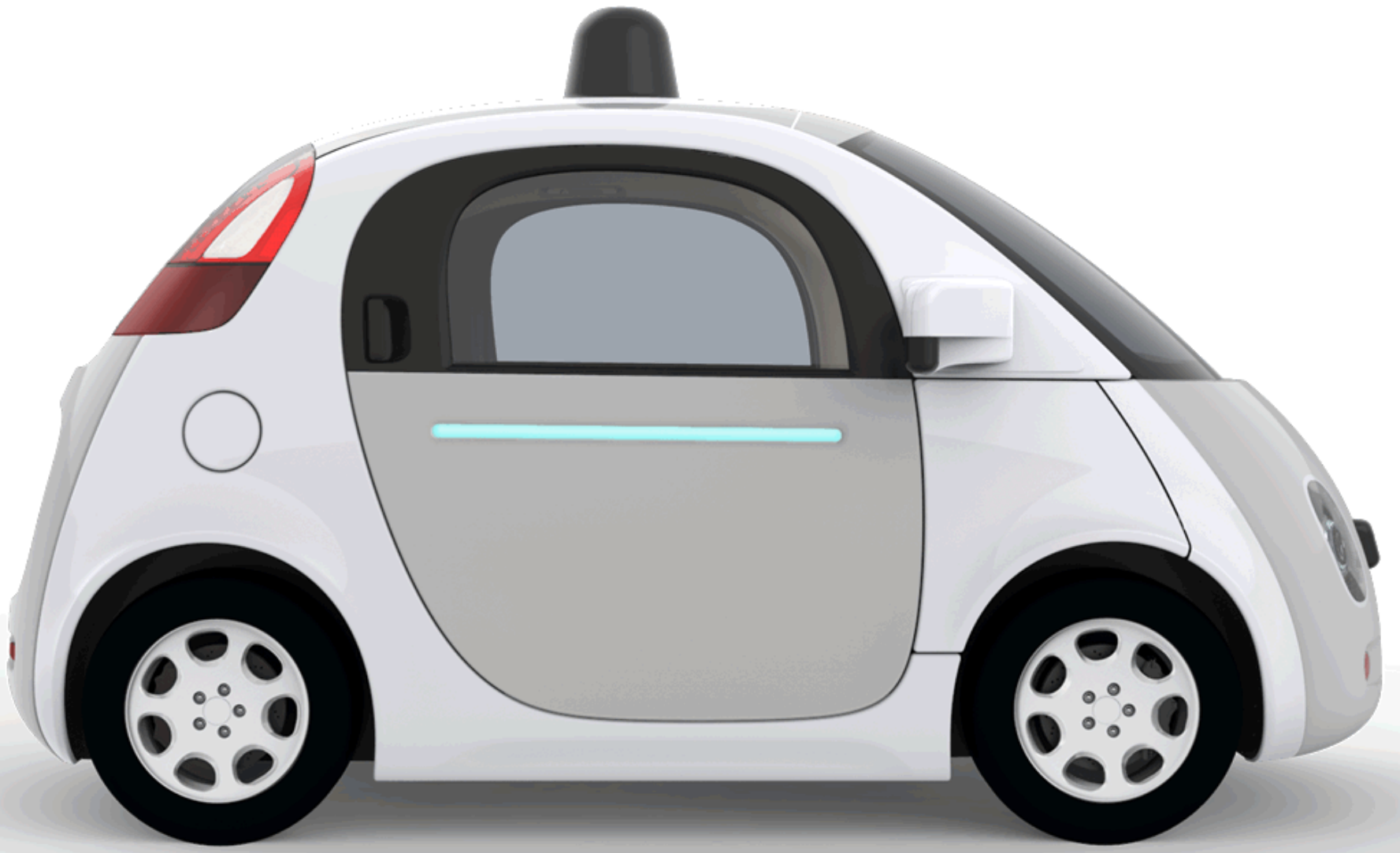
PC MAGAZINE

HOW HOME VIEWING IS EVOLVING

WILL HUMAN AUGMENTATION BE A HARD SELL?

THEY'RE HERE, THEY STEER, GET USED TO THEM

Driverless Cars



DIGITAL EDITION
SEPTEMBER 2016

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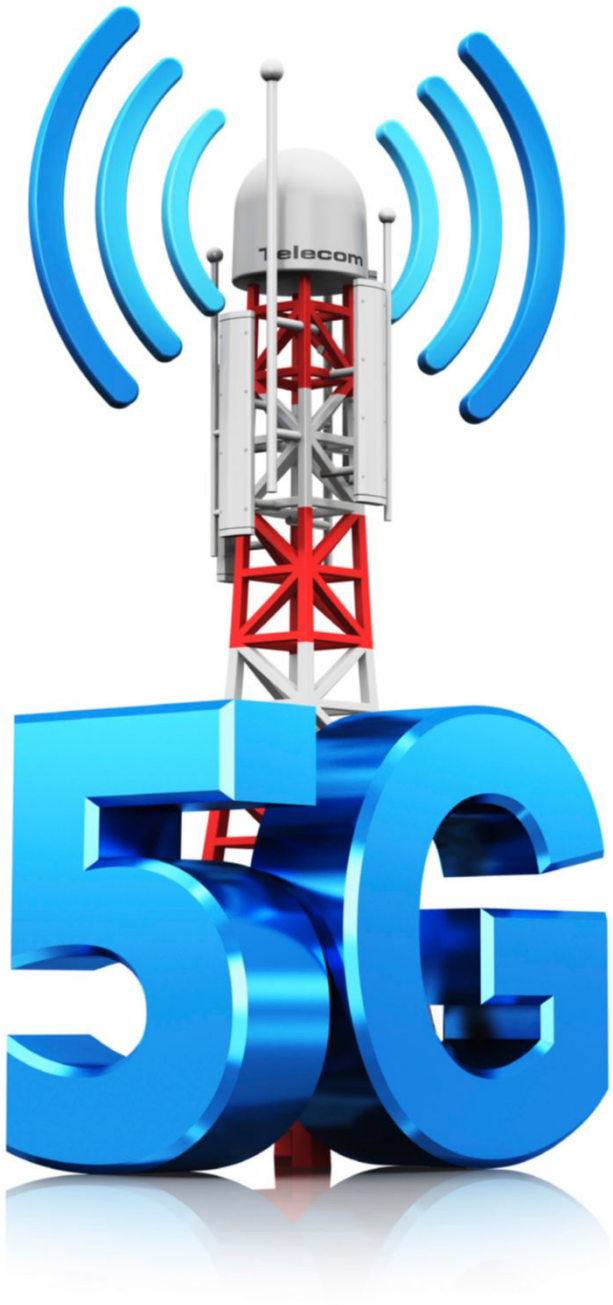

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DAN COSTA

Let Go of the Wheel

Living in New York City, I have a decidedly ambivalent relationship with the automobile. I moved here with a 10-year-old Toyota Camry 25 years ago and quickly discovered my car was not the advantage it had been in high school and college. Finding a parking spot in Hoboken could take 30 minutes. And forget about commuting into the city. I was so happy the day I sold that car; I felt free.

When I needed to head out of town, I rented a car. When Zipcar opened up shop, I was first in line. Reservations were a little hard to come by, but with some forethought, you could almost always get a car for an hour or a few days Suddenly, I had an automobile on demand, and I never had to replace the oil. In fact, I barely bought gas. I never felt like I was missing out by not owning a car.

During this time, I drove all sorts of cars. Avis and Budget use only a few brands, but Zipcar had everything from Mini Coopers to Ford F150s. And since I'm a journalist, automakers were happy to let me test-drive their latest top-of-the-line models. I was a car fan; I just wasn't a car owner.

I drove a lot of the most state-of-the-art vehicles on the market. Yet, somehow, I never really believed that we would have self-driving cars in my lifetime. Sure, I would cover the DARPA Grand Challenge year after year, but those were just prototypes in an empty desert. Even when Google started sending its pods around Mountain View, self-driving cars looked more like an experiment that would never reach the mainstream. It all

seemed a little too futuristic, even to a professional technology writer. And now, they're here.

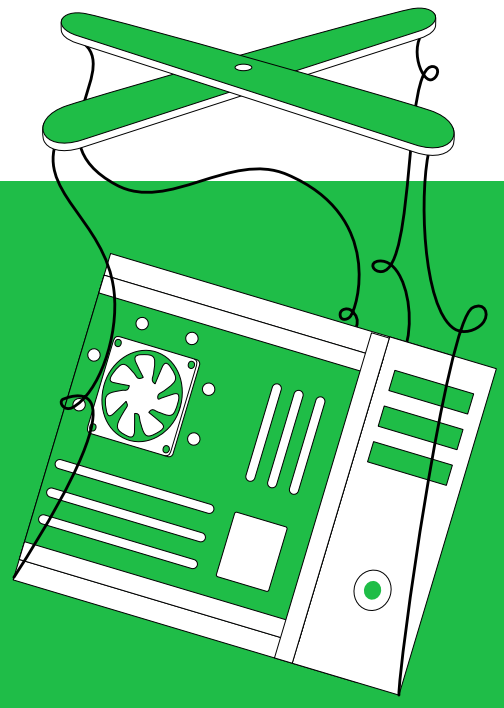
Ford CEO Mark Field has announced that the company will commercialize a fully autonomous car in 2021. "If someone had told you ten years ago, or even five years ago, that the C.E.O. of a major automaker American car company is going to be announcing the mass production of fully autonomous vehicles, they would have been called crazy or nuts or both," he said.

And it isn't just Ford. Mercedes-Benz and GM plan to have autonomous vehicles on the road before then. Tesla cars have driven more than 140 million miles on AutoPilot, and the system gets smarter every week.

Not only will self-driving cars hit the road in my lifetime, but very likely, my next car will have at least limited self-driving features. The same goes for you. But what exactly does that mean? Check out Evan Dashevsky's cover story "Self-Driving Cars: They're Here, They Steer, Get Used to It!"

I'll let Evan give you the details, but as he says, "It's gonna be a hell of a ride."

dan_costa@pcmag.com



Take Control of Your Tech

Matthew Murray's opinion column in our August issue on building your own PC brought out the DIYers among our readers. and Sascha Segan's pro–unlocked phones stand resonated positively as well.

"NO, BUILDING A COMPUTER IS *NOT* TOO HARD"

Wonderful article... [It] was a fun read and brought back some nostalgic memories of PC gaming as a kid.

—shadow1w2

Forget about Config.sys and Autoexec.bat. What about setting IRQs with DIP switches via trial and error because the only documentation you had was a tiny bit of useless print? File that under 'things I do not miss.'

—ThomasD

Back in the day, I stayed up all night trying to install a 28.8-baud modem on my Packard Bell Pentium 60. It turns out that it would have never worked, but my 16-year-old brain didn't know it at the time... Now, It's easier than ever. In fact... I don't need to keep up on the newest stuff and how-tos. Everything works well and is easy to install. Just find a guide or watch a short vid. Good time to be a PC gamer.

—Youngie76

It is not "too hard" if everything goes well. However, I've encountered situations when a newly build PC started misbehaving with random, infrequent blue screens of death that [were] not necessarily consistent enough to point to some particular piece of hardware or software. Trying to debug and find the cause without testing equipment, without spare parts to swap and see

what happens, and without deeper experience in hardware and software issues can become nightmare for the newbie.

—ja_1410

My friends and I had this competition: Who could do a better autoexec.bat and config.sys? Winner was the one with the biggest low memory available (that one the was only 640kb, and people say that Bill Gates said was enough). Good times, had a lot of fun. Now I am happy with my Xbox One. Not much time left to play after getting married and having kids, so I need the system to work in the fews minutes I have to play, and not waste them updating drivers and other issues. Maybe when my kids grow up and I have more time I will build another machine...

—Fred

"THE CASE FOR BUYING AN UNLOCKED PHONE"

It seems to me that one reason people don't buy a phone that meets their needs and then buy a service plan that meets their needs is because of the upgrade treadmill. I know people who count the days until they can get a new phone under their plan. To them, cell phone service is like leasing a car; instead of ownership at the end of the contract period, they switch to the latest model.

—Jeffrey Clinard

The Nexus lineup of phones [is] my preferred unlocked phone choice. I currently use the Nexus 5X, and I couldn't be more happy. No bloat, fast charge times, great battery life, works flawlessly with Verizon—just pop in your Nano SIM, and you are off and going. And... I get the latest and greatest in Android updates.

—SparkStormrider

I've never bought a smart phone from a carrier but have bought them direct from China from Ali-Express, China's equivalent of Amazon... When you can get an unlocked dual SIM, multi-standard global smart Android phone for between $65 to $200, it's a steal. Screen size varies from 3.5 inches to 5.5 inches, most if not all have OTG micro USB, most if not all can accept a 32GB microSD card memory upgrade, and the number of CPU cores varies from 2 to 8.

—WTF

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.

Why We're Not Building Space Tech in Space—Yet

BY GRAHAM TEMPLETON

These days, engineering for space has a lot to do with packaging. Your biggest, most ambitious ideas have to be deliverable in small chunks that can be reassembled later, or blown up like a balloon, or folded up like an origami crane. Everything you want to do in space—say, super-telescopes and Mars colony ships—has to fit into the tip of a rocket, either once or over and over. You have to design space technology for zero gravity but build it in single gravity. It's annoying! But what if you could get around the

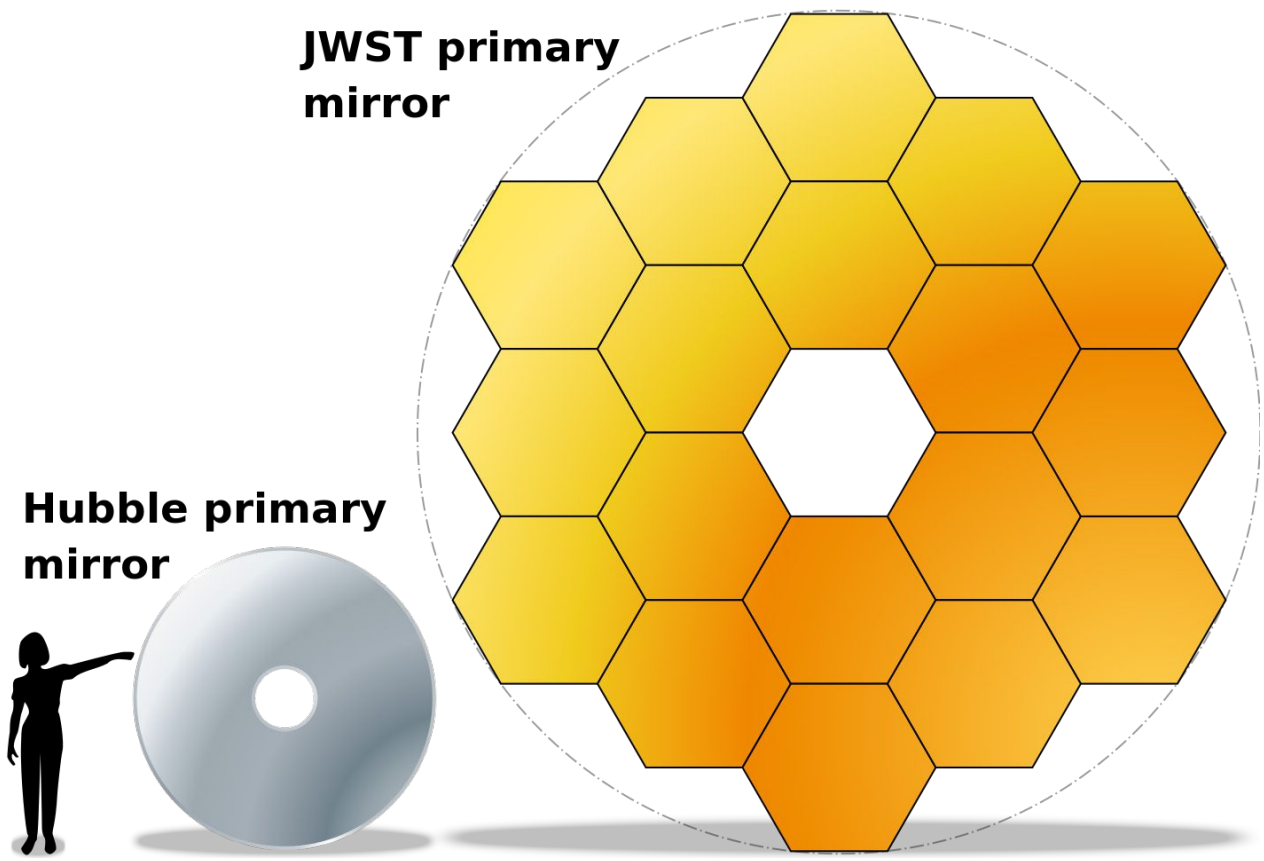
ZERO-G CONSTRUCTION

Any robust future for mankind in space will almost certainly require a way to build things there. A few solutions are already being tested.

problem by building tech in the same environment in which it's designed to operate?

The idea of doing construction in space has existed for a long time, but like many ideas about What NASA Ought To Do, it's been easier written than realized. Now, scientists are making serious propositions for increasingly detailed mission profiles, aimed at giving mankind its first space-based shipyard. One mission was recently proposed in the *Journal of Astronomical Telescopes, Instruments, and Systems*, going through all the steps in building and assembling a modular 100-meter space telescope called the Robotically Assembled Modular Space Telescope, or RAMST.

The advantages of constructing space technology in space are obvious — if something is only ever going to



SPACE TELESCOPES
The relative primary mirror sizes of the Hubble versus James Webb telescopes. The Webb mirror had to be launched in a folded form and then expanded.

have to function in zero gravity, building it there means it can be far more fragile than a machine that has to be able to support its own weight down on the surface. In space, you can build objects that are bigger and more convoluted without fear of internal collapse due to lack of significant tensile strength.

For the most part, building in space could realize the machines many astrophysicists have been imagining

Building in space could realize the machines many astrophysicists have been imagining.

STAR GAZING IN OUTER SPACE
A full-scale model of the James Webb Space Telescope, a space observatory scheduled to launch in October of 2018.

since they were children and which your graduate education in physics told you would always be impossible. As long as there's been a space program, there's been a will to create a space construction program—the only question has been how to actually get it done.

The most obvious answer was to simply do the construction in space. Get some astronauts, put them in space, give them building tools, and have them build things. The first problem with this is that space suits don't lend themselves to physical labor, or precision work, or long-term use in general. You might get rid of some headaches in designing your next satellite, but those reduced costs and delays will likely be more than offset by the increased crew, food, equipment, and oxygen requirements, not to mention the increased chance of injury and crisis.

Designing a solution is no small feat. How do you build in orbit, where the near-zero pressure, absence of combustible gasses, and lack of an objective "down" all throw a wrench into the construction technologies we've developed over the past few thousand years? More to the point, how do you do it when human labor can't even be part of the solution? Virtually no poured, hardening material would work right off the bat. All the sturdiest forms of welding are based on having oxygen available, and an atmosphere to quickly cool a molten welding material. Even mechanically snapping pieces together often relies on the downward pull of gravity to keep everything stable and connected.

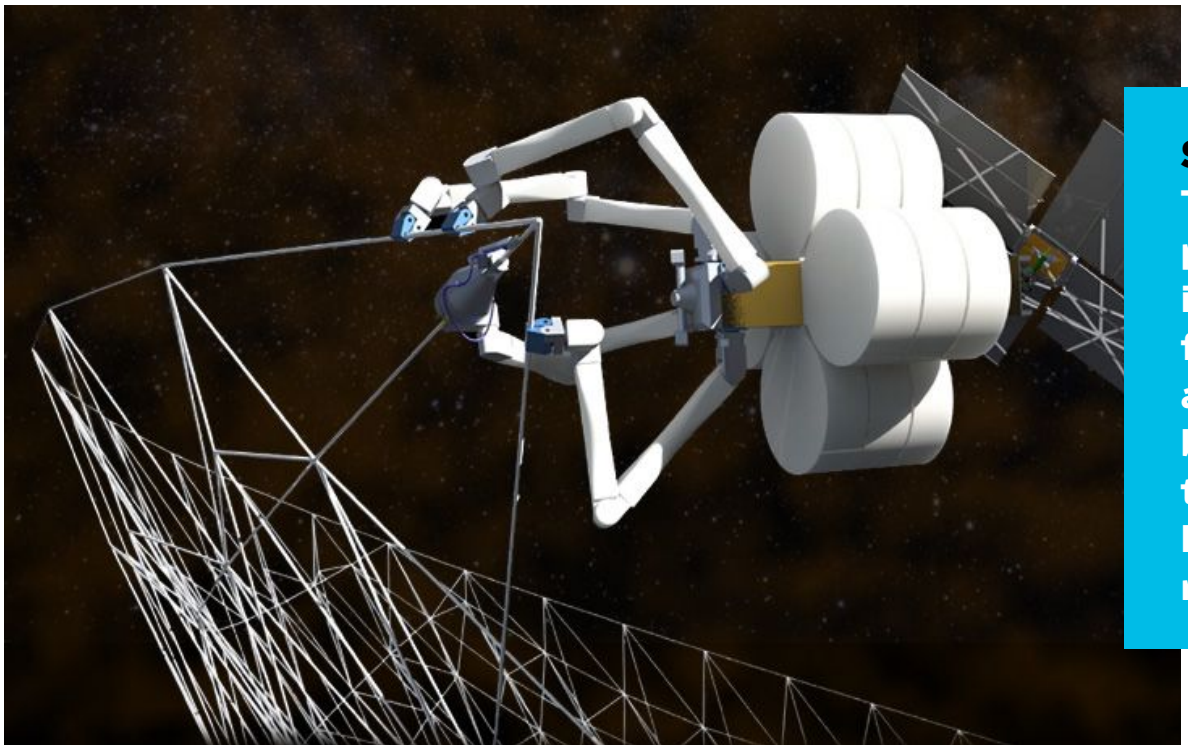
One possible way forward is 3D printing. As with welding, most 3D printing

materials require the convection of air to cool the construction material and fuse it to the growing object — but not all. NASA has been working on a space-based 3D printing project called SpiderFab, aimed at creating "kilometer-scale" metal frameworks in space. SpiderFab would lay down the enormous skeleton of a space platform, for instance, and incorporate more complex components sent up from the surface. Not just tools and computer systems but objects with wider materials demands, like windows, would likely come up from traditional factories and fabs.

So, the quickly-oncoming James Webb telescope, with its segmented, folding mirror, might not look so out of date in the era of space-based construction; we probably won't be vacuum-printing such high-precision objects as telescope mirrors any time soon.

But the basic ability to build in space will be important to develop if we're ever to make sizable

Putting down roots in alien soil will require many of the same skills as printing in space—and space is closer.



SPIDERS FROM MARS?
The SpiderFab 3D printing project could radically improve space construction for missions requiring large apertures or large baselines by reducing launch mass, thus requiring smaller launch vehicles and reducing total costs.

colonies on the Moon or other worlds. Putting down roots in alien soil will require many of the same skills as printing in space—and space is closer. If we're going to try building structures on Mars, we'll need to start with less ambitious goals.

This is a theme in the space world right now: modular, replaceable parts launched and assembled by

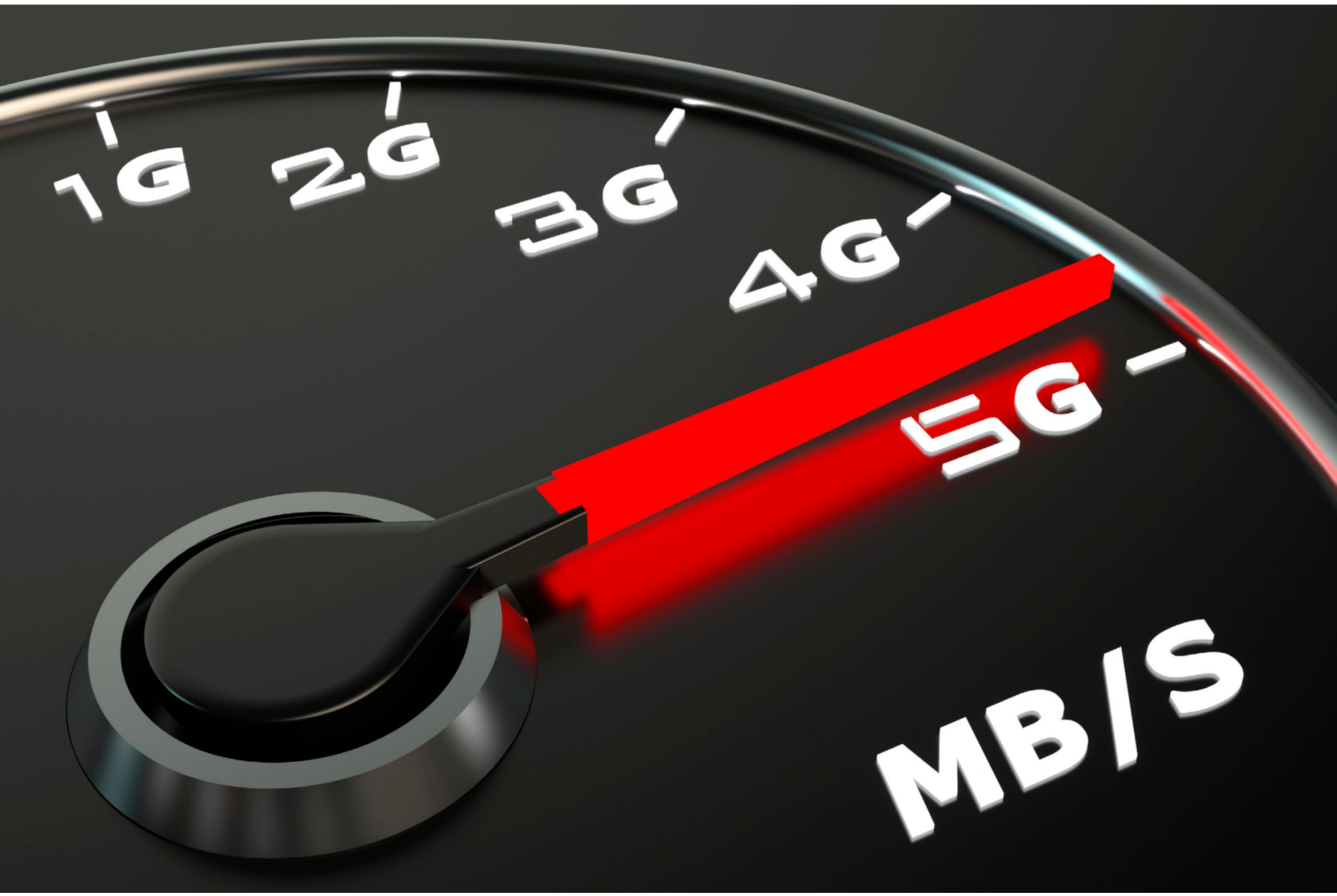
robots. DARPA is still plugging away on Project Phoenix, which is aimed at undoing some of the incredible waste of mankind's various space programs by scavenging old or aging satellites for parts and assembling those parts into all-new space-based devices: Take a central processing unit with newfangled sensing devices and send it up as part of a bulk shipment, then have Phoenix attach a scavenged solar panel or two, some thrusters in good condition, and anything else that can be found in Earth's ever-more-crowded graveyard orbit.

Of course, unless we're going to be making these scaffolds out of moon-dust, we're still going to have to launch the raw materials the robot will use to print the basic skeleton of a structure and attach pre-fabricated parts to that skeleton. In principle, you're still launching the entire vehicle from Earth but taking the packing efficiency to its logical conclusion—printer-ready cartridges or ingots of printing material packed nice and tightly, with no wasted volume on your launch vehicle.

Even with a vastly more affordable method of reaching space—perhaps a space elevator with a large lift capacity—space-based construction will remain necessary. There's enough profit potential in space to make full use of pretty much whatever launch capacity is available, so there's always going to be an incentive to pack light.

What is 5G?

BY SASCHA SEGAN



We've had 4G cellular networks for only a few years, but all the wireless carriers are already talking about 5G. It's actually surprisingly easy to do so, because there isn't any official definition of 5G yet. What's happening now is that all the players in the wireless world, from chipset makers to carriers, are jockeying to be able to define 5G and establish themselves as 5G leaders. So head with me down the rabbit hole that is 5G as I try to explain what the heck is going on here.

1G, 2G, 3G, 4G, 5G

The G in 5G means it's a generation of wireless technology. While most generations have technically been defined by their data transmission speeds, each has also been marked by a break in encoding methods, or "air interfaces," which make it incompatible with the previous generation.

1G was analog cellular. 2G technologies, such as CDMA, GSM, and TDMA, were the first generation of digital cellular technologies. 3G technologies, such as EVDO, HSPA, and UMTS, brought speeds from 200kbps to a few megabits per second. 4G technologies, such as WiMAX and LTE, were the next incompatible leap forward, and they are now scaling up to hundreds of megabits and even gigabit-level speeds.

WHAT IS 5G?

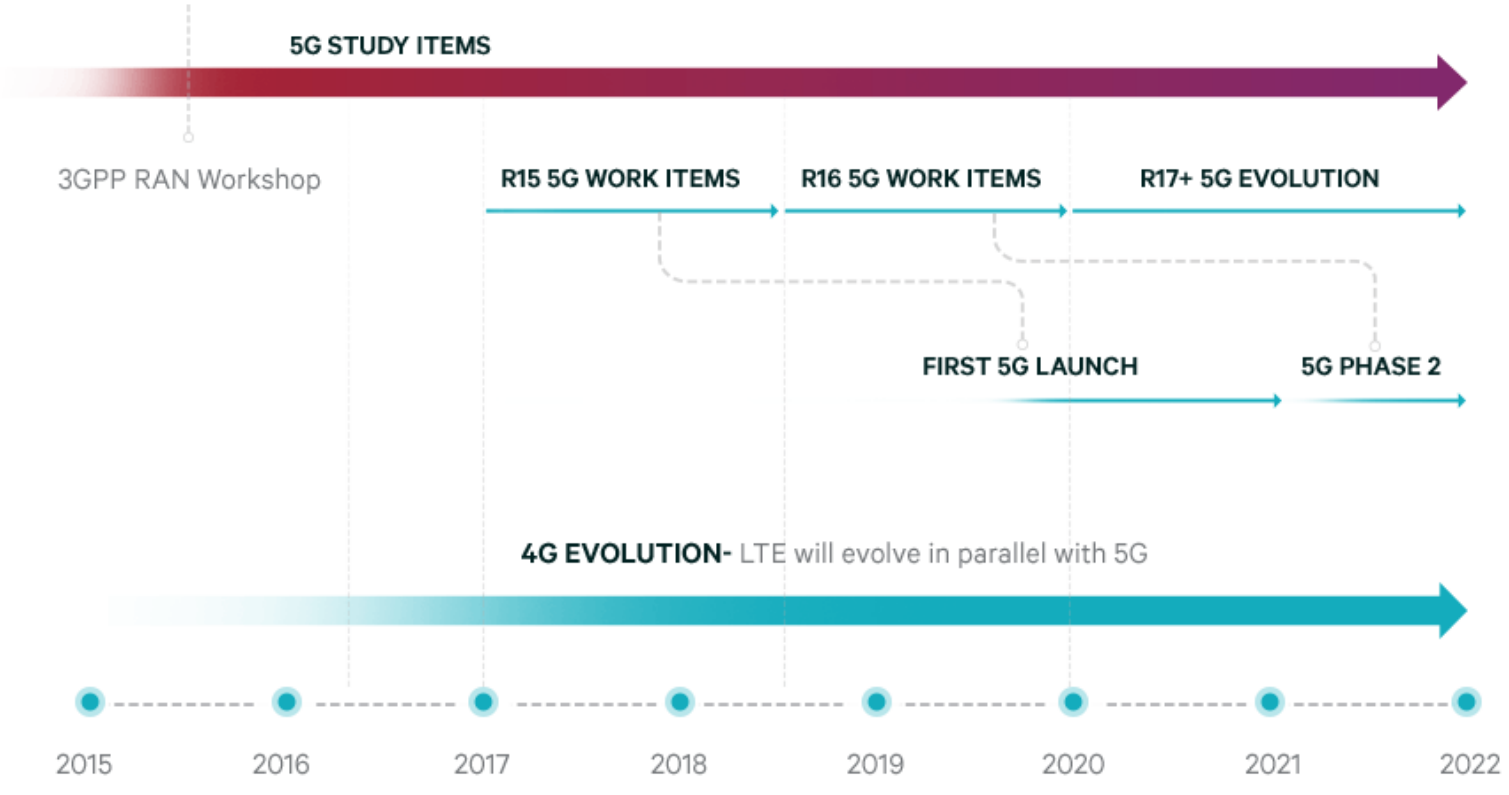
5G is a new network system that has much higher speeds and capacity, and much lower latency, than existing cellular systems. The technologies to be used in 5G are still being defined, but there are some general themes everyone agrees on.

5G networks will use a type of encoding called OFDM, which is similar to the encoding that LTE uses. The air interface will be designed for much lower latency and greater flexibility than LTE, though.

The new networks can use frequencies as low as old TV channels or as high as "millimeter wave," which are frequencies that can transmit huge amounts of data, but only a few blocks at a time. 5G may also bring in Wi-Fi as a seamless part of a cellular network. Or it may transmit LTE-encoded data over Wi-Fi frequencies, which is called LTE Unlicensed.

5G networks are much more likely to be networks of small cells, even down to the size of home routers, than to be huge towers radiating great distances. Some of that is because of the nature of the frequencies used, but a lot of that is to expand network capacity.

"The technologies to be used in 5G are still being defined, but there are some general themes everyone agrees on."



So 5G networks need to be much smarter than previous systems, as they're juggling many more, smaller cells that can change size and shape. But even with existing macro cells, Qualcomm says 5G will be able to boost capacity by four times over current systems by leveraging wider bandwidths and advanced antenna technologies.

AT&T has also spoken of "edge intelligence" as being part of its 5G vision. With edge intelligence, the individual small cells have much more autonomy to decide how and where to route data, which can greatly lower latency.

The goal is to have far higher speeds available and far higher capacity per sector, at far lower latency than 4G. The standards bodies involved are aiming at 20Gbps speeds and 1ms latency, at which point very interesting things begin to happen.

WE'VE GOTTA HAVE STANDARDS

The 3rd Generation Partnership Project (3GPP) aims to create a blueprint for first deployments of 5G technology in 2019—or even sooner.

5G MIGHT BE FOR HOMES

The first applications we'll probably see for 5G are in home Internet. The technologies used in 5G for the home will be closely related to millimeter-wave fixed wireless ISPs such as Starry in Boston and Monkeybrains in San Francisco. But with bigger players such as Verizon and AT&T in the mix, they'll be much more widely available. AT&T, for instance, has talked to me about potentially using 5G to replace its old DSL offerings, letting the company deliver a "quad play" of DirecTV TV service, 5G home Internet, wireless phone, and home phone. Verizon says "fixed wireless," meaning home Internet, will be its first 5G application.

The key here isn't speed—it's capacity. 5G may give cellular carriers enough

capacity to offer truly unlimited home service plans, as the data caps on current wireless plans just don't work for home use. This could really increase home Internet competition in the U.S., where, according to a 2016 FCC report, 51 percent of Americans have only one option for 25Mbps-or-higher home Internet service.

5G MIGHT BE FOR CARS

Driverless cars may need 5G to really kick into action. First-generation driverless cars will be self-contained, but future generations will interact with other cars and smart roads to improve safety and manage traffic. Basically, everything on the road will be talking to everything else on the road—and to the road itself.

To do this, you need very low latencies. While the cars are all exchanging very small packets of information, they need to do so basically instantly. That's where 5G's sub-1-millisecond latency comes into play: when a packet of data shoots directly between two cars or bounces from a car to a small cell on a lamppost to another car. (One light-millisecond is about 186 miles, so most of that 1ms latency is still processing time.)

5G MIGHT BE FOR CITIES

Another aspect of 5G is that it will connect many more devices. Right now, 4G modules are expensive and power-consuming, and they demand complicated

5G may give cellular carriers enough capacity to offer truly unlimited home service plans.

CARS THAT COMMUNICATE
Acura's second-gen automated development vehicle is tested at GoMentum Station, an automated and connected vehicle proving ground.

service plans. So much of the Internet of Things has stuck with either Wi-Fi and other home technologies for consumers and 2G for businesses. 5G networks will accept small, inexpensive, low-power devices, so they'll connect a lot of smaller objects and different kinds of ambient sensors to the Internet.

5G WILL ENABLE MOBILE AR/VR

So . . . what about phones? The biggest change 5G may bring is in virtual and augmented reality. As phones transform into devices meant to be used with VR headsets such as the HTC Vive (shown at right), the very low latency and consistent speeds of 5G will give you an Internet-augmented world, if and when you want it. Sprint recently demonstrated streaming wireless VR at the Copa America soccer tournament. The small cell aspects of 5G may also help with in-building coverage, as 5G encourages every home router to become a cell site.

WHAT WILL YOU NEED?

We don't know. No existing device will work on 5G networks, and as the 5G standards haven't been fully baked, no one is making consumer-ready 5G-compatible devices yet. Whatever you have, you'll need a new one to access 5G. That said, 4G LTE and Wi-Fi aren't going away; they're a key part of 5G strategy, and their performance will get better as technology advances.

WHEN IS 5G HAPPENING?

The official 5G standard, known as 5G NR (new radio), probably won't come out until 2018, with full commercial rollouts in 2019 or 2020. But that's not stopping the wireless carriers from getting a jump on the technologies.

Verizon and AT&T both insist they'll have "5G" in 2017. This won't be 5G. It'll be non-standard, pre-5G. It could be used for backhaul or home Internet, or for internally knitting together networks that customers then experience using 4G devices. T-Mobile, for its part, has pooh-poohed these pre-standard rollouts and said it'll be full in with 5G in 2020.

How DNA Data Storage Works

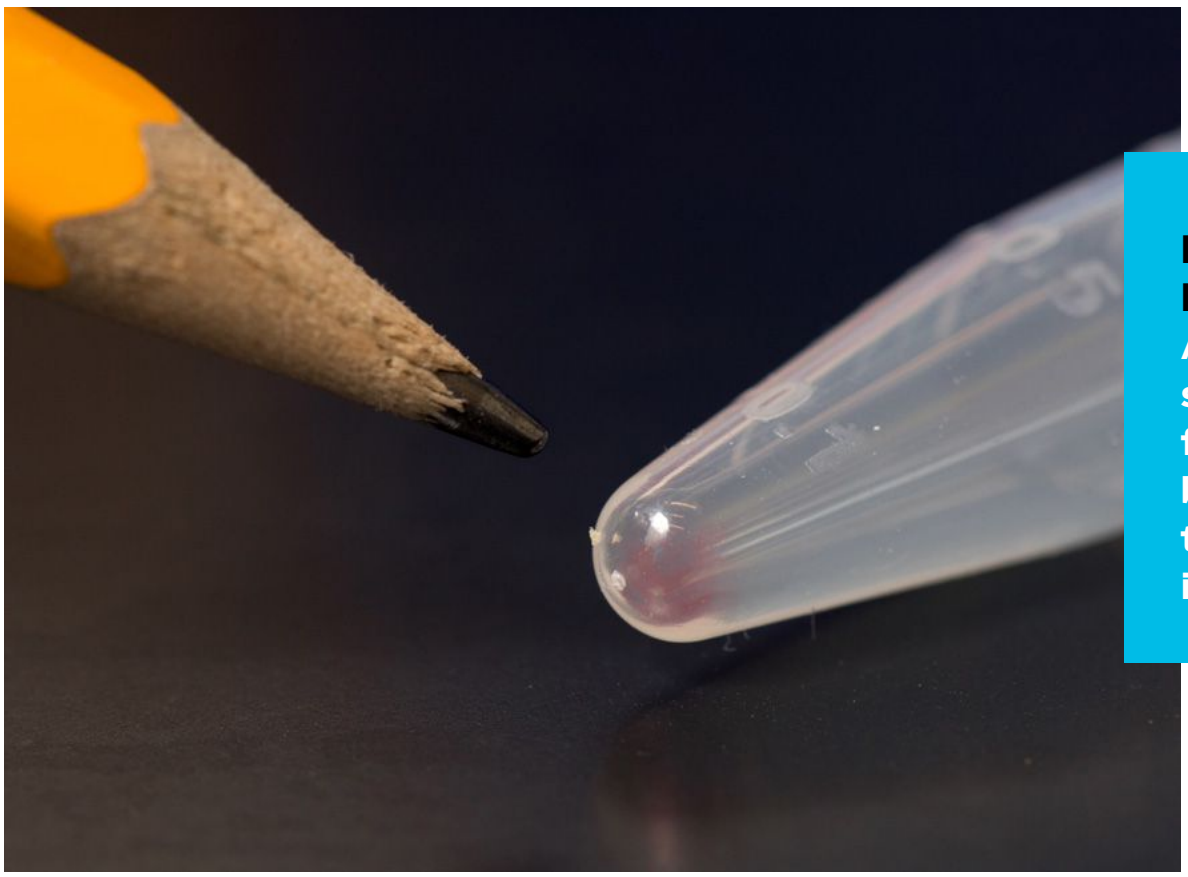
BY GRAHAM TEMPLETON

DNA data storage is a big deal. Partly, it's because we're based on DNA, and any research into manipulation of that molecule will pay dividends for medicine and biology in general. But it's also because the world's most wealthy and powerful corporations are getting discouraged by cost estimates for data storage in the future. Facebook, Apple, Google, the U.S. government, and more are all making astounding investments in storage ("exabyte" is the buzzword now). But even these mega-projects can only put off

the inevitable for so long; we are simply producing too much data for magnetic storage to keep up, without a major unforeseen shift in the technology.

That's why Microsoft recently decided to invest in the prospect of storing information with a totally different sort of tech: biotech. It might seem off-brand for the software giant, but teaming up with academics to take on molecular biology has produced stunning results: The team was able to store and perfectly recall digital data with incredible storage density. According to an accompanying blog post, they managed to pack about 200 megabytes of data into just a fraction of a drop of liquid, including a compressed music video from the band OK Go. Even more impressive, that data was stored in a quickly and easily accessible form, making it more akin to computer RAM, than computer storage.

They managed to pack about 200 megabytes of data into just a fraction of a drop of liquid.



BIOTECH BITS AND BYTES

A new DNA data storage system has broken records for information density — but the easy versatility of the system is even more impressive.

So how did they accomplish this incredible feat? First, they had to convert the digital code of 1s and 0s to a genetic code of As, Cs, Ts, and Gs, then take this lowly text file and manually construct the molecule it represents. Each of these is a feat in itself. DNA storage requires cutting-edge techniques in data compression and security to design a sequence both info-dense

KEEP IT COOL
The more tightly you pack silicon transistors, the more heat you'll create. The DNA double helix offers a great solution to heat buildup, with its super-efficient packing structure.

enough to realize DNA's potential and redundant enough to allow robust error-checking to improve the accuracy of information retrieved down the line.

Very little of the technology on display here is new, since the most important parts of the system have existed much longer than mankind itself. But if all the data necessary to code for Albert Einstein was contained within the nucleus of every single cell of Albert Einstein's body, as it was, then this classical approach to data storage must have something going for it. Researchers in this field set out to understand and harness that something, and they're getting better at it, seemingly every couple of months.

At the end of the day, DNA's key special attribute is data storage density: How much information can DNA fit into a given unit volume? The NSA's largest, most notorious data-center is an enormous, sprawling complex full of networked racks of magnetic storage drives—but according to some estimates, DNA could take the volume of data contained in about a hundred industrial data centers and store it in a space roughly the size of a shoe box.

DNA achieves this in two ways. First, the coding units are very small, less than half a nanometer to a side, where the transistors of a modern, advanced computer storage drive struggle to beat the 10 nanometer mark. But the increase in storage capacity isn't just ten- or a hundred-fold—it's thousands-fold. That differential arises from the second big advantage of DNA: It has no problem packing three-dimensionally.

See, transistors are generally aligned on a flat plane, meaning their ability to fully use a given space is pretty low. We can stack many such flat boards one atop another, but at that point a new and totally debilitating problem arises: heat. One of the most challenging parts of designing new transistor-based technologies, whether they're processors or storage devices, is heat. The more tightly you pack silicon transistors, the more heat you'll create, and the harder it will be to ferry that heat away from the device. This both limits the maximum density, and requires that we supplement the cost of the drives themselves with expensive cooling systems.

With its super-efficient packing structure, the DNA double helix offers a great solution. Chromatin, the DNA-protein system that makes up chromosomes, is essentially a very complex mechanism designed to allow an inherently sticky molecule like DNA to roll up really tight, yet still unroll quickly and easily later on, when certain patches of DNA are needed by the body.

> **We are simply producing too much data for magnetic storage to keep up, without a major shift in the technology.**

This at-hand nature of the chromatin system, which allows any gene to be "called" from any part of the genome with roughly equal efficiency, has led researchers to dub their storage system a DNA version of a computer's random access memory, or RAM. Like RAM, the physical location of a piece of data within the drive isn't important to the computer's ability to access that information.

But storing information in DNA differs from storing it in computer RAM in some pretty significant ways. Most notable is speed; part of what makes RAM RAM is that its easy-access system is also a quick access system, allowing it to hold data the computer might need at an instant's notice, and make it available on those timescales. On the other hand, DNA is significantly harder and slower to read than conventional computer transistors, meaning in terms of access speed, it's actually less RAM-like than your average computer SSD or spinning magnetic hard-drive.

That's because the incredible abilities of evolution's data-storage solution were tailored to evolution's unique needs, and those needs don't necessarily include performing thousands of "reads" per second. Regular, cellular DNA data storage has to untangle the complex chromatin structure of stable DNA, unwind the DNA double helix itself, make a copy of the sequence of interest, then zip everything right back up the way it was. It takes a while.

For our purposes, we must then add the extra step of reading the DNA. In this case, that's achieved by using an age-old technique in biotech labs called the polymerase chain reaction (PCR) to amplify, or repeatedly duplicate, the sequence we want to read. The whole sample is then sequenced, and everything but the many-many-many-times repeated sequence we amplified is discarded. What remains is our sequence of interest. These stretches of DNA are marked with little target sequences that allow the PCR proteins to bind and the replication process to begin.

In cells, genes are turned "on" and "off" largely by changing the availability of these target sequences to the always-waiting machinery of DNA replication. This can be done via the winding and unwinding of chromatin, the direct addition or removal of a blocker protein, or even interaction with other areas of the genome to promote or preclude transcription. In a man-made data-storage system, we could theoretically make something better suited to our needs—stronger, or more efficient, or less wasteful on forms of security we don't need for this purpose. But that will require a level of sophistication in protein engineering that still seems distant.

Cadillac's Slick, High-Tech 2016 CT6

BY TOM BRYANT

Loathe to be seen as a carmaker whose luxury brands' popularity peaked in the 1950s, General Motors has tried everything from making smaller cars with European-style looks and handling to airing "Is that a Buick?" TV commercials aimed at millennials.

The company's latest effort, in full splendor on the new Cadillac CT6, involves packing as much technology as it can into its luxury cars. Cadillac already offers

IS THAT A CADILLAC?

From the rearview mirror's integrated HDR display to the haptic feedback touchpad, the CT6 is not your father's Caddy.

high-tech features such as 4G LTE hotspots in its entire consumer model range. With the CT6, though—a new offering for the 2016 model year—the company is blurring the lines between concept and production car, both inside and out.

Outside, you'll find a car that more closely resembles a Mercedes-Benz S-Class or BMW 7 series than the 1990s-era Caddys tooling around the average nursing-home parking lot. During *PC Magazine*'s recent test drive, a tollbooth operator who said he was a retired auto factory worker ogled the car, exclaiming that its black metallic paint "must be European."

As head-turning as the outside is, the inside is even more impressive. This is a car of firsts, from a rearview mirror with built-in streaming video to a twin-turbo V6 featuring auto stop/start and cylinder deactivation. When the first CT6 rolled off the production line last year, Karl Benz must have rolled over in his grave.

As head-turning as the outside is, the inside is even more impressive. This is a car of firsts.

BEEN THERE, SEEN THAT

The CT6's rearview mirror's very wide screen offers the driver a field of view four times greater than what's found in a standard rearview mirror.

NO HDR ON TV YET? TRY THE MIRROR

Planning tech integrations for a car like the CT6, a fair number of which will likely end up in black-car fleets, is always a challenge for automakers: They have to distribute features evenly for private owners who drive themselves as well as for high-paying customers who sit in the back seat.

A BETTER VIEW
Activate the HDR-enabled rearview mirror's LCD for a live video feed from two rear cameras. It helps to reduce glare and gives you a crisper image in low light.

The CT6's rearview mirror aims to please both. With its integrated screen turned off, it's just an ordinary mirror. But activate the LCD display, with a resolution of 1,280-by-240 pixels, and you get a live, high dynamic range (HDR) video feed from the car's two rear-facing cameras.

Cadillac says the extraordinarily wide screen offers the driver a field of view four times greater than what's found in a standard rearview mirror. It's also good for rear-seat passengers, who won't feel the need to duck if their chauffeur needs to back out of a parking spot or change lanes.

The mirror takes some getting used to. If you already have an HDR-enabled TV, you won't be impressed by its image quality. Cadillac's engineers used HDR technology primarily to reduce glare and allow for a crisper image in low-light situations. Don't expect colors to pop on this display.

Perhaps what requires the biggest learning curve is the extraordinarily wide field of view. It's so wide that you can see all six lanes of a clogged urban freeway at once, or a car backing out of a parking stall several spots away. That's distracting at first, but once I activated the screen, I never looked back—er, I never reverted to the normal mirror.

The HDR mirror is something you'll want to try out extensively in a test drive at night and during the day. It shows some glare in the midday sun, as well as graininess around dusk. If you don't want to use the mirror during those times, it's perhaps one of the easiest of all the CT6's electronic accessories to deactivate. You just flip the black tab on the bottom of the screen—no fiddling with settings in the infotainment system.

It's still early days for HDR technology, and the CT6 is the first road-legal car with this type of mirror. But other manufacturers, including BMW, are also testing the technology, so expect it to be an option on more cars in the near future.

CUE THE TOUCHPAD

To help CT6 owners control the Cue infotainment system, Cadillac installed a touchpad in the center console, just forward of the elbow rest. It's certainly not the first car to feature a touchpad: The German luxury brands also have them as standard or as options. What makes this one unique is its haptic feedback option. There's no cursor on the screen, so to alert you when you scroll to a new menu selection, the touchpad will briefly vibrate, similar to how 3D Touch works on the iPhone 6s.

When you scroll to a new menu selection, the touchpad will briefly vibrate, similar to how 3D Touch works on the iPhone 6s.

TOUCH AND GO
The CT6 has a touchpad in the center console to help owners control the Cue infotainment system, which features apps for navigation, climate, and more.

An iPhone this isn't, though. The pad's response times were atrocious, even when I maxed out the sensitivity settings—to the point where I was experiencing several haptic clicks all at once as I tried to scroll through menu items. I quickly turned off the haptic feedback.

CUE DASHBOARD SCREEN
You'll want to be careful about using this interface while also keeping your eyes on the road.

Even with the responsiveness issues, the touchpad is still a useful way to control the Cue system. Not only does it prevent fingerprints from accumulating on the touch screen, but also the CT6's dashboard screen is large enough that many drivers will find it uncomfortable and perhaps unsafe to reach the entire display.

The Cue interface itself is well designed and feels more intuitive than Audi's MMI, which *PC Magazine* used extensively on the A4s Silvercar loaned us for our Fastest Mobile Networks drives. Instead of the proprietary MMI screen layout, Cue is more like your average Android smartphone: apps like navigation, climate, and more show up on the home screen, and you simply tap them to open.

The Cue system on the CT6 I tested also included Android Auto and Apple CarPlay. Unfortunately, the touchpad isn't compatible with CarPlay, but the steering-wheel audio controls are. To wake up Siri, you simply long-press the voice command button. (A short press activates Cue's own digital assistant, which understood me remarkably well, especially when I was entering navigation commands).

YOUR CT6 IS WATCHING YOU

There are seven exterior cameras on the CT6. Although that number pales in comparison to the 34-speaker Bose sound system, they make the CT6 feel a bit like a filming platform for a Hollywood car chase.

In addition to powering the rearview mirror, night vision, and auto parking systems, the cameras can also be configured to record footage on an SD card in the trunk. There are two recording modes: one will cycle through four of the seven cameras while the car is stationary. That's primarily useful for people who are paranoid about people keying their CT6 or otherwise vandalizing it (remember, this is a head-turning car).

The other mode records video while you're driving, Russian-dash-cam-style, and at least on paper it sounds exciting. Unfortunately, it's limited to displaying the front and rear camera views, and at painfully low frame rates, so don't expect it to provide jaw-dropping footage of your coastal road trip.

"The Cue system on the CT6 I tested also included Android Auto and Apple CarPlay."

KEEPING WATCH
The rear cameras can be configured to record footage on an SD card in the trunk.

The recording options can be configured via the Cue system. You can also play back footage on the in-dash center screen while the car is stationary, in addition to removing the SD card from the trunk to import the video to your computer.

While the CT6 owners probably won't use their cars for donuts, drag races, or other stunts, owners of GM sports cars would certainly appreciate more nuanced controls for the surround video recording system, if it's ever extended to those models. Cadillac does offer a performance data recorder system on V-Series cars, which allows drivers to record, view, and analyze their driving experiences with real-time video, cabin audio, and performance data.

FUN IN THE BACK SEAT

While most of its innovative tech is in the front, the CT6 also pampers its rear-seat passengers with features they'd expect from a Benz or Beemer. You'll find two 10-inch monitors and wireless headphones for audio. There's a built-in Blu-ray player accessible from the back seat, and the system will also play back content streamed from devices connected to the car's Wi-Fi network. The device has to be Miracast-enabled, which means Android 4.2 or later. Apple iOS doesn't support Miracast, though Cadillac suggests that Apple users download a third-party app with Miracast support to connect.

To skip that hassle, you can also plug a Chromecast, Apple TV, or other streaming stick into the included HDMI port and wirelessly stream content that way. Leave the device plugged in while you're at your meeting to curry favor with your chauffeur, who can display the inputs from the rear seats on the front screen while the CT6's transmission is in park.

The wireless remote included with the rear-seat entertainment system works similarly to the one that comes with your TV at home. It controls each screen individually, with a slider at the bottom allowing you to toggle between them. When you're not watching video, press the remote's power button, and the screens automatically slide out of view into compartments built into the backs of the driver and passenger seats.

“The CT6 also pampers its rear-seat passengers with features they'd expect from a Benz or Beemer.”

Other back-seat niceties in our test car included heated and ventilated seats that also reclined. The automatic rear sunshade and two manual side shades are great for keeping out the heat and prying eyes. If you want a view, you can always gaze out of the giant sunroof, which extends into the rear compartment.

AN IMPRESSIVE PRICE

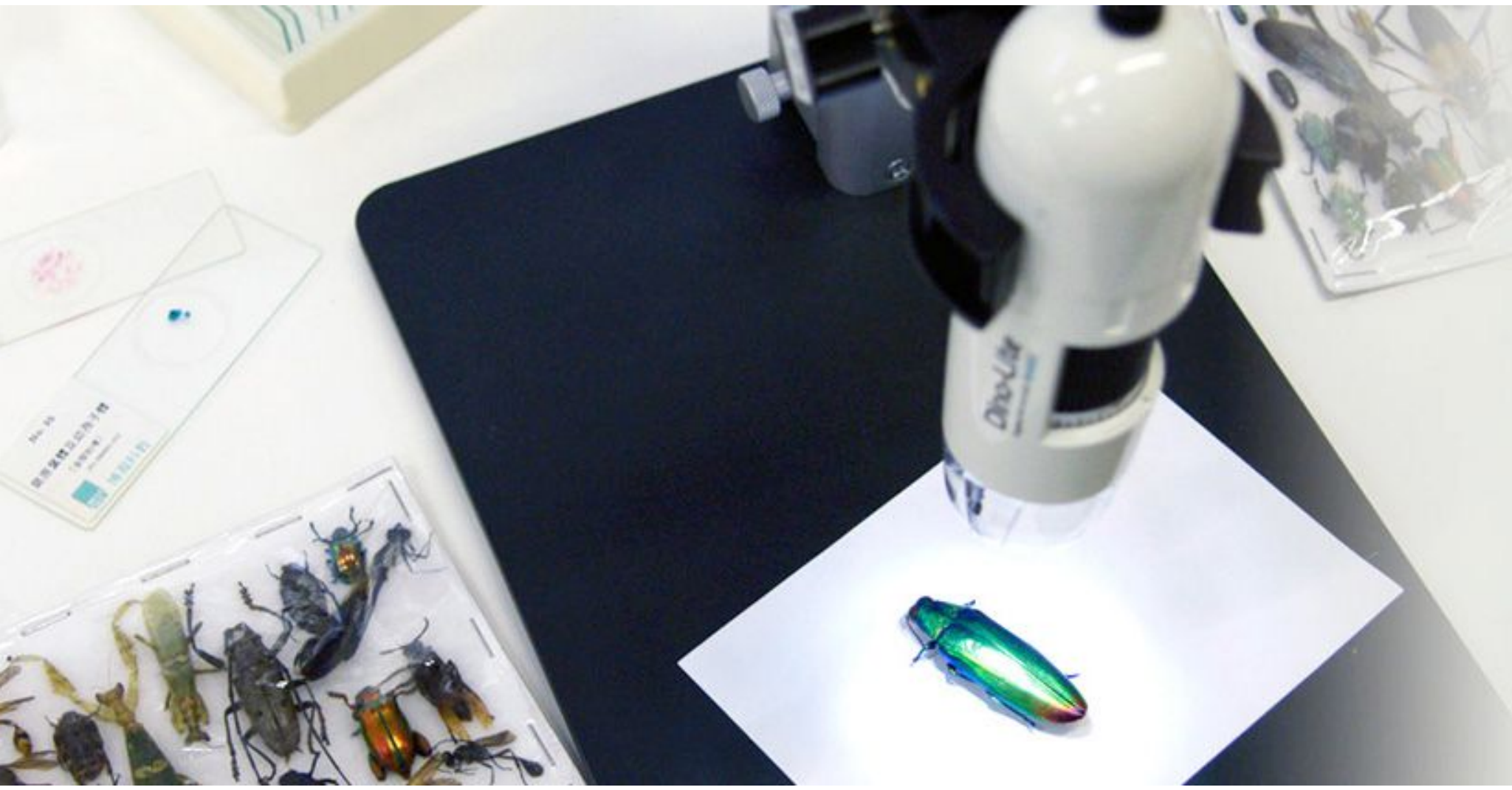
The mirror, cameras, and entertainment system barely scratch the surface of all the other technology you'd expect to find in the CT6. Along with night vision, adaptive cruise control, and automatic parallel parking, they make the CT6 fun to drive. Strip all the tech away, and you get an ordinary luxury car. Sure, you can easily understand whispers while going 70mph on the highway, and its ride is less, uh, boaty than Cadillacs of old. Ultimately, though, you'll buy this car for what's in the cabin rather than under the hood.

Speaking of buying, the CT6's price is also very impressive relative to its competition. Our test car, with a 3.0L twin turbo V6, came to $87,465 before delivery charges. The cheapest Mercedes S-Class, the S550, starts at $95,650, and a fully optioned S600 can push $200,000.

You'll still have to come to terms with the fact that despite all that technology, you're driving around (or being driven around) in a Cadillac. That said, GM's efforts to rid itself of Cadillac's stodgy reputation may be working: Other than the test car, the only CT6 I've ever seen was parked at a tony tennis club in the San Francisco Bay Area that's frequented by software engineers, UC Berkeley professors, and more than a few Bernie Sanders supporters.

What We Love Most This Month

BY STEPHANIE MLOT



DINO-LITE DIGITAL MICROSCOPE AM2111

Clunky desktop microscopes are so last century. The Dino-Lite Basic AM2111 is a digital tool that aims to stimulate interest and excitement in science. Boasting magnification from 20x to 200x, the scope can record observations as images or videos directly to a Windows or Mac computer via USB—a luxury the ancient Greeks certainly didn't have. The lightweight instrument measures only 0.22 pounds, so it's easy to transport to and from school or the lab.

$99 dino-lite.com

What We Love Most This Month

BY STEPHANIE MLOT

OSMO WONDER KIT

Apps like Pokémon GO entice children to get off the couch and into the real world. Osmo, though different in its approach, does the same: The kid-themed kit turns mobile games into physical activities. The Wonder Kit comes with a base and reflector—a small mirror that snaps over an iPad's front-facing camera to virtually register a player's movements. It also features six iOS titles and the pieces needed to interactively learn. The less expensive Starter Kit ($79) includes only four games, and the premium Complete Kit ($189) adds one game and some accessories (a creative board, dry-erase markers, and a fuzzy pouch).

$145 playosmo.com




What We Love Most This Month

BY STEPHANIE MLOT

NEO SMARTPEN N2

Not everyone is allowed a laptop or tablet computer in the classroom, but transcribing handwritten notes—especially those half-asleep scribbles—can be torturous. Enter the Neo smartpen: It writes like a conventional ballpoint, but when paired with Bluetooth, turns hard-copy notes into digital records. Simply jot notes into a compatible N notebook, then study them on the go with your smartphone via the Neo Notes app. Entries can sync with Evernote and shared with friends who missed the day's lesson.

$169 shop.neosmartpen.com

What We Love Most This Month

BY STEPHANIE MLOT

ORION TI-84 PLUS TALKING GRAPHIC CALCULATOR

Math is daunting enough without the added hurdle of not being able to see the calculator. The American Printing House for the Blind partnered with Orbit Research and Texas Instruments to produce the Orion TI-84 Plus Talking Graphing Calculator—a modified number-cruncher with an additional six function keys, five cursor keys, and stereo speakers. Users can explore graphs via spoken announcements or "sonograph" audio and haptic (vibrating) feedback.

$599 aph.org




What We Love Most This Month

BY STEPHANIE MLOT

AMAZON FIRE KIDS EDITION

The Amazon Fire Kids Edition is not a toy: It's a full-featured tablet with a 7-inch screen for watching *Frozen* (again), a quad-core processor for playing Angry Birds (still), and front and rear-facing cameras to capture every moment. The Fire Kids Edition also comes with a year of FreeTime Unlimited—a hand-curated subscription of 10,000-plus kid-friendly books, movies, TV shows, educational apps, and games. Best of all, the Kid-Proof Case (available in three colors) promises protection against drops, bumps, and other kid mayhem.

$99.99 amazon.com

The Hidden Threat in Verizon Buying Yahoo

Oh, how the '90s have fallen. In its second purchase of an iconic mid-1990s Internet company, Verizon will soon buy Yahoo, according to Bloomberg, wrapping it up with AOL into an even bigger bundle of financially failed Internet content sadness.

I don't have an opinion on the financial sense of this deal. Smarter financial minds say that all of Yahoo's actual financial value consists of Yahoo Japan and its stake in Chinese e-commerce site Alibaba, meaning that the Web services, content, and advertising elements we see here in the U.S. are worth less than zero.

The deal is more meaningful because it makes Verizon's post-saturation growth strategy clear. We've reached a point in America where everyone who wants a cell phone has a cell phone. That's called saturation. If they don't develop new businesses, the wireless carriers will be able to make money only by raising prices or stealing customers from one another. Cable companies reached this point a while ago, so they keep merging and raising prices. But the U.S. government, at least under Obama, for now, has said that the four major wireless carriers can't merge. So they need to get more creative.

Sprint and T-Mobile, each half the size of Verizon, can grow by picking off the weak subscribers from AT&T and Verizon. But the two bigger carriers need other ideas. AT&T's strategy,

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for a few years now, has been to become the default carrier for cars, home security systems, and other non-phone devices. This is super smart, because those devices have high purchase and/or installation costs, and if they're carrier-locked or designed for only one carrier, they're very difficult to switch between carriers. They become very sticky users.

Verizon's plan seems to focus on becoming a content and advertising company. It'll offer preferred access to its 120 million wireless subscribers and its millions of DSL and FiOS subscribers through its own ad products, and it'll let those advertisers reach other users through its content sites. Meanwhile, Verizon will harvest massive amounts of user behavior data to better target more ads and content. This isn't much different from Google's and Facebook's strategies, and they're hugely successful.

Yahoo adds some meat to Verizon's ad sandwich. According to eMarketer, Verizon had about $1.33 billion in ad revenue last year to Yahoo's $3.28 billion. (Google had $53 billion.) Bloomberg says the company has 200 million visitors of various sorts. Yahoo's revenue is on the decline, according to eMarketer, so presumably Verizon thinks it can turn things around through better management.

With its huge, semi-captive audience, making money through becoming an advertising platform may be a good idea for Verizon. But the company's attempts to branch out into content have fallen really flat. Other than letting AOL's existing websites, such as Engadget, just plug along (and Engadget's site ranking has been going down for the past year, according to Alexa), Verizon's biggest new content offering has been a streaming service called go90, which even Verizon admitted was "overhyped."

Does this approach endanger the free and open Internet? Of course it does. Any unholy combination between service provider and content offering means that the service provider may prefer its content offering over that of others. This doesn't mean Verizon would damage Google or Facebook access—users want those sites too intensely—but maybe just that smaller ad providers and content networks wouldn't get priority or very good customer service from a carrier incentivized to promote its own products. Yes, users can switch wireless carriers, but the smothering of other ad networks and upstart content providers wouldn't necessarily be obvious to end users.

Verizon has come out in support of basic net-neutrality principles, pointing out that since it owns AOL, getting into a blocking-and-throttling war with other network providers would damage its own content sites. But the regulators need to keep a close eye on this Yahoo transaction and on Verizon's business going forward, because there are sneakier ways to slowly suffocate competing ad providers—especially when your company's new strategy seems to be to become an advertising powerhouse.

"Verizon will harvest massive amounts of user behavior data to better target more ads and content."

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Autonomous Cars Will Usher in Things We Never Saw Coming

Despite all the hysteria around the recent Tesla Autopilot crash, there's no doubt that full self-driving cars are coming. We just have no idea what a future world of autonomous vehicles will look like.

We know that they'll reduce car accidents, time wasted in traffic, parking hassles, and probably road rage. But there are also big unknowns, and not just about mundane aspects of self-driving technology such as insurance, liability, and vehicle ownership. We'll encounter things we never saw coming.

To help people—at least those my age, give or take a decade—understand the unforeseen impact of self-driving cars, I ask you to think back 20 years, to when the Internet was still in its dial-up infancy. Imagine that in 1996, you had told someone that in 20 years we would use the Internet to post pictures of food online so that our family and friends could view and comment on them; that people would post their observations and thoughts on the Web 140 characters at a time—and that it would help overthrow governments; or that you would be able to view cute cat videos at any hour of the day.

Car tech expert Doug Newcomb has written for *Popular Mechanics*, *Road & Track*, and other publications, and is the author of *Car Audio for Dummies*.

No one can predict the future or exactly how self-driving cars will remake our means of moving around in metal containers with wheels. But I recently ran across a blog post by Jan Chipchase, the founder of the research and design consultancy firm Studio D Radiodurans, which is an interesting—and at times, scary—take on what to expect.

Whether or not Chipchase's forecasts, which are "inspired by a session with an automotive client," are accurate, his insights further confirm that we have no idea what's down the road.

CARBAITING, CONVOYADS, AND DRINGERS

I'm sure that some of Chipchase's predictions are already occurring as Google's autonomous vehicles (AV) are tested in California. Car baiting, for example, is "an action by a human to trigger a response from an autonomous vehicle."

Chipchase also notes that "motivations include … the very human enjoyment of being mischievous," such as stopping suddenly in front of an AV or seeking "financial rewards from an insurance claim."

I can also see ConvoyAds, or self-driving cars plastered with ads driving around a city, occurring sooner than later. Modesty windows, which "will sense when the vehicle's occupants are asleep and/or engaged in a highly personal activity," are also totally foreseeable.

But others give us a glimpse of what an autonomous vehicle future may hold. Closely related to car baiting, "drone-car baiting" employs "UAVs to trigger a response from an autonomous vehicle, from the annoyance of setting off a car alarm by landing on its roof to flying close to its sensors to force [a] non-

avoidable accident event." Chipchase foresees this leading to autonomous vehicles "adopting anti-drone defenses."

For various reasons (to deter ConvoyAds, for example), Chipcase suggests municipalities may restrict self-driving cars in certain ways—for example, requiring that someone be in the vehicle at all times. That where a "dringer" comes in: someone hired to function as the car's babysitter. "The legal boundaries between jurisdictions will be marked by clusters of hired-on-demand humans waiting to dring," Chipcase writes.

Perhaps most disturbing (and unfortunately, not farfetched) is AVBIED, or autonomous vehicle–borne improvised explosive devices. Chipchase notes, "As anyone who has spent time in a city where VBIEDs are common will attest, you'll never look the same at a vehicle again."

Luddite hardcore car enthusiasts who fear that the pleasure of human driving will be taken away will be forced to "go vinyl" and drive "full manual." Let's hope that in 20 years that won't be illegal.

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"Self-driving cars are coming. We just have no idea what a future world of autonomous vehicles will look like."

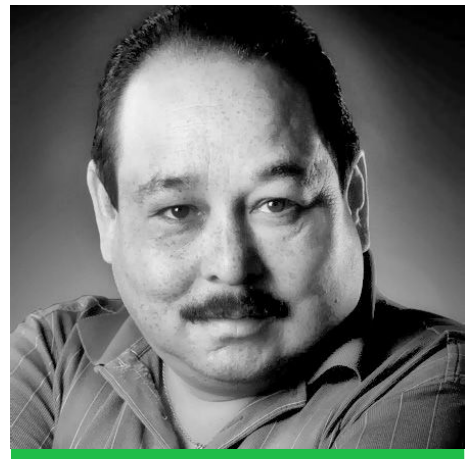
Apple VR? Don't Hold Your Breath

In late February, I argued that Apple needs to get into VR soon. But here we are, some six months later, and the best we have is Tim Cook saying AR and VR are interesting, during an earnings call. I understand that Apple is not one to jump on a trend right away, but I decided to take a closer look at why Apple might be avoiding VR for now.

As most Apple watchers know, Cupertino tends to watch a new technology enter the market and study closely what type of interest and impact it has. Then, if Apple sees the technology has real demand, the company introduces its own version, which can be tied to its large ecosystem of apps and services.

Apple did not invent the PC. But it improved upon the concept with the Mac, which introduced the mouse, graphical user interfaces, and smaller floppy drives. Apple also did not invent MP3 players, but the iPod quickly eclipsed all competitors.

I believe that as Apple is eyeing VR, it's viewing it as it did the early MP3 player market. Although some early VR headsets are picking up steam with gamers and early adopters, I don't believe this is a market in which Apple has a high interest. For one thing, these devices are not high volume. And at the low end, which includes the Samsung Gear VR, they are low quality.



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

So, the big question is, when will Apple enter the VR space? As I look at what is in the market today, I really don't believe that Apple will introduce a tethered solution or low-end headset powered by an iPhone. I think Apple should enter this market with a powerful, standalone device.

Knowing Apple, I suspect it would also opt for very high-quality optics and make the overall VR experience a fully hands-free one as much as possible by applying AI via Siri for many levels of input and navigation. Then it would create a special VR-optimized version of iOS and deliver a dedicated SDK for developers.

My best guess is that Apple still needs more powerful mobile processors and GPUs to pull this off. What is interesting is that in talking with key semiconductor players, I've found that they too don't believe a tethered headset will ever gain mass-market adoption. I suspect Apple will need at least another one or two years to advance its A series processor before it can go in an Apple-acceptable VR headset.

So I don't expect Apple to enter the VR space anytime soon. But if history is our guide, even if Apple is "late" to the VR game, it could end up delivering one of the best solutions and driving unit sales in the millions per month. Of all the players out there, Apple is probably in the best position to bring VR to a mass market.

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Nikon's Top-of-the-Line SLR Edges out Canon

PC MAGAZINE EDITORS' CHOICE

If you're in the market for a true pro-grade SLR—one with a huge battery, a build that's going to withstand the rigors of daily use, a full-frame image sensor, and a focus system that can keep up with high frame rates—you have two real choices: Canon or Nikon. If you land on the Nikon side of the fence, its latest top-tier model, the D5 ($6,499.95, body only), gives owners of the D4 and D4S serious reasons to upgrade. The new camera features a redesigned autofocus system with 153 individual focus points, an updated image sensor with more resolution and excellent low-light quality, and 4K video recording. It just barely edges out the rival Canon EOS-1D X Mark II to earn Editors' Choice honors in its class, inheriting the title from the D4S.

Nikon D5

$6,496.95

DESIGN AND CONTROLS

Nikon sells the D5 in two versions—one with dual XQD memory-card slots and another with dual Compact Flash (CF) slots. They're priced the same and are physically identical aside from the memory-card slots.

The D5 is one of the largest SLRs you can buy. It measures 6.2 by 6.3 by 3.6 inches (HWD) and weighs 3.1 pounds without a lens attached. The large body incorporates an integrated vertical shooting grip—with smaller bodies like the D810 (3.9 by 5.8 by 3.3 inches, 2 pounds), that's an optional add-on. The huge battery is rated for 3,780 shots by CIPA, more than three times that of the 1D X Mark II. There's no built-in flash, but that's not a big deal for pro users—it's not a feature that you'll find on a camera of this type.

A TRUE PRO-GRADE SLR
The Nikon D5 features a 20.8-megapixel full-frame image sensor and a focus system that can track action while shooting at 12fps.

There's nothing less than pro-grade about the D5's body. Its chassis is magnesium, finished in matte black and covered with textured rubber in places that you'll hold on to. It has extensive sealing to protect the internal electronics from dust and moisture, so you can use the D5 in almost any environment. And it's built for the long haul—its shutter is rated for 400,000 images, which is a number you may hit when shooting at 12fps.

Nikon D5

PROS Fast 153-point autofocus system. 12fps continuous shooting. Strong high ISO image quality. 20MP full-frame image sensor. Tough, durable build. 3.2-inch touch LCD. Clean HDMI output. 4K video capture. Available with dual XQD or CF slots.

CONS 4K video is cropped. Underwhelming autofocus for video. No Wi-Fi or GPS. Omits in-body flash.

The optical viewfinder is rated at 0.72x magnification and is quite bright and clear. The area of focus coverage is marked by a thin black outline, and active focus points light up in red; a framing grid can also be displayed. Exposure settings run along the bottom, below the image, in crisp blue LED lighting. The current EV compensation setting is shown to the right of the image.

The D5 uses a 3.2-inch LCD with touch input capability and a 2,359k-dot resolution for Live View photography and image review. The LCD is bright and extremely crisp. Touch input is a bit limited—you can't use it to navigate menus, but you can swipe through photos during review, and double tap or pinch to zoom in to check focus.

The dual memory card slots are covered by a locking door—you need to lift a plastic flap and press a button to open it. Depending on which version of the D5 you buy, you'll get dual XQD or dual CF slots. The battery slides out of the grip with the twist of its removable locking cover (so you can store the D5 without a battery, but with the compartment still sealed). The charger that ships with the camera can handle two batteries simultaneously, but only one is included.

PERFORMANCE AND AUTOFOCUS

The D5 won't leave you wanting in terms of speed. It starts, focuses, and fires in about 0.4-second. In bright light, it locks focus almost instantly, although it can slow to about 0.3-second in very dim conditions. If you use Live View for focus, expect about a 0.5-second delay as the camera locks on and fires an image, both in bright and dim light. The D5's focus system can lock onto targets in light as low as -4EV, about as bright as the illumination given off by a waning gibbous moon.

SIZEABLE SENSOR
The D5's full-frame image sensor is larger than sensors found in DX format SLRs, such as the Nikon D500.

Burst shooting is possible at up to 12fps with focus and exposure adjusted for every shot, or up to 14fps with the mirror locked in the up position. When shooting at 14fps, you won't be able to see the scene as it changes, which limits its practicality. When shooting Raw+JPG the D5 can keep the 12fps pace for 84 shots, with a minimal delay before being able to shoot again, or for 200 Raw or JPG images. With either of those formats, you can start shooting again almost immediately after the 200-shot limit is reached. Those results are based on testing the XWD version of the camera with Lexar 440MBps memory installed.

The D5 has the most advanced autofocus system that Nikon has put into a full-frame camera. It features 153 phase detection sensors, 99 of which are the more sensitive cross-type and 15 points that can be used with lenses with a maximum f/8 aperture. You can't manually select each and every point, as only 55 are visible in the viewfinder; the extra sensors are used to better track moving subjects.

Focus can be set to single or continuous mode, and you can set the system to choose a point automatically, select a single point manually, or leverage the Group AF function. It acts like the single point selection, so you can still move it around using the rear joystick, but looks for focus across a wider area. The entirety of the focus points cover about the width of an APS-C image sensor, so you don't get coverage up to the edges of the frame. The Nikon D500 pairs the same focus system with an APS-C (DX) format image sensor, so coverage extends almost to the edge of the frame.

Most SLRs can lock focus on static subjects with aplomb. The D5's strength is in continuous autofocus, and its ability to shoot away at a high frame rate while keeping moving targets in crisp focus. In AF-C mode, the D5 does just that. It has a number of different, movable focus points—including both a single point and Group AF, and movable 9-point, 25-point, and 72-point

The D5 has the most advanced autofocus system that Nikon has put into a full-frame camera.

selection areas. It also has a dynamic 153 area selection, which uses the entirety of the focus system, and an automatic point selection mode.

But the real strength of the Nikon system, and what sets it apart from the Canon 1D X Mark II, is its 3D tracking function. In this mode, you have a single focus point (which can be manually moved around the frame), and once you've used it to lock focus on a target, the camera moves the point around to follow said subject. It works exceptionally well, as long as the subject remains within the area of the frame that the focus point covers. It's very useful for tracking subjects as they move through the frame, and also works well for portraiture—set the point on your subject's eye and it will stay there, even if the subject moves or if you move the camera to recompose the shot.

There's another neat feature offered by the focus system—automatic calibration. Like the D500, the D5 can use its contrast-based Live View focus system to determine if the phase detection system isn't properly focusing with a lens and dial in an offset based on any discrepancy, to ensure that a particular lens catches subjects in crisp focus.

A SHOT IN THE DARK

The top LCD and rear control buttons are backlit, making it easier to operate the camera in dim light.

IMAGE AND VIDEO QUALITY

The D5 uses a 20.8-megapixel full-frame image sensor, an increase in resolution from the 16-megapixel sensor used by the D4 and D4S. I used Imatest to check the amount of noise that the sensor records when its ISO is pushed—and you can push the D5 far, all the way to ISO 3276800. When shooting JPGs at default settings, noise stays under 1.5 percent through 12800, and under 2 percent through ISO 51200. The camera isn't at its best at ISO 12800—there's some very fine detail visible in ISO 6400 images that's smudged at ISO 12800—but images are certainly useable. As you move to higher sensitivities, image quality suffers. At ISO 25600 and 51200, details are blurrier and become downright muddy at the top native setting, ISO 102400. The extended settings, ISO 204800 and beyond, are very rough, with objects becoming almost unrecognizable from ISO 819200 through the top setting. They'll help you get a shot if you're staking out a suspect, but aren't useable for fine art work.

“The D5 also supports Raw capture, which will net you crisper, more detailed results at higher sensitivity settings.”

The D5 also supports Raw capture, which will net you crisper, more detailed results at higher sensitivity settings. Images are packed with detail, with little distracting noise through ISO 25600. At ISO 51200 there's a grainy quality, but details are still very clear. Noise starts to overtake photos and detract from clarity at ISO 102400. You can get away with shooting at ISO 204800 if you don't mind an image with rough, excessive grain, but if you move beyond, image quality falls apart. Still, those are fantastic results; the Canon 1D X Mark II falls behind the D5 by about a stop in terms of high ISO noise control.

The D5 has taken some criticism for a lack of dynamic range when compared with its predecessors. This is evident when you attempt to pull detail out of the shadows in Raw images, especially those shot with a wide range of exposure in a single scene and at a lower ISO. When you brighten the shadows to show more

A MULTITALENTED DISPLAY
The rear LCD supports touch control for image review and to select a focus point in Live View mode. The Live View toggle button is located beneath the LCD; it's surrounded by a switch that toggles between video and still modes.

detail, you'll see more noise than with other Nikon cameras, including the D500 and D810. But when you're shooting in challenging light, the D5's high ISO capabilities outshine the competition, a plus for photographers who need to shoot at very short shutter speeds to freeze fast-moving action. The D5's shutter can fire as quickly as 1/8,000-second, and long exposures are possible at durations of up to 30 seconds, with longer bulb and timed exposures possible when shooting in Manual mode.

Video capabilities are strong. The camera records crisp 4K footage at 24, 25, or 30fps to internal memory in QuickTime format, and it can record in 1080p and 720p at standard frame rates up to 60fps. Video recorded to a memory card is compressed, but the D5 can output an uncompressed 4K signal over HDMI, so you can use a field recorder. When the camera launched, 4K recording was limited to 3 minutes per clip, but a firmware update has extended this limit to the more common 30-minute duration.

When you're shooting in 4K, the footage is cropped by about 1.5 times, mimicking the field of view delivered by an APS-C image sensor. This limits your ability to record footage with an ultra-wide lens. You do have the option of using DX lenses, which are made for the APS-C format, so you can use a lens such as the AF-S DX Nikkor 10-24mm f/3.5-4.5G ED or Sigma 8-16mm F4.5-5.6 DS HSM to compensate for the crop.

You can record in 1080p or 720p without a crop, using the full width of the sensor. Alternatively, to shoot extreme telephoto video, a 3x crop mode is available in 1080p. It uses the central 1080p (1,920 by 1,080 pixels) area of the sensor only.

The D5 uses contrast-based focus for video and Live View. It's accurate and fast, but it does have to move past the point of peak focus and quickly return to

it to lock onto a target. This quick back-and-forth effect is distracting. You'll get the best results by locking focus before starting a shot and manually focusing when required. Mirrorless cameras such as the 4K-capable Sony Alpha 7R II and SLRs with on-sensor phase detection, including the Canon EOS-1D X Mark II, are better choices for autofocus video, as there's no back-and-forth when acquiring focus.

The sound quality from the internal mic is what you'd expect—it picks up voices clearly when the subject is close to the camera, but it also picks up a lot of background noise. You'll want to invest in an external mic for serious video work.

CONCLUSIONS

If you want a top-end SLR that can keep focus locked on moving subjects, shoot at an incredible burst rate, and deliver the image quality you expect from a full-frame system, you have two excellent options among current models: The Canon EOS-1D X Mark II is one, and the Nikon D5 is the other. You'll pay a premium for either choice, but you'll walk away with an excellent camera that is built to withstand demanding use.

But for photographers on the fence, the answer isn't as transparent. The D5 and 1D X Mark II are very close in performance. The Canon earns points for its video autofocus capability, shadow recovery, built-in GPS, and higher maximum shooting rate, and Nikon wins the battle in high ISO image quality, battery life, and automatic focus calibration. The D5 also has a leg up in terms of pure video quality, supporting uncompressed 4K output, even though it isn't as convenient for autofocus. And it has some ergonomic benefits, including a sharper rear display and backlit control buttons. For this reviewer, the decision comes down to the autofocus system. The D5's is just a bit snappier, and its 3D tracking system gives you more control than Canon's. The capabilities of the 1D X Mark II and the D5 are both top-notch, but the D5 has a slight overall edge and earns our Editors' Choice recommendation for high-end SLRs.

JIM FISHER

A Unique Unlocked Android Phone, With a VR Headset

Alcatel Idol 4S

$399

The Alcatel Idol 4S ($399, 32GB) is a sign of the times. Rather than coming in a typical cardboard box, the phone comes inside a companion VR headset. It's also bundled with a bunch of other free accessories, including JBL earphones, a collection of Incipio cases, and a tempered-glass screen protector. With all that swag, you might worry that Alcatel is trying to distract you from the quality of the phone. But the Idol 4S has a sleek glass-and-metal build, a gorgeous Quad HD AMOLED display, and strong performance. It can't beat the OnePlus 3, but it brings something different to the table and offers good value for the price.

DESIGN AND FEATURES

If it wasn't for the Alcatel logo on the back, you probably wouldn't be able to tell that the sleek Idol 4S is the successor to the far less glamorous Idol 3. The front and back are both covered in glass that's held in place by a strip of metal running along the sides. It's like a cross between the OnePlus X and the Samsung Galaxy S7. The back of the phone doesn't feel slippery, though it picks up fingerprints and smudges, so you'll probably want to use one of the cases that it comes with.

At 6.06 by 2.97 by 0.28 inches (HWD) and 5.26 ounces, the 4S is remarkably svelte. It's thinner and lighter than the OnePlus 3 (6.01 by 2.94 by 0.29 inches, 5.57 ounces) and the Apple iPhone 6s Plus (6.23 by 3.07 by 0.29 inches, 6.77 ounces), so you can easily slip it into your pocket. I had no problem using the phone with just one hand.

Alcatel Idol 4S

PROS Relatively affordable. Attractive build. Gorgeous Quad HD display. Solid audio. Dual-band Wi-Fi and NFC. Latest Android software. Plentiful accessories.

CONS Mediocre camera performance. Processor sometimes stutters while gaming. Heavy custom UI layer and some bloatware.

IDOL HANDS
The back of the phone is glass (finger-print smudgeable) and features a fingerprint scanner below the camera sensor.

You'll find a variety of buttons along the metal edges. There's a volume rocker on the right and a Boom key below that. The Boom key activates several context-dependent functions. On the home screen, it generates live wallpaper effects; using it in the racing game

Asphalt 8 activates turbo boost; and tapping it while listening to music or on a phone call kicks up the volume. The functions are programmable, so you can also have it turn the screen on with one press, take photos with a double press, take burst shots with a long press, or launch any app on your phone. You can also disable it entirely.

There's a power button on the left, and a combined SIM/microSD card slot below that. The 4S had no trouble working with a 200GB SanDisk card, and Alcatel says it can handle cards up to 512GB. The bottom is home to a micro USB charging port.

The back of the phone is made of black glass and features a fingerprint scanner below the camera lens. It works, but it's not very fast. It usually took at least two seconds to register and turn the screen on in testing, and I sometimes needed to trigger it more than once to get the phone to unlock.

Rather than coming in a typical cardboard box, the phone comes inside a companion VR headset.

DISPLAY AND VR

The Idol 4S has a gorgeous 5.5-inch, 2,560-by-1,440 AMOLED display, which works out to a dense 534 pixels per inch (ppi). It looks both sharper and more saturated than the 1080p, 401ppi display on the OnePlus 3. Viewing angles are great, and I had no trouble seeing the screen outdoors. It's as good as any top-tier phone we've tested.

PHONE CONTROLS
The right side has a volume rocker and a programmable Boom key; the latter can activate several context-dependent functions.

As mentioned earlier, the 4S comes packaged in a VR headset. The headset is made of sturdy white plastic and includes a comfortable, cushioned velcro strap. If you wear glasses, you can keep them on, which is a nice selling point compared with VR alternatives such as Google Cardboard and the Samsung Gear VR, which you can't use with your glasses on.

The headset features two capacitive forward and back buttons on the bottom with haptic feedback. The 4S recognizes when it has been placed into the headset and immediately launches into VR mode, which includes Games, Video, Photo, 360-degree Video, 360-degree Photo, a Tutorial, and Littlestar, an app that plays select movies and videos in VR. There's also a VR Store that essentially pulls VR apps from Google Play. Two games are also preloaded: Lamper VR and Titans of Space.

Using the headset was comfortable and intuitive, though the phone heats up and feels warm to the touch after extended periods of use.

NETWORK PERFORMANCE, CONNECTIVITY, AND AUDIO

The Idol 4S is available unlocked. It supports LTE bands 2/4/5/7/12/17, so it works well on AT&T and T-Mobile networks. I tested it on T-Mobile in midtown Manhattan, and saw solid speeds both indoors and out. The phone also supports dual-band Wi-Fi, and I got speeds of 150Mbps down and 80Mbps up when connected to our 5GHz FiOS test router. You also get NFC, which is useful for quick pairing and Android Pay.

Call quality is strong. Transmissions are clear and free from any crackling or distortion. Voices sound natural, and noise cancellation is great at blotting out background noise. The earpiece delivers ample volume; you'll have no problem using it in noisy environments.

VR ON THE SIDE
Snapping the 4S into the VR headset automatically starts the VR Launcher app. The headset was comfortable and intuitive to use.

Similar to the Idol 3, the 4S features front and back speakers nestled along the top and bottom edges of its frame. As far as phone speakers go, these are positively booming, and more than capable of filling a room with sound. The 4S is certainly louder than the HTC 10, which has a single mono speaker. That said, don't expect much in the way of bass; this is still a phone, after all.

Wired audio is even better. Plugging in the included earbuds makes for a pleasant listening experience, thanks to hi-fi audio. Music sounds excellent, with good bass and clarity across a variety of genres. You can customize sound profiles using the Waves MaxxAudio app, which is a further boon for audio-minded users. Sound quality isn't quite as strong as it is on the HTC 10, which has a 1-volt headphone amp, but it's still impressive for the price.

“Plugging in the included earbuds makes for a pleasant listening experience, thanks to hi-fi audio.”

PROCESSOR, BATTERY, AND CAMERA

The 4S is powered by an octa-core Qualcomm Snapdragon 652 processor. On the AnTuTu benchmark, which tests system performance, the phone scored 81,576, which is twice as high as the Snapdragon 617-powered Motorola Moto G4 Plus (47,210). Those numbers show that the phone delivers a lot of power, though not as much as the Snapdragon 820-powered OnePlus 3 (141,429).

With 3GB of RAM under the hood, the 4S can handle multitasking without issue. You'll notice occasional sluggishness when playing a high-end game—Asphalt 7 and GTA: San Andreas push the phone to its limits. In-game graphics are beautifully rendered and controls are responsive at first, but if you play for a long time, the phone becomes warm and you'll experience stuttering imagery and some latency in controls, but that won't ruin your game.

Battery life is solid. The phone managed to last for 6 hours of streaming full-screen video over LTE at

APPS OUT OF THE BOX

You'll find that some bloatware comes with the 4S. There's the VR Store, of course, which you can't uninstall. You also can't remove Littlestar, Fyuse, TiZR Lifecasting, and NextRadio. Altogether, though, it's not a heavy load.

maximum brightness. That's just as long as the Moto G4 Plus, but almost four hours short of the OnePlus 3 (9 hours, 48 minutes). You should have no trouble getting a full day's usage out of the phone, and the included adapter supports Quick Charge 2.0, which fully charges the device in 95 minutes.

The 16-megapixel rear camera is a bit disappointing, despite sounding promising on paper. It has manual controls, supports 4K video capture at 30fps, and has a bunch of unique modes, including 360-degree video and iPhone-style live photos. But when it comes down to actual performance, a lack of optical image stabilization meant that a number of pictures I took came out blurry. More significant, I had some issues with consistent exposure. Pictures I took outside during a sunny day were clear, with minimal noise and grain. But pictures taken at the same location on a cloudy day were filled with noise and grain and were often too dark, with trees and buildings cast into shadows and the sky overexposed. The 5-megapixel front camera is passable, but nothing special. Both the OnePlus 3 and the G4 Plus offer better camera performance.

SOFTWARE

The Idol 4S comes running Android 6.0.1 Marshmallow, and Alcatel has promised that it will get an update to Android 7.0 Nougat. While this is encouraging, fans of stock Android will likely be turned off by Alcatel's heavy UI layer and custom launcher.

I actually like the look. App icons are quite different, as are screen transitions, animations, and the notification shade. And that's not to mention the lock-screen images that change every time you turn on the phone, and the wallpaper with live effects that recalls HTC circa 2010. I can't help but wonder whether the phone would run even smoother without all these modifications.

In addition to the UI overhaul, Alcatel doesn't skimp on additional features. It includes a range of new functions, including gesture controls, drawing on the screen with your finger to launch certain apps, a Glove mode that makes the screen more responsive when you're wearing gloves, and a Reversible mode, in which the phone interface flips when you're using the phone upside down.

You'll also find a bit of bloatware on the 4S. There's the VR Store, of course, which you can't uninstall. You also can't remove Littlestar, Fyuse, TiZR Lifecasting, or NextRadio. The two VR games can be uninstalled, as can Facebook, SwiftKey, Twitter, and WhatsApp. You're left with 23.53GB of storage available, out of a total of 32GB. It's not a terribly heavy load, and the phone supports Android's Adoptable Storage, letting you use a microSD card to expand the memory capacity without having to worry about what's stored in the phone's memory and what's on the card.

CONCLUSION

The Alcatel Idol 4S is a sleek Android phone with a beautiful display and lots of useful accessories for the price. At $400, it's a relatively affordable way to get into VR, especially compared with buying a Gear VR and a pricey Samsung phone to go with it. But you will be making some compromises: You can't push the phone as hard as the OnePlus 3 when it comes to high-end gaming, and the 4S doesn't have the same camera performance and minimally altered UI you get with a OnePlus phone. If you're looking for something more affordable, we like the new Motorola Moto G4 and the Blu Life One X. That said, if you're tired of smartphones that all look, feel, and act the same, the Idol 4S is a breath of fresh air.

AJAY KUMAR

Xbox One S Is Small and Sleek but Loaded With Powerful Features

Microsoft Xbox One S

$399.99

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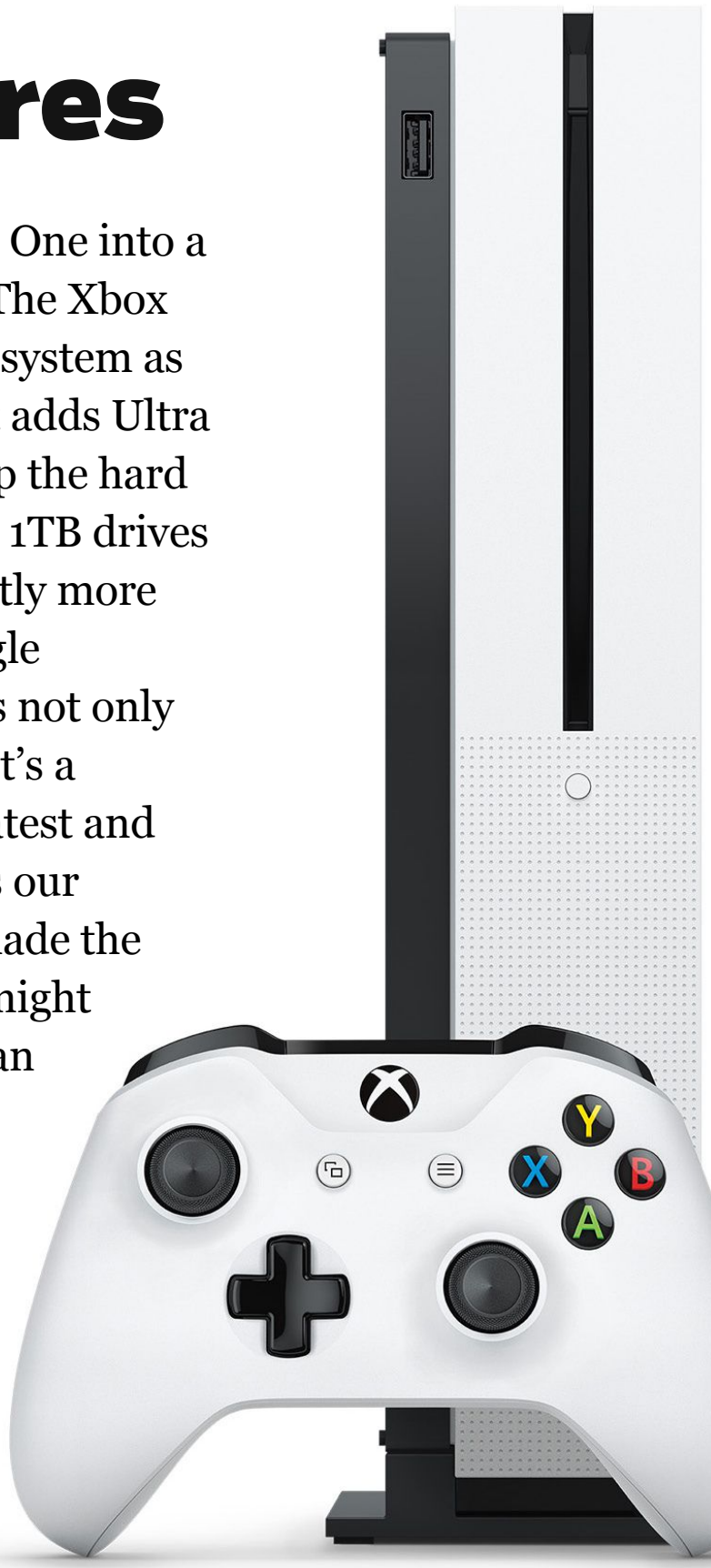
PC MAGAZINE EDITORS' CHOICE

Microsoft has redesigned the Xbox One into a slimmer, sleeker, whiter package. The Xbox One S ($399.99) is the same game system as the original Xbox One at heart, but adds Ultra HD Blu-ray disc support, pumps up the hard drive to a full 2TB (bundles with 500GB and 1TB drives are available for less), and introduces a slightly more convenient gamepad, all while making a single compromise few gamers will even notice. It's not only an excellent replacement for the Xbox One, it's a powerful media player that can handle the latest and most advanced physical disc format. It earns our Editors' Choice, though users who haven't made the jump to ultra high definition (UHD, or 4K) might want to go with the original system, which can be found for much less.



DESIGN

The Xbox One S is much smaller than the original Xbox One, though it keeps the same blocky, rectangular form. At 2.5 by 11.6 by 8.9 inches (HWD), it's downright svelte next to the Xbox One (3.2 by 13.5 by

10.4), and slightly taller but a bit more shallow than the PlayStation 4 (2 by 10.8 by 12 inches). Not only is it smaller than its predecessor, its power supply is completely internal, like the PS4, so you're also shedding the 2.1-by-6.6-by-2.9-inch power brick the first Xbox One needs to work.

Besides its smaller size, the Xbox One S is white to the Xbox One's black. Otherwise, it shares a broadly similar visual style, with corners at sharp right angles and a front panel distinguished by a disc slot on the left and a glowing Xbox logo and power button on the right. The button is now physical, so you need to actually press it to turn on the system. This is a small improvement over the previous system and the Xbox 360 Slim before it, which both have extremely sensitive touch sensors for power buttons.

Microsoft Xbox One S

PROS Ultra HD Blu-ray playback. Smaller footprint. Increased storage options. Redesigned gamepad features a headset jack.

CONS 4K video streaming not yet available. Games aren't upconverted to 4K. No Kinect.

A STREAMLINED CONSOLE
The Xbox One S is much smaller than the original Xbox One, though it keeps the same blocky, rectangular form.

The system's white shell, which is split into a smooth left half and a textured, almost Lego-like right half, sits on a slightly smaller square black base. The front edge of the base holds a USB port, an infrared sensor, and a controller pairing button (relocated from the left side of the original Xbox One).

The back panel holds two more USB ports, plus an HDMI input, an HDMI output, a 3.5mm infrared blaster port, an optical audio output, an Ethernet port, and a slot for a notebook lock. It lacks a Kinect port; Microsoft seems to have completely abandoned the once-included camera. But the HDMI input, the infrared receiver and blaster, and the addition of a headset jack in the gamepad preserve the system's Cortana voice control and OneGuide television support.

The console comes with a black plastic stand you can use to hold it vertically, as you can with the PS4. The original Xbox One can be used only horizontally. The black of the stand blends in with the black of the system's base, so it looks good in both configurations.

CONTROLLER

Microsoft also revised its gamepad for the Xbox One S. A stock white controller is included; additional gamepads are available in white and with customized colors through the Xbox Design Lab. We look more closely at the new controller in our review of the Xbox Design Lab version, but it's almost identical to the original Xbox One Wireless Controller, save for two small changes: A 3.5mm headset jack now sits on the bottom edge of the controller, next to the headset adapter port, and the undersides of the hand grips are slightly textured rather than smooth. Otherwise, it performs exactly like the previous version.

GAME PERFORMANCE

As a game system, the Xbox One S works just like the Xbox One. It's compatible with all disc-based and downloadable Xbox One games, along with the library of Xbox 360 games Microsoft has made backward-compatible. It can also hold many more of those games, since its 2TB hard drive is four times larger than the Xbox One's 500GB drive.

The Xbox One S can output 4K video, but that doesn't mean it's more powerful for gaming. The 3,840-by-2,160-resolution video output is only for media such as Ultra HD Blu-ray discs, which I'll discuss more in the next section. Games are still output at 1080p, as with the original Xbox One. Don't expect any sort of upconversion or performance boost.

I gave the system a spin with a handful of Xbox One and Xbox 360 games, including Castlevania: Symphony of the Night, D4: Dark Dreams Don't Die, Dead Rising 3, Double Dragon Neon, and Gears of War: Ultimate Edition. They all ran perfectly fine. Loading occasionally stuttered, but this is likely because I was downloading my entire Xbox One game library to the new system at the time; it will have no trouble performing smoothly if you're not installing a few dozen games in a row.

MEDIA PLAYBACK

The Xbox One S has two important new tricks for media playback. The system can output ultra-high-definition video, and it can play Ultra HD Blu-ray discs. While Blu-ray is in the name (and the Xbox One S can still play regular Blu-rays), Ultra HD Blu-ray discs are actually a new physical media that can't be played on normal Blu-ray players, including the original Xbox One and PS4. In fact, Ultra HD Blu-ray players are still rare and pricey; the Samsung UBD-K8500 that we've reviewed costs as much as the Xbox One S itself.

Physical media is still very useful to have, because it doesn't depend on a fast Internet connection. 4K video, especially with HDR, requires a great deal of bandwidth to reliably stream. Movies on Ultra HD Blu-ray discs are natively 4K rather than 1080p, and the discs support advanced features like high dynamic range (HDR) video and Dolby Atmos audio. HDR support was not yet enabled at the time of testing, but the Xbox One S played Star Trek on Ultra HD Blu-ray in 4K with no issue.

MEDIA MAVEN
The Xbox One S can output ultra high-definition video, and it can play Ultra HD Blu-ray discs— a new physical media that can't be played on normal Blu-ray players.

Besides optical disc support, the Xbox One S features the same media functionality as the original Xbox One, including a variety of streaming video apps including Amazon, Hulu, Netflix, Twitch, and YouTube, plus live television integration with OneGuide and the HDMI input. 4K video support currently extends only to Ultra HD Blu-ray discs, though. Currently, none of the third-party streaming apps have been updated to support 4K video streaming.

> **It's not only an excellent replacement for the Xbox One, it's a powerful media player.**

CONCLUSION

The Microsoft Xbox One S is everything a streamlined, updated game system should be. It's smaller and sleeker, and it can hold four times as many games as the original Xbox One, all for the same price. It doesn't support the Kinect, but the Kinect is a dead accessory, and the addition of Ultra HD Blu-ray disc playback is a far more compelling feature. In fact, considering the Xbox One S costs as much as a dedicated UHD Blu-ray player, it stands out as a compelling media hub on its own—and a strong value.

The Xbox One S earns our Editors' Choice for its features and design, but as always, you should consider the available games before committing to a system. Exclusives can help define a console, and that often boils down to a matter of taste. Purely based on what you can do with the Xbox One S, though, it's a hit.

WILL GREENWALD

Build Kid-Friendly Gadgets With the New LittleBits Kit

LittleBits Rule Your Room Kit

$99

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We've been impressed by LittleBits, maker of modular electronics kits. Several kits and Bits are available, including the Editors' Choice–winning Gizmos & Gadgets Kit and the Arduino Bit. They all offer different ways to get your children or students into learning about and playing with electronics, and they can also serve simply as an easy-to-work-with platform for your own experiments. The Rule Your Room Kit ($99) is the newest addition to the catalog.

Like the other LittleBits kits, it's a solid starting point for learning, teaching, and experimenting. The Rule Your Room Kit revolves around the Makey Makey Bit,

which is based on the Makey Makey project board, a popular component for teaching children about conductivity. The kit is a bit light on other parts, but it comes with everything you need to make a solid handful of kid-friendly gadgets, and it's one way to build (or expand) a LittleBits collection for more advanced and complex projects.

WHAT ARE LITTLEBITS?

Each Bit is a discrete electronics component designed to easily connect to other Bits to create a device. Magnetic connectors hold pieces together and ensure all contacts are aligned properly, so the current flows in the proper direction. The Bits are color-coded, with each project requiring a blue Bit for power and usually some combination of pink input Bits and green output Bits. Orange Wire Bits and Logic Modules can add a lot more complexity to devices, including options as simple as forking wires and as complicated as Arduino controllers.

LittleBits Rule Your Room Kit

PROS Easy to learn and play with. Makey Makey Bit adds interesting possibilities. Can be instantly expanded with other kits and Bits.

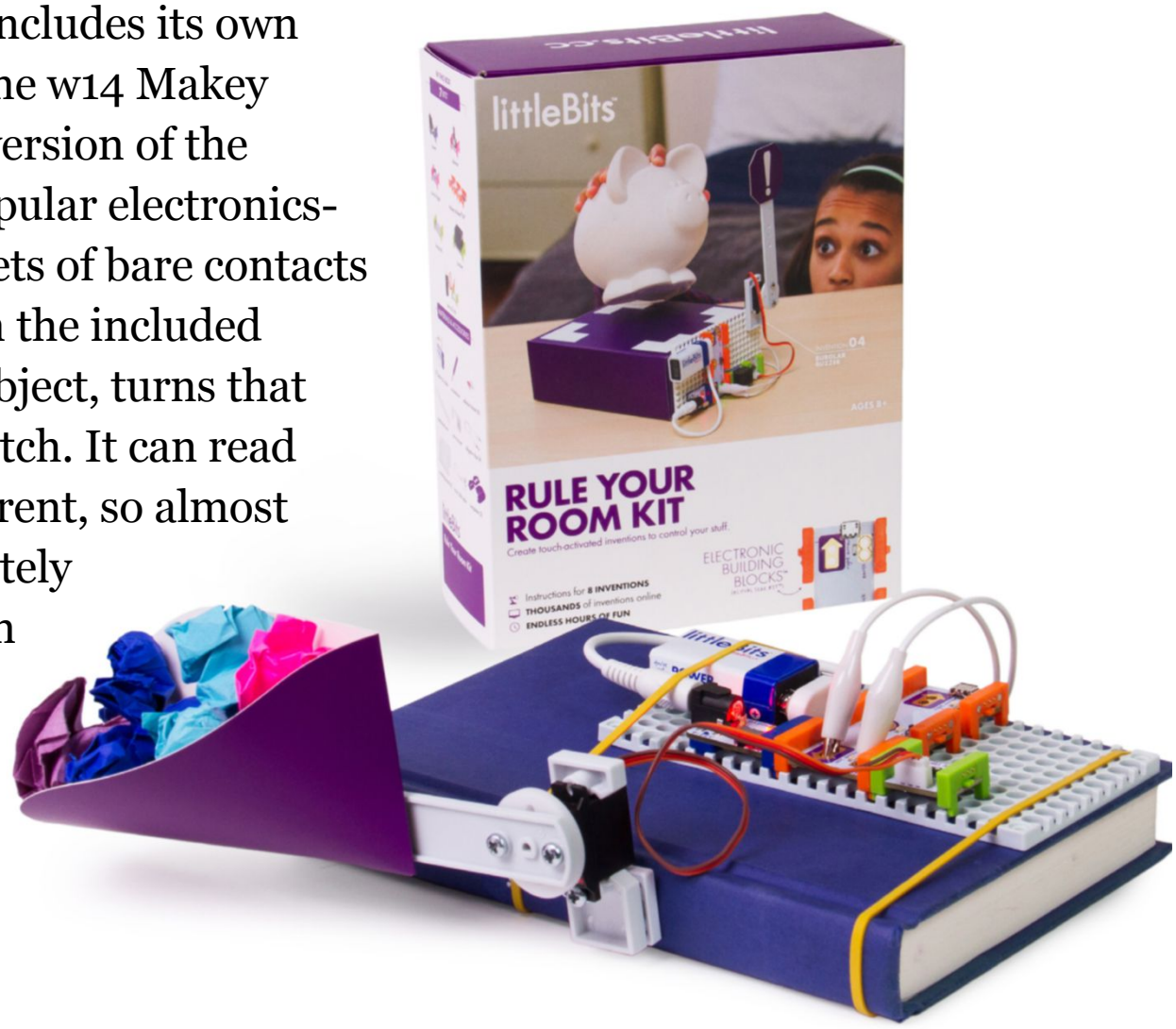
CONS Relatively few Bits for the price.

A LITTLEBIT AWESOME

The Rule Your Room Kit has all the components to serve as a good starting point for budding inventors.

WHAT'S IN THE KIT?

The Rule Your Room Kit includes its own crown-jewel Orange Bit, the w14 Makey Makey. It's the LittleBits version of the Makey Makey board, a popular electronics-kit component that uses sets of bare contacts that, when connected with the included alligator clip wires to an object, turns that object into a button or switch. It can read very small amounts of current, so almost anything that isn't completely and perfectly insulated can work with it (Makey Makey often uses a banana as an example).



The Makey Makey Bit

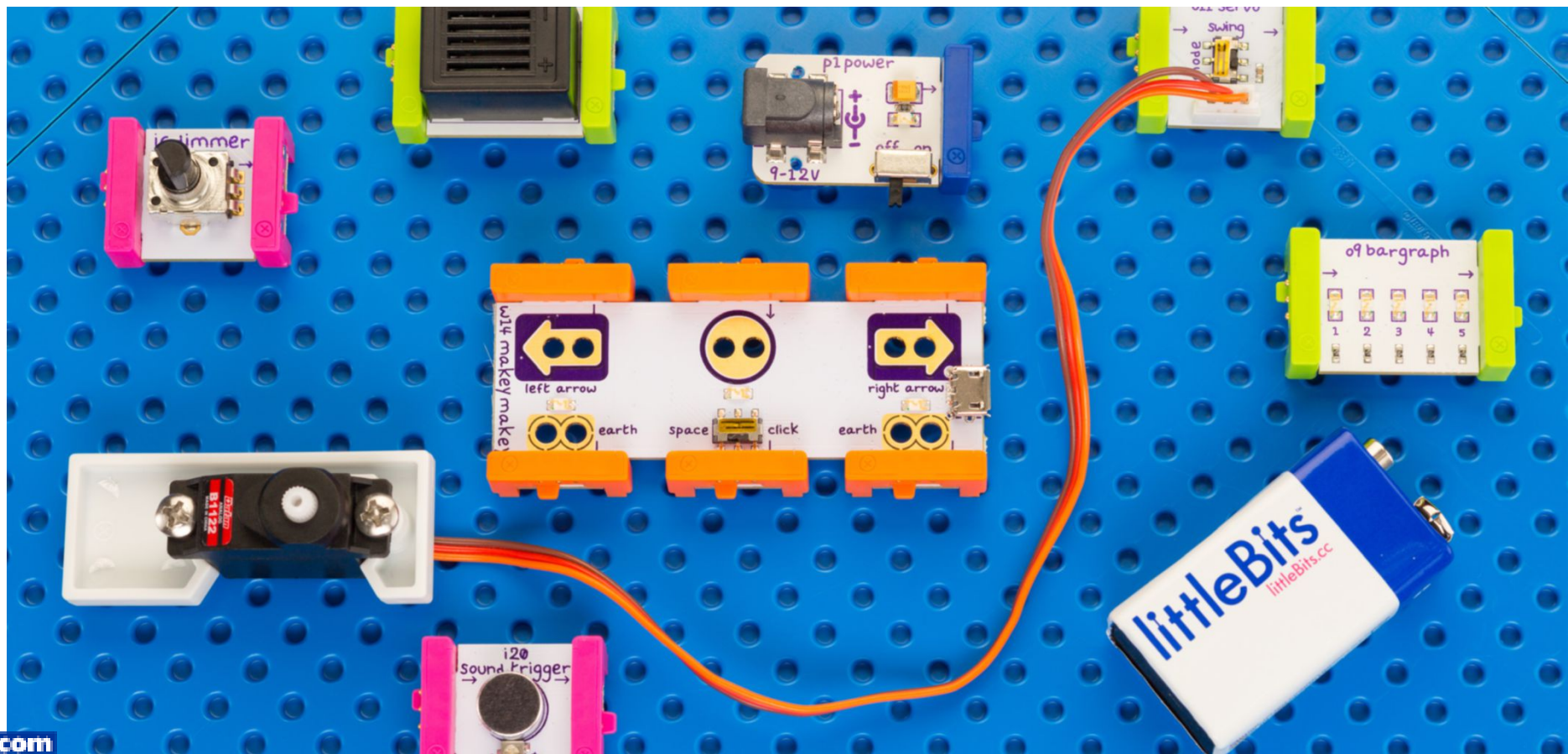
doesn't have quite as many functions as the full Makey Makey board. The smaller Bit instead has only Left, Right, and Space/Click inputs, compared with the board's four buttons and two directions. A small switch toggles whether the center input is a space bar key press or a mouse click, and a micro USB port lets you connect the Bit (when powered as part of a project) to a PC to work as an input device.

Besides the Makey Makey Bit, the Rule Your Room Kit includes a p1 Power Bit with 9-volt battery connector (a battery is included), an i6 Dimmer input, an i20 Sound Trigger input, an o6 Buzzer output, an o9 Bargraph output, and an o11 Servo output. The Dimmer Bit is a simple knob that adjusts how much current is sent to the next Bit. The Sound Trigger Bit has a microphone that sends a signal to the next Bit when a loud enough sound activates it; the microphone's sensitivity can be set with the small potentiometer located directly below it. The Buzzer Bit is a piezoelectric buzzer that makes a loud noise when it receives a signal. The Bargraph Bit is a line of five LEDs that light up, from green to red, depending on how much current it receives. And the Servo Bit is a servo motor with a fixed range of motion, which rotates within that range according to how much current it gets.

The Rule Your Room Kit includes its own crown-jewel Orange Bit, the w14 Makey Makey.

MAKEY MAKEY IT

The Makey Makey Bit (center) lets you make a touchpad out of everyday objects—say, bananas—to control your other LittleBits components.



In addition to the Bits themselves, the Rule Your Room Kit comes with a bunch of accessories to aid with projects, including two mounting boards covered in holes that securely hold assembled projects through small plastic feet on each Bit, four sets of alligator clips, six adhesive feet that can connect to different Bits, and a few plastic arms, wheels, and mounts for the Servo Bit.

PROJECTS

Since the Makey Makey Bit is the biggest part of the Rule Your Room Kit, most of the projects included in the kit's instructions revolve around using it. This generally boils down to setting up some unassuming object as a trigger with the Makey Makey Bit and alligator clips and activating the device when something is moved. It ties in with the whole Rule Your Room name, with several simple alarm, light, and sign-waving welcome projects. The kit comes with several cardboard and paper cutouts for constructing these projects, but you have to provide the actual conductive materials to activate the Makey Makey circuit. These can be fruit, aluminum foil, pencil drawings, or keys, as just a few examples.

Another included project uses the Sound Trigger Bit (but not the Makey Makey) to activate a light, which appears to be spooky eyes when used with an included cardboard cutout.

I played with the kit and assembled a few of the projects. They're easy to build and work as described, and they'll likely help anyone who's interested in learning about electronics to better understand the principles behind current and conductivity.

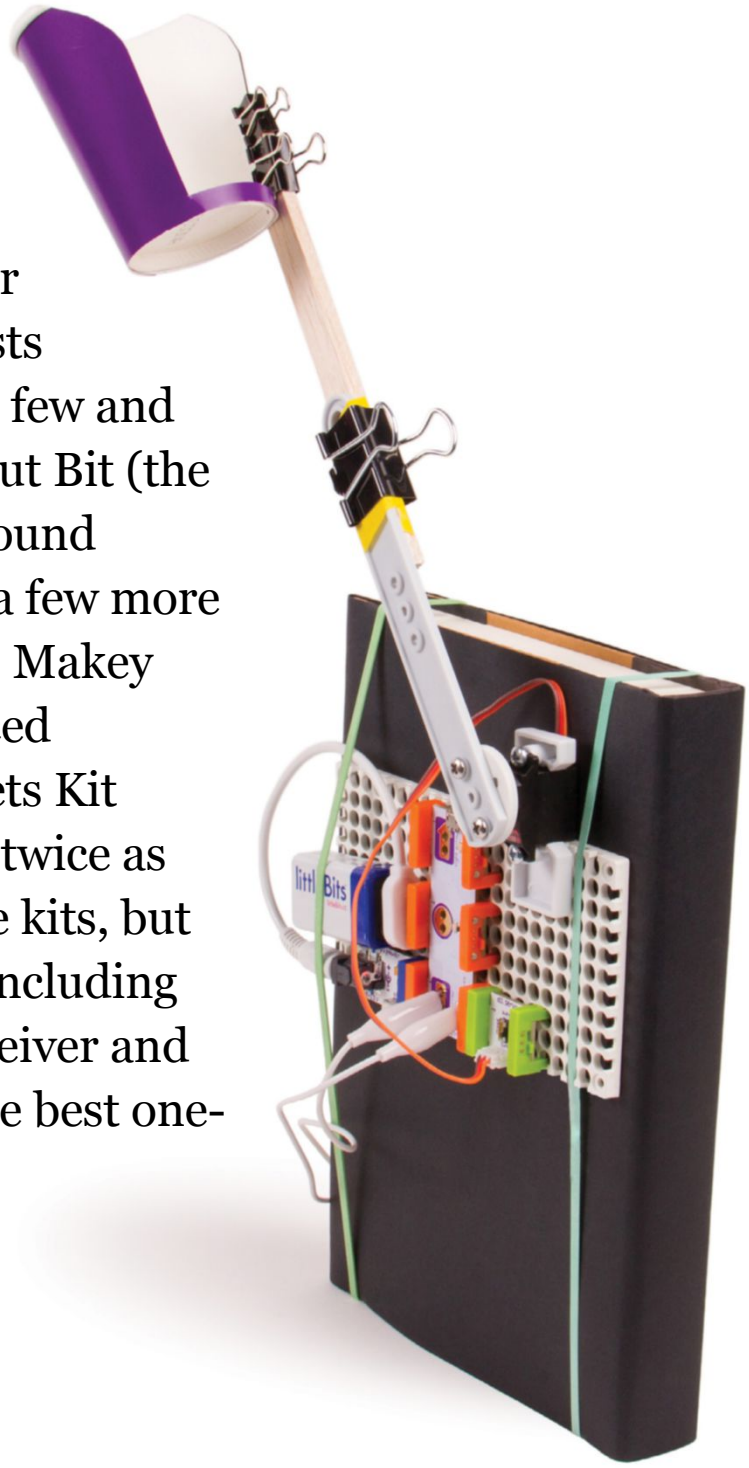
HOW TO BE A MAD SCIENTIST
The Rule Your Room Kit has instructions for eight projects you can build with its components—or you can invent your own.

SOME EXPANSION NEEDED

Like all other LittleBits kits, the Rule Your Room Kit can be easily expanded with other kits and individual Bits. Adding a few input and output Bits can really broaden the possibilities of what you can do. Button and Switch Bits in different forms are available for $7.95 to $9.95, with more advanced sensor input Bits costing up to three times that. Light, sound, and motor output Bits can also be purchased for $7.95 to $25.95 each. All LittleBits pieces work with each other, so you don't need to worry that a Bit might be incompatible with the ones you already have.

As a standalone package, the LittleBits Rule Your Room Kit is a little light for its $99 price.

CONCLUSION



As a standalone package, the LittleBits Rule Your Room Kit is a little light for its $99 price. Nearly half of that price can be accounted for with the Makey Makey Bit, which costs $49.95 on its own. The other bits are few and simple, with only one switch-like input Bit (the Dimmer) and only one sensor (the Sound Trigger). The LittleBits Base Kit has a few more varied Bits for the same price, but no Makey Makey Bit or any particularly advanced centerpiece Bit. The Gizmos & Gadgets Kit remains our Editors' Choice. It costs twice as much as the Rule Your Room or Base kits, but it's loaded with useful components, including the triple-input/output Wireless Receiver and Wireless Transmitter Bits, and it's the best one-piece starting point for getting into electronics experimentation with LittleBits.

WILL GREENWALD

Laptop Size and Features, Chromebook Price

PC MAGAZINE EDITORS' CHOICE

PC Manufacturers have positioned chromebooks like the Acer Chromebook 14 (starts at $279.99; $299.99 as tested) as prime choices for budget laptops. Although they have attractively low prices, the majority of top-rated examples have been compact models, such as the Asus Chromebook Flip and the Acer Chromebook R 11, our recent top picks. But instead of a 10- or 11-inch screen, the Acer Chromebook 14 has an expansive 14-inch screen that's easier on the eyes and likely to serve a wider audience. Add to this sturdy all-metal construction, almost 12 hours of battery life, a full HD screen, and above all that, a competitive price, and you have our top recommendation for chromebooks.

Acer Chromebook 14

$299.99

DESIGN AND FEATURES

The Chromebook 14 measures 0.67 by 13.43 by 9.31 inches (HWD) and weighs 3.32 pounds, which is average for a 14-inch laptop. Its styling is modern, with a fancy brushed aluminum finish (and Google Chrome roundel) on the lid; that and the all-aluminum body help the system look and feel more like a $1,000 laptop than other relatively plain-looking models including the Asus Chromebook C202SA-YS02, the Dell Chromebook 11 Non-Touch, and the Toshiba Chromebook 2.

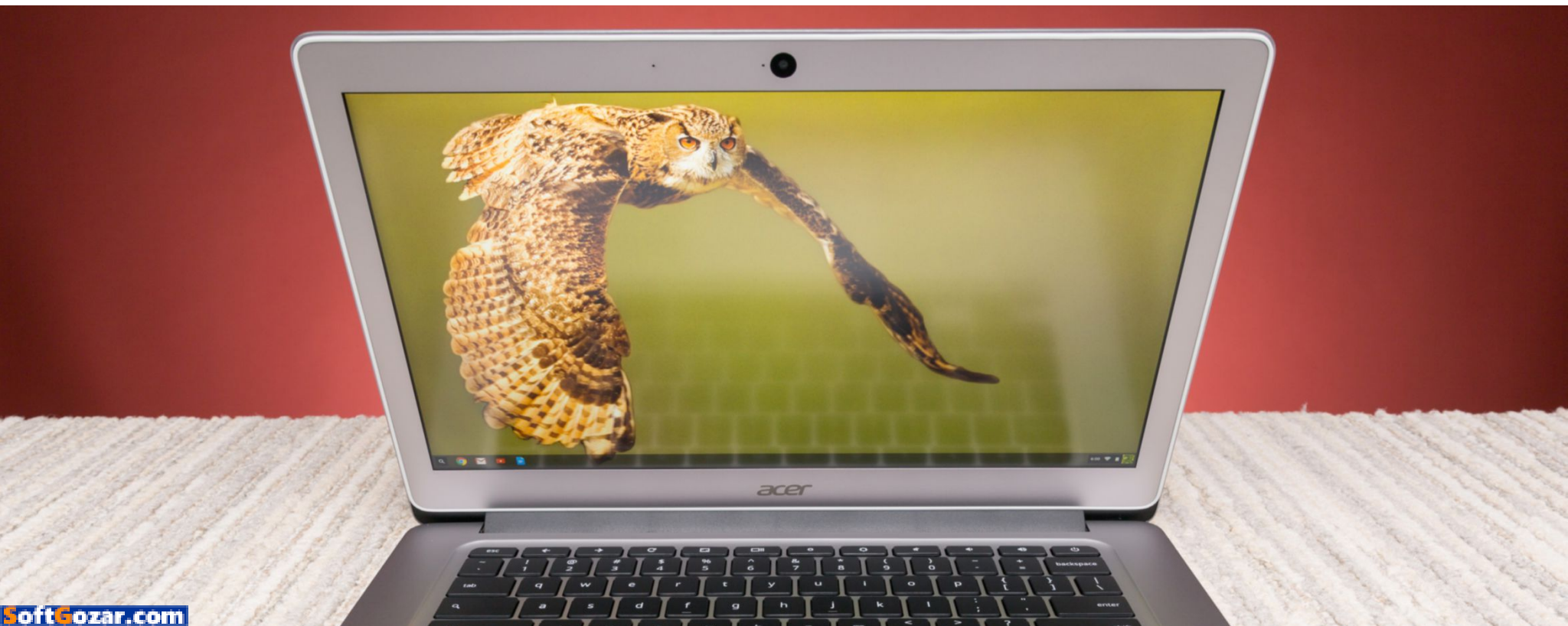
The 14-inch IPS screen is sharp and bright, with a 1,920-by-1,080 (full HD) resolution. This is a big improvement over the 1,366-by-768 resolution common to smaller chromebooks like the CTL J5 Chromebook and the Asus C202. The extra space is nice if you're working on a large spreadsheet or word processing document, and it lets you view YouTube and other online videos at a sharper resolution with greater levels of detail. It's also a good size to share among two or three friends, so you can watch the same program or participate in a group webcam session using the built-in HD webcam. Viewing angles are good, with only a little dimming in off-center picture quality. The screen has a matte antiglare coating, so it works well in a brightly lit room. Some touch-equipped laptops like the CTL J5 have glossy glass over their displays, which can show annoying reflections.

Acer Chromebook 14

PROS Affordable price. Almost 12 hours of battery life. Large 1080p HD screen. Metal body. 4GB of memory. Matte screen.

CONS Stiff keyboard. No SD card slot.

A BIGGER SCREEN
The Chromebook 14's 14-inch IPS screen is sharp and bright, with a 1,920-by-1,080 (full HD) resolution.



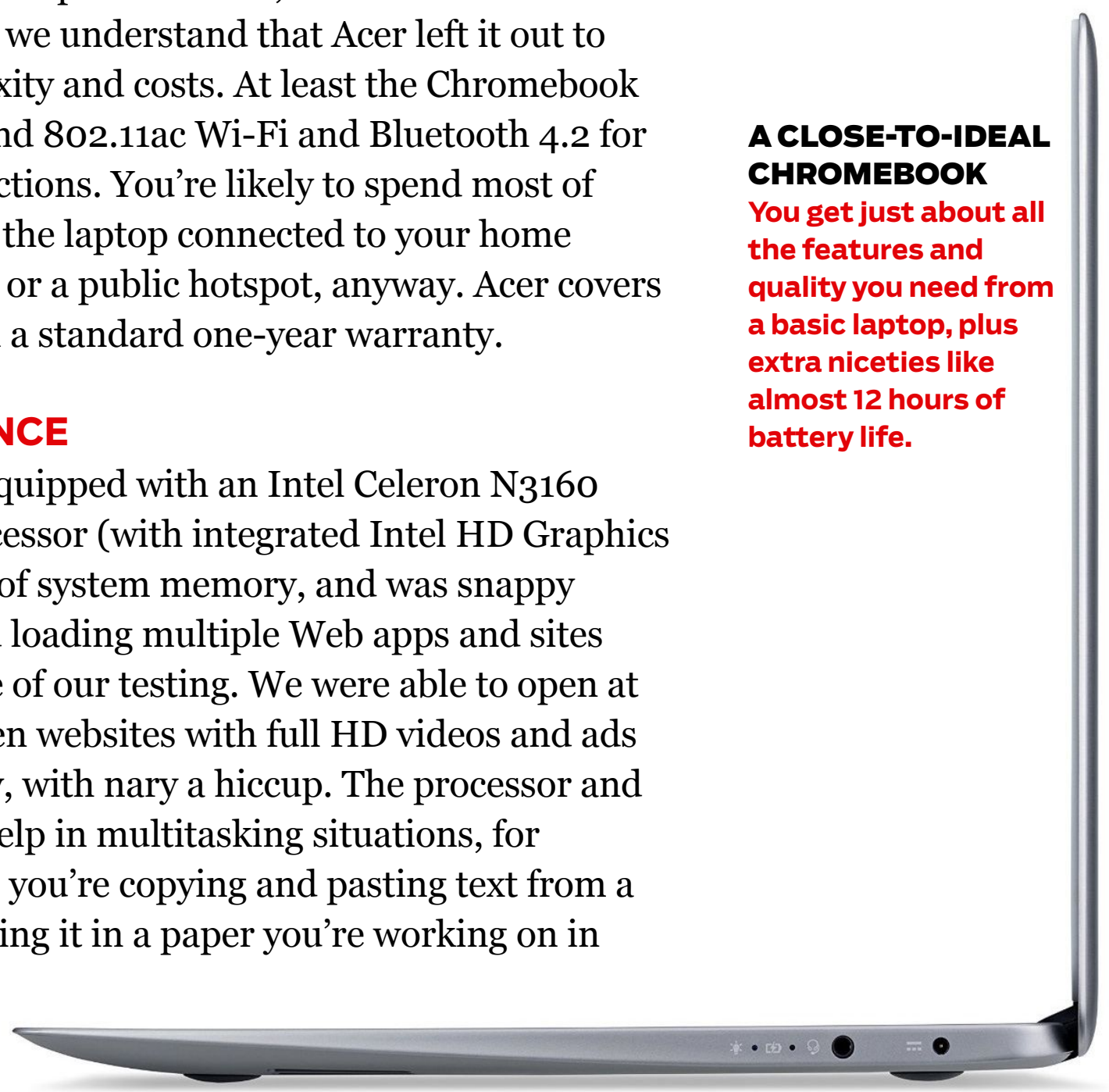
The keyboard has full-size keys, though they are a little slippery and have a stiffer keystroke than those on the Lenovo Thinkpad 11e; you may have to spend some time getting used to how the keys feel. The one-piece touchpad is wide enough for everyday use and responds quickly to multitouch inputs. Downward-firing stereo speakers sound clear and are loud enough for a small-to-medium-size room.

Connectivity is good, including an HDMI jack, a Kensington lock port, and a pair of USB 3.0 ports on the left side of the laptop. A headset jack is situated next to the Power connector on the right side. Notably absent is any type of SD card slot, which would let you add to the system's 32GB of eMMC flash storage. That's not a lot, though Google encourages you to store online. To that end, you also get 100GB of Google Drive storage service for two years. In a perfect world, we'd want an SD card option too, but we understand that Acer left it out to reduce complexity and costs. At least the Chromebook 14 has dual-band 802.11ac Wi-Fi and Bluetooth 4.2 for wireless connections. You're likely to spend most of your time with the laptop connected to your home wireless router or a public hotspot, anyway. Acer covers the laptop with a standard one-year warranty.

"The keyboard has full-size keys, though they have a stiffer keystroke than thos on the Lenovo ThinkPad 11e."

PERFORMANCE

The laptop is equipped with an Intel Celeron N3160 quad-core processor (with integrated Intel HD Graphics 400) and 4GB of system memory, and was snappy booting up and loading multiple Web apps and sites over the course of our testing. We were able to open at least six to seven websites with full HD videos and ads simultaneously, with nary a hiccup. The processor and memory also help in multitasking situations, for example, when you're copying and pasting text from a website and citing it in a paper you're working on in



A CLOSE-TO-IDEAL CHROMEBOOK
You get just about all the features and quality you need from a basic laptop, plus extra niceties like almost 12 hours of battery life.

INEXPENSIVE STYLE
The Acer Chromebook 14 has the look of a much more expensive laptop, with its all-aluminum body.

Google Docs, while monitoring a live stream on Facebook and listening to music on Spotify in the background. The Chromebook 14 is certainly capable enough for the home user for entertainment and school use.

Battery life is a definite highlight. For most large laptops, you'd be expected to keep the AC adapter handy during the day. The Chromebook 14 lasted 11 hours 50 minutes on our battery rundown test. And it's much longer than the Toshiba Chromebook 2 (5:32), Acer Chromebook R 11 (10:35), Lenovo Thinkpad 11e (7:35), CTL Chromebook J2 (8:55), and Dell Chromebook 11 Non-Touch (10:37). The Asus Chromebook C202SA (12:05) and CTL J5 (12:21) were able to outlast the Acer Chromebook 14, but not by a significant margin.

CONCLUSION

The Acer Chromebook 14 has a 14-inch 1080p HD IPS screen, premium-feeling aluminum construction, a quad-core processor, better-than-average system memory and storage, good connectivity, and a sweet $300 price tag to top it off. Its only drawbacks are a lack of SD card expansion and a slightly stiff keyboard. We think this chromebook is close to the ideal for the category, and a viable alternative to a "traditional" Windows or Mac laptop that costs $500 or higher. That makes it our new Editors' Choice. If you want a Windows laptop that costs even less than the Chromebook 14, consider our budget ultraportable Editors' Choice, the $180 Dell Inspiron 11 3000 Series (3162).

JOEL SANTO DOMINGO

The Most Customizable of Gaming Mice

SteelSeries Rival 700

$99.99

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Everyone has quirks. Even gamers. So when it comes to gaming mice, personalization is the name of the game. Usually you see it in the form of programmable buttons and RGB lighting options, but the SteelSeries Rival 700 ($99.99) goes a couple of steps further with its modular design, OLED screen, and tactile alerts. While these might seem like unnecessary bells and whistles, they're features that can be useful for experienced gamers. But for the price, the Razer Mamba remains our Editors' Choice for gaming mice thanks to its extra features and sophisticated, wireless design.

DESIGN AND FEATURES

Out of the box, the design of the Rival 700 isn't going to turn heads. Measuring 1.65 by 2.7 by 4.92 inches (HWD) and weighing 4.8 ounces, it's fairly standard in size for a gaming mouse. The mouse is mostly black plastic, with a matte finish on the left- and right-click buttons. The body features a hefty curve on the right for comfort, giving it an asymmetrical shape, and texturized rubber grips on both sides. Unfortunately, the asymmetrical design means the Rival 700 is for righties only. On the left side of the mouse are three programmable buttons (two above and one in front of the thumb), along with an OLED screen. There's also a ridged scroll wheel with RGB lighting, and a button beneath it that lets gamers toggle between two sensitivities that can be set in the SteelSeries Engine 3 software. All seven buttons are programmable in the software, which you can also use to customize the RGB lighting settings, OLED display, and tactile alerts. The Rival 700 also comes with both a 3-foot rubber cable and a 6-foot braided cable.

For me, the star of the show is the Rival 700's black-and-white OLED screen, as it's a rather unusual feature for a gaming mouse. It will display any small picture file you import into Engine 3; it works best with JPEGs, PNGs or GIFs that are 128 by 36 pixels in size.

SteelSeries Rival 700

PROS Modular design, RGB lighting, OLED screen, and tactile alerts are novel approaches to gaming personalization. Adjustable sensitivity.

CONS Additional modular components are expensive. For right-handed use only

HOLD ON TIGHT
The Rival 700's body has a hefty curve on the right for comfort, and texturized rubber grips are on both sides.

Animations play back at a rate of 10 frames per second, and SteelSeries's website offers a number of pre-made GIFs, including one of actor Nicolas Cage's head spinning in an endlessly amusing loop. (Technically, any GIF may be used, but they may vary in quality.) The placement of the screen makes it easy enough to see, but also easy to ignore if you're more attuned to what's happening on your computer. SteelSeries suggests the OLED might be useful for a "scrolling roster of information," but the catch is that this works only with the three preloaded games in Engine 3: Counter-Strike: Global Offensive, Dota 2, and Minecraft. Although the OLED screen is definitely a gimmick, it's an enjoyable one, and outside of gaming, Cage's spinning head has been a source of entertainment and a good conversation starter in our Lab.

For me, the star of the show is the Rival 700's black-and-white OLED screen, as it's a rather unusual feature for a gaming mouse.

Another feature that sets the Rival 700 apart is the tactile alerts. You can choose from 13 different effects that vary in strength, speed, and duration, with most ranging from a one-off buzz to a pulsating vibration. That being said, some of the effects, like Strong Click, Sharp Click, and Soft Bump (all one-off buzzes) can be hard to differentiate. The main draw is that you can set

TINY PICTURES
You can display the small image file of your choice on the side OLED screen, including GIFs.

tactile alerts to let you know when you've reached certain in-game events, such as your character running low on health or a cool-down period expiring. Again, this only works with the three aforementioned games, so the Rival 700 should especially appeal to fans of those titles. If you don't play those games, however, you can still program tactile alerts on individual buttons, but they're not quite as helpful.

You can also program the RGB lighting to correspond with game events (provided you're playing one of the preloaded games). The non-gaming lighting options are pretty much in line with what you'd find with other RGB mice like the Logitech G502 Proteus Spectrum$59.99 at Amazon or the Corsair M65 RGB Laser Gaming Mouse. But with the Rival 700, it's admittedly cool to look at the scroll wheel LED and get a visual indicator of how much health your character has left: green if you're at full strength and red if you're on the brink of death.

Lastly, what makes the Rival 700's design interesting is that it's modular. The cover of the mouse can be easily snapped off and swapped. The mouse we tested came with a patterned, matte cover with an RGB SteelSeries logo, but two additional covers—one glossy with the RGB logo, one textured with an anti-sweat finish—can be bought in the Rival 700 Cover Pack 1 for $14.99. Another modular component is the rubber 3D nameplate at the back of the mouse. While SteelSeries doesn't sell or design additional nameplates, anyone savvy with a 3D printer can download the necessary files to create their own. The last, but perhaps most important, modular component is the sensor itself. While the Rival 700 comes with a PixArt PMW3360 optical sensor, fans of laser sensors can swap it out for a Pixart 9800 Laser sensor ($24.99). To switch out a sensor, just flip over the mouse and unscrew four screws. The optical sensor delivers up to 16,000dpi of sensitivity, while the laser sensor goes up to 8,200dpi.

MAKE WHAT YOU WANT OF IT
The SteelSeries Rival 700 has a modular design: You can swap out the cover, the rubber 3D nameplate on back, and even the sensor.

PERFORMANCE

The Rival 700's simple design is also suited for everyday use. And while I initially thought the asymmetrical curve gave the mouse an awkward feel, it wasn't noticeable after a few hours. While playing Counter-Strike: Global Offensive, the mouse performed well: There was no lag, tracking was accurate, and all buttons were easy to reach. My main concern with the Rival 700 was that the tactile alerts might disrupt tracking in-game. On that front, the strongest alerts did not cause the mouse to move, and the weakest alerts were noticeable enough to be useful. As long as you can remember which alert is which, this can be a helpful function. But unless you can keep your eyes on two things at once, the OLED screen's functionality is reduced to the postgame stat scroll, and the lighting goes mostly unappreciated.

One consideration: The Rival 700 does offer fewer programmable buttons (seven total) than other similarly priced gaming mice. For instance, the Proteus Spectrum has 11, while the Corsair M65 has eight. Ultimately, this will impact only those gamers who really value having the extra buttons, and the tradeoff for tactile alerts and functional RGB lighting may very well be worth it.

CONCLUSION

All in all, the Rival 700 is a gaming mouse that takes a novel approach to personalization. While it may be argued that the tactile alerts, OLED screen, and RGB lighting are mostly gimmicks, they can serve a functional purpose and add a bit of fun. But the added cost of modular components could be a major drawback for what is already an expensive mouse. If you're going to shell out for the ultimate gaming mouse, the Razer Mamba still has our vote for Editors' Choice thanks to its wireless capability, adjustable click feedback, premium design, and 10 programmable buttons.

VICTORIA SONG

Great PC in a Small Package

PC MAGAZINE EDITORS' CHOICE

If you don't care about playing intensive 3D games, a small-form-factor (SFF) desktop PC such as the Asus VivoMini VC65-G042Z (starting at $409; $499 as tested) is an attractive option: It takes up very little desk space, is expandable, and has the power to do everyday tasks. Like our top pick, the Acer Revo One, it naturally fits into the home- theater-PC category when connected to your HDTV, but you could put this on your high-school or college student's desk as well. It's an inexpensive, competent choice for home PCs, and our latest Editors' Choice for SFF desktops.

Asus VivoMini VC65-G042Z

$000.00 Price

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DESIGN AND FEATURES

The VivoMini VC65 is definitely on the small side even for SFF PCs, measuring about 1.9 by 7.8 by 7.8 inches (HWD), which is taller than but about as wide as the venerable Apple Mac mini. What's notable about its dimensions is that the system has its power supply built in; unlike the Acer Revo One, InFocus Kangaroo Mobile Desktop Pro, and Zotac Zbox Pico PI320, it doesn't use an external power brick.

The system is made mainly from black-colored plastic, which helps keep the weight under 5 pounds. Like the Acer Revo One (and unlike the Mac mini), the top of the VivoMini VC65 opens up for access to two 2.5-inch drive bays. Our review unit is the two-drive version, but some configurations have a taller lid and can accommodate up to four drives or an optical drive

bay. The system can be mounted on the back of a TV or other display with an optional VESA mount kit (not included) or hidden under a desk shelf.

Removing the lid is as simple as sliding it back half an inch and lifting it off. You'll need a small Phillips-head screwdriver (the kind used for eyeglasses) to open the drive bay brackets, which is less convenient than on the tool-less Revo One. As shipped, the system has a single

Asus VivoMini VC65-G042Z

PROS Compact size. Can accommodate an additional 2.5-inch drive. Quiet. User upgradable. Speedy processor. Uses 802.11ac Wi-Fi.

CONS Disassembling the hard drive bay is required to access memory slots. Cheap wired keyboard and mouse. Single-partition hard drive can be confusing to you and potentially dangerous to your data.Some bloatware.

SMALL IS THE NEW BIG

The Asus VivoMini VC65-G042Z takes up very little desk space, is expandable, and has the power to do everyday tasks and much more.

1TB hard drive installed, with one drive bay free. Of the two SO-DIMM slots under the drive bay, one is free. There's 8GB of system memory installed, and the desktop can accommodate 16GB total.

Having to unscrew and remove the drive bay to get to the memory slots is inconvenient, but at least it's a relatively easy process if you've ever turned a screwdriver. That can't be said for the Mac mini or the HP Pavilion mini, both of which are more challenging to disassemble and upgrade. Our Editors' Choice for budget PCs, the Shuttle XPC Nano is also a SFF PC, but it's equipped with a wallet-friendly Celeron processor and far less memory (2GB) and storage (32GB) when you take it out of the box.

WHAT'S ON BACK
The rear ports include a DisplayPort connector, an Ethernet port, an HDMI jack, a headphone jack, a Kensington lock port, among others.

Connectivity is excellent, rivaling that of the larger Lenovo Ideacentre 300s. Two USB 3.0 ports are in easy reach on the front panel, an SD card slot on the top loads like a toaster, and a larger selection of I/O ports are on the back. These ports include a DisplayPort connector, an Ethernet port, an HDMI jack, a headphone jack, a Kensington lock port, a microphone port, a serial port, two USB 2.0 ports (for the wired keyboard and mouse), two additional USB 3.0 ports, and a VGA port. Wireless connections include 802.11ac Wi-Fi and Bluetooth 4.0.

The VivoMini VC65 fully supports both 4K and full HD displays. The included wired keyboard and mouse feel a little cheap, but they do the job fine. You can, of course, replace them with a wireless set at your own expense later.

The system's 1TB hard drive is partitioned in two: one 150GB drive for Windows 10 and programs and a 780GB drive (D:) for data. This setup can help if your kids regularly visit free game sites that surreptitiously install adware or worse: If the system starts to act up from all the crapware, you can blow away

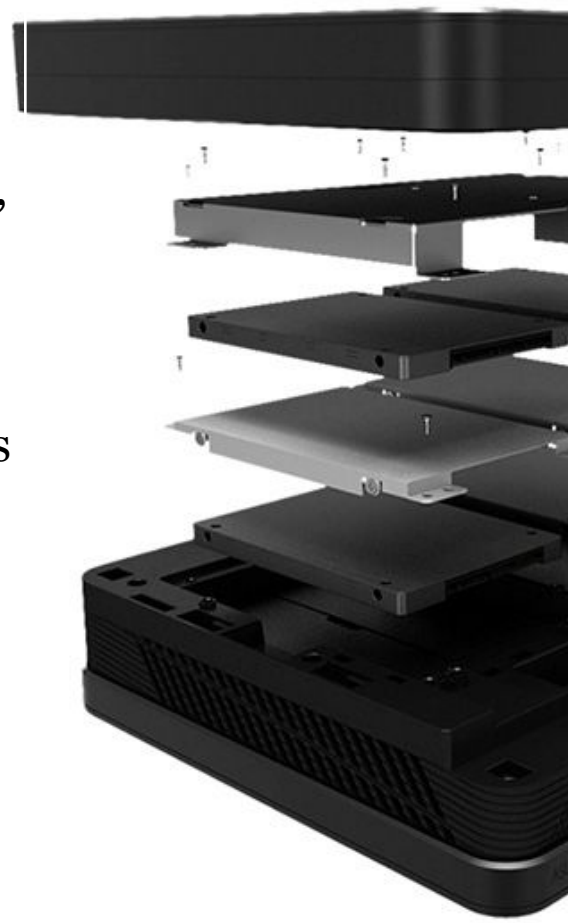
and reset your C: drive while keeping your data safe on the D: drive. Keeping track of which partition you store your files on can be confusing to novice users, however. Also, since both partitions are on the same physical drive, this scheme will not help you if the drive mechanism fails.

A few extraneous programs are included on the hard drive, among them Flipboard, HeathVault, Fresh Paint, Pics Art, Sway, and Netflix; for the most part, they're relatively innocuous. The system comes with a one-year warranty.

PERFORMANCE

Equipped with a current-generation Intel Core i5-6400T processor with Intel HD 520 graphics, the VivoMini VC65 led the SFF desktops overall on our performance benchmark tests. It returned a score of 2,914 points on the PCMark 8 Work Conventional test, ahead of systems with Intel Atom, Pentium, Core i3, and Core i5 processors.

Likewise, the system was quick on our HandBrake (1 minute, 41 seconds) and Photoshop CS6 (4:51) tests. The Ideacentre 300s just edged the system on the Photoshop CS6 test (4:44), likely because of its faster hard drive, but the VivoMini VC65 will probably last the longest before it starts to feel slow. Scores in our 3D gaming tests were tops for this category, but still, you're going to be happier playing Minecraft, Diablo III, or older titles like Half-Life 2 or Doom 3, rather than the 2016 version of Doom. Even when we were stressing the system on our benchmark tests, it remained quiet, with very little noise coming from the internal cooling fan.



CONCLUSION

The Asus VivoMini VC65-G042Z gives you just about all you'd need from a basic, compact home PC. It includes a powerful Intel processor, expandable memory and storage, and lots of connectivity, and it comes in at around $80 less than the Acer Revo One. Sure, the Acer has a wireless keyboard and mouse, and makes it a little easier to upgrade drives, but the VivoMini is ultimately faster and doesn't need an unsightly power brick. Therefore we award the Asus VivoMini VC65 our latest Editors' Choice for SFF desktop PCs.

BY JOEL SANTO DOMINGO

Win 10 Update Offers More Ways to Interact With PCs

PC MAGAZINE EDITORS' CHOICE

Innovative features like Cortana, Windows Hello biometric security, and comprehensive touch interface capabilities have distinguished Windows 10 since its launch a year ago. The Anniversary Update improves those and adds impressive new features and helpful design updates, many of which were prompted by a tremendous amount of user feedback. You can now get the new version simply by running Windows Update; if you still haven't moved up from Windows 7 or 8, you'll have to pay for Windows 10, as I'll explain.

Microsoft Windows 10
(Anniversary Update)
$109.99

Microsoft Windows 10
(Anniversary Update)

PROS Intuitive and responsive. Fast startup. Rich software and device ecosystem. Familiar interface with Start menu. Biometric login with Windows Hello. Fast, compatible Edge browser. Improved gaming features. Improved security features.

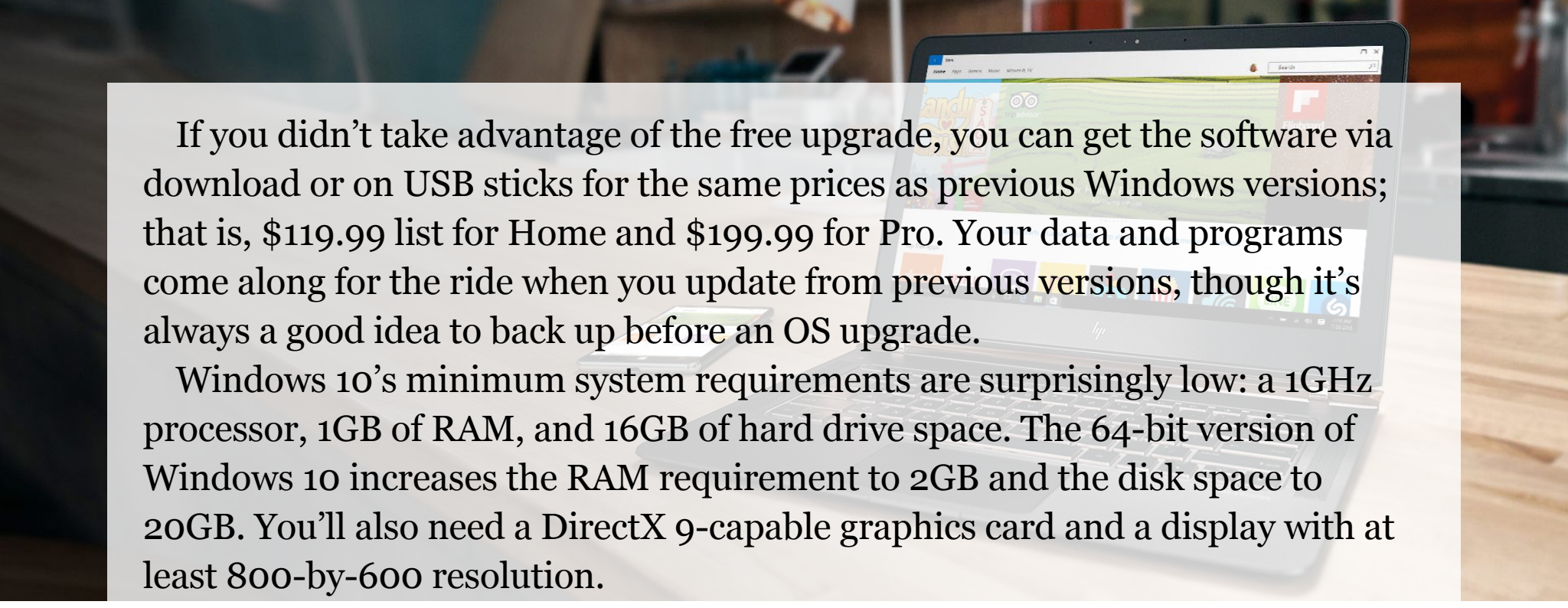
CONS Separate Settings app and Control Panel. Lacks video editing app. Skype integration doesn't match up to Mac's Continuity. Windows 10 Mobile not widely used.this color justify david bowie fulfil kitchen tables and into the wild is just hungry forever.

Windows 10 has been a far greater success than its ill-fated predecessor, Windows 8. In just a year, Windows 10 has attained a 20 percent desktop operating system share, with more than 350 million copies installed, and a faster adoption rate than any previous version of Windows.

Microsoft tells us that Windows 10 has a higher satisfaction level than any previous version. Contributing to that satisfaction, the company says, are more than 75 million feedback points from preview testers, which has resulted in over 5,000 new features in Anniversary Update. We'll hit the high points.

The Windows 10 Anniversary Update is available to most users in just two editions, Home and Pro (with 32-bit and 64-bit options for each), but all of the major features appear in both version. Pro adds business-y things like network domain joining, Hyper-V virtualization, group policy management, and BitLocker encryption. That last one may be of interest to security-conscious personal users, too.

There are other editions of Windows 10 for special use cases: Enterprise is still an option for large organizations that want bulk licensing deals. Anniversary Update also introduces two new Education versions for K-12 institutions: Windows 10 Pro Education and Windows 10 Education (which don't include Cortana for now). And let's not forget the lightweight edition that powers Internet-of-things devices and the Raspberry Pi: Windows 10 IoT Core.



If you didn't take advantage of the free upgrade, you can get the software via download or on USB sticks for the same prices as previous Windows versions; that is, $119.99 list for Home and $199.99 for Pro. Your data and programs come along for the ride when you update from previous versions, though it's always a good idea to back up before an OS upgrade.

Windows 10's minimum system requirements are surprisingly low: a 1GHz processor, 1GB of RAM, and 16GB of hard drive space. The 64-bit version of Windows 10 increases the RAM requirement to 2GB and the disk space to 20GB. You'll also need a DirectX 9-capable graphics card and a display with at least 800-by-600 resolution.

Windows 10 Anniversary Update presents almost no learning curve for longtime Windows users, while managing to incorporate many of the advances of Windows 8—faster startup, tablet capability, better notifications, and an app store. Its windowing prowess remains unmatched, letting you easily show the desktop and snap windows to the sides and corner quadrants of the screen. The newest Windows still runs the vast majority of the millions of Windows programs in the wild. Yes, that means it still uses the much-derided Registry to maintain configuration settings, but on today's fast hardware, that no longer presents issues. (Microsoft recommends against using any third-party registry-optimizing software for Windows 10.)

When setting up a Windows 10 account, unlike with Mac OS X, which requires an Apple account, you can log in to a local account without the need for a Microsoft account, but you'll lose many of the OS's best features if you do so. A lot of critics have nevertheless called out Microsoft for harvesting usage data by default, so if you're the paranoid type, you shouldn't set up the PC using Express Settings, which enable anonymous usage data collection.

INTERFACE

Aside from the improvements to headliner features such as Cortana, Hello, and Ink, the Anniversary Update makes some more subtle but useful improvements to the desktop interface. For example, the Start menu has been updated: Now it shows the All Apps list without a second button press, and it also shows most used and newly installed apps. I've often found clicking the date in the Taskbar useful, since it pops up a calendar; now you can also see your appointments in that view.

Live tiles have also been updated in a way that makes more sense: Now, when you click on a live tile, you'll go to the content highlighted there rather than just to the app. For example, you'll go directly to the news story or the email or the

MAIN SCREEN
Windows 10 Anniversary Update adds subtle changes to the main desktop screen, with all apps now listed and the Action Center icon now all the way to the right side of the Taskbar.

photo showing on the live tile.

The Windows Store also gets another redesign, this time with features designed to appeal to gamers in particular. It's aligned more closely with the Xbox Store and now offers game bundles and subscriptions. For everyone else, the new design does make it a bit easier to get to the top apps, music, and movies. The Store's download progress indicator is now bigger and clearer, too. The Action Center icon now is all the way at the right of the Taskbar, making it an easier reach. And a new interface option, Dark mode, shows apps with black window backgrounds, which can be gentler on the eyes.

Another interface feature I've started to cherish is File Explorer's Quick Access section. This lets you easily find whatever file you were last working on in whatever application you were using. So if you edit an image and want to add it to another app, it's right at the top of the Quick Access list; you never have to remember where you just saved a file to find it.

Overlap between the Settings App and Control Panel still remains an interface legacy of Windows 8, but really, it's no longer such an issue. For simple system settings, you use the Settings app; for deep, technical system options, you go to the Control Panel.

NEW CORTANA TRICKS

Cortana, Windows' voice-responsive AI digital assistant, may be Windows 10's highest-profile feature, and the Windows Anniversary Update adds some interesting new capabilities. I should note that you can no longer completely disable Cortana in the Update, but you can prevent her from accessing your location, email, contacts, browsing history, and communications. Cortana is the search function in the OS, but you can hide the search bar if you never want to use it.

You can now use Cortana from the lock screen. This is useful for things like playing a particular music playlist, asking about today's weather, or asking for

information. Intel also has new wake-on-voice technology that means you could say “Hey Cortana!” and have the PC respond even if it’s in sleep mode. It’s sort of like an Amazon Echo, without needing a separate device.

Cortana in Windows 10 now interacts more tightly with Cortana apps on other devices, such as Android phones and iPhones. You can enable notifications from the phone, including things like low-battery warnings, to show up on Cortana on Windows. You also see messages from WhatsApp, Facebook Messenger, and SMS from the phone. The integration also works more fully with Android devices than with iOS devices, since the latter restrict access to some system capabilities.

WINDOWS INK

Touch and pen input support is a major differentiator between Windows 10 and Apple’s Mac OS X. Apple sticks with Steve Job’s edict that touch screens don’t make sense on laptops and desktops. But a touch screen is the most intuitive interface type possible. You see something you want to interact with, such as a button, and you press it with your finger. I’ve been using PCs with touch screens for the past year or so, and I’ve gotten to the point of trying to tap my old, work-issued ThinkPad’s screen out of habit.

Microsoft is touting Windows’ digital ink capabilities for this release, which allow stylus input to work just like a pen or pencil, converting it to text. This is a technologically cool feature, but it will be of interest only to owners of tablets and convertibles like the Surface Pro 4, the Surface Book or the Lenovo IdeaPad Miix 700.

This new Ink Workspace can be summoned by clicking a stylus button. You can also take advantage of some Cortana smarts in the new sticky notes. For example, if you write “Wednesday,” the text is turned to a blue link, and clicking this gives you the option to set a Cortana reminder.

Sketchpad, which resembles the whiteboard app on the Surface Hub, offers ballpoint pen, pencil, highlighter, eraser, ruler, and touch writing tools. It also lets you crop an image, copy it, and share it to any Universal Windows app in the share sidebar. A ruler tool lets you draw perfectly straight lines, and even includes a compass.

One of the coolest inking capabilities is the pen keyboard. You switch to this mode from the standard on-screen keyboard. Start writing on the line, and text predictions show up. Hit enter, and your writing turns into text in whatever text area you’re writing in. It does surprisingly well with even poor penmanship, and striking through your writing deletes it easily.

RETURN OF THE TOUCH PEN
Touch and pen input support is a major differentiator between Windows 10 and Apple's Mac OS X.

EDGE WEB BROWSER GETS MORE CAPABLE

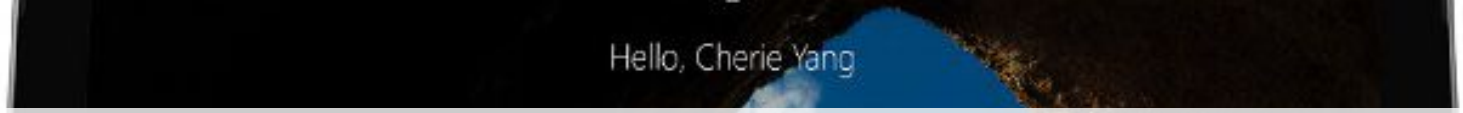
The Edge Web browser that comes with Windows 10 is fast and compatible, and it offers unique tools, such as Web Notes that let you mark up and share webpages, a clean (ad-free) Reading view, and built-in Cortana information. But until now, it has lacked a feature that power users insist on: Extensions.

Edge's new Extensions menu option links to the Windows app store, where you can finally get Edge extensions. I tested by installing one I consider essential—LastPass—but you'll find extensions for Amazon, Evernote, Microsoft Translator, OneNote, Pinterest, Pocket, and more. Though it's not a long list yet, those are some heavy hitters that will make the browser appealing to more demanding users.

After downloading the LastPass extension, I hit the Launch button on its store page, and then saw a message in the top-right corner of the browser notifying me that a new extension was available and offering to turn it on. I then had to log in to my LastPass account on a webpage.

Unlike most browsers' extensions, Edge's appear in the overflow menu rather than next to the address bar. The LastPass extension worked fine with this setup, but I do prefer having the icon in the toolbar, saving me two clicks. LastPass's on-page features, such as automatic password fill-in, also worked well via the extension.

Edge now gets 460 out of a possible 555 points in my testing on the HTML5Test.com site, making it highly compatible with modern Web standards. It's actually ahead of Firefox, which gets 456, though Chrome still leads with 492. The update further reduces Edge's battery drain on portable PCs and tablets, too, doing things like turning on Flash only when the user requests it. I also did a quick speed test using the JetStream benchmark on a Surface Book



with an Intel Core i5 and 8GB RAM. The benchmark runs three times through a bank of 38 tests. Bigger scores are better. Firefox got a score of 142, Chrome achieved 168, and Edge came in at 196. That's not so surprising: Earlier Edge versions even beat Chrome on Google's own Octane benchmark.

WINDOWS HELLO AND IMPROVED SECURITY

Another focus of the Anniversary Update is security, including Windows Hello biometric authentication. Hello is supported on Surface Pros and Books, and you can also use third-party biometric login devices, such as the Eidon Mini fingerprint reader and Intel's RealSense cameras. Coming for Hello is the ability to log in simply through proximity with a Microsoft Band 2 health monitor/ smartwatch wearable.

In more security news, the included anti-malware software, Windows Defender, adds the ability to schedule regular system scans and new notifications about threats. Enterprise security feature adds include two major new features: Windows Defender Advanced Threat Protection, which detects and resolves advanced network threats; and Windows Information Protection, which isolates corporate data from personal data on work PCs.

CONCLUSION

The Windows 10 Anniversary Update offers more ways to interact with your desktop PC than any competitor, along with more third-party hardware and software options. Whether it's using your voice with Cortana, gesturing on a touch screen, or writing with a digital pen, Windows is the OS of choices. It's the platform that offers the most choice in form factor, from the smallest tablets to massive gaming PCs and the giant Surface Hub. Its only device-based weakness is the flagging Windows Phone ecosystem.

After the long dark period of Windows 8, Microsoft has delivered an operating system that's familiar, innovative, and adaptable to the size and capabilities of the hardware it's running on. For managing to include so much new technology while remaining intuitive to use, Windows 10 earns a PCMag Editors' Choice for desktop operating systems, an honor it shares with the polished and impressive Mac OS X.

BY MICHAEL MUCHMORE

Wipe Out Malware With a Reboot

The Kure

$19.99

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Testing antivirus utilities with live malware can be risky. To minimize the possibility of damage during testing, I use virtual machines. When the testing is done, I just revert the virtual machine to its clean, pre-test state. The Kure does something very similar to protect your PC. When you reboot, it restores the PC to a previous malware-free state, wiping out any changes except your own documents, pictures, and so on. And a ransomware-recovery feature reverses malicious changes to those documents.

The main thing it can't do is claw back any data that may have been stolen by a Trojan—it reverts only your PC, not the outside world. Malicious changes in folders you've exempted from The Kure's ministrations also can't always be reversed.

That being the case, you do still need some kind of real-time antivirus protection—but at $19.95 per year, The Kure isn't an expensive addition. VoodooSoft VoodooShield 2.0, a somewhat similar utility, costs about the same. Quietzone also bears some similarity to The Kure, but at $14.99 per month, it's in a different price league.

Several months ago I reviewed an earlier version of The Kure, one that attempted to incorporate an antivirus engine licensed from McAfee. That antivirus integration proved seriously problematic. It just didn't work right. The company went back to the drawing board, eliminating integrated antivirus and focusing on the effective revert-to-safety technology that's at the heart of The Kure. They also made a few fixes and streamlined a number of awkward areas that I pointed out in my earlier review. That edition of The Kure is a big improvement.

But the ransomware protection in that updated edition failed in my testing. The developers went back to the drawing board and came up with a completely different (and significantly better) method for ransomware recovery. After examining it, I deemed it important enough to update my review.

The Kure

PROS On reboot, restores your PC to a clean, malware-free state. Exempts personal folders from being wiped. Ransomware recovery proved effective in testing. Live-chat tech support built in.

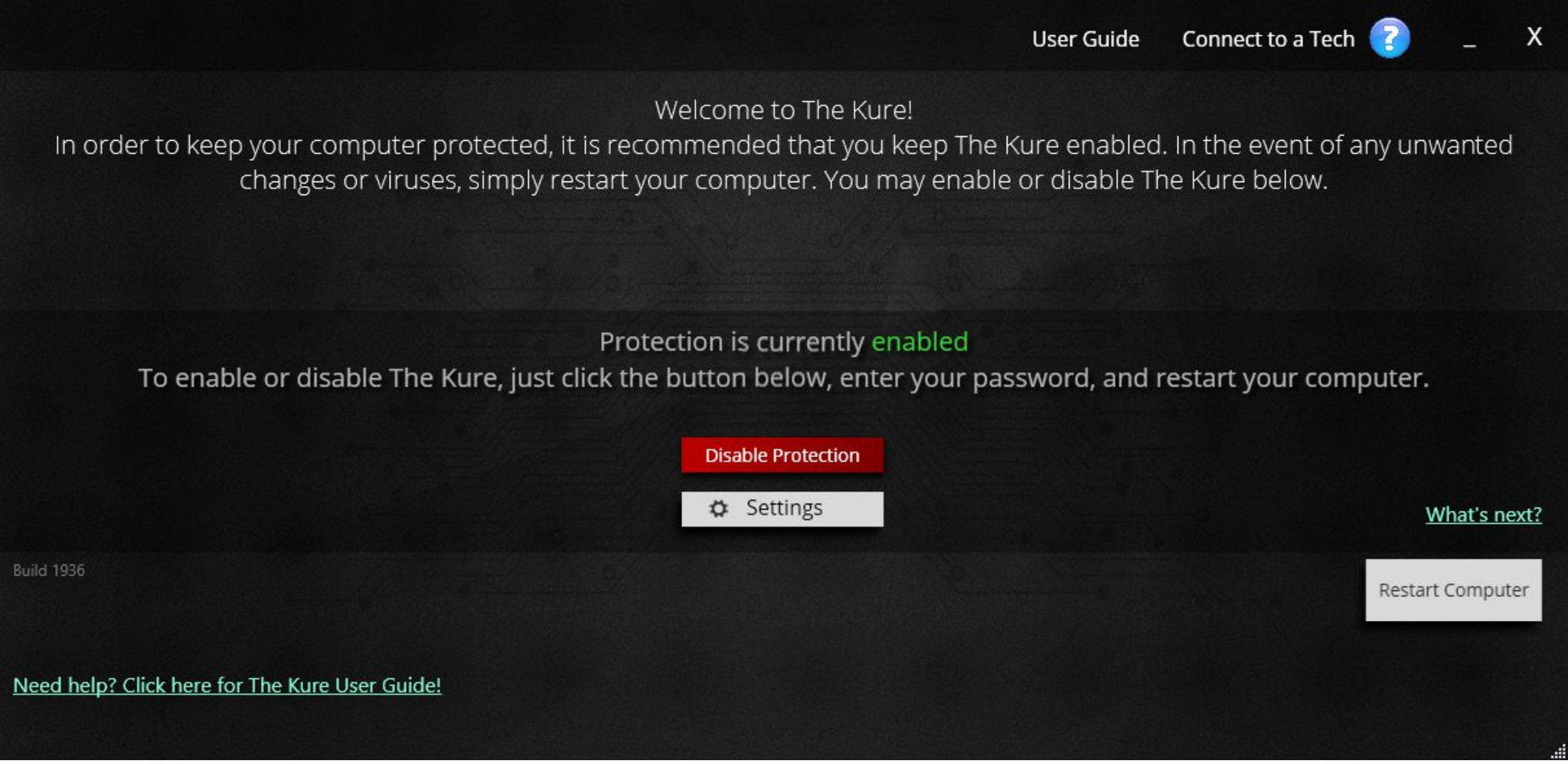
CONS Malware can act freely until eliminated by reboot. Doesn't offer 24-hour tech support.

GETTING STARTED WITH THE KURE

When you purchase The Kure, you receive a transaction number that identifies you as a customer and a serial number for the particular installation. Hang onto those; you'll need them.

Before you start to install The Kure, you absolutely must make sure that you've got a clean system. Use a free, cleanup-only antivirus to do a thorough scan. Our Editors' Choice in this area is the well-known (and free) Malwarebytes Anti-Malware 2.0.

Now you can install The Kure. The process is straightforward: Run the install wizard, give it your credentials, and reboot.



After you launch the program, there's a little more work to do. Necessarily, The Kure starts off disabled. Before you enable it, you should take care of some minor configuration issues. When you click Settings, you notice that The Kure handles Windows Updates automatically. That's nice! Quietzone doesn't handle those updates itself; you have to disable it, run the updates, and enable again.

Don't meddle with Advanced Settings. If you do, you get two layers of warnings telling you to leave these settings alone unless instructed by Tech Support.

Do click the Saved Folders button, however. This button lets you review and possibly modify the list of folders where The Kure allows permanent changes, which survive its reset-on-reboot purge. By default, the list includes desktop, pictures, music, documents, and favorites for each user of the system. You can add other folders whose contents shouldn't be discarded on reboot.

When you're done, click Go Back twice to reach the main screen. Click the Enable Protection button and reboot. The Kure is now active.

START ALL OVER AGAIN

When The Kure is enabled, rebooting discards all system changes since the Windows session began (except for protected user data folders).

HOW IT WORKS

When The Kure is enabled, it virtualizes all changes to the file system and Registry. Programs work just as they would without The Kure. However, when you reboot, The Kure discards all of those changes. Really, it's as simple as that.

Of course, if you just finished writing the Great American Novel only to have it vanish on reboot, you wouldn't be too happy. That's why The Kure exempts the personal folders I mentioned earlier, ensuring that files you save there won't be discarded.

You may have used The Kure's commercial version without realizing it. Did you ever use a public computer kiosk in a hotel lobby to print your boarding pass? Many of those kiosks—two million of them, according to the company website—are automatically sanitized using The Kure's technology. The company has recently received a U.S. patent for this technology.

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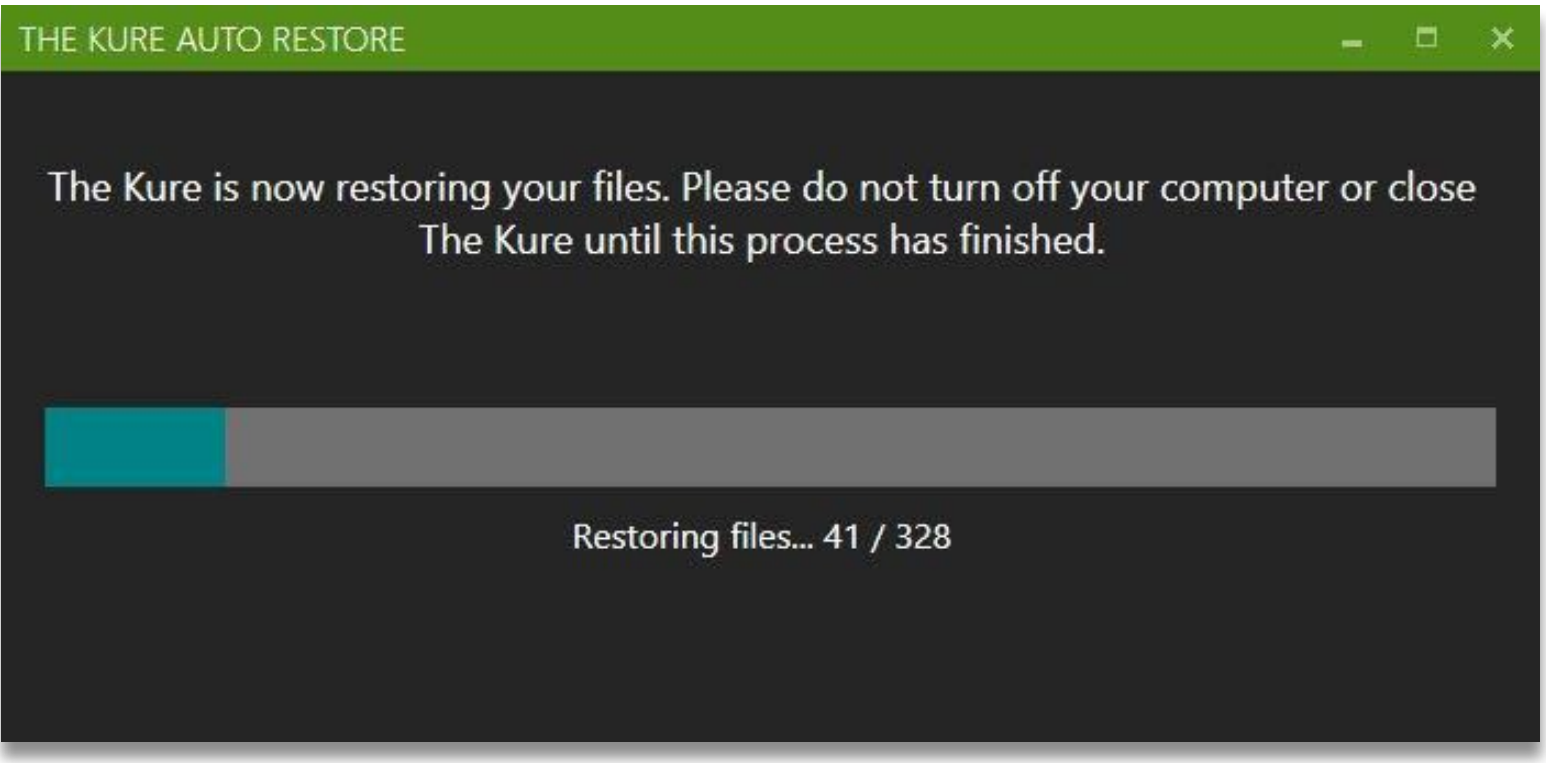

AUTO RESTORE
After an attack by encrypting ransomware, The Kure automatically restores the unencrypted versions of files in your personal folders.

CHANGE YOUR HABITS

When you rely on The Kure for protection, you absolutely must get in the habit of turning your computer off at the end of the day. If it just goes into sleep mode or hibernation with no actual reboot, then it doesn't get sanitized by The Kure.

When you install new software on a system protected by The Kure, it's a multistep process. First, disable The Kure and reboot. Next, install the software. Finally, re-enable The Kure and reboot once more. If you forget and start to install a new program while The Kure is enabled, it pops up a helpful reminder and offers to reboot in unprotected mode. That's handy!

The Kure automatically handles getting Windows updated, but not your browsers or other programs. Your best bet is to set aside some time every week to make sure everything gets necessary updates. Disable The Kure and reboot. Launch your browsers and make sure they get any needed updates. Check things like Adobe Reader and Adobe Air. Many programs include a menu item to check for updates; find and click all those.

During this update-fest, don't do anything else on the computer. Don't visit websites. Don't check email. Don't plug in any USB drives. Do nothing but install updates. When you're done, enable The Kure and reboot. Once you get used to this regimen, it shouldn't take long.

CHANGE YOUR ANTIVIRUS

What about antivirus protection? According to The Kure's website, you don't need any! But I don't buy that. Without real-time antivirus protection, a malware infestation could own your computer, right up to the moment you reboot. And yet, your usual antivirus will have some trouble working alongside The Kure.

Symantec Norton Security Premium's one-year plan boasts "pulse updates" that bring it the latest malware definitions as often as every few minutes. Most competing products check for signature updates at least every hour or so. And having the latest updates is essential to defending against the latest malware. The ill-fated McAfee integration was intended to solve this problem.

In this situation, Webroot SecureAnywhere AntiVirus (2016) is a logical choice. It doesn't rely on a local signature database, instead detecting malware by checking behavioral signatures with its cloud component. When it detects a suspicious program, it journals all activity pending full analysis, and rolls back everything the program did if the program later proves malicious.

I asked my Webroot contact how the program would handle The Kure's reboot-to-revert mechanism. He noted that it might cause a bit of trouble for the journaling mechanism, but that in general it shouldn't be a problem for the user. Of course, you should include the antivirus in your periodic update regimen, in case program updates turn up.

RANSOM ME NOT!

I am pleased to note that The Kure promises protection against the growing problem of ransomware. As it happens, three items in my collection of malware samples are ransomware, though one of them won't perform on demand. One sample doesn't attempt to encrypt files. Rather, it takes over the desktop and locks away all Windows features and programs. That one was a snap for The Kure, since the ransomware requires a reboot to get fully entrenched. Upon reboot, no ransomware!

I loaded my test system's documents and music folders with some tempting files and turned the encrypting ransomware sample loose, after disabling the test system's network connection. The ransomware couldn't resist; it encrypted the files and displayed a message warning that I would lose them forever if I didn't pay the ransom. Luckily, I have The Kure! I rebooted the system to recover. Alas, it didn't start up properly.

I clicked the prominent Connect to a Tech link in the main program. The Kure live support is available only from 8 a.m. to 6 p.m. Eastern, meaning West Coast users had better make sure to connect before late afternoon.

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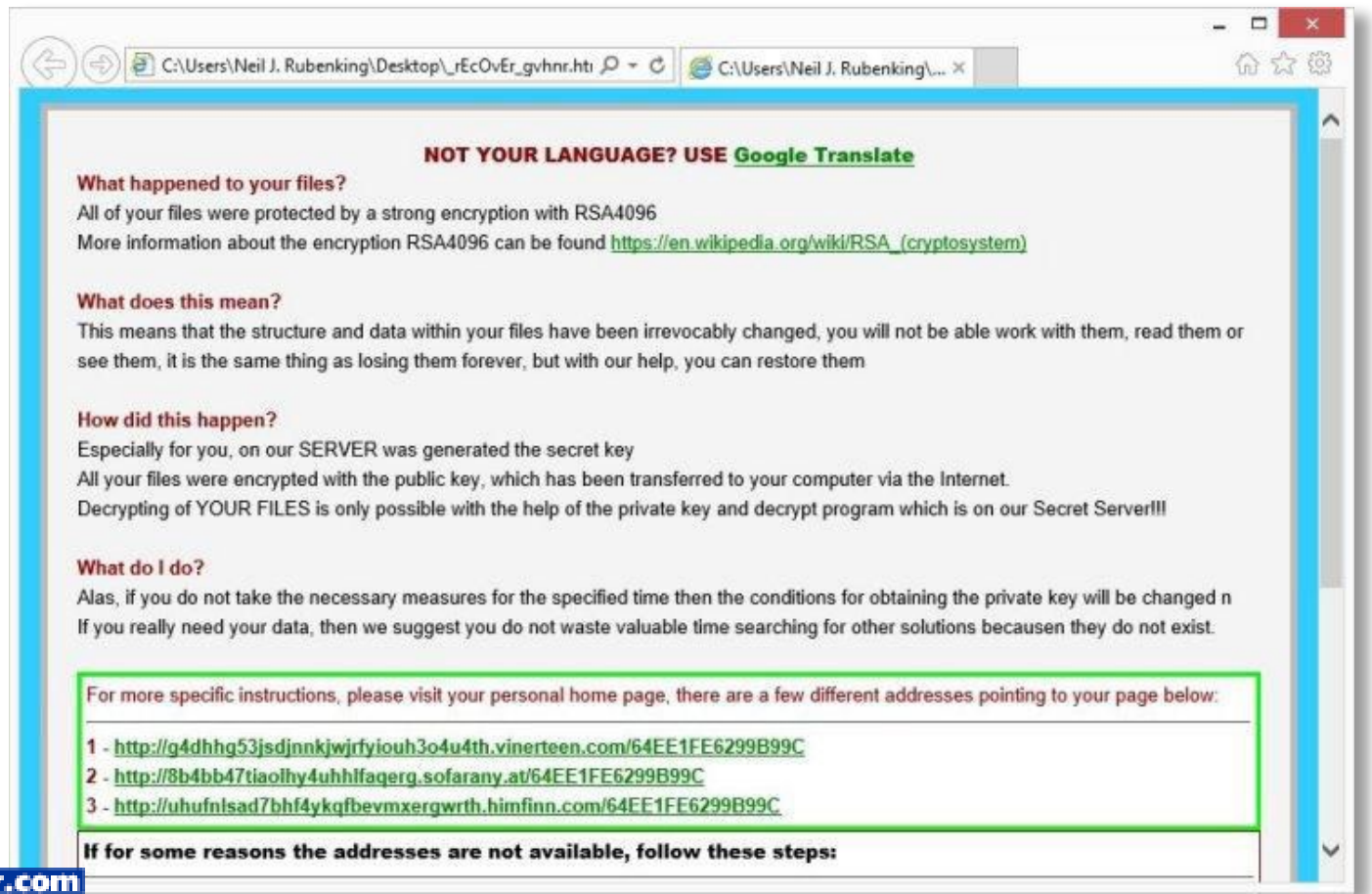
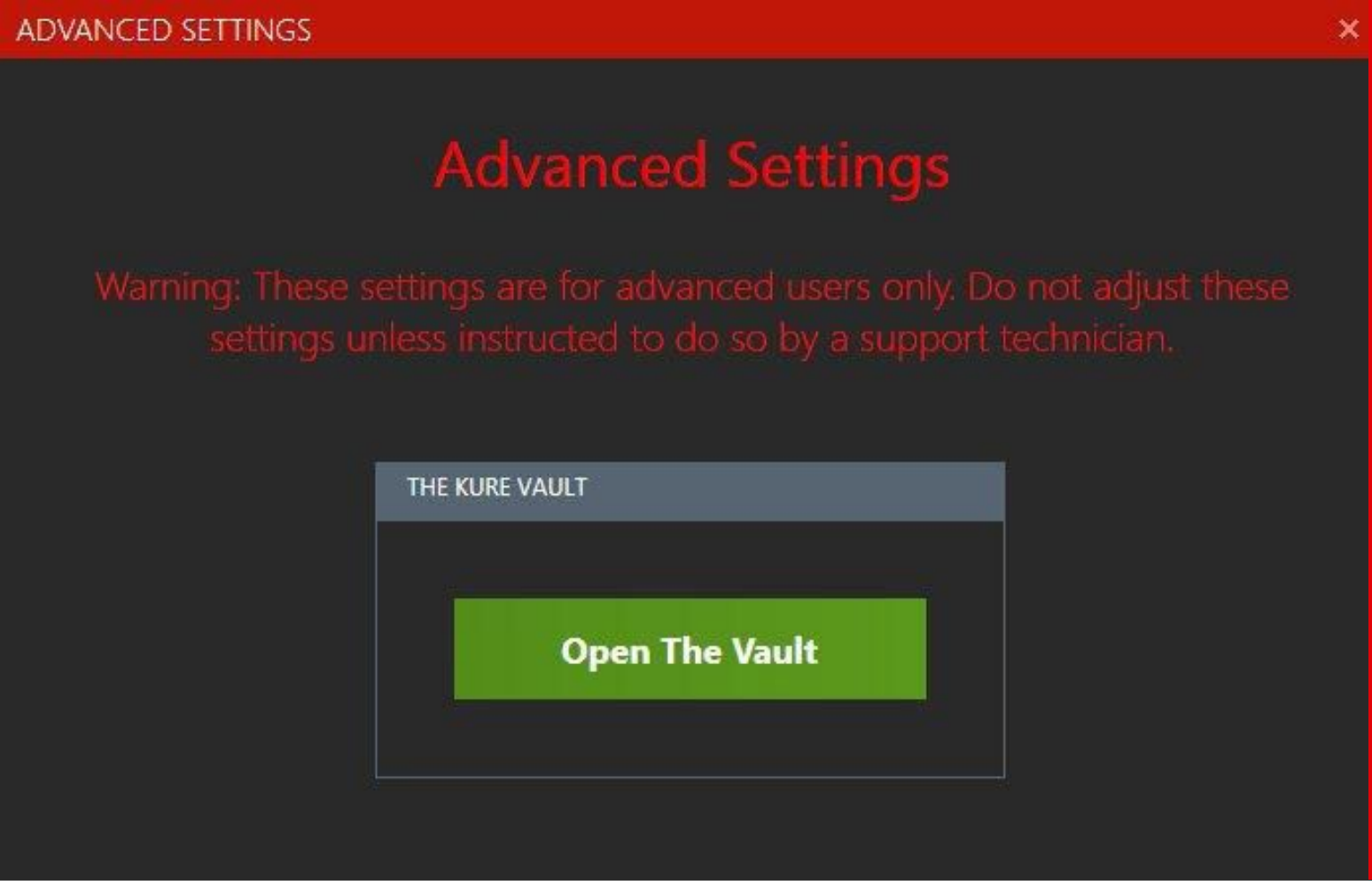


RANSOM NOTE
The Kure promises to rescue files encrypted by ransomware, but in testing, I found that it can do so only when the ransomware also renames the files.



DANGER, DANGER
This is the second of two warnings that you get when you click the Advanced Settings button. They really don't want you to mess with this!

The technician took control of the test system and checked the logs, then restarted an essential service. The Kure immediately popped up to say it was automatically restoring my files, with a progress bar to show how the job was going. When it finished, all of the files were back to their pre-encryption state.

When I tested The Kure two months ago, it failed this same test. The technician had opened the double-locked Vault in Advanced Settings, hoping to recover the original files, but he found that the saved copies were already encrypted. Since that time, the product's designers devised a new technique for detecting and foiling encrypting ransomware. They've quite reasonably asked me not to reveal details about how it works. No need to give clues to the bad guys! But as far as I can see, it should work against any attack of this type.

If the malware had succeeded in permanently encrypting my files, I still wouldn't have been eligible for The Kure's $1,000 guarantee. That applies if the technicians are unable to remove the malware itself. It doesn't cover reversing all of the malware's effects.

The Kure succeeded in this test, but don't let that make you complacent. Sooner or later, some cyber-hooligan will come up with a ransomware attack that gets past The Kure's protection. To make sure your data or your business can't be harmed by encrypting ransomware, use a backup utility to keep your important data in a safe online archive. Make sure the backup service retains multiple file versions, else you could wind up with nothing but backups of the encrypted files. Then if you're hit with a ransomware attack that The Kure can't handle, you'll have a way to recover.

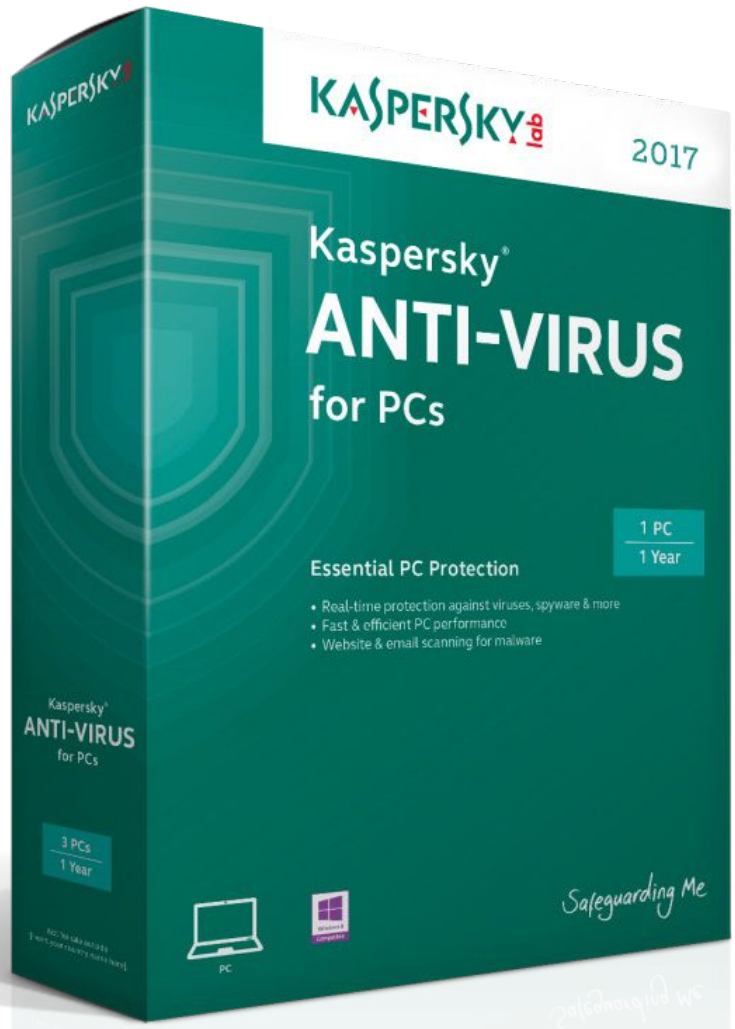
CONCLUSION

When you reboot a computer that's protected by The Kure, every file and Registry change that occurred since the last reboot gets swept away, bring the system back to a clean state. Folders containing user data are exempted from this process, naturally. The Kure can't reverse interactions with the outside world, such as a data-stealing Trojan sending your credit card number to its master. And malware-related activity in those exempt folders can't always be reversed. If a Trojan or virus infests the protected system, it will have free rein until the next reboot. But in general the reboot-to-revert system works exactly as promised, and ransomware recovery is now more robust.

Clearly this product is best used in conjunction with a tool that provides real-time antivirus protection. We've actually defined four Editors' Choice antivirus tools: Bitdefender Antivirus Plus, Kaspersky Anti-Virus, McAfee AntiVirus Plus, and Webroot SecureAnywhere AntiVirus. Of these, Webroot is the most likely pairing, because it doesn't rely on frequent antivirus signature updates.

NEIL J. RUBENKING

In general, the reboot-to-revert system works exactly as promised, and ransom-ware recovery is now more robust.



All the Labs Agree: Kaspersky Is At or Near the Top

PC MAGAZINE EDITORS' CHOICE

When you're shopping for a new appliance, you probably look for one that gets a good rating from consumer research agencies. When you're shopping for an antivirus program, you want to see excellent scores from the independent antivirus testing labs. The labs uniformly rate Kaspersky Anti-Virus at or near the very top, giving it the best aggregate lab score I've seen. The 2017 edition doesn't ace all of my hands-on tests, but given the vast resources the labs can bring to bear on testing, their results hold more weight than my own small-scale tests. Kaspersky remains an Editors' Choice this year.

Kaspersky Anti-Virus (2017)

$59.99

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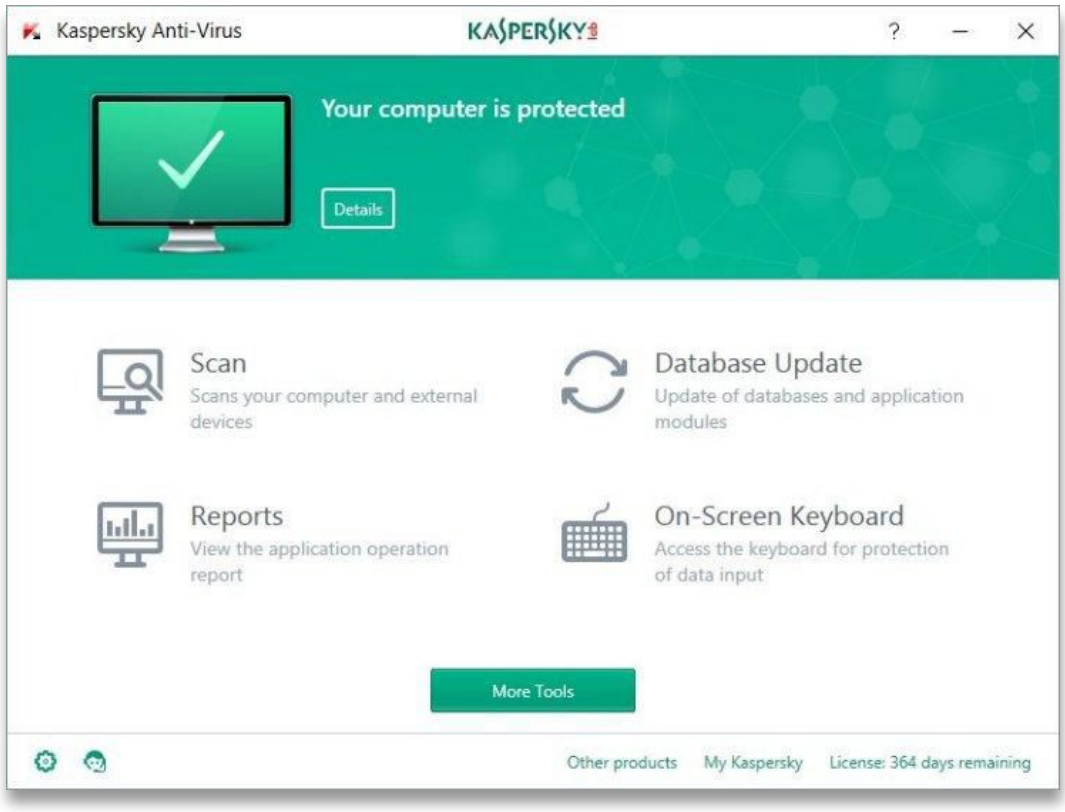
A year of Kaspersky protection covers up to three PCs and lists for $59.99, though special offers often yield a much lower price. Typically, you make your purchase online, then log in to the My Kaspersky portal to download and install the product. Don't forget to let it download the latest antivirus signatures. Note that volume discounts are available. A five-PC license lists for $79.99 and a ten-PC license for $129.99.

The program's main layout has changed a bit since last year. Four large icons let you scan for malware, update the signature database, view reports, or open the on-screen keyboard. They're now bigger and arranged in a two-by-two matrix, where they used to be in a single row. The top banner still represents security status. When there's a problem, it turns bright red. Clicking the Details button lets you quickly fix whatever is wrong.

Kaspersky Anti-Virus (2017)

PROS Fantastic scores from independent antivirus labs. Best score in our hands-on antiphishing test. Speedy full-system scan. Numerous useful bonus tools.

CONS So-so scores in our hands-on malware-blocking and malicious URL–blocking tests.



A (SLIGHTLY) NEW LOOK
The main window for Kaspersky Anti-Virus retains the same color scheme and large icons found in last year's edition, but arranges them differently.

A full antivirus scan of my standard clean test system took 24 minutes, which is quite good. The average for current products is 43 minutes, with Microsoft Windows Defender 4.9 and a few others taking more than an hour. Clearly this initial scan performed some degree of optimization, as a repeat scan finished in just four minutes.

LABS LOVE IT

Most of the independent testing labs that I follow include Kaspersky in their testing, and they uniformly rate it at the very top. I track five different tests performed by researchers at AV-Comparatives, among them static detection, dynamic protection, and performance. In every test, Kaspersky earned Advanced+, the highest rating. Of the products I cover, only Bitdefender Antivirus Plus 2016 has equaled that feat.

AV-Test Institute rates antivirus tools on three criteria: protection, performance, and usability, assigning up to six points for each. Kaspersky earned six points for protection against malware, six points for low performance impact, and another six for usability, meaning that it didn't flag valid programs or websites as malicious. That sums to a perfect 18 points. Avast, Norton, and Trend Micro Antivirus+ Security 2016 each managed 17.5 points.

Earlier this year, I started tracking tests by MRG-Effitas. This lab's tests are unusual in that quite a few of the tested products just flat-out fail. Kaspersky and Webroot SecureAnywhere AntiVirus (2016) were among the few to pass a test specifically focused on financial malware.

This lab's 360 Assessment exposes test systems to several hundred in-the-wild malware samples and rates how well programs protect on their own, without any user interaction. To get Level 1 certification, a product must completely prevent every sample from installing on the test system. If some of the samples manage to run initially but get eliminated within 24 hours, that's worth Level 2 certification. Anything else is a failure. Kaspersky dropped from Level 1 to Level 2 in the latest test, but that's still very good. Symantec Norton Security Premium and Webroot were among the few others to receive this certification.

HEAD OF THE CLASS
This independent lab awarded Kaspersky a perfect six on each of its three test criteria.

Kaspersky doesn't participate in the certification programs offered by West Coast Labs and ICSA lab, and it hasn't appeared recently in the RAP (Reactive and Proactive) test by Virus Bulletin. Dropping the RAP score actually raised Kaspersky's rating in my aggregate score chart to an impressive 9.8 of 10 possible points. The labs are clearly impressed by Kaspersky's technology.

HANDS-ON TEST RESULTS

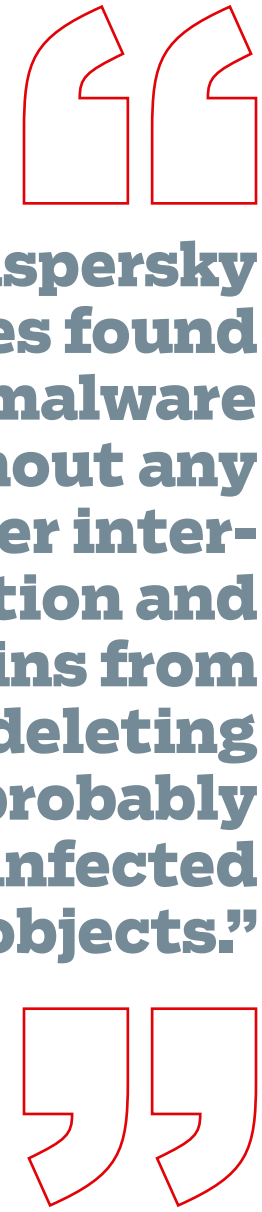
As initially configured, Kaspersky handles found malware without any user intervention and refrains from deleting "probably infected objects." For testing purposes, I turned these settings off, so I could see what it was doing.

When I opened my folder of malware samples, Kaspersky went into action, deleting those it recognized on sight as malware. The process took a while, because it first attempted disinfection on each item, quarantining it only if disinfection failed. It wiped out 71 percent of the samples at this stage.

I observed an interesting feature when I launched the remaining samples. In a couple of cases, Kaspersky reported suspicious behavior after the malware was installed and running. It offered to roll back the malicious program's activity and perform advanced disinfection. Each time it wiped out every trace of the malware. A similar detection and rollback feature is a mainstay of the way Webroot handles unknown processes.

The real-time protection didn't react at all to several of the samples, though, giving Kaspersky an overall detection rate of 84 percent. It scored 8.4 of 10 possible points in this test, lower than several other products tested using the same sample set.

My malicious URL–blocking test uses a daily feed of malware-hosting URLs supplied by MRG-Effitas. I launch URLs from the current day's feed and observe



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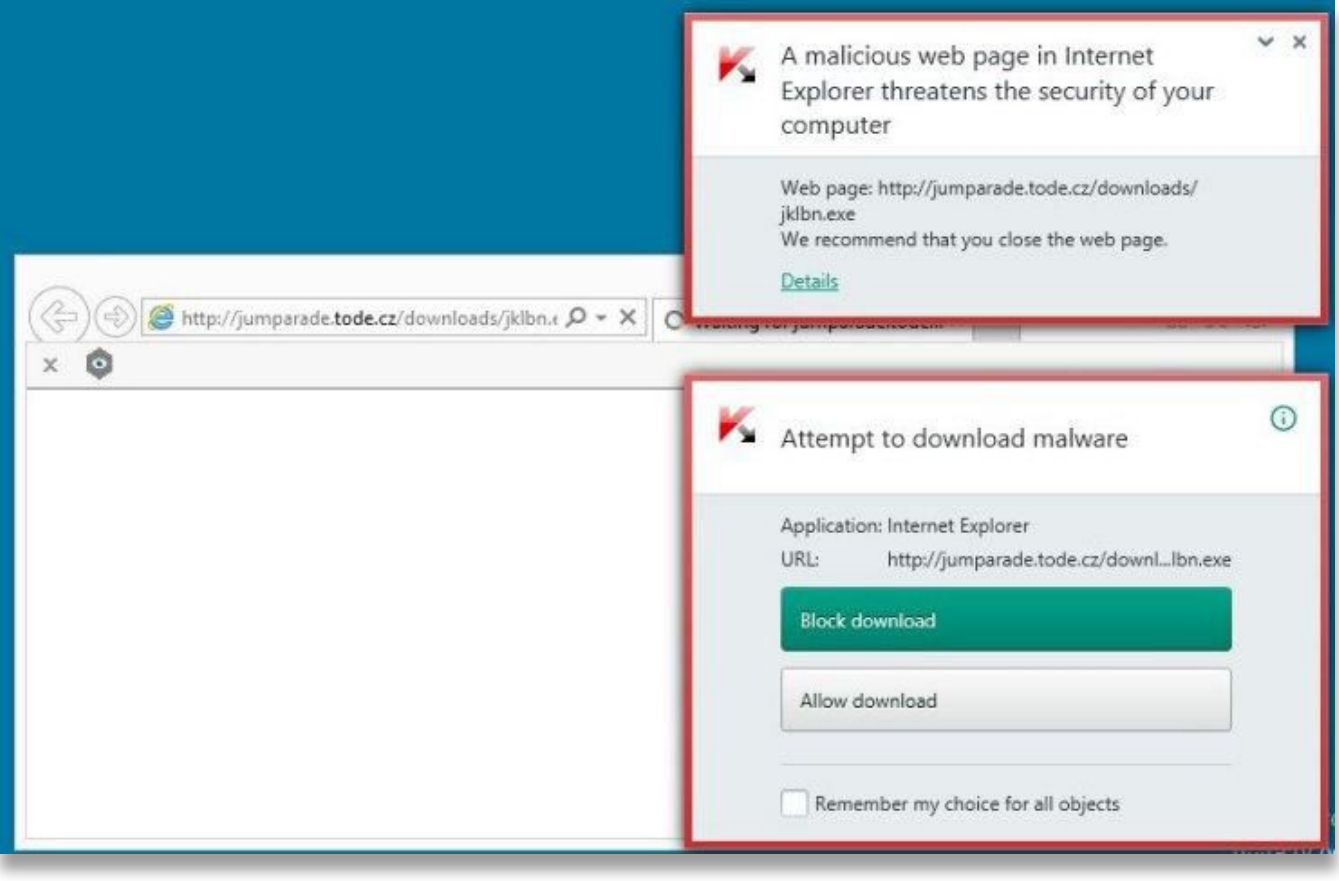


whether the product blocks all access to the URL, wipes out the downloaded malware, or does nothing. I keep at it until I've recorded data for 100 URLs.

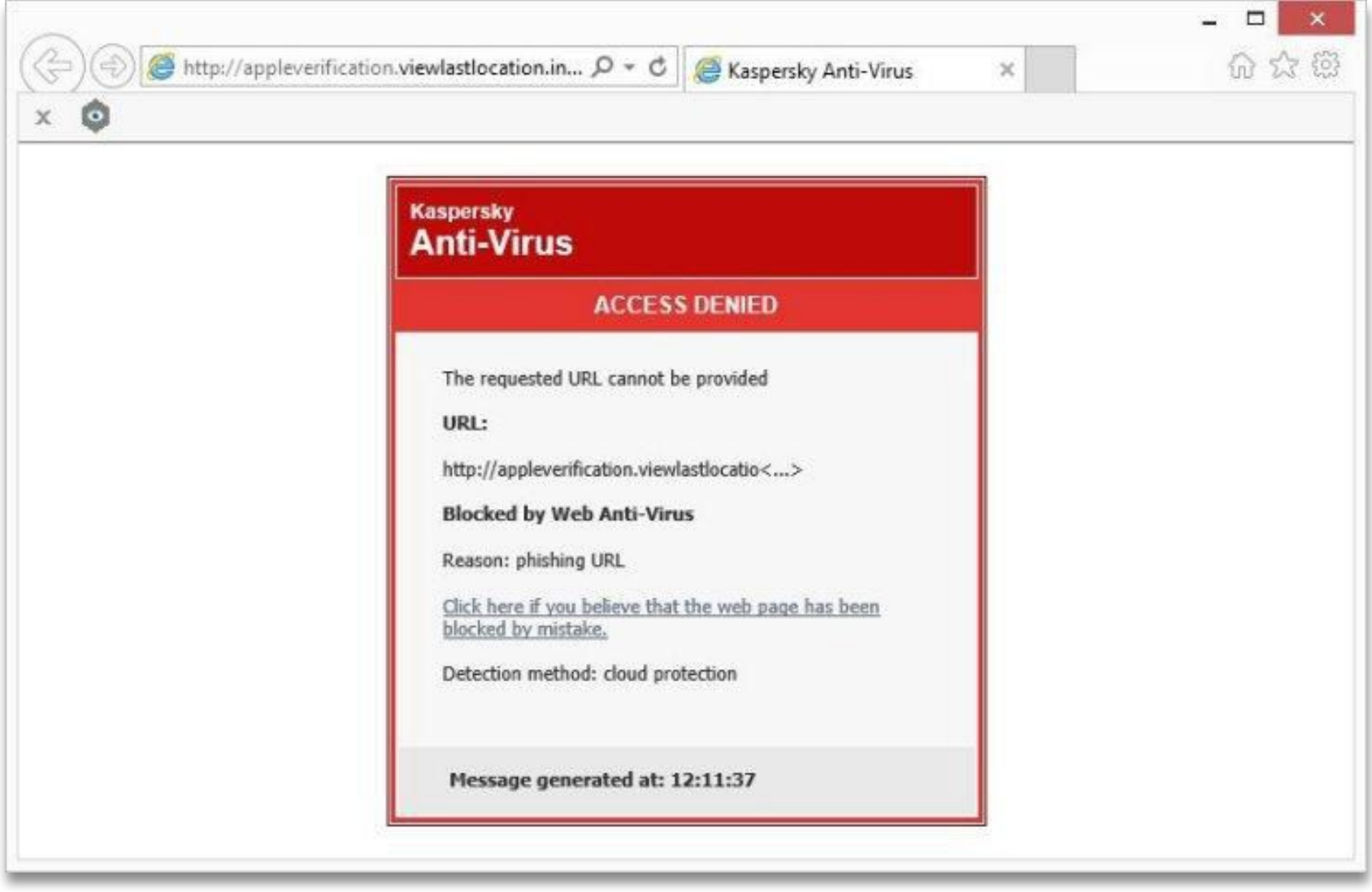
Kaspersky blocked 65 percent of the samples, almost all of them by steering the browser away from the dangerous URL. That's not a great score. Avira Antivirus Pro 2016 blocked 99 percent, all at the URL level. Norton and McAfee AntiVirus Plus (2016) came in second, with 91 percent.

Some antivirus products don't participate in lab testing, making these hands-on tests my only way of rating their effectiveness. Others do equally well with the labs and in my own tests. Year after year, Kaspersky blows it out of the park with the labs but doesn't do as well in my tests. It's puzzling, but given the huge amount of resources the labs can bring to bear, I defer to their results when there's a difference.

Year after year, Kaspersky blows it out of the park with the labs but doesn't do as well in my tests.

AMAZING ANTIPHISHING

The same browser plug-in that blocks access to malware-hosting URLs also serves to keep users from falling for phishing schemes, fraudulent sites that try to steal login credentials for sensitive websites. It proved vastly more effective against phishing than against malware-hosting URLs.



For this test, I scour the Web to find newly reported fraudulent sites, many of them too new to have made it onto phishing blacklists. I launch each URL simultaneously in five browsers, one protected by the product under testing, one by Norton (a long-time antiphishing winner), and one each by the built-in security in Chrome, Firefox, and Internet Explorer. I discard any that don't load properly in all five browsers, or that aren't actually phishing sites.

Because the URLs are different every time, I report the product's success relative to that of Norton and the three browsers. Almost every product I've tested lags behind Norton, and quite a few can't even beat the built-in browser protection.

Bitdefender and Webroot did slightly better than Norton in this test, but Kaspersky beat them both. Its detection rate came in 5 percentage points higher than Norton's, the best I've seen.

BONUS TOOLS

Some antivirus products just stick to the task at hand, with few extras; F-Secure Anti-Virus 2016 is an example. Others, like Kaspersky, add quite a few security-related bonus features.

One bonus in particular gets top billing: the On-Screen Keyboard. The first time you click its icon, featured prominently on the main window, it needs a restart for full functionality. Thereafter you can invoke it any time to enter passwords without the possibility of capture by a keylogger—even a hardware keylogger.

You access the rest of the bonus tools by clicking the main window's More Tools button. From the resulting menu, you can view files in quarantine, check the status of the Kaspersky Security Network online, or create a Kaspersky Rescue Disk. The rescue disk can clean malware that prevents you from accessing Windows or launching the regular Kaspersky malware scanner. Wise users will create a rescue disk right away and stash it against future need.

When you choose Vulnerability Scan, Kaspersky performs two rather different system checks. It reviews your Windows configuration to report settings that aren't the best for security, with the option to fix them. Don't like what it did? You can roll back the changes. It also looks for applications that don't have the latest security patches. Unlike the Software Updater in Kaspersky's full security suite, the Vulnerability Scan leaves you to manage necessary updates yourself.

A couple times during my hands-on testing, the Microsoft Windows Troubleshooter popped up and offered to change system settings that might have been tweaked by malware. You can also launch this scan at any time from the More Tools menu. There's a certain amount of overlap with the Vulnerability Scan; for example, both offered to turn off AutoRun for various drive types.

The Privacy Cleaner wipes out various traces of browsing and computer use, and the Browser Configuration Checker looks for problems with your Internet Explorer configuration (it didn't find any on my test system). As with the other bonus scans, you can roll back changes made by either of these.

CONCLUSION

The fantastic scores awarded to Kaspersky Anti-Virus by the independent testing labs far outweigh its uneven performance in my hands-on tests. Its malware scan is fast, and it includes numerous security-related bonus features. If an unknown program exhibits malicious behaviors, the antivirus can roll back that program's actions completely. Kaspersky is an Editor's Choice for standalone antivirus protection. It shares that honor with Bitdefender Antivirus Plus, McAfee AntiVirus Plus, and Webroot SecureAnywhere AntiVirus.

NEIL J. RUBENKING

DRIVERLESS CARS

Autonomous cars will be the most important extension of the Internet since smartphones. And they'll be ubiquitous much sooner than you think.

BY EVAN DASHEVSKY

For those who are perpetually frustrated by the tech industry's continued failure to live up to Hollywood-style depictions of the future, self-driving cars might seem about as likely as warp speed or time-traveling cyborgs. But unlike those other unfulfilled sci-fi promises, we have the technology necessary to make driverless cars a reality right now. In fact, fully automated vehicles are teetering on the edge of commercial viability.

As researchers around the globe continue to tinker with autonomous driving software, they're also anticipating its potential impact. Handing the keys over to algorithms means our cars will, in effect, become an information technology. But unlike laptops and smartphones, connected cars will alter the world around us in many ways.

INCHING TOWARD INEVITABILITY

Aside from the still-very-much-in-beta fully automated vehicles (AVs) currently being road-tested by the likes of Google, technologies that allow cars to operate at least somewhat independently have been with us for years and, in some cases, decades.

In 2013, the National Highway Traffic Safety Administration (NHTSA) released a blueprint outlining how advanced forms of automation should be introduced to public roads. It included five levels of autonomy ranging from Level 0 ("No Automation") to Level 4 ("Full Self-Driving Automation").

Most cars on the road today are either Level 1 ("Function-Specific Automation," which includes familiar things like electronic stability control and anti-lock brakes) or Level 2 ("Combined Function Automation," which incorporates newer bells and whistles like adaptive cruise control and automatic lane centering). Google's Little Tikes-esque AVs are considered Level 3 ("Limited Self-Driving Automation") because drivers are still expected to commandeer navigation at some points along the journey. Once we reach Level 4, passengers just get in and say "Hey Siri, take me to Grandma's house."

Before anything approaching Level 4 is let loose in the wild, though, a not-insubstantial number of legal, ethical, and technical issues need to be addressed—the sensors on Google's cars, for example, reportedly still have trouble discerning between a bag blowing in the wind and a deer galloping into oncoming traffic. Still, it's a good bet that most people reading this will see an autonomous car on a street near them in their lifetime.

Car makers including Tesla, Toyota, and Volvo have already promised to deliver fully autonomous vehicles by the end of this decade. The question is no longer, "Is it possible?" but rather, "How long until it's available"?

"I see two kinds of scenarios," says Professor Raj Rajkumar, the co-director of the General Motors-Carnegie Mellon Autonomous Driving Collaborative Research Lab. "First is that I can see vehicles being deployed in restrictive scenarios where the road is clear of pedestrians and bicyclists, and the vehicle could stop only at designated places. People would get on or off from the vehicle at specific locations—just like a shuttle, for example. I can see that happening in two to three years' time."

Rajkumar also suggests a continued piecemeal introduction of features (for example, GM's super cruise or Mercedes-Benz's steering assist). This steady accretion, he says, can bring us to Level 4 automation in "about 10 years."

CAR TALK
Vehicle-to-vehicle (V2V) and vehicle-to-infrastructure (V2I) communication will work in conjunction with an AV's onboard tech to ensure it operates predictably, efficiently, and safely.

Technologies that allow cars to operate at least somewhat independently have been with us for years and, in some cases, decades.

"I think we are on the right trajectory. The technology has been demonstrated in relatively constrained situations—for example, in regions where there is no heavy rain or snow," Professor Rajkumar points out, though Ford earlier this year started testing its autonomous vehicles in snow. "Then we have also had a bunch of recent incidents where the interactions between human drivers and self-driving vehicles are still being fleshed out."

By “fleshed out,” Rajkumar was diplomatically alluding to a number of recent accidents involving AVs, which were mostly caused by the human-navigated vehicles sharing the road with them. Our interview took place a few weeks before the public learned about the NHTSA’s investigation into the first known fatality involving self-driving technology.

In that case, an early adopter placed a little too much faith in the semi-autonomous Autopilot feature on his Tesla Model S. He trusted that his car would be able to decipher between the brightly lit sky on the horizon and the white side of a tractor trailer running perpendicular across the highway. Sadly, it was not.

Not to relegate a person’s death to a statistic, but history will probably view this accident as one awful step back before we take several gigantic leaps forward in regards to public safety. In contrast to much of the media frenzy surrounding the deadly accident, this incident reinforces the need for *more* automation on the roads, not less.

THE MOST DANGEROUS THING YOU DO EVERY DAY

Safety advocates, regulators, and the car industry are quick to point out that America’s roads are safer than at any point in history. Road deaths have been nearly halved over the past four decades—dropping from 53,000 in 1970 to 33,000 in 2014—which is even more impressive when you consider the population has swelled by half, and we’ve tripled the number of miles we drive each year.

While we’ve come a long way toward mitigating the carnage, we shouldn’t lose sight of the fact that a stadium’s worth of people die each year on U.S. roads (plus more than a million more around the world). Even if you’re the most attentive hands-at-ten-and-two driver, who always obeys the speed limit and never gets behind the wheel after imbibing even a sip, there’s a good chance some other driver sharing your stretch of road isn’t as responsible.

We could continue implementing partial solutions, such as seatbelt laws, crumple zones, and median barricades, or we could accept the underlying problem: humanity. The good news (from a public health perspective) is that humans are a problem that is unsettlingly correctable—technologically speaking.

Like any complex machine, AVs are not the result of a single technical breakthrough. Most current models incorporate several kinds of sensors (cameras, RADAR, and LiDAR, for example), which provide a steady stream of real-time data to increasingly "wise" algorithms. Specifically, AVs employ "machine learning" algorithms. Machine learning is a subset of artificial intelligence that allows computers to react to novel scenarios they weren't specifically programmed to encounter (since no program could possibly anticipate every road eventuality).

"For the people who are experts in this area, they have all pretty much come to a consensus that no single sensing technology nor any single set of algorithms is sufficient to achieve the level of robustness that a human would drive at," said Jim McBride, Ford's senior technical leader for autonomous vehicles. "We use any information we can, and multiple algorithms running on that perception information to extract the most accurate picture of the world."

There may be some warranted hesitation about handing high-speed life-or-death decisions over to machines. (Pop quiz: The drowsy driver to your right is drifting into your lane. Should you attempt to pass the SUV with a family of six on your left, or stop short and hope that 18-wheeler behind you slows down in time?) But an AV's literally superhuman awareness can potentially stop these close-call scenarios from even occurring.

When it comes to the ethics of autonomous-car decision making, "Our intention, because we have such great situational awareness, is to not get into these positions in the first place," says McBride. "A lot of these difficult decisions are because people are inattentive or they don't have a 360-degree view around them. We would encounter such situations far less frequently than a human would."

The path to self-driving critical mass will probably be messy—but hopefully not deadly, especially as we enter the transitional time when the roads are shared by cars navigated by neurons and those by algorithms. To that end, there is a public-private effort to develop solutions such as vehicle-to-vehicle (V2V) and vehicle-to-infrastructure (V2I) communication technologies that would theoretically prevent accidents like the one involving Tesla's Autopilot. But more important, they'll work in conjunction with an AV's onboard tech to ensure it operates predictably, efficiently, and safely.

Beyond handing potentially consequential decisions to robots (and yes, AVs are robots), the very prospect of them infringing on our turf elicits a knee-jerk unease among many people. But history has shown that society inevitably learns to embrace the benefits of the non-sentient entities in its midst, be they faceless ATMs offering 24-7 convenience or the steely perfection of automated airport monorails that operate with little-to-no human oversight.

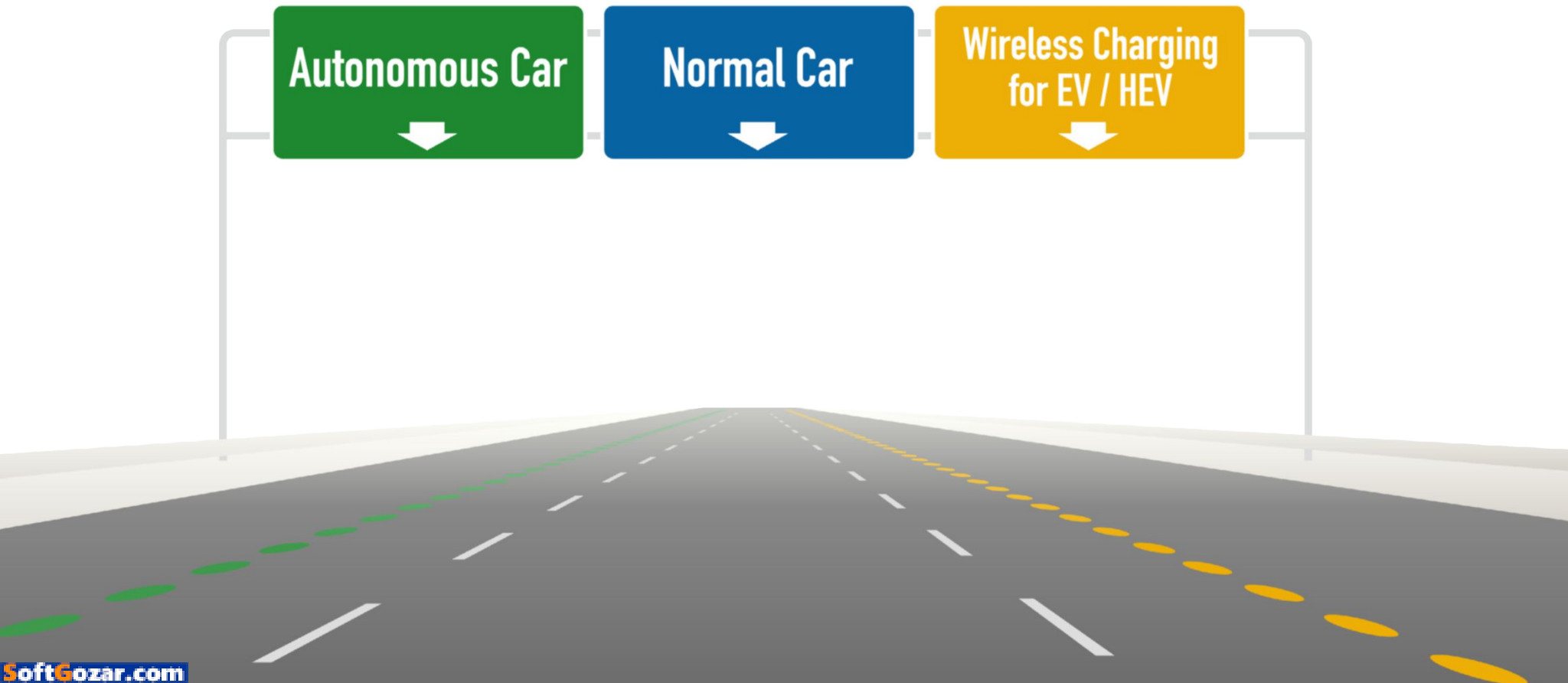
"The consumer acceptance is going to be like flipping a switch. I often hear things like 'I don't want the car driving for me,' or, 'How can you trust a machine?'" says connected car expert and president and founder of the C3 Group, Doug Newcomb. "I trust a machine more than I trust a teenage driver or my 89-year-old dad or someone texting and driving. These sensors are doing one thing all the time: Looking at the road. The technology is here. There's no doubt about it."

The prospect of fewer deaths is this technology's most compelling raison d'etre, but it's far from the only benefit. AVs will open the world to people who lack access to the analog road due to financial, medical, or legal prohibitions. Even for those with the means and ability, driverless technologies will completely revolutionize the way we get from A to B.

History has shown that society learns to embrace the benefits of the non-sentient entities in its midst.

GETTING THERE

The path to self-driving critical mass will probably be messy as we enter the transitional time when the roads are shared by cars navigated by neurons and those by algorithms.



WAITING FOR THE UN–MODEL T

A new housing development in San Francisco's Outer Sunset neighborhood recently made headlines for an unconventional offer it extended to prospective residents. The developers—in partnership with the app-based ridesharing company Uber—will pay tenants a monthly stipend of $100 if they agreed not to own a car. Uber, in turn, caps shared "Uber Pool" rides to and from public transportation hubs at $5.

The agreement is a win for residents who are comfortable with the tech-enabled, cosmopolitan lifestyle because it eliminates the hassles of car ownership. It's a win from the developer's point of view because it removes the need for land-ravenous, on-site parking. And Uber is always happy when fewer people are driving themselves. But this deal might also offer a glimpse of the self-driving world to come.

The decision to forgo car ownership lays waste to a longstanding pillar of the American Dream, but it's one that more and more Americans are making, some enthusiastically so. A recent University of Michigan study found that the percentage of people with licenses has plummeted across nearly all age groups in recent decades, but especially among teens. In 2014, only 24.5 percent of 16-year-olds and 69 percent of 19-year-olds had a license; compare those figures to 1983, when those numbers were 46.2 percent and 87.3 percent, respectively.

The mythos of car ownership that was so fundamental to previous generations appears to have long since peaked and shows no sign of coming back. Millennials have come into adulthood knowing only financial and global instability, and have thus shied away from avoidable financial obligations. Thankfully, they (and the even more linked-in "Generation Z" behind them) are well versed in the tools that allow them to avoid these commitments via "the sharing economy." This is a generational inclination that is attracting some hefty corporate bets, from Silicon Valley to Detroit.

“The decision to forgo car ownership lays waste to a longstanding pillar of the American Dream, but it's one that more and more Americans are making.”

From the stony vantage point of a quarterly report, the least important ingredients in the ridesharing model are the carbon-based lifeforms with their hands on the wheel. Uber has repeatedly demonstrated that cultivating career-long relationships with its human drivers isn't vital to its long-term goals. But recent investments may reveal the priorities the company does have for the future (certainly, by the time the IPO clock strikes 12).

Despite the fact that Uber only recently flirted with profitability, it has poured a great deal of resources into self-driving R&D. A 2015 poaching spree decimated academic institutions by luring more than 50 researchers into the for-profit world. "Are we going to be part of the future or are we going to resist the future, like that taxi industry before us?" CEO Travis Kalanick asks. "For us, we're a tech company, so we've said, let's be part of that. It's a super exciting place to be."

Developing robo-taxis may indeed be a "super exciting place to be," but it's not a super lonely one. Rival ridesharer Lyft recently entered into a half-billion-dollar partnership with General Motors to develop its own self-driving fleet. In mid-July, Tesla CEO Elon Musk laid out Tesla's plan for the next decade, which anticipates a fleet of autonomous taxis consisting of privately owned Teslas that can earn money for their owners when they aren't using them (you know, all that non-driving time wasted while users are at work or sleeping). Overseas, Chinese ridesharing company Didi Chuxing just accepted a $1 billion investment from Apple before merging with Uber China.

"The car-sharing paradigm has very powerful financial incentives, and therefore I think this one of the biggest competitive forces pushing the technology forward," explained Professor Rajkumar. "I think Uber is a great example. For every dollar that's considered revenue, about 75 cents of that dollar goes back to the driver, the human driver. But if the human driver is no longer there, that 75 cents literally drops down to their bottom line. So that's a very enormous incentive for Uber to try to make this technology happen sooner rather than later."

Even that most iconic of American automakers, the Ford Motor Company, has transitioned from viewing vehicles solely as things that customers buy to a more fundamental role as things that get customers from point A to B. During

NOT YOUR DAD'S FORD
The iconic automaker is pivoting toward technology-driven transportation service.

this year's CES tech show, CEO Mark Fields announced Ford's pivot towards technology-driven "transportation services," including alternative models such as ridesharing, pay-by-mile rentals, and continued investments in self-driving tech.

It's clear why Big Auto would invest in this nascent field, but we shouldn't understate the interest from Big Tech. Particularly, we need to consider the kinds of business plans Silicon Valley excels at, such as selling access to services. This might very well mean that the self-driving Model T—that first popular, affordable incarnation that brings this technology to The People—won't be a thing you purchase in a dealer's lot, as you would a new Tesla; it'll be a service you subscribe to on your phone, like Netflix.

"You can imagine when this technology has become reliable, affordable, and so on, people living in dense, urban locations including city downtowns and such, the incentive to own a car would go down very rapidly," explains Rajkumar. "If you're living next to a metro, why do you need to have a car? An autonomous taxi would come to you any time you pick up the phone and press a button."

If the future rolls out the way many are betting, the dream of owning a car might become the Blockbuster LLC of life goals.

It's clear why Big Auto would invest in this nascent field, but we shouldn't understate the interest from Big Tech.

SMART ASPHALT

As the first analog automobiles chugga-chugga-popped their way toward critical mass a century ago, the biggest impacts initially were on rural communities; in 1921, 75 percent of cars were registered in towns with fewer than 50,000 people. But the effects of the wheeled Internet will probably be most immediately felt in urban centers.

In crowded, desirable locales such as New York City and San Francisco, many residents already choose not to own a car. A communal self-driving taxi system would be a perfect accessory for this lifestyle choice. Not only would it reduce the number of privately owned cars in these areas, it would allow cities to free themselves of the often-wasteful infrastructures that come with analog cars.

In fact, it's currently quite in vogue for cosmopolitan centers to pooh-pooh the idea of cars altogether. There are plans to ban all cars in the city centers of Oslo, Madrid, Brussels, Paris, Dublin, and Milan. Even New York City has placed "pedestrian plazas" smack dab in the middle of the tourist hell squeeze that is Times Square.

Automated vehicles would brilliantly complement high-density city centers by transporting human cargo to the edge of a car-free- or car-light zone before puttering off to pick up another customer or park and wait at a faraway lot. This would free up acres of valuable city space currently wasted on things like curbside parking and garages. The denser a city, the faster this transformation will likely take place.

Even New York City has placed "pedestrian plazas" smack dab in the middle of the tourist hell squeeze that is Times Square.

A CAR-FREE CITY? Fewer human-driven autos in urban environments mean more space is freed up for public use.

"An expensive and congested downtown could really benefit from these new technologies. That's where the land is clearly valuable," says Dr. Kara Kockelman, a professor of engineering at the University of Texas who has led research how public ridesharing schemes using AVs might be implemented in the Austin, Texas metro area. "The price of parking is high. There's not a lot of available space for parking, so people are going into underground lots and paying quite a lot."

Parking is a huge resource-suck. Parking spaces—a metered spot on the side of the street or in a multi-story private garage—are little more than storage lockers for machines, which spend up to 95 percent of the time sitting idle. Once you remove parking (both the noun and the verb) from the equation, a city changes dramatically.

"An automated car might be able to actually go find a parking spot even outside the core of the city, so then these really prime sections of real estate could be redirected to something more useful," explained Dr. Rajkumar. "One of the prominent headaches for city mayors is that roughly between 25 percent to a third of cars in downtown areas are just going round and round looking for a parking space. "

Removing curbside parking might allow streets to become wider (and perhaps compensate for the additional glut of AVs on the road), or the space could be reallocated for sidewalks or retail space, depending on a city's priorities. The rethinking of public space would even open up beyond urban cores, since totally automated traffic flows in close formation, meaning that space along highways and major thoroughfares could be repurposed for other uses.

These changes will surely hit large cities first, but they will also become part of the greater transportation mix in less-populated regions as the model matures.

ROAD TRIP THROUGH THE INTERNET

For those without access to analog driving, Level 4 AVs could prove transformative. The carless poor would have a rich new tapestry of transportation options that could supplement (or, in some instances, replace) infrastructure-heavy mass transit. Furthermore, AVs could open the world to the young and the very old, who are prohibited from driving due to health or legal concerns, and would be an absolute game changer for the disabled.

For everyone, these technologies could extend our physical horizons by encouraging people to make more and longer road trips that they might otherwise forgo due to costs or hassle.

"There's a lot of pent-up demand that [AVs] could induce—they could create new reasons for travel," said professor Kockelman. "People living further from their destination might start taking a lot of long-distance trips on the weekend that they used to avoid, because they required getting a ticket in advance, and airline tickets are expensive."

(Somewhat ironically, this accessibility of movement might actually lead to more congestion on the road. It will be interesting to watch how the technology's inherent digital precision compensates for the increased demand.)

AVs might also affect the decisions we make in our recreational lives. For starters, AVs would render "designated drivers" obsolete. If there were no more legal or operational ramifications, then "partaking" while out and about would surely increase. In fact, commuters might feel liberated to engage in all sorts of activities from which they now refrain. One researcher even cheekily suggested to *The Toronto Sun* that AVs inevitably lead to "a lot more sex in cars."

Aside from new opportunities to engage with fellow passengers, newly idle hands (and eyes, ears, and other sensory organs) will present an economic prospect that's too good for the tech industry to pass up.

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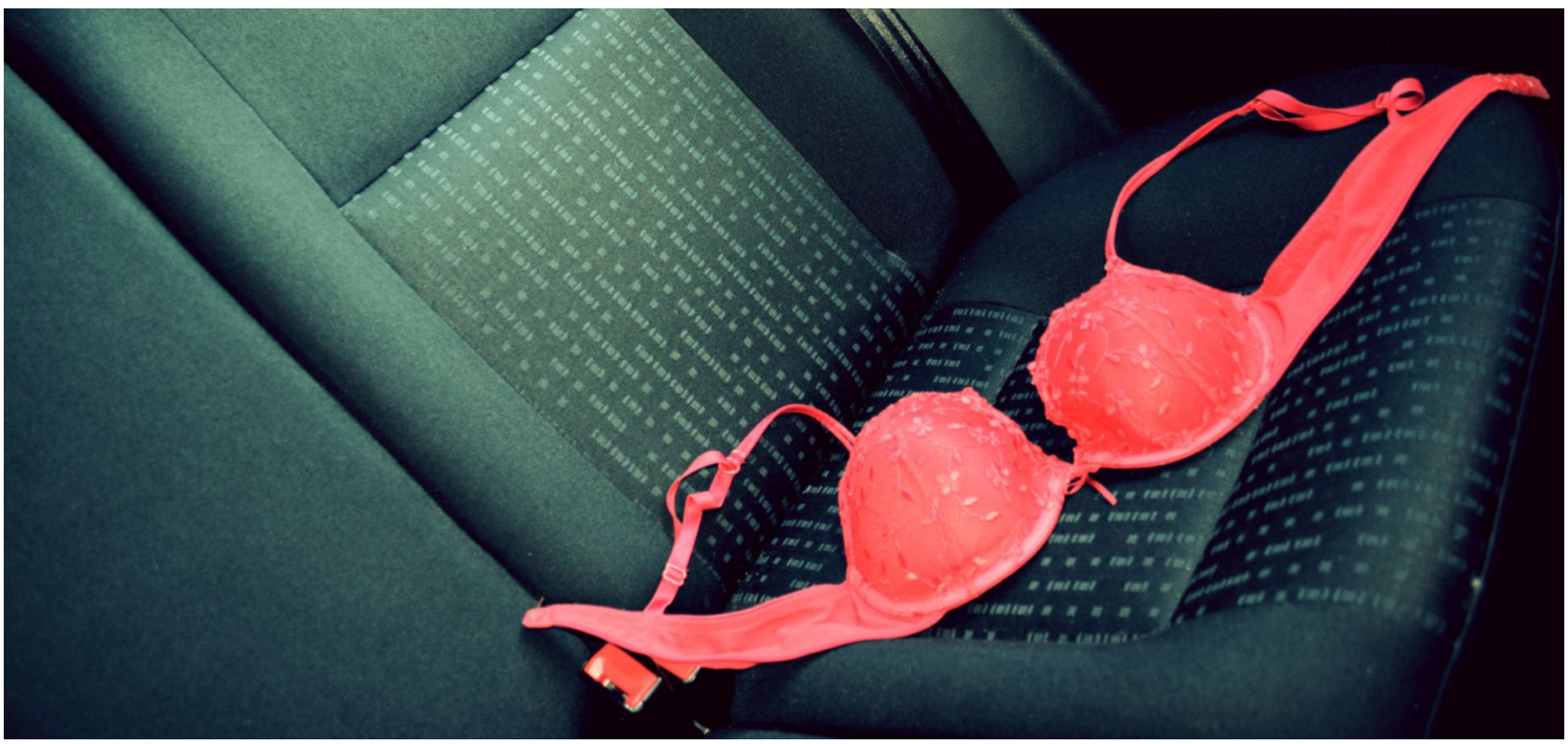


This is where Big Tech's participation in the driverless project might become particularly relevant (especially if the shared model is what takes off). Silicon Valley excels at wringing out every potentially monetizable data crumb from its users. Our emails, mobile data, and social media interactions are tirelessly monitored, quantified, and brought to market by faceless algorithms lurking underneath the Web's polished exterior. On one hand, these invisible data monsters help provide useful personalized experiences (for instance, Google Now reads your email confirming your upcoming flight and then provides you with the gate number before you get to the airport), but corporations also use them to sell you stuff.

Once you enter the wheeled Internet, you will be a captive audience of ad bots that have access to a delicious new set of data, including your location ("Feeling sleepy? There's a Starbucks just two blocks away!"); your destination ("There are three Starbucks near where you're going!"); and probably your transportation history ("Only two more stamps and you can get a free latte at Starbucks!"). But they'll also know what TV shows, books, or music you listen to while in transit ("You know what type of beverage might pair well with that movie?").

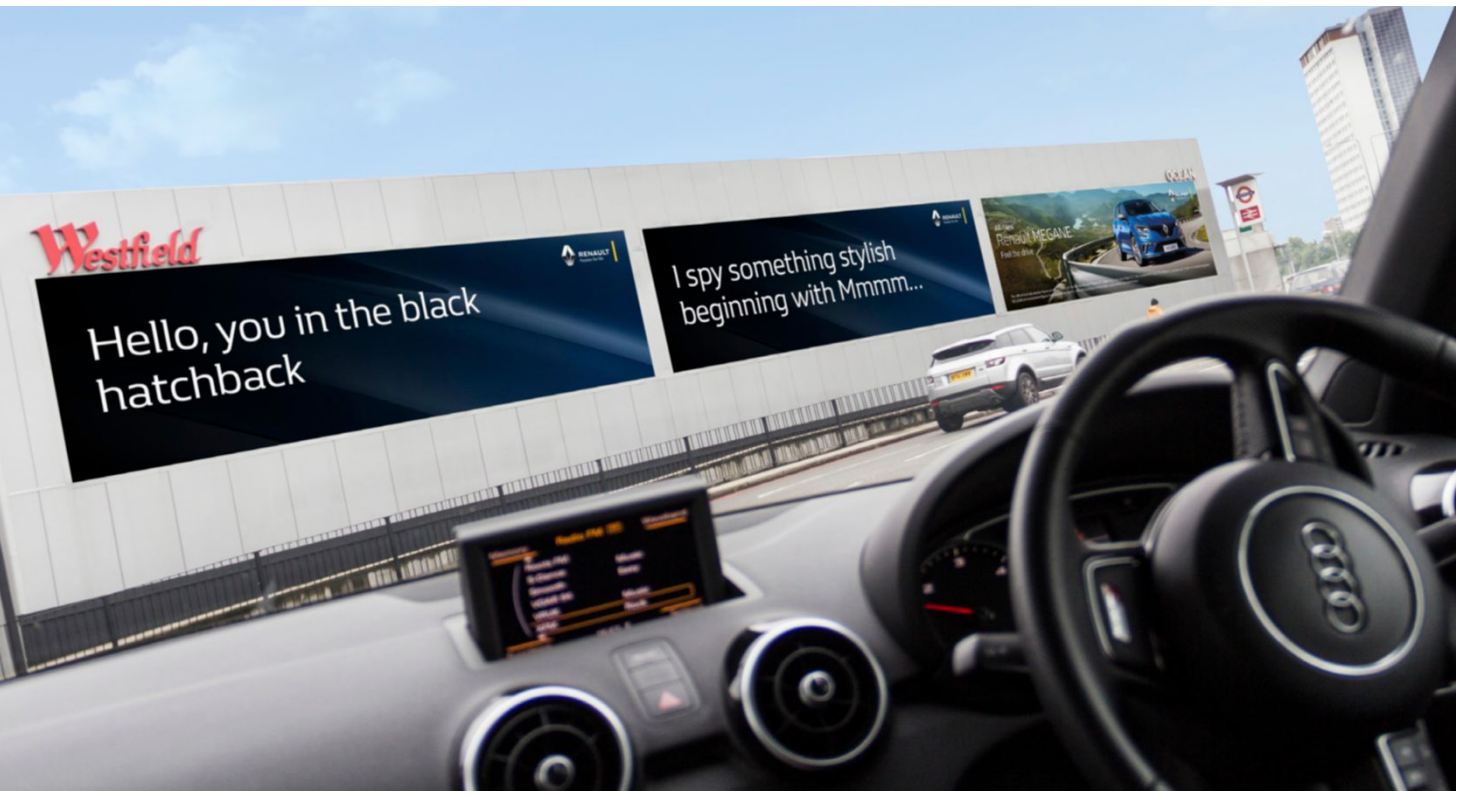
Once you enter the wheeled Internet, you will be a captive audience of ad bots that have access to a delicious new set of data.

All forms of the Internet (wheeled or otherwise) are gaining wild new abilities to quantify human behavior. Increasingly capable voice-activated UIs are becoming a preferred way to interact with our machines and will surely follow us into our Internet cars (in fact, that's already happening with today's infotainment systems). That means anything that happens to fall within the car's "earshot" could potentially be plundered for data. Furthermore, emergent machine-vision technologies might even allow an AV to mine data points based on what any of its cameras see.

In the future, entering a car might be similar to going online today: You'll be inundated with all manner of

services, which run alongside easily ignored ads and nano-targeted corporate messaging. Perhaps there will be a way to pay for a premium, ad-free experience or deploy the vehicle version of ad blockers.

For a glimpse of what this traveling ad market might look like, look no further than a giant set of billboards adjacent to a roundabout in a well-to-do part of London. Using vehicle recognition technology, the billboard serves up ads based on the car you're driving. It's easy to see how these ads might get even more creepily specific.



REALLY, REALLY TARGETED ADS
Digital Out of Home (OOH) Vehicle Recognition Technology uses cameras installed on billboards to scan cars stopped at traffic lights.

This all might sound kind of freaky to contemporary sensibilities, but if history is any indication, we will grow comfortable with self-imposed surveillance. Remember all the pearl clutching inspired by new concepts like "phone-cams" or the idea that (gasp) someone might perform a Google search on you? Hysteria followed by acceptance is a process through which all new technologies must pass.

I'm playing a bit of a "what if" game right now, but one potential silver lining is that this model could bring down the cost of transportation (think of all the free services you currently use in exchange for renting out

If history is any indication, we will grow comfortable with self-imposed surveillance.

your eyeballs and earholes to advertisers; hello, Facebook.) The economics still have yet to be established, but there might be a way to barter access to you for free rides—a transportation ecosystem built on the Gmail business model.

FULL-THROTTLE ALGORITHMS

In the wee decades of the 20th century, the analog automobile ushered in changes that reshaped the nation's literal (and figurative) landscape with industrial-powered efficiency.

For starters, public and legal infrastructures had to be wholly reimagined to accommodate brand-new concepts such as gas stations, traffic lights, public garages, speed limits, auto insurance, license plates, driveways, crosswalks, and miles of sprawling highway. The economy jettisoned jobs tied to the horse industry while welcoming entirely new sectors that included everything from auto repair to state police forces.

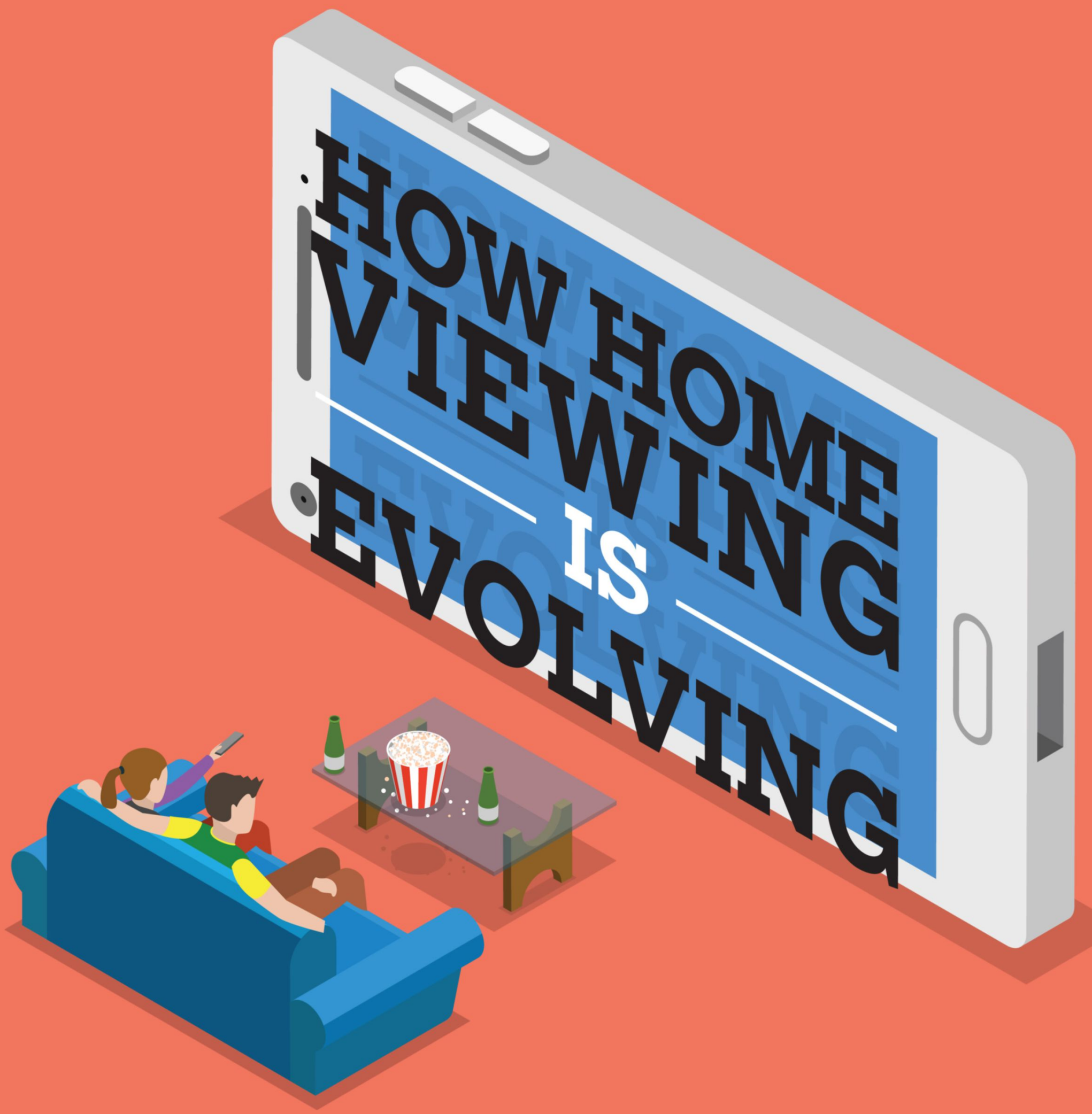
But the automobile's most audacious act of transformation happened to our expectations. Once-insulated rural families now had access to the figurative town square while middle-class urbanites were freed to seek professional and recreational opportunities far from their home turf. Cars even accelerated the growth of a new in-between world known as suburbia, where cheaper land allowed working people to have coveted things like backyards and big homes.

The emerging technology prompted a global engineering race that swiftly evolved the car from a plaything of the wealthy into an indispensable ingredient of everyday life. Consider that in 1918, only one in 13 families owned a car; 11 years later, that rate soared to four out of five, an astounding rate of adaptation.

And now, in the wee decades of the 21st century, we stand at the precipice of another era-defining transportation shift. And just as it was 100 years ago, a similar global race is being run to bring it to the masses. Once self-driving technology becomes mainstream (and it will—the million-plus lives spared each year are well worth society's price of admission), the effects on everything from our infrastructure to our collective psyche will be drastic and unforeseeable, just as they were a century ago.

It's gonna be a hell of a ride.

EVAN DASHEVSKY



We're in the middle of huge changes in both what we watch for home entertainment and how we watch it. You know this; you've seen it in your own home.

Consider this data from an IBM Cloud Video report called "Everybody Wants to Rule the Streaming World," from July 2015: Two-thirds of the adults in the U.S. use a streaming video-on-demand service, such as Netflix, Hulu, or Amazon Prime. Of those video streamers, a little over half watch online programming just as much as they watch traditional television.

While streaming services have altered how we access entertainment, what we watch on them has also seen a shift.

STREAM ON
Of people who use streaming services, more than half watch online programming just as much as they watch regular TV.

WHAT WE'LL WATCH

Nowadays, streamed series are a major part of our entertainment diet, but initially, Netflix was primarily a movie library. In 2007, the service began offering on-demand streaming video—and that forever changed home viewing.

While streaming services have altered how we access entertainment, what we watch on them has also seen a shift. Netflix began offering original series in 2011, with "House of Cards" (the service chose to release full series all at once, helping us all to become binge watchers). Following the HBO model of featuring exclusive series let Netflix please subscribers while putting less emphasis on its movie library. The service now has so

many originals that many people probably haven't even noticed that the Netflix movie library has condensed considerably: According to the website AllFlicks, Netflix's movie library shrunk by a third in less than two and a half years.

Netflix is the leading subscription-video service, but it isn't the only one. When these services first became popular, many pundits suggested that cable and satellite's days were over, and that we'd soon stream all our entertainment. The cord-cutting trend, however, plateaued as people decided they preferred a combination of traditional and streaming services.

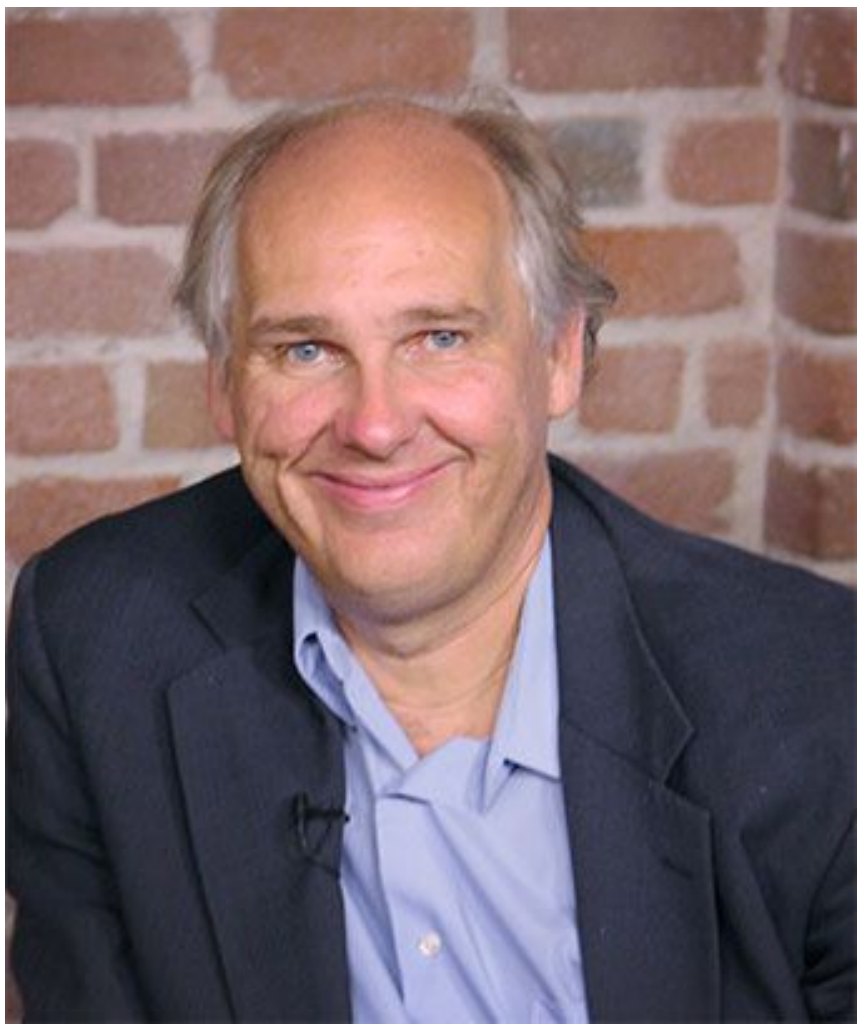
We're now seeing an explosion of streaming options with new business models, such as virtual multichannel video program distributors. Also called "skinny bundles," these are low-priced bundles of channels that provide a cable TV–like experience through streaming video; Sling TV is the best example.

Other options include combined services (offering one-stop subscriptions to multiple cable or streamed services) and low-priced niche networks. That last one especially is gaining ground, with services such as Crunchyroll (which specializes in anime), Acorn TV (British mysteries and dramas), and SeeSo (off-beat new and classic comedy from NBC). The only question is, how many subscriptions will the average household allow?

"Everything will be niche. Even what we see today with Netflix trying to appeal to everyone is not sustainable. There is no mainstream anymore," says Joel Espelien, senior analyst with The Diffusion Group.

Where will home viewing go from here? It's easy to imagine that subscription services will continue to lead with originals—that's what wins awards and gets people talking—but that would leave movie lovers unsatisfied. The bright side is that it would create a new business opportunity.

"The entertainment universe abhors a vacuum," notes Steve Vonder Haar, a senior analyst with Wainhouse Research. "If distribution rights cannot be sold profitably to a Netflix or Hulu, it will be easy enough for multiple studios to band together to launch their own 'movies galore' online video offering for unlimited access to older movie libraries. New releases will likely still be sold on a revenue-share, pay-per-view basis with Netflix, Hulu, Amazon, or another distribution outlet."



DIY DISTRIBUTION
Studios may band together to offer unlimited-access packages to their older movies, says Steve Vonder Haar.

Espelien predicts that Netflix will increasingly feature original content, and Hulu will evolve into a skinny-bundle service.

It's also likely that the major studios will grow increasingly unhappy with their role as a pipeline of content for streaming services. If that happens, Espelien predicts that Netflix will increasingly feature original content, and Hulu will evolve into a skinny-bundle service that offers a limited number of ad-supported, on-demand channels for a smaller monthly fee than cable. The studios will either create their own streaming content, or their catalogs will be acquired.

HOW WE'LL WATCH IT

They ways in which we watch all that online video are also evolving. While viewing full movies on a phone's screen would have seemed ridiculous a decade ago, we now think nothing of it. Mobile viewing has been growing steadily for years, counting for 55 percent of all mobile data traffic in 2015, according to Cisco's Visual Networking Index. In recent months, there's been an explosion in outlets streaming video to our living room TVs. The reason why is simple: Now that ratings specialist Nielsen can finally measure that viewing, thanks to its Total Audience Measurement tool, networks can effectively sell ads on it, making them willing to send more video over-the-top.

The element most likely to alter how we watch TV in the next decade is the growth of virtual reality video. While even many in the video industry are skeptical of the claims made for VR and wonder if it's the next 3D—a much-hyped product that, so far anyway, has failed with viewers—others see it as a bold new platform that's sure to rise in importance.

"VR headsets will be much more significant in ten years," says The Diffusion Group's Espelien. "They provide great quality and immersion at a very cheap price. This will become a compelling combination, just like high-quality headphones have largely replaced speakers for music listening." He doesn't see VR as a threat to the living-room TV, as the experience is personal and individual. It's more the evolution of smartphone video.

While viewing full movies on a phone's screen would have seemed ridiculous a decade ago, we now think nothing of it.

VIRTUAL REALITY
While some people are skeptical of the claims made for VR and wonder if it's the next 3D, others see it as a bold new platform that's sure to rise in importance.

Espelien is not alone in predicting big things for VR: "Virtual reality (VR) and augmented reality (AR) have the potential to become the next big computing platform, and as we saw with the PC and smartphone, we expect new markets to be created and existing markets to be disrupted," notes Heather Bellini, business unit leader of the Technology Research Group at Goldman Sachs, in the January 2016 report "Profiles in Innovation: Virtual and Augmented Reality."

"As the technology advances, price points decline, and an entire new marketplace of applications (both business and consumer) hit the market, we believe VR/AR has the potential to spawn a multibillion-dollar industry, and possibly be as game-changing as the advent of the PC," says Bellini.

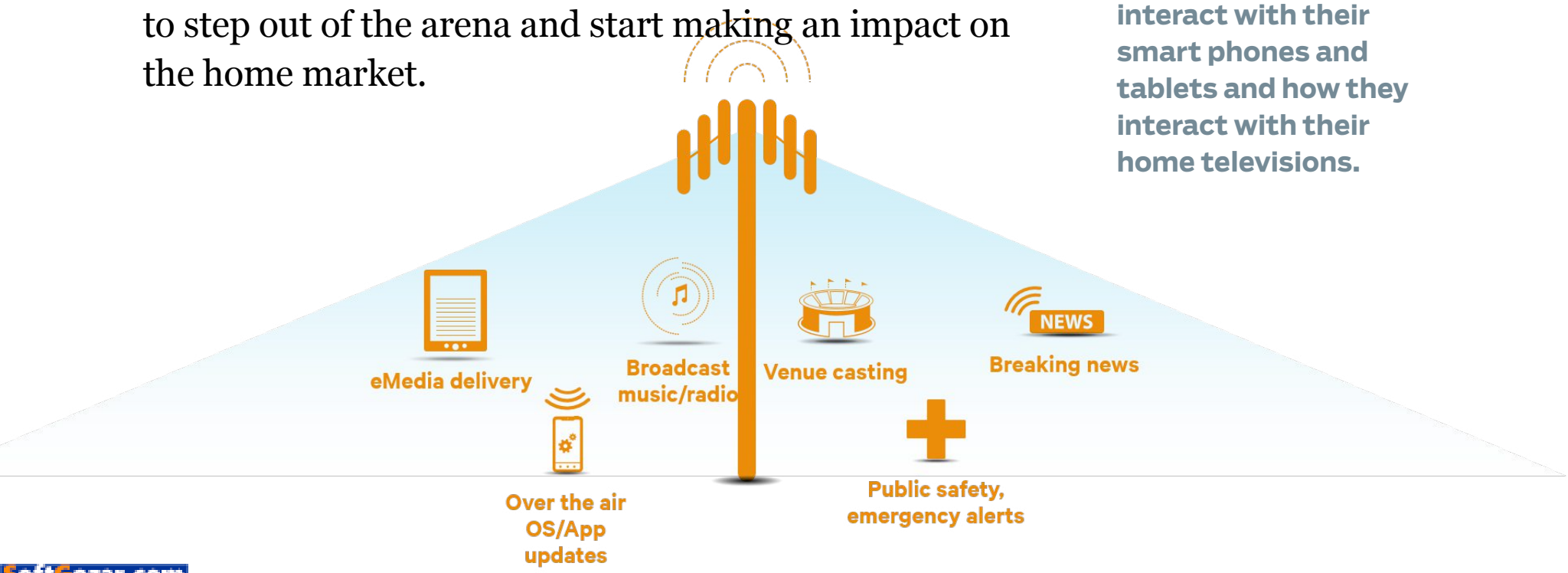
In its base scenario, Goldman Sachs sees VR/AR becoming an $80 billion market by 2025.

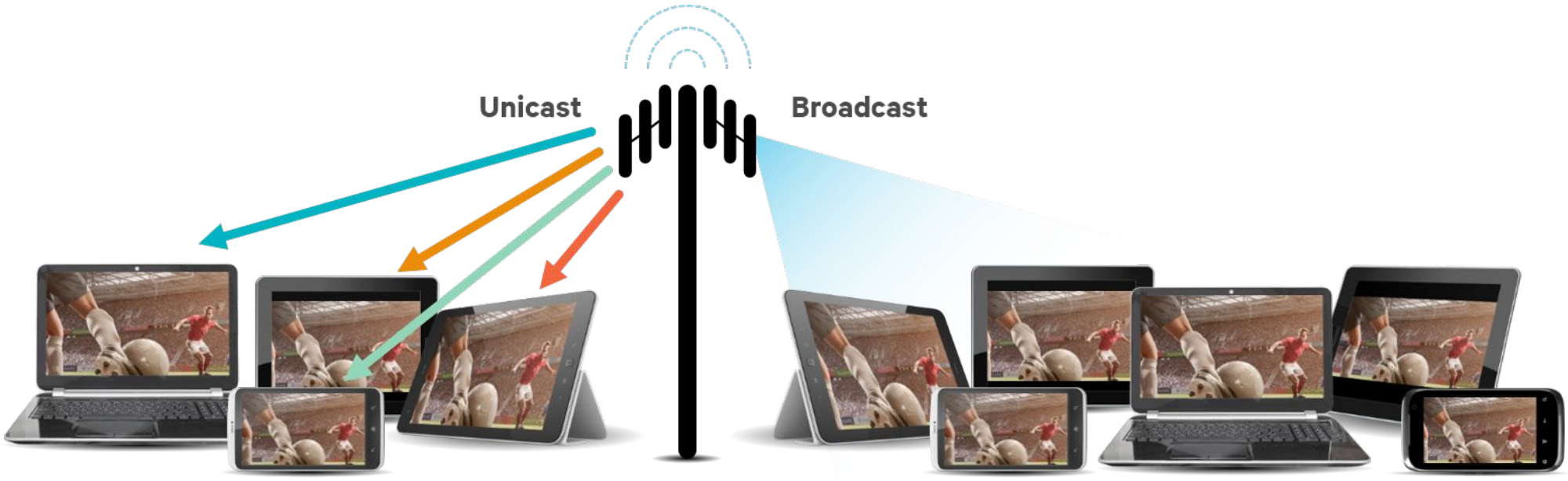
Another technology that could disrupt how we view video is LTE Broadcast, which uses cellular networks to efficiently stream content to masses of people. The technology has mostly been trialed in arenas or other sporting venues, providing varied choices of camera angles to those in attendance. LTE Broadcast requires a phone with a comprehensive system on a chip that supports the cellular standard. While it's taken a few years to reach the market, the technology is finally at a mature phase, says Peter Carson, senior director of marketing for Qualcomm. It's time for LTE Broadcast to step out of the arena and start making an impact on the home market.

In its base scenario, Goldman Sachs sees VR/AR becoming an $80 billion market by 2025.

LTE BROADCAST

Experts expect LTE-B to blur the lines between how viewers interact with their smart phones and tablets and how they interact with their home televisions.





TARGETED BROADCASTS
LTE-B sidesteps the need for large TV towers by using cell towers to distribute content to specific groups of mobile device users.

"There's a movement underway to look at the feasibility of converging the digital terrestrial standards for broadcast in Europe with the mobile broadcast standards of LTE Broadcast," Carson says. "That would do two things: It would create a converged ecosystem in terms of devices designed to a common standard, so you get economies to scale, and it would tap into a richer set of services that were originally aimed at mobile devices—smart phones and tablets—and deliver that same kind of multi-stream experience to a larger screen in a home."

As that happens, and when LTE Broadcast reaches the U.S., expect it to blur the lines between how viewers interact with their smart phones and tablets and how they interact with their home televisions.

The only thing to be sure of in home entertainment is that transformation will keep happening. What it will look like in the coming decades is something we can only guess at, but it's trending toward becoming more personal, convenient, and immersive.

TROY DREIER

WILL HUMAN AUGMENTATION BE A HARD SELL?

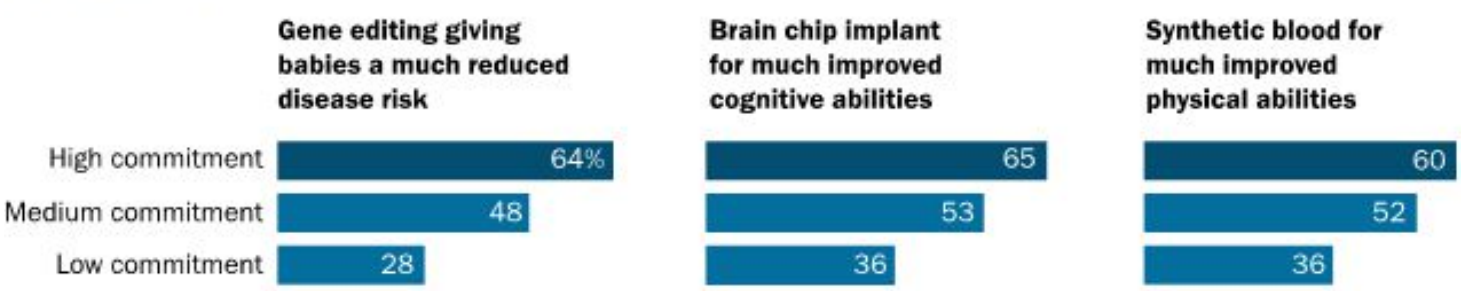
BY GRAHAM TEMPLETON

There are basically two arguments against non-medical human augmentation. One is that it's too medically dangerous to be ethical. The other is that it will have negative-enough effects on society that even medically safe procedures are unethical. One is a scientific argument in need of a scientific appraisal, while the other is essentially a moral or philosophical argument that should be addressed in a distinct way. The general public doesn't seem to draw this distinction, muddying up the purely scientific question of safety with the purely personal question of social benefit, and the right (not the ability) of man to muck with nature.

That's just one of the implications of polling data collected by the Pew Research Center, summarized in a long and involved report titled "U.S. Public Wary of Biomedical Technologies to 'Enhance' Human Abilities" published in July of this year. It gets at not just how people feel about the future of biotechnology but also their opinions about specific initiatives and possible futures. The report reveals some intriguing patterns of belief, some pretty reasonable fears, and some pretty ridiculous ones. It focuses most powerfully on gene editing of babies and adults, upgraded synthetic blood, and intracranial brain implants for cognitive enhancement. Each produced distinct worries from the study's subjects.

A majority of highly religious Americans consider these potential enhancements to be meddling with nature

% of U.S. adults in each religious commitment group who say _____ is meddling with nature and crosses a line we should not cross



Note: Respondents who say "as humans, we are always trying to better ourselves and this idea is no different" or who did not give an answer are not shown. See Methodology for details on index of religious commitment.

Source: Survey of U.S. adults conducted March 2-28, 2016.

"U.S. Public Wary of Biomedical Technologies to 'Enhance' Human Abilities"

PEW RESEARCH CENTER

HUMAN NATURE

Pew's research shows those who score high on a three-item index of religious commitment are more likely than those who score lower to say enhancements are "meddling with nature."

According to the study's results, people in general have no problem with the idea of healing the sick, fixing a deficiency, or even acting preemptively to prevent later degeneration. But they draw the line at enhancement beyond a natural level. Many futurists and boosters of human augmentation, however, talk about certain totally normal aspects of human life as deficiencies—the need

to sleep, the menstrual cycle, even death itself. Could we one day view the human inability to perfectly focus long-term attention at will as a deficiency? Might we one day think of access to technology that grants such an ability as a basic human right?

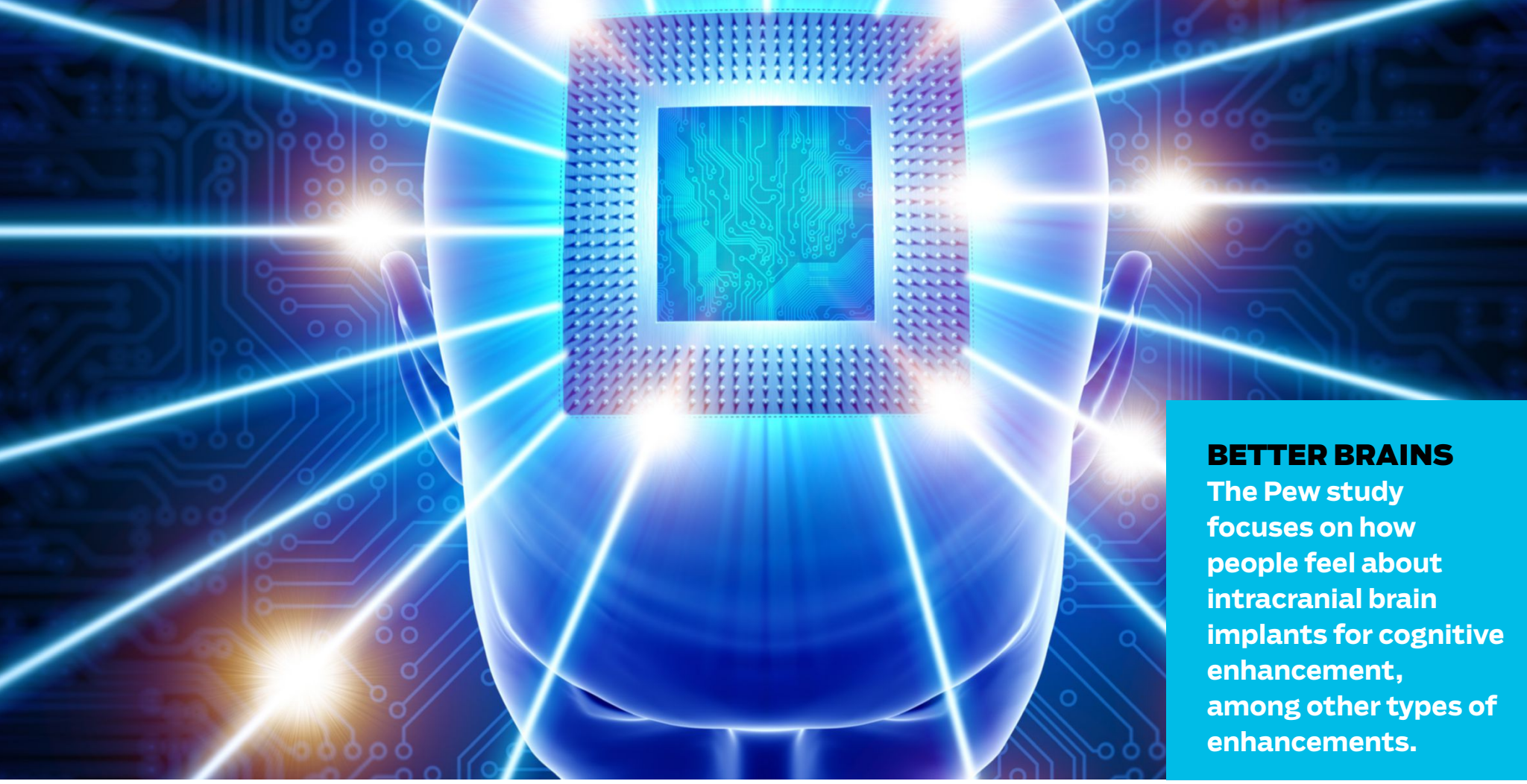
If we do come to such an understanding of augmented abilities, it will likely be because augmentation becomes necessary to remain socially and economically competitive. That's a major concern for the people polled here: that standards for performance will endlessly increase, and we'll all suffer for it. People won't be able to keep up without investing not only their time but also their bodies. "I think [synthetic blood] would sort of fundamentally change who we are. … You would have this culture of people just obsessed with being bigger, stronger, faster, and just outperforming everybody," said one 35-year-old Atlanta man.

WHAT, ME WORRY?

I'm skeptical of these sorts of concerns. For one thing, it's a fallacy to imply that the vast majority of first-world citizens have the slightest need of—or will experience the slightest increased success from—most physical augmentations. Being stronger and faster, having higher endurance, or being able to see far better than 20/20: How many of us will actually be able to derive a real extra benefit from this, in a practical sense? And if we did, say by winning the local marathon or reading street signs from further away, how much will that success impact those around us? Outside of some specific areas, such as sports, there's little reason to believe that physical enhancement will be a requirement for economic success.

Of course, we sedentary Westerners offset our lack of muscle-work with a whole heck of a lot of brain work, and one area of interest for this study was brain implants. These could help with memory formation, attention span, or even mood. But the participants were unified in their worry about the technology. Some feared the pure medical implications, simply refusing to believe that science could insert large numbers of cranial implants at a high enough level of safety. Others again fear the creation of super-people with super-abilities that make the modern state of social inequality look like an egalitarian paradise.

The fears do seem to embody the current social-justice zeitgeist, in which unequal opportunity is seen to give rise to unequal results, which in turn produce even more unequal opportunities. If the wealthy can gene-edit their babies into having high IQs and give them brain implants to help focus those



BETTER BRAINS
The Pew study focuses on how people feel about intracranial brain implants for cognitive enhancement, among other types of enhancements.

IQs with laser precision, what proportion of the poor will be able to compete for the highest paying jobs or the most elite school programs?

Not all the fears are particularly reasonable. Much squeamishness seemed to arise from the idea that nature is good and that unnatural things are bad. Partly, it's about the far-less-formed idea that we will lose something important as we move further from evolution's latest beta version of human biology. A 59-year-old woman in the focus group claimed, "You kind of … lose individuality, because you have all these kind of super-people that can remember everything, [but there are] no individuals anymore. They're all just the same robotic people." I'd argue that there's really no evidence of a connection between having a perfect memory and the loss of individuality.

These worries also correlated with religious sentiment: The more religious someone claimed to be, the more wary of augmentation they were. Historically, highly invasive medical procedures have been used mostly in situations of dire medical need, so only the most dedicated sects withheld the tech from their followers. With more arguably frivolous gains at stake, there will undoubtedly be a larger proportion of faiths directing their followers to stay away from augmentation. This could lead to predictably different outcomes for different populations in North America, perhaps driving people either into or out of secularism, but it could also dramatically affect the global competitiveness of mostly secular versus mostly religious nations around the world.

THIS MAY BE INEVITABLE

Let's also remember that being wary of something is different from opposing it. People are wary of genetically modified foods, but they also buy such species by the megaton in grocery stores around the country. It's been widely argued that the advent of the ubiquitous automobile has left us more socially disconnected, as we spend our travel time locked in soundproof boxes and zip by one another at high speeds. This hasn't stopped the automobile from dominating virtually every culture on Earth, even those that put an emphasis on inadvertent interaction with strangers. It may be that the automobile is a net negative for the health of human societies, but if so, that fact hasn't meaningfully slowed adoption.

Few of the concerns expressed in this study would produce a strong enough legal challenge to actually stop research. Certainly, the safety of human test subjects is an issue, but the medical research industry is more than capable of dealing with that challenge. To actually prevent this research, with its incredible potential to change the human experience and produce profit, you need something better than squeamishness—unless you're a senator or congressperson. If a sufficiently large proportion of legislators get up in arms, they could stop progress in a stem cell–like spate of obstructionism, but that will happen only if enough voters demand it.

Will they? These are all thoroughly new technologies, getting at issues people find genuinely distressing, from DNA manipulation to chunks of metal in the brain. The fact is, you just can't keep steroids, focus drugs, and blood oxygenating agents out of people's hands when they have even the slightest incentive to use them. With advanced biotech research becoming so incredibly doable without much of a budget, it would take a very robust block to adequately put an end to augmentation research.

Whether these public fears are justified will be judged on a case-by-case basis, and we certainly shouldn't dismiss the idea that augmentation science could be overzealous and unethical. But there is little precedent to justify the idea that such worries will lead to a meaningful stoppages in human advancement: Even prohibitions on full stem-cell research haven't meaningfully slowed it down but have simply driven it out of certain countries.

Human augmentation is coming. If you're worried about it, you're in abundant company—and your national political representatives are your only way to stall the inevitable.

How Eight Evernote Alternatives Stack Up

BY JILL DUFFY

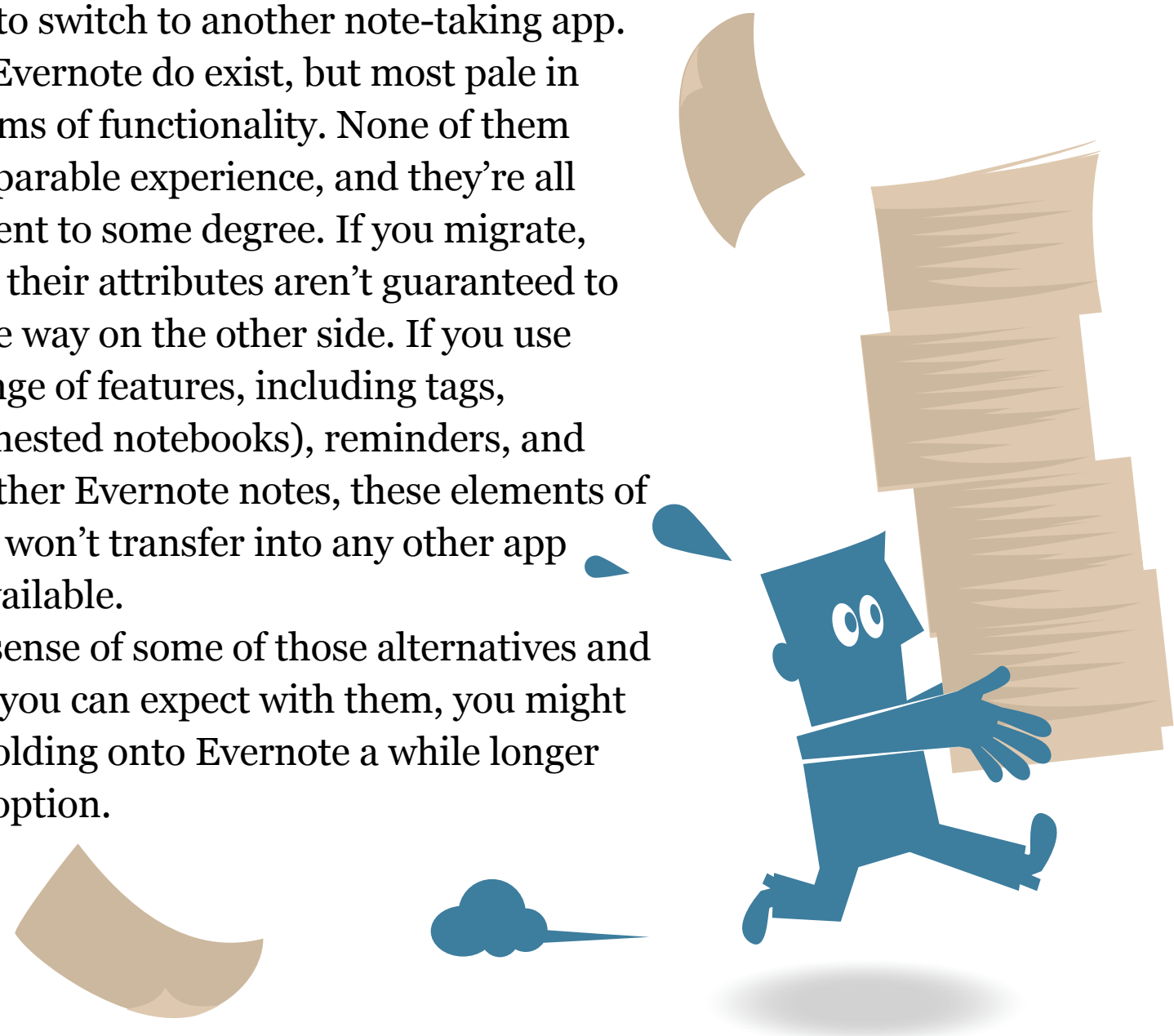
Evernote is one of my favorite tools for staying organized and productive. But changes to Evernote's plans and pricing have burned its users, who now have to face paying a lot more or finding an alternative. The company jacked up the price on the highest tier of service by about 55 percent and gutted what's included in the lower tiers of service, including the free offering. Loyal users aren't getting grandfathered into a better deal, and the community is pretty ticked off. Many, including *PC Magazine*'s Sascha Segan, are talking about leaving Evernote, showing their dissatisfaction by taking their money—and their notes—elsewhere. But doing so is easier said than done.

Imagine taking all your clothes out of the closet and trying to rearrange them into your kitchen cupboards instead. The space is different. There's no bar for hangers. And where the hell do you put your shoe rack? You could make it work, but do you want to? If you're an Evernote power user, that might be how it's going to feel when you try to switch to another note-taking app.

Alternatives to Evernote do exist, but most pale in comparison in terms of functionality. None of them offers a truly comparable experience, and they're all structurally different to some degree. If you migrate, your notes and all their attributes aren't guaranteed to come out the same way on the other side. If you use Evernote's full range of features, including tags, notebook stacks (nested notebooks), reminders, and internal links to other Evernote notes, these elements of your organization won't transfer into any other app that's currently available.

Once you get a sense of some of those alternatives and the shortcomings you can expect with them, you might start to see why holding onto Evernote a while longer could be the best option.

Alternatives to Evernote do exist, but most pale in comparison in terms of functionality.



Microsoft OneNote

The strongest alternative to Evernote at the moment is Microsoft OneNote. On its own, it's a fine service. It has apps for Windows, Mac, the Web, Android, iOS, and Windows Phone. It supports text notes, audio notes, image uploads, free-form handwriting, OCR on handwriting (which turns your handwriting into searchable text), a Web-clipper browser plug-in, and more. It's also a key part of Microsoft's cloud-syncing service OneDrive.

But if you're moving to OneNote from Evernote and are used to the Evernote way of doing things, you're in for a lot of adjustments.

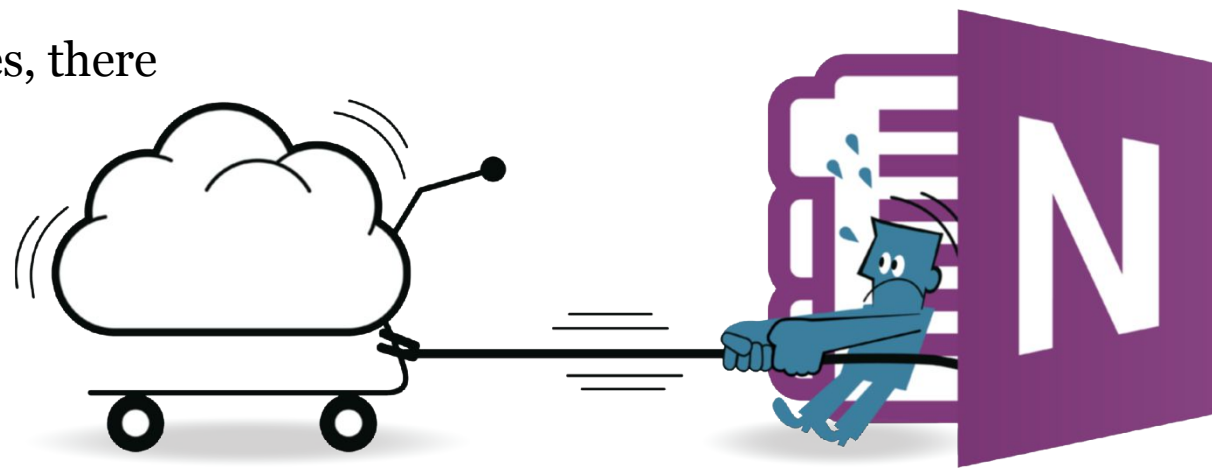
Migrating notes and notebooks from Evernote into OneNote is a pain, even when using the tool that the OneNote team built specifically for this purpose. The OneNote importer tool for Evernote is available only on Windows, at the moment. A Mac version is supposedly in the works, although in March, it was said to be "a few months" away. Four months later, it still hadn't shown up. The migration is slow. It preserves notebooks (yay!). It turns your Evernote notes into OneNote notes (hurray!). And it turns your tags into a curious mess (huh?).

Tags get turned into hashtags, and that's fine, but the first tag on every note also gets turned into a section. A section is like a tab within a notebook, and that's entirely different than being a tag. It can really mess up your sense of organization and order, because the first tag you put on a note isn't necessarily one that you want to call special attention to.

Another tool for moving Evernote notes into OneNote (also for Windows only) turns all Evernote tags into OneNote sections—but in doing so, it duplicates the notes. If a note has five tags, you now have five copies of that note, each with its own section. That's just too messy.

Even if the migration goes well, it still takes a while to get used to the different interface and the OneNote lingo. I have moments when I can't even distinguish OneNote's Web app from the Microsoft Word Web app, except that one is purple and the other is blue.

On top of the migration issues, there are many differences between Evernote and OneNote. And if one of them affects some kind of functionality that you need, it might be a deal-breaker.



Google Keep, Google Docs

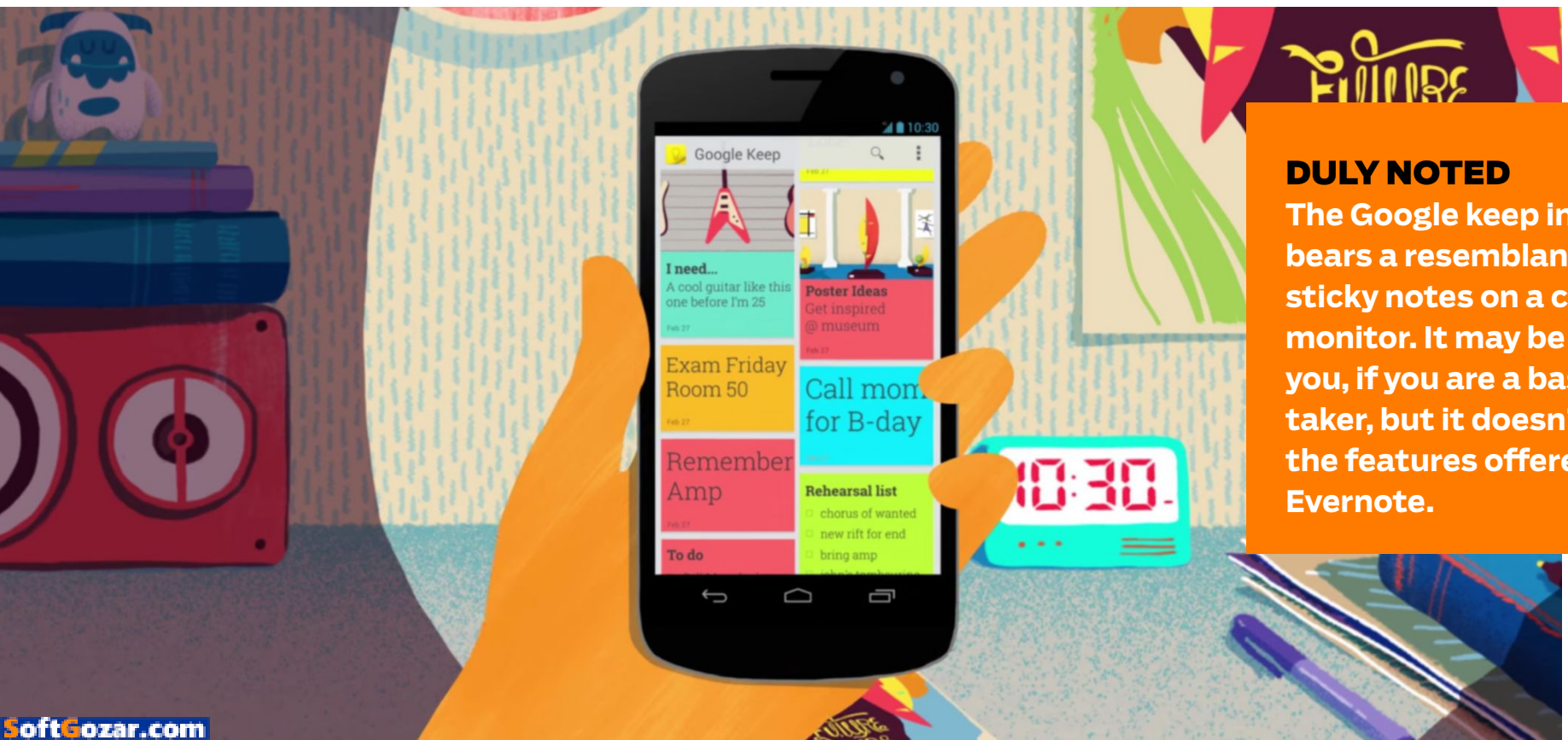
Google Keep is a note-taking application that seems more similar to Stickies than to Evernote. The interface looks like sticky notes on a computer monitor. It's a place to jot down information, and it does a nice job of keeping recent notes in front of your eyeballs, but it's not very capable at handling notes in the same way that Evernote does.

Some people have made the case that Google Docs is a better alternative to Evernote than Keep. That's not a terrible idea. Docs certainly has more functionality than Keep, and the search function is strong. Also, Google Docs and Evernote can already integrate, both on their own and through automation tools such as Zapier and IFTTT.

But fundamentally, Docs is a word processor, which is different than a note-taking app.

To me, the difference between a note-taking app and a word processor is the kind of content I put into it and how I use that content later. I return to notes and search them often. They contain business card information, summaries of research that I read, recipes, and other information that I call upon more than once and use on an ongoing basis. The appeal of Evernote has always been how easy the app makes it for me to get at that information no matter where I am or what device I have on hand.

My Word docs, however, tend to be useful in the moment until a project is complete, and then they typically retire or expire. I only ever open a handful of them again. My word processing files tend to be text-dominant. My notes are a mix of text, pictures, audio recordings, and PDFs. If you don't make these kinds of distinctions, then Google Docs or even Microsoft Word might be a totally acceptable replacement to Evernote for you.



DULY NOTED

The Google keep interface bears a resemblance to sticky notes on a computer monitor. It may be fine for you, if you are a basic note-taker, but it doesn't have all the features offered by Evernote.

Zoho Notebook

Zoho recently released a new app called Notebook that aims to become an alternative to Evernote, but it's not there yet. So far, Notebook is available only on iOS and Android. The company says that desktop apps and a Web app are in the works, but even so, Zoho Notebook is very light on features so far.

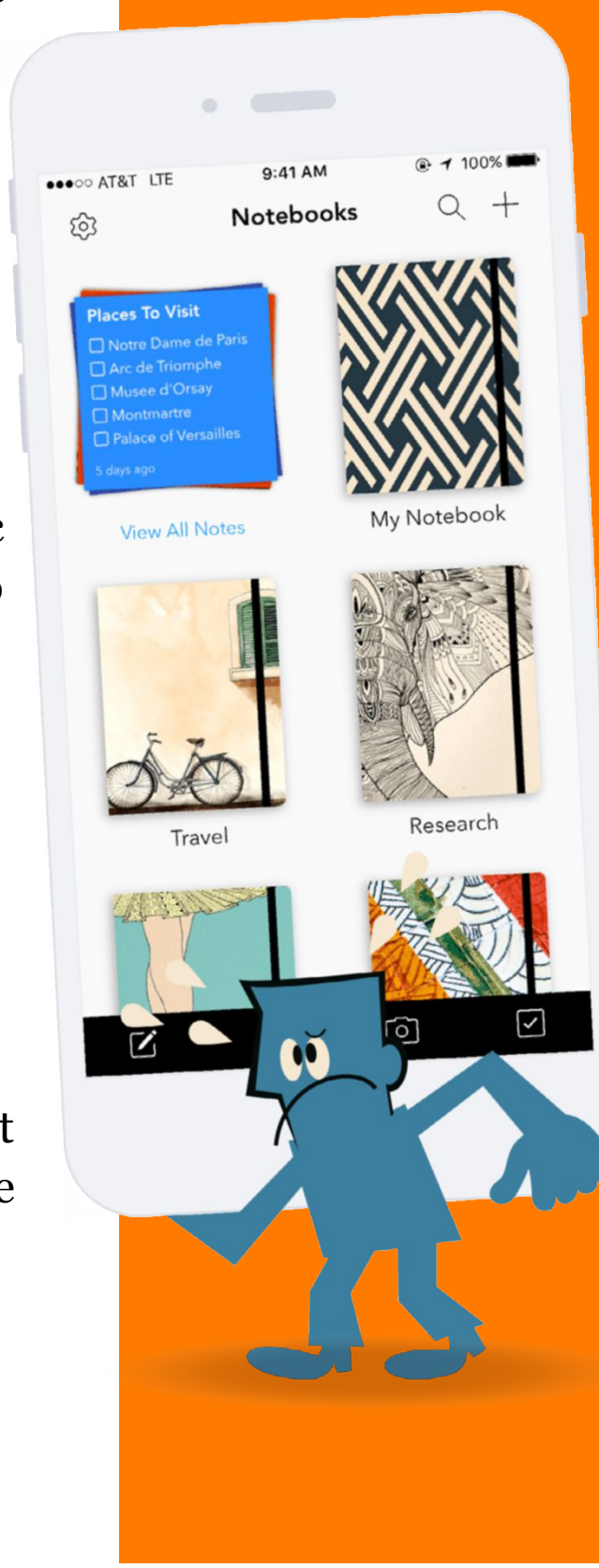
When trying out the app, I was immediately limited by the fact that an audio note can't have text on it, but a text note can have audio added. It's all a matter of which type of medium you choose to start your new note. I often record interviews and transcribe right into the same note where the recording lives. I like the full text and the recording to stay together, but if I hit the button to quickly start an audio recording, I can't append text to it. I have to make sure I start a text note first. More important, without a desktop or Web app, I can't do much real typing to transcribe the audio.

So many other features are missing, like tags, that Evernote users would find Zoho Notebook far too basic to consider using yet. It might be a viable alternative to Evernote in a year or so, but right now, it's not close to offering a comparable experience. This is a brand-new service, however, and I look forward to seeing how it develops.

Moleskine, Simplenote, Laverna, OpenNote, and Others. There are plenty of other note-taking apps besides the ones described above, but either they lack critical features, or they have unique angles that make them significantly different from Evernote and thus not good replacements. Moleskine is simplistic. Simplenote doesn't have notebook organization or stacks of notebooks, and like Laverna, it's really more of a markdown text editor. OpenNote has you host all your own notes (good for privacy, but not if you want someone else to foot the storage bill) and is missing some key features, too.

PERSONAL NOTES

Each of the distinctive notebook covers found in Zoho Notebook are hand drawn by in-house artists. You can add your own, too.



SHOULD YOU STAY WITH EVERNOTE?

Let's review the pros and cons of each tier of service and its price.

Evernote Basic, free. This version's main drawback is that it limits you to using Evernote on only two devices, plus the Web app. Say you have a smartphone, a personal laptop, and an office computer. If you primarily use Evernote for personal reasons, you could get by just fine by having it on your phone and laptop. On the rare occasion you want to access your Evernote account from your office computer, you can do so within the Web browser.

The other big limitation with the free account is that you can upload only 60MB of data per month. That means you can't upload a gazillion photos, but you can make text notes and not really worry about hitting the ceiling.

Evernote Plus, $34.99 per year or $3.99 per month. The mid-tier service Evernote Plus honestly wouldn't seem so bad, except that longtime Evernote customers compare it with what came before—and by comparison, it's skimpy. There are no limitations on the number of devices you can use to access your Evernote account, and you get 1GB of storage space each month for new uploads, but you can upload only files up to 50MB. One big benefit is the ability to save notes offline so you can edit them when you don't have Internet.

Evernote Premium, $69.99 per year or $7.99 per month. Premium is now expensive, but it gives you the real-deal Evernote in all its glory. Premium members can upload 10GB of new notes every month, and the maximum file size is 200MB. In addition to all the Plus features, Premium members get the ability to search for text in PDFs and attached Microsoft Office documents. They can also digitize business cards and turn a note into a presentation.

NO NEED TO RUSH

My current Evernote subscription ends in February, so I have time to make a decision, and maybe you do, too. In that time, OneNote's migration tool may improve and also become available to Mac users. Maybe Evernote will change its mind and decide to grandfather in existing users to a better deal. If not, I'll probably downgrade to a Plus account and wean myself away from Evernote and into another productivity tool that meets all my requirements. but I have no urgent need to a shift to another service. And right now, no other tool does it all, at least not to the deep extent that I use Evernote.

If you're not an Evernote power user, your options are much better. The fewer features you've used in Evernote and the fewer notes you have, the easier it is to switch to another service.

How to Access Your Wi-Fi Router's Settings

BY LANCE WHITNEY

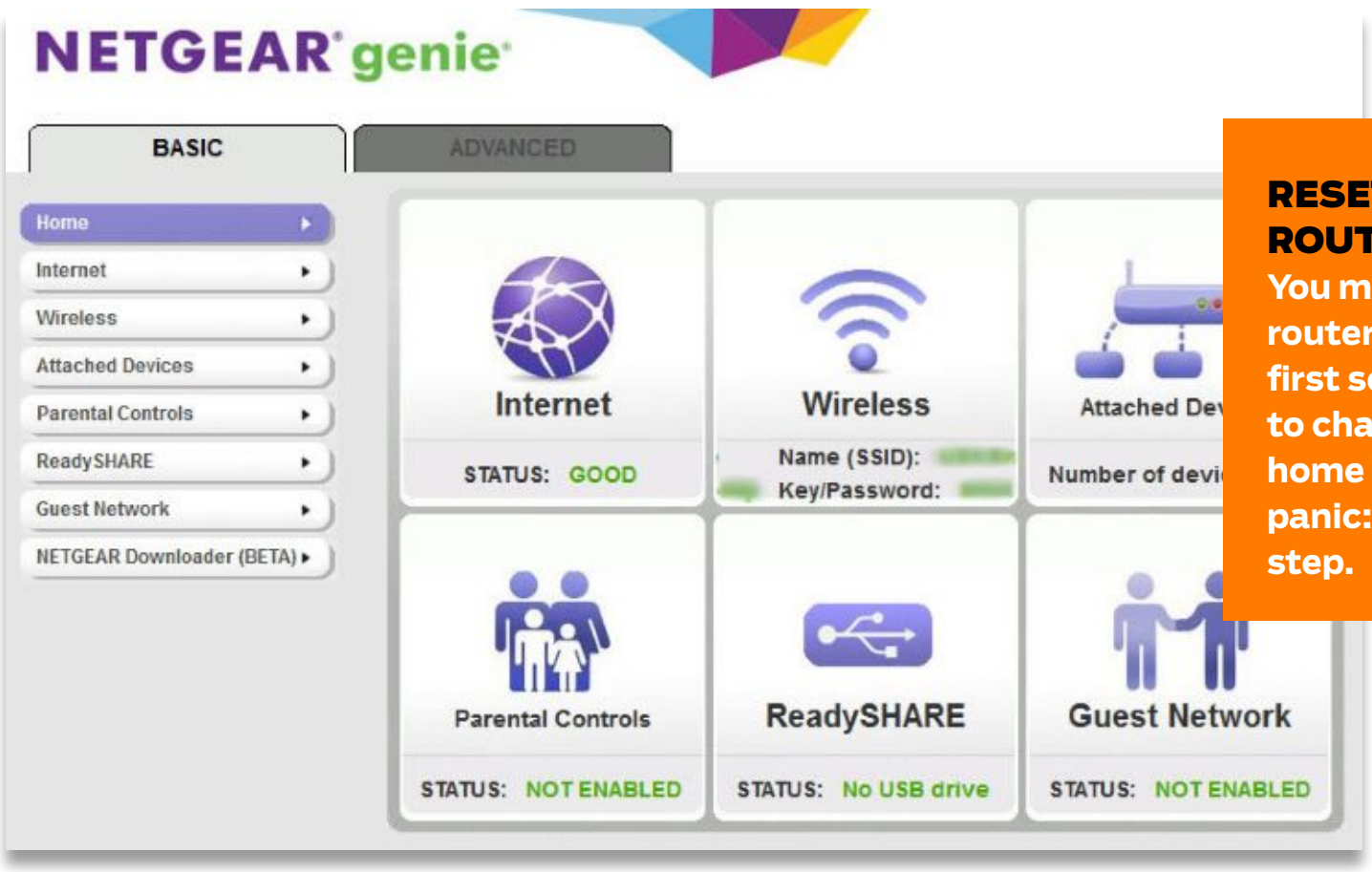
Your router stores the settings for your home Wi-Fi network. So when you want to change something, you have to log into your router's software, also known as firmware. From there, you can change the name of your network, the password, and the security level; create a guest network; and set up or change a variety of other options. But how do you get into your router to make those changes?

You can log into your router's firmware through a browser—any browser will do. In the address field, type the IP address of your router. Most routers use an address of **192.168.1.1.** But that's not always the case, so first, confirm the address of your router.

Open up a command prompt from within Windows. In Windows 7, click on the Start button and type **cmd** in the **search programs** and **files** field. In Windows 8.1 and above, press the Windows + R buttons and type **cmd.** At the command prompt window, type **ipconfig** at the prompt itself and press Enter. Scroll to the top of the window until you see a setting for Default Gateway under Wi-Fi. That's your router, and the number next to it is your router's IP address.

Close the command-prompt window by typing **exit** at the prompt or clicking X on the pop-up. Type your router's IP address in the address field of your Web browser and press Enter. You'll be asked for a username and password to access your router's firmware. This is either the default username and password for your router or the unique username and password that you created when you set up the router.

If you created a unique username and password, and you remember what they are, that's great. Just type them into the appropriate fields, and your router's firmware settings appear. You can now change whatever elements you want, typically screen by screen. On each screen, you may need to apply any changes before you move onto the next screen. When you're done, you may be asked to log in again to your router. After you've done that, just close your browser.



RESETTING YOUR ROUTER

You may not have seen your router settings since you first set it up, but if you need to change something in your home Wi-Fi settings, don't panic: We take you step by step.

OK, that doesn't sound too hard. But (there's always a "but") what if you don't know the username and password for logging into your router? Many routers use a default username of **admin** and a default password of **password**. Try those first, to see if they get you in.

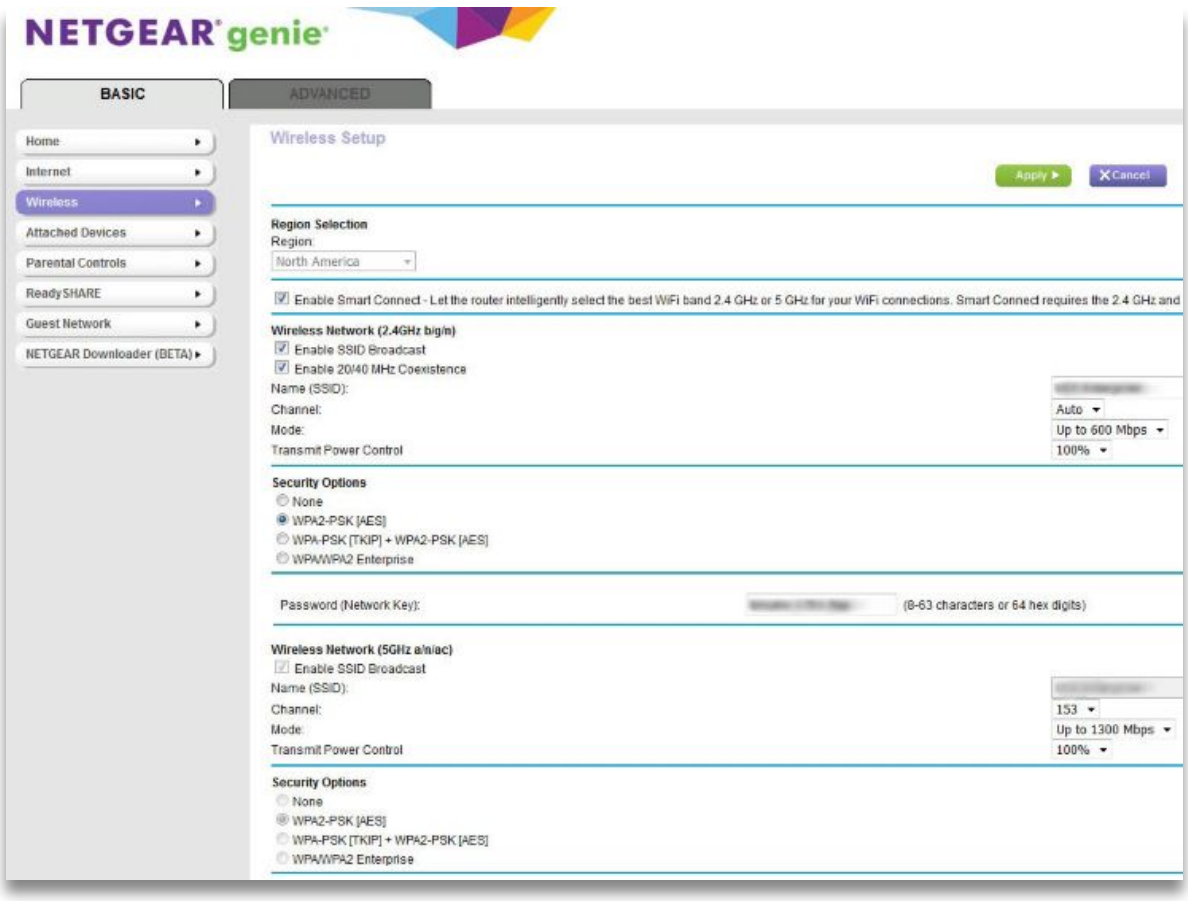
If not, some routers offer a password-recovery feature. If this is true of your router, this option should appear when you enter the wrong username and password and then press Cancel at the login prompt.

Still can't get in? Then you'll need to try to find the default username and password. Your best bet is to run a Google or Bing search with the brand name of your router, followed by the phrase **default username** and **password**, such as "netgear router default username and password" or "linksys router default username and password." Your search results should display the

> **Many routers use a default username of admin and a default password of password. Try those first.**

default username and password.

Now try logging into your router with those default credentials. Hopefully, that will get you in. If not, then that probably means you changed the default username and password at some point. In that case, you may simply want to reset your router so all settings revert back to their defaults. You'll usually find a small Reset button on your router. Use a pointed object such as a pen or paper clip to push in and hold the Reset button for around 10 seconds. Then release the button.



MAKE YOUR WI-FI NETWORK YOUR OWN

If you've never named your wireless network or set a password or security level, make those your first tasks once you get into your router's settings.

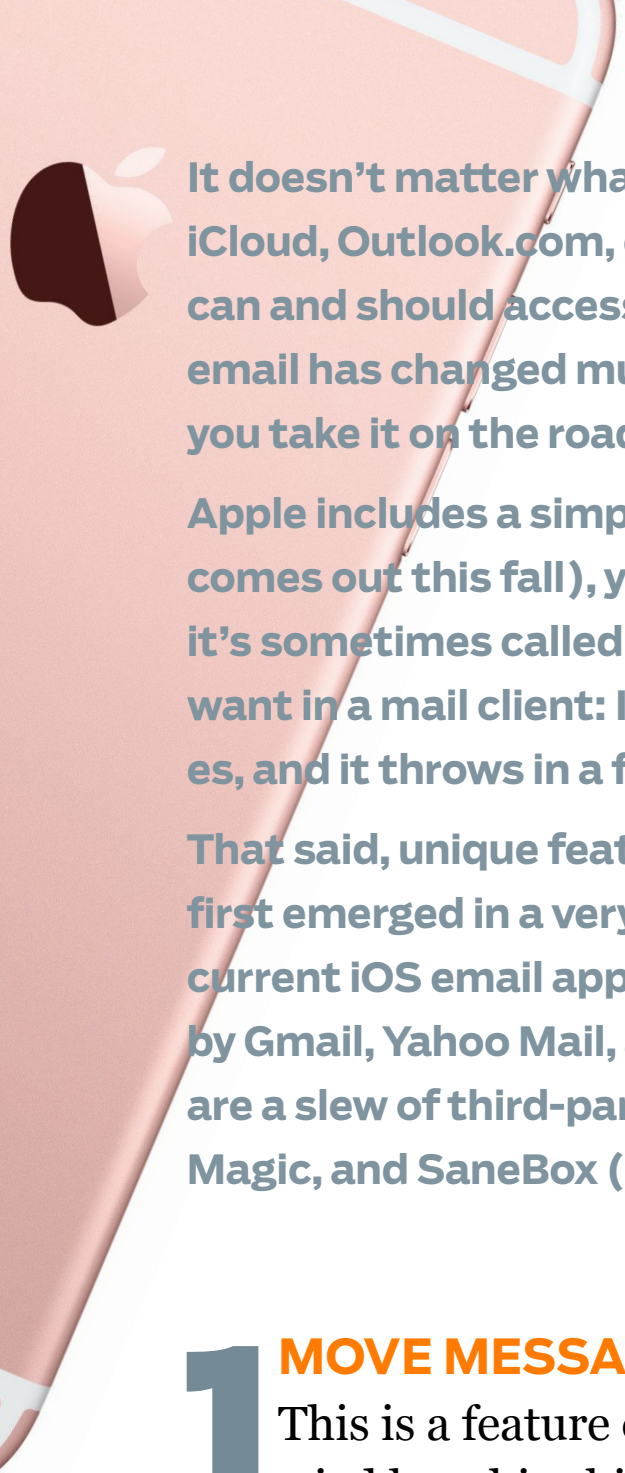
You should now be able to log into your router using the default username and password. Your first task will be to change the wireless network name, wireless network password, and security level. You should also go through each screen to see if there are other settings you wish to change. Documentation and built-in help should be available to assist you with these screens, if you're not sure how to set them. Most current or recent routers also have setup wizards that can take care of some of this labor for you.

The process for logging into your router should be the same whether you use your Internet provider's router or one you purchased yourself. It should also be the same whether you use a dedicated router or a combination modem/router supplied by your provider.

Finally, you can and should change your router's username and password from their default values. This better secures your router so that only you can access the firmware screens. Just remember the new credentials to avoid having to reset the router to make any changes in the future.

12 TIPS TO MASTER EMAIL ON IOS

By Eric Griffith



It doesn't matter what you use for your baseline email account—Gmail, Yahoo, iCloud, Outlook.com, or systems that use Exchange or IMAP or even POP3—you can and should access your messages on the go with your iPhone. It's not like email has changed much in 30 years, but the experience is totally modern when you take it on the road.

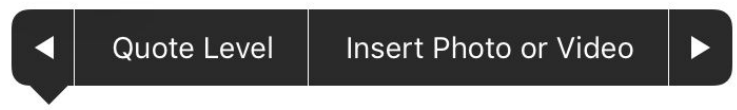
Apple includes a simple yet powerful app with iOS called Mail—in fact (until iOS 10 comes out this fall), you can't even delete it. But you may not want to. Mail.app, as it's sometimes called to keep things straight, does pretty much everything you'd want in a mail client: It sends, receives, replies, composes, and organizes messages, and it throws in a few extras that we'll cover here.

That said, unique features exist in certain third-party email apps, many of which first emerged in a very hyped app that no longer exists: Dropbox's Mailbox. Several current iOS email apps still emulate it, among them Gmail and the separate Inbox by Gmail, Yahoo Mail, and Outlook, which earned our Editors' Choice. Then there are a slew of third-party apps, including Inky, Boxer Pro, Inboxcube, Spark, CloudMagic, and SaneBox (also an Editors' Choice)

1 MOVE MESSAGES BETWEEN ACCOUNTS

This is a feature of the iOS Mail app—only. No other email app I've ever tried has this ability, and it's invaluable. If you've got multiple email accounts and a message is sent to one but you'd rather file it with another, just open a message and click the File icon at the bottom (it looks like a file folder), or as you look at the list of messages, click Edit at the top and select all you want, then click the Move link at the bottom. On the next screen are all the folders and labels for that account. But if you click Accounts at the top, you can choose from any of your integrated email accounts. Click one, pick a folder or label, and file it.

2 EASY ATTACHMENTS



It used to be hard to stick something in a message in Mail.app. Now, you can long-press in a message and the pop-up menu lets you not only paste, or insert video/photos in your camera roll, but also add actual attachments. The default is to pick from iCloud files, but if you click Locations at the top, you can add files from other backup/sync services you may have installed. I had options for Dropbox, Google Drive, and OneDrive.

If the attachment is bigger than your email service can handle, the app uses

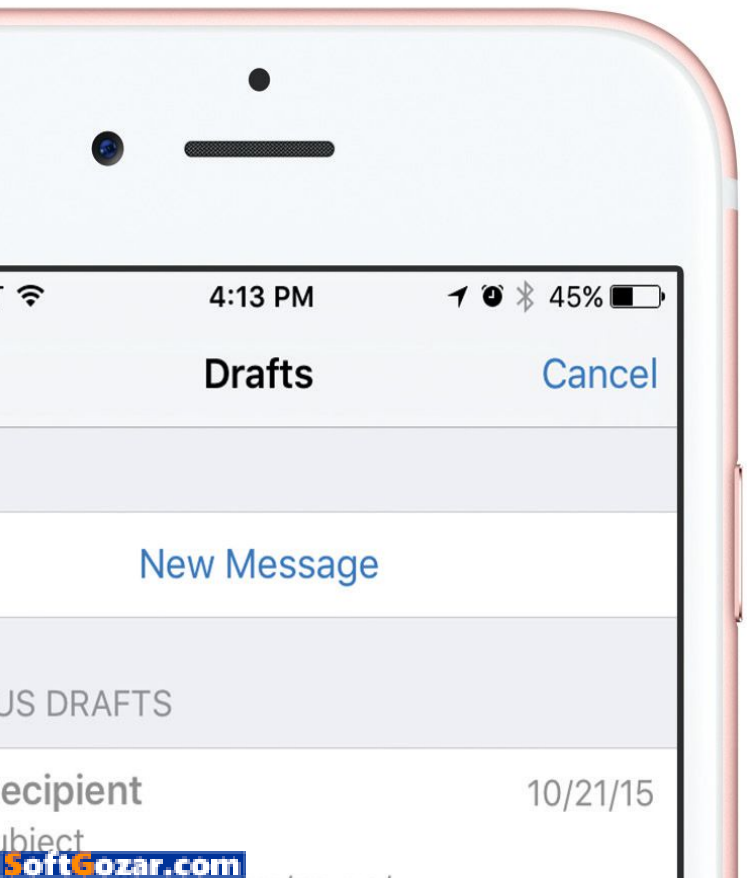
Mail Drop; the recipient gets a link to the file rather than actually getting it in the message, so they can be on any operating system at all. This way, you can "send" a file as large as 5GB from iOS. Mail Drop should kick in automatically for any file over 20MB that you try to send. And as a bonus, the file doesn't count against your iCloud storage. That's why the link for the recipient is only good for 30 days.

3 SEARCH WITH SPOTLIGHT (OR NOT)

Spotlight search came back with iOS 9 and lets you easily search your messages in Mail. Just swipe right from your home screen to get to the screen, type in a search term at the top, and the results of searches across the operating system appear. If you've got multiple email client apps installed, they may all show up in the results, redundantly displaying the same messages. On the iPhone, go into Settings > General > Spotlight Search and switch off any client you don't want to appear in the search.

4 IPAD MULTITASKING

If you've got a newer iPad, you've got an extra bit of Mail app goodness: the ability to run the app concurrently with other apps on the tablet. The Slide Over app sidebar lets you slide in from the right and check email while you still have another app open. If that second app supports multi-tasking, you can enter Split View, which lets both apps fill half the screen. There is even Picture-in-Picture feature for those times you're still writing an email, but have to use Facetime at the same time.



5 QUICK SAVE DRAFTS

Writing a message in the Mail app and need to check something else? Just swipe down from the top. The mail is saved—you'll see it still at the bottom of the screen, with the subject line showing. Tap it again to bring the drafted message back up and finish it. It even works with multiple draft messages, showing them in a stack so you can access them again later. Swipe a message in the stack left, or click the X to delete it.

6 RECOVER DELETED DRAFTS

If you accidentally delete a message draft in Mail, immediately hold your finger down on the Compose button at the bottom of the screen. If the draft is recoverable, it'll show up in a list here, so you can go back in and finish writing it.

7 DELETE OR ARCHIVE EASILY

At the bottom of the screen in Mail.app is a button that looks like a file box with the lid on top. Tapping either deletes the current message or archives it. Which action it takes depends on how you set up the account in the Mail, Contacts, Calendars settings. Go into each account, tap Advanced, and you'll see the check is either next to "Deleted Mailbox" or "Archive Mailbox." But it doesn't really matter: Hold down your finger on that icon and a menu pops up giving you the choice to "Trash Message" or "Archive Message," whichever you deem most appropriate.

8 SET UP SWIPES

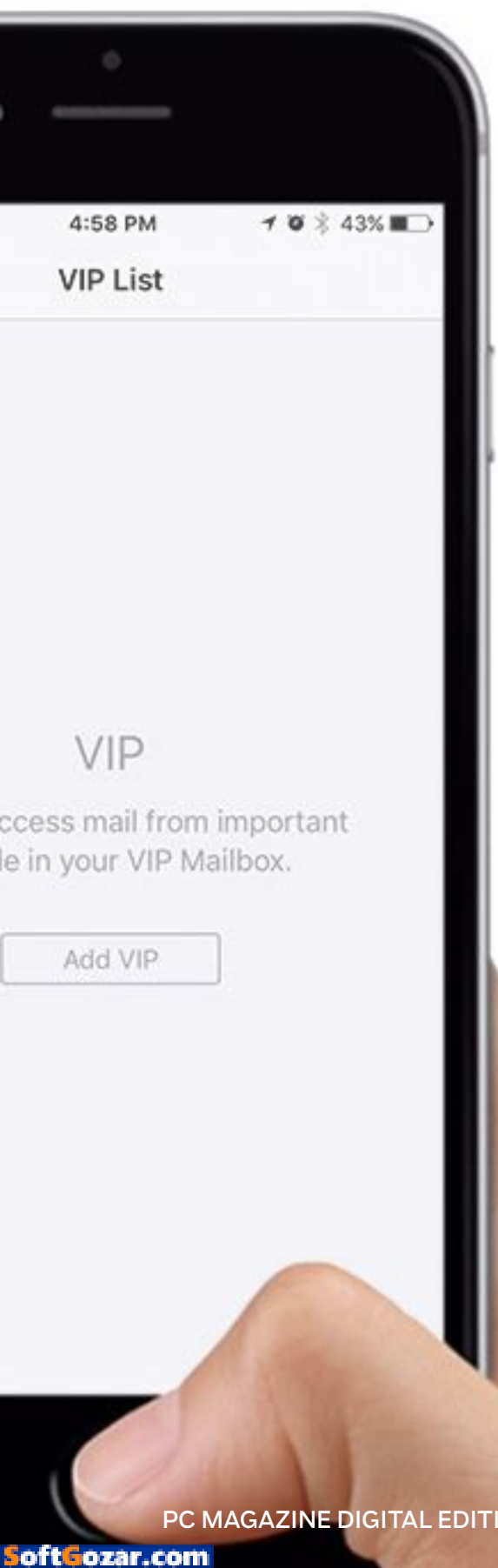
We owe the swipe-gesture-mania in email apps to the late Mailbox by Dropbox, and it's come to the Apple Mail app as well. You don't need to even open a message now to delete it, archive it, move, or mark it read/unread. Just swipe it left or right. What happens depends on what you've set up in your Settings > Mail, Contacts, Calendars > Swipe Settings. You can set the app to Archive (or Delete) if you swipe left, or Move a file if you swipe right, for example. It's all an effort to get you to inbox zero as quickly as possible. That said, Mail. app definitely has a weak implementation of swiping. You'll be better off going with Outlook for super-simple swipes, or my current favorite email app, Email from EasilyDo. It offers two commands on each swipe—just swipe farther left or right for the second one. The app is free and supports Gmail, iCloud, AOL, Outlook, and Yahoo accounts.

9 SNOOZE MESSAGES

In Mail.app, you can't snooze a message (which means pushing it back so it leaves your inbox and your mind until a later, predetermined time). But other apps have this excellent productivity-or-procrastination tool, including the aforementioned Email as well as Boxer and Inbox for Gmail. Note that if you snooze a message with one app, it's only snoozed with that app. If you need to access it elsewhere—say, on the desktop—look for a folder or label called Snooze to find it.

10 USE TOUCH ID ACCESS

Got some secure email that is for your eyes only, Mr. or Ms. Bond? Then try a mail app that lets you use the Touch ID fingerprint scanner to get access. It's an extra layer of security, so if your phone gets in the wrong hands, and they manage to get access to your home screen, they won't be able to open your email. Mail.app doesn't have this feature, but apps that do include Outlook and CloudMagic.



11 DESIGNATE VIPS

If you turn off notifications in Mail.app but still want to know when special people get in touch, set up VIPs that always generate a buzz—literally. If you don't see VIP in Mail.app's list of Mailboxes, click Edit at the top and turn it on. Back in the list, click the I in a circle and start adding VIPs to the list. Note that they have to already be in your iOS contacts. Then click VIP Alerts. That takes you to Settings > Notifications > Mail > VIP to create special notification alerts for those contacts.

12 MARK UP YOUR ATTACHMENTS

If you attach a picture or PDF to a message in Mail, hold your finger on it, and the Markup option comes to life. Write on it, draw on it, mark it all up. This isn't an option with other email apps on iOS. But it's good to know you can run all the apps you want and get the best out them all.

Apps to Help Jumpstart Your College Social Life

BY EVAN DASHEVSKY

Welcome to college! You have finally been freed from the harsh dictatorship of your parents. You've suffered through the drudgery of high school. And now you're ready to let loose and live the collegiate lifestyle that Hollywood has promised you. (And, you know, to fit in some studying and stuff, too.)

College is filled with all sorts of confused, eager folks like you. It can be difficult to find your social footing. You have the dorm, the quad, and the cafeteria, but surely there's more. Well, thanks to technology, the world is just a few taps away.

You've grown up with digital connections spreading in all directions, but chances are that your virtual tendrils didn't expand far beyond your high school. Now you have the chance—nay, the obligation—to meet hundreds (if not thousands) of new people, both in and out of your new academic home.

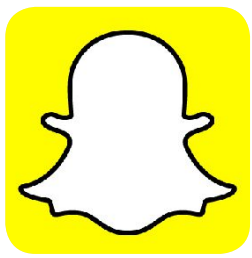
FACEBOOK

Have you heard of this little website and app startup? It's mostly for old people, but its ubiquity and widespread adoption makes it the best way to keep up with your social circle and find locals with similar interests. Your school probably has a page for incoming freshman to chat and get to know one another before you arrive on campus. Facebook Messenger is also an easy way to communicate with new friends whose phone numbers you might not have yet.

INSTAGRAM

Instagram is a light photo-editing and serious photo-sharing app. Many of the filters you can apply to images give them a retro-hip style, but they're fun and can turn out some beautiful images with a little practice. That's nice and all, but at college, Instagram will let everyone know where you've been, where you're going, and (probably) what you ate. Search specific hashtags to find people in your dorm, at a concert, or hanging out on the quad.

SNAPCHAT



No, you shouldn't trust Snapchat to be your go-to ephemeral image service. Everything you post on the Web is indeed forever. But Snapchat's run as a disposable-image repository was, like, four or five pivots ago. (*Pivot:* That's a word young entrepreneurs-in-training will use a lot.) Snapchat has, against all odds, evolved into a legit full-featured platform and one you will definitely need to enhance your social life.

TWITTER

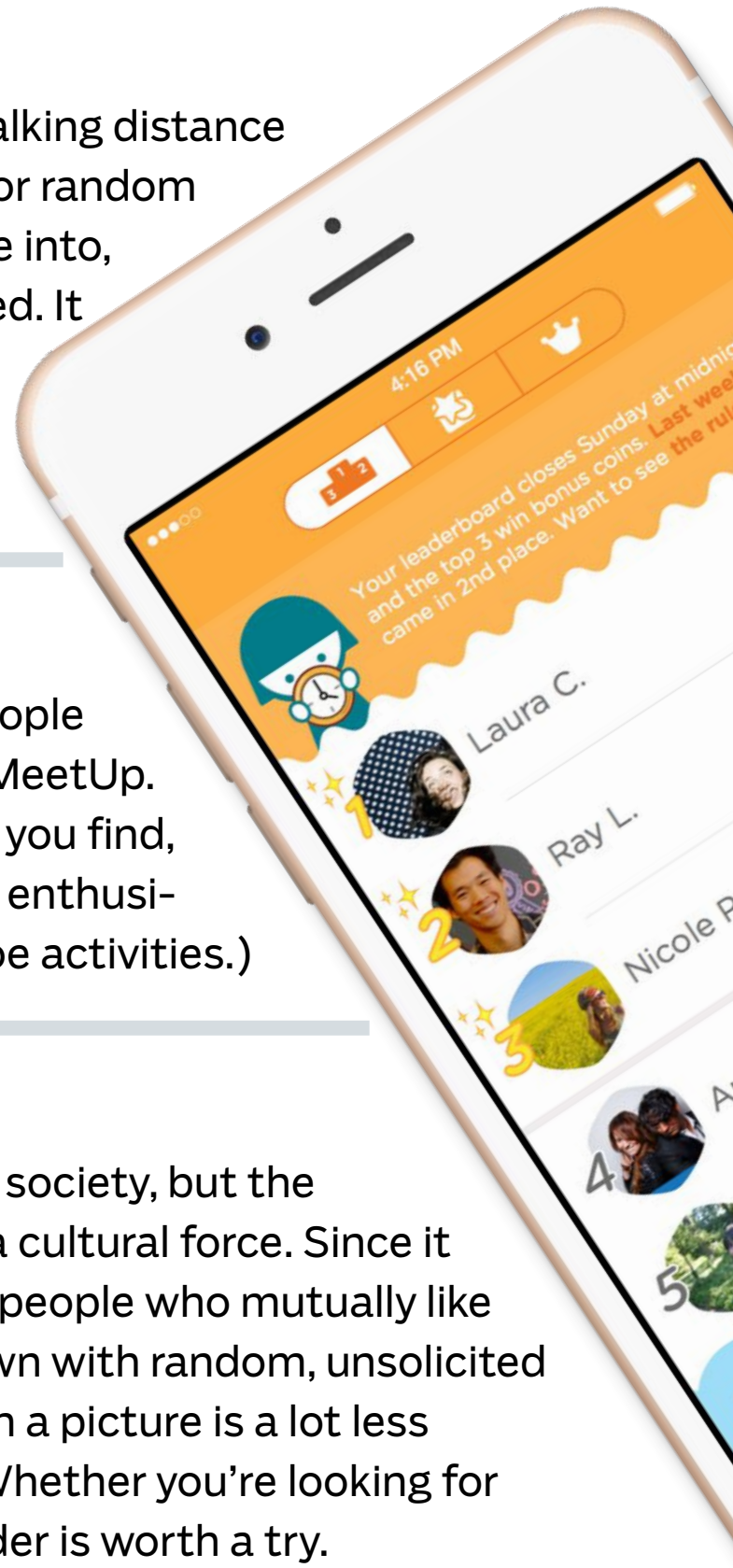
It helped ignite revolutions the world over. But you can use it to find people who share similar interests, based on location and search hashtags. It's also a fun way to waste time when you should be writing that term paper.

LINKEDIN

Theoretically, you are in college to help you launch your desired career. LinkedIn (iOS, Android, Windows Phone) is a way to keep in touch with employers and coworkers at internships, but perhaps more important, it helps you meet new people based on similar interests or those who attend your college or university.

SWARM

Wondering whether anyone within walking distance wants to join you for pizza, skee-ball, or random wanton destruction? Whatever you're into, Swarm (iOS, Android) has you covered. It helps you find nearby friends and message them. And it got Foursquare-style mayorships back last year.



MEETUP

Like canoeing? Wanna meet other people near your school who like canoeing? MeetUp.com or its apps (iOS, Android) will let you find, meet, and organize with fellow canoe enthusiasts. (Meetups also include non-canoe activities.)

TINDER

It may not say great things about our society, but the quick-and-easy dating app Tinder is a cultural force. Since it allows communication only between people who mutually like each other, you won't get bogged down with random, unsolicited love notes. And swiping left or right on a picture is a lot less stressful than combing through an entire profile. Whether you're looking for the love of your life or something more casual, Tinder is worth a try.

OKCUPID

Less let's-get-down-to-it than Tinder, OKCupid (iOS, Android) is a must-have for your newly emancipated single life. OKCupid crunches data points to suggest relationships based on shared interests, but it also lets you choose those with whom you might want to mix and mingle.

POKEMON GO

Want to hunt for little cartoon monsters? Well, with Pokemon GO (iOS, Android), you can do just that. But unlike other mobile games, this one requires that you be out there IRL. Where the people are! By the way, it's now more popular than Tinder.

SCHOOL-CENTRIC APPS

Your school probably has a dedicated app. A quick survey showed us that a lot of these apps are little more than ported versions of the school's website. But they also can include info—say, upcoming-events calendars—that's central to any self-respecting undergrad's social life. Also, one thing that can either make or break your freshman year is your roommate, and colleges are hoping to alleviate some of that angst by allowing incoming students to use services like RoomSync or StarRez to find their ideal match rather than taking a chance on a rando. Be sure to ask if your college offers some sort of roommate-finding software or app.

JOHN C. DVORAK

Your Email Is Never Going to Be Safe

Microsoft deserves some credit for fighting the government over access to its customers' accounts. This battle is not over, but suffice to say the government will always win and get what it wants in an era of ever-increasing terrorism.

According to reports, Microsoft has received 2,600 secrecy orders for data from the Microsoft cloud, which comes with a gag order, though that information could be bogus. (The number 2,600 is suspect, since it refers to 2600Hz, the unused line-signaling frequency for long-distance POTS calls and 2600 Magazine the Hackers Quarterly. So the number may be a nod to someone or a group of some sort. End of digression.)

Also, calling these "secrecy letters" is usually a reference to the ludicrous patent secrecy letters that impede American inventiveness. Read this and weep. It's more likely that National Security Letters (NSL) are involved. Here is an excellent rundown of that device.

A THREAT TO THE CLOUD BUSINESS

Whatever the case, and whichever form of government demand mechanism is used, it has to be a pain in the butt for Microsoft, whether it gets 10 or 10,000 of these requests and demands. It rightly sees all of them as a threat—to its cloud business in particular.

I'm seeing more lost sales to American companies. If I'm concerned about my trade secrets, internal memos, strategy sessions, and internal proprietary tricks, I might not want to use

Microsoft cloud products. This is a trade issue in a global economy. I might prefer a Swedish cloud service. Better still, I'd use no cloud service at all and keep it all in-house; I assume the Swedes have long since been compromised.

There are plenty of IT pros who can secure a system and keep it that way.

At least Microsoft continues to fight the good fight. I congratulate the company.

DATA LEAKS EVERYWHERE

Unless you secure everything, you'll go on the Internet to move some things around. That means there are still other ways for the government to get the data even in-house.

That material is discoverable by capturing ISP streams. Your protection is extended with various VPNs, but these systems leak when people email outside the umbrella of the VPN.

Assume that whatever you do on email will get into the wild, somehow. That is exactly what happened to the DNC (Democratic National Committee) with 20,000 emails sent to Wikileaks. While various pundits are trying to blame Russian hackers, it is more likely an inside job by a disgruntled employee.

Security experts will tell you: The biggest threat is the insider who has full or even partial access. Today a 128GB thumb drive on a keychain plugged into a USB 3.0 port can suck down scads of documents in seconds. Ed Snowden epitomizes this serious problem. It can never be controlled.

While it is possible to limit USB and other access with specially built machines, nobody wants the inconvenience of hand-made secure computers with no ports. So everything is up for grabs.

LEARN GOOD EMAIL PRACTICES

This should be taught in school. After you write an email, read it and ask, “Do I want the whole world to read this document?” Then ask, “How damaging would it be if they did?” The answer to the second question is important.

As for the cloud, Microsoft, and the government, this is a losing battle insofar as privacy is concerned. Debate it all you want, but there is no evidence that anyone is going to back off on government snooping. What is the response to the fact that the snooping regarding terrorists has failed to prevent numerous attacks? More snooping is needed, of course. The perfect argument.

It’s hopeless. My advice is bring IT back in-house. You won’t regret it. Then establish rules for composing email and stick to them.

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