignores What's Wrong With the Mac

Apple makes great software. I use Windows and macOS daily, and macOS is cleaner, smoother, and more stable for basic tasks. Windows gives me the power I need to do great work, but I relax into a macOS browser window at home.

Apple's Mac shipments have been steady year over year in a declining PC market, according to Gartner. So you could be excused for thinking Apple doesn't have a problem at all; everything's fine. That's not the sense I'm getting from tech-savvy users, though. They're buying new Macs because of macOS software, and they're grumbling increasingly about the hardware. But they're trapped, because, of course, no hardware runs macOS other than Macs. That raises the question of when, if ever, these users will snap and jump ship.

Last year, I needed a new Mac, and I bought a 2015 MacBook Pro. Yes, I bought a 3-year-old laptop—because it's better than Apple's current models. (Yes, I know the 2017 Macbook Pro got a PCMag Editors' Choice. We can have more than one opinion on our staff. Mine is that the last time Apple made great PC hardware was in 2015.)

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Sascha Segan

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Apple's hardware changes in the past few years have been awful. Its flat, loud, painful "butterfly" keyboards are now subject to three class-action lawsuits and can be disabled by bits of dust. The Touch Bar is like OpenDoc and 3D Touch, an "innovative" Apple technology that lies nearly useless because third parties decided not to take it up. (And I was a 3D Touch believer!) The latest laptops have a ridiculous lack of ports.

It was almost laughable when Craig Federighi called out Apple's software support for external GPUs, because what people really want is a 13-inch MacBook Pro with some sort of discrete GPU option and not Intel Iris Plus. Apple said in April that it won't introduce a new Mac Pro until 2019.

But Apple has always been better at playing up its strengths than admitting its weaknesses. We saw this with its iPad-in-education event in March. Under-resourced, over-tested American schools are turning away from the iPad because they want something more durable and less expensive. Apple instead doubled down on rich, creative curricula those schools probably won't be able to pull off. The new iPad is the best midrange tablet available today, and it's not a realistic choice for most of the schools it's aimed at.

With Macs, Apple is coasting on the stickiness of its OS here, and on the ties between macOS and iOS. I can't help but feel they're getting only replacement buyers at this point, and that they're even losing some of those to compelling Windows PCs such as the Microsoft Surface.

iPhones continue to sell in multitudes. And Apple's "sneak peek" developer feature, by making it easier for devs to bring hot iOS apps to Macs in 2019, is going to help the platform. Continuity, iMessage, and other cross-OS features also keep pulling iPhone users over to the Mac. But the platform will leak passionate professionals if its keyboards continue to be rage-inducing garbage and there's nowhere to plug in peripherals.

"The platform will leak passionate professionals if its keyboards continue to be rage-inducing garbage."

The potential light at the end of the tunnel: macOS Mojave is coming out "this fall," which means new Mac hardware is probably also coming out this fall. I wonder how many Mac users will switch to Windows before then?

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Ben Dickson

COMMENTARY

Why Nintendo's Gamble on Retro Consoles Paid Off

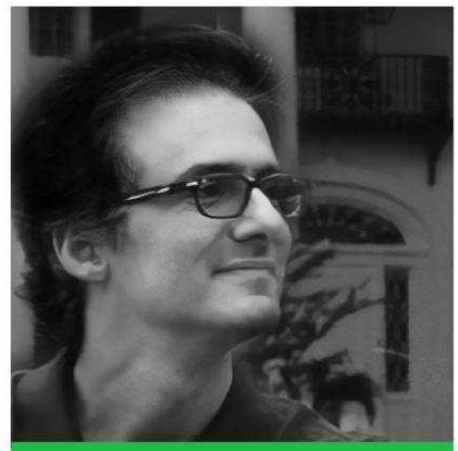
Nintendo is rebooting the Classic Edition of its NES and SNES consoles, which are 33 and 28 years old, respectively; they'll ship on June 29. But anyone who tries to revive two 8- and 16-bit consoles in a market dominated by the likes of the PlayStation 4 and Xbox One is probably committing business suicide—right?

Well, Nintendo is not just anyone. In its first launch of the retro NES Classic in late 2016, the company sold approximately 2.3 million units in five months and sold out its entire stock by July 2017. It then sold 5 million units of the SNES Classic in a few months.

This doesn't mean that dusting off any old gaming console is a recipe for success. Nintendo has mastered the art of rebooting through perfect timing and meticulous planning. We have yet to see how these retro gaming consoles will perform this summer—but if the past is any indication, they'll be a hit. Here's everything that made the NES and SNES Classic such huge successes.

THE RIGHT MIX OF NOSTALGIA AND TECHNOLOGY

By most accounts, the NES and SNES are two of the most successful gaming consoles in history. The NES ushered in a new era of gaming that featured quality sound and music. The SNES



Ben Dickson is a software engineer who writes about disruptive tech trends, including artificial intelligence, VR and AR, the IoT, and blockchain. Ben also runs the blog Tech Talks.

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surpassed it with even more features, including a comfortable and multi-buttoned gamepad and 16-bit graphics and sound, and dominated console gaming through the 90s.

For most 30- and 40-somethings, like me, the NES and SNES introduced them to the world of gaming—and, in my case, computer programming. Even if most of us don't play games that frequently anymore, we still remember Nintendo's consoles fondly, as icons of our childhood. The retros provide us with a chance to revisit a time where games were no more than a few hundred kilobytes of code; sprites and MIDI songs stuffed into a plastic cartridge. For younger generations, the NES and SNES reboots were a chance to travel back in time to see what paved the way for the super-rich and complicated games they play on high-end consoles.

Both Nintendo consoles also pack the right combination of past and present technology. For instance, the NES Classic has a CRT Display mode that revives the nostalgic feeling of playing on old television sets (its Pixel Perfect mode gives you high-quality video output.)

And it has some additional features that weren't possible when the original NES was built—such as the possibility to save your progress at any time—that removes frustration for gamers who aren't used to the limited saving modes of old consoles. (Personally, I think part of the fun and challenge of playing on old consoles was the fact that you could save games only at distinct points.)

NOT A REPLACEMENT FOR CONTEMPORARY CONSOLES

The Classics weren't created to compete with current consoles. Rather, they're a welcome respite and a distraction from the norm. The NES and SNES Classic give you a few days' worth of 80s and 90s love and childhood memories—and then you can get back to playing Xbox One, PS4, or the Nintendo Switch. If you get hooked, though, you might spend a bit more time beating some old-time favorites. I had to go through Contra III and Donkey Kong Country again before I put the SNES away.

> **The NES and SNES Classic give you a few days' worth of 80s and 90s love and childhood memories.**

In fact, the consoles' prices reflect the goal of providing short-lived entertainment. At $60, the NES Classic came with 30 games. The $80 SNES Classic offers 21 hit games. Compared with current consoles (the $500 Xbox One and the PS4 and Switch, each $300, all excluding games), those are very reasonable prices.

As became evident later, aficionados were willing to dish out much more to get their hands on the retro consoles. After the NES and SNES Classics sold out, people bought them on eBay at several times the retail price, sometimes at the insane amount of several thousand dollars.

PERFECT TIMING AND SUPPLY

The original NES Classic shipped in November 2016, right in time for the holiday season. The release date was also significant because it was a few months before Nintendo released the Switch, the successor to its Wii U gaming system. By the time the Switch shipped in March 2017, the NES Classic had already sold more than 1.5 million

units worldwide, whetting the gaming community's appetite for the Nintendo's new console.

The Switch has been a very successful product, outselling its predecessor less than a year after its release, but the NES Classic played an important role in helping build the hype around the Nintendo brand as the Switch's release date approached.

"The NES Classic helped build the hype around the Nintendo brand as the Switch's release date approached."

The limited supply and the exciting secondary market that surfaced after the consoles sold out created the perfect environment for the next release of the NES and SNES, perfectly timed for summer vacations.

Nintendo has already made more than $500 million selling old consoles in the past 18 months. And given the well-planned reboot, it's likely to make even more on the second release of the NES and SNES Classic Editions. Down the road, expect more surprises from Nintendo, such as special editions of the NES and SNES Classics loaded with niche games such as the Dragon Ball series. That will appeal to its unique audience (and translate to more sales, of course).

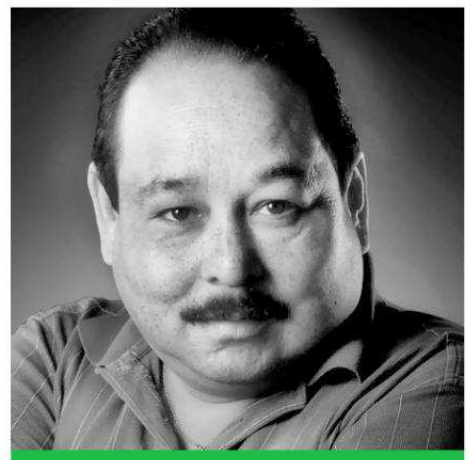
Now if you'll excuse me, I have a game of Double Dragon II to get back to.

Tim Bajarin

COMMENTARY

Truly Flexible Displays Will Reinvent Smartphones

One of the things I learned early in my career is that if you want to get a glimpse of the future, you need to go to technology trade shows that are focused on components and deeply entrenched in the world of engineering. That's where you see the technology that will likely show up in consumer gadgets two to three years down the line.



Tim Bajarin is the president of Creative Strategies and a consultant, analyst, and futurist covering personal computers and consumer technology.

One such show is the Society for Information Displays (SID) conference, which took place recently in Los Angeles. Dedicated to the world of display technology, SID showcases all types of screens, including next-generation OLEDs for TVs and laptops, as well as the star of this year's show: flexible and even rollable displays.

Visionox kicked off the event with a keynote that highlighted its foldable display in a video, but I did not see an actual model in its booth. On the other hand, BOE, one of the largest makers of displays in China, showed off two types of mobile devices with working flexible displays. A smartphone with a display surface of close to 9 inches folded completely in the center, and even in that folded position, the image and videos worked flawlessly.

The second phone it showed had an actual bendable screen. The 5.5-inch screen folded in half to make a smaller device that would be easier to carry (in photo below).

I saw a few other flexible screens I can't yet discuss, but it is clear this is the next big thing in smartphones.

If you look closely at the BOE flexible display in the photo above, you can see why foldable displays matter. Our smartphone screens today pretty much top out at 6 inches, but BOE's flexible display adds about 3 more inches in viewing space, making it more like a tablet that fits in your pocket. The flexible or foldable display in the other photo provides even more portability.

While these screens are early demos, I'm told they are not far off. In fact, we could see one in a smartphone from a major manufacturer in early 2020. My best guess, though, is that given the challenges in actually making these flexible screens in high volumes, they might not have a dramatic impact on smartphone designs until 2021 or 2022.

In the short term, the smartphone industry is well on its way to giving us an interim approach. By early 2019, look for more smartphones with dual screens that, when opened, double the size of the viewing space. In this case, you will be viewing two screens and thus have two displays for content. A seam in the middle separates them, in contrast to the smartphones with flexible displays in which the content is delivered on a single display.

Another new concept in displays at SID was shown by E Ink, a company best known for supplying the electronic digital paper used on Amazon Kindles. In the picture on the right, you can see a prototype of a rollable display using its digital paper display. It's only in black and white, but it's an interesting twist on electronic digital paper.

I also saw color E Ink screens that are destined to be used in all types of advertising displays in stores and any place where signage needs to be changed or updated on a continual basis.

Although I do think that AR and mixed-reality glasses tied to a smartphone will eventually have a more revolutionary impact on mobile computing, the introduction of flexible and foldable displays is important to advancing the designs of smartphones in general. I personally like the idea of having a smartphone that, when opened up, could become a tablet.

Motorola Moto Z3 Play Keeps the Mods Dream Alive

Motorola Moto Z3 Play
$499.00

Moto Mods live. The new Moto Z3 Play, which will be available this summer, extends Motorola's three-year run of modular add-ons, providing a new phone to go with your extra battery, boombox speaker, or Polaroid printer Mods. I got a chance to take an early look at the phone, and while I have some reservations about its price, I'm happy to see that Motorola hasn't abandoned its commitment to modularity.

DESIGN AND SPECS

The Z3 Play looks like a flagship phone from a design perspective. It's quite attractive, with a shimmering ultra-dark-blue glass back, and super-thin at 0.27 inches. The rear cameras (one 12MP, one 5MP for depth effects) pop out on a pronounced disc with sharp edges. That bump is there so the cameras aren't recessed too far when you put on a magnetic back cover or a Moto Mod.

The front is an 18:9, 6-inch, 2,160-by-1,080 AMOLED screen with very rich colors. There's no physical home button; the fingerprint sensor is on the side. At the bottom of the screen, you can switch between standard Android virtual buttons or a new, Android P/iOS-like horizontal bar, which you can tap or swipe to navigate. The phone is running Android 8.1; Motorola assured us that it will get upgraded, but not on any specific time frame. "We continue to embrace a pure Android platform," said Jeff Snow, Moto's GM for premium smartphones.

Motorola Moto Z3 Play

PROS Works with all existing Moto Mods. Rich color screen. Elegant software build.

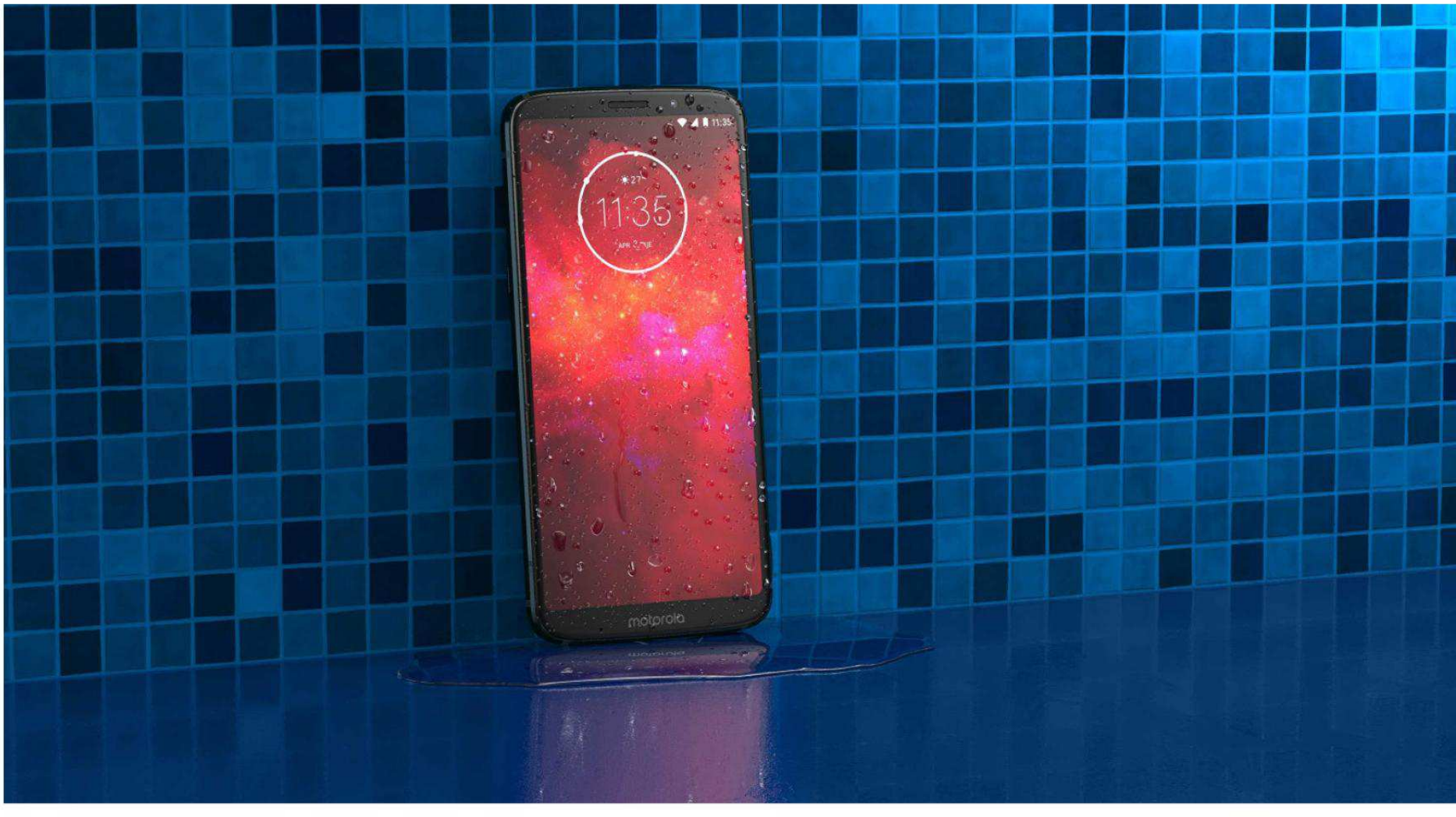
CONS Awkwardly priced. Average processor.

The phone is splash-resistant but not waterproof. It has no headphone jack—the phone comes with a USB-C dongle. It has a 3,000mAh battery but no wireless charging, although, of course, Motorola offers a wireless charging Mod.

The major corner cut here is on the processor and memory. A Qualcomm Snapdragon 636 with 4GB of RAM and 32GB of storage (plus a microSD slot) is fine, and Motorola says it's 30 percent faster than the Z2 Play, but it won't come anywhere near the OnePlus 6's performance. On the plus side, it will support all of the US LTE network bands except LAA, Snow said.

Without much in the way of new features to talk about, Motorola leaned on showcasing some camera modes. The Z3 Play will do bokeh both on the front and back cameras; on the rear camera, it will do selective black-and-white or partially moving cinemagraph effects. Those are all cool, sure, but they're not exactly enough to sell a $500 phone.

Without much in the way of new features to talk about, Motorola leaned on showcasing some camera modes.



MODS ARE HERE TO STAY...FOR NOW

Mostly, the Z3 Play feels like an "affordable" platform for Mods: It's a phone you can add a battery to, or one of several big speakers, or a projector, or a printer. I'd really like to see this feature cascade down through Motorola's product line into its G and E series.

Mods are great. I tend to bring Moto Z phones to trade shows because slapping a battery Mod onto the phone is easier than using a battery case or a cabled battery, and adding the JBL speaker Mod with its kickstand makes the phone a great bedside radio. The major problem is that Moto just doesn't sell enough Mod-compatible phones to create its own third-party accessory ecosystem. No company but Apple seems to sell enough phones to do that.

While there are currently more than a dozen Moto Mods, the high-profile third-party add-ons that we saw at CES six months ago haven't hit the market yet. The Livermorium Slider Keyboard Moto Mod, which was supposed to come out months ago, is still being tweaked, Snow said. The Lenovo Vital Moto Mod for healthcare uses was supposed to be out in April; it "doesn't have a sales channel," Snow said.

PRICED OUT?

The Z3 Play will be sold unlocked, running on all the major US carriers and bundled with a battery Mod. I don't think it has a chance, though, because I don't think there's a US market for $500 phones that don't have a monthly payment plan. This is the same problem the OnePlus 6 has. Fortunately for Moto, the Z3 Play will also go on sale at Sprint and US Cellular, and $20 a month goes down much more easily for Americans than $500 upfront.

My initial instinct is to wait until we see the rumored non-Play Z3, which will likely come with a Snapdragon 845 and payment plans on more carriers. It'll probably cost $200 more, but it'll have true flagship performance.

SASCHA SEGAN

3Doodler Create+ Lets You Freehand 3D Objects

Part creative tool and part toy, the WobbleWorks 3Doodler Create+ ($79.99) is the fourth generation in this line of handheld 3D printers. This cool little gadget lets you freehand three-dimensional objects out of quick-hardening liquid plastic. The structures you create are not very sturdy, so don't expect 3D printer-quality products, and it takes a few tries to get the hang of the technique. But this tool is unmistakably fun and has excellent creative potential.

WobbleWorks 3Doodler Create+

$79.99

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SLEEK 3D PRINTER

I tested the 3Doodler Create+ Essential Pen Set, which includes the pen and three packs of plastic, but there are upgraded packages available. For $99.99, the Create+ Deluxe Pen Set contains the pen, four packs of plastic filament, a Mini DoodlePad paper doodle surface, and a set of six changeable nozzles. The Create+ Master Creator Pen Set goes for $149.99 and includes the pen, the set of nozzles, a full-size DoodlePad, a book of printing ideas, a set of 3D models you can doodle on top of, and six packs of plastic. If you already own a previous version of the 3Doodler or Create pen, this new model is available through a trade-up bundle offer.

WobbleWorks 3Doodler Create+

PROS Light, compact, and easy to hold. Helpful guide packet and tutorials online. Intuitive controls.

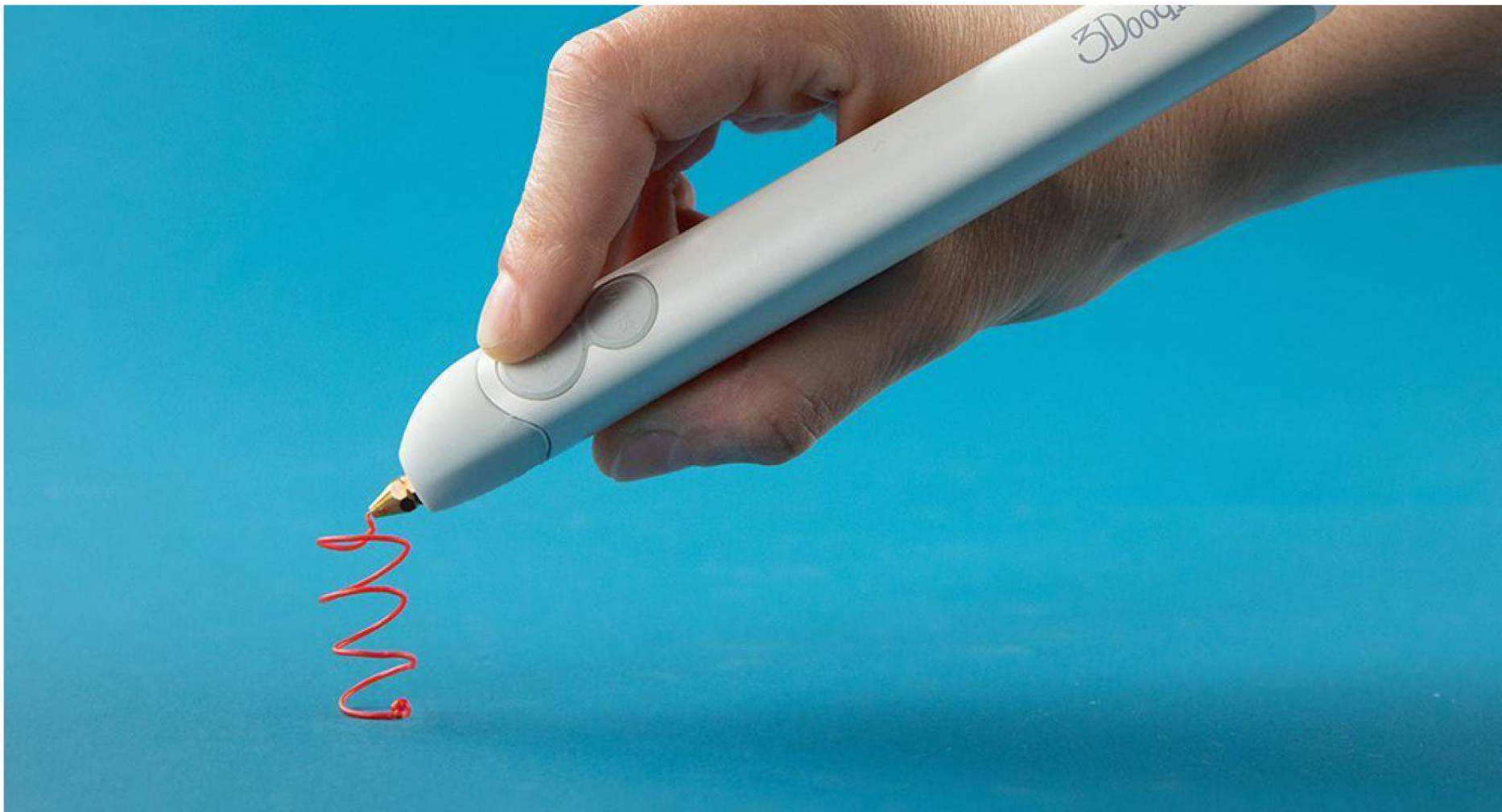
CONS Chance of burns. Hot-plastic smell while using.

The Create+ is small and sleek, weighing only 1.7 ounces. At 6.25 inches from nozzle to end and about half an inch thick, it's compact and comfortable to hold. It's offered in blue or white via the 3Doodler web store, and in black, camo green, gray, or pink exclusively from Amazon, and has a smooth glossy finish. The body has a control switch at the top. Fast and Slow speed buttons are located near the bottom.

Included in the box are 75 sticks of plastic filament in 14 colors. These feed into the Create+'s loading port, where they are then melted and turned into printing material. Two of the most popular 3D printing filaments, acrylonitrile butadiene styrene (ABS) and polylactic acid (PLA) plastic, are included with the Essential Pen Set. The Create+ also supports FLEXY, a third kind of plastic, but this wasn't included in our testing. For the purposes of the Create+ pen, there isn't much difference besides ABS and PLA, aside from the colors available in the 3Doodler store and the slight burning smell that ABS plastic makes as it melts. If the smell bothers you, switch to PLA plastic.

This cool little gadget lets you freehand three-dimensional objects out of quick-hardening liquid plastic.

Also in the box are the power adapter; a tool for unblocking and pushing plastic into the drive gear; a mini screwdriver for removing the maintenance cover to adjust temperature; and a mini spanner for unscrewing the nozzle, in case you buy additional nozzles and want to swap them out. (Note that you should only unscrew the nozzle when it's hot, so use extreme caution when doing so.) The 3Doodler online store sells more accessories for the Create+, including additional nozzles, stands, and filament.

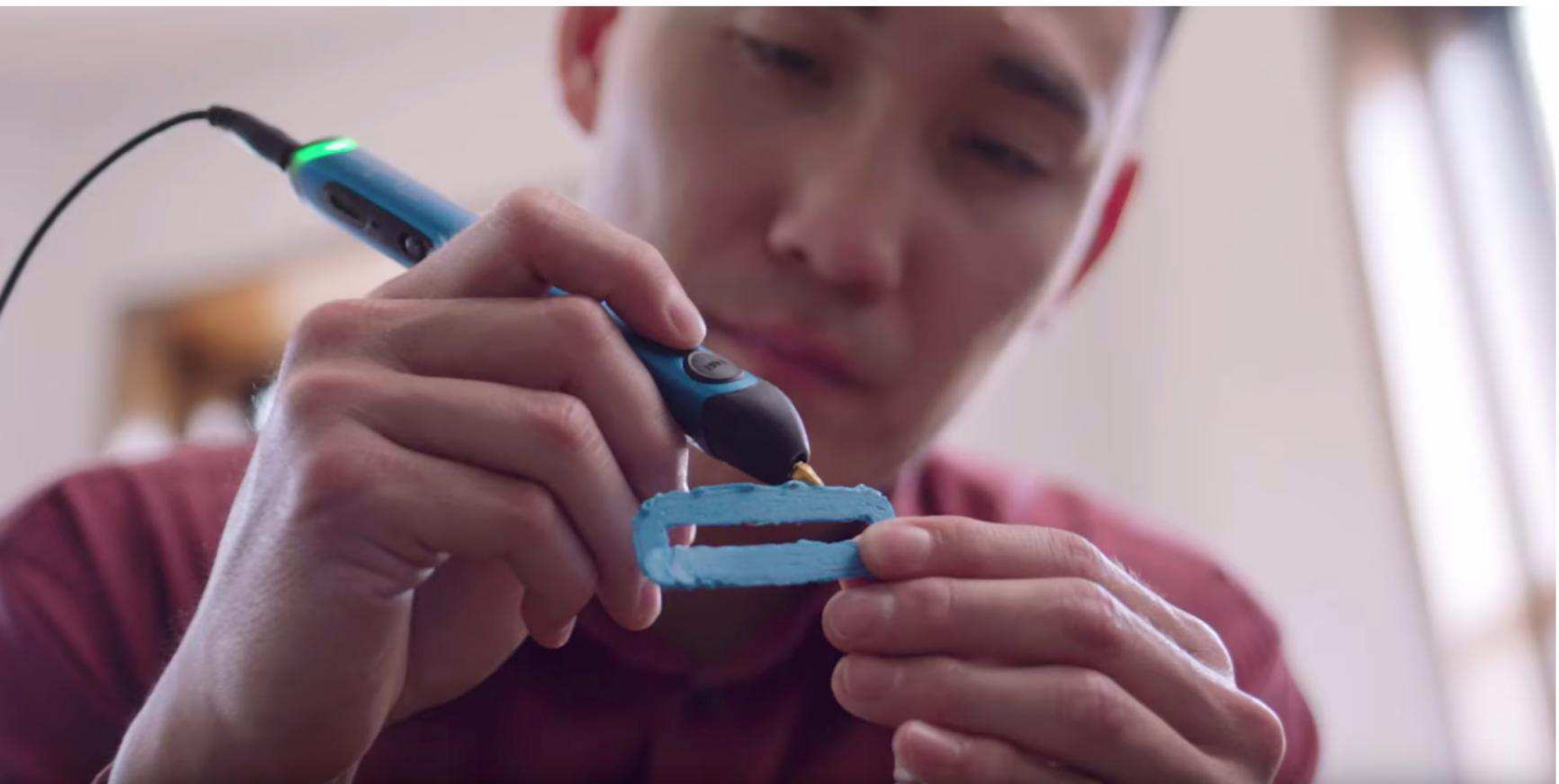


PREPARING TO PRINT

To start using the Create+, plug in the power cord and slide the control switch from Off to either PLA or ABS/FLX, depending on the kind of filament you're using. For testing, I chose ABS. Unfortunately, unlike the 3Doodler Start (a model aimed at children age 8 to 13), the Create+ isn't wireless and has to remain plugged in. But the power adapter cord is long enough to let you move comfortably while doodling—just make sure to keep the Create+ tip from touching the cord.

The pen takes about 80 seconds to warm up, at which point the light turns from red to blue to indicate that the Create+ is ready to use. Note that the nozzle tip is small but very hot. Between the lower speed button and the nozzle is a silicone cap that blocks heat from where you hold it, but it won't completely shield fingers from a burn if your hand slides too far forward. For this reason, it's probably best to keep it out of the hands of younger kids. 3Doodler's website notes that the 3Doodler 2.0 (the previous version) is intended for ages 14 and up. There isn't any age range specifically mentioned on the box of the Create+, but a company representative suggests 12 and older.

To start printing, insert a plastic stick into the loading port—a small hole at the end opposite the nozzle. Pressing the Fast key starts the drive gear, which pulls the plastic through the Create+. It takes about 8 seconds to load the first stick of plastic. Once it reaches melting temperature, a fine line of plastic extrudes from the nozzle, and you're ready to create. You may notice an initial burning-plastic smell and a bit of smoke.



USING THE CREATE+

You'll need a flat surface to print on, and doodling on top of a piece of paper gives the plastic something to melt to. The filament will peel cleanly off the paper after it cools. You'll first need to draw a base for your creation. I recommend starting with the Slow speed to get a feel for the motion. Fast mode is hard to control at first—straight lines might curl if your Create+ moves slower than the rate at which the plastic is extruded. I used Slow with much more success. The plastic solidified quickly and wasn't pulled up from my paper when I moved the Create+ away.

To build vertical structures, set the Create+ to Slow and draw a line from the base to the desired height. Hold the Create+ still for several seconds at this height until the plastic cools and hardens enough to support its own weight. Pausing the Create+ for a few seconds might cause the tip to cool slightly, and it will still be hot to the touch, but the plastic inside may solidify and get stuck momentarily until it reheats and the plastic resumes flowing. Globs of dried plastic might form at the tip of the Create+, but these can easily be removed with a pair of tweezers.

Straight lines might curl if your Create+ moves slower than the rate at which the plastic is extruded.

One-click buttons for Fast and Slow settings are great for drawing longer lines and larger shapes, because unlike with earlier models, the button doesn't need to be held down for continuous doodling. Click once to start, and click a second time to stop. You can doodle in only one color at a time, but you can switch colors: A double click of either button reverses the direction the drive gear pushes the filament. Just reverse the filament and eject it to place a new color in. You'll want to be sure to switch off the power when you're done, but a new sleep mode will automatically shut the printer down after about 3 minutes of inactivity.

One-click buttons for Fast and Slow settings are great for drawing longer lines and larger shapes.

USEFUL GUIDANCE

The number of resources that 3Doodler provides to get you started is impressive. The company's YouTube page has a number of instructional videos, as well as project tutorials for the Create+ for once you've mastered the technique but aren't sure what to doodle.

Two helpful booklets are included in the box: the "Ultimate Guide To Doodling" and a more technical user guide. The user guide offers details and tips, such as how to create vertical structures, with colorful pictures of projects and simple directions on how to get started.

Don't expect to be an expert in 3D drawing right off the bat, though. While the controls are easy to grasp, mastering the technique takes some trial and error. For example, when drawing flat shapes, I first held the Create+ about a half-inch above the surface of the paper, because I was hesitant to touch the nozzle directly to the surface. I had much more control over the shape of my doodle by gently pressing the nozzle to the paper, like you might with a ballpoint pen on paper.

The two positions that were most comfortable to me while holding the Create+ resulted in my fingers not even touching any of the control buttons, or with my fingers resting directly on both buttons at once and accidentally clicking buttons repeatedly. After clicking the button once, the plastic comes out continuously until a second click, so you'll want to position your fingers so you can quickly hit the control buttons, especially when trying to draw precisely.

FUN FOR ARTISTS AND HOBBYISTS

The Create+ is a user-friendly, intuitive handheld 3D printing pen that has great creative potential. Even though the 3Doodler pen lacks the ability to make objects with the high-resolution detail of a 3D printer, it makes up for that in versatility and ease of use if you're willing to be patient and practice the technique. For help getting started or inspiration for projects, the community page on the 3Doodler features a collection of website tutorials, tips, videos, and stencils.

“The community page on the 3Doodler features a collection of website tutorials, tips, videos, and stencils.”

If you already own a previous version of the 3Doodler, trading up to this new model is worthwhile for the slimmer design and easier controls (plus, you get the discount mentioned earlier). If you own a 3Doodler Create, the Create+ features are fairly similar, so unless you're particularly interested in safety features like sleep mode, upgrading your Create isn't particularly urgent. While $79.99 might seem a little steep for a niche product, the opportunity to sketch 3D art in mid-air is exciting. The 3Doodler will appeal to artists in search of a new medium, DIY hobbyists looking for a way to make funky creations, and tech enthusiasts ready to hop on board with the latest in 3D rendering tools.

LIZ SULLIVAN

Logitech G305 Lightspeed Wireless Gaming Mouse

It's been two years since the debut of the Logitech G900 Chaos Spectrum, the wireless gaming mouse that made lower latency a spec that mice of its type should aspire to. In all but name, the Chaos Spectrum wielded the same Lightspeed wireless technology that now powers the all-new Logitech G305 Lightspeed Wireless Gaming Mouse. Logitech claims it takes just 1 millisecond (ms) from the time you click a button to the time that the alien craft is blown to smithereens in your favorite space shooter. We couldn't quite measure that, but our hand did tell us this is one snappy gaming mouse, for a wireless model.

Logitech G305 Lightspeed
Wireless Gaming Mouse

$59.99

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It's also a fairly basic one. The Logitech G305 Lightspeed lacks many of the features you would expect from a high-end wireless gaming mouse, like the Logitech G903 Lightspeed. The big strength of the G305: It migrates the same wireless functionality in that killer mouse over to a mid-priced peripheral that gamers and non-gamers alike will appreciate for its minimalist design, good battery life, and impressive real-world performance.

AUSTERE ON THE OUTSIDE

The appeal of the Logitech G305 Lightspeed emerges from touching it, not looking at it. Not that it's homely in either of its finishes (matte-black or white), but it won't outshine other, more muscular models in Logitech's lineup.

The 1.5-by-2.5-by-4.6-inch (HWD) shape starts off curved at the heel, to fit your palm, and it narrows as you reach its two front mouse buttons. Between the main buttons is a rutted scroll wheel that emits tactile, bumpy feedback as you roll it. Aft of the wheel is a sensitivity button that allows you to change the tracking resolution, which ranges up to 12,000dpi.

Weighing 3.42 ounces, the G305 Lightspeed is on par with other mice in its class. The Roccat Kova, for example, weighs 3.5 ounces, and the HyperX Pulsefire FPS comes in at 3.3 ounces. The Razer Mamba, a pricier, Editors' Choice–winning wireless competitor to the G305 Lightspeed, on the other hand, weighs a comparatively whopping 4.32 ounces. It's notable that the G305 doesn't feel heavy despite having a AA alkaline battery tucked inside its shell as its power source.

Logitech G305 Lightspeed
Wireless Gaming Mouse

PROS Affordable path to wireless gaming. 1ms response time. Lengthy battery life.

CONS Not rechargeable. No Bluetooth option. Minimal customization.

Speaking of which, if you can't find the 2.4GHz USB dongle at first, that's because it's stored inside the mouse, to the left of the battery. You access both items by pressing down on the rear half of the mouse shell and sliding it off. Note that the USB receiver (which you can tuck inside an included USB extender cable) is the G305 Lightspeed's only means of wireless transmission. This mouse doesn't support Bluetooth.

BIRD'S EYE

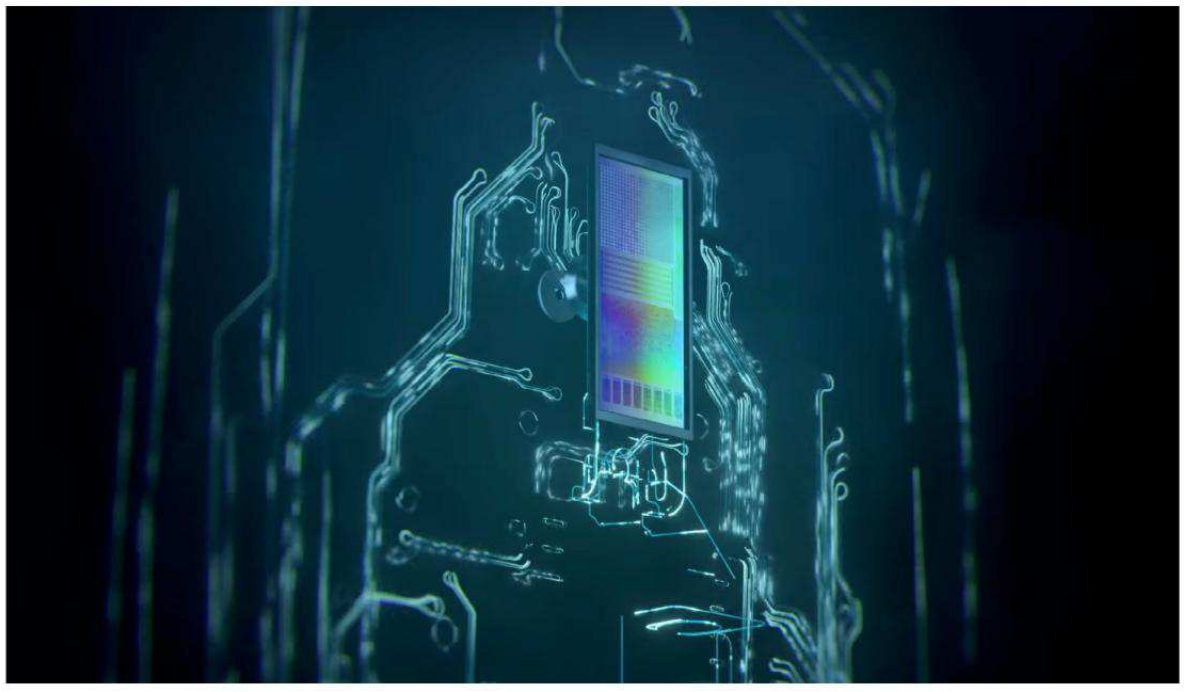
Toward the rear of the mouse is the Logitech "G" logo, which, naturally, stands for gaming. Gamers accustomed to more ostentatious mice will notice the absence of colorful lights beaming through that emblem. Because the G305 Lightspeed foregoes all forms of LED frippery, customization is limited to the pair of buttons on its left side. Out of the box, these come programmed to the forward/back actions in your browser, but by downloading the Logitech Gaming Software (LGS) utility, you can assign them to any mouse function, keystroke, or multi-key macro you can whip up.

Toward the rear of the mouse is the Logitech "G" logo, which, naturally, stands for gaming.

On the bottom of the G305 Lightspeed, you will find the same Hero-branded optical sensor used in Logitech's more expensive mice. Its resolution ranges from 100dpi to 12,000dpi, so don't expect quite the same amount of flexibility you would get from the 16,000dpi-maximum Razer Mamba. That said, at the upper fringes of mouse resolution, it's mostly a numbers game as opposed to what you can actually perceive.

Many gamers argue that tracking speed and acceleration are more important specs than dpi. From the G305 Lightspeed in particular, you can bank on a maximum speed of 400 inches per second (IPS) at which the mouse can accurately track movement. Meanwhile, the maximum gravitational force at which the G305 Lightspeed can trace your exact motions is rated for 40G. In this regard, the Razer Mamba fails to keep up in the speed-spec sweepstakes, at 210 IPS, though its acceleration is higher at 50G; it also costs $30 more than the G305 Lightspeed.

With the exception of e-sports pros, these numbers won't mean much to most people; you probably won't be moving your mouse over 30 feet in a second unless you're so outraged by your teammates' performance that you fling the G305 Lightspeed across the room. As for the gravitational-force threshold, anything between 30G and 50G is enough to register your hand's abrupt jolts and jerks.



KEEPING UP WITH THE COMPETITION

When testing the Logitech G305 in Fortnite and Wolfenstein II: The New Colossus, I noticed no difference between it and the Razer Basilisk I use at home in terms of performance. I think that's what Logitech was going for: a wireless mouse with latency low enough to be indistinguishable from the wired mice preferred for competitive gaming and first-person shooters. I can swing my cursor across the screen and aim in all directions just as quickly as I can with the Basilisk, a feat for a gaming mouse in this price range to pull off.

I can swing my cursor across the screen and aim in all directions just as quickly as I can with the Basilisk.

Logitech claims 250 hours of battery life from the AA cell in the G305 Lightspeed. But that's only the case when the mouse is set to the default Performance mode in LGS. Another mode, Endurance, is a choice alongside it. When Endurance mode is enabled, Logitech says, the battery life rises to a full nine months, but the response time rises from 1ms to 8ms; an increase in latency is one of the trade-offs for conserving battery life.

To my surprise, the two modes feel pretty distinct. In Endurance mode, the cursor lags behind my movements ever so slightly while, in Performance mode, it feels a lot closer to true one-to-one tracking.

Once the battery life wanes to 15 percent, a light below the sensitivity button flashes red to warn you that it's time to replace the disposable AA Duracell that ships in the G305's package. Otherwise, a gray, five-bar battery gauge icon sits in the upper left-hand corner of LGS. In the week that I've been using the Logitech G305 Lightspeed in Performance mode, that battery gauge has not depleted a single bar.

Logitech says the G305 Lightspeed's switches can withstand 10 million clicks, half the rating of the Logitech G603 Lightspeed. Given that it would take years to suss out that claim, we'll have to take Logitech's word, but the fact that the G603 is rated for such long endurance tells us that a lesser-source switch was used in the G305 Lightspeed.

Logitech says the G305 Lightspeed's switches can withstand 10 million clicks, half the rating of the Logitech G603.

Likewise, Logitech advertises "advanced button tensioning" in the G305 Lightspeed, which is marketing-speak for "the buttons require less force to click than those of other gaming mice on the market." In practice, I could perceive no difference between the click force of the Logitech G305 Lightspeed and the HyperX Pulsefire Surge. And I noted a negligible amount of resistance compared with the Razer Basilisk.

The polling rate of the Logitech G305 Lightspeed ranges from 125Hz to 1,000Hz. (As is our custom, we tested at 1,000Hz.) In addition to letting you designate the DPI "steps" and the number of sensitivity levels you can access by way of the dedicated DPI-switcher button, LGS allows you to set the polling rate. What's more, you can choose from the LGS home menu whether you want the G305 Lightspeed's settings stored on your computer or in the on-board memory of the mouse itself. This could prove useful when traveling, perhaps for gaming competitions.

Subdued in style, the Logitech G305 Lightspeed seems a basic gaming mouse at first blush. Get your hand on it, though, and you'll appreciate its high-end wireless tech at a modest price.

Last, in LGS, the Input Analysis tab performs much the same function I saw when I reviewed the Logitech G513 Carbon mechanical keyboard. You get two options on this sub-menu: Key Press Heat Map and Key Duration Heat Map. LGS tracks your button presses over an arbitrary period (you manually start and stop a mouse-button "recording session" you want to analyze), and when done, the software provides you with a rundown of how many times you pressed each button in the session (Key Press Heat Map) and for how many seconds you pressed each one (Key Duration Heat Map). This can come in handy when you're trying to keep track of how fast you're firing or how much time you spend aiming with sniper mode engaged. Mostly, though, it's a curiosity.

WIRELESS GAMING ON A BUDGET

The wireless mouse for the frugal gamer has been done before—but done well is another matter. The Logitech G305 Lightspeed may be plain compared with the likes of competitors such as the Razer Mamba, but its strength comes from its guts rather than its outer shell.

Packing a cordless gaming mouse with low latency and a big resolution range at a low price means trade-offs are inevitable. Here, omitting Bluetooth, many buttons, and a rechargeable battery are the big ones. But if all you want to do is save money and play fast-twitch games without a tether, the Logitech G305 Lightspeed wireless gaming mouse will do the trick.

GABE CAREY

Robo R2: A Revised and Much-Improved Version

Robo R2
(2018)
$1,499.99

When I first tested the Robo R2 3D printer in late 2017, it was problematic on several levels. Calibration was time-consuming, print quality was uneven, and—worst of all—the touch screen often would not respond to even the simplest commands. The company recently approached me with a revamped version. It has a new operating system to make the printer more responsive and easier to set up, plus tweaks to the print bed and leveling sensor.

I'm pleased to report that the user experience is considerably better. Print quality is improved, calibration is easier, and the touch screen is generally more responsive. Although it falls short of unseating the Dremel DigiLab 3D45 as our Editors' Choice midrange 3D printer, the 2018 Robo R2 is a noticeable improvement over the original R2 and is, for the most part, a pleasure to use. It's a good midrange choice when the amount of vertical printing area matters.

ONE SUBSTANTIAL 3D PRINTER

The rebooted Robo R2 is a tall, stylish printer, measuring 23.8 by 16.8 by 16.6 inches (HWD) and weighing 25.5 pounds. It has an off-white frame with an open top, gently curving sides with large plastic windows for viewing the print bed, and a see-through front door with a magnetic latch. A 5-inch touch screen is set below the door.

The build area is 10 by 8 by 8 inches (HWD), a bit larger than that of the Dremel 3D45 (6.7 by 10 by 6 inches), and closer to square than the MakerBot Replicator+, our Editors' Choice high-end 3D printer, whose build area measures 6.5 by 11.6 by 7.6 inches.

Robo R2
(2018)

PROS Fine print quality. Supports printing with PLA, ABS, and a variety of specialty filament types. Versatile software suite. Mobile printing support.

CONS Touch pad is somewhat balky. Printing process is noisy.

The Robo R2 has an open top with sides that are primarily clear-plastic windows. In front is a door that you open to remove printed objects or for maintenance, and close when a print job has commenced. The fact that normally only the top is open during printing greatly reduces the chances of anyone being burned by touching the hot extruder, as you would have to reach down underneath the build chamber to touch the extruder from the top when the door is closed.

The open top has one disadvantage, though: The Robo R2 (2018) is fairly noisy. I was occasionally distracted by its sounds, even at a distance of some 25 feet.

> **Print quality is improved, calibration is easier, and the touch screen is generally more responsive.**

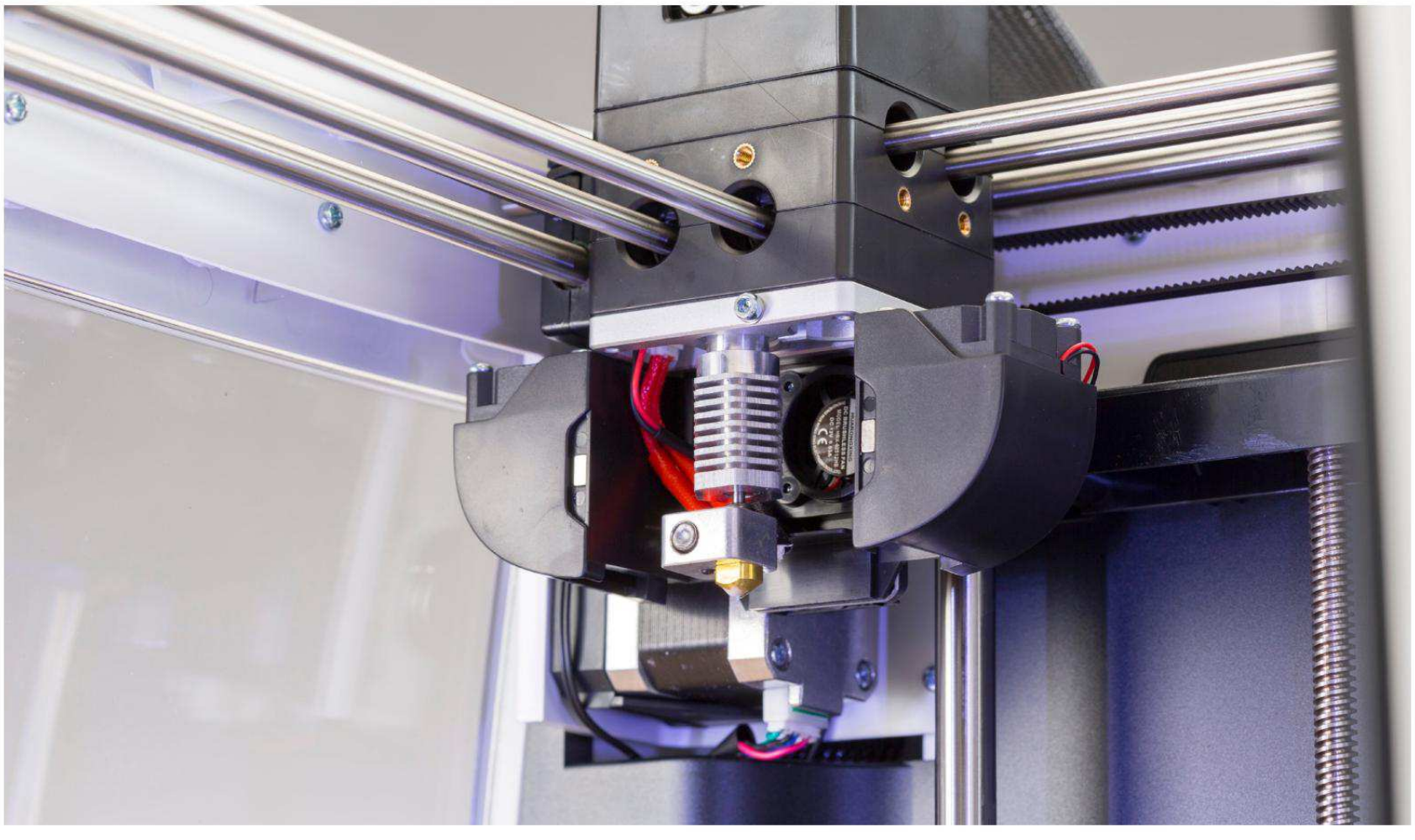
GETTING THE ROBO READY

To set up the printer, I followed the quick-start guide that Robo includes. After unboxing the unit and removing the packing material from around the print bed and extruder, you remove tape, zip ties, and clips that stabilize the extruder assembly and other components during shipping. After that, you connect the power cord—which includes a power adapter—with the printer and an electrical outlet. A couple of minutes after you turn the power on, the touch screen—which initially displays a Robo logo—shows a menu with three main tabs: Files, Printer, and Utility.

From the Files tab, you can select files to print from memory or from a USB thumb drive. From the Printer tab, you can control the temperature of the extruder and the print bed as well as the extruder's position in three dimensions. The Utilities tab lets you launch wizards to perform various setup and maintenance functions, including filament loading and Z-axis calibration.

This printer has two filament spool holders around the back. I used only one, as the second is intended for two-color printing when Robo introduces a promised dual-extruder-head kit. To load filament, you extend the top spool-holder rod downward to a horizontal position. You then insert one end of the filament feed tube into a hole in a nearby sensor block, and the other into the top of the extruder assembly. Once you put a filament spool onto the holder, you can feed filament from the loose end of the spool into the sensor block and through the feed tube.

You then launch the filament-loading wizard, which heats the extruder. To feed filament into the extruder, you press a button on the top of the extruder (which requires a bit of force) while pushing down on the filament until it meets resistance. From there, gears should pull the filament strand into the heating chamber. Once the molten filament starts coming out of the nozzle, the loading is complete.



One nice feature of the Robo R2 is that it doesn't use proprietary filament cartridges and is compatible with other types of 1.75mm filament, in addition to the standard acrylonitrile butadiene styrene (ABS) and polylactic acid (PLA) kinds. Robo sells 1.1-pound spools of PLA filament for $20 per spool, with specialty filaments (wood, carbon fiber, metallic, and glow-in-the-dark) for $35 to $40. Glass-fiber filament costs $89 per spool. These specialty filaments contain fibers or shavings of wood, carbon, metal, or glass, and retain some of the properties of those materials. Robo also sells 2.2-pound spools of PLA and ABS for $35 each.

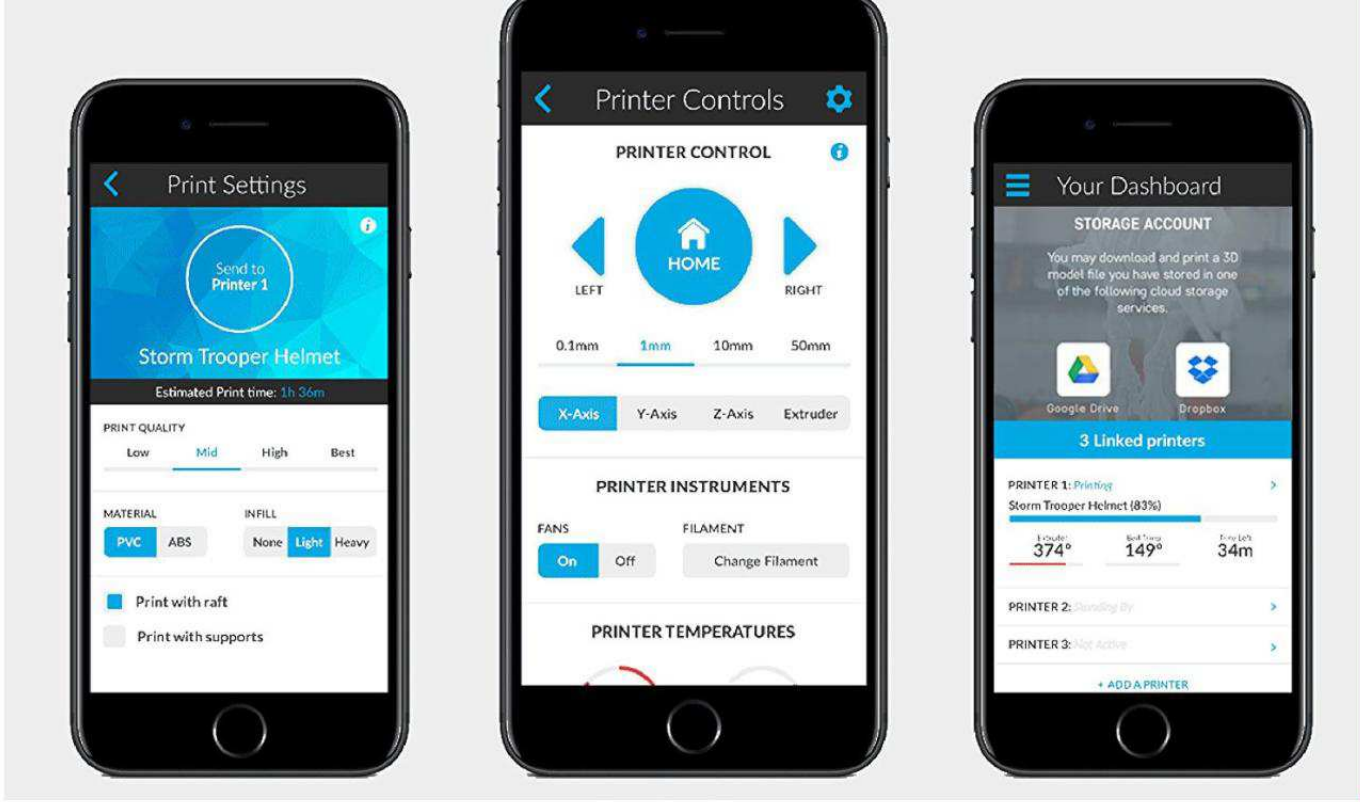
The Robo R2 doesn't use proprietary filament cartridges and is compatible with other types of 1.75mm filament.

CALIBRATING THE ROBO R2

A 3D printer's Z-axis is its vertical axis, and calibrating it ensures that when a print job commences, the extruder is placed just above the print bed, close enough to slide a piece of paper under and encounter slight resistance. (Robo includes a "Z-Offset Tool"—a little card—for this purpose, but a sheet of paper or a Post-It should do just as well.) When you launch the Z-offset wizard, the print bed will ascend until it comes to rest a bit below the extruder nozzle. You then move the print bed toward the extruder in increments of either 0.1mm or 0.2mm.

I was able to calibrate the Z-axis much more quickly with this model than with the original Robo R2. Even better, once the Z-axis is calibrated, the printer retains the setting, so you don't have to recalibrate it after each and every print.

The rest of the calibration process, which ensures that the print bed is level, is automated. With some 3D printers, the entire process is automated, although with many models you still have to manually calibrate the Z-axis as with the R2.



This revised and much-improved version of the Robo R2 3D printer, packing a roomy print area and support for multiple filament types, produces consistently good print quality.

A BETTER TOUCH SCREEN

When I tested the original Robo R2 and pressed the touch screen's buttons, often nothing would happen. After speaking to a technical rep at Robo, I got the screen to work more consistently by jabbing or poking the buttons (rather than just applying pressure), either with a finger or with the stylus that comes in the Robo R2's accessory kit.

Fortunately, with the 2018 version of the printer, you won't need to make a Herculean effort to get the screen to respond. Normal pressure, either with a finger or stylus, is usually enough. Sometimes, though, when working from the touch screen, the screen would freeze, and I would have to reboot the printer.

CONTROL SOFTWARE FOR DESKTOP AND MOBILE

For printing from a desktop computer, Robo offers an open-source program, Cura 2.5, which is commonly used by 3D printers, including the LulzBot Mini and the Ultimaker 2. The software is easy to use, and it lets you resize, move, and save objects; load multiple objects for printing; and change the print resolution and other settings. It has profiles for a number of filament types. You can send files to the printer over a Wi-Fi or Ethernet connection, or load them onto a USB thumb drive for direct printing.

In addition to desktop software, Robo offers the free Robo iOS app: It lets you select 3D files stored on Dropbox or Google Drive from an Apple mobile device, send them to the Robo R2 (or other Robo or OctoPrint-enabled 3D printer) for slicing and printing, monitor the progress of prints on multiple printers (including from your R2's onboard camera), and change or purchase filament.

PRINTING TEST SAMPLES

I printed nine test objects using PLA filament supplied by Robo: two at Cura's default normal-resolution setting of 100 microns and the rest at the low-resolution setting of 200 microns. (The software also offers a high-resolution setting of 60 microns.) The quality difference between the prints at the two settings was trivial, but it took considerably longer for the normal-resolution prints. So, unless quality is paramount, you should be fine sticking to the low-resolution setting.

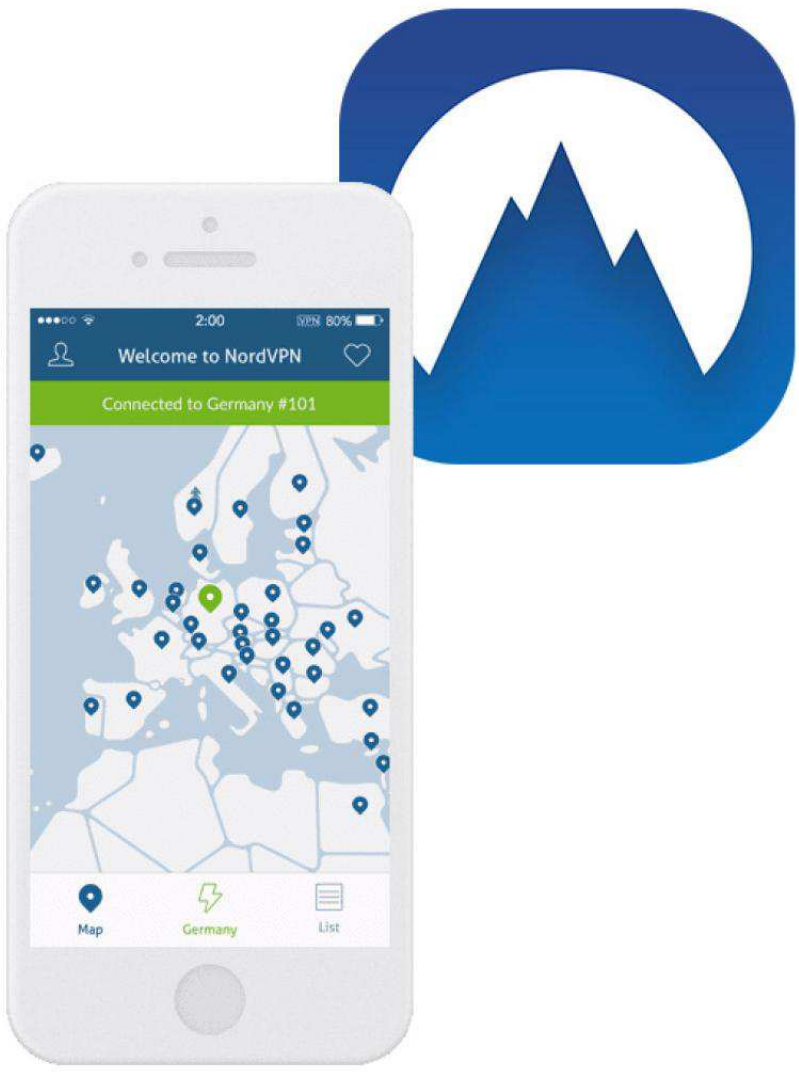
The print quality in our testing was consistently good to very good. With a test object consisting of geometric shapes and raised text arranged on a near-vertical plane, the printer did very well in printing text but less well at handling areas with overhanging printed material. Print quality wasn't quite the equal of the Dremel DigiLab 3D45, an Editors' Choice, but it was an improvement versus what we saw with the original Robo R2, which showed inconsistent quality in testing.

AN IMPROVED R2

The 2018 version of the Robo R2 brings lots of positives to the Robo feature list: a roomy build area, the ability to print taller objects than some of its peers, support for an abundance of filament types, and a good set of connection choices. The setup process and overall operation are easier than with the original Robo R2, though I still have some issues with the touch screen.

Also, print quality is better and more consistent than what we saw from the original R2, though still shy of the best fused filament fabrication (FFF) printers we've tested, including the Dremel 3D45. Given its price and performance, the R2 is a good choice for hobbyists, high schools and colleges, and product designers and artists who want to work with more vertical printing space than many midrange 3D printers offer.

TONY HOFFMAN



NordVPN (for iPhone) Is Award-Worthy

PC MAGAZINE EDITORS' CHOICE

The simplest way to ensure your privacy and protect your connection from snooping eyes while using an iPhone is to route your connection through a virtual private network, or VPN, such as NordVPN. With the NordVPN iPhone app, you can connect to servers around the world, including some intended specifically for torrenting and other activities. It's one of the best overall VPN services we've tested, and it's an Editors' Choice for iPhone VPN apps, along with KeepSolid VPN Unlimited.

NordVPN
(for iPhone)
$11.95 per month

WHAT IS A VPN?

Most of us probably assume that our internet connections are secure from the prying eyes of spies or the nefarious activities of attackers. We shouldn't, though. When you connect to the free Wi-Fi at the coffee shop, another patron on the same network may be snooping on your traffic. A savvy attacker could even create a phony Wi-Fi network and decrypt personal information you've sent—passwords, bank information, and so on. Out on the web, advertisers and three-letter agencies gather information about you when you visit websites; they also compare data from different sites to correlate your movements across the web.

To guard against these threats, and to take your privacy back into your own hands, you need a VPN. When you activate a VPN connection, your web traffic travels through an encrypted tunnel. That means nobody, even people on the same network as you—even if it's a bogus network operated by criminals—can read your traffic. From the VPN server, your traffic exits back onto the open internet, but with a twist. To any observer, your data appears to emanate not from your iPhone, but from the VPN server—even if that server is thousands of miles from your actual location.

Journalists and activists use the location-spoofing and privacy-ensuring properties of VPNs to reach the rest of the world when operating in places with restrictive internet policies, such as China or Russia. You can also use a VPN to access region-locked content. For example, you might access free streams of BBC shows when you're not in the United Kingdom. That said, several streaming services, and Netflix in particular, have started cracking down on users connecting via VPN. Also, using VPNs could violate terms of service, or even local laws.

NordVPN
(for iPhone)

PROS More than 3,000 servers in diverse locations worldwide. Unique, specialized servers. Strong customer privacy stance. Six simultaneous connections. Blocks ads, other web threats.

CONS Expensive. Lacks some features of the Windows edition.

Cellular data traffic is considered more secure than Wi-Fi traffic because of encryption built into the system. But researchers have shown that even cell traffic is vulnerable. One scenario involves jamming the LTE and 3G bands and thereby forcing nearby phones to connect, via the less secure 2G band, to a tiny portable cell tower called a *femtocell*.

It's unlikely you'll encounter an exotic attack like this, but there are easier ways crooks can nab your data. Consider that many phones automatically connect to Wi-Fi networks they've connected to before. We've seen for ourselves how attackers can configure malicious access points to emulate friendly networks and trick passing phones into connecting, without the owner suspecting a thing.

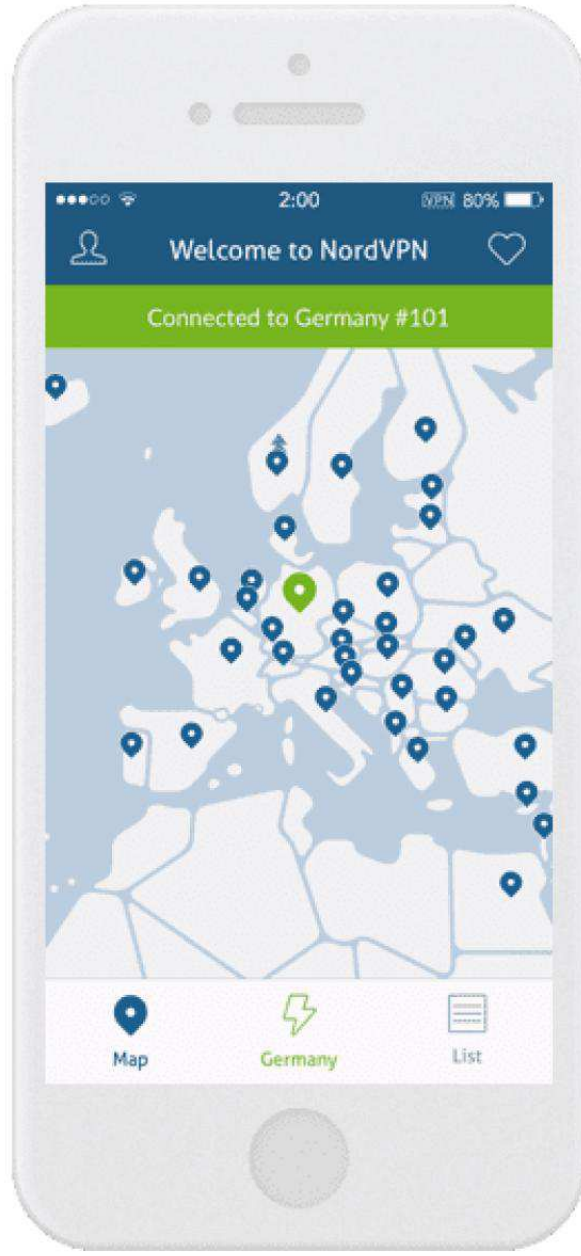
Attackers can configure malicious access points to emulate friendly networks and trick passing phones into connecting.

FEATURES AND PRICING

The NordVPN iPhone app is available as a free download from the iTunes App Store and works on both iPhones and iPads. It is also available for Android. Note, however, that VPN apps are at a bit of a disadvantage on iOS compared with other platforms. For example, VPN services tend not to include our preferred VPN protocol, OpenVPN, as doing so requires additional vetting from Apple. KeepSolid VPN Unlimited (for iPhone) is among the few iPhone VPN apps that support OpenVPN.

NordVPN doesn't offer a free subscription. The app does say you can try the first three days for free, but it also attempts to make you complete an in-app purchase to start using the service. This isn't unusual, but it is annoying.

A 30-day subscription with NordVPN costs $11.95, whether you're using it for iPhones or PCs. This puts it on the higher end of VPN services, price-wise. VPN protection through the Private Internet Access iPhone app, for example, costs $6.95 per month, and VPN Unlimited costs a mere $4.99 a month. There are also several worthy free VPN services available, if cost is a major issue. Note that NordVPN also offers a one-year plan for a very reasonable $69.00 and a two-year plan for an even better $79.00. You can sign up online using a number of different payment options, including anonymous ones, but payment is handled through iTunes on the iPhone.



One subscription lets you use up to six devices at a time on NordVPN's service. That's a smidge above the industry average of five and is quite a good value. CyberGhost VPN pushes the envelope with seven simultaneous devices, at the same price as NordVPN. NordVPN operates under Panama's jurisdiction, where there are no laws requiring data retention. It boasts a no-logging policy and will not restrict your bandwidth. A lack of logs is good for privacy, as it means there's no information for spies or investigators to gather via subpoena or other means.

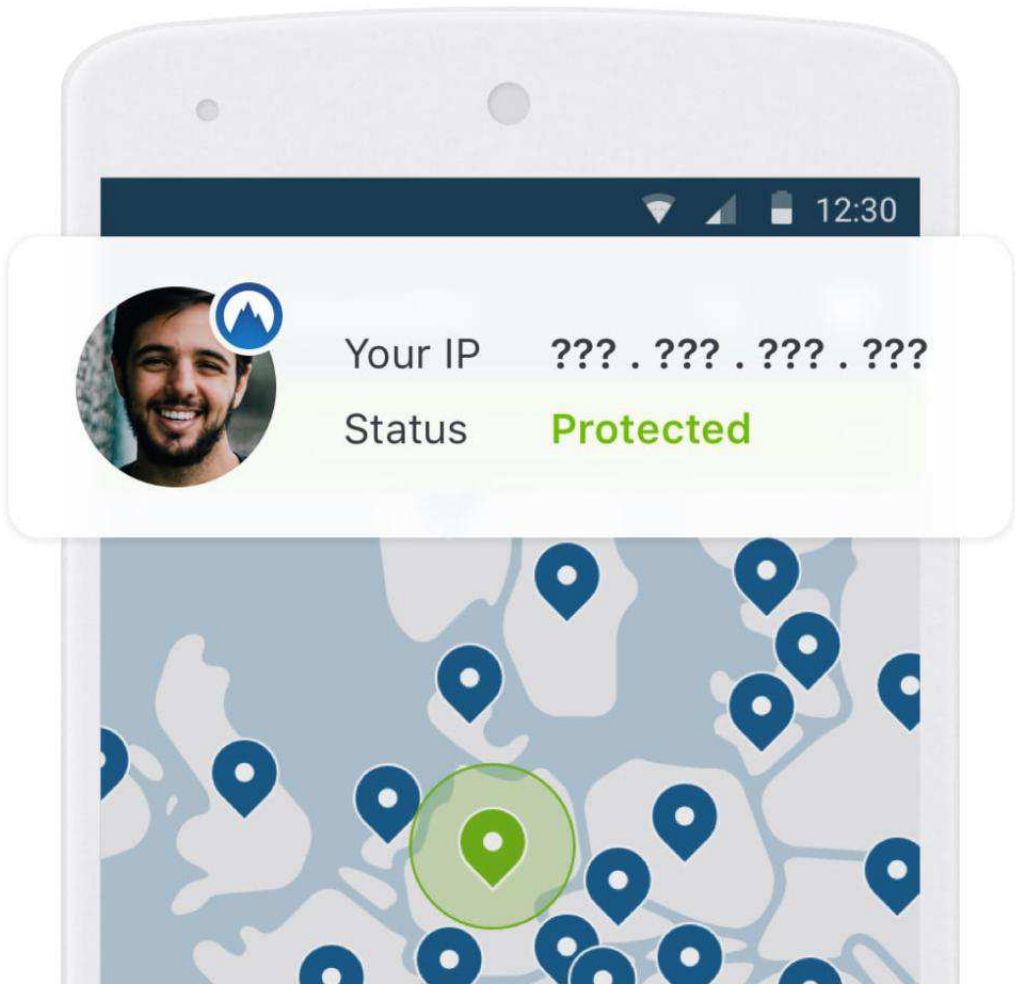
A subscription grants access to NordVPN's network of 3,400 VPN servers spread across 58 different countries. The company boasts that, except for Antarctica, it has at least one server location in each continent. This includes places like Russia and China, where using a VPN is a necessity. NordVPN also offers servers in areas typically underserved by competitors, such as Africa (in Egypt and South Africa) and the Middle East (including Cyprus, Israel, and Turkey). It's a first-class list, and slightly better than the 3,275 servers offered by Private Internet Access VPN (for iPhone).

The Windows version of NordVPN uses the OpenVPN protocol by default. We prefer that VPN services use the OpenVPN protocol. It's generally faster, and it's also carefully vetted for potential security flaws because it is open source. However, Apple requires extra vetting for apps that use OpenVPN; few of the iOS VPNs we've seen support OpenVPN. NordVPN uses the modern IKEv2 protocol under iOS, unlike Private Internet Access and Hotspot Shield, which rely on the older IPSec protocol.

You can, however, connect using OpenVPN with a NordVPN subscription on your iPhone. To do so, you must download and configure the aptly named OpenVPN iPhone app, log in with your credentials, and you're off and running. Our testing, however, focuses on using NordVPN's service with NordVPN's app.

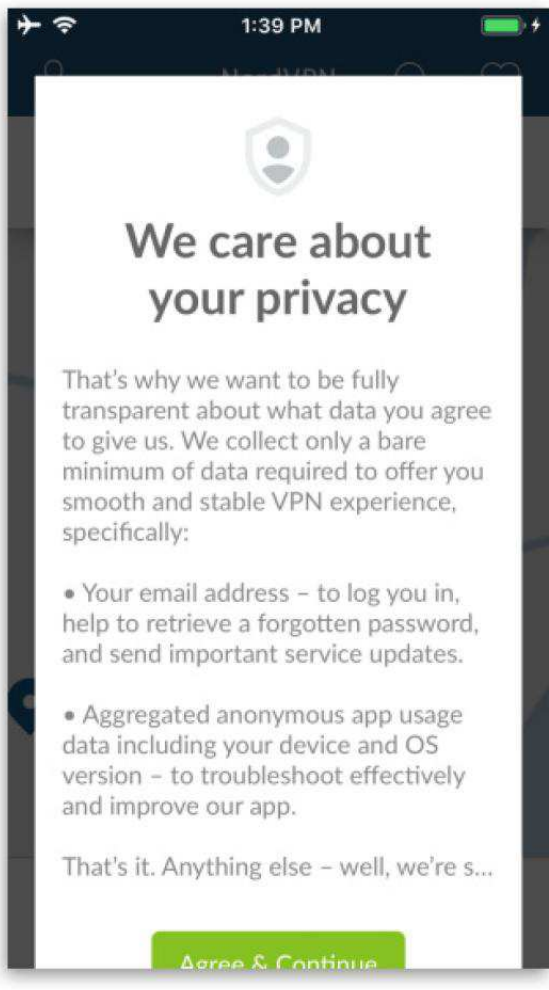
NordVPN includes a trio of security features it calls CyberSec: ad blocking, malicious website protection, and DDoS protection. This last feature is interesting, as the company says that even if your device is infected, it can prevent it from joining in a DDoS attack. Note, however, that the website protections offered in CyberSec are based on blacklists of known malicious and phishing sites. This would supplement but not replace the built-in web browsing protection from Apple.

In 2017, NordVPN announced that its servers are accessible from within China. This means that anyone within the country could circumvent government control over websites. That's particularly notable, because China's so-called Great Firewall greatly restricts the sites that can be accessed from within the country's borders. We'll see how that holds up against China's recent efforts to restrict VPN use. NordVPN recommends that if you are using its product to avoid government censorship, you should use the Obfuscated Servers option in the Settings menu, or contact tech support for assistance.



YOUR PRIVACY AND NORDVPN

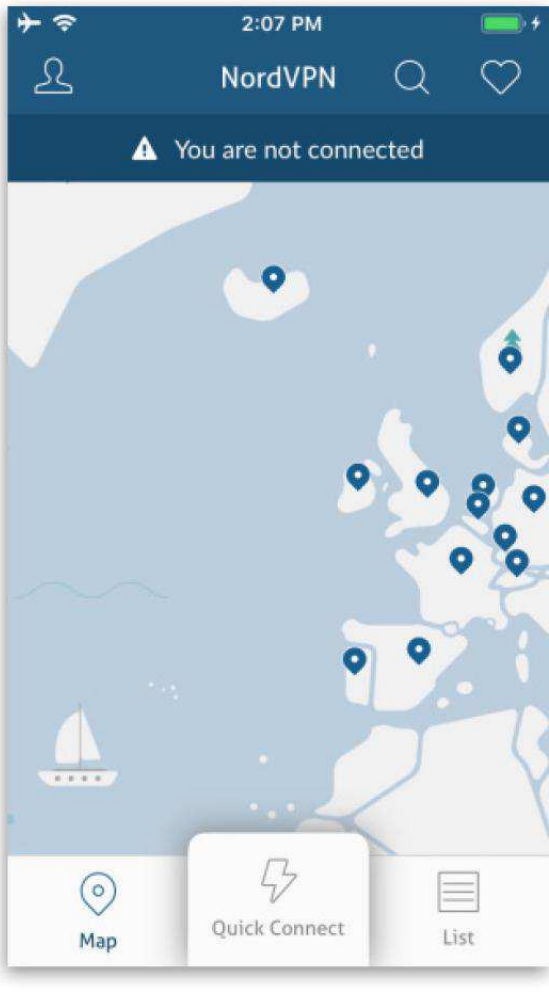
When you use a VPN, it has as much insight into your online activities as your ISP does. If it so desired, it could examine every bit of information passing through its system. It also can potentially identify you to another party—law enforcement, for example—making it possible to track you online. That's why it's important that before you buy a VPN subscription, you understand and are comfortable with the steps the company has made to safeguard your privacy.



A representative from NordVPN assured us that the company does not insert ads into your web traffic, nor does it profit from the sale of user data. As for the data it gathers, the company representative told us that NordVPN collects only aggregated app-crash statistics and voluntary diagnostic data.

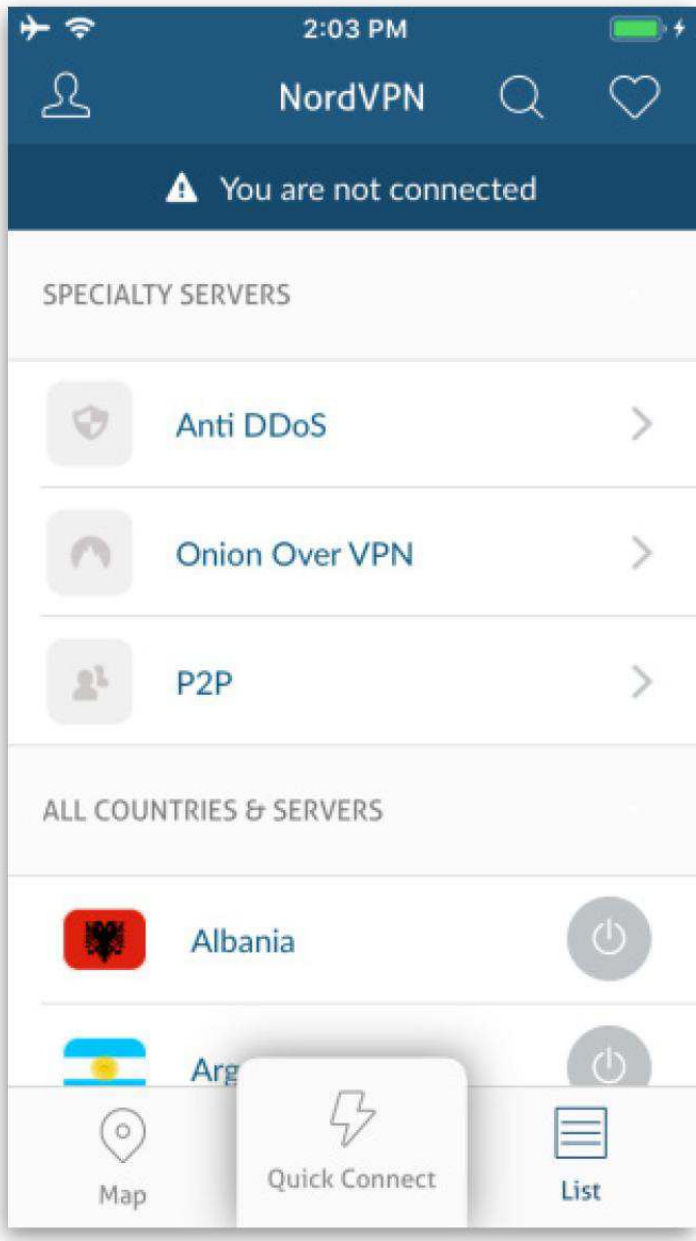
HANDS ON WITH NORDVPN

The iPhone app has the same layout as NordVPN's Android app. The main page features a large map of the world with pins representing all the NordVPN server locations. Tap one, choose a server, and you are quickly connected. We're suckers for a good visual impression, and NordVPN's map, with its subtle colors and cartoon submarines, looks great. If you're in a rush, you can tap the Quick Connect button, which connects you to the nearest (and therefore likely fastest) VPN server. TunnelBear VPN (for iPhone) and VPN Unlimited also let you select servers from a map.



Tap List, and you can choose your server location from a list instead of a map. We're pleased that this list now includes NordVPN's specialty servers. Tapping the account icon lets you toggle the Kill Switch and Smart Reconnect features, as well as access your account information. The Kill Switch automatically blocks data from flowing out of your phone should the VPN lose its connection. Note that this feature is much less common on iPhone VPNs. Some companies have told us it's not possible on iOS.

The full list of servers starts with specialty ones: Anti-DDoS, Onion (TOR) over VPN, and P2P. A list of available countries follows these specialty types. Within each country (or specialty), the servers you've marked as favorites show up first. We really like it when VPN companies organize their servers by the actions users want to perform: This helps demystify the whole process and can help novice users access some of a VPN service's more advanced features more easily. Hide My Ass offers a similar purpose-based selection mode, PureVPN (for iPhone) takes this concept to an even greater depth, and CyberGhost identifies each purpose with a high-resolution animated image.



Many mobile security apps skimp on design, which is a shame, because an ugly app or one that is difficult to navigate won't appeal to the average consumer. Private Internet Access, for example, has one of the most robust VPN infrastructures on the market, with thousands of servers available. But it has an ugly app on just about every platform. NordVPN, on the other hand, always appears reliable and friendly, even on a small screen.

GOOD SPEED TEST SCORES

Regardless of which VPN you choose, it's going to have some kind of effect on your internet connection. Generally, the process of routing your web traffic through additional servers far from your current location increases connection latency and slows your overall speeds. For testing purposes, we used an Apple iPhone SE.

In rare cases, the VPN service may connect you to higher-bandwidth infrastructure or use other optimization techniques that can improve your internet connection speeds. Indeed, the traffic optimization used by AnchorFree Hotspot Shield Elite (for iPhone) significantly increased upload and download speeds. Turning on traffic compression in CyberGhost also sped uploads and downloads to a lesser degree.

To test VPN speeds, we use Ookla's internet speed test tool (Ookla is owned by Ziff Davis, the publisher of PCMag). We turn off cellular data and connect to Wi-Fi. We run several tests without connecting to a VPN server and then calculate the percent change from tests run with the VPN connected. Of course, networks are notoriously finicky things, so your mileage may vary.

In general, NordVPN turned in average performances in our testing. We found that NordVPN increased latency by 31.7 percent. That's better than average, but CyberGhost increased latency only by 3.7 percent, and Private Internet Access by 15.7 percent.

In the download test, NordVPN reduced speeds by 25.7 percent, slightly worse than average. That's not too bad, considering that TorGuard slowed the download test by 59.7 percent. Interestingly, our latest results on Windows have TorGuard at the top in this test. As noted, Hotspot Shield aced this test, speeding up the download by 76.1 percent. CyberGhost came in next, slowing downloads by just 9.5 percent.

None of the tested products dramatically slowed upload speed. The biggest hit came from Private Internet Access and TorGuard VPN (for iPhone), both of which slowed uploads by 8.5 percent. HotSpot Shield sped up uploads by 4.3 percent, and PureVPN only slowed uploads by 2.2 percent. NordVPN's 5.5 percent impact is somewhere in the middle.

NordVPN clearly has a moderate impact on internet performance, which we found reflected in our time using the service. We found that web pages, even those with numerous media items, loaded as swiftly as we expected with NordVPN enabled. As with the latest Windows edition, we managed to stream content from Netflix.

Web pages, even those with numerous media items, loaded as swiftly as we expected with NordVPN enabled.

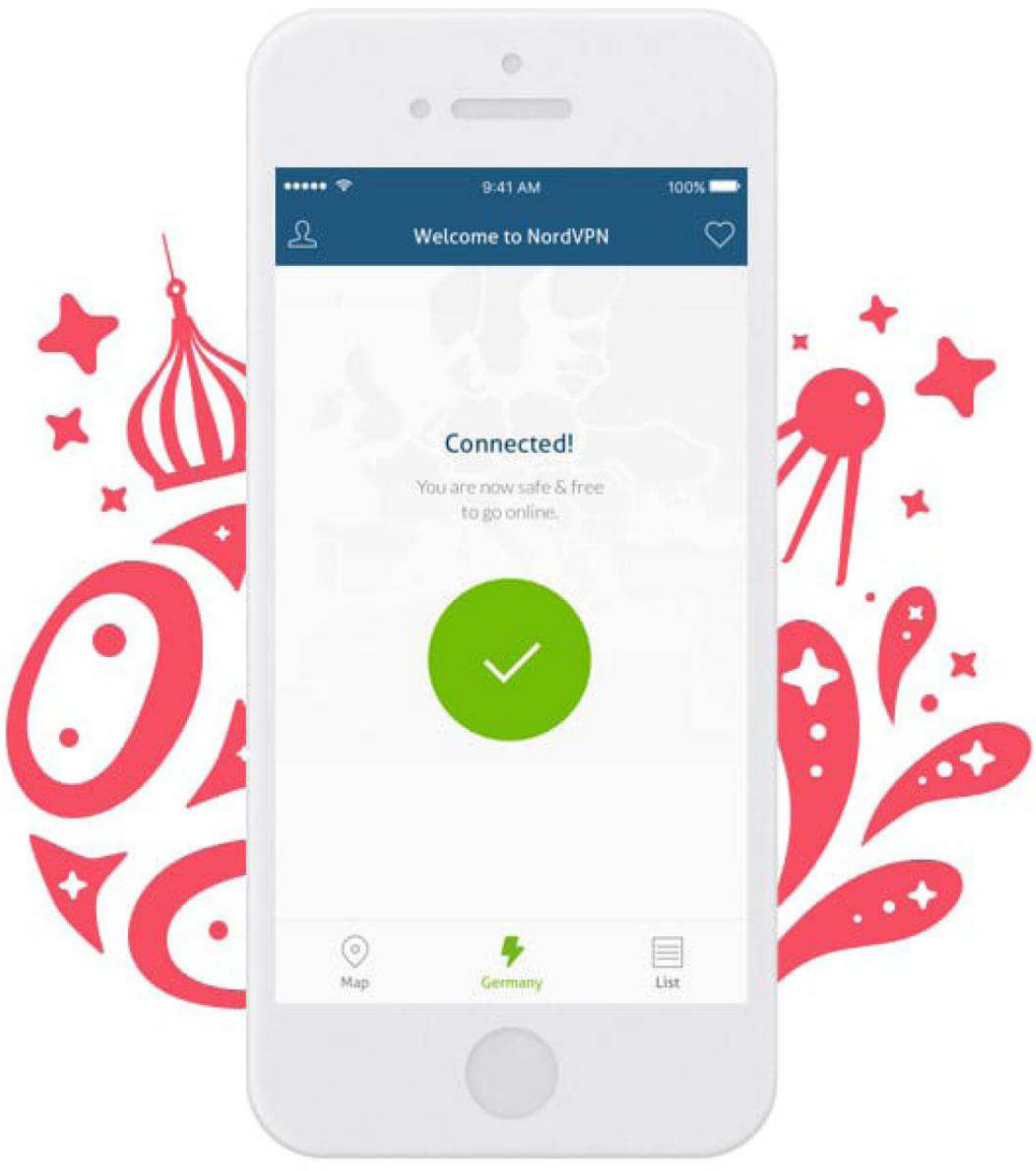
Netflix continues to ramp up its protections, though, so this ability might not last.

AN AWARD-WORTHY VPN

It's easy to make the case for the NordVPN iPhone app, despite its relatively high price. It offers numerous servers the world over, letting you choose where your connection appears to come from and providing a nearby choice wherever you might travel. NordVPN's inclusion of specialized servers means that you can easily find the right one for your needs, and its excellent design means you won't mind using it. We wish it directly supported OpenVPN, but that's really an Apple issue. NordVPN is an Editors' Choice for iPhone VPN apps, along with KeepSolid VPN Unlimited.

MAX EDDY, NEIL RUBENKING

NordVPN's inclusion of specialized servers means that you can easily find the right one for your needs.



Street Fighter 30th Anniversary Collection (for PC)

PC MAGAZINE EDITORS' CHOICE

Film aficionados rely on The Criterion Collection to take vital classic and contemporary movies and present them in thoughtful, information-filled packages for modern audiences. Until very recently, the 40-year-old video game industry lacked its own Criterion Collection, letting important pop culture contributions slip into oblivion due to incompatible hardware and software formats, expired licenses, and plain neglect. Thankfully, Digital Eclipse has taken up the games preservation task, blessing gamers with titles that celebrate classic titles via accurate emulation and a bounty of production-related extras and modern touches. The company's first foray into the fighting game genre is Street Fighter 30th Anniversary Collection.

Street Fighter 30th Anniversary Collection
Collection (for PC)
$000.00 Price

The compilation is a historical document in video game form that includes the mainline 2D arcade titles and a wealth of production-related materials. It's a marvelous collection, one that shows why Street Fighter is one of the most important and beloved video game series.

ENTER THE DRAGON (PUNCH)

You won't find Street Fighter: The Movie, the Street Fighter EX titles, or X-Men vs. Street Fighter (likely due to licensing reasons), but you will find all the core arcade releases. The lineup includes Street Fighter (1987), Street Fighter II (1991), Street Fighter II: Champion Edition (1992), Street Fighter II: Hyper Fighting (1992), Super Street Fighter II: The New Challengers (1993) Super Street Fighter II Turbo (1994), Street Fighter Alpha (1995), Street Fighter Alpha 2 (1996), Street Fighter III: New Generation (1997), Street Fighter III: 2nd Impact Giant Attack (1997), Street Fighter Alpha 3 (1998), and Street Fighter III 3rd Strike: Fight For The Future (1999).

Cynics will likely scoff and dismiss the 12 games as multiple iterations of just three series, but that's a shortsighted take. The five Street Fighter II games might seem excessive, but they highlight the changes that balanced characters, expanded the roster, and added gameplay elements that would become series (and genre) standards that remain in effect to this day.

Street Fighter 30th Anniversary Collection
Collection (for PC)

PROS Contains all the mainline, sprite-based Street Fighter games. Robust production documents. Strong online multiplayer play. Cool animation viewer and music jukebox. Lets you save at any time. Old-school filters.

CONS Some games lack practice and online multiplayer modes. No end quotes or stage switching in multiplayer moder.

For example, Street Fighter II: Champion Edition added mirror matches and player-controlled bosses, while Super Street Fighter II Turbo added juggling and Super Combos. These forward progressions exist throughout the Street Fighter Alpha and Street III, too, making you appreciate the huge gameplay, graphics, and technology leaps between the lowly O.G. Street Fighter and the visually stunning 3rd Strike. You'll also appreciate the more forgiving special move inputs that appear in the collection's later games, as the early ones require very precise motions to fire off Hadokens and Flash Kicks.

MOSTLY AS YOU REMEMBER

Capcom states that the collection's games are arcade-perfect replications, and in my time with the games, I certainly found that to be the case. From the score's dusty drum samples to combo timing, the 12 titles feel just as I remember them. In fact, I had more than a few nostalgic, warm fuzzy moments while playing the Street Fighter II games. The titles transported me back to very specific times and places, with specific people. If you were a part of the arcade scene—all but dead now—at the time of the games' original releases, you'll take a trip down memory lane, too.

From the score's dusty drum samples to combo timing, the 12 titles feel just as I remember.

Digital Eclipse could've easily crafted a bare-bones collection, but the developer added several extras to sweeten the package. The original arcade games lacked online multiplayer combat, but that functionality has been added to four titles: Street Fighter II: Hyper Fighting, Super Street Fighter II Turbo, Street Fighter Alpha 3, and Street Fighter III: 3rd Strike. I understand the reasoning to focus on just these titles—they still boast passionate and competitive player bases, after all. Still, the idea of taking janky-ass original Street Fighter online amuses me in a way that few things do. Plus, there are Street Fighter III adherents who prefer, say, 2nd Impact to 3rd Strike. They, too, should be allowed to catch these hands via the internet.

Unlike the original games, the titles in the Street Fighter 30th Anniversary Collection let you save anywhere which is a tremendous addition. It's a feature that comes in extremely handy when you face off against Gil for the twentieth time in a night and want to take a break to expunge the salt from your system without losing your progress.

Unfortunately, the multiplayer mode has a couple of quirks. The games don't display post-match win quotes after an opponent takes a loss, which dampens the arcade-like experience a bit. Furthermore, you can't switch stages in multiplayer action unless you exit the mode, reenter, and pick another.

A HISTORY OF VIOLENCE

Much like Disney Afternoon Collection and Mega Man Legacy Collection, two other recent Digital Eclipse joints, Street Fighter 30th Anniversary Collection is fat with supplemental material. Frank Cifaldi, Head of Restoration at Digital Eclipse and a noted video game historian who champions the much-needed games preservation cause, has put his fingerprints all over this collection.

The Museum section has production documents that explain the origins of Street Fighter, Street Fighter II, Street Fighter III, and the Street Fighter Alpha series. The character designs and gameplay notes offer unique insights into the creative process, and some are items that I've never seen before in previous Street Fighter collections or art books. In fact, there are numerous documents showcasing canned characters, stages, and gameplay features. There are also in-depth character bios that showcase fighters' martial arts style, physical stats, and the games in which they've appeared. If you're into video game history, Street Fighter 30th Anniversary Collection will serve you well.

Each game has an animation viewer that lets you check out, say, Ryu's Shoryuken in frame-by-frame fashion. This delightful feature proves especially useful when viewing the mind-boggling, detailed Street Fighter III sprites that remain video game design marvels to this day.

The 30th Anniversary Collection boasts jukeboxes for each game that let you listen to music and sound effects.

On the audio side, Street Fighter 30th Anniversary Collection boasts jukeboxes for each game that let you listen to music and sound effects. These tracks aren't just the stuff you'll hear during the fight but also the audio you hear during ending sequences, attract modes, and credits, too. The Street Fighter II, Street Fighter Alpha, and Street Fighter III audio effects are classic sounds forever associated with Capcom's CPS arcade system boards.

LOW SPECS, BIG FUN

It doesn't take much PC horsepower to run Street Fighter 30th Anniversary Collection. The game's Steam page states that you need a PC with at least a 3GHz Intel i3 CPU, Intel HD 4400 GPU, 4GB of RAM, and the Windows 7 operating system. In other words, even computers with a bit of dust on them should boot the collection with ease.

The collection's resolution defaults to whatever your PC's GPU is capable of displaying. For example, if you have a 4K-compatible GPU and monitor, the collection's UI, Museum assets, and other items display at that resolution. The original games, however, are not displayed in 4K. These are games that are more than 20 years old, people!

Local bouts, in single and multiplayer matches, run without a hitch. Although I've read stories of laggy online play (particularly when playing the Nintendo Switch version), my experience over a Fios line has been quite different. I've enjoyed several hiccup-free fights in Casual and Ranked modes.

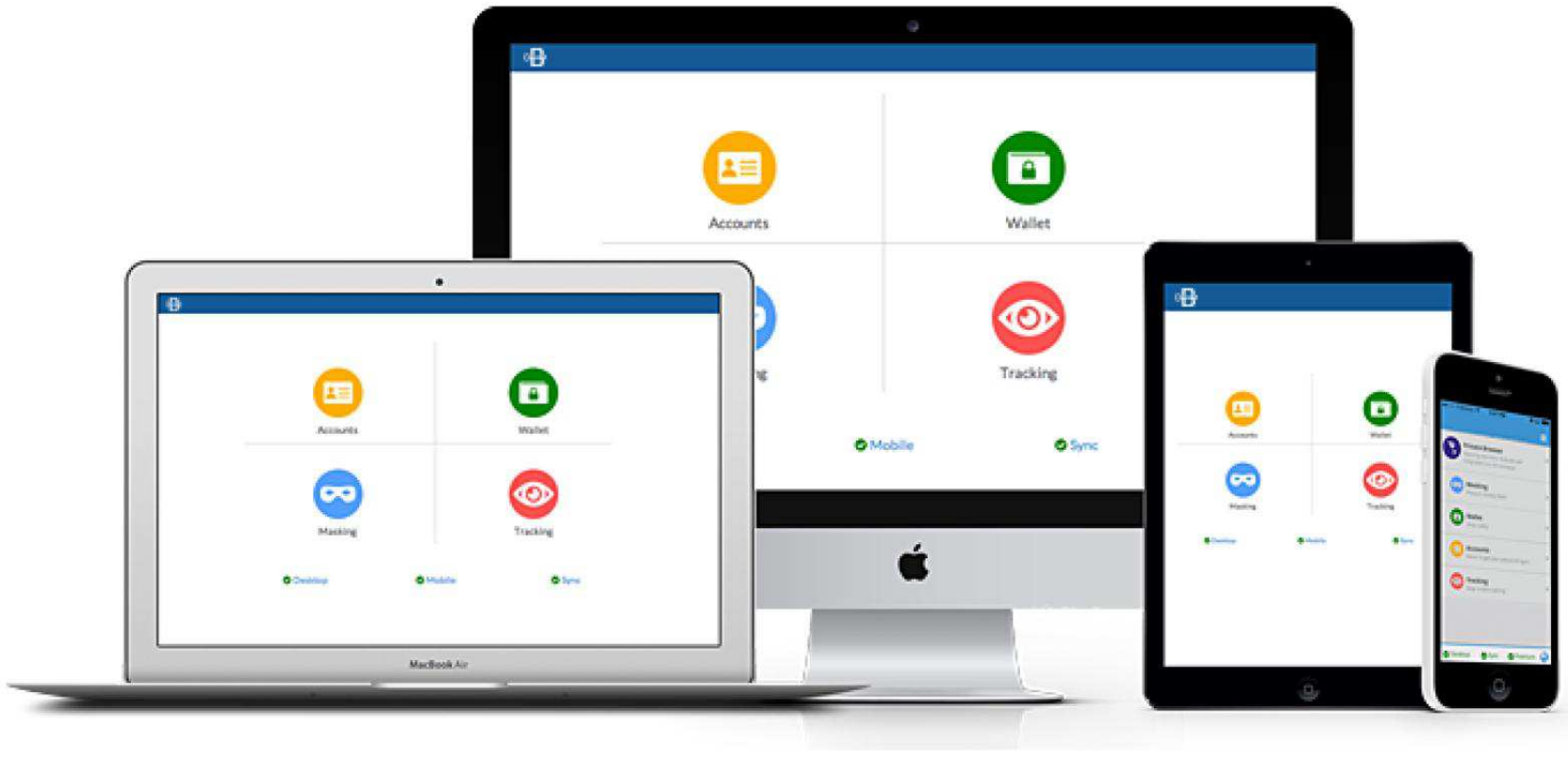
The collection doesn't let you tweak the resolution, but you can explore the other visual options to customize the experience. You can apply cool CRT monitor-like filters or apply/remove decorative borders around the default 4:3 ratio playfield. There are additional options that let you alter the playfield if the 4:3 setting isn't to your liking: Full (which zooms in closer to the action) and Wide (which stretches the visuals into a widescreen format). I prefer to play in the default 4:3 view, with the TV filter applied, which adds light scanlines for a retro look.

AN INCREDIBLE PACKAGE

Street Fighter is the rare video game franchise—like Madden, Super Mario, and Tetris—that even non-gamers know from its sheer cultural impact. In particular, its second installment made fighters a viable genre, inspired dozens of successful and hacky clones, and takes over ESPN2 during the Evolution Championship Series Grand Finals.

The Street Fighter 30th Anniversary Collection explores how the franchise came to be, via the games themselves and robust documentation. Digital Eclipse's obvious love for the video game medium shines brightly in all their releases, and this stellar collection in particular proves that video games can be so much more than mere products.

JEFFREY L. WILSON



Abine Blur: An Impressive Solution for Online Privacy

PC MAGAZINE EDITORS' CHOICE

Common wisdom holds that you should never reveal your personal information online. Sometimes, though, you can't avoid doing just that. When you buy the latest drone or smart speaker online, you have to give the merchant your address for shipping, credit card details for payment, and email address for notifications. But for $39 per year, Abine's Blur service lets you shop and surf in privacy, masking your actual personal details. It also includes a basic password manager. A free edition includes password management, email address masking, and tracker blocking.

Abine Blur

$39.00 a year

●●●●◐

Blur installs in your browser (Chrome, Edge, Firefox, Internet Explorer, Opera, and Safari) and puts a single, simple button on the toolbar. Clicking the button brings up a small panel that in turn offers access to four major function areas: Accounts, Wallet, Masking, and Tracking. Your private data is all stored locally.

For full access to the program's dashboard, simply click the word Blur at the bottom left of the popup panel. The dashboard lets you configure the same four function areas: Accounts, Wallet, Masking, and Tracing. From the dashboard you can also send a link to install Blur on your iOS or Android devices.

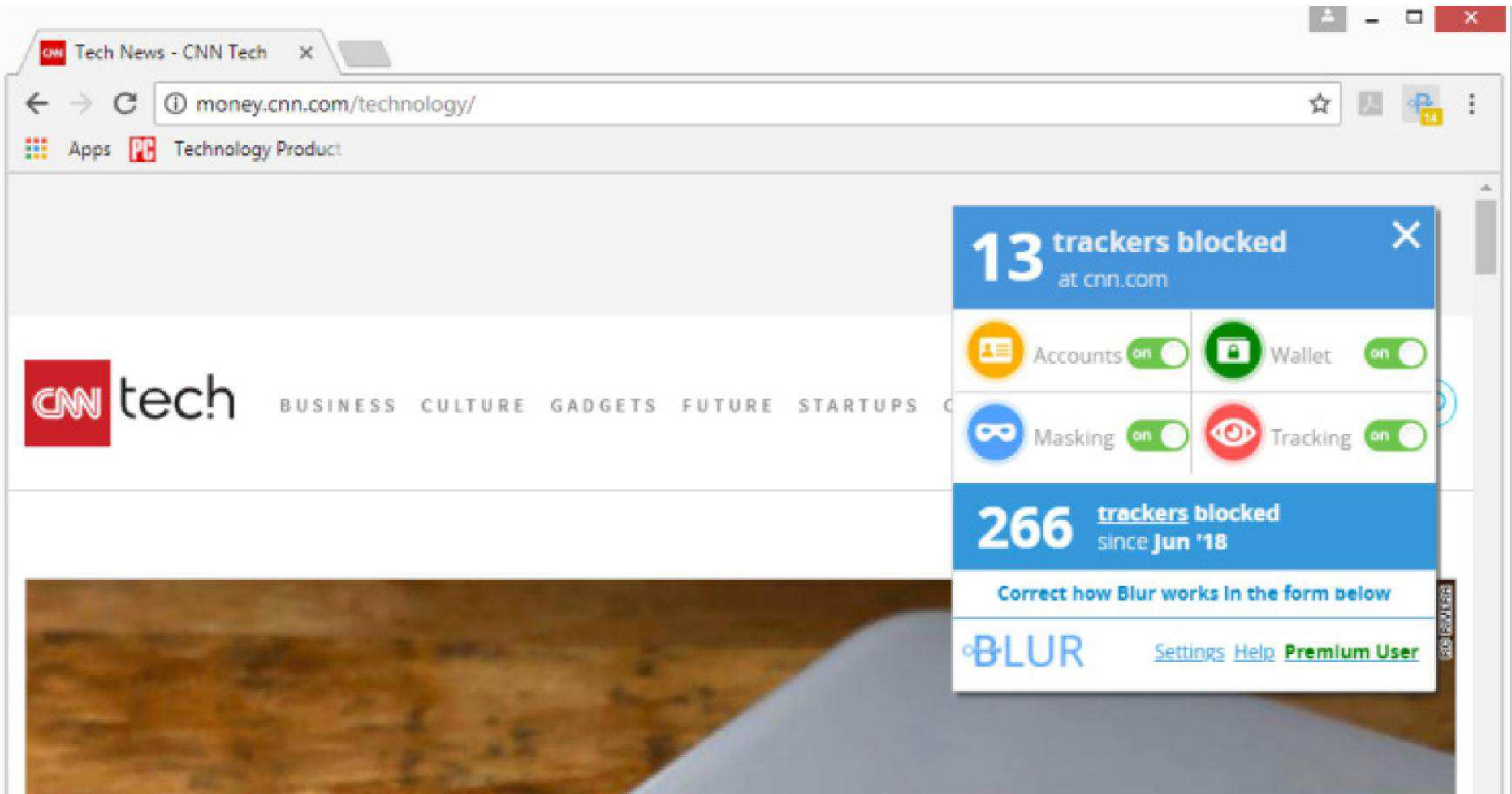
DO NOT TRACK

Your web surfing habits are your own business, right? In truth, advertisers, social media sites, and web analytics groups all profit by tracking where you go on the web. Your browser can send a Do Not Track header, but websites can choose to ignore it. Abine pioneered the idea of a Do Not Track system that actively prevents this kind of tracking. Several general-purpose security products include a similar active Do Not Track function, among them AVG AntiVirus Free and Kaspersky Internet Security.

Abine Blur

PROS Prevents advertisers from tracking your browsing. Manages passwords. Masked email addresses help block spam. Masked credit cards protect real card number. Masked phone number blocks unwanted callers.

CONS Requires giving a lot of private data to Abine. Local-only password storage can be lost on browser cache clear.

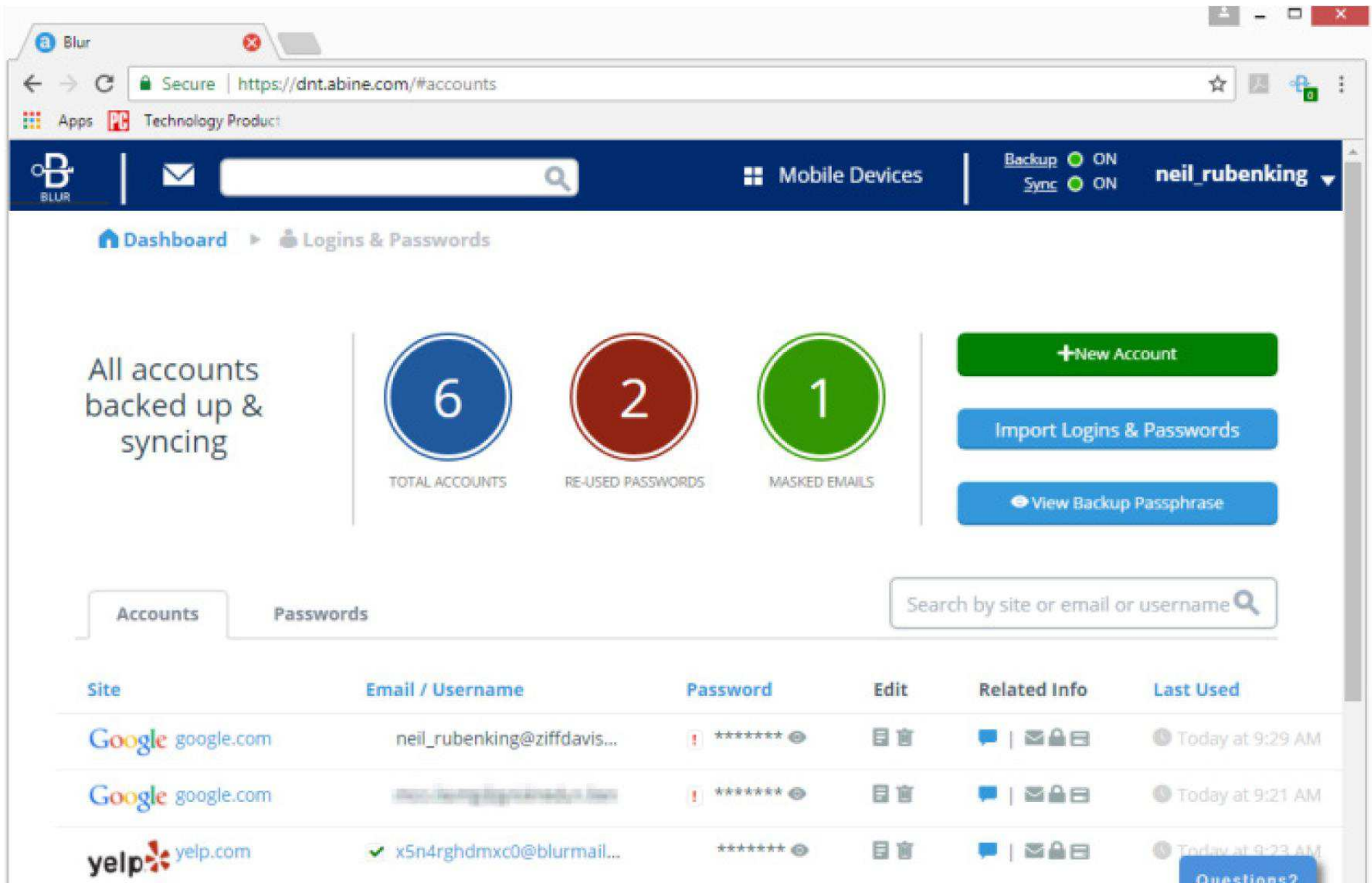


For each website you visit, the Blur toolbar button in the browser displays how many trackers it detected and blocked. Clicking the button brings up the access panel for Blur services; clicking Tracking in that panel displays full details. You can see exactly which ad aggregators, social media sites, and web analytics systems Blur prevented from tracking you. This panel also lets you turn off blocking for any specific tracker, or for an entire website. Clicking a link opens a chart of your tracker-blocking statistics over time.

PASSWORD MANAGEMENT

Blur includes a straightforward password manager. As expected, it captures credentials when you log in and automatically fills saved credentials when you revisit the site. If you've saved more than one set of credentials, it offers a menu of available logins.

From the online dashboard, you can view a list of all your passwords and optionally edit or delete entries. Like LastPass, Dashlane, and many others, Blur lets you assign a friendly label to each saved password. However, you can't organize them into groups or categories. Blur can import passwords from LastPass, Dashlane, RoboForm, AgileBits 1Password, and several other password managers.



You can enhance protection of your stored passwords by enabling two-factor authentication. Blur supports authentication using Google Authenticator or a work-alike such as Twilio Authy or Duo Mobile. You can also set it to lock automatically after a period of inactivity, or when the browser restarts.

Blur offers to generate a strong password when you're signing up for a new service or changing an existing password. Initially, it offers to make a strong password, or a strong password with customization. It defaults to 10-character passwords using uppercase letters, lowercase letters, digits, and special characters. That's rather low, though, given that you don't have to remember the generated password and that many users just accept the default. LastPass and 1Password default to 20 characters, and the free Myki Password Manager & Authenticator generates 30-character passwords out of the box.

It defaults to 10-character passwords using uppercase letters, lowercase letters, digits, and special characters.

To customize, you can raise the password length and disable digits or special characters for sites that don't accept them, but your generated passwords always include capital and small letters. Keeper Password Manager & Digital Vault, Dashlane, LastPass, and many others give you full control over character sets used.

If you forget your master password, you can create a new one, but you'll lose all your saved passwords. To avoid that awkward situation, Blur generates what it calls a "Backup Passphrase." Mine consisted of 12 words, more than 80 characters. You can use this passphrase to regain access to your passwords in an emergency. Abine suggests you store it securely.

Blur used to rely on your Dropbox account for syncing your stored data across multiple PC, Mac, or mobile devices, but now uses its own servers. It encrypts your data locally, so nothing is exposed to Abine.

The Backup and Sync features aren't available in the free edition; premium users can also opt for local-only storage. But be warned, local storage can be iffy. The FAQ states "If you have your information stored locally (i.e. you do not have Backup & Sync authorized), DO NOT CLEAR YOUR CACHE, unless you are OK with having your accounts & passwords removed. If you lose your accounts due to a cache reset, there is no way to recover those lost accounts." That's pretty dire. If you must use local-only storage, be sure to export your data frequently.

> **If you forget your master password, you can create a new one, but you'll lose all your saved passwords.**

Blur used to rate your overall password security using an algorithm that took into account password strength and reused passwords. In an unusual twist, reused usernames also lowered your security, so to get a top rating you had to make use of masked emails. The current edition displays a simple dashboard that shows the total number of accounts, the number of reused passwords, and the number of masked email usernames (more about those below). You can see a password strength rating by opening any item. LastPass, Keeper, LogMeOnce Password Management Suite Ultimate, and a few others have an actionable password strength report that lists all your passwords from weakest to strongest.

Blur doesn't include advanced features such as secure sharing of passwords or digital password inheritance after your death. It does automatically fill web forms, but that ability technically belongs to the Wallet feature, discussed below.

ANONYMOUS EMAIL ADDRESSES

Every time you enter your email address at a website, you're risking the possibility that the site owner will sell it to spammers or that hackers will exfiltrate your data from the site. Blur solves that problem with masked email addresses. Instead of giving the site your actual address, you generate a masked address using Blur and add a descriptive reminder for where you used this specific address. Messages sent to the masked address arrive in your inbox, but the merchant or other website never sees your true address.

A temporary inbox displays the messages you've received via masked email addresses for a day, but typically you'll view them in your regular email client. This feature does give you a quick way to notice spam and turn off the corresponding masked address.

From the dashboard, click Masking and then click Masked Emails to view all your masked email addresses, along with the number of times you've used each. If you start getting spam via one of these masked addresses, simply turn off mail forwarding or delete the address completely. To make that process simple, Blur inserts a header in the forwarded email with a link to block the corresponding masked email address. It's a clever solution to an annoying problem.

MASK YOUR CREDIT CARD NUMBERS

Tracker blocking, password management, and masked email addresses are all available in the free edition of Blur. For access to masked credit cards and other advanced features, you must upgrade to the premium edition. New users get to try premium features free for 30 days.

Masked credit cards work much the same way as masked email addresses. You register an actual credit or debit card with Abine; online merchants never see that card. When you click in the credit card field to pay online, Blur pops up and offers to create a masked card.

At the time you create the masked card, you fill in the precise amount that you're about to pay online. In truth, a masked credit card is more like a prepaid gift card that happens to hold precisely the amount needed for your current transaction. The merchant can't charge more than the specified amount.

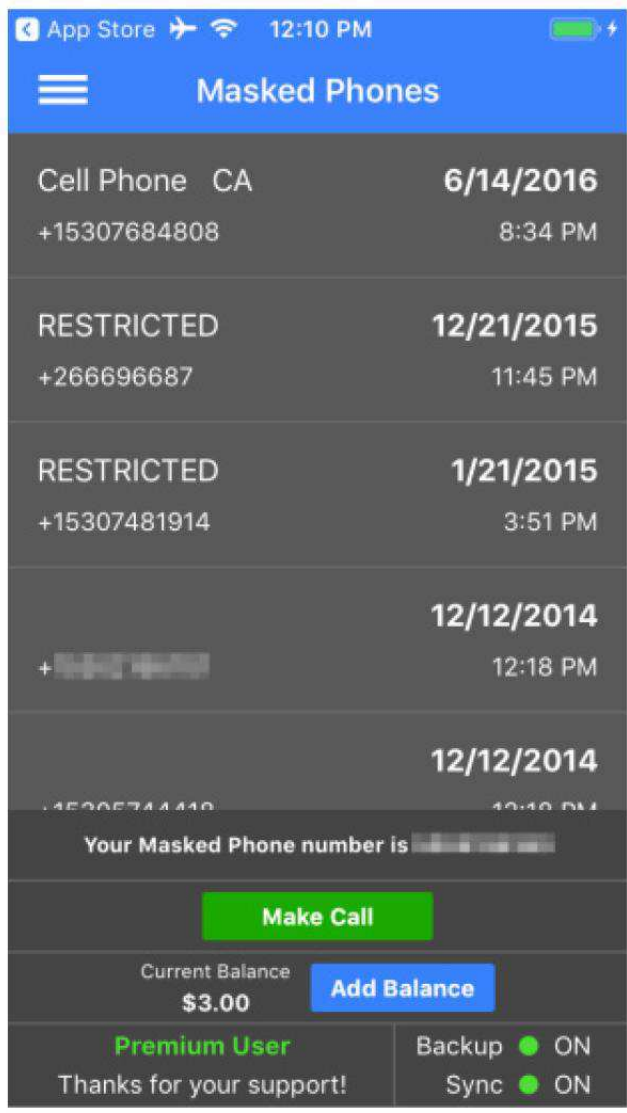
When you confirm creation of the masked card, Abine bills your actual credit card for the amount you chose. You use Blur to automatically fill in your own address for shipping and Abine's address for billing. The transaction shows up on your credit card bill as a charge from Abine. If you wind up not using the masked card, you can cancel it and request a refund with one click.

I tried the service right up to the point of actually spending money. It worked very smoothly, and I had no trouble getting the correct amount refunded. Note that you can't create a masked card worth less than 10 dollars, but if you truly need to charge a smaller amount, you can spend it and then get a refund for the remainder.

KEEP YOUR PHONE NUMBER PRIVATE

You can install Blur on your Android or iOS phone or tablet and sync your data through Abine's servers. Syncing is seamless, once you've set it up on your desktop. You get all the same features as the desktop edition offers.

The mobile edition adds one major new feature—a masked phone-number option. Unlike masked emails and credit cards, the masked phone number is a singular new phone number that forwards calls, texts, and voicemails to your actual phone number. When filling web forms, you can click "Mask My Phone" to enter the masked number.



All callers appear in the Blur dashboard. If you don't want to receive any more calls from a number, just set forwarding to OFF for that number. The caller will hear a message stating that the number is no longer available. You can make calls from the masked number and receive texts, but you can't send texts. You can't use masked phone numbers everywhere, but Blur supports use in the US, the UK, and 13 other countries.

Your subscription gets you $3 per month for masked phone usage. Each call and text costs one cent, and each minute of talking costs another penny. If you run out of money, you can add more in increments of $1, $2.50, or $5 directly from the app.

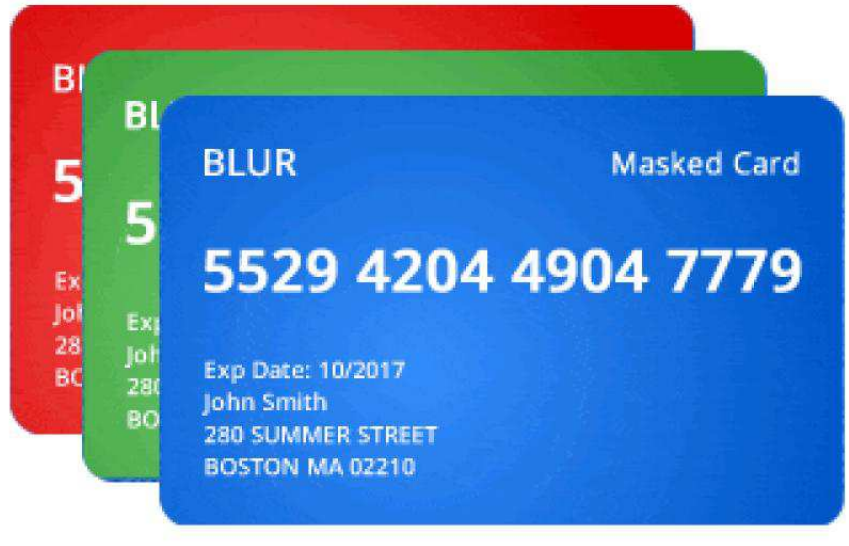
The mobile edition offers a few other features not found in Blur's desktop edition. On modern iPhones and Androids, you can authenticate to Blur using your fingerprint. And you can set it to force biometric authorization for purchases made through the app.

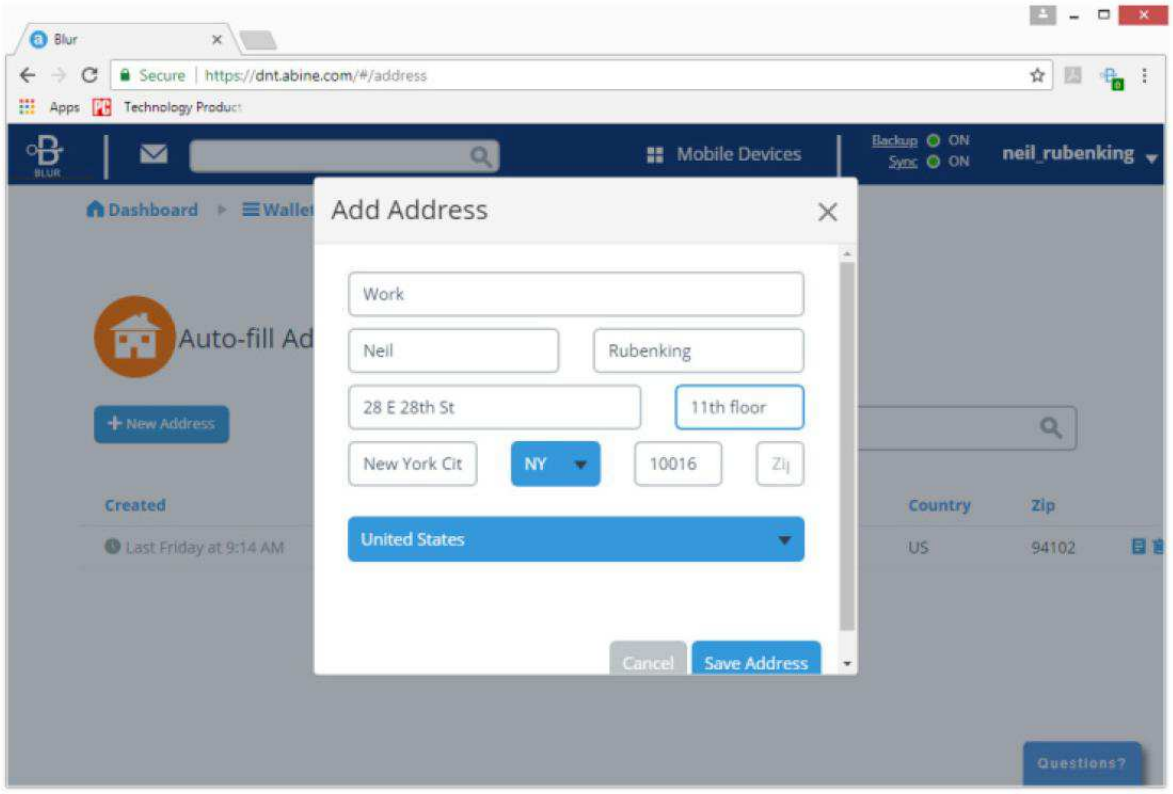
On an iPhone, if you want tracker blocking and access to all Blur features, you use the built-in browser or work in Safari via Blur's extension. Blur also offers instructions on how to tweak your iPhone's settings to limit advertiser tracking and location tracking. Android users can choose to enable Blur in Chrome and other apps using Android's Accessibility feature. But in general, the feature sets are very similar between iPhone and Android.

BLUR WALLET

The Masked Cards icon also appears as an option in Blur Wallet, along with three Auto-fill options. Many password managers, most notably RoboForm, use their skills to fill web forms as well as login credentials. Blur can fill addresses, credit cards, and identities.

Address refers to a simple snail-mail address, with name, street, apartment number, city, state, ZIP Code, and country. Cleverly, Blur asks for just the ZIP and automatically fills the corresponding state and city. There's no option for a second address line, but you might be able to make do using the apartment field.





Each Identity shows up on two tabs, Auto-Fill Preferences and Your Info. On the first of those pages, you enter a full name, select an existing address (or create a new one), and indicate whether you want to use a specific email and phone number or use masked ones by default. By default, Blur automatically generates a strong password for password fields and a masked card for credit card fields, though you can turn these options off if you choose.

Blur generates a strong password for password fields and a masked card for credit card fields.

On the Your Info page, you can enter gender, date of birth, preferred username for new accounts, the URL of your website, your company and title, your SSN, and your driver's license number. Other products offer a wider variety of data fields. For example, with Keeper you can enter Home, Mobile, and Work phone numbers. RoboForm Everywhere allows multiple instances of any field. But Blur covers the basics.

You can have only one credit card backing your masked cards, but you can record details for any number of non-masked cards in the Blur Wallet. Start by recording one or more snail-mail addresses, then enter each credit card's details and associate it with one of your addresses. That's it! The popup dialog that offers the masked credit card feature also lets you choose a non-masked card and fill in the details.

In testing, Blur did a better job than in the previous review. It filled in almost all fields correctly and offered to generate a masked credit card. The only real error was that it filled the SSN value into both the SSN and driver's license fields.

CLEAR DATA PRIVACY POLICIES

The point of using Blur is to protect your online privacy, but you have to give a ton of personal information to Abine. Abine's clear data-privacy policy details precisely which data items Abine necessarily retains and which items are completely out of the company's reach.

Abine's clear data-privacy policy details precisely which data items Abine necessarily retains.

For example, Abine must retain your email address and your masked email addresses to seamlessly ensure that mail reaches your inbox. But it encrypts your passwords locally on your device and optionally stores them in encrypted form for syncing, so Abine has no access to them. The US government requires payment processors to retain purchase records, but Abine won't share those (or anything else) with third parties. If served with a subpoena, the company would of course provide information to law enforcement, and that would include purchase records.

BLURRING THE LINES

You can surf the web anonymously using a VPN or TOR, but when it comes to making purchases, you have to tell the website where to send the merchandise and enter your email address, and credit card information. Abine Blur does an admirable job of preserving your privacy and also serves as a basic password manager and form filler. There's nothing else quite like it. Blur is an Editors' Choice for privacy protection.

NEIL J. RUBENKING

FASTEST MOBILE NETWORKS 2018

BY SASCHA SEGAN

In this, our last Fastest Mobile Networks survey of the 4G era, Verizon once again cements its position as the 4G leader. The nation's largest carrier also runs the nation's fastest LTE data network, with the fastest download speeds and lowest latency.

We've been drive-testing American mobile networks since 2010, first 3G and then 4G, watching speeds grow and coverage expand. Yes, dead zones still exist—American cities have less reliable mobile coverage than Canadian cities, we've found. But we've seen steady improvement over the years, especially from T-Mobile, and Americans in major metropolitan areas can now generally assume a level of service they couldn't a few years ago.

Compared with 2017, we're seeing faster, more consistent LTE connections on all four major US wireless networks. Peak speeds have jumped from the 200Mbps range to the 300Mbps range, average download speeds have bumped up by 10Mbps or more, and latency has dropped by 10ms. That's an impressive change in one year, and it continues the trend of improvement that we've seen over the past several years of testing. You can read about how speeds have changed over the past few years in our "Regional and National Winners" section of this story.

Much more than in previous years, we saw many cities where the carrier with the fastest average download speeds didn't win the award. We're okay with that. Our speed score tries to balance all of the components of a mobile connection: downloads, uploads, availability, and latency. (For more details, check our "Testing Methodology" section.) As we get to a world where we can assume 20Mbps or higher download speeds on 4G in most cities, other questions arise: Where are those speeds most consistent? Where is the network most responsive, especially when you're downloading pages made up of many small files?

Our tests cover data speeds and reliability; we don't make voice calls. But our awards for data service apply more and more to voice, too. All of the carriers other than Sprint now use voice-over-LTE, piping their voice calls through their data networks. So the reliability of those LTE data networks translates into the reliability of your HD voice calls as well.

Next year, we're going to have a new challenge: 5G is coming. While all of the carriers have built somewhat similar 4G networks (well, except for Sprint's extreme focus on downloads over uploads), they're taking radically different approaches for 5G. AT&T and Verizon are going for much higher speeds over smaller areas; T-Mobile is looking to blanket the nation but at slower speeds. While they're all going to call their new networks 5G, it'll be like they're coming from different worlds. To find out more, read the section in the story called "4G and 5G: What's Next?"

What does this mean for choosing your wireless carrier? We've seen broad multi-year trends developing recently. Verizon and T-Mobile are the clear network leaders for smartphone users, with T-Mobile's strength coming in uploads for the social-media, content-creator crowd. AT&T and Sprint have focused on download speeds, so they are best for content consumption, video streaming, and web browsing.

If you're dissatisfied with your speeds and coverage, consider switching your phone before you switch your carrier. All four major carriers have been laying down new technologies recently that old phones just don't support. "Why You Need a Faster Phone" explains this further.

National results make great headlines, but we think our city-by-city results will be more relevant to you. Verizon won in 20 cities/areas, but other carriers won the 16 other awards. We stopped by more than a dozen locations in each of 30 US cities and collected data on the drives between them to build our city results.

Regional and National Winners

NATIONWIDE WINNER: VERIZON WIRELESS

Verizon has won our national award for several years running. The carrier doesn't often trumpet its network upgrades—but quietly, in the background, it's laying down the latest network technologies on a massive amount of spectrum. Verizon won or tied in 20 of our 36 cities/areas, making it the national leader.

Verizon's repeated wins show the advantage of being one of the original wireless carriers, with prime spectrum held since the 1980s. But T-Mobile's strong second-place showing, winning or tying 15 of our 36 awards, shows there's another way—grabbing new spectrum when it's available and building out smartly. T-Mobile has been acquiring spectrum in nearly every auction for the past decade. Most recently, it's started to build out a broad rural network based on its new 600MHz Band 71 spectrum, which is filling in the gaps in their formerly metro-oriented network. We saw Band 71 pop up in rural Kansas, Oklahoma, and Oregon.

“Verizon's repeated wins show the advantage of being one of the original wireless carriers, with prime spectrum.”

AT&T had the second-highest average download speeds nationwide, but the company has recently focused on building a network that goes beyond phones, for smart cities, smart homes, and smart cars. That means availability and coverage is more important for the carrier than speed. AT&T has also chosen to use its fast Band 66 spectrum for downloads rather than uploads, which penalized it in the upload category of our ratings.

Sprint got hit heavily in our ratings because of its very slow upload speeds, but the good news is that its download speeds have increased massively over the past few years. Sprint had the fastest downloads in Philadelphia, St. Louis, Oklahoma City, Houston, and Seattle. If we were rating only by downloads, like some other organizations do, we could hand out some shiny trophies to Sprint right now.

Regionally, Verizon dominated the Midwest and Southwest; most of the rest of the country was a mix of Verizon and T-Mobile winning the day.

National	AT&T 4G	Sprint 4G	T-Mobile 4G	Verizon 4G
Download Speed (Mbps)				
Maximum	293.4	275.3	266.0	354.9
Average	43.9	38.4	39.2	49.7
Downloads Above 5Mbps (%)	91%	79%	88%	91%
Upload Speed (Mbps)				
Maximum	66.0	29.3	59.8	65.2
Average	13.9	4.4	18.9	19.0
Uploads Over 2Mbps (%)	89%	70%	91%	89%
Average Ping (ms)				
	41.42	41.68	30.11	27.78
Reliability (%)				
	96%	93%	96%	95%
Speed Score				
	88 out of 100	75 out of 100	93 out of 100	99 out of 100

ATLANTA: T-MOBILE

Wow, Atlanta is fast. We saw the nation's highest average download speeds there, with T-Mobile and Verizon both busting the 90Mbps level. Every single one of our hundreds of T-Mobile tests came through over 5Mbps, which is truly extraordinary. Sprint is also very fast, with average downloads over 65Mbps—it's just that T-Mobile and Verizon were so thrillingly speedy that Sprint didn't have a chance.

One of our two fastest download tests in the country came in Atlanta—a blazing 343Mbps down on Verizon in the Old Fourth Ward neighborhood. The fastest overall test site of our 12 Atlanta locations, meanwhile, was right down at Centennial Olympic Park, where both Sprint and T-Mobile averaged well over 100Mbps. AT&T and Sprint have both made Atlanta one of their initial 5G launch cities, so you're going to see some spectacularly fast speeds and new networks there next year.

AUSTIN: VERIZON WIRELESS

Verizon's balanced network outweighed AT&T's somewhat faster download speeds and greater download consistency in Austin. Verizon scored very well on download speeds but also aced uploads and latency, making it the most versatile mobile network in our tests. All in all, though, speeds in Austin weren't great this year, and we had expected differently from a city where AT&T said it's installing its gigabit "5G evolution" technologies. Maybe next year.

BALTIMORE: VERIZON WIRELESS

Verizon charted spectacular average download speeds in a city that's always been tough for consistent coverage. We stopped at more than 20 locations around Baltimore trying to get a handle on things; the city's mix of hills and water has challenged wireless carriers for decades. Right now, Verizon and AT&T are handling that challenge best. Verizon scored best on all measures in Baltimore. AT&T had a relentlessly reliable network; if you use AT&T in Baltimore, it looks like you can really count on your connection.

BOSTON: T-MOBILE

Our speed score doesn't just measure downloads—we balance a range of factors to decide which carrier gives the best overall experience. In Boston, that's T-Mobile. Even though Verizon showed faster download speeds there, T-Mobile had faster upload speeds and lower latency, making for a better overall experience. That said, AT&T, T-Mobile, and Verizon all delivered rock-solid, well-balanced connections in our 11 tests across Boston, and all three carriers will serve you well.

CHARLOTTE: T-MOBILE

This one's an upset. AT&T has long had a dominant position in Charlotte, and this year AT&T has by far the fastest downloads in the city. But our algorithm takes other things into account, and T-Mobile's faster uploads, lower latency, and slightly more consistent fast uploads and downloads pushed it ahead of AT&T and Verizon.

Our “down above floor” and “up above floor” measures are critical here: They measure how frequently uploads and downloads are faster than an acceptable threshold. So what happened here? Both AT&T and T-Mobile got perfect scores for downloads over 5Mbps in our 12 fixed testing locations, but AT&T had just a tiny blip when we were on the road around town. When networks are this close, that can make the difference.

CHICAGO: VERIZON WIRELESS

Verizon absolutely crushed the competition in Chicago, and that wasn’t the only surprise we saw there. Earlier this spring, we checked out AT&T’s super-fast LAA installation in downtown Chicago. At the time, we charted speeds of over 500Mbps on the carrier’s network. But our drivers, whose routes are a little randomized, did not run into LAA connections, so their Chicago results looked low.

Sprint, on the other hand, did surprisingly well, notching second place on download speeds to Verizon. That’s impressive, and it’s part of a great leap forward for Sprint this year. We expect even better things from the carrier next year, as Chicago is one of its first 5G cities.

DALLAS: VERIZON WIRELESS

Verizon had the fastest upload and download speeds in our Dallas tests, outpacing traditional leader AT&T. AT&T’s network was somewhat more consistent, though—Verizon’s speeds wobbled up and down a bit. T-Mobile scored well because of excellent upload speeds. Dallas is going to be a major 5G battleground next year: AT&T, Sprint, and T-Mobile have all announced that it will be one of their first 5G cities—AT&T for hotspots and Sprint and T-Mobile for phones. Expect new service plans, new devices, and new opportunities by next May.

DENVER: T-MOBILE

We've seen several results this year where the carrier with the lowest average download speed wins the award for the fastest mobile network. That's because downloads are only 40 percent of our score; if a carrier flubs the rest of the equation, it can't win. That's what happened with AT&T in Denver. We can't explain why AT&T showed so much more latency than the other carriers, but it did so consistently over 14 test sites and five different servers. Those high latencies threw the win from AT&T to T-Mobile.

Still, though, all four carriers ended up quite close in Denver, having different strengths. AT&T and Sprint showed terrific download speeds, making them great for music and video streaming. Verizon had a balanced network. But T-Mobile came out in the lead, in large part thanks to those very low latencies (in its case, to four different servers).

DETROIT: VERIZON WIRELESS

Verizon didn't have the fastest download speeds in the Detroit area this year, but its balance of downloads, uploads, and low latency gave it the win. We kept seeing a big gap in latency between Verizon/T-Mobile and AT&T/Sprint in many of our cities. It's worth explaining what that means to average mobile users.

Latency is the amount of time it takes to get a request answered by another server on the internet. It becomes very relevant in browsing modern web pages, which may involve more than 100 requests for small files: While none of those little files really spin up a carrier's maximum download speeds, you can feel the difference in latency in terms of pages taking a few seconds longer. In the Detroit area, your web pages will feel sprightlier on Verizon than on any other carrier.

HOUSTON: T-MOBILE

T-Mobile's strong balance between uploads and downloads made it the winner in our Houston tests. While Sprint showed the fastest download speeds, its network is very strongly biased toward downloads, while T-Mobile's network is considerably more balanced and has lower latency. Sprint's downloads may get even faster next year, as Houston is scheduled to be one of the carrier's first 5G cities.

Houston is a gigantic sprawl with four rings around it. For our 15 tests, we focused inside the first two rings because they're the densest, with the highest concentration of business headquarters, universities, and other job centers. As it's a relatively flat, low-rise city, Houston was covered by all four networks pretty well. Each network had fast spots and slow spots in the area; T-Mobile just averaged out the best.

INDIANAPOLIS: VERIZON WIRELESS

Verizon showed by far the fastest download and upload speeds in our Indianapolis tests, making it the clear choice this year. Verizon has used Indy for tech demos before—there was a 5G demonstration at the Speedway last year—so we aren't surprised to see excellent performance.

As we saw in 2017, there's something odd about AT&T's network in Indianapolis. Our usual testing methodology forces phones to go outside their carrier's network for their speed test, making sure we're checking the carrier's connection to the rest of the internet rather than just the connection from the phones to the towers. Just as we saw last year, there's a huge difference between AT&T speeds to the local ISP our algorithm was selecting and to AT&T's own servers—the within-AT&T results were much higher.

That means that AT&T's network has really good bones—you won't get a lot of blocked calls or connections. But the carrier needs to level up its connections to the rest of the internet in Indianapolis for the best speeds.

KANSAS CITY: VERIZON WIRELESS

We don't have another city this year where all four carriers are as evenly matched in download speeds as they are in Kansas City. So what won it for Verizon? Latency. We saw dramatic differences in latency between the various carriers in Kansas City, and Verizon showed the shortest path to the three different servers that our test phone selected in the KC metro area. This was something we saw in some other cities, too; Verizon has a terrific set of interconnections, smoothing the path for its customers to get off its network and out to the internet.

Sprint is based in Kansas City, so it shouldn't be surprising that it's one of the carrier's first 5G cities. Kansas City will see high-speed 5G from Sprint in 2019, and hopefully it'll be in time for us to test it next year.

LAS VEGAS: T-MOBILE AND VERIZON WIRELESS (TIE)

T-Mobile has poured effort into Las Vegas recently, including sponsoring the arena for the shocking Stanley Cup contenders, the Las Vegas Golden Knights. Maybe its entertainment focus explains T-Mobile's upload-focused network in Las Vegas—the carrier really wants you Snapchatting, Instagramming, and uploading video of those hockey games. T-Mobile's upload speeds and low latency overcame the slowest average download speeds of the four major carriers to tie Verizon for the lead in our ratings. T-Mobile's position in Vegas will become even stronger next year, as it has announced Las Vegas as one of its initial cities for higher-speed mobile 5G in 2019. Verizon had the fastest average download speeds, making it the best network for video and audio streaming. AT&T, on the other hand, had the best reliability across our Las Vegas test sites.

LOS ANGELES: VERIZON WIRELESS

Verizon scored the best on all of our measures in the LA area, making it the clear choice in the nation's second-biggest city. AT&T came in second, thanks to powerful download speeds. Frankly, both Verizon's and AT&T's experiences are good enough that Angelenos should be satisfied with either. On the other hand, Sprint's extremely download-focused network had serious trouble in LA. While its download speeds were competitive, we saw very slow uploads in our tests, and the carrier's latency to the nearest Speedtest server was considerably higher than the competition. Los Angeles is going to be a major 5G battleground in 2019. Verizon will be selling 5G home internet service, and Sprint and T-Mobile both plan to launch networks for 5G phones in LA next year.

MIAMI: T-MOBILE

T-Mobile notched an unequivocal win this year in Miami, with the highest upload and download speeds and the lowest latency. Verizon was a close second. AT&T's and Sprint's results in Miami showed those carriers' strong preference for downloads over uploads, which penalizes them a bit in our rankings. Both AT&T and Sprint also had a bit more trouble maintaining consistently high speeds over the Miami area than Verizon and T-Mobile did.

NEW ORLEANS: VERIZON WIRELESS

Verizon simply smashed the competition on all our major measurements in New Orleans, with the fastest upload and download speeds and the lowest latency. AT&T makes a good second choice; with the highest peak download speeds we saw, its performance could have been a winner if Verizon wasn't just so spectacular here. Sprint's lopsided network really suffered in our scoring. At our 16 New Orleans locations, Sprint showed respectable 4G download speeds, but its uploads often looked like 3G. Sprint is going to argue that mobile users do a lot more downloading than they do uploading, which is certainly true—but come on, folks, at least make an effort for all the Snapchatters out there.

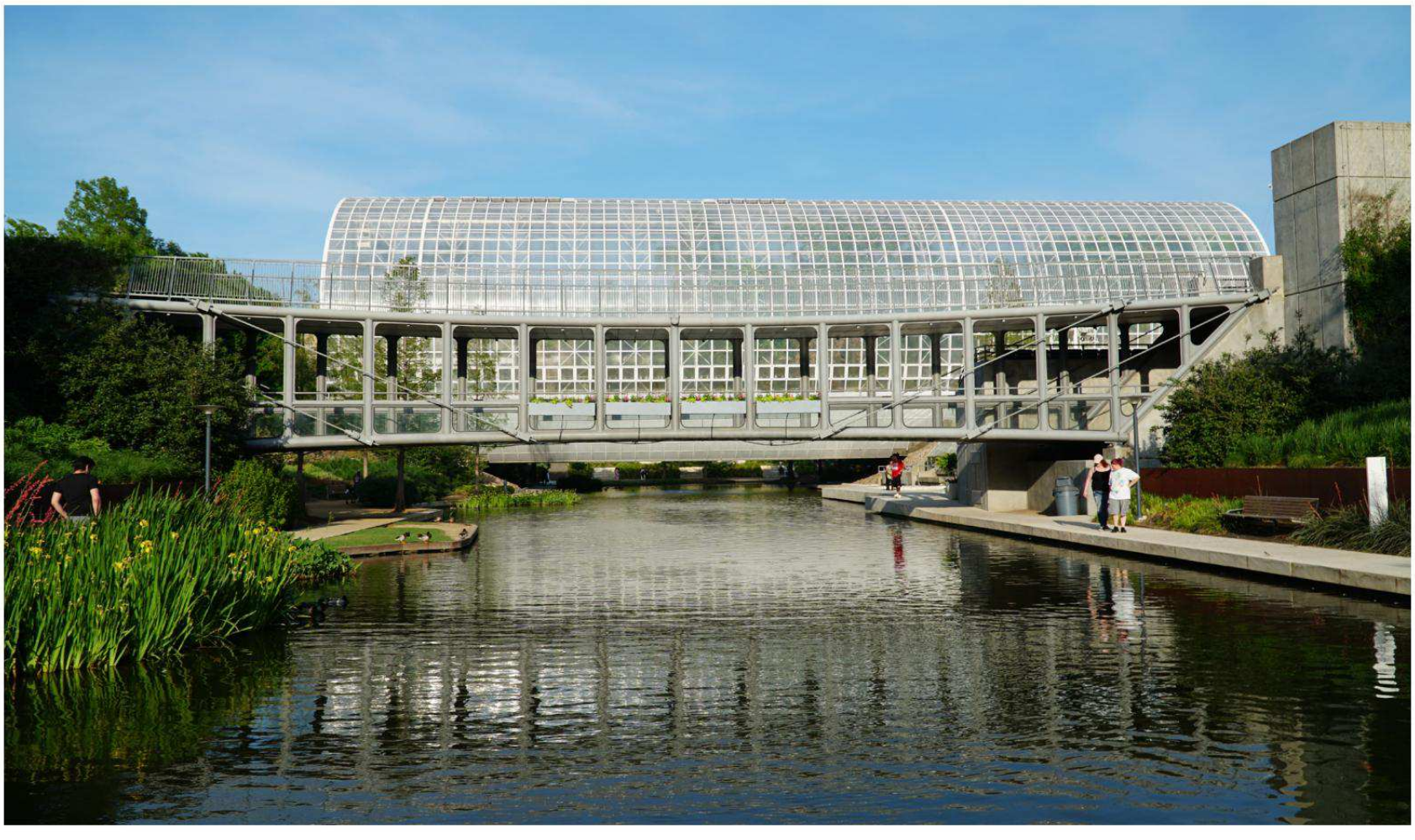
NEW YORK CITY: VERIZON WIRELESS

Verizon won in New York City clearly and unambiguously. This year, we tested in Manhattan and some of the densest parts of Brooklyn and Queens. With T-Mobile performing so well in New York in recent years, we were surprised at how much better Verizon did this year—that may just mean T-Mobile users are facing congestion from their network being so popular.

AT&T and Sprint have both made decisions in New York that give them very fast download speeds at the price of uploads. With uploads being 20 percent of our score, that penalized them. AT&T's Bands 29 and 66 are being used for downloads only, and Sprint has biased its Band 41 toward downloads. Still, though, those Sprint download speeds are impressive. A few years ago, could you have imagined Sprint would have faster downloads than T-Mobile in New York? I know I couldn't have. Our tests in New York will get even more exciting next year, as we anticipate both Sprint and T-Mobile will be running 5G networks in the city.

OKLAHOMA CITY: T-MOBILE

Oklahomans probably haven't considered T-Mobile for quite a while because of coverage issues. They should take a fresh look, using a Band 71–compatible phone. T-Mobile had the most consistent overall mobile broadband performance in Oklahoma City, but the real news for Oklahomans is that T-Mobile's new 600MHz network is dramatically improving coverage in the rest of the state. To get that coverage, though, you'll need a new phone that supports Band 71, such as the Samsung Galaxy S9, the LG G7, or the OnePlus 6. If you're not interested in a new, high-end smartphone, you can stick with AT&T. AT&T had even faster download speeds than T-Mobile, along with a history of consistent coverage across Oklahoma.



ORLANDO: VERIZON WIRELESS

This was our first year officially testing Orlando; over the past eight years, we've bounced around various Florida cities. Verizon did best in Orlando across all measures, with the fastest upload and download speeds and the lowest latency, making it the best choice in central Florida. T-Mobile also performed very well across Florida, and its results in Orlando would have been a win in many other cities—it's just that Verizon did so well here. Sprint, on the other hand, really underperformed. We've seen Sprint offer fast download speeds in several other cities this year, but it just didn't succeed in Orlando.

PHILADELPHIA: T-MOBILE

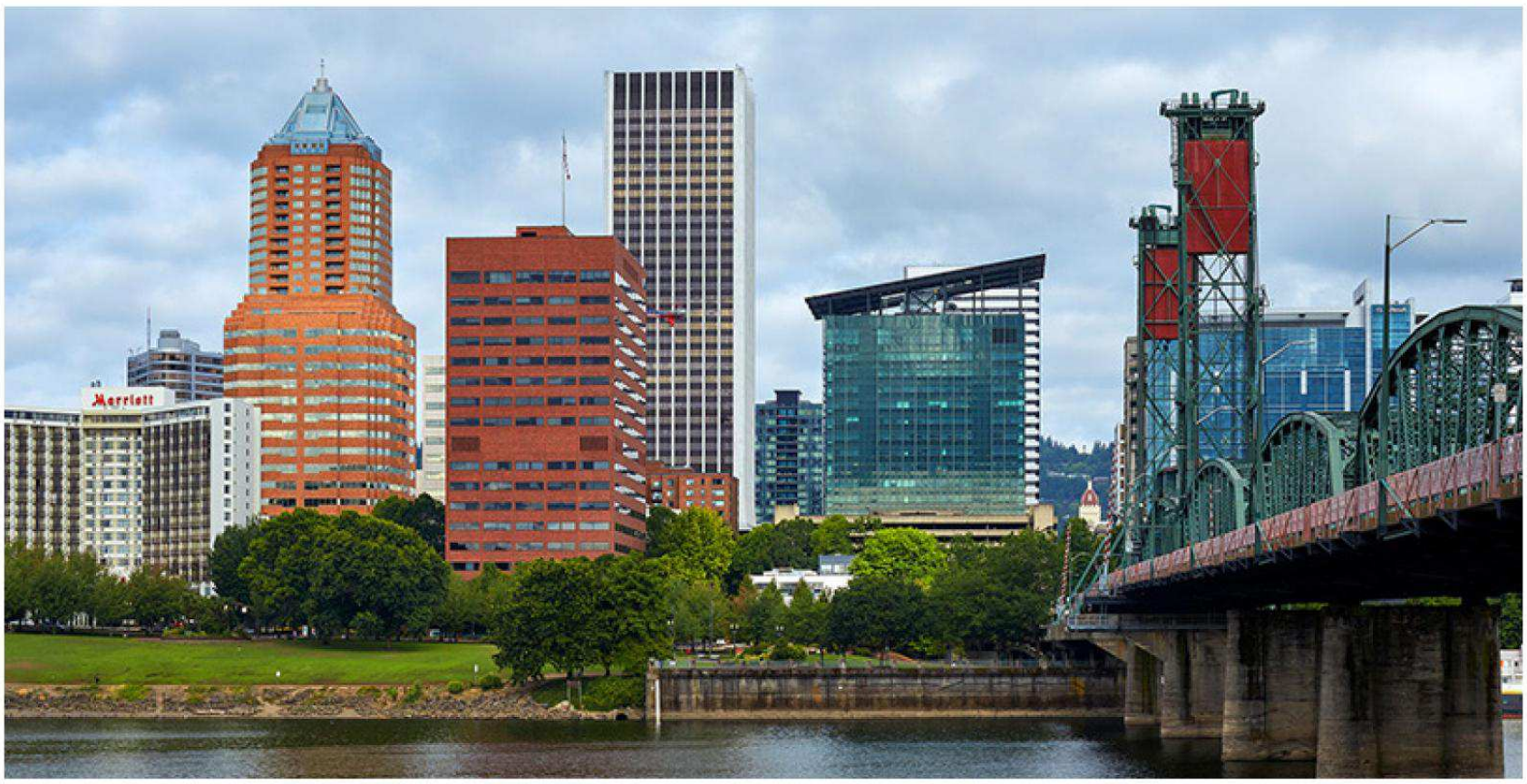
T-Mobile wins Philadelphia by offering the most holistic network. It isn't about download speeds; in fact, as the winning carrier, it had the slowest overall downloads. But T-Mobile crushed the competition on uploads and latency, both of which are critical elements in our Facebook/Instagram/Snapchat world. But Philadelphia is one of five cities where Sprint led on downloads, and it offered consistently high download speeds all over the city. Sprint may still be the fourth-place carrier nationwide, but in Philadelphia, it's absolutely competitive.

PHOENIX: VERIZON WIRELESS

Verizon won our Fastest Mobile Network crown in Phoenix in large part thanks to showing lower latency than the other networks in our testing. Latency tells you the amount of time it takes to get a message back to a remote server, and it's crucial to having a fast web experience. Web pages consist of many small files, so latency plays as large a role as download speeds on many websites. If you're focused on video and audio streaming, AT&T's download speeds were almost as good as Verizon's, so that network would be our second choice. Sprint may get a boost in Phoenix next year, as it's one of the initial cities that the carrier has announced for its 5G rollout. The equipment Sprint uses for 5G speeds up 4G networks, as well.

PORTLAND: T-MOBILE

T-Mobile won with the fastest average upload and download speeds across our 14 Portland test sites. Within Portland, T-Mobile's network was notable for not really having any slow spots—it was fast pretty much everywhere we went, in all four quadrants of Portland. Sprint won further north in Seattle, and in Portland, it also showed terrific download speeds and low latency. But its high download speeds couldn't overcome how dramatically download-biased its network is, with very slow upload speeds. That makes Sprint (and AT&T) better for content creation than for content consumption.

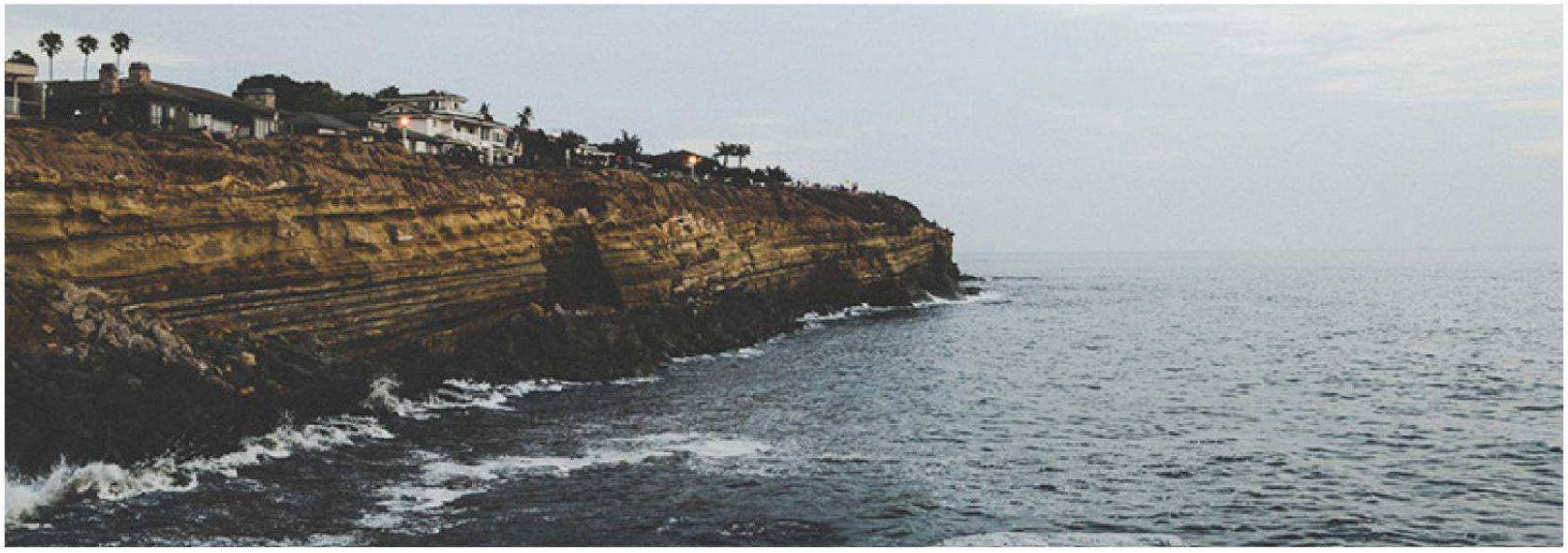


RALEIGH-DURHAM: AT&T

AT&T has historically done very well in the Carolinas in our tests, and it maintained its win in Raleigh-Durham this year thanks to dominant download speeds. It's safe to say that wherever you go in the Triangle, you'll be able to get a solid, speedy connection with AT&T. But Sprint and T-Mobile showed new strength in North Carolina that we want to note this year. First of all, look at Sprint's download speeds—while the network still isn't consistent, Sprint has really amped up speeds where it has coverage. And T-Mobile's North Carolina coverage problems are being helped by the new Band 71, which is replacing AT&T roaming throughout eastern North Carolina. If you're a T-Mobile user in central or eastern NC, get a Band 71-compatible phone before you consider switching carriers—you'll see a real improvement.

SALT LAKE CITY: VERIZON WIRELESS

Verizon unequivocally won our tests in the Salt Lake City area, with the fastest upload and download speeds and spectacularly low latency. We consider that to clearly outweigh the slightly lower reliability we saw on the Verizon network—the carrier had a little bit of trouble at four of our 15 test sites, especially on uploads. If you're looking for the most consistent fast downloads, turn to Sprint. Sprint had terrific download results in some of our western cities but was hampered by slow upload speeds.



SAN DIEGO: T-MOBILE

This year's Fastest Mobile Networks awards are a tale of two kinds of networks, and we see that struggle in our San Diego results. While AT&T had the fastest downloads, our ratings aren't based only on downloads, and T-Mobile had the most consistency, the lowest latency, and the fastest upload speeds. We stopped at 16 locations in the San Diego area. Looking at the difference from last year's results, T-Mobile appears to have overcome the congestion problem that it faced back then, letting it outpace AT&T in our overall score.

SAN FRANCISCO: VERIZON WIRELESS

Verizon wrested San Francisco back from AT&T this year with the fastest peak speeds we saw anywhere in the country. We got a consistent connection over 300Mbps at a test site in Hayes Valley and another 300Mbps+ connection nearby in the Fillmore. Our scores try to smooth out these outliers, but the fact is that Verizon delivered the fastest uploads and downloads nearly everywhere we went across the Bay Area. We spread out our test sites a little more creatively than usual this year, hitting some secluded, more rural spots, including Half Moon Bay, as well as making sure to get a few tests in Silicon Valley and the East Bay. Verizon will keep you connected wherever you go in this area.

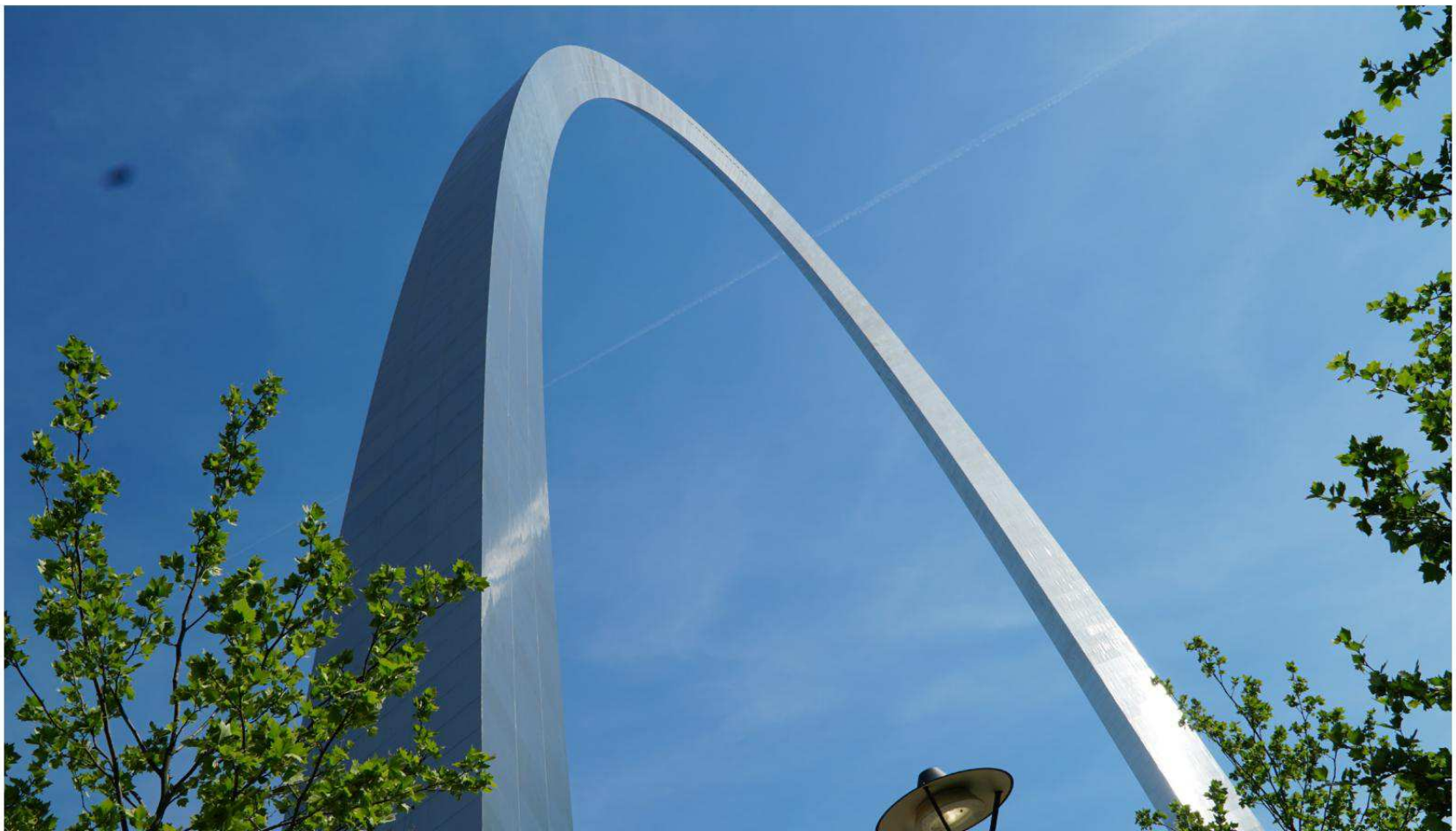
SEATTLE: SPRINT

Take that, T-Mobile! Sprint won outright in Seattle, T-Mobile's hometown, by putting the pedal to the metal on download speeds. Sprint's download speeds were so much faster than the competition that the difference outweighed Sprint's relatively slow uploads to make it the best all-around choice in Seattle. Sprint has poured energy into improving its network in Seattle recently, and it shows.

So what's up with that very low Verizon reliability number? Taking a closer look at our results, it looks like Verizon just had a really bad day. Near South King Street and 5th Ave South, the network kept blinking in and out. Ditto at Pike Place and in Fremont. These are dense, highly populated areas, and there's no excuse for the dropouts we saw on Verizon in those locations.

ST. LOUIS: VERIZON WIRELESS

Verizon was the clear winner in St. Louis, with the best-balanced network, most consistent fast downloads, and lowest latency. But it wasn't the biggest news: The surprise in St. Louis was how well Sprint performed. Sprint notched the highest average download speeds across our 13 St. Louis test sites, and notably, it didn't show a deep dip at any location—it was fast all over town. Sprint couldn't win, though, because its network is so biased toward downloads rather than uploads. If you're streaming music or video rather than posting it, you'll have a great experience on Sprint, but Verizon is the best network for the widest variety of uses.



TUCSON: VERIZON WIRELESS

Verizon won our Tucson testing with the fastest upload and download speeds of any of the four major carriers. T-Mobile was highly competitive, though, and both carriers showed very fast speeds. We hit 15 locations in Tucson, from the airport up to the foothills. The best overall coverage and speeds across the four carriers happened on the University of Arizona campus, where all the carriers have small-cell installations to handle the dense population. Coverage got a little shaky on East Broadway by Iron Horse Park downtown.

WASHINGTON, DC: VERIZON WIRELESS

Verizon showed excellent download speeds in Washington, DC, and suburban Virginia, making it our choice for the national capital area. In DC, you see two different network philosophies going on, which result in starkly different performance. Verizon and T-Mobile are both going for balanced networks with low latency. That's harder to achieve than a download-biased network, and T-Mobile, in this case, doesn't quite make it.

AT&T and Sprint are both prioritizing downloads at the cost of upload speeds and latency. That makes them great networks for streaming music and video. Sprint's performance will further improve over the next year, as it has announced Washington, DC will be one of its first cities for 5G. Sprint's 5G equipment boosts 4G speeds as well.

RURAL/SUBURBAN RESULTS

Northeast: T-Mobile
Southeast: AT&T and T-Mobile (tie)
North Central: T-Mobile
South Central: AT&T
Northwest: Verizon Wireless
Southwest: Verizon Wireless

Outside the major cities, the nation's 4G networks look very different. But you may be surprised by some of the results. Our "northeast" drive mostly took in the congested I-95 corridor, so it was primarily suburban, not rural. T-Mobile does just fine in those northeastern suburbs, the places around cities including New York, Philadelphia, and Baltimore. A few years ago, the carrier had serious coverage problems north of New York, but it has significantly improved recently. If you still don't trust T-Mobile's coverage, though, AT&T and Verizon are neck and neck with it in our ratings.

A few years ago, the carrier had serious coverage problems north of New York, but it has significantly improved.

Our "southeast" drive went from Raleigh through the Triad to Charlotte, crossed South Carolina to Atlanta, then cut straight down the middle of Florida. AT&T, T-Mobile, and Verizon all did admirably. If we biased our ratings a little more toward downloads, AT&T would have been a clear winner; T-Mobile ended up tying because of the lower latency we found on its network.

Our "north central" drive went from Indianapolis up through Chicago, diagonally down through Illinois, across Missouri, and down through Kansas, with stops in central Missouri and in Wichita. The big news here is a major expansion of T-Mobile's network, which has finally made it competitive with AT&T and Verizon in the smaller towns and cities in Missouri and Kansas. Here's the thing, though—that expansion is largely on

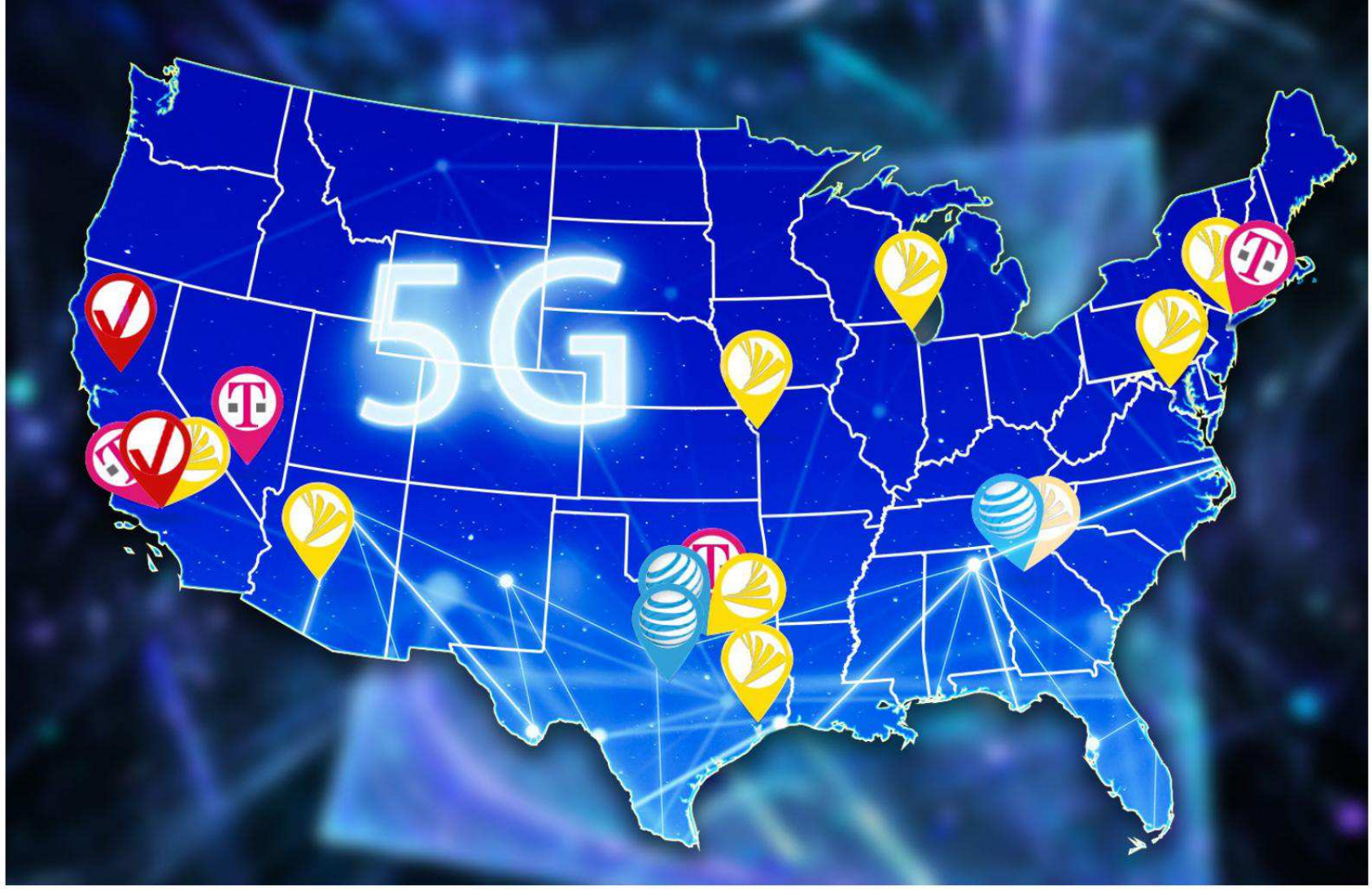
Band 71, and there are relatively few Band 71 phones, so that network is fast right now because it's unloaded. Hitting that lightly loaded network gives T-Mobile a win for the region this time. If you live in this area, just know that there's real competition out there now.

Our "south central" area included a drive down the middle of Oklahoma, the Texas Triangle, and the drive from Houston to New Orleans. AT&T has had a strong presence in Texas and Oklahoma since it was SBC, and it still provides strong, reliable connectivity across the hills and flatlands of the state.

Our "south central" area included a drive through Oklahoma, the Texas Triangle, and the drive from Houston to New Orleans.

Our "northwest" drive included the Oregon coast, the redwoods in northern California, I-15 in Utah, a good chunk of I-80 in Wyoming, and parts of northern Colorado. There were parts of that drive where all of our phones dropped out completel, especially on the rural Oregon coast. We'd suggest that you have a satellite safety locator if you intend to go camping or traveling in adverse weather. While we saw the first T-Mobile LTE in Wyoming that we've ever seen—Band 71 to the rescue!—Sprint and T-Mobile both have a lot of work to do to cover those rugged rural areas. If you have to rely on a wireless carrier in that part of the country, Verizon is the carrier you want to rely on.

Our "southwest" result includes the suburban areas between LA and San Diego and between Tucson and Phoenix; the long, dusty drive from San Diego to Tucson; and stops in Flagstaff and northern Arizona. T-Mobile and Sprint coverage in northern and western Arizona is still not great, and we got reliability numbers much lower than we'd prefer for those carriers. Verizon is really the carrier you need to rely on out in the desert.



4G AND 5G: WHAT'S NEXT?

This year's Fastest Mobile Networks results aren't stunningly different from last year's. All four major US wireless carriers now have 4G LTE networks that cover the heavily populated parts of the country, although they're still working on rural areas. Between now and our launch of Fastest Mobile Networks 2019 next June, though, we expect to see some major changes in networks that you should be aware of.

In the 4G realm, LAA (Licensed Assisted Access) is going to boost speeds in dense city centers and other hot spots such as sports stadiums and university campuses over the next year. We tested AT&T's LAA in downtown Chicago and T-Mobile's LAA in midtown New York City and got speeds up to 500Mbps using the short-range technology, which typically stretches only two to four blocks from one of its towers. Verizon is also installing LAA but won't say where. Beyond spectacular speeds, LAA should also help eliminate slow spots and dead zones in urban canyons.

All four major carriers will be expanding their use of carrier aggregation over the next year, which combines up to four different bands of spectrum for greater speeds. While they've all said they're doing three-carrier aggregation, four-carrier aggregation is spreading, speeding things up even further.

We should also expect to see a major expansion in T-Mobile's rural network over the next year. We've already started to see T-Mobile's 600MHz, Band 71 coverage pop up in states such as Kansas, Oklahoma, Missouri, and Oregon. The new network is built on old UHF TV spectrum; as more TV stations move out of the spectrum over the next year, T-Mobile will expand its rural coverage. Spectrum Gateway has a good feature on who's clearing the spectrum when.

HOW ABOUT 5G?

The first mobile 5G networks are scheduled to appear in late 2018. AT&T will come first, with a hotspot-based service in Atlanta, Dallas, and Waco, Texas, as well as nine other cities that haven't been announced yet. AT&T's 5G is likely to initially be a very high-speed, limited-coverage service that essentially brings an unlimited, cable-like internet to PCs on the move.

Sprint and T-Mobile will follow with mobile 5G in early 2019. Both companies have said they intend to wait for the first 5G phones, which are likely to appear at Mobile World Congress in late February and be launched in March or April. T-Mobile's 5G network will initially be based primarily on its wide-ranging 600MHz spectrum. Exec Karri Kuoppamaki said to expect that network to be about 25 to 50 percent faster than 4G, initially. Using the low-frequency spectrum will allow T-Mobile to blanket wide areas with coverage quickly. The company has said that Dallas, Las Vegas, Los Angeles, and New York will be among its first few 5G cities.

Sprint's network will be based on its 2.6GHz spectrum, and has targeted Atlanta, Chicago, Dallas, Houston, Kansas City, Los Angeles, New York, Phoenix, and Washington, DC for its first cities.

For at least their first several years, 4G and 5G will be inseparable. The first 5G networks are "non-standalone" networks, which means devices will rest on 4G networks and jump up to 5G only when the 5G network tells the 4G network that it's available. And as those who experienced the 3G-to-4G transition remember, the first year of a new network technology usually means devices with kinks that need time to be worked out. We'll test both 4G and 5G when we go on the road next year.

People shopping for phones in 2018 and beyond should focus on ones that have the latest 4G standards and not worry about the upcoming 5G launches. For the best coverage on any network, look for at least a Qualcomm X16 modem. If you're on AT&T, T-Mobile, or Verizon and you spend a lot of time in a dense downtown area, check whether your phone has LAA. If you're on T-Mobile, Band 71 will help with coverage across the country.

TESTING METHODOLOGY

For year eight of our Fastest Mobile Networks testing, we used custom field-test software designed by Ookla, the creator of Speedtest.net. (Note: Ookla is owned by Ziff Davis, PCMag.com's parent company.) The software was loaded onto sets of four Samsung Galaxy S9 phones, chosen because they can access the latest network upgrades on all the major wireless carriers. Three sets of phones were driven around the country in rental cars—one down the East Coast, one down the center of the country, and one down the West Coast.

The software runs tests every 90 seconds. We measured uploads and downloads to a neutral, non-carrier server, as well as pings to the nearest server in Ookla's network. Over the course of driving, we tested downloads from 196 different servers and pings to 434 different servers, executing about 88,000 test runs.

We stopped at between 12 and 20 locations, for at least 15 minutes each, in our 30 cities. We averaged the data in each location, then averaged the locations together for an overall city result. The aggregated data from traveling between the test locations counted into the overall averages as two more locations. As we're testing LTE networks, we didn't average in speeds on non-LTE networks. When a phone dropped off an LTE network, it was treated as though the test failed.

Along with our 30 cities, we report suburban/rural areas, which are summaries of the drives between the metro areas. Our six regional scores are averages of the five cities in each region, plus the suburban/rural score. Our national score is an average of the 30 cities and six suburban/rural regions.

We tested mostly during business hours, from May 1 through May 23, 2018. We visited different cities on different days.

The PCMag Speed Score is a weighted average that looks at six components of the mobile data experience.

THE PCMAG SPEED SCORE

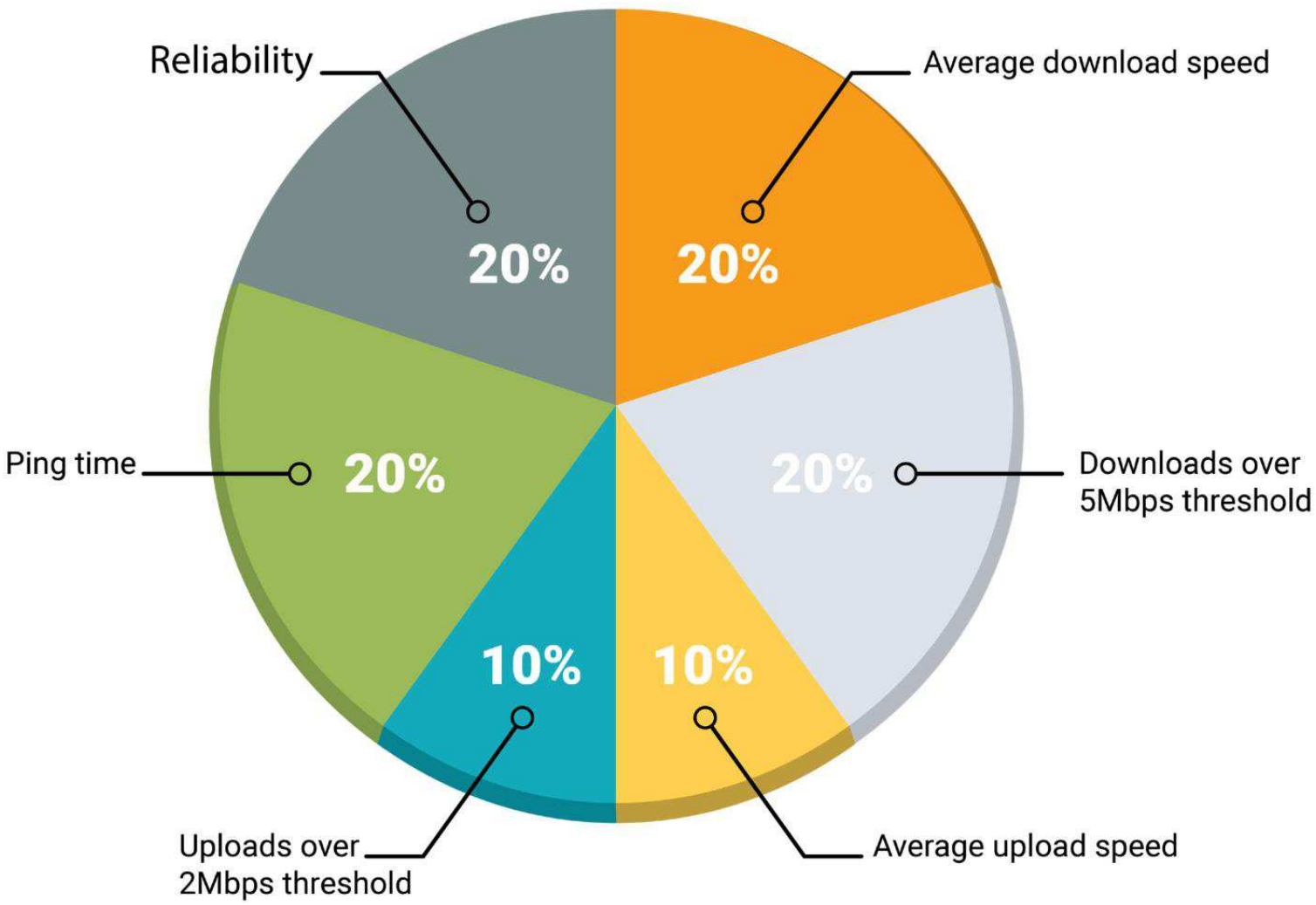
The PCMag Speed Score is a weighted average that looks at six components of the mobile data experience.

We're using the same speed score methodology as we have the past two years, for consistency. It takes into account downloads, uploads, latency, reliability, and consistency.

Since most mobile internet usage consists of web page downloads and small-screen video streaming, it's just as important to have a consistent experience as a fast one. Smartphone users may not be able to see the difference between 20Mbps and 100Mbps, but they can definitely feel the difference between 2Mbps and 5Mbps. So we created a "threshold score" showing the percentage of downloads over 5Mbps, and the percentage of uploads over 2Mbps.

To create our reliability score, we counted the number of tests and divided by the number of non-zero LTE uploads and downloads. Stalled tests, or areas without LTE coverage, received reduced scores.

Here's how it all comes together:



CROWDSOURCING VS. DRIVE TESTING

There are a lot of "fastest" awards out there. They're all correct, according to their own testing and methodology, and they all have something interesting to say.

In testing, the main division is between crowdsourcing and drive testing. Crowdsourcing, which is done by Nielsen, Ookla Speedtest, and OpenSignal, relies on users to run speed tests on their own devices. With a big enough crowd, you can get a good picture of a network.

Crowdsourcing is always happening, so it's up to the minute. And it uses a great range of devices, so you can tell the difference between them. We use Ookla's crowdsourced data in our analysis showing how the Galaxy S9 is faster than earlier phones, for instance.

But crowdsourced apps often can't tell whether a test is indoors or outdoors, which makes for very different results. They may not do a good job of finding dead zones if their users don't run tests in places that obviously have no signal. They may have bigger crowds with some carriers, or in some cities. And they leave open the possibility that people using one carrier might be using better phones, in better weather, on a less congested day, than people on another carrier.

Drive testing is what we do, along with Root Metrics and P3. This kind of testing lets us compare carriers using the same device, in the same place, at the same time. This way, we can eliminate variables and map out coverage on our route. It lets us make sure we have as much data as we want in each city, so we feel confident in our results.

Drive testing lets us compare carriers using the same device, in the same place, at the same time.

But drive testing takes enough work that it isn't happening continuously in every city. It won't show you the performance of phones you don't drive with. And it can cover only the routes you drive along.

Methodology-wise, we balance six different elements for our speed score. Other studies may focus on downloads, or use a different measurement of latency, or (in Nielsen's case) attempt to measure the speeds coming into various mobile apps. We think our balance makes the most sense, but we also respect the different decisions others have made.

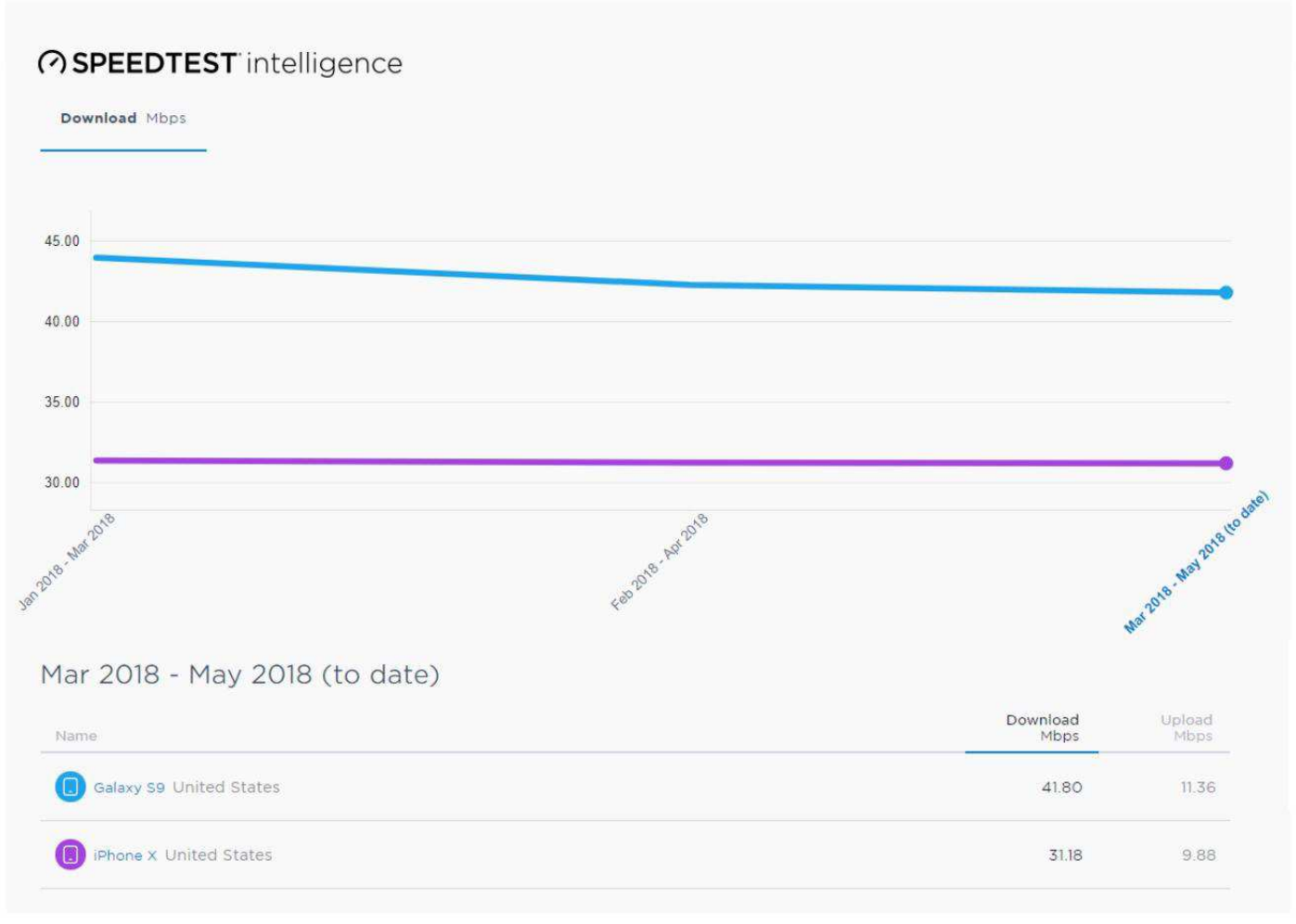
WHY YOU NEED A FASTER PHONE

If you're struggling to stay connected, switching carriers might not be the right solution for you. You might just need a new phone. All four of the major carriers have been adding new frequency bands and technologies nearly every year, but you can access them only when you have the right device.

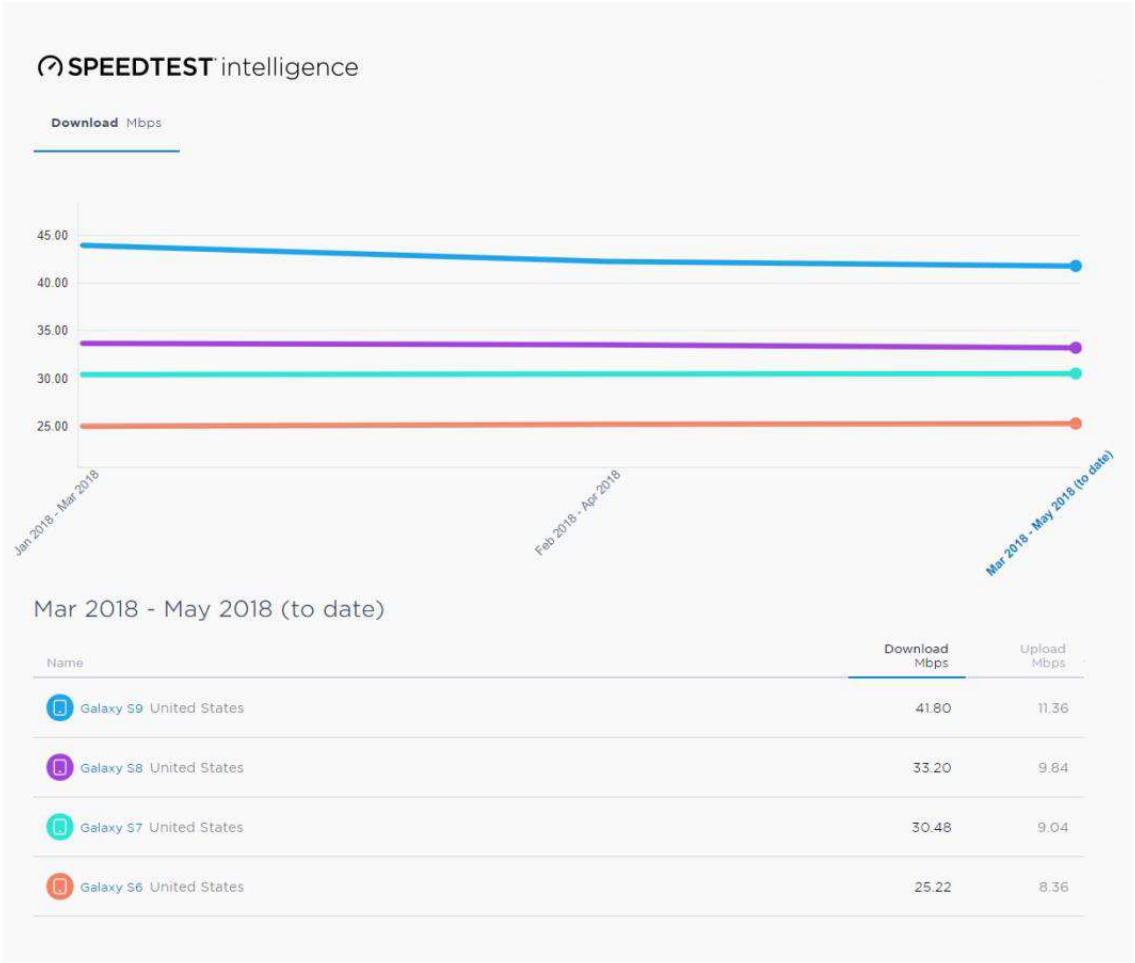
A new phone can improve both speed and coverage—especially on T-Mobile. T-Mobile just added a new rural band, Band 71, which we've seen popping up across a lot of the country. But only some very recent phones, including the Samsung Galaxy S9 and the LG G7—but not any iPhones—support Band 71.

To show you what a difference a new device makes for speed, we dipped into the Speedtest Intelligence database of thousands of crowdsourced speed tests on different devices. The Samsung Galaxy S9 has gigabit LTE with 4x4 MIMO, which improves both speed and range. The iPhone X lacks 4x4 MIMO. See how that shakes out in the graphic below.

Within product lines, we're seeing each year's phone chart faster speeds as new models take on new technologies. The iPhone X doesn't have 4x4 MIMO, but it has 256QAM, which lets it pack more information into one burst of data than the iPhone 7 did. The iPhone 7 is able to aggregate, or combine, more bands of spectrum than the iPhone 6s did. All of these advances translate into faster real-life speeds and better real-life coverage, as you can see below.

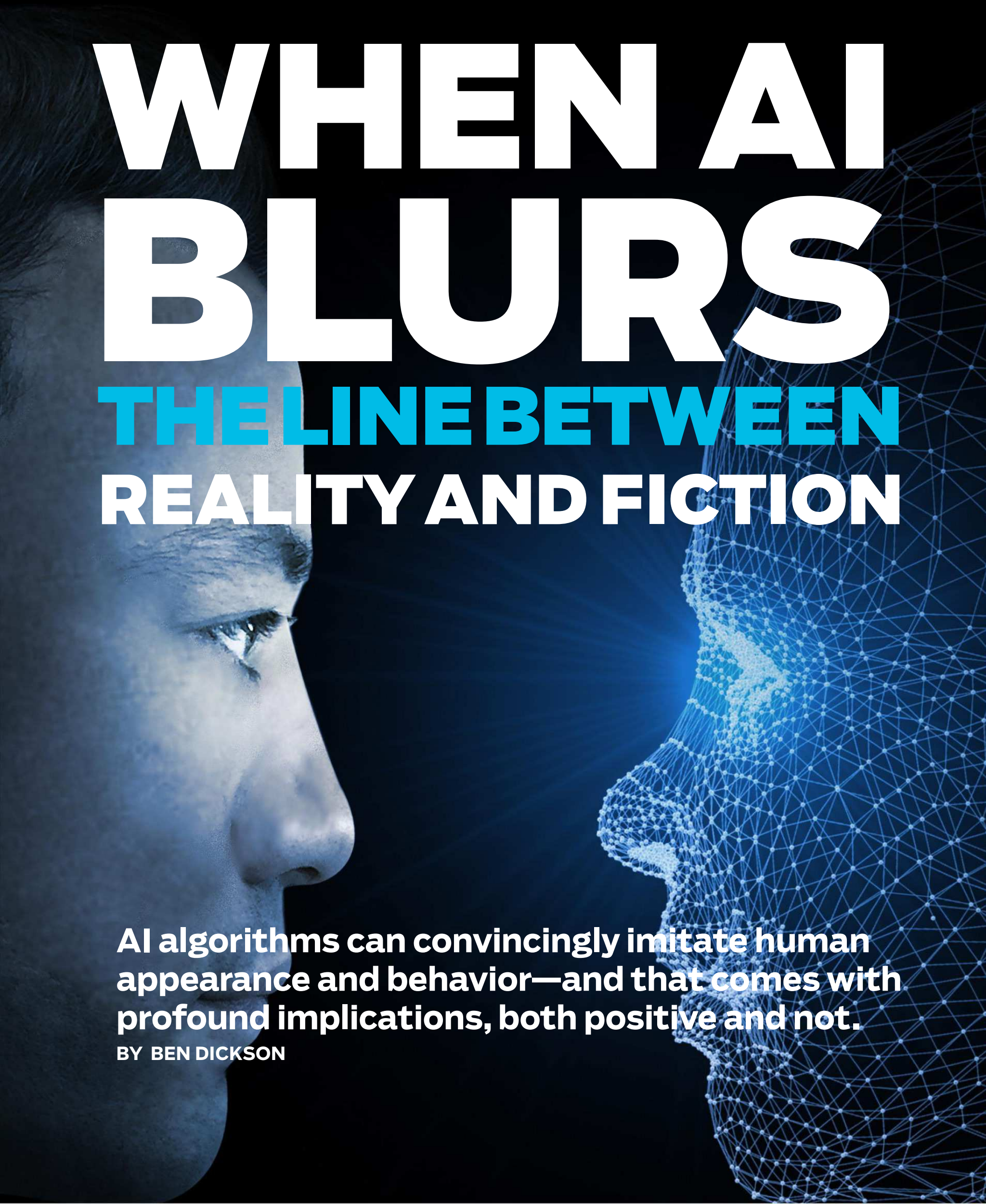


The same goes for Samsung Galaxy phones (and for other brands, too). If you're on Sprint, you need a Samsung Galaxy S8 or later to get High Performance User Equipment (HPUE), which extends range. 4x4 MIMO also came with the S8, for both improved speed and range. On all the carriers, the Samsung Galaxy S9 brings LAA, which greatly boosts speeds in downtown hot spots and brings improved 4x4 MIMO capabilities. If you've considered your Galaxy S7 good enough, the chart below might convince you otherwise.



FEATURES

WHEN AI BLURS THE LINE BETWEEN REALITY AND FICTION



AI algorithms can convincingly imitate human appearance and behavior—and that comes with profound implications, both positive and not.

BY BEN DICKSON

Somewhere in the dark recesses of YouTube is a video that shows an excerpt from the movie *The Fellowship of the Ring*—but it's not quite the movie you remember, since Nicolas Cage stars as Frodo, Aragorn, Legolas, Gimli, and Gollum, all at the same time. Other videos show Cage in *Terminator 2* as T2000, *Star Trek* as Captain Picard, and *Superman* as, well, Lois Lane.

Of course, Cage never played in any of those movies. They're "deepfakes" produced with FakeApp, an application that uses artificial intelligence algorithms to swap faces in videos. Some of the deepfakes look quite convincing, while others have artifacts that betray their true nature. But overall, they show how powerful AI algorithms have become in imitating human appearance and behavior.

FakeApp is just one of several new AI-powered synthesizing tools. Other applications mimic human voices, handwriting, and conversation styles. And part of what makes them significant is that using them doesn't require specialized hardware or skilled experts.

The impact of these applications is profound: They will create unprecedented opportunities for creativity, productivity, and communications. But the same tools can also open a Pandora's box of fraud, forgery, and propaganda. Since it made an appearance on Reddit in January, FakeApp has been downloaded more than 100,000 times and has precipitated a storm of fake pornographic videos featuring celebrities and politicians. Reddit recently banned the application and its related communities from its platform.

“Ten years ago, if you wanted to fake something, you could, but you had to go to a VFX studio or people who could do computer graphics and possibly spend millions of dollars,” says Dr. Tom Haines, lecturer in machine learning at University of Bath. “You couldn’t keep it a secret, because you’d have to involve many people in the process.”

That’s no longer the case, courtesy of a new generation of AI tools.

THE IMITATION GAME

FakeApp and similar applications are powered by deep learning, the branch of AI at the heart of an explosion of AI innovations since 2012. Deep-learning algorithms rely on neural networks, a software construction roughly fashioned after the human brain. Neural networks analyze and compare large sets of data samples to find patterns and correlations that humans would normally miss. This process is called training, and its outcome is a model that can perform various tasks.

In earlier days, deep-learning models were used mostly to perform classification tasks—labeling objects in photos, for example, and performing voice and face recognition. Recently, scientists have used deep learning to perform more complicated tasks, such as playing board games, diagnosing patients, and creating music and works of art.

To tune FakeApp to perform a face swap, the user must train it with several hundred pictures of the source and target faces. The program runs deep-learning algorithms to find patterns and similarities between the two faces. The model then becomes ready to make the swap.

The process isn’t simple, but you don’t have to be a graphics expert or machine-learning engineer to use FakeApp. Neither does it require expensive, specialized hardware. A deepfakes tutorial website recommends a computer with 8GB or more of RAM and an Nvidia GTX 1060 or better graphics card—a pretty modest configuration.

“Once you move to a world where someone in a room can fake something, then they can use it for questionable purposes,” Haines says. “And because it’s one person on their own, keeping it secret is very easy.”

In 2016, Haines, who was then a postdoctoral researcher at University of College London, coauthored a paper and an application that showed how AI could learn to imitate a person's handwriting. Called "My Text in Your Handwriting," the application used deep learning algorithms to analyze and discern the style and flow of the author's handwriting and other factors such as spacing and irregularities.

The application used deep learning algorithms to analyze and discern the style and flow of the author's handwriting.

The application could then take any text and reproduce it with the target author's handwriting. The developers even added a measure of randomness to avoid the uncanny valley effect—that unsettling feeling that we get when we see something that is almost but not quite human. As a proof of concept, Haines and the other UCL researchers used the technology to replicate the handwriting of historical figures such as Abraham Lincoln, Frida Kahlo, and Arthur Conan Doyle.

The same technique can be applied to any other handwriting, which has raised concerns about the technology's possible use for forgery and fraud. A forensics expert would still be able to detect that the script was produced by My Text in Your Handwriting, but it's likely able to fool untrained people, which Haines admitted in an interview with Digital Trends at the time.

Lyrebird, a Montreal-based startup, used deep learning to develop an application that synthesizes human voice. Lyrebird requires a one-minute recording to start imitating the voice of a person, though it needs much more before it starts to sound convincing. In its public demo, the startup posted fake recordings of the voices of Donald Trump, Barack Obama, and Hillary Clinton. The samples are crude, and it's obvious that they're synthetic. But as the technology improves, making that distinction will become harder. And anyone can register with Lyrebird and start creating fake recordings; the process is even easier than FakeApp's, and the computations are performed in the cloud, putting less strain on the user's hardware.

In its public demo, the startup posted fake recordings of the voices of Donald Trump, Barack Obama, and Hillary Clinton.

The fact that this technology can be used for questionable purposes is not lost on the developers. At one point, an ethics statement on the Lyrebird's website stated: "Voice recordings are currently considered as strong pieces of evidence in our societies and in particular in jurisdictions of many countries. Our technology questions the validity of such evidence as it allows [people] to easily manipulate audio recordings. This could potentially have dangerous consequences such as misleading diplomats, fraud, and more generally any other problem caused by stealing the identity of someone else."

Nvidia presented another aspect of AI's imitation capabilities. Last year, the company published a video that showed AI algorithms generating photo-quality synthetic human faces. Nvidia's AI analyzed thousands of celebrity photos and then started creating fake celebrities. And the technology may soon become capable of creating realistic-looking videos featuring unreal people.

THE LIMITS OF AI

Many have pointed out that in the wrong hands, these applications could do a lot of harm. But the extent of the capabilities of contemporary AI is often overhyped.

"Even though we can put a person's face on someone else's face in a video or synthesize voice, it's still pretty mechanical," says Eugenia Kuyda, a cofounder of Replika, a company that develops AI-powered chatbots, about the shortcomings of AI tools such as FakeApp and Lyrebird.

Voicery, another AI startup that, like Lyrebird, provides AI-powered voice synthesizing, has a quiz page where users are presented with a series of 18 voice recordings and are prompted to specify which are machine-made. I was able to identify all the machine-made samples on the first run.

Kuyda's company is one of several organizations that use natural language processing (NLP), a subset of AI that enables computers to understand and interpret human language. Luka, an earlier version of Kuyda's chatbot, used NLP and its twin technology, natural language generation (NLG), to imitate the cast of HBO's TV series *Silicon Valley*. The neural network was trained with script lines, tweets, and other data available on the characters to create their behavioral model and dialog with users.

Replika, Kuyda's new app, lets each user create their own AI avatar. The more you chat with your Replika, the better it becomes at understanding your personality, and the more meaningful your conversations become. After installing the app and setting up my Replika, I found the first few conversations to be annoying. Several times, I had to repeat a sentence in different ways to convey my intentions to my Replika. I often left the app in frustration. (And to be fair, I did a good job at testing its limits by bombarding it with conceptual and abstract questions.) But as our conversations continued, my Replika became smarter at understanding the meaning of my sentences and coming up with meaningful topics. It even surprised me a couple of times by making connections to past conversations.

Though it's impressive, Replika has limits, which Kuyda is quick to point out. "Voice imitation and image recognition will probably become much better soon, but with dialog and conversation, we're still pretty far [off]," she says. "We can imitate some speech patterns, but we can't just take a person and imitate his conversation perfectly and expect his chatbot to come up with new ideas just the way that person would."

Alexandre de Brébisson, the CEO and a cofounder of Lyrebird, says, "If we are now getting pretty good at imitating human voice, image and video, we are still far away from modeling an individual language model." That, de Brébisson points out, would probably require *artificial general intelligence,* the type of AI that has consciousness and can understand abstract concepts and make decisions as humans do. Some experts believe we're decades away from creating general AI. Others think we'll never get there.

POSITIVE USES

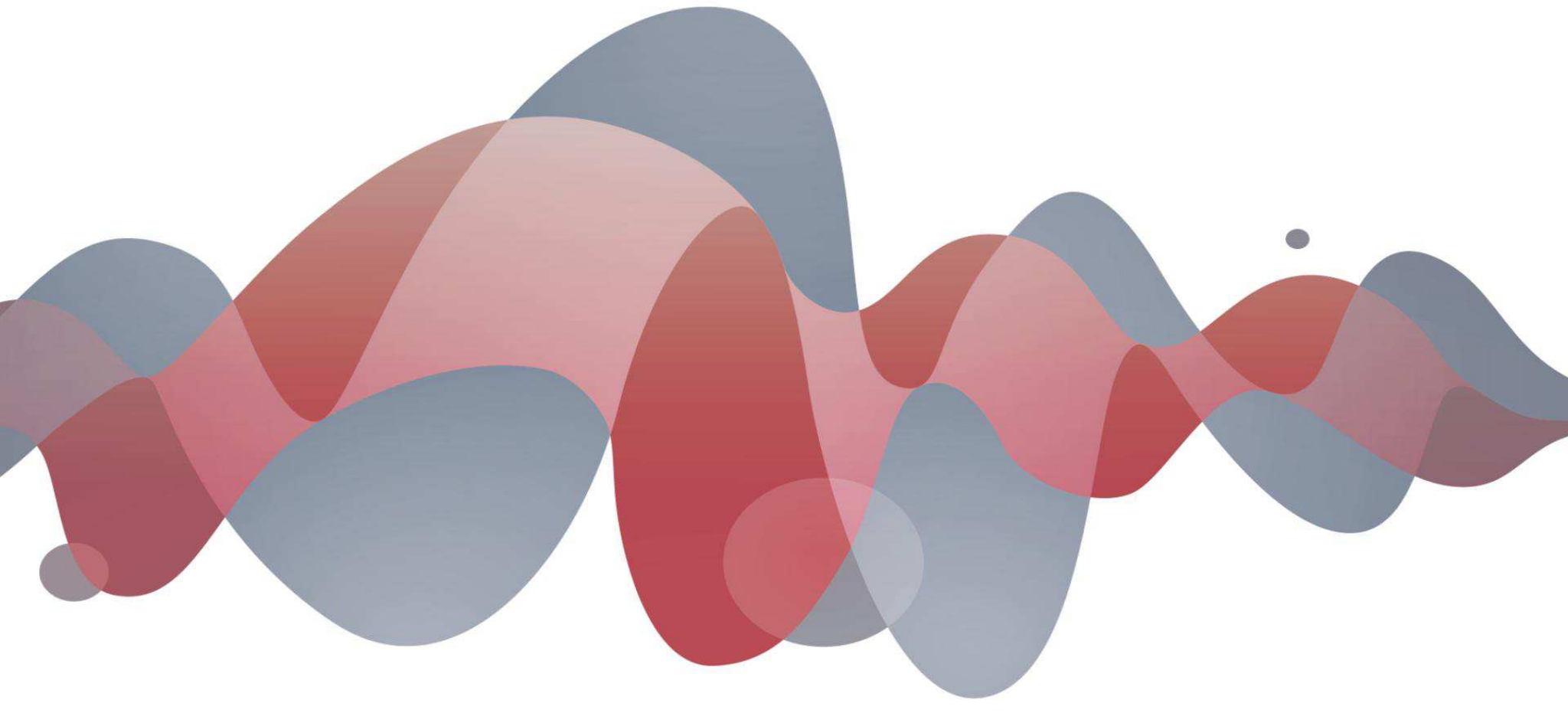
The negative image that is being projected about synthesizing AI apps is casting a shadow over their positive uses. And there are quite a few.

Technologies such as Lyrebird's can help improve communications with computer interfaces by making them more natural and, de Brébisson says, they'll provide unique artificial voices that differentiate companies and products and thus make branding distinction easier. As Amazon's Alexa and Apple's Siri have made voice an increasingly popular interface for devices and services, companies such as Lyrebird and Voicery could provide brands with unique human-like voices to distinguish themselves.

“Medical applications are also an exciting use case of our voice-cloning technology,” de Brébisson adds. “We have received a lot of interest from patients losing their voice to a disease, and at the moment, we are spending time with ALS patients to see how we can help them.”

Earlier this year, in collaboration with Project Revoice, an Australian non-profit that helps ALS patients with speaking disorders, Lyrebird helped Pat Quinn, the founder of the Ice Bucket Challenge, to regain his voice. Quinn, who is an ALS patient, had lost his ability to walk and speak in 2014 and had since been using a computerized speech synthesizer. With the help of Lyrebird’s technology and the voice recordings of Quinn’s public appearances, Revoice was able to “recreate” his voice.

“Your voice is a big part of your identity, and giving those patients an artificial voice that sounds like their original voice is a bit like giving them back an important part of their identity. It’s life-changing for them,” de Brébisson says. At the time he helped develop the handwriting imitating application, Dr. Haines spoke to its positive uses in an interview with UCL. “Stroke victims, for example, may be able to formulate letters without the concern of illegibility, or someone sending flowers as a gift could include a handwritten note without even going into the florist,” he said. “It could also be used in comic books where a piece of handwritten text can be translated into different languages without losing the author’s original style.”

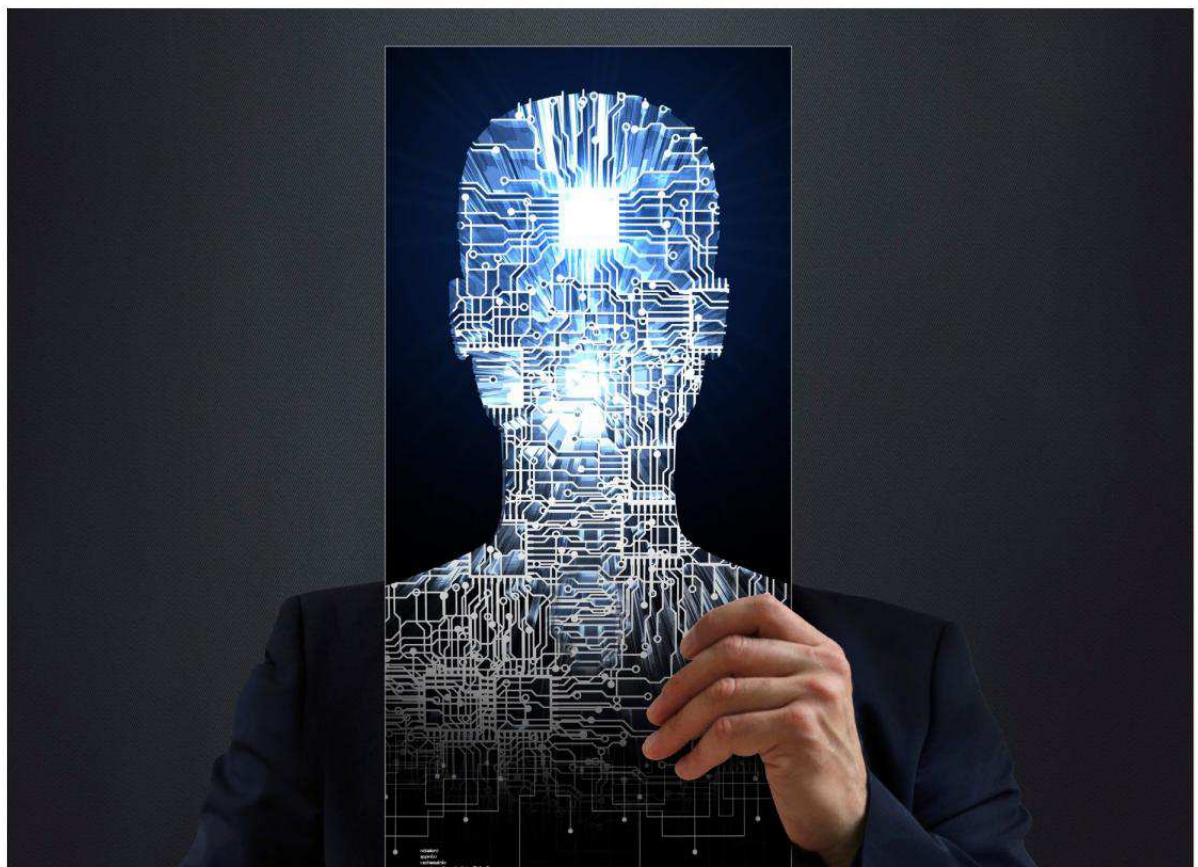


Even technologies such as FakeApp, which have become renowned for unethical usage, could have positive uses, Haines believes. “We’re moving toward this world where anyone could do highly creative activity with public technology, and that’s a good thing, because it means you don’t need those large sums of money to do all sorts of crazy things of an artistic nature,” he says.

Even technologies such as FakeApp, which have become renowned for unethical usage, could have positive uses.

Haines explains that the initial purpose of his team was to find out how AI could help with forensics. Although their research ended up taking a different direction, the results will still be useful to forensics officers, who will be able to study what AI-based forgery might look like. “You want to know what the cutting-edge technology is, so when you’re looking at something, you could tell if it’s fake or not,” he says.

Replika’s Kudya points out that human-like AI applications might help us in ways that would otherwise be impossible. “If you had an AI avatar that knew you very well and could be a decent representation of you, what could it do, acting out of your best interests?” she says. For instance, an autonomous AI avatar could go and watch hundreds of movies on your behalf, and based on its conversations with you, it would know which ones you would like.



These avatars might even help develop better human relationships. “Maybe your mom could have more time with you, and maybe you can actually become a little closer with your parents, by letting them chat with your Replika and reading the transcript,” she says as an example.

But could an AI chatbot that replicates the behavior of a real human being actually result in better human relations? Kuyda believes it can. In 2016, Kuyda gathered the old text messages and emails of Roman Mazurenko, a friend who had died in a road accident the previous year, and fed them to the neural network that powered her application. What resulted was a chatbot app that—after a fashion—brought her friend back to life and could talk to her in the same manner that he would.

“Could an AI chatbot that replicates the behavior of a real human being actually result in better human relations?”

“Creating an app for Roman and being able to talk to him sometimes was an important part of going through the loss of our friend. The app makes us think more about him, remember him in a more profound way all the time,” she says of her experience. “I wish I had more apps like that, apps that would be about my friendships, my relationships, things that are actually really important to me.”

Kuyda thinks it will all depend on intentions. “If the chatbot is acting out of your best interests, if it wants you to be happy to get some valuable service out of it, then obviously talking to the Replika of someone else will help build a stronger connection with a human being in real life,” she says. “If all you’re trying to do is sell advertisements in an app, then all you will be doing is maximizing the time spent on the app and not communicating with each other. And that, I guess, is questionable.”

For the moment, there's no way to connect your Replika to other platforms—making it available as a Facebook Messenger chatbot, for example. But the company has an active relationship with its user community and is constantly developing new features. So letting others communicate with your Replika is a future possibility.

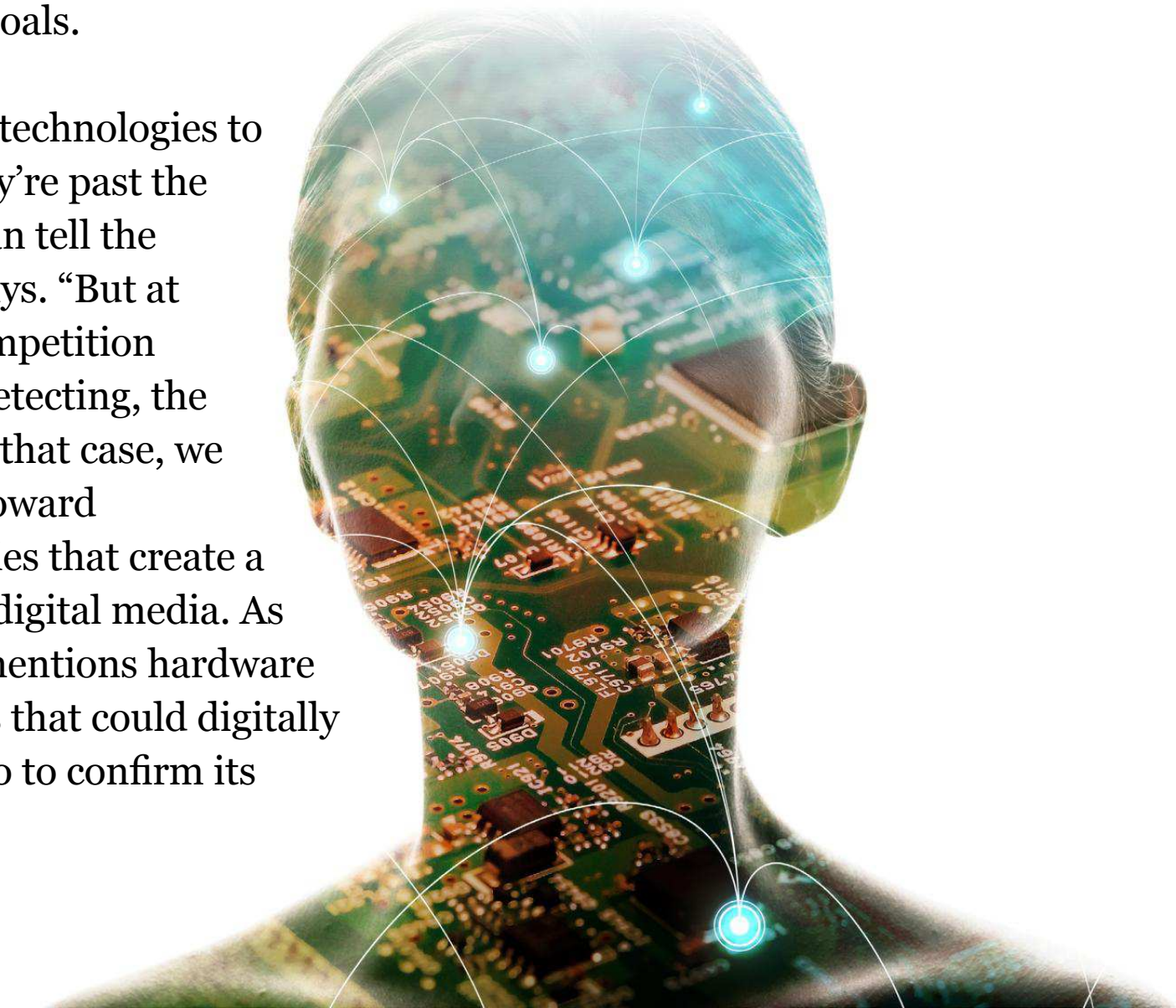
HOW TO MINIMIZE THE TRADE-OFFS

From the steam engine to electricity to the internet, every technology and discovery humans have made has had positive and negative applications. AI is no different. "The potential for negatives is pretty serious," Haines says. "We might be entering a space [in which] the negatives do outweigh the positives."

So the question is, how do we maximize the benefits of AI applications while countering the negatives? Putting the brakes on innovation and research is not the solution, Haines says—because if we did so, we have no guarantee that other organizations and states would follow suit.

"No single measure will help solve the problem," Haines says. "There's going to have to be legal consequences." Following the deepfakes controversy, lawmakers in the US are looking into the issue and exploring legal safeguards that could rein in the use of AI-doctored media for damaging goals.

"We can also develop technologies to detect fakes when they're past the point that a human can tell the difference," Haines says. "But at some point, in the competition between faking and detecting, the faking might win." In that case, we might have to move toward developing technologies that create a chain of evidence for digital media. As an example, Haines mentions hardware embedded in cameras that could digitally sign its recorded video to confirm its authenticity.



Raising awareness will be a big part of dealing with forgery and fraud by AI algorithms, de Brébisson says. “It’s what we did by cloning the voice of Trump and Obama and making them say politically correct sentences,” he says. “These technologies raise societal, ethical, and legal questions that must be thought of ahead of time. Lyrebird raised a lot of awareness, and many people are now thinking about those potential issues and how to prevent misuses.”

What’s certain is that we’re entering a new age where reality and fiction are merging, thanks to artificial intelligence. The Turing test might meet its biggest challenge. And soon enough, everyone will have the tools and power to create their own worlds, their own people, and their own version of the truth. We have yet to see the full extent of exciting opportunities—and perils—that lie ahead.

“What’s certain is that we’re entering a new age where reality and fiction are merging, thanks to artificial intelligence.”

How to Stream PC Games to Your Phone or Tablet (Even iOS)

BY WHITSON GORDON

Mobile gaming has nothing on the PC—the vast library of in-depth games on the desktop is tough to beat. But at the end of a long day, it's hard to sit at a desk when the couch is oh-so-inviting.

The new Steam Link app for Android can stream PC games to your phone or tablet, so you can play right on the couch. Unfortunately, it was blocked from the iOS App Store, but there's an alternative that works almost as well: It's called Moonlight.

STEAM LINK VS. MOONLIGHT

You may not realize this, but game streaming has already been available on mobile devices for some time. Moonlight is an open-source app for iOS, Android, and Chrome that reverse-engineers Nvidia's GameStream feature, allowing you to stream games to just about any device (instead of just the officially supported Nvidia Shield). It requires an Nvidia card in your PC, but as long as you have that, you can stream games right to your phone, tablet, or even another PC.

You may not realize this, but game streaming has already been available on mobile devices for some time.

If you're on iOS, you'll have to use Moonlight for now, since Steam Link has been blocked from the App Store. But if you're on Android, you have a choice to make: Steam Link works well but requires a gamepad and doesn't have very many settings. Moonlight has lots of settings you can tweak to alter performance, and it supports gamepads and touch controls. (It doesn't support the rumble feature as Steam Link does, though.)

I recommend starting off with Steam Link. In my testing, it was an incredibly smooth experience, and if you run into any issues or missing features, give Moonlight a try. Graphics and streaming were comparable in our tests, but your mileage may vary depending on your device and your network speed.

HOW TO CONNECT A GAMEPAD TO YOUR DEVICE

Moonlight lets you play with on-screen touch controls, but as any mobile gamer can tell you, touch controls are rarely ideal. You'll have a much better experience if you play with a dedicated gamepad. (And Steam Link requires one, so you don't have a choice.)

If you're using an iPhone or iPad, you'll need an Apple-approved, made-for-iPhone (MFi) controller. I highly recommend the Gamevice ($79 to $99). It attaches directly to your device and turns it into a Nintendo Switch-esque gaming console for any game that supports MFi controllers (thankfully, Moonlight does). If you're on more of a budget and willing to prop your tablet up somehow, though, the SteelSeries Nimbus ($50) is a good standalone alternative.

Android users don't have anything quite like the Gamevice for tablets, but there are Gamevice models for Samsung Galaxy phones ($40-$70). For everyone else, the SteelSeries Stratus XL ($40) is a solid wireless gamepad. If you have a wired Xbox 360, Xbox One, or PlayStation 4 controller, you can also use those by plugging them into a USB OTG cable (either Micro USB or USB-C) and plugging that into your device.

If you're using a wired controller, just plug it in and your device should recognize it. If your controller is wireless, pair it with your device from your Bluetooth settings like any other wireless accessory.

HOW TO SET UP STEAM LINK AND START PLAYING

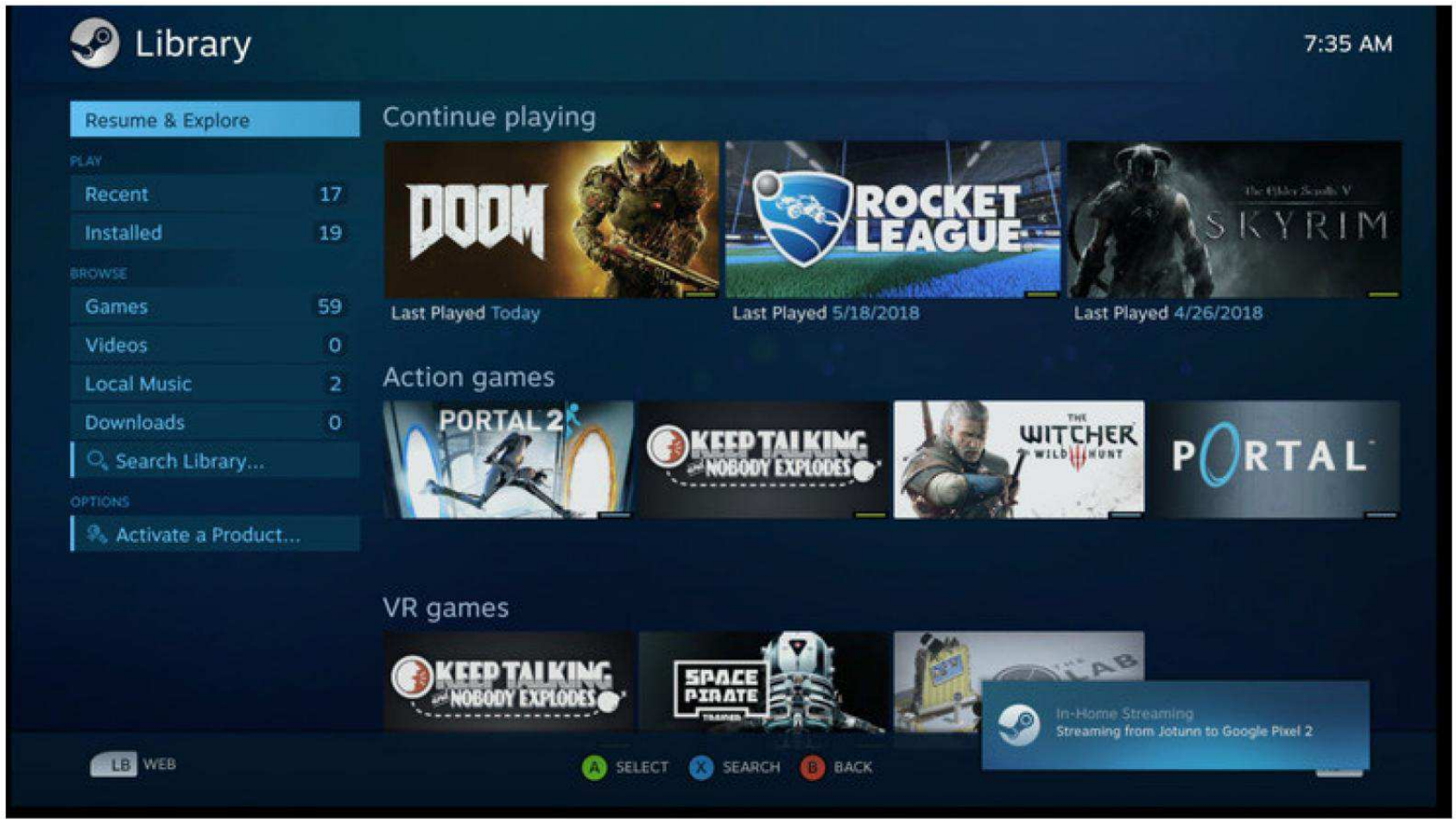
The Steam Link app is remarkably easy to set up. When you launch it for the first time, it'll ask you whether you want to pair a Steam Controller or another controller (if you don't have one plugged in already). Pick your hardware of choice and continue.

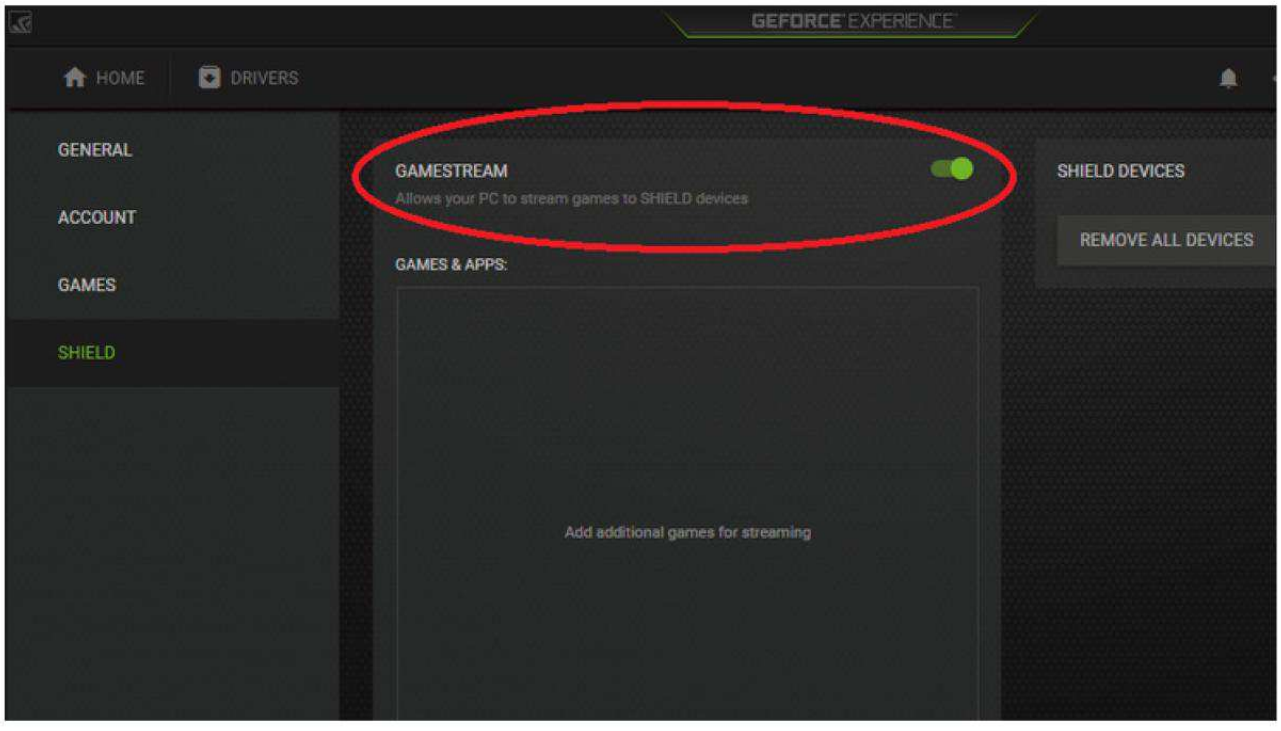
Once that's done, the app will scan your network for computers running Steam and present a list of them. Tap your computer, and you'll be given a 4-digit PIN on your phone. Type this PIN into the popup that appears in Steam on your PC to initiate the connection. It'll test the network to make sure it's fast enough, then drop you at the home page.

From there, tap "Start Playing."

BIG PICTURE MODE

It'll begin streaming Steam Big Picture Mode from your PC, and you can select your game and begin streaming. If you want to jump into the settings, you can do so from Steam Link's home page. You can change streaming quality to "Fast" if your network is a little choppy, or "Beautiful" if you have the bandwidth for better graphics, as well as tweak some advanced settings. But for the most part, I found Steam Link's default settings to be just about perfect.





HOW TO SET UP MOONLIGHT AND START PLAYING

First, ensure the latest version of Nvidia GeForce Experience is installed on your PC. Open the GeForce Experience window, click the Settings cog, and click the "Shield" tab. Toggle the GameStream switch to on.

Next, jump on your phone or tablet and download Moonlight from your respective app store (iOS or Android). When you start the app, it should show a list of your GameStream-enabled PCs on the network. Tap on the one you want, or tap "Add Host" and enter your PC's IP address if it doesn't appear automatically. Moonlight will give you a PIN, which you'll need to enter into the popup that appears on your PC.

GAMES TO STREAM

When you click Connect, your phone or tablet will present you with a list of games, ready to stream. If you tap one, it should start playing right on your device—with full gamepad support, if you have a compatible one plugged in or paired.

TWEAK SETTINGS

That's all it usually takes to get up and running, but if you want the best possible experience, you'll probably want to tweak a few settings.

When you click Connect, your phone or tablet will present you with a list of games, ready to stream.

From Moonlight's main screen, tap the arrow on the left (for iOS) or the settings cog along the top (for Android). Moonlight has many more settings on Android than iOS, but most users should at least tweak their resolution and framerate targets: 1080p at 60Hz is ideal for the best graphics and smooth playback, but if the stream is choppy, lowering it to 720p or 30Hz may help. You may also get better results by limiting network congestion—so tell your roommate to stop watching Netflix while you're trying to stream games.

You may get better results by limiting network congestion—so tell your roommate to stop watching Netflix.

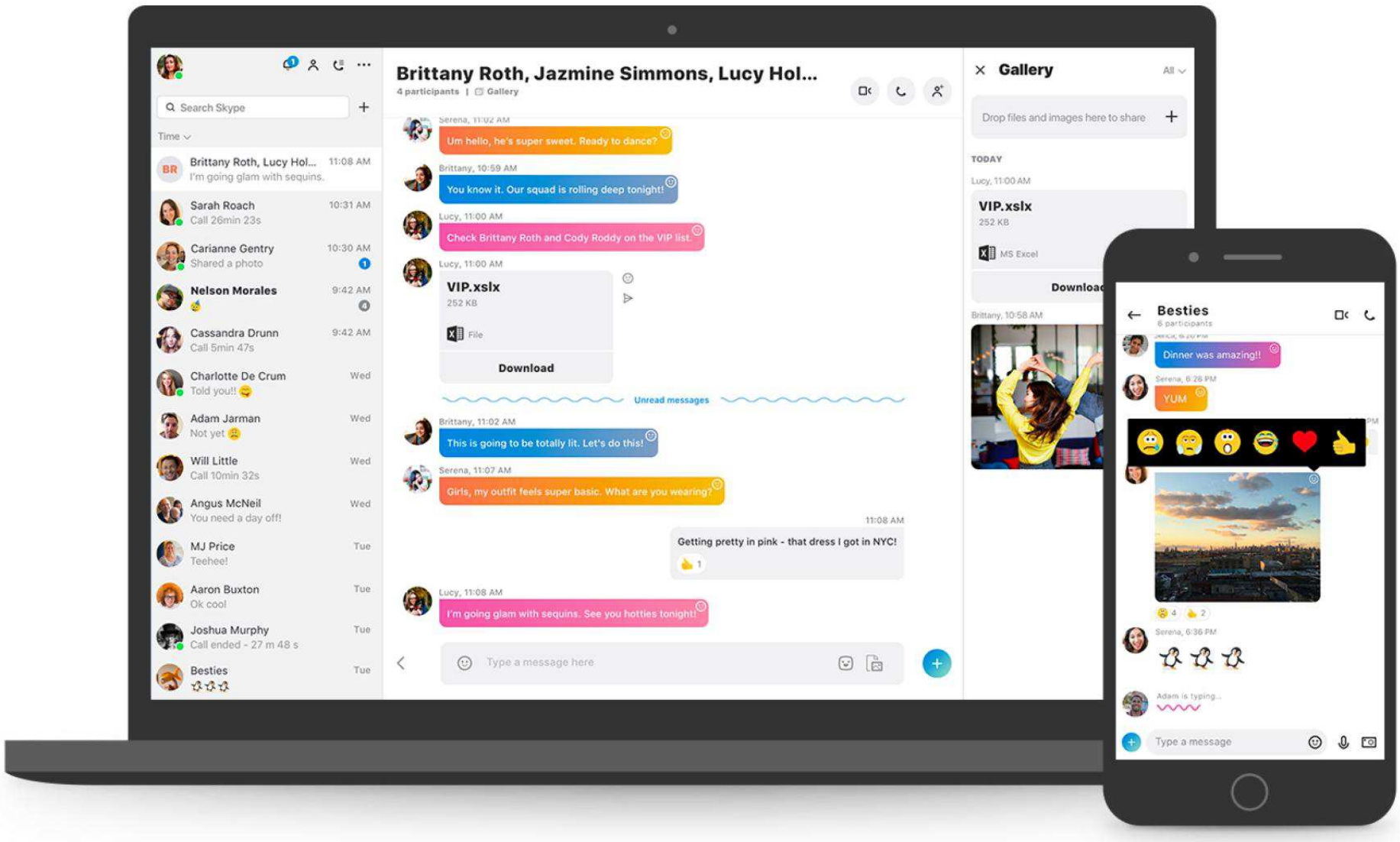
Last, I recommend tweaking the on-screen controls you see. Not all gamepads will have L3 and R3 buttons, so setting on screen controls to "Auto" (on iOS) or "Only show L3 and R3" (on Android) will give you touch buttons for just those functions.

It's worth noting that streaming technology is still pretty new, and it won't be perfect. You may get an audio pop here and there, and your graphics will be a tad fuzzier than if you were playing on the PC itself. But it's hard to beat playing Shadow of War from the couch without having to fight your spouse for the TV.

If you experience any other issues while streaming, there might be a solution—like disabling your firewall or tweaking some of Android's other settings. Check out Moonlight's setup guide and troubleshooting page for more. The setup page even has instructions for streaming over the internet, though your mileage may vary depending on your internet speed. Network streaming will definitely produce the best results.

How to Upgrade Your Skype Account

BY LANCE WHITNEY



Do you use the free version of Skype for internet calls and video chats? It may be time to upgrade your account. The free Skype restricts you to calling other Skype users, but a paid subscription lets you call mobile phones and landlines and certain other countries. Alternatively, you can keep your free account and purchase Skype credit when you need it.

Here are the different options for upgrading your Skype subscription.

SIGN IN

At the Skype website, click on the "Sign in" button in the upper-right corner, and click on the link for "My Account." At the "Sign in" screen, type your email address, phone number, or Skype username. Click Next. At the "Enter Password" screen, type your Skype password. Click Sign in.

SKYPE CREDIT

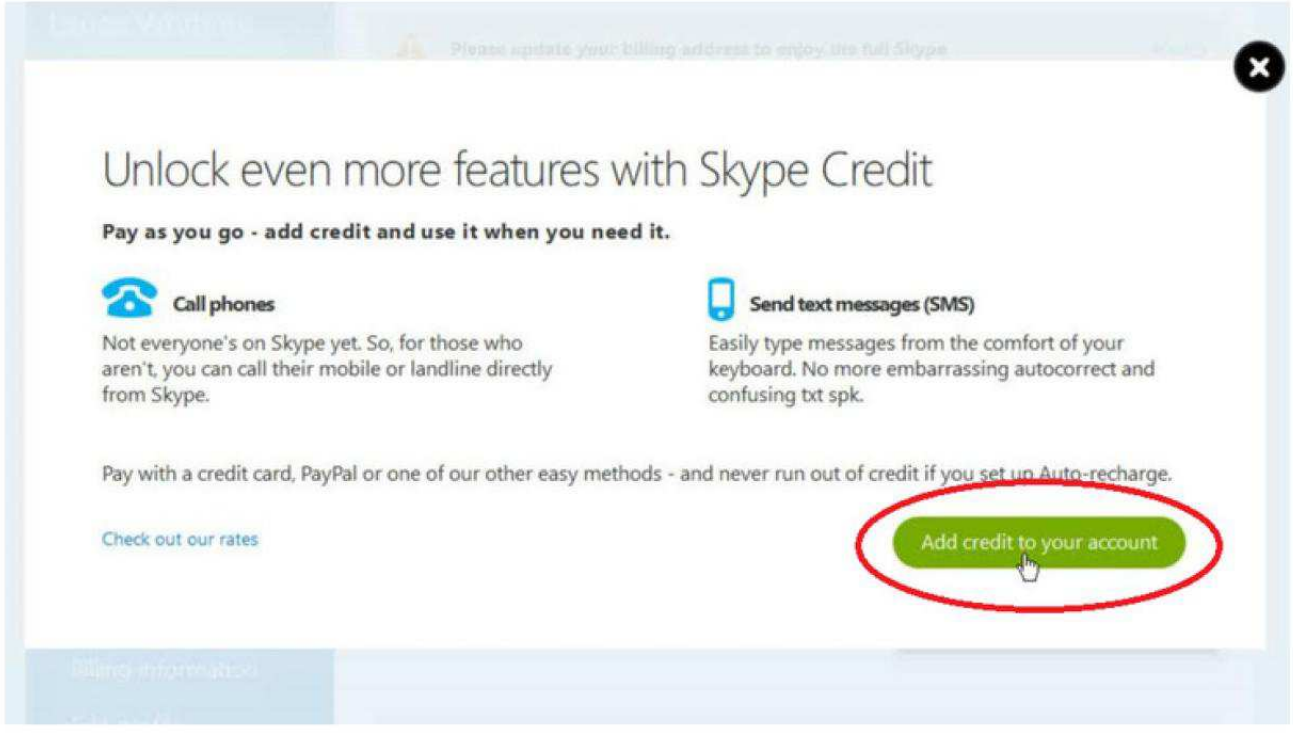
By purchasing Skype credits, you can make Skype calls to people who aren't on Skype via their mobile phones or landlines. It's a handy option if you don't expect to make too many calls to non-Skype users, and would like to have a "pay as you go" option. You can also make international calls to certain countries, which you can't do through a free Skype account.

At your "My Account" page, click the "Discover credit" button.

A paid Skype subscription lets you call mobile phones and landlines and certain other countries.

ADD CREDIT

A screen called "Unlock even more features with Skype Credit" pops up to explain how you can use the credit you purchase. Click on the button to "Add credit to your account."



SELECT YOUR AMOUNT

At the “Skype Credit” page, click on the amount of credit you wish to buy—$10 or $25. You can also opt to refill your account with more credit when you’re running low: Click Continue. A pop-up will ask if you’d like to enable Auto-recharge, which will top up your balance if it ever falls below $2.

BILLING INFORMATION

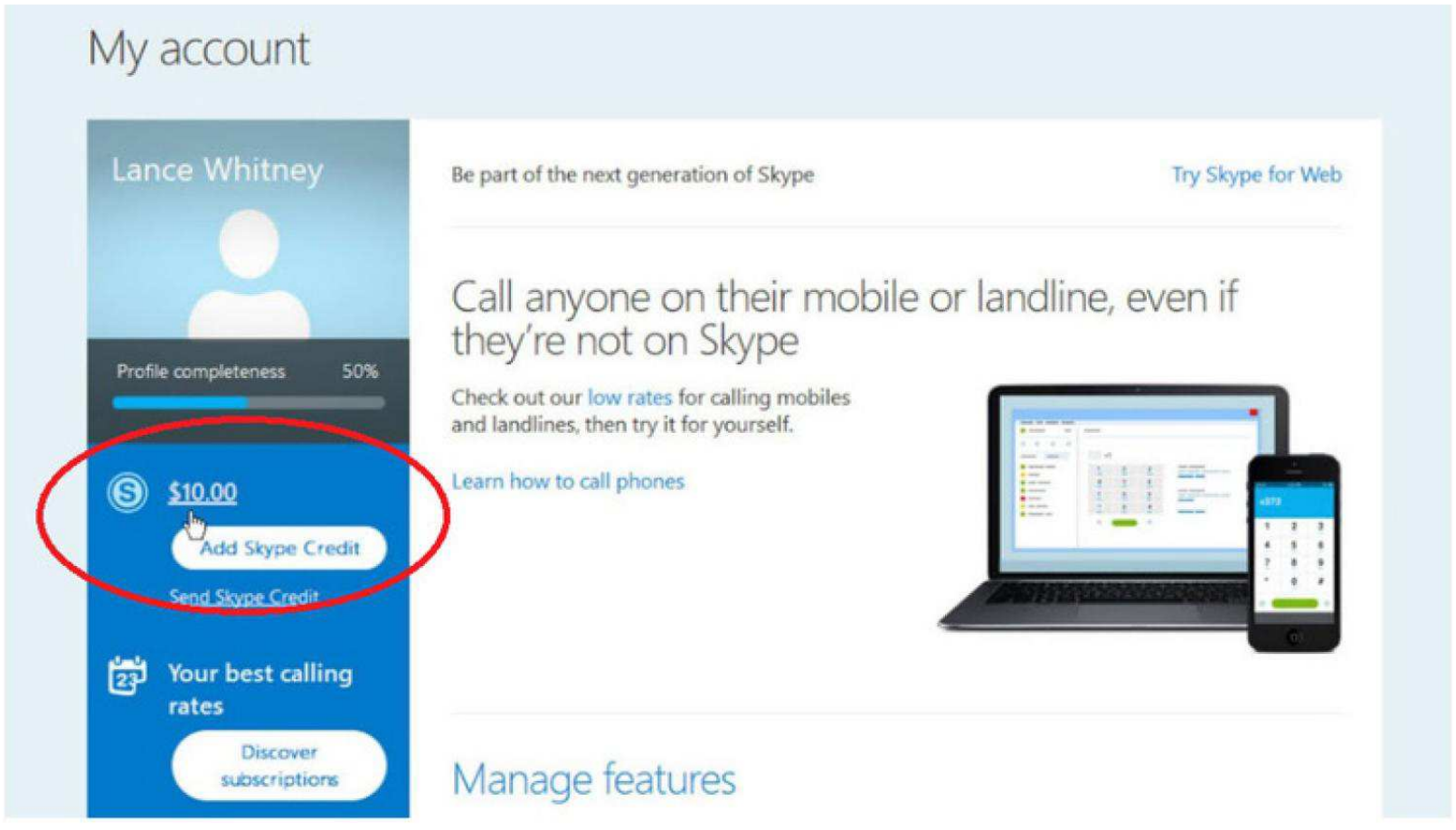
At the “Enter billing address” page, enter your billing information.

PAYMENT METHOD

At the “Check your order and pay” page, choose your payment method and fill out the payment information. Click “Pay now.” The credit gets processed for your account. At the “Thank you” page, click Continue.

BALANCE

Your “My Account” page now shows the available Skype credit and will keep track of the amount as you use it.

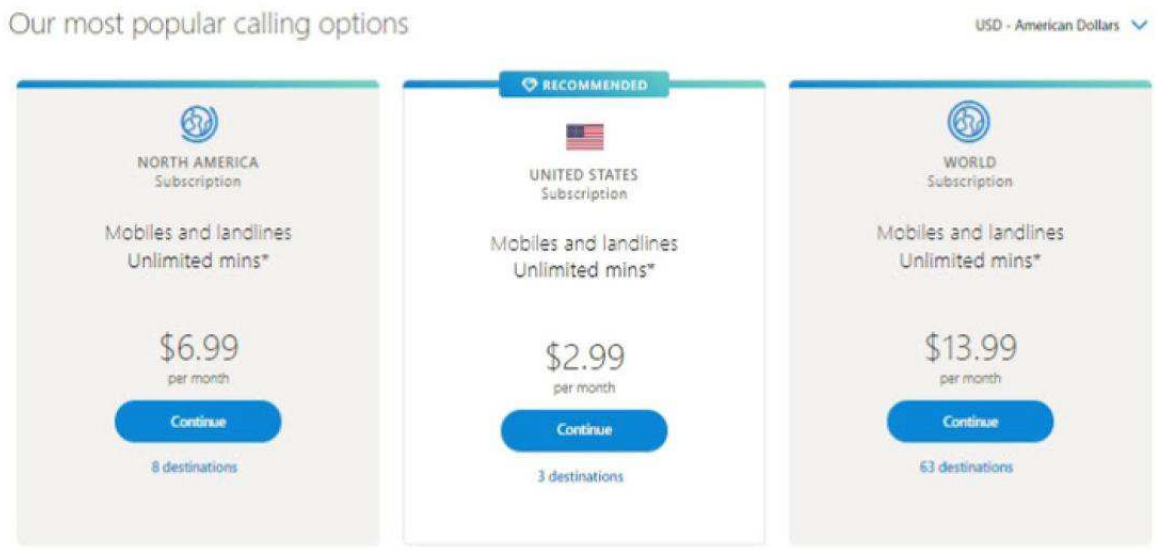


SUBSCRIPTIONS

If you make a lot of calls to mobile phones and landlines as well as certain countries, then a Skype subscription might be simpler and more cost-effective. At your “My Account” page, click on the “View All Subscriptions” button.

PICK A PLAN

To make international calls to a specific country, type it in the search field. Skype displays different plans with different price tags depending on how many minutes you want and what types of phones you plan to call. Select the plan you want.



UNLIMITED PLANS

Alternatively, you can get an unlimited plan to call landlines and cell phones in certain regions like the US ($2.99 per month), North America ($6.99 per month), Europe (plans vary), and the World ($13.99 per month to call landlines in 63 countries, and mobile phones in eight).

BILLING

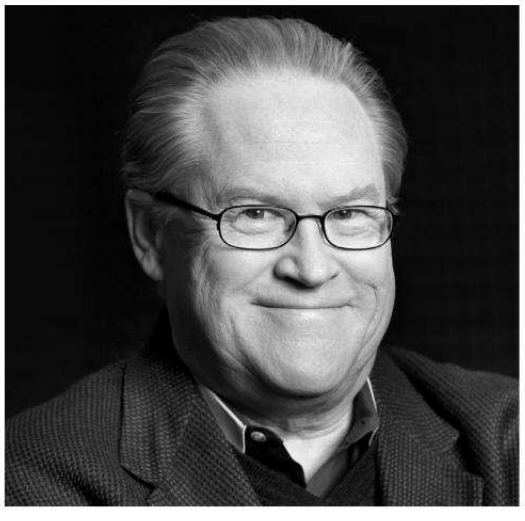
When you've selected a plan, click "Continue," which will take you to a page where you're asked to select your billing period. You can pay once, every three months, or once a year. The latter two options will save you 5 percent and 15 percent, respectively.

At the "Check your order" page, choose a payment option if you don't already have one. Click Continue. The "Thank you" page confirms that your order has been placed. Click Continue. Your "My Account" page displays your new subscription.

OFFICE 365

There is one more way you can snag a Skype subscription: through an Office 365 account. Beyond offering the standard Microsoft Office applications, access to OneDrive, and other benefits, an Office 365 Personal subscription throws in 60 minutes worth of Skype calls to mobile phones and landlines around the world. An Office 365 Home subscription ups the ante by offering the same deal for up to five people.

JOHN C. DVORAK



The FOMO Plague Is Turning Us Into Smartphone Zombies

There's been a lot of discussion recently regarding tech addiction, especially by millennials who—according to comScore—dominate cell phone usage. This should come as no surprise to anyone who has been out and about lately.

Assuming you too are not buried in your smartphone, look up and notice how many of us are staring at or holding a mobile device. Some are posting to social media, clutching the smartphone grip and trying out different angles. Others are just obsessively checking and rechecking the phone, whether they received a notification or not.

In the process, they get into car accidents (often killing people) or stupidly walk into walls, poles, or holes. We've all seen people hit something when walking and looking at their screen.

Much of this is attributable to an odd phenomenon called FOMO—fear of missing out. I've seen people randomly check their phone during a conversation or dinner or while in a meeting. When I ask what's so important, the person rarely has a good reason. It's just habitual.

They're worried about missing out on some developing news they have only a casual interest in yet feel the need to know about it immediately. Unless a notification involves something I am doing at the time or my current safety, I can't see why this information can't wait. In fact, I often don't care to ever find out.

Not with millennials. Above all other phone users, they have this crazy need to know. This makes the group very susceptible to well-structured internet hoaxes and even propaganda. This is despite their belief that they, as a group, have built-in BS detectors that prevent it from happening.

ComScore, in its 2017 U.S. Mobile App Report, discussed the observed phenomenon and the FOMO effect on the app industry, but it failed to explain the sociology of millennials regarding FOMO and other peculiarities of usage. A tidbit from the report: People in the 18- to 24-year-old age range spend 3.2 hours per day on mobile phone apps. Instagram seems to be the go-to app for everyone.

If you've been watching any TV news over the past few months, you'll have seen numerous reports on mobile phone addiction and how it gives you a shot of dopamine or some pleasurable hormone each time you scroll the screen. This phenomenon is not new and was also apparent during the BlackBerry era: Remember when the device was nicknamed the Crackberry?

Is this about a need to feel important? You walk down the street with the phone at the ready because you are important, and something's about to happen? You'll be ready for it by walking into a pole! Is this part of the self-esteem movement? You holding the phone tells people you are someone special, a big shot?

This is the easiest explanation, in my opinion, but it's superficial and needs serious study. Because right now, this all looks like some science-fiction comedy act that needs to stop.

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