

PC

MAGAZINE

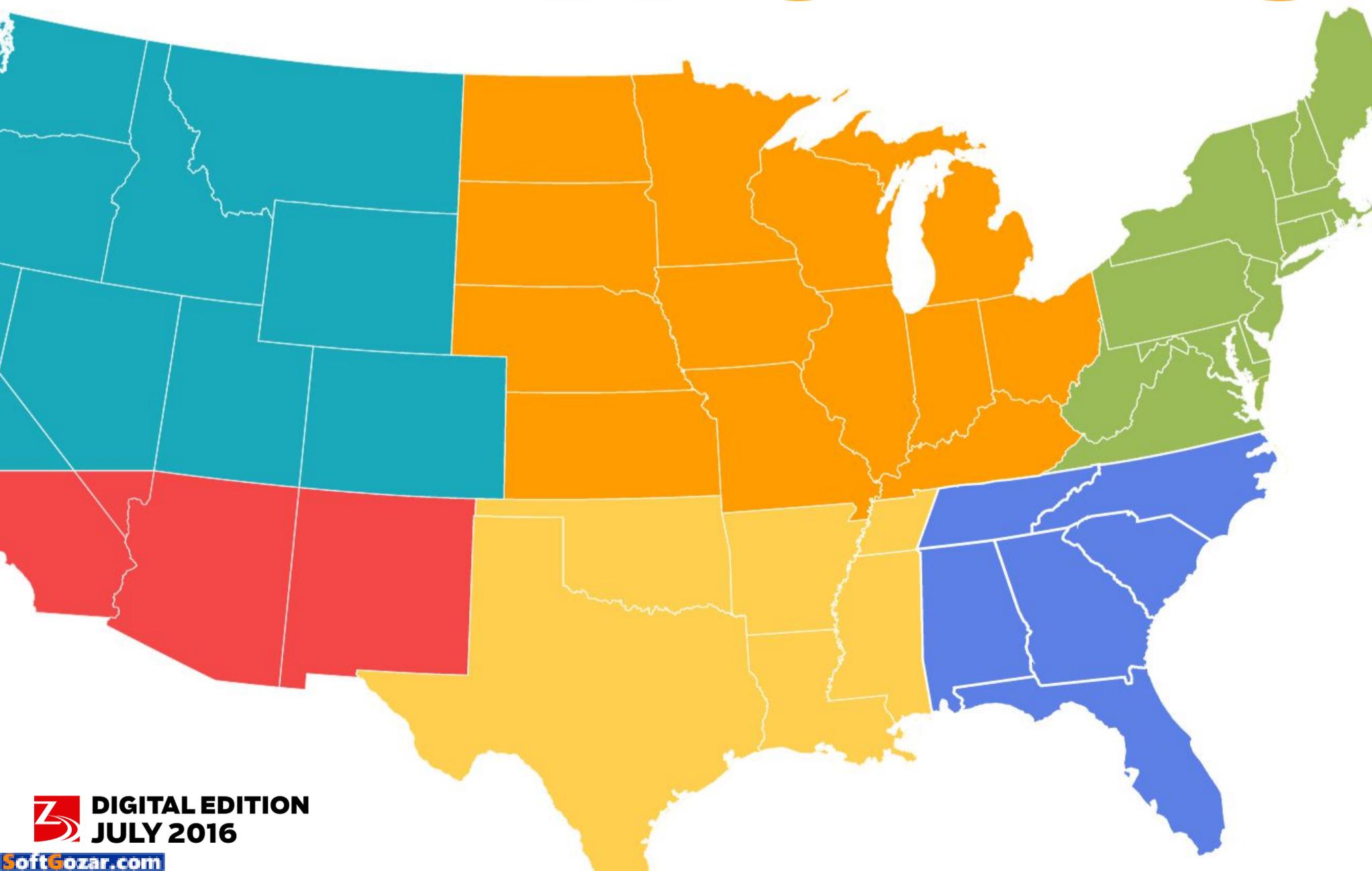
WHO IS #1?

2016

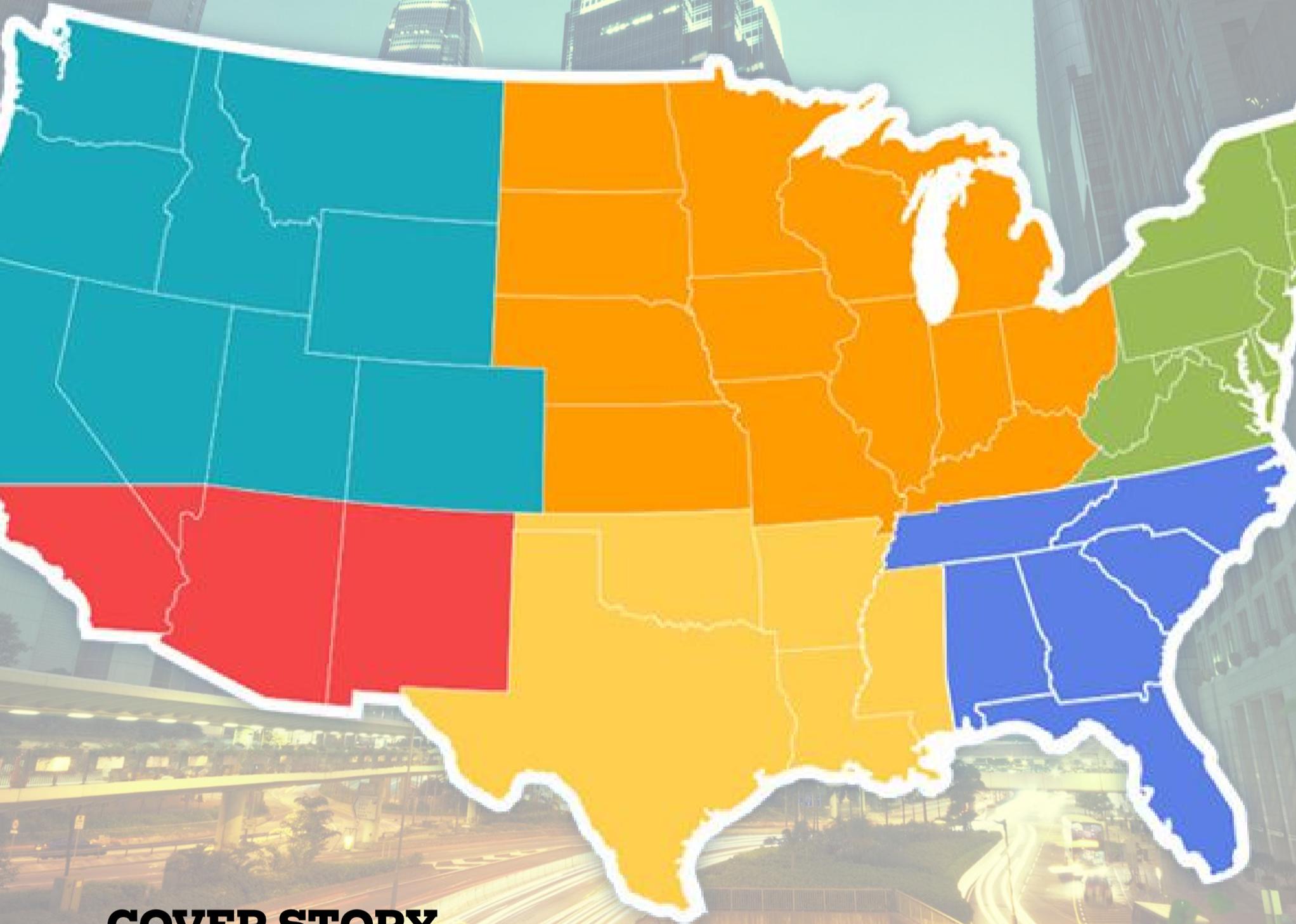
FASTEST

MOBILE

NETWORKS



FEATURES



COVER STORY

FASTEST MOBILE NETWORKS 2016

In our annual quest to find the fastest mobile Internet service in the U.S., *PC Magazine* testers drove thousands of miles (in silver Audi A4s, no less) to see how the big four carriers stack up. Read on to find out which is number one in your region.

REVIEWS

CONSUMER ELECTRONICS

Nikon D500

Misfit Ray

TCL Xess

Samsung Galaxy S7 Active



Nikon D500

HARDWARE

Razer Blade

Intel Core i7-6950X Extreme Edition

Tenda F3 N300 Wireless Router

Dell OptiPlex 24 7000 Series All-In-One (7440)

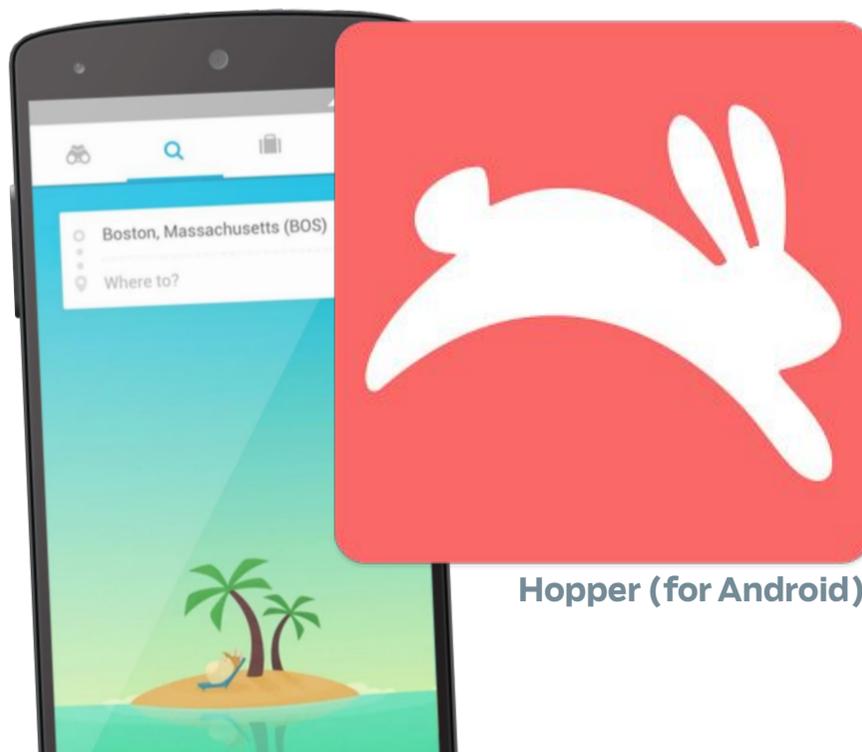


Intel Core i7-6950X

SOFTWARE & APPS

CyberLink PowerDVD 16 Ultra

Hopper (for Android)



Hopper (for Android)

WHAT'S NEW NOW



THE BEST OF COMPUTEX 2016

Our firsthand view of the latest and greatest in computing.

STEELERS USE ROBOTS TO TACKLE CONCUSSIONS

The MVP—Mobile Virtual Player—can take the hits.

AI: THE NEXT BIG THING IN MEDICINE

It could be a force multiplier across every medical field.

COULD NANOSCALE VACUUM TUBES REPLACE TRANSISTORS?

Caltech thinks so, and it's building proof-of-concept devices.

TOP GEAR



OPINIONS

DAN COSTA

First Word

READER INPUT

EVAN DASHEVSKY

With Voice, Offline No Longer Exists

MATTHEW MURRAY

Stepping Away From Antisocial Media

TIM BAJARIN

Supercomputers Will Power Autonomous Cars

“

If I were a goofy kid with a penchant for hacking, I'd go after home automation systems.

”

JOHN C. DVORAK

Last Word

DIGITAL LIFE



GET ORGANIZED

Stop Fighting Email with More Email

HOW TO

How to Take a Screenshot on Any Device

TIPS

12 Tips for Successful Roku Streaming

CONNECTED TRAVELER

When to Prepay for Travel



Trust, but Verify

P*C Magazine* has a 34-year history of keeping tech vendors honest. Whether we're benchmarking laptops or counting pixels in the latest digital camera sensor, our lab-based testing sets us apart from the crowds of bloggers and online opinion makers. In a world where the line between editorial and advertising is becoming increasingly blurred, our tests are our touchstone. Applying that philosophy to a service such as the one wireless carriers provide isn't easy, though.

The vendors themselves aren't very helpful. T-Mobile claims it has doubled its LTE footprint in the last year. Verizon says it's number one in speed, data, reliability, and overall network performance. AT&T claims the "strongest LTE signal." And Sprint is using former Verizon pitchman Paul "Can you hear me now?" Marcarelli in a commercial, explaining why he switched over to Sprint.

Third-party services aren't much help, either. Rootmetrics says Verizon is the fastest carrier, but OpenSignal says T-Mobile is faster. If that wasn't convoluted enough, Neilson says that Sprint's Spark 4G network is faster than both of them. Put simply: It's a mess. And these statements don't take into account that carrier performance varies widely, depending on where you are.

Into this labyrinthian landscape, *PC Magazine* releases its Fastest Mobile Network award. You can read our picks for the speediest networks regionally and nationwide, but perhaps more

important is our methodology. We drove around the country over a three-week period, testing in 30 cities and the rural areas between them. Our test software ran on identically configured Galaxy S 6 handsets. Tests on each carrier were run at the same location and the same time, so we could most accurately gauge performance across carriers. Altogether, we collected more than 178,000 test results. And our conclusions are completely independent.

I'll let you discover the full results for yourself, but I'll point out a few things that make our awards unique. First and most pertinent, we consider upload speed a fundamental part of network performance, so it makes up 20 percent of our overall score. This is the same percentage we use for calculating the fastest landline ISPs, so the consistency is appealing. Also, we use ping time and reliability to reflect the overall experience users can expect on each service. These are results you can trust.

That said, this story comes with an important caveat. We give awards by city, region, and nationwide, but the most important results are those that you get at home, at the office, and in between. I'd love to switch to T-Mobile, for example, but I have zero LTE coverage at my house upstate. That's a deal breaker. Before you make a buying decision that could lock you up for years, go to www.pcmag.com/speedtest and run some tests for yourself.

As usual, our staff applies the same rigor to more conventional consumer electronics and hardware products. Gamers are already familiar with Razer's excellent products, but the new Razor Blade ultraportable gaming laptop should garner some crossover appeal with business users as well. It's one of the most impressive and unique Windows



**PC Magazine's
labs-based
testing sets
us apart from
the crowds of
bloggers and
online opinion
makers.**



10 machines on the market. We also put the Samsung Galaxy S7 Active smartphone to the test to make sure it really can stand up to the champagne torture test.

Visit us on Facebook at www.facebook.com/PCMag and let us know what you think of this issue. Also on Facebook, each weekday at 10 a.m., we stream a video show called “Random Access”: It features tech news, real-time audience questions, and close-up looks at cool products being tested in the Labs. It’s just like the Digital Edition you’re reading now—except that it’s unscripted, unedited, and completely random.

dan_costa@pcmag.com



Tim Bjarin's opinion column, "Are Phones Becoming too Complicated?" (from our June 2016 issue), garnered some strong responses. Readers came down on both sides of the question, but most were inclined to defend the ever-more-capable smartphone.

I don't agree with your example of the HP Elite X3 being more complicated. The Windows Phone is not more complicated because of Continuum, it's only more useful....

Those 10 to 15 percent of people who need to be productive now when using their phones are the perfect initial target users. But when people (emerging market, younger generation) who are purchasing only smart phones run into instances of needing to use some sort of productivity software ([and will also need] a large screen, mouse, and keyboard), this is a great option available to them, without making them have to purchase a PC or 2 in 1.

—*Greenberrywoods*

Smart phones, as well as PCs before them, have always been trying to be all things to all people, resulting in a messy, high-tech mishmash of marginally useful features run by increasingly incomprehensible operating systems. There is also a considerable element of "solutions seeking problems" instead of the other way around.

—*tahoel*

The beauty of Continuum is the flexibility you get from the choice to buy and use those peripherals. If everything at work is done via thin client and remote terminal setups, for instance, the only thing really limiting a smartphone from that role is the tiny screen size and limited input.

Think of a device like the Elite X3 as a way to consolidate a company issued phone and laptop into one core device and a couple peripherals. As

opposed to the Atrix concept, which just shoehorned Android into a role it's very poorly suited for.

—*Daniel Glass*

I would disagree with the Windows device being too complicated. I used Android [on] the G1 and LG G2x. To come back occasionally now to Android 6.0 is irritating, to say the least, but that is strictly as a phone, not with a docking station or trying to use it as a PC. I also used iOS for four months; I will never do that again. I use an HTC One M8 with Windows now. I like it the best to date, because it is the least crammed with junk and the most productive device I have had so far. It also performs faster than my wife's Android [phone]. I still think it may be a preference thing in the long run, but I can see the casual user getting annoyed well before the ones who really nerd out about it.

—*12InchPianist*

I don't want a complicated device in my pocket. Nor do I want my smartphone and desktop/laptop to share the same interface. They're combining the worst of all worlds into the new phones, laptops, and desktops. No thanks.

—*Alex B*

Phones are only as complicated as you make them with apps and add ons. If you want basic phone and email, don't load any apps. Keep it simple. Nothing easier than that! Alternatively, Walmart still sells flip phones...

—*AppleBerrySandwich*

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.



What's New Now

THE BEST OF COMPUTEX 2016

**USING ROBOTS TO TACKLE
CONCUSSIONS**

**AI: THE NEXT BIG THING IN
MEDICINE**

**COULD NANOSCALE VACUUM
TUBES REPLACE TRANSISTORS?**

TOP GEAR

The Best of Computex 2016

BY JOHN BUREK



This year, the organizers of the Computex trade show in Taipei—the second biggest show in the world for tech, apart from the annual CES bombast in Las Vegas—made an effort to reinvent the show. The themes they pushed were the centrality of the Taiwan design and manufacturing ecosystems to the fields of Internet of Things (IoT) and PC gaming, as well as the vibrancy of the Taiwan startup scene. Also big on the Computex stage: virtual reality, which is only natural since one of the two big early VR players (HTC) is Taiwan-based. Many of the major and some less familiar names showed how they'll support this nascent field with hardware and software/platform pushes; among the biggest news from the show was the announcement by Microsoft of the opening of its HoloLens platform to hardware partners.

The show was also, as always, a showcase for the best new PC tech coming out of Taiwan's major players, as well as a few others. It was also the venue for two of the biggest core-component launches for the PC of this or any year.

Chip giant Intel launched its most powerful consumer-accessible PC processor ever, in the Core i7-6950X Extreme Edition, the flagship of a new line of four "Broadwell-E" desktop processors, while distant CPU competitor AMD outlined its latest ("7th-Gen") family of power-efficient mobile processors for laptops. And as it did last year, Nvidia started off the show by rolling a giant gun to the graphics-card front: the GeForce GTX 1070, which brings much of the power of the already impressive GeForce GTX 1080, released a few weeks earlier, to a much more aggressive price point, starting at \$379.

Read on to find out all about the best of what we saw.

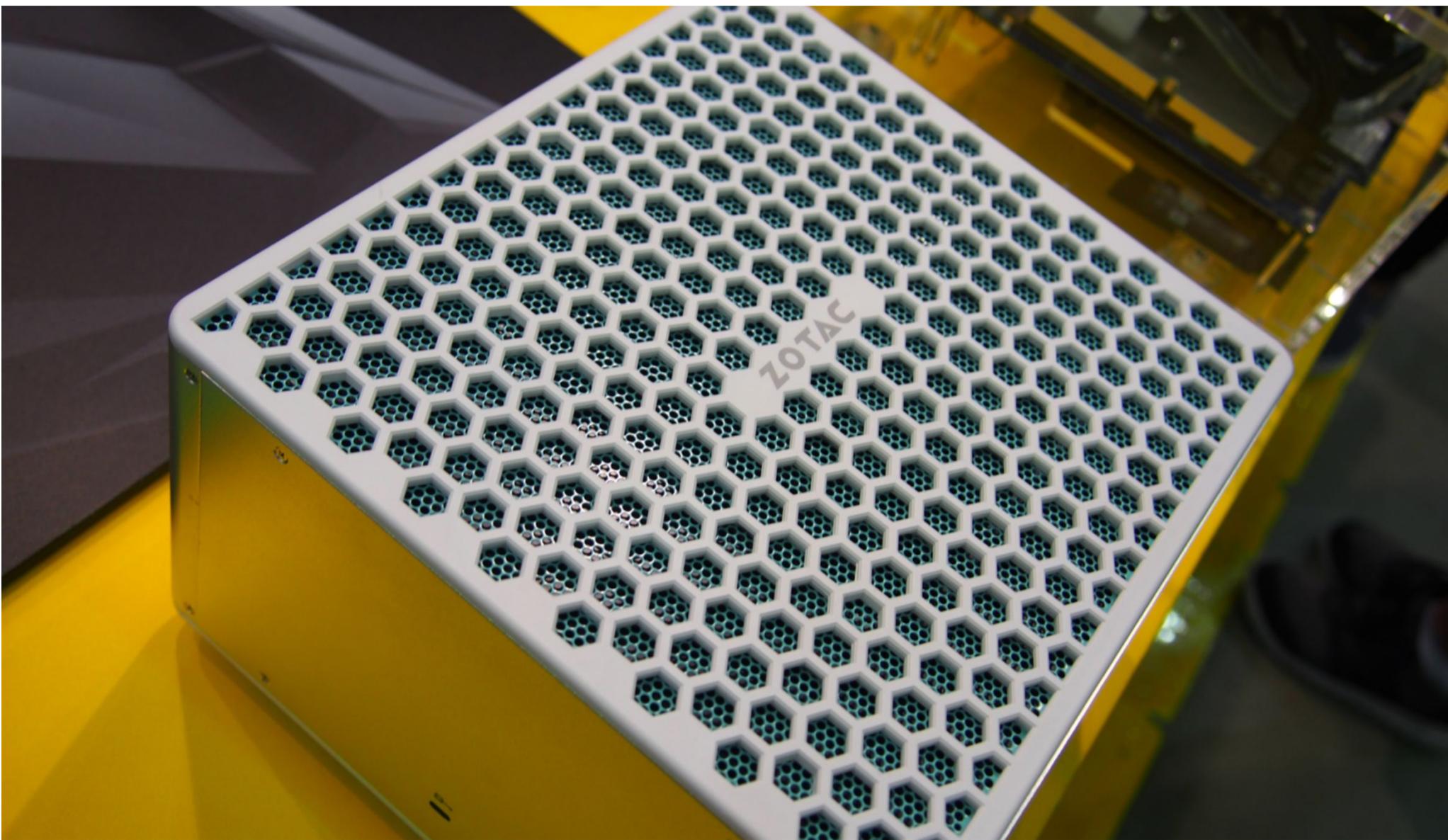
BEST NEW LAPTOP



Asus ZenBook 3

Don't call it a MacBook, though you'd be forgiven for mistaking it for one. Asus's 2-pound super-slim Windows 10 laptop will pack real muscle (Intel Core i-level processors) and afford a better typing experience than Apple's skinniest laptop. Like that machine, it will feature only one proper port (a Type-C USB), but the 1080p screen will be a smidge larger on the diagonal than Apple's display, and the pricing will start at a lower \$999. The Type-C port will also be a Thunderbolt 3 port, so the machine will be able to use that port's exceptional bandwidth with thus-equipped displays and storage devices, and the ZenBook 3 will charge over the port, too. (According to Asus, it will fast-charge to around 60 percent in under an hour. You can choose from royal blue, silver, or rose gold. The Gorilla Glass protecting the screen and the ZenBook's signature radial etching on the lid make for one of the most striking Windows ultralights on the horizon.

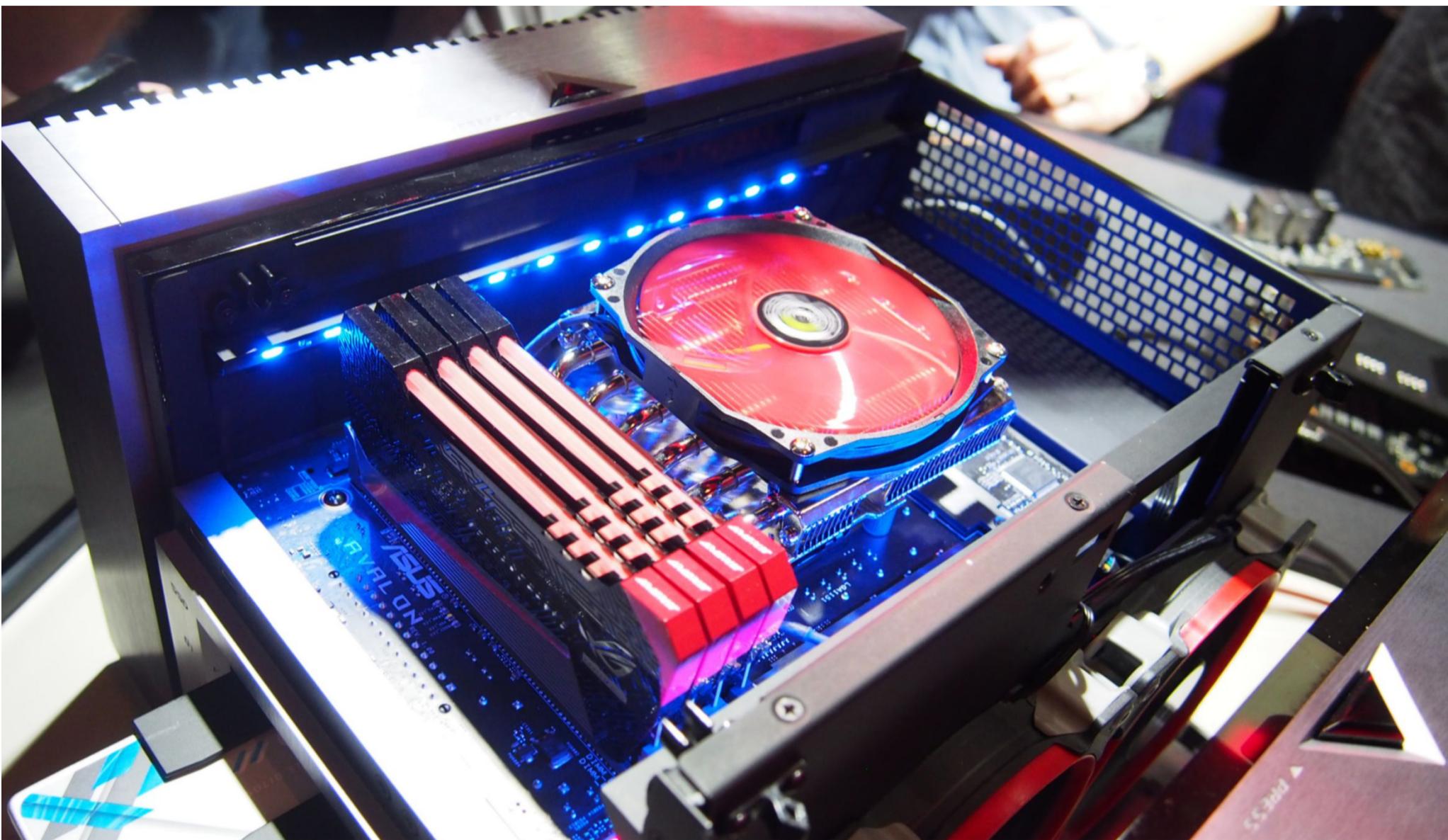
BEST NEW DESKTOP



Zotac Zbox Magnus EN980

The “VR-ready” PC so far has fallen into two classes: very high-end gaming laptops with rarified graphics processors like the “mobile desktop” version of the GeForce GTX 980 and the usual hulky PC towers that can host full-size graphics cards. The Zbox Magnus EN980 stakes out a middle ground, in a compact, liquid-cooled Core i5 desktop that packs a VR-capable GTX 980 and the choice of bare-bones, partly configured, or fully configured versions. Expect to pay around \$1,599 for the Magnus EN980 in bare-bones trim (minus an OS, an SSD, or RAM), or \$1,999 for a fully configured version with a 1TB hard drive, a 120GB SSD, 8GB of RAM, and Windows 10. Zotac will also offer the Magnus in a “backpack” version that will let you VR away the day from a battery, without trailing wires to trip over.

BEST CONCEPT PC



Asus Project Avalon

What's Computex without a crazy prototype? Here's one, but it may not be as crazy as it looks. A few vendors have tried to push modular-PC designs over the years (most recently, Razer at a recent CES with its still-vaporous "Project Christine"), but none has taken hold. Asus is pushing the idea anew in "Project Avalon," a PC based on a spiffy In Win chassis and some custom Asus motherboards and PCBs that allow for interchangeable I/O, drive controllers, and more. The Project Avalon PC was easy to strip down, in the demo we saw, and consisted of a custom motherboard with an assortment of attachable daughterboards, letting you swap in various audio- or connectivity-centric IO panels. The SATA and other storage connectors were on an additional board, and the chassis had snap-off sides that allowed for the installation of video cards, liquid-cooling gear, and other hardware. The idea: You might be able to swap in or upgrade mainboard subassemblies or other components without changing out other essentials. It's all very nascent, but the PC was up and running, and it looked closer to prime time than any such modular dream machine we've seen.

BEST NEW TABLET or 2-in-1



Asus Transformer 3 Pro

At this Computex, Asus decided to take on not just the Apple MacBook but also another iconic current computer: the Microsoft Surface Pro. The Transformer 3 Pro is a Surface-style 2-in-1 that will come with a roomy backlit keyboard. The overall design looks more premium than most Surface alternatives from the likes of HP and Lenovo. Connectivity includes full-size USB 3.0 and HDMI ports (impressive for a device this thin), as well as a Thunderbolt 3/USB 3.1 port and a MicroSD slot for adding storage. Asus says the Transformer 3 Pro will even work with the company's ROG XG Station 2 external graphics box for gaming-grade graphics. That's impressive, and a first that we know of for a device like this. Pricing will start at \$999; for a maxed-out model with a Core i7 processor and a 1TB solid-state drive, expect to spend much more, though. More pricing details and availability specifics were still pending at this writing.

BEST NEW MOTHERBOARD



Gigabyte X99-Designare EX

The Intel X99 platform is suddenly of renewed interest, thanks to the debut of Intel's monstrous 10-core Core i7-6950X Extreme Edition processor at Computex 2016. As a result, the usual PCB suspects rolled out a host of X99 Socket 2011-v3 boards to coincide with the launch. Arguably the tops of the bunch is the pair of Designare boards from Gigabyte, one for X99 and one for the more price-sensible Z170/"Skylake" platform. We liked the X99-Designare EX for the sheer excess of it. The board costs \$419 and features eight DIMM slots that can support up to 128GB of DDR4 RAM. And with certain G.Skill memory, XMP profiles will let you hit 3,600MHz on that RAM with no need for complex overclocking. Also, the board features not one but two native U.2 ports, letting you attach a pair of Intel's blistering 750 Series mega-SSDs for the maximum speed you're likely to get today from a consumer-accessible PC storage subsystem. RGB LEDs on the board and headers for LED strips also let you use the Designare as the basis for the ultimate LED-blinged-up PC.

BEST NEW GRAPHICS PRODUCT



Nvidia GeForce GTX 1070

Nvidia brought out the killer GTX 1080 a few weeks before Computex, and it sold out in moments, with supply still a bit short at this writing. The board that most of us, primed for a video-card buy but actually constrained by mere-mortal concerns such as “budgets,” needed to hold out for, though, was the GTX 1070. It launched at Computex. We tested Nvidia’s handsome Founders Edition of the board, which rings up for \$449. It matches or beats the mighty GeForce GTX 980 Ti and even gives the GeForce GTX Titan X a run for your money. If you’re looking to do light gaming at 4K resolution, all-out play at 2,560x1,440, or mess around in VR’s early days, this card is today’s sweet spot for future-proofing your buy.

BEST PROCESSOR RELEASE



Intel Core i7-6950X Extreme Edition

Ten cores, for around \$1,700? No one will be calling the Core i7-6950X a bargain anytime soon, but all other consumer processors will need to call it “Sir.” The Core i7-6950X isn’t clocked to the max of Intel’s consumer silicon, meaning that unless you really need the maximum cores and extra PCI Express bandwidth afforded by this chip, you might be better off with a “lesser” Broadwell-E chip or even one of the 6th-Generation Skylake models. (The next chip down the new “Broadwell Extreme Edition” stack is “only” \$1,000 and eight cores.) But the i7-6950X chip has some overclocking potential, and with heavily threaded software such as video editors and media converters, we did see some of the fastest conversion and rendering action to date. It’s a niche piece of silicon, but for those who need it, there is no other. (See our review in this issue.)

Steelers Use Robots to Tackle Concussions

BY STEPHANIE MLOT



A motorized self-righting mobile training dummy called the Mobile Virtual Player (MVP) has joined the NFL team during off-season workouts at the UPMC Rooney Sports Complex in Pennsylvania. “It’s an awesome piece of football technology,” coach Mike Tomlin said in a statement. “I am always interested in ways to utilize technology in terms of teaching football.”

Developed and first implemented at Dartmouth College, the technology is currently in use by a number of college football departments, including Michigan State University, Central Michigan University, University of Minnesota, Western Michigan University, Harvard University, St. Thomas Aquinas, and Davenport University. The USA Rugby Seven's Olympic men's and women's teams are also taking it for a spin.

The MVP weighs more than 140 pounds (half the average load of an NFL athlete). Controlled with a remote and powered by a motor, the device can move as fast as anyone on the field—it boasts a five-second 40-yard dash.

“The applications we are quickly finding are endless,” Tomlin said. “It never gets tired. It runs at an appropriate football speed. All of the position groups are getting an opportunity to use it. . . . It's been fun watching that.”



Increasing concern over concussions and other repetitive play-related head blows in American football led Dartmouth coach Buddy Teevens in 2010 to ban live tackling in practice. But you're not going to win many championships without honing your skills. So members of the Thayer School of Engineering went to work, and the MVP was born.

GRIDIRON MAN

The MVP can cut, weave, stop, and start, and it has speed. “It's an awesome piece of football technology,” said Steelers Coach Mike Tomlin.



“We were tasked with how [to] practice tackling without utilizing another player,” said former Dartmouth defensive tackle Elliot Kastner, co-founder and director of research and development for MVP. “What it comes down to is, repetitive impact on players is what we are trying to eliminate. We realized the safest thing to do is pull one of those players out of the drill. It was introduced to reduce player-on-player contact.”

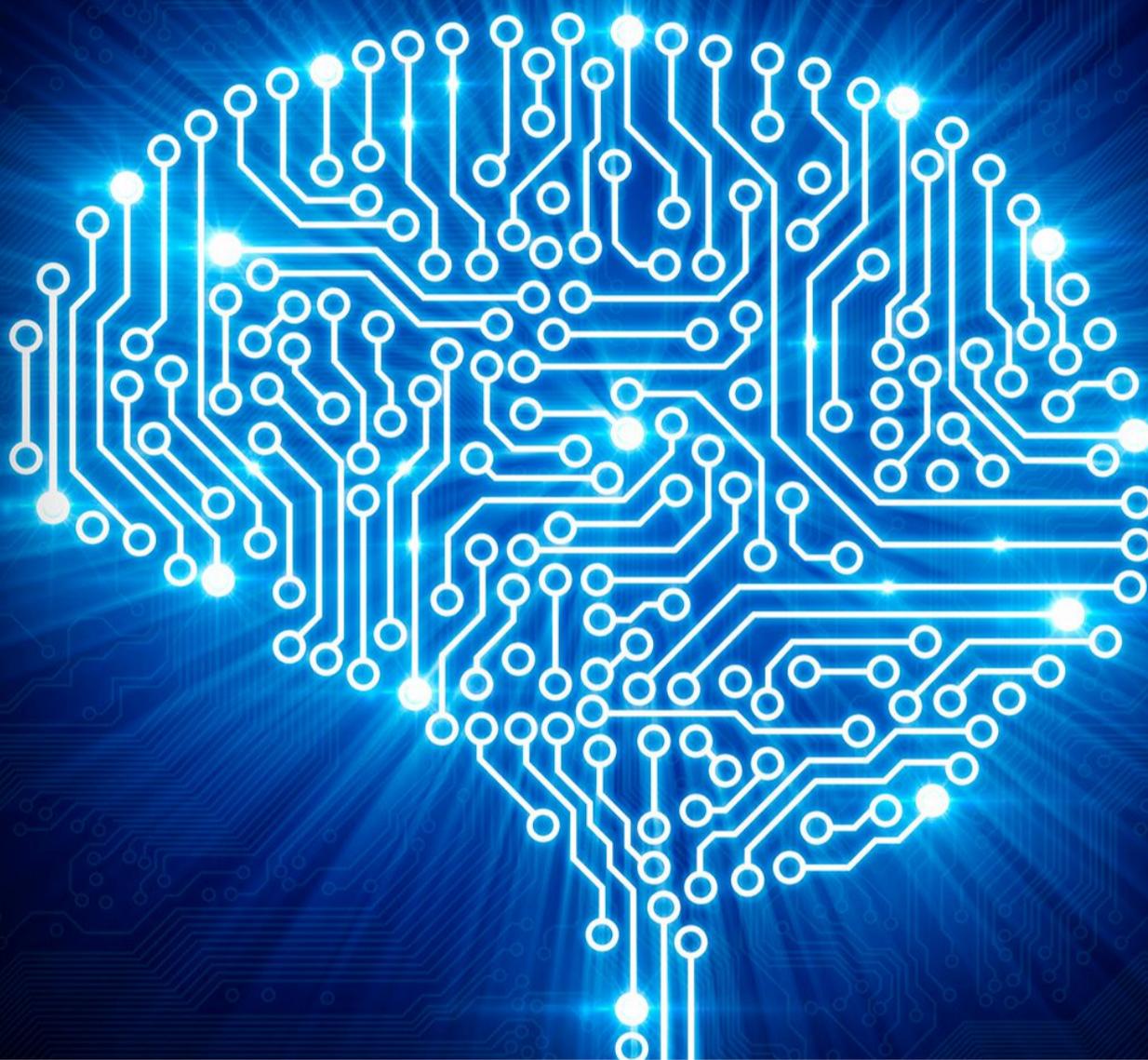
Tomlin believes the robot will do some good for his team and others in the league. “In today’s NFL, with player safety the focus that it is, I think it’s going to provide opportunities to improve in that area without the hand-to-hand or man-to-man combat associated with that teaching,” he said.

“It’s a pretty neat contraption,” defensive end Stephon Tuitt added. “Being able to chase it opens our mind and opens us a little bit.” The Steelers’ version of the Mobile Virtual Player is still in the testing phase; the goal is to make it available to additional teams, ages, and abilities next year.

BLOCK AND TACKLE
The MVP can be used not only for tackling practice but also for passing drills and as a running back. The most important thing is that it reduces repetitive impact on players.

The Next Major Advance in Medicine Will Be the Use of AI

BY JESSICA HALL



Over the last few decades, medical research has shifted from treating transient illnesses to curing long-term diseases. This work, which built on the efforts of Lister, Pasteur, Salk, and the like, has been slow and difficult, with many promising drugs and treatments ultimately failing their clinical trials. The heyday of antibiotics is waning, but we still have designs on eradicating disease.

What's next? I think it's artificial intelligence.

AI stands poised to act as a force multiplier across every field of medicine, because rather than being useful against one kind of ailment—as are antibiotics or radiation—AI can work alongside humans to make better decisions in the

day-to-day, regardless of what the use case might be. In the same way that antimicrobial agents are the corollary and companion of germ theory, there's every reason to believe that AI will enable us to apply our knowledge of "omics" (genomics, proteomics, metabolomics, and so on) to human health. We've started to interact directly with the information contained in the genome, so it stands to reason that the next big leap will have to deal with information processing.

Multivariate analysis is by far the greatest strength of AI, because it allows the kind of contextual decision-making intelligence used in systems like the human mind, while also drawing from the eidetic memory of a hard disk. No parsing through the emotions is required, and there are no attentional omissions. AI doesn't need sleep, and doesn't get fatigued after focusing on one topic for too long. At the same time, AI has the benefit of massively parallel processing. The ability to handle huge volumes of data is of increasing value, and AI can drink from the firehose. With enough memory and processing power, a medical AI could hold a whole family tree's worth of medical records in context, scour databases for pertinent diagnostic information, and call up banks of medical and social resources—all at the same time.

For the purposes of this story, I'm defining AI as a computerized system that can perform tasks usually requiring human intelligence, tasks such as speech and image recognition, translation between languages, and decision-making. But there are degrees of sophistication in such systems, and they can be under more or less computerized control depending on what humans can currently ask computers to do within polynomial time. We don't currently trust AI enough to let it be fully autonomous; even planes with autopilot always carry trained human aviators. But some smart systems that have varying degrees of intelligence and automation operate in real time—Google's self-driving car, for



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example. Weighted decision-making is a technique that lets software inch closer to human-level situational awareness, even in silico. A system doesn't have to be HAL to be AI. (Given how that worked out, it probably shouldn't be).

STATE OF THE ART

The health applications of software AI seem to stem mainly from its ability to remember and relate things, but they also come from its ability to personalize medicine, work fluently in natural language, and handle big data. Humans use context to determine the meaning of otherwise ambiguous words or events, and with natural language processing, so can AI. And these systems are in use today. A couple of worthwhile examples are the partnership between IBM's Watson and Sloan-Kettering, and a medical AI called Praxis.



We currently don't trust AI enough to let it be totally autonomous; even planes with autopilot always carry trained human aviators.

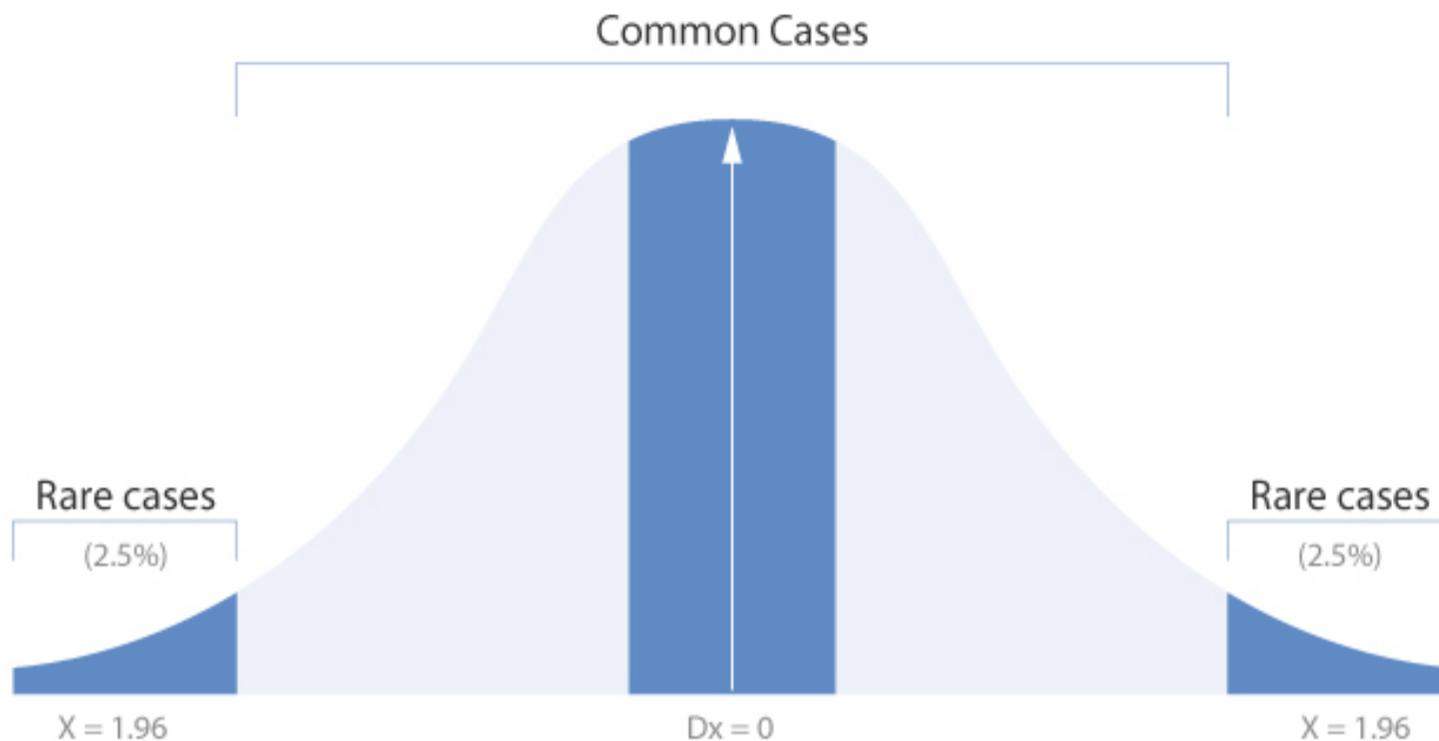


COME, DR. WATSON, THE GAME IS AFOOT!

In addition to competing on *Jeopardy!*, IBM's Watson is joining the medical field: It's "pioneering a new partnership between humanity and technology with the goal of transforming global health, according to IBM.

Watson has been in the news because of its recent performances on *Jeopardy!* and playing chess. It's well versed in game theory, but it's also capable of learning and analyzing new information, and now Watson is applying its talents as a diagnostician. Watson is

Types of cases



working with a group called Wellpoint, and Wellpoint's Samuel Nessbaum has said that in tests, Watson got a 90-percent-correct diagnosis rate for lung cancer, while doctors only got 50 percent. IBM, Sloan-Kettering, and Wellpoint are trying to train Watson as a cloud-based diagnostic aid that would be available to any doctor or hospital willing to pay.

But Watson, even with its formidable talents, wasn't built for medicine. To see medical AI in the field, look to Praxis, medical-records-handling software that's built around concept-processing AI. Its learning model records a doctor's vocal or typed input, then classifies it into a net of semantic nodes based on how closely the words or phrases are related to concepts the program has already seen. Praxis remembers those relationships, too, so the more it's used, the smarter and faster it becomes.

By the way, if you've ever wondered whether there's a way to fit patient care to risk-factor relationships found in the genome, there may be; the basic premise is sound. Genetically personalized medicine can already account for single-nucleotide mutations that impair a drug's function, as demonstrated in the design of

REFLECTING HUMAN THOUGHT PROCESS

This chart represents the learning model that medical-records-handling software Praxis uses to build its semantic webs via concept processing.

different drugs for different stages in the progression of CML, a form of leukemia. The Geisinger hospital system in Pennsylvania, which treats about 3 million people, is participating with a company called Regeneron in a huge longitudinal genomics study that will work with anonymized data on patient exomes from DNA samples they've volunteered. They intend to use the unaltered data to tailor health care to the patients in the study. As pioneers in the field, no doubt they'll experience problems and setbacks, but the example Geisinger sets will be an important proof of concept.

THE INTEGRATED, EVOLVING AI

The important thing about force multipliers, ultimately, is that they reduce the amount of energy you have to spend to get a job done. This is where AI can really excel: offloading work from brains to silicon.

Programmers have come a long way toward creating logically consistent software compatible with external control. What we need now is more independent, reliable, computerized control systems that can fluently integrate environmental input, human direction, and its own software controls. The state of the art in AI is already pretty sexy, all things considered, but I want to prognosticate a little about how we could develop AI from here.

Imagine putting an AI to work on the Geisinger/Regeneron database. The system just begs for a control AI. Leaving lab techs to scour DNA sequences manually is just cruel and unusual, even if they somehow speak Python. The database control AI would store the actual DNA sequences, of course, but it could also track the statistics of which DNA sequences tend to lead to which diseases, and even correlate that against living situations, environmental exposure, and known disease clusters. It could produce visualizations of the data for the scientists and doctors who queried the database. Such a system would be a solid step toward an



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autonomous medical records management AI that would offload a huge amount of work from humans, freeing up desperately needed man-hours in the medical establishment.

Imagine that the Praxis software mentioned above made friends with the controller AI that administered the Geisinger/Regeneron genetics database. It could listen to a patient's narrative, append it to the patient's chart, and suggest diagnoses to support a physician. The AI could then use the data to track geographical clusters of medical problems, or diagnose and study syndromes with behavioral symptoms. Such software could be profoundly empowering to women and minorities; it provides a confidential avenue for diagnosis that's free of any medical paternalism, and independent of any one doctor's biases. Further, it could parse out descriptions of symptoms, cross-correlate them with a patient's genome and medical record, and compare that to the hospital database in order to report on any relationships it finds.

When it comes to hardware AI, there are a few ways this can go. Some systems seem beautifully tailored toward integrating AI. While I'm not a big fan of the Internet of Things, there's a huge amount of untapped potential in terms of how your things can serve your health. Imagine a cross between Jarvis and BayMax. Suppose your grandma's smart house was aware of her particular health issues—for example, that she's at risk of having a stroke, which puts her at risk for a fall. A FitBit-style bracelet with an accelerometer and a six-axis gyro could collaborate with her house's motion-detection system to deploy her personal healthcare assistant and alert emergency services, if it suspected she had fallen. But it could also closely monitor her heart rate and skin conductance and append that timestamped data to her medical record. She could choose to allow her primary care doctor to release the anonymized data to a study designed to develop faster, more accurate diagnoses.



AI IN MEDICAL HARDWARE

Wearable devices can already monitor health indicators such as heart rate and skin conductance; these devices could collaborate with other smart systems to keep us healthier.

Medical imaging is another place where hardware and software can work together with medical professionals to make a system greater than the sum of its parts. We're already working on combining better math with modern medical imaging to get finer and more accurate interpretations of the images we get from an MRI. The longitudinal collection of personal environmental data, combined with a system that combined patient outcomes with a series of medical images taken over time, could yield finer diagnostic accuracy and contribute to early detection.

But imagine you could integrate all of these notions: software controls, useful hardware, and imaging. It could supplement a pared-down hospital infrastructure that's able to cater to patients who need more intensive care than a well-stocked home diagnostics bot could provide. At this level, the line between hardware and software and between product and producer begins to blur. I think that's where we're heading: toward a mostly public, much less formal, less appointment-based model of personally tailored health care, focused on prevention and administered by AI.

FOOLS RUSH IN

What about the privacy and security implications of systems like these? The power held by an advanced AI with context-sensitive intelligence and access to your biometrics and genome just boggles the mind. Far beyond the purview of HIPAA compliance or iPhone fingerprint readers, what happens when someone steals your identity via your retinal scan? Such technology would create a whole new avenue for crime. Perfect transparency may be the only way not to spiral out of control into a Black Mirror dystopia, where genetically targeted "approved content" is beamed straight to your optic nerve by the corporate state. Who controls the data?



Sufficiently advanced AI could call any number of its memories into context, weight them impartially, and do so in massive parallel. This could afford superhuman judgement and reaction times. It could also allow detection of relationships too far separated in context to catch a human's attention. But an AI advanced enough to do these things could still become hidebound in the tyranny of algorithms, and the larger the system, the more points of vulnerability there are. What happens to the patients if a critical care AI is hacked, corrupted, or just wrong? What do we do if the AI we put in control is quite positive it's smarter than we are? What if it's right? How much control do we want to give away?

As AI research expands and refines our understanding of intelligence and machine learning, we'll see more and more applications cropping up. Some of the branches of AI will be useful to the military-industrial complex, no doubt. Because the stakes of integrating artificial intelligence and decision-making capabilities into medicine are so high, the systems we develop will need to be both robust and accurate. This isn't a revolution that'll happen in a year or two.

Long-term, however, the integration of AI into various facets of medicine could produce a revolution not seen since the discovery of antibiotics or the discovery of germ theory. The ability to tap the sum total of human knowledge in a particular field and then to apply that to an individual's specific genome or particular situation could yield dramatically better outcomes than those we see today.

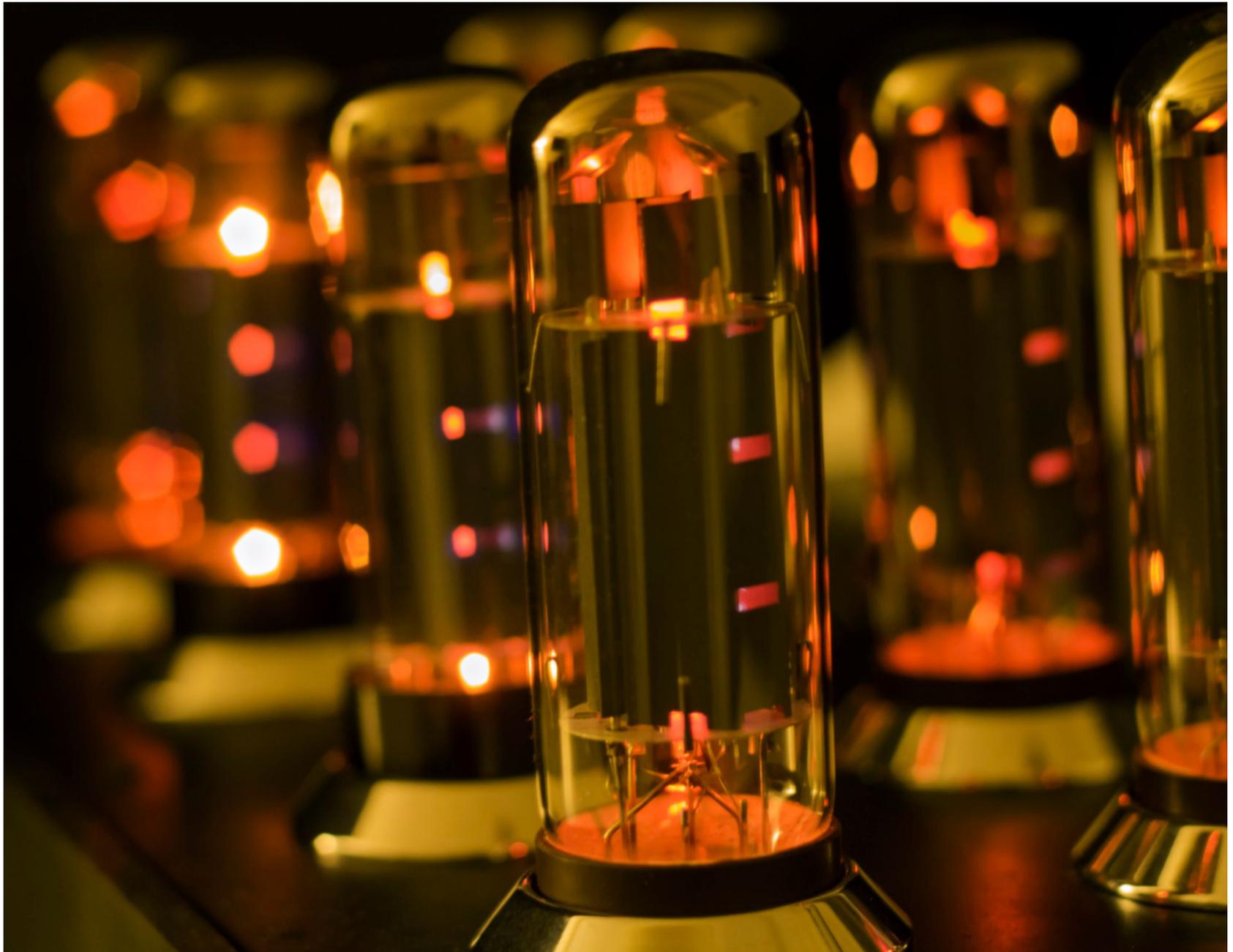


What do we do if the AI we put in control is quite positive it's smarter than we are? What if it's right? How much control do we want to give away?



Could Modern Nanoscale Vacuum Tubes Replace Transistors?

BY JOEL HRUSKA



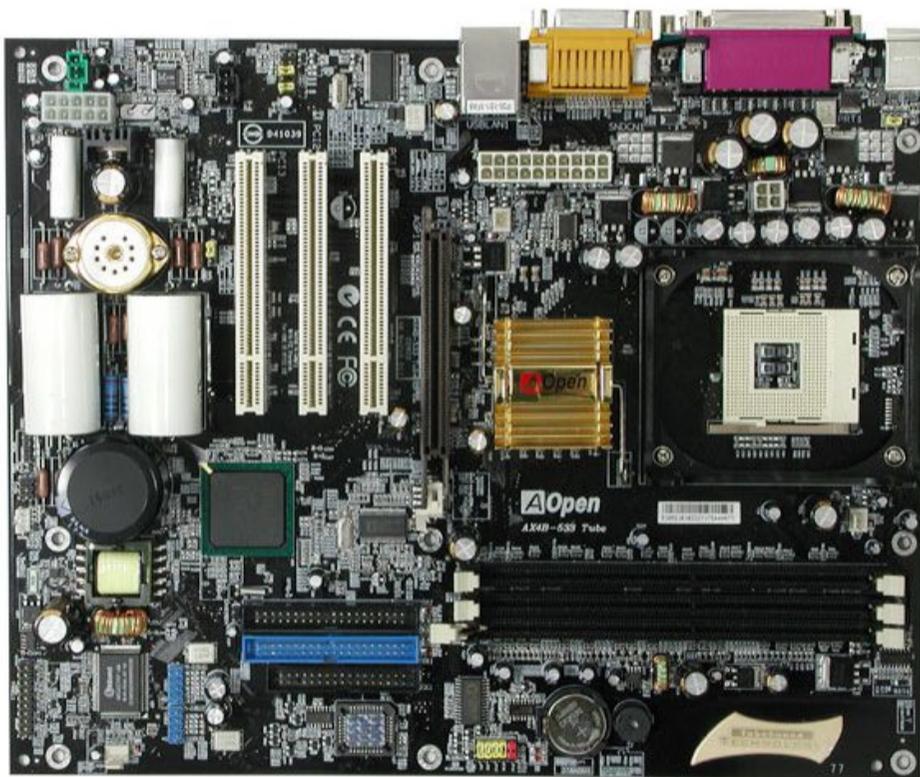
A recurring topic of conversation in technology is the difficulty of continuing to scale semiconductor technology; add to that the related problem of improving chip performance without having to increase clock speed. While Intel and other manufacturers continue to search for long-term solutions, no known next-generation technology is expected to restart silicon scaling and allow for a return to traditional clock-speed gains.

TUBULAR

Nanoscale vacuum tubes are about 1,000 times smaller than a human blood cell—6 to 8 nanometers.

Researchers at the California Institute of Technology think they may have a solution to this problem—one that involves returning to a very old technology. Vacuum tubes, according to Dr. Axel Scherer, could be the key to improving transistor performance and lowering power consumption.

Chances are, when you think “vacuum tubes,” you think of old radios or possibly Aopen’s AX4B-533 “tube amp” motherboard. The systems that Dr. Scherer and his research team are working on are nothing like classic vacuum tubes, though. According to the team, the structures are roughly 1,000 times smaller than a human blood cell, which would make them 6nm to 8nm. One problem with modern CPUs is that they suffer from significant amounts of electricity leakage: Scherer’s designs would use leakage current to flip states on purpose, thereby improving efficiency and overall performance.



One reason for this research is that Scherer thinks the microprocessor teams scaling below 10nm will encounter problems. The properties of silicon apparently change at that point, becoming both elastic and emitting light. “It’s a different material, and it gives you this different behavior,” as Scherer told *The New York Times*.



Being is funding Dr. Scherer’s research because of its potential applications in space and aviation tech.



EVERYTHING OLD IS NEW AGAIN
Microscopic vacuum tubes could be the answer to the problem of how we continue to scale semiconductor technology.

Dr. Scherer isn't trying to reinvent the transistor or replace the silicon economy. Boeing is funding his research because of its potential applications in space and aviation technologies, and silicon will obviously be the gold standard for everyone for years to come. But it's interesting to consider the question: Could such a fundamentally different technology, shrunk to a microscopic scale, solve the problems of transistor scaling and performance?

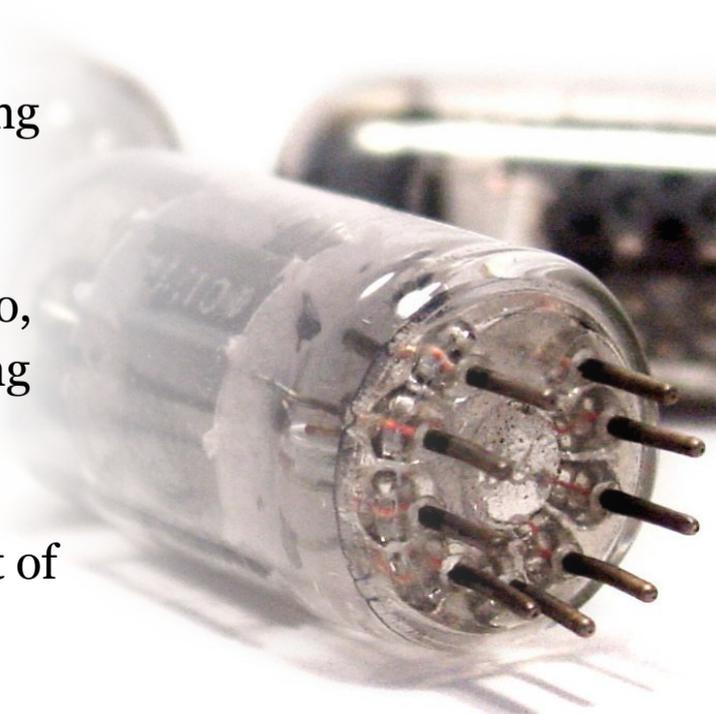
Maybe—but there are a lot of problems to solve between here and there. First, there's the question of manufacturing: Can we crank out tens of thousands of vacuum-based processors in a month? What does it cost to build these solutions, to switch out manufacturing hardware and build an ecosystem around them? Can they be built quickly enough to maintain current production rates, and how will they integrate into existing product lines?

These questions might seem boring compared with the technology's promise, but the boring questions are what ultimately determine whether tech comes to market. When we talk about Intel not being able to build faster CPUs, it doesn't mean silicon is the fastest semiconductor ever. It means that Intel can't find a method of building faster chips that's cost-effective, scalable, and likely to last multiple product generations.

Miniature vacuum tubes could evolve into a major driver of PC performance, particularly if they can be manufactured at scale, but the cost and manufacturing challenges are a huge roadblock to any different technology establishing itself as a silicon competitor. Neither carbon nanotubes nor graphene have done so, despite huge initial hype. There's something satisfying in the idea that a century-old technology could be adapted and improved to the point that it boosts modern computing, but it's going to take an awful lot of expensive work to prove it can do so.

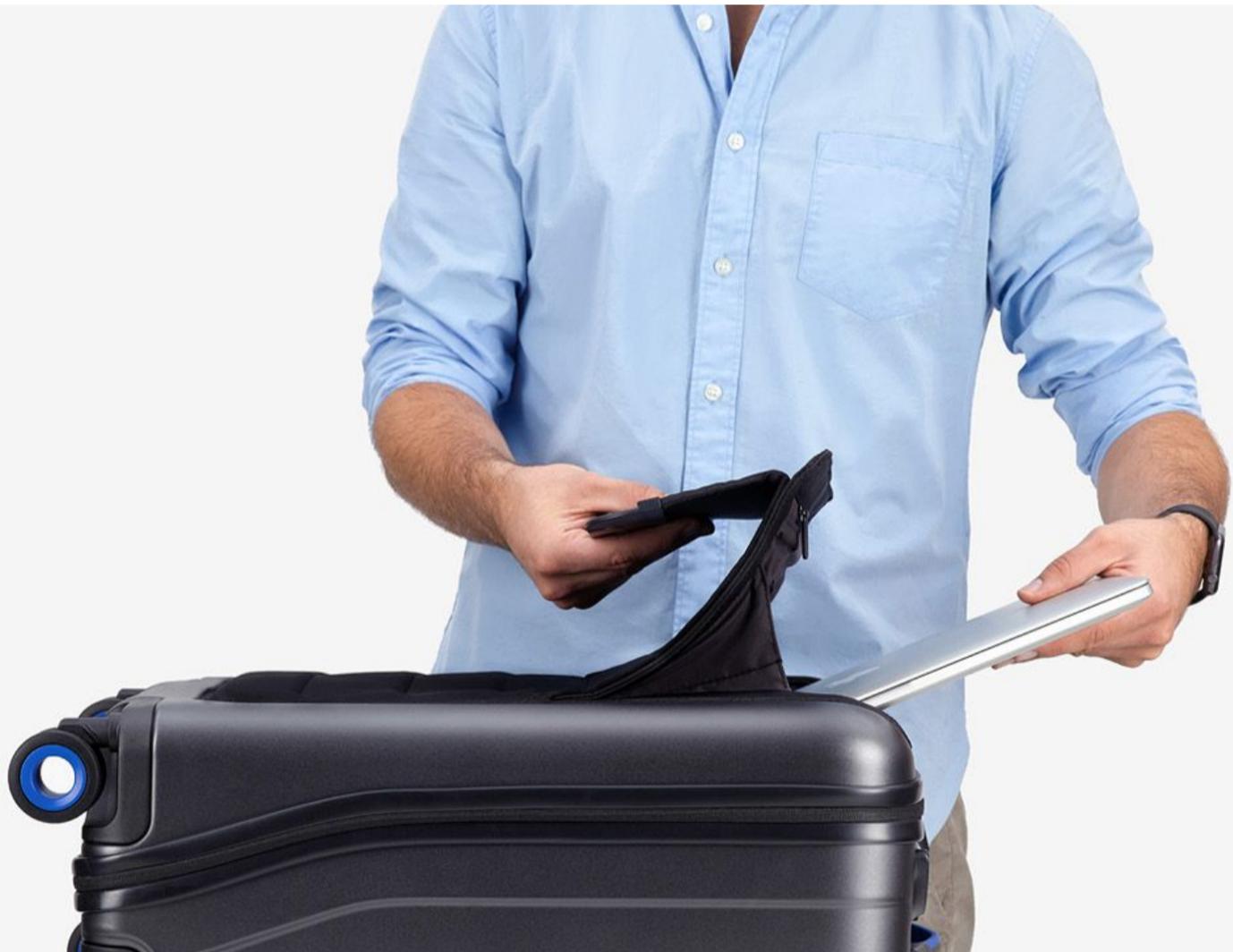


What does it cost to build these solutions, to switch out hardware and build an ecosystem around them?



What We Love Most This Month

BY STEPHANIE MLOT



BLUESMART SMART SUITCASE

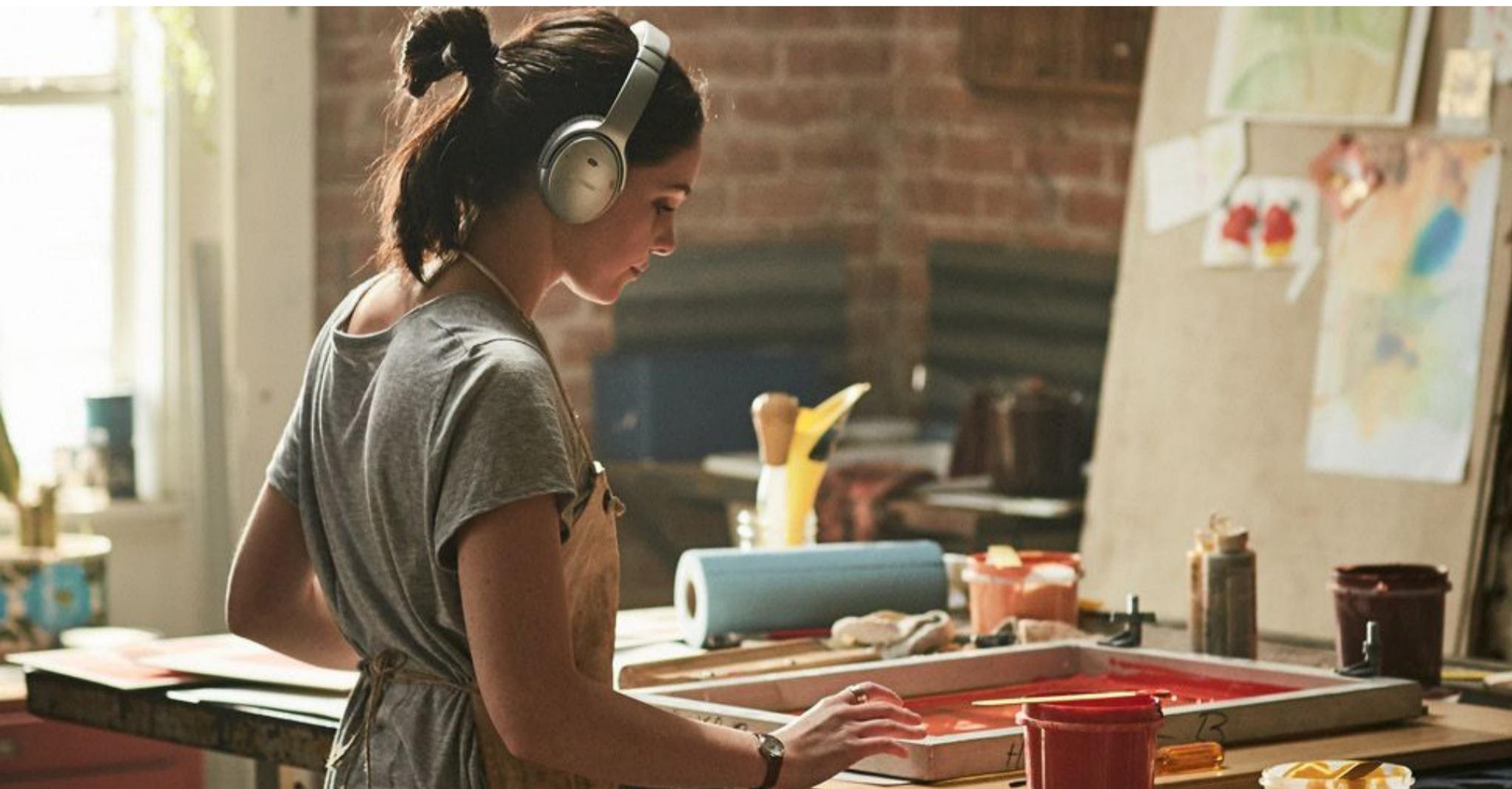
School's out, vacation days are in, and the great outdoors is calling your name. But before leaving for a sunny family getaway, consider upgrading that rickety old suitcase, the one with the missing zipper, ripped edges, and broken handle. Modernize your gear with the Bluesmart One: a smart carry-on masquerading as a plain-Jane piece of luggage. Featuring a location tracker, digital scale, battery charger, and remote lock, the bag syncs with your iOS or Android device for seamlessly connected travel.

\$449.00 bluesmart.com



What We Love Most This Month

BY STEPHANIE MLOT



BOSE QUIETCOMFORT 35 WIRELESS HEADPHONES

Ladies and gentlemen, the captain has turned on the Fasten Seatbelt sign. Please make sure your seat-back and folding trays are in their full upright positions. And that your Bose QuietComfort 35 wireless headphones are cradling your ears. Available in black or silver, these wire-free headphones deliver significant noise reduction—even while that baby cries her way through the flight. The free Connect app works with Apple and Android devices.

\$349 [bose.com](https://www.bose.com)



What We Love Most This Month

BY STEPHANIE MLOT



PHOTOJOJO IRIS LENS

Step up your Instagram game with the Photojojo Iris Lens set for iPhone 6, 6 Plus, 6s, and 6s Plus. Usable with or without a case, the monocle-like interchangeable lenses strap onto your handset, creating fisheye, wide-angle, and macro images with the same 8- or 12-megapixel camera you already use to snap cat portraits and brunch photos.

\$69.99 photojojo.com



What We Love Most This Month

BY STEPHANIE MLOT



MOKO SELFIE STICK

OK, who has the longest arms? The selfie-stick craze doesn't seem to be ending any time soon. So if you can't beat 'em, why not join 'em? As a bonus, the Moko "self-portrait monopod" can double as a wireless, extendable, Bluetooth-enabled tripod. And what better way to stand out in a crowd of selfie-taking narcissists than with the gold hue of this rechargeable stick? The Moko is designed to hold most iOS and Android smartphones, including various iPhone, Galaxy S, HTC One, Sony Xperia, Google Nexus, and LG G models.

[\\$24.99 to \\$29.99](#) mokodirect.com



What We Love Most This Month

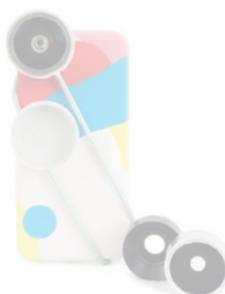
BY STEPHANIE MLOT



OLYMPUS TOUGH TG-TRACKER

Whether you're sunbathing by the waves, gathering Disney character autographs, or pitching a tent for the summer, don't forget the pocket-sized TG-Tracker video camera. Packed with an LED headlight, a tilt-out monitor, and built-in GPS and Wi-Fi, the handheld camcorder is ready for adventure. Drop it, freeze it, submerge it, or crush it, and it will keep shooting Ultra HD 4K video. It'll probably even fit on your Moko selfie stick, for those hard-to-reach shots.

\$349.99 getolympus.com



Opinions

EVAN DASHEVSKY

MATTHEW MURRAY

TIM BAJARIN

You can be
assured that
machines will
one day search
all that audio
for marketing
data points.

EVAN DASHEVSKY

“WITH VOICE, OFFLINE NO
LONGER EXISTS”

With Voice, Offline No Longer Exists

Data is the lifeblood of the modern Internet. And all those “free” tech-enabled magical abilities we take for granted (the ability to Facebook-stalk your family and co-workers, Google the universe, or buy anything with a few clicks) aren’t actually free, of course. We’ve rented out our eyeballs in exchange for cool future toys.

By quantifying our behavior, companies can deliver surgical marketing strikes to potential customers. And the platforms that package this behavior are making a killing selling it to advertisers (Apple is an outlier: It sells a closed ecosystem rather than your data).

Taking this data-thirsty business paradigm into consideration, what are we to make of Big Tech’s push into the always-listening digital assistant space? Devices like the Amazon Echo and the recently announced Google Home allow users to scour the Web, make purchases, and control other connected devices just by speaking. These devices are activated into service by specific voice prompts. And for those interactions to work, the microphone must always be turned on.

Hands-free UIs have been around in some form for a number of years—think phone-based tech like Siri, Google voice search, and Cortana. Facebook has even experimented with a feature that can use your device’s microphone to identify what music or TV shows you’re listening to. But



Evan Dashevsky, a features editor for *PC Magazine*, has been writing about tech since 2010 for such publications as *PC World*, *TechHive*, *ExtremeTech*, and *Digital Times*.

we're beginning a whole new chapter with these always-listening appliances. These devices are all part of a compromise. We allow Silicon Valley to listen to our living rooms (and other previously offline oases) in exchange for letting us feel like we're commanding the Enterprise.

True, consumers are getting some very useful and cool tech out of it. For example, I'm an avid user of the "OK Google" voice search on my phone. It's far superior to tapping in a search query on a touch screen. But there is one freaky aspect: Google keeps these voice searches (and their machine-guided transcripts) on its servers. And they'll likely stay there forever, unless I decide to remove them.

To peruse your past searches, go to google.com/history, click the hamburger in the top-left corner, and select "Voice & Audio Activity." Here you'll find data about every time you've used the function. In my case, it went back years.

Listening to my vast library of recordings, it wouldn't be difficult to piece together key elements of my life. In one search, the sound of a TV clearly revealed the show my kid was watching. And the voices of my wife and son were captured in the background. That's unsettling. In effect, I willingly volunteered to bug my own house and place my family under surveillance.

Google's lawyer language states that one of the reasons these recordings are stored is that "your voice & audio activity items help Google understand what you say when using features like voice search." And to be sure, the company's machine-learning technologies have used these recordings to improve speech understanding over time. This is no simple task and helps me use the technology. (Note also that Google lets you delete particular recordings from their servers—or you

can choose to not use the feature.)

But if it's not happening already, you can be assured that machines will one day search all that audio for marketing data points. This isn't some way-out future tech: It's called "audio content analysis," and it's a huge new field of research. Even if companies aren't yet scraping audio recorded in our homes, they are free to pivot their business models at any time. And let us not forget about hackers and other malevolent players. But at this point, there's probably no turning back. Once the engine of technological progress turns on, it doesn't turn off.

The good news is that when tech companies compete, the public gets to enjoy a tsunami of #FutureCool—think of how mobile phones evolved from the Motorola RAZR V3 to the Apple 6 Plus in just a decade, while the less lucrative microwave market features 2016 models that are largely indistinguishable from those sold in 2006. The bad news is the privacy tradeoff that many people aren't even cognizant of.

I love technology, and I genuinely believe that its evolution ends up being a plus for humanity. But don't lose our awareness of the fact that technology is literally becoming unavoidable. In the 1990s, the Internet had access to us only when we rode our screeching modems online. In the mobile age, the Internet (via ever-strengthening data networks) travels with us throughout the day, but there are still times when we put the phone down or turn the Fitbit off. Soon enough, this will no longer be the case—the very concept of "going offline" will be rendered obsolete.

evan_dashevsky@pcmag.com



Even if companies aren't yet scraping audio recorded in our homes, they are free to pivot their business models at any time.



Stepping Away From Antisocial Media

This year has been momentous in the lives of my Facebook friends. Four got engaged. One had a baby. Two who are married and have been trying to get pregnant for the better part of 10 years announced that they were finally expecting. And I didn't find out about any of this when it happened.

Why? Because I relied on Facebook for following their lives.

As a reminder, your Facebook News Feed is not actually live. It displays just the “Top Stories” Facebook wants you to see, as determined by Facebook's algorithms on Facebook's servers. (Not that this explains why the above posts didn't appear, since they all had dozens and in some cases hundreds of reactions and comments.) Even if you change your News Feed setting to display the “Most Recent” stories, Facebook displays only the stories it chooses for you, as they come in—you still won't see everything. And, of course, this setting doesn't stick; I've had to change it multiple times a day, every day.

If I'm not learning too little about my friends, I'm learning too much. The endless Hillary Clinton–Bernie Sanders wars were bad enough; now it's all Hillary Clinton versus Donald Trump, which, because I support neither, is the digital equivalent of a root canal. My friends across the pond ensured that I heard every single facet of every single side of their opinions about the



Matthew Murray, managing editor for hardware at *PC Magazine*, has also edited its software and consumer electronics content, and been an editor at *Computer Shopper*.

referendum for the United Kingdom to leave the European Union. And most of the rest of my feed is filled with one-dimensional, content-free memes designed to make you think they're saying something, when in fact they say nothing.

There are ways to gain more control over what you see, sure. Put someone in your Close Friends list to display all their activity—which isn't that much help, if your friends are as into games and quizzes as some of mine are. You can see all of a friend's posts by visiting his or her individual page, though when you have as many friends as I do (nearly 600), that's not practical. Or you can spread your Facebook reading around multiple devices. For whatever reason, the posts that are fed to your PC are not always the same as those sent to mobile devices. (It was only because I happened to look at the app on my iPad that I discovered the major events in my friends' lives that Facebook hadn't deigned to show me on my desktop.) If there are things you don't want to see, you can suppress content from certain external sources, or block or defriend people.

Or you could escape to Twitter. But it has plenty of its own problems. Its rigorous one-click nature means the political climate is even more charged there, with endless retweets of the same quotes, articles, and polls, with no room to add any commentary or personality. Too many other people see the platform as ideal only for jokes, or for reporting their video game progress, or, worst of all, cross-posting with Facebook or Instagram. I've written before about Twitter's reputation for stamping out views it doesn't like; though many of these allegations have yet to be conclusively proven, the accusations haven't gone away. At least Twitter lets you turn off its toxic curation system, though considering how hard it pushes

its useless Moments and “While You Were Away” features, it doesn’t feel that much better.

That’s why I’ve decided to take a more drastic step that I hope will make me feel better: I’m leaving it all behind.

Except for my work Twitter feed, which I have to maintain in at least a minimal way, I’m going to step back from all social media for the foreseeable future to try to regain some sense of perspective about how I approach my friends and how they approach me. Because other companies have proven incapable of doing it for me.

To be clear, Facebook and Twitter are private companies that offer their wares for an advertisement-supported version of free, so they have every right to do what they want. But by promoting themselves as bastions of communication and free speech, and then squelching those very principles so frequently, they’re increasingly proving that they’re not worthy of my eyeballs. So I’d much rather spend my time—and send my “content”—elsewhere.

For better or worse, I’m becoming part of a trend. The Information recently reported that sharing of personal content on Facebook had dropped 21 percent year over year by mid 2015. As for Twitter: In late April, the *New York Times* reported a user base of only 310 million, up just 5 million from the end of 2015, and its revenues for the first quarter of the year were well below industry estimates. Maybe neither service is hurting (Facebook has nearly two billion users, after all), but things aren’t rosy, either—maybe people just don’t love how dictatorial the services have become about controlling what we view.

Whatever the reason, I’m done. Just know that this isn’t a decision I’ve made lightly. I’m completely aware that there are many events I



I’m going to step back from all social media for the foreseeable future to try to regain some sense of perspective about how I approach my friends and how they approach me.



will miss, and some people I may fall away from, because lots of people rely on Facebook and Twitter for everything from birth and marriage announcements to party invitations and (sigh) political discussions. But it doesn't matter if my friends trust the services to get the word out and I trust the services to get the word to me if the services don't trust us—and they don't. So lots of important stuff gets lost, people get thrown out of the loop, and we ultimately drift further apart rather than coming closer together.

It's not going to be easy to go back to the way things worked in the pre-Facebook days. If my friends want to know what's going on with me, they can call me, email me, or find me and ask—and I can do the same with them. Then, we won't have to worry about anyone else getting in the way, about anyone else deciding what we're allowed to see, and when. If they want to hear me make stupid puns, they'll have to ask (sorry officemates, you'll still have to endure them), and if they want me to expound on the virtues of the writing of Edward Kleban, I no longer plan to do so unbidden.

How long will I last? I don't know. If it becomes unbearable, if I miss out on enough of what's making my friends' lives special, I may have to go back. But it's because my friends are so important that I'm taking the risk. I want to be a part of their lives, not apart *from* their lives. The pain I'll feel staying away from social media remains to be seen, but I doubt it will compare with the pain of not being there for my friends when they needed me most—pain that Facebook and Twitter didn't salve, but instead created, all on their own.

matthew_murray@pcmag.com



It doesn't matter if my friends trust the services to get the word out and I trust the services to get the word to me if the services don't trust us—and they don't.



Supercomputers Will Power Autonomous Cars

At Nvidia's developer conference, I talked to many people about the company and its partners' autonomous-vehicle plans. Nvidia CEO Jen-Hsun Huang used his keynote to introduce an updated version of Nvidia's Drive PX system for self-driving vehicles, basically a supercomputer that sits in the trunk of a car. Its HD mapping tools can sense, plan, and react to all types of road and driving conditions.

The operative word here is "supercomputer." Over the last 10 years, Nvidia has created some of the world's fastest processors around its GPU architecture. It recently announced a breakthrough product it calls the world's first supercomputing system dedicated to deep learning: the DGX-1. This system stacks up to eight Tesla P100 processors on top of one another and delivers 170 teraflops in a box, 2 petaflops in a rack, at a breakthrough price of \$129,000. This architecture was a huge announcement at the conference, and its work is now trickling down to autonomous vehicles, too.

This became clear when Gill Pratt, CEO of the Toyota Research Institute, emphasized its partnership with Nvidia and the role a supercomputer-like system in a car will play in future autonomous-vehicle plans. Pratt pointed out that the number-one reason Toyota made a



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

commitment to self-driving cars is because “the fact that we tolerate 1.2 million people killed per year is astounding, and it’s a shame. It far exceeds the number of people killed in war.”

Pratt’s keynote gave us a sense that Toyota will play a key leadership role in the development of safe self-driving cars. In fact, Pratt went on to say that the research Toyota is doing is so important to public safety that the company is opening up much of its research to its competitors—something he calls “co-opetition.”

I see Nvidia playing a major role in this area, too. I spent some time with Danny Shapiro, Nvidia’s smart-vehicle-program guru, and he showed me the Drive PX 2 motherboard. The system is based on the kind of neural networks that will be necessary to process key decisions for just about every type of driving situation imaginable. I realize that most of the big semiconductor companies have chips for use in autonomous vehicles, but as I walked away from the Drive PX 2 demo, I thought to myself that if were in a self-driving car, I would want a high-powered supercomputer piloting it.

I suspect that is the thinking behind many of Nvidia’s automobile customers. The work that Nvidia is doing, coupled with the new Drive PX 2 system, makes it one of the most important semiconductor companies tackling the problems and challenges in delivering an autonomous vehicle. And from what I saw at the event, it may take supercomputing-level processors to deliver ultra-safe autonomous vehicles.

Reviews

CONSUMER ELECTRONICS

Nikon D500

Misfit Ray

TCL Xess

Samsung Galaxy S7 Active

HARDWARE

Razer Blade

Intel Core i7-6950X Extreme Edition

Tenda F3 N300 Wireless Router

Dell OptiPlex 24 7000 Series All-In-One (7400)

SOFTWARE & APPS

CyberLink PowerDVD 16 Ultra

Hopper (for Android)



A Modern Pro APS-C Nikon Camera Is Here at Last



The D500 is the replacement for the ancient D300S, and the D500 ups the ante considerably. The highlight of the 20.9-megapixel SLR is an autofocus system that covers the sensor horizontally from edge to edge and is able to track moving action while firing off images at 10 frames per second. Add such features as 4K video capture and a tilting touch-screen LCD, and you've got a camera that will make photographers invested in the Nikon system quite happy. The D500 is a top-end performer in almost every regard, replacing the Canon EOS 7D Mark II as our Editors' Choice.

Nikon D500

\$1,995.95, body only



DESIGN

The D500 is a hefty SLR. It measures 4.5 by 5.8 by 3.2 inches (HWD) and weighs 1.9 pounds without a lens. It's a bit larger and heavier than the model below it in Nikon's line, the D7200, but it lacks the integrated vertical shooting grip and huge battery that make the D5 and D4S intimidating beasts for some photographers to handle. Like the D4S and D5, the D500 doesn't include an in-body flash.

The D500's rear display is a 3.2-inch LCD with a 2,359k-dot resolution. It's one of the sharpest you'll find on an SLR—its closest competitor, the Canon EOS 7D Mark II, uses a fixed 3-inch LCD with a 1,040k-dot resolution. The D500's versatility is expanded thanks to a tilting, touch-screen design. Instead of a traditional mode dial, the D500 features a single mode button: Hold it down and turn the rear dial to change among Program, Aperture, Shutter, and Manual shooting modes. The White Balance, Quality, and Metering buttons that sit next to the Mode button to the left of the hot shoe operate in the same manner. All four of these buttons are backlit.

Nikon D500

PROS Solid build. Advanced, edge-to-edge autofocus system. 10fps capture with tracking focus. Large buffer for extended shooting. Superb high ISO image quality. Clean HDMI output. Excellent control layout.

CONS Snapbridge wireless transfer needs some work. 4K video is cropped. Omits built-in flash.

PRO-GRADE CONTROLS

They include dual dials, a joystick dedicated to the autofocus system, and a dial to change the drive mode.



On the front of the camera, the Pv button activates an optical depth-of-field preview—it stops the lens down to the aperture you have set for a shot to show you what’s going to be in focus and what’s not. It’s one of the many controls that can be reassigned via the menu.

CONNECTIVITY

The D500 has all the connections that you expect from a pro camera, including a PC sync socket for studio lighting, a dedicated remote port, a micro USB 3.0 port, headphone and microphone jacks, and a mini HDMI connector that outputs clean, uncompressed 8-bit 4:2:2 video. There are dual memory card slots—one for high-speed XQD media and a secondary slot for use with SD, SDHC, and SDXC memory cards.



The D500 is the first Nikon camera to utilize its new wireless transmission protocol, SnapBridge. It’s so new, in fact, that at the time I wrote this, you could take advantage of the system only with an Android handset. Nikon is expecting the iOS version to be available for download this summer.

“Such features as autofocus, 4K video capture, and a tilting touch screen will make Nikon photographers quite happy.”

BODY IMAGE

We reviewed the D500 as a camera body only, but it’s also available in a kit with a 16-80mm f/2.8-4 zoom lens.

The D500 uses both Bluetooth and Wi-Fi for communication and also supports NFC for initial setup. It's an interesting approach that, at least on the Android platform, makes image transfer between camera and phone an automatic operation, but it's not without caveats.

SnapBridge takes seconds to get up and running, and if you opt for automatic transfer of all your photos it does so with transparency, as long as you remember to launch the app while you're shooting. Additionally, you can set the app to add GPS data to photos as you shoot them—it can embed the metadata right onto the images on the D500's memory card. But this feature was inconsistent among handsets in testing.

Wi-Fi comes into play when you want to use your phone as a remote control. The remote is very basic: Select a focus point by tapping on the live feed shown on your handset's display, and fire the shutter. That's it. Nikon would be wise to upgrade this to allow full manual control via the app, as with similar apps.

PERFORMANCE AND AUTOFOCUS

The D500 is all about speed. It starts, focuses, and fires in about 0.35-second and can rattle off images at up to 10fps. Its hit rate is excellent when shooting a moving target in AF-C mode, even at top speed. That pace can be kept up for about 40 Raw+JPG, 200 Raw or 200 JPG shots when you're using a Lexar 440MBps memory card. Recovery time to clear the buffer after one of those bursts is pretty quick as well—4 seconds for Raw+JPG, 3 seconds for Raw, and almost instantly for JPGs.

Switching to SD memory—even the fastest 280MBps SanDisk card—is more limiting. The camera can manage 25 Raw+JPG, 46 Raw, or 200 JPG shots with SD, but it takes longer to clear its buffer.



CARRY THAT WEIGHT

The D500 is a hefty SLR. It measures 4.5 by 5.8 by 3.2 inches (HWD) and weighs 1.9 pounds before you even attach the lens.

The D500's autofocus system is the best you'll find in this class of camera. Its 153 points cover the frame from edge to edge horizontally, although it doesn't have quite the same coverage from top to bottom. Of the 153 points, only 55 are selectable manually, but surrounding points are examined by the focus system when in Single or Group AF mode.

You can also let the camera choose a focus point for you. Unlike most SLRs, the D500 can perform face detection when you're using the optical viewfinder to focus, thanks to its high-resolution metering system. The D500 also does a phenomenal job of following a subject when shooting in AF-C mode with 3D tracking.



IMAGE AND VIDEO QUALITY

I used Imatest to evaluate the D500's image quality across its full ISO range. It can be set to capture JPG or Raw images anywhere from ISO 100 through ISO 51200, with low extended (ISO 50) and high extended (up to ISO 1638400) settings available.

With default noise reduction enabled, the D500 renders JPGs that keep noise under 1.5 percent through ISO 12800. There is some visible smudging of details,



I don't think there's a perfect camera, but the Nikon D500 comes close.



TILTING LCD

The D500's tilting touch-screen LCD is a boon for setting up low-angle shots via Live View.

though. Realistically you can push the D500 to ISO 1600 without any noticeable loss of image fidelity, with just a slight drop in clarity at ISO 3200. Details start to show some blur at ISO 6400 and ISO 12800. At ISO 25600 and ISO 51200, images are noticeably blurred. ISO 102400 is beyond what I'd recommend using when shooting JPGs, and the very top settings are just not useable for most photographic applications.

When you're shooting in Raw format, you don't have to worry about in-camera noise reduction. I examined the Raw output from the D500, converted using Lightroom CC with default develop settings enabled. Detail is strong and noise isn't distracting through ISO 12800.

4K video is becoming fairly common in mirrorless cameras, but it's a feature that's not common to SLRs. At the time we wrote this, the D500 was the least expensive SLR to support 4K video capture. 4K footage is extremely crisp, and the APS-C image sensor gives you control over depth of field. But the footage is cropped by a factor of 1.5x.

CONCLUSIONS

It took Nikon a long time to bring the D500 to market, but it's here, and it's outstanding. Image quality is as good as you'll get from an APS-C camera, the autofocus system is top-notch, it offers 4K video capture, and the body is built like a tank. Add in wireless file transfer, a tilting display, and solid ergonomics, and it's clear that the D500 will tickle the fancy of many photographers.

The D500 is expensive, more so than entry-level full-frame SLRs and competing mirrorless models. It serves a very different purpose than bodies such as the D610 and Canon 6D, however, both of which feature larger sensors but comparatively simplistic autofocus systems. But if your needs exceed mirrorless cameras' current capabilities—or if you prefer an optical viewfinder to an electronic one, or a bulkier body—traditional SLRs remain a solid choice.

I don't think there's a perfect camera, but the D500 comes close. There's some room for improvement in SnapBridge—iOS support is still forthcoming, and the D500's Wi-Fi could be better utilized for more quickly transferring files to a smartphone. But the pluses far outweigh the minuses, and the D500 is an overall stronger performer than the competing Canon 7D Mark II. For those reasons, it earns Editors' Choice honors in the premium APS-C SLR category.

JIM FISHER



A Great-Looking Fitness Tracker That's Accurate, Too

The Misfit Ray (\$99.99) is the most comfortable and stylish fitness tracker I've tested. It makes up for the lack of a display with accurate measurements of your activity and sleep, customizable bands, and useful extras, like the ability to remotely control your phone and smart lighting. The Ray is a top pick for the fashion conscious, though the Fitbit Charge HR still retains an edge for its convenient display and ability to measure heart rate.

Misfit Ray

\$99.99



PRICING, DESIGN, AND FEATURES

The Misfit Ray isn't the first style-minded fitness tracker I've seen this year, although it certainly is the most attractive; the the Fitbit Alta and the Withings Go also make noble attempts. Like the Alta and Go, the Ray is a modular device with a central tracking component. You can switch out bands to match your outfit. The tracker portion is a tiny cylinder made of brushed matte aluminum that measures 1.5 inches long and half an inch around and weighs 0.3-ounce. It comes in black, green, navy, white, stainless steel, or rose gold with a silicone band for \$99.99, or with a leather band for \$119.99. Double-loop leather bands or drop necklaces are also available for \$29.99 apiece. I tested the silicone band model.

The adjustable strap is one of the most comfortable ones I've worn. As with the Withings Go, I frequently forgot I was wearing it. The Ray is also one of the few trackers that's actually comfortable to wear while sleeping. And as mentioned, the bands are swappable, though that requires an included tool: It's not quite as simple as just popping the tracker out of one band and into another as you're running out the door.

The Ray has no display to view your progress, like you'll find on many trackers in this price range. Instead, it has a lone LED that blinks various colors in conjunction with a vibration motor, depending on the situation. When you haven't been moving much, the Ray will blink red and vibrate. When it's time to wake up, it will blink purple and vibrate. And when you're getting a phone call on your connected device, the Ray will blink green and vibrate. Texts are blue. You can double-tap the Ray to view your activity progress: Red is a quarter of the way to your daily goal, orange is half, and purple means you've reached it.

Misfit Ray

PROS Sleek design. Comfortable. Water-resistant. Long battery life. Automatically and accurately tracks activities.

CONS No display. Requires tool to switch bands.



The tracker is powered by three replaceable 393 button cell batteries (included) that last four to six months depending on usage. If you receive a lot of calls and other phone notifications, the Ray will run out of juice quicker. Still, that's a longer life than most fitness trackers, which typically last about a week. The best I've seen in terms of battery life is the Withings Go, which lasts up to eight months.

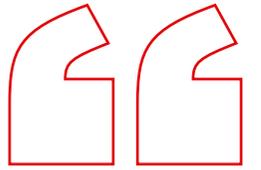
The Ray is rated 5ATM for water resistance, which means it can go up to 164 feet underwater. It's not meant for diving, but you can wear it for laps in the pool and afterwards in the shower.

SETUP, APP, AND PERFORMANCE

The Misfit Ray pairs via Bluetooth 4.0 with Android and iOS devices. I connected it to an Apple iPhone 6 and a Samsung Galaxy S6. Setup was smooth and quick, though I had to update the Android version of the Misfit app so that the Ray would appear on the list of devices I could connect with. Once configured, the Ray automatically pairs with your device whenever it's in range.

The app is the same one used with other Misfit devices, including the Flash Link and Shine. Keep in mind you'll be using it a lot, since the Ray lacks a display. The home screen shows you a score based on your activity goal, which you can set in the Goals page; I stuck with the default suggested setting of 1,000 points. The app does a solid job of suggesting how to accomplish your goal. For example, it told me that I can walk for an hour and a half or run for 30 minutes to meet expectations.

You can also view your calories burned, miles traveled, and steps taken on the home screen. Scroll down and you'll see a more detailed timeline for all the activities you've accomplished during the day, including sleep data and activities, which are tracked automatically.



The adjustable strap is one of the most comfortable ones I've worn. I frequently forgot I was wearing it.



Equipped with a 3-axis accelerometer, the Ray's tracking proved accurate in testing. I wore it on my wrist for about a week alongside the Fitbit Blaze, and they both reported similar results. The Ray records how long you are active, and you can later designate the type of activity you were doing in the app. Unlike the Withings Go, the Ray automatically tracked every jog, run, and walk I did, which I was then later able to identify. Misfit gives you a good assortment of activities to choose from, including basketball, cycling, running, soccer, swimming, tennis, and walking. If your main priority is running, however, you'll want a device that adds GPS and a heart-rate monitor to the mix, such as the TomTom Spark.

In addition to steps and activity, the Misfit Ray tracks sleep extremely well. It analyzes light and deep sleep periods, as well as awake times, and you can see the total amount of time for each type. I wore the Ray for a week and found the data it collected about my sleeping habits to be accurate (at least as far as I can tell in my waking life).

The Ray also works with the Misfit Link app, which lets you trigger various functions by triple-tapping the tracker. For instance, you can use it to find your connected phone (the phone will buzz or ring), control music (Play/Pause, Next, Previous), toggle your phone's



The Misfit Ray records how long you are active, and you can later designate the type of activity you were doing in the app.



COMPATIBILITY FACTOR

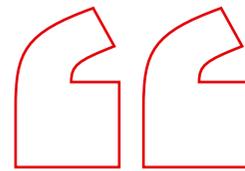
The Misfit Ray can work together with the company's other products, including the Misfit Bolt Connected Smart Bulb.

camera shutter, and even turn the Misfit Bolt Connected Smart Bulb on or off. All of these actions worked perfectly in testing and could become surprisingly useful.

CONCLUSIONS

It's not an overstatement to say that the Misfit Ray is by far the best-looking fitness tracker I've seen. It's also comfortable to wear, and offers accurate tracking capabilities for your steps and sleep. It's one of the only fitness trackers I'd recommend to style aficionados, and if it had a display, I'd be tempted to give it our Editors' Choice award. But looks aren't everything, so that honor remains with the Fitbit Charge HR. It costs more, but it lets you see your progress at a glance on a built-in display, and its heart-rate monitor gives you a better look at your overall health.

TIMOTHY TORRES



The Misfit Ray tracks sleep extremely well. It analyzes light and deep sleep periods, as well as awake times.



**TCL Xess**

\$499.99



TCL Xess: The Future of Tablets Is... the Kitchen?

The TCL Xess stands out in a sea of similar tablets—both because of its size and the fact that it's primarily intended for use in the kitchen. At \$499.99, it's a niche product aimed at cooking enthusiasts who want a large screen for following recipes and streaming videos. The 17.3-inch display is big and bright, a built-in stand keeps the tablet propped up at just the right angle, loud JBL speakers provide sound, and customized Android software provides cooking timers and recipes. But performance is sluggish, the built-in gesture controls are limited, and the tablet isn't waterproof, which could prove disastrous in the kitchen. Overall, the Xess is an interesting concept, but you'll likely get more utility out of an inexpensive tablet with a rugged case and a stand.

DESIGN, DISPLAY, AND FEATURES

The Xess is huge, at 16.4 by 10.5 by 0.3 inches (HWD) and a hefty 6 pounds. It dwarfs other large tablets, such as the 12.9-inch Apple iPad Pro (12.0 by 8.68 by 0.27 inches; 1.59 pounds) and the Microsoft Surface Pro 4 (11.5 by 7.93 by 0.33 inches; 1.73 pounds). Its closest rival is the Samsung Galaxy View, which is actually a bit larger at 17.79 by 10.86 by 0.47 inches and lighter at 5.8 pounds.

The front of the tablet is dominated by a 17.3-inch 1,920-by-1,080-pixel display, which is surrounded by a solid black bezel. That's the same resolution as you'll find on many TVs and monitors, but it's not nearly as

TCL Xess

PROS Big, bright display with good viewing angles. Customized Android software with integrated recipes and multi-panel view. USB and microSD support. Powerful speakers.

CONS Expensive. Sluggish. Limited gesture control functionality. Not waterproof.



sharp as the 2,732-by-2,048 iPad Pro or the 2,736-by-1,824 Surface 4 Pro. In fact, the resolution works out to a sparse 127 pixels per inch. When viewed up close, icons, text, and games look pixelated. If you're watching video from four or more feet away, though, the image is bright and clear without any noticeable pixelation. Viewing angles are good.

THREE KITCHEN TOOLS IN ONE TABLET
The TCL Xess's home screen is divided into three panels, so home chefs can use cooking timers, recipes, and video separately and simultaneously.

A large, circular metal hump protrudes from the slate's glossy-white plastic back, preventing it from being laid flat. The hump is home to several features, including a metal carrying handle that you slide out from the top, a kickstand with a range of 150 degrees, two bottom-firing JBL speakers, a microSD card slot that worked with a 64GB Leef Pro card, a slot to hold the included stylus, and a magnetic charging port for the proprietary adapter.

At the very center of the hump is yet another circle with a TCL logo. When you press it, the circle pops out slightly, giving you access to two USB ports. They worked with a flash drive and a Cooler Master Quick Fire Rapid-i keyboard. They'll also work with an RJ45 dongle, allowing you to connect the tablet to an Ethernet cable.

The bottom of the smaller circle is also home to a 3.5mm audio jack. The placement isn't very convenient for using wired headphones, but the JBL speakers are loud enough to fill a room with ease. They're some of the most powerful tablet speakers we've heard, and not at all tinny, which is a pleasant surprise.

The only elements not located on the hump are a power button and volume rocker. Their placement at the top right of the back panel makes it a bit of a hassle to turn the tablet off or quickly change the volume.

The Xess is a tablet designed for the kitchen, so I was surprised and disappointed that it isn't waterproof. You won't want to touch it with wet fingers while cooking, and you should probably just keep it away from the sink entirely.

In addition to the physical buttons, the Xess supports gesture controls. You can wave your hand to move to the next video or photo, raise two fingers to take a photo, raise a palm to play and pause, and put a finger to your lips to mute. This would be a handy feature for keeping your screen mess-free while cooking, but the controls are available only in the Gallery app, which means you can use it only for photos and videos stored locally on the Xess. Alcatel says it hopes to bring gesture control functions to other parts of the device.

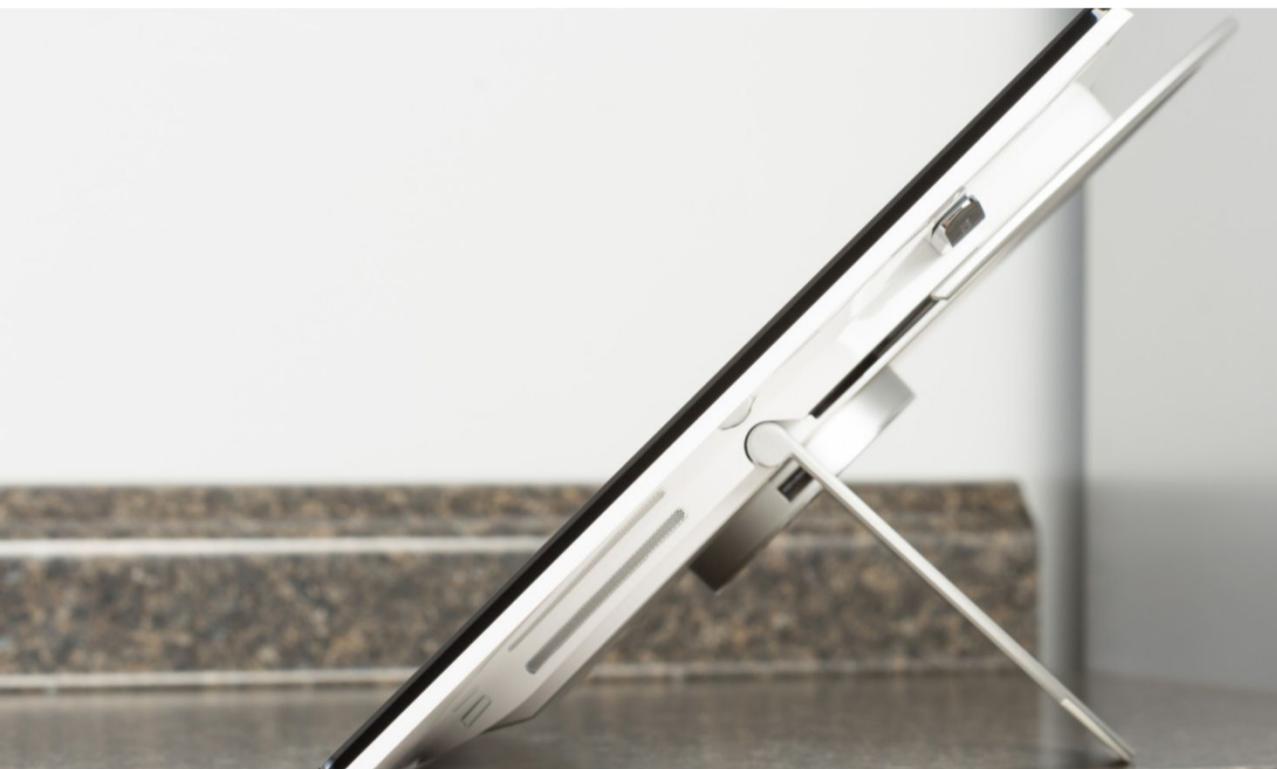
PERFORMANCE AND BATTERY

The Xess supports dual-band Wi-Fi and Bluetooth 4.1. It's powered by a midrange MediaTek MT8783T processor clocked at 1.5GHz. It scored a modest 40,552 on the AnTuTu benchmark, which tests overall system performance. It offers more power than budget tablets such as the Lenovo Tab 2 A8 (20,432), but falls short of even midrange offerings including the Nvidia Shield Tablet K1 (73,626) and can't hold a candle to the blazing-fast iPad Pro.

Despite its 3GB of RAM, the Xess feels sluggish in general usage. The screen suffers from noticeable lag when you're trying to interact with widgets or icons. Switching between apps and Web browsing also results in pronounced wait times. The Xess isn't intended for high-end gaming, but it can handle low-impact titles like Angry Birds.

CAMERA AND ACCESSORIES

The Xess has 5-megapixel front-facing camera that's clear enough for video chatting in a well-lit kitchen, with good voice capture thanks to dual mics. Video is recorded at 1080p at 30fps. Lower-light pictures and video suffer from grain. There's no rear-facing camera, but the Xess comes with an Internet Protocol (IP) camera that connects to your home Wi-Fi network and lets you stream video to the Xess, so you can keep an eye on the kids in another part of the house while you're working in the kitchen.



COOKING WITH XESS

The Xess is designed to sit propped up on a kitchen counter. Surprisingly, though, it's not waterproof, so you probably don't want to place it next to the sink. On the back of the tablet is a circular metal hump; when you press the center, you get access to two USB ports that work with a flash drive and a Cooler Master Quick Fire Rapid-i keyboard. There's also a 3.5mm audio jack for wired headphones.

SOFTWARE AND USABILITY

The Xess comes running the dated Android 5.1 Lollipop, with a heavily customized skin on top. By default, Xess Mode is enabled. It divides the home screen into three distinct panels.

The left panel shows the time, date, and weather, plus a multipurpose pane that can switch between the calendar, the IP camera, cooking timers (a maximum of three), and settings. The middle panel is home to a Kitchen Stories widget, which shows you pictures of various recipes. Clicking on one takes you to a video, along with instructions on how to make the dish. You can save your favorite recipes in the widget, search for new recipes, and keep track of your shopping list.

The right panel is meant for kids. It has a Nickelodeon widget, which streams movies and shows for those with a subscription. You can switch to Noggin (which also requires a subscription), Amazon Shopping, the Gallery app, and YouTube. The apps are all launched in the widget, rather than taking over the entire screen.

The navigation controls have also been modified. An arrow on the bottom left corner brings up all the apps installed on the Xess and lets you scroll through them horizontally. The standard Android navigation buttons are all tightly packed together at the bottom right corner of the screen, next to the mode switcher.

Switching from Xess Mode to Google Mode takes you to an almost-stock Android layout. You'll find apps, an app drawer, a notification shade, and all the other things you'd expect to see on any Android tablet. Android definitely isn't optimized for such a big-screen experience, but I found it a bit more responsive to navigate when installing apps.

The Xess comes with a number of pre-installed apps, most of which can be uninstalled. You're left with 23.38GB of available storage out of a total of 32GB. With the ability to use microSD cards and USB flash drives, you shouldn't have any problem with storage space.

CONCLUSIONS

The TCL Xess is a reasonably capable tablet with a giant screen and lots of bells and whistles. \$500 is a lot of money for what is ultimately a midrange device with sluggish performance, though. If you're looking for something to keep you entertained in the kitchen, the \$200 Nvidia Shield Tablet K1 and an inexpensive tablet stand will give you a lot more bang for your buck—though it has a gaming focus, the K1 is an excellent all-around Android tablet. The Apple iPad Air 2 is pricier but also worth considering for its extensive app and case options. Or you can go the super-inexpensive route with the Amazon Fire, which has a smaller 7-inch screen but is equally capable of displaying recipes and YouTube videos. You'll have plenty of money left over to buy some deluxe ingredients for your next recipe.

BY AJAY KUMAR



Samsung Galaxy S7 Active Is More than an S7 in Rugged Clothing



Exclusive to AT&T, the S7 Active (\$749.99) does indeed have a more durable, shatter-resistant build than its predecessor. It also has a bigger battery and a customizable Active button, which makes it an even better

smartphone for anyone into camping, hiking, or other outdoor adventures. Aside from a bulkier build than the standard S7, the Active has the same beautiful display, sharp camera, and blazing performance that makes the S7 one of the best Android phones available (along with our Editors' Choice, the Galaxy S7 Edge). Fittingly, that makes the S7 Active the best rugged Android phone on the market, and worthy of Editors' Choice honors.

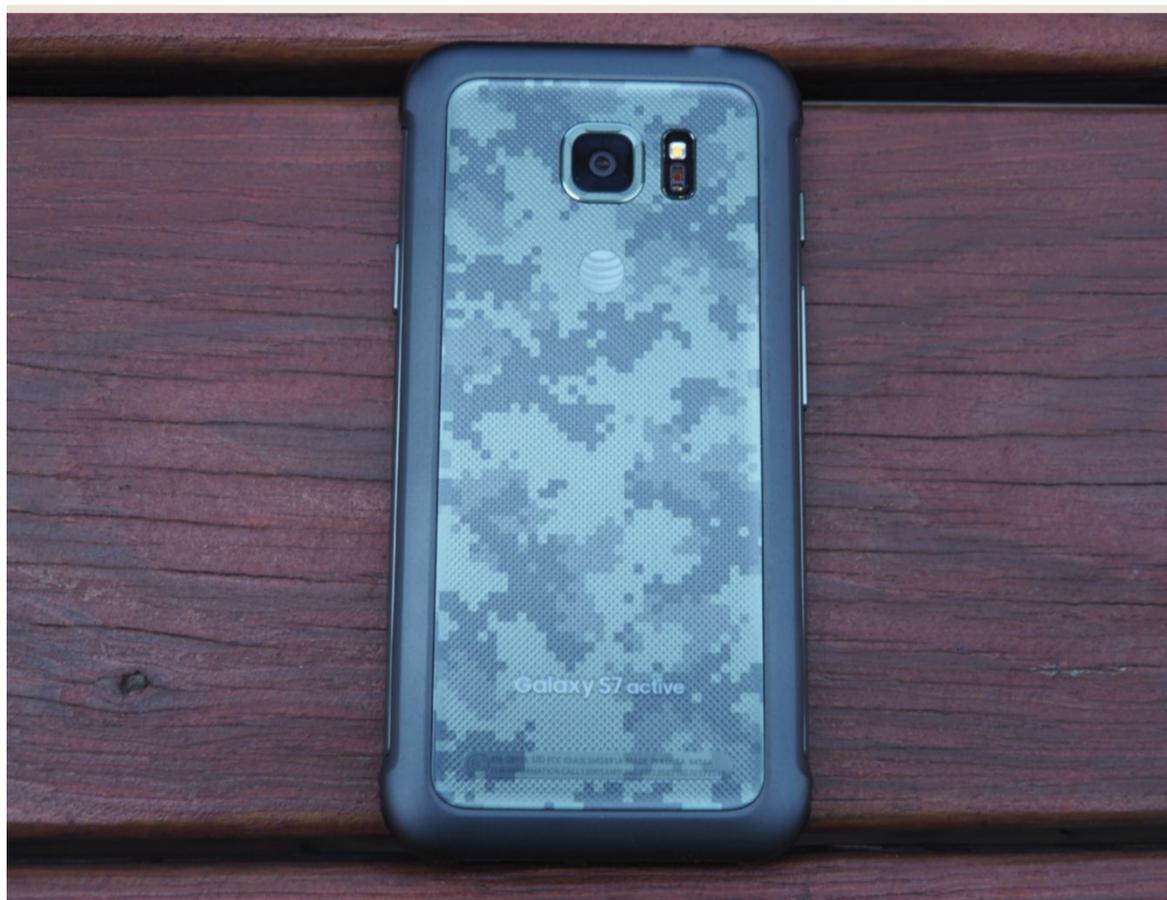
Samsung Galaxy S7 Active

\$749.99



DESIGN AND FEATURES

When it comes to rugged phones, you need to be prepared to make a bit of a compromise in the design department. The S7 Active is an attractive phone in its own right, but it's no Galaxy S7. Gone is the glass-and-metal build that makes the S7 so attractive; it's replaced by a matte-green reinforced metal frame, rubberized edges, and a textured camouflage back. You can also get the phone in gold or gray, but at the end of the day, aesthetics come second to functionality for this phone.



That said, the S7 Active is the rare rugged phone that's not an absolute brick. Measuring 5.86 by 2.95 by 0.39 inches (HWD) and 6.53 ounces, it's bigger and heavier than the standard S7 (5.61 by 2.74 by 0.31 inches; 5.36 ounces), but it's not bulky compared with heavy-duty options like the Kyocera Duraforce (5.39 by 2.78 by 0.55 inches; 7.06 ounces) or the Sonim XP6 (5.39 by 2.54 by 0.81 inches; 9.52 ounces). One-handed use is easy, and despite the increased weight, the S7 Active won't weigh down your pocket.

For that increase in size, you get the same level of durability as with last year's S6 Active. That includes

Samsung Galaxy S7 Active

PROS Rugged build. Fast performance. Long battery life. Excellent camera. Sharp, bright display. Customizable Active button.

CONS Middling call quality.

GET A GRIP

The back of the S7 active is textured to provide better grip. The metal frame is reinforced, and the edges are rubberized.

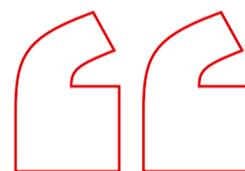
IP68 waterproofing, which means the phone is able to withstand submersion in up to five feet of water for 30 minutes. The standard Galaxy S7 boasts this same level of water protection, but it doesn't meet the MIL-STD-810G rating, as the S7 Active does. That allows the Active to handle extreme temperature, shock, vibration, pressure, altitude, and a number of other potentially hazardous conditions.



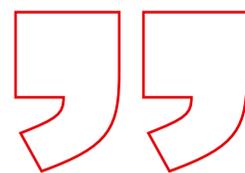
To test durability, we washed the phone in the sink, kept it immersed in a bowl of water, put it in the freezer, and repeatedly dropped it from a five-foot height onto the (hard) rubberized floor of the PCMag test lab, as well as onto concrete, tile, and wood surfaces. The S7 Active remained unharmed throughout our torture tests. Try doing that with a Galaxy S7 (actually, don't). Rugged qualities aside, the S7 Active is basically the same as the Galaxy S7 we know and love. The front of the phone has the same gorgeous 5.1-inch Quad HD AMOLED display, with great viewing angles and strong visibility in sunlight. Below the display are three physical buttons, including a smooth Home button with a built-in fingerprint sensor like the Galaxy S7. The S7 Active also includes textured Back and Options buttons on either side of the Home button. They aren't backlit, but they're responsive and easy to distinguish under your thumb.

STAY CONNECTED IN THE WILD

Heading for the great outdoors? The rugged Galaxy S7 Active is a great choice for hikers, campers, and other adventurers.



To test durability, we washed the phone in the sink, kept it immersed in a bowl of water, and repeatedly dropped it.



There's a power button on the right side of the phone, along with a combined SIM and microSD card slot that worked with a 200GB SanDisk card. The left side has a textured Active button, which can be programmed with several different functions (more on those later), and a volume rocker. There's a micro USB charging port and speaker on the bottom, and a 3.5mm audio jack up top.

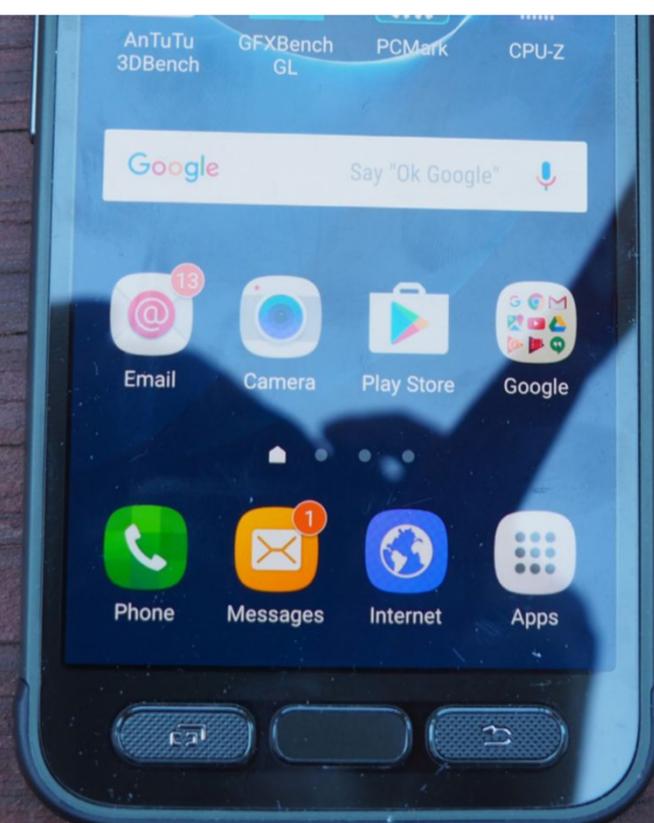
PERFORMANCE, BATTERY, AND SOFTWARE

Call quality is decent, but nothing to write home about. Transmissions are clear and free from garbling, but voices can sound harsh and robotic. On the plus side, earpiece volume is loud, and noise cancellation is excellent at blotting out loud background sounds

The S7 Active has the same internal hardware as the S7, including a Snapdragon 820 processor, 4GB of RAM, a 12-megapixel rear camera, and a 5-megapixel front camera. You can read our online review of the Galaxy S7 for a full performance rundown, but in short: It's fantastic. The Galaxy S7 (and, in turn, the S7 Active) is one of the most powerful Android phones you can buy, with one of the best mobile cameras we've tested.

Battery life on the S7 Active is even better than it is on the original, thanks to a larger 4,000mAh battery. The phone lasted 10 hours and 30 minutes in our rundown test, in which we stream full-screen video over LTE at maximum brightness. That's significantly longer than the standard Galaxy S7 (9 hours), as well as rugged phones including the Kyocera Duraforce (6 hours 6 minutes). In addition to its supersize battery, the S7 Active supports fast charging, allowing it to go from zero to fully charged in 90 minutes using the included adapter.

The phone runs Android 6.0.1 Marshmallow with Samsung's TouchWiz skin over it. You get the same home screen, apps, and general look as the regular S7,



VIEWING PLEASURE

The Galaxy S7 Active has the same bright, rich Quad HD AMOLED display as the standard S7, with strong visibility in sunlight.

with one major addition: Pressing the Active button launches the Activity Zone app, which shows a grid of tiles containing widgets for Weather, Barometer, S Health, Compass, Flashlight, and Stopwatch. A longer press of the Active button launches DirectTV, and a double press launches Emergency Zone, which allows you to quickly call 911 or emergency contacts. The Active key can also be programmed to launch any three apps of your choice, which is handy if you're not interested in the default setup.

COMPARISONS AND CONCLUSIONS

At \$750, the Samsung Galaxy S7 Active costs \$55 more than the standard Galaxy S7. If you're the type of person who regularly needs to replace broken phones, that's a small price to pay compared with buying extended warranties or a whole new device. Compared with other rugged AT&T devices such as the Kyocera Duraforce and the Sonim XP6, the S7 Active is significantly more expensive. But those phones feature seriously dated hardware and software, which is a big compromise to make in the name of durability. Ultimately, the choice between the S7 and the S7 Active comes down to whether you're willing to sacrifice the S7's sleek design for the S7 Active's rugged build and bigger battery. At the end of the day, the Galaxy S7 Active is every bit as good a phone as the standard S7, and in some respects, it's even better. No matter which you choose, you can rest assured that it offers a top-notch experience.

AJAY KUMAR



The Samsung Galaxy S7 Active is every bit as good a phone as the standard s7, and in some respects, it's even better.





Razer Blade Ultraportable Wins in Gaming



The 2016 Razer Blade (\$1,999.99 as tested) is a 14-inch ultraportable gaming laptop with strong performance, a QHD+ touch display, and a best-in-class compact design. Razer doesn't cut any features to achieve the lower (by \$400) cost, and adds USB-C with Thunderbolt 3 and the individually backlit keyboard we first saw on the Razer Blade Stealth. Its gaming prowess doesn't match that of large laptops or gaming desktops, but with a new Skylake processor, double the graphics card VRAM of the 2015 Blade, and a trademark super-portable design, the new Razer Blade is an easy pick as our Editors' Choice for ultraportable gaming laptops.

Razer Blade

\$1,999



DESIGN AND FEATURES

With its Blade line, Razer has consistently offered premium build quality, and the 2016 version is no exception. The entire chassis is black machined aluminum, which looks attractive and feels luxurious. There are two muscle lines on the lid, with the lime-green Razer logo centered in between. The laptop measures 0.7 by 13.6 by 9.3 inches (HWD) and weighs 4.26 pounds, which is quite impressive for a laptop that can play serious games. These dimensions are identical to those of last year's Blade, but that version was slightly heavier at 4.47 pounds.

Compared with the larger 15.6- or 17-inch screens in most gaming laptops, the 14-inch display is a compromise that comes with the compact, light design. Though most gaming laptops aren't designed to travel,



the Blade is easy to grab and throw in a bag. If portability appeals to you, even with a smaller screen, this design can't be beat.

To drive the difference home, the 17-inch MSI GT72 Dominator Pro G-1438 measures 1.89 by 17 by 11.75 inches and weighs about 8.5 pounds—larger and roughly double the weight. The Asus ROG (G752VT-

Razer Blade

PROS Improved performance over predecessor at a lower price. Slim, light design with premium aluminum build. Sharp and vibrant 3,200-by-1,800-resolution touch display. USB-C with Thunderbolt 3. Good battery life for a gaming laptop.

CONS Graphics card not powerful enough for native QHD+ resolution when playing cutting-edge games. Short on storage. Runs hot while gaming.

ALL THE COLORS

The quality of the Razer Blade's 14-inch display is outstanding, featuring a QHD+ 3,200-by-1,800 resolution and IGZO technology for vibrant colors.

DH72), also 17 inches, weighs even more at 8.8 pounds. The 15-inch Acer Aspire V 15 Nitro comes closest to the compact form of the Blade, at 0.94 by 15.3 by 10.1 inches and 5.3 pounds.

A 14-inch display is probably as small as I'd go for gaming, but the Razer's screen quality is outstanding with QHD+ 3,200-by-1,800 resolution and touch capability. The 2015 Blade also had a touch display, while most other gaming laptops don't support touch input. The screen looks sharp, gets plenty bright, and boasts vibrant colors thanks to Indium Gallium Zinc Oxide (IGZO) technology. The QHD+ resolution is higher than those of many gaming laptops: the Alienware 15, the MSI Dominator Pro, and the Asus ROG (G752VT-DH72) all feature Full HD 1,920-by-1,080-resolution displays, as do more expensive systems such as the Origin EON17-X. The previous Razer Blade is one of few to match the resolution, but the Acer Nitro trumps all with a 4K screen.

It's worth noting that higher screen resolutions are strenuous on a system, making it more difficult to run 3D games at full resolution at or near max settings. Even high-end modern laptops—which are much more

MOBILE GAMING

This laptop is incredibly compact and light for a dedicated gaming system, measuring just 0.7 by 13.6 by 9.3



powerful than in years past—don't typically have the specs to pull off more than Full HD on the highest settings and maintain a smooth frame rate, which is why most opt for a 1080p resolution. QHD+ and 4K look nicer, but ultimately will negatively impact performance to the point where your games will drop below a smooth frame rate, forcing you to choose between lowering the resolution and downgrading some visual effects. That said, having a QHD+ ceiling allows you to go that high if you prefer or when you are running a less strenuous program, and still lets you drop down to 1080p when required. The Performance section below details how the Blade was able to handle this resolution while gaming, but these guidelines generally hold true for all systems.

The keyboard is a real standout, borrowing features from the Blade Stealth that add some functionality unique to this line. Through the included Razer software, you can customize the lighting and function of each key. Some gaming laptops integrate lighting you can change across all keys at once, or discrete sections of keys that can change together, but the Stealth was the first to feature per-key backlighting, and now the full-size Blade has followed suit. You can set effects, such as a constant color cycle or color ripple for each key strike, as well as several other patterns. The keys feel good, support full anti-ghosting to prevent input jamming, and are programmable with the included software.

The touchpad is also solidly built and tracks input well. The pad isn't clickable as mouse buttons; instead Razer opted for dedicated left and right mouse buttons below the pad, which make very audible but satisfying clicks. On either side of the keyboard are speaker strips, which provide a rich sound and get quite loud, especially for a system this size.

For storage is a 256GB solid-state drive (SSD) on board, which is a good amount for a system with a slim build, but it might leave you a bit short for



**MAKE THE
KEYBOARD YOURS**
The Razer Blade's
keyboard and touchpad
are well built and feel nice
to use, and the keys are
now individually backlit
and customizable.



Connectivity options are versatile, if not plentiful, including three USB 3.0 ports, an HDMI port, a USB-C with Thunderbolt 3 port, and an audio jack.



gaming. (The system is available with a 512GB SSD for \$200 more.) As games continue to creep up beyond 20GB and 30GB file sizes, storage can run low after you've installed just a few titles. Larger, less portable systems usually pack in 500GB or 1TB hard drives in addition to smaller boot SSDs, giving you room to install more of your library. The larger EON17-X, the Lenovo IdeaPad Y700-17 (80Q0001NUS), and MSI Dominator all have the physical space to include roomy hard drives in addition to smaller SSDs. That said, the Aspire V 15 Nitro is a pretty slim system too, and it includes an SSD and a 1TB hard drive. So total storage capacity is a mark against the Blade.

Connectivity options are versatile, if not plentiful. On the left side, you get two USB 3.0 ports, the power jack, and the audio jack. On the right is another USB 3.0 port, an HDMI port, and a USB-C with Thunderbolt 3 port—a useful addition that last year's model lacks. The Blade also includes speedy dual-band 802.11ac wireless by Killer, Bluetooth 4.1, and a TPM 2.0 security chip. Several proprietary programs, such as Razer Synapse and Razer Comms, are preinstalled to help manage keyboard customization and in-game communication. Razer covers the Blade with a one-year warranty.



A LIGHT AND SOLID GAMING RIG

This year's Razer Blade ultraportable delivers premium design, solid performance, and high-end features all in a very slim build. It even adds a few extras over its predecessor, but it costs \$400 less. And bonus: Keys are individually customizable for function and backlight color.

PERFORMANCE

This year's version of the Razer Blade is equipped with a 2.6GHz i7-6700HQ processor, an Nvidia GTX 970M graphics card, and 16GB of memory. The 970M is the same card found in last year's Blade, but Razer has doubled the VRAM from 3GB to 6GB. This isn't the most cutting-edge graphics card available, even less so now than a year ago. But with the extra dedicated memory and other speedy components, this laptop is fast.

On the PCMark 8 Work Conventional productivity test, the Blade scored 2,819 points. This is well behind the Asus ROG (G752VT-DH72) (3,571 points), the MSI Dominator Pro (3,726 points) and the 2015 Razer Blade (2,955), which is disappointing. It fared better on the multimedia tests, scoring alongside or just behind these other systems on the Photoshop, Handbrake, and CineBench tests; the Blade is more than capable of completing complicated media projects.

The real focus is on 3D and gaming performance, though, and on these tests the 2016 Blade fared quite well, scoring 19,892 points on the 3DMark Cloud Gate test and 3,349 points on 3DMark Fire Strike Extreme, just a bit higher than the 2015 Blade on both tests, but slightly behind the ROG. The Dominator Pro was far behind on CloudGate (12,825 points), but fared better on Fire Strike Extreme (4,296 points).

On the Heaven and Valley gaming tests set to Medium quality, the Blade scored 113 frames per second (fps) and 94fps, respectively. As expected, cranking the settings up to Ultra quality (which includes using the display's native 3,200-by-1,800 resolution) caused the numbers to drop significantly to 15fps on Heaven and 17fps on Valley. Turning the resolution down to 1,920-by-1,080 while set to Ultra quality resulted in much smoother frame rates, around 40fps. Real-world gaming tests reflected these test results. Playing The Witcher 3: Wild Hunt at max settings at the native resolution was way too strenuous for

a smooth frame rate; though dialing down to High settings was better, it was still too choppy for normal play. In both cases, tuning the resolution down to 1080p was the ideal compromise between appearance and performance, since, as explained above, QHD+ proves too much for the hardware on the highest settings.

The Blade became fairly hot during testing, and all the cooling fans are on the bottom of the laptop, which doesn't seem ideal. That said, I never experienced any problems because of it during my testing. You will certainly hear the fans working to cool the system, however.

As an ultraportable gaming system, battery life is a lot longer than with larger gaming laptops. The Blade eked out an impressive 5 hours 4 minutes on our rundown test, slightly better than the 2015 Blade (4:52), and well above the Asus ROG (2:51) and the MSI Dominator Pro (3:25). The Alienware 15 is the closest, with 4:58, and the relatively slim Nitro only lasts 2:59.

CONCLUSIONS

The new Razer Blade, like the 2015 version, is a very capable gaming laptop with a beautiful build that's a lot more portable than other game-focused machines. Performance may be only marginally improved, but the latest Blade costs \$400 less than last year's model without any feature compromises. It's also slightly lighter and offers the new highly customizable Chroma keyboard. More-traditional gaming laptops may offer a bit more power within the same price range, but nothing matches the design quality and portability of the Blade line. Not only does the new Blade earn our Editors' Choice award for ultraportable gaming laptops, it challenges bigger gaming machines as well.

MATTHEW BUZZI



Intel Core i7-6950X CPU Is Powerful—and Pricey

Since the early Pentium and Core 2 models, Intel's top-of-the line, consumer-focused Extreme Edition (or "X-Series") processors have catered to two groups: professional content creators for whom rendering time equals lost productivity and revenue, and enthusiast PC builders and PC gamers who crave the best possible performance and don't mind paying for it. With Intel's X-Series Broadwell E platform, those two intertwined groups of consumers may be about to split. For professionals who need all the cores and threads they can get, the company's new top-end 10-core, 20-thread monster, the Core i7-6950X Extreme Edition, will be tough to ignore. Gamers, though, will want to take a deep breath first before getting too excited.

**Intel Core
i7-6950X
Extreme Edition**

\$1,723



Based on Intel's 5th-Generation Broadwell architecture and stock-clocked at 3GHz with 25MB of cache, the Core i7-6950X is the most powerful consumer processor you can buy, thanks in large part to the addition of two cores over the previous-generation Haswell-E Core i7-5960X Extreme Edition chip that debuted back in 2014. But you'll have to pay a hefty sum to land this chip. Intel is listing the Core i7-6950X at a staggering \$1,723. That price is per chip in 1,000-unit quantities, as Intel doesn't typically offer up a list price for individual chips in this line, so street pricing may differ. But it's safe to say that if you want all the cores Intel has to offer in a single consumer chip, you'll be paying much more than \$1,000.

BROADWELL-E FEATURES & CHIP MODELS

All of the new Broadwell-E chips will be backward-compatible with most X99-based Socket LGA 2011-v3 motherboards, provided that the motherboard maker offers up a BIOS update to support Intel's latest chips. So upgraders who invested in the previous generation's high-end platform should be able to save some money by using an existing motherboard.

Also, nearly all the new Broadwell-E chips will have 40 PCI Express 3.0 lanes leading directly to the CPU. That's not an upgrade from the previous-generation Haswell-E platform, but having those lanes is arguably more important today, now that super-fast PCI Express/NVMe-equipped solid-state drives (SSDs) such as Samsung's SSD 950 Pro are readily available.

TURBO BOOST MAX TECHNOLOGY 3.0

Aside from the new architecture carried over to the Extreme Edition family (borrowed from the Broadwell chips we saw in mainstream desktops in laptops throughout 2015), the primary new feature with Broadwell-E is Intel's Turbo Boost Max Technology 3.0, which is available on all four of the new chips.



Intel Core i7-6950X Extreme Edition

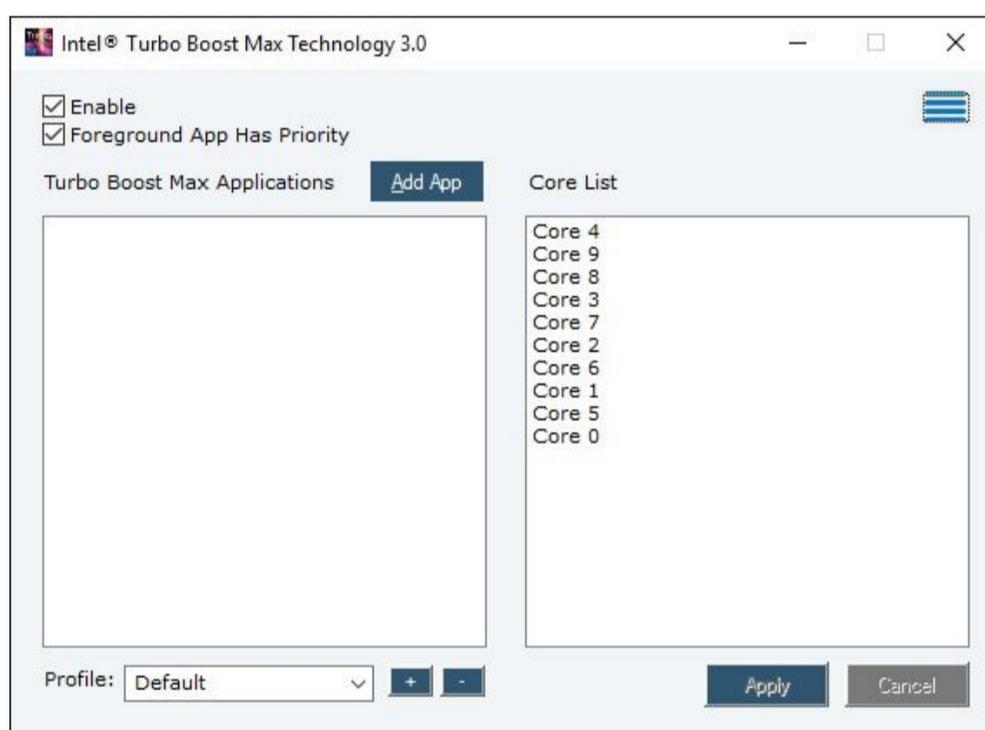
PROS First consumer CPU to sport 10 cores, with Hyper-Threading for 20 concurrent processing threads. Most powerful consumer CPU available. Review sample overclocked well.

CONS Hefty price premium over already expensive eight-core alternatives. Comparatively low clock speed.

Previously, Turbo Boost let individual CPU cores ramp up to higher speeds under ideal thermal conditions when a task wasn't pegging all available cores. But the core chosen to jump up to these higher speeds was arbitrary. That's fine when all cores are equal, but Intel has confirmed that some of its cores have the ability to ramp higher than others. So you might not always get the best possible performance from your processor if the chip doesn't know which core or cores have the highest possible frequency ceiling.

That's where Turbo Boost Max 3.0 comes in. The Broadwell-E chips combined with an Intel driver/utility can determine the best core for these types of tasks and use it whenever a lightly threaded workload arises. That should let you squeeze some extra performance from your processor.

This is the kind of feature that, ideally, should be baked into the operating system itself. But at the moment, that's not the case. Intel provided us with a



TWEAK THE FEATURES

The interface for Intel's Turbo Boost Max Technology 3.0 software is visually simple, and was completely stable when we used it.

piece of software (the company calls it a driver, but it also includes a user interface for tweaking features) that needs to be installed and running for Turbo Boost Max 3.0 to work. The software lists all available cores, and it positions the fastest at the top. When running, the software should assign tasks that most benefit from fast clock speeds to the fastest core (or cores) automatically. You can also choose to pin specific programs to a core or cores.

This sounds promising and may show benefit for some chips and in some specific cases. But the fact that you need to make sure the software is running to make Turbo Core Max 3.0 work makes the feature feel a bit cumbersome.

BENCHMARKS & PERFORMANCE ANALYSIS

There's no denying, though, that for tasks like video editing and other high-end content creation and research tasks, the Core i7-6950X is the fastest chip to date to land on our test bed. In Cinebench R15, an industry-standard benchmark test that taxes all available cores of a processor to measure raw CPU muscle, the Core i7-6950X flat-out dominated. With a 36 percent increase here over the previous-generation Core i7-5960X, it's clear that the new chip benefits not only from the couple of extra cores, but also from the architecture changes between Haswell and Broadwell. The new top-end Intel chip also turned in a score here that's close to three times that of the closest AMD part.

Our iTunes Encoding Test, using version 10.6 of iTunes, taxes only a single CPU core, as much legacy software does. The Core i7-6950X took a substantial tumble here. It managed to easily best any of the AMD chips and outpace the previous Extreme Edition part. But all three of the lesser 4th-Generation/"Haswell"-based Core chips scored better on this timed test—even the sub-\$150 Core i3-6100.

Our Handbrake version 0.9.9 test tasks the CPUs to convert a 12-minute-and-14-second 4K MOV file into a 1080p MPEG-4 video. Here again, the Core i7-6950X wound up on top. The new Extreme Edition CPU shaved nearly two minutes, or about 20 percent, off the time of the Core i7-5960X, and finished in less than half the time of the Core i5-6600K.

On our Photoshop CS6 test, which has the processor apply a series of complex filters to a large image, the 10-core Extreme Edition chip wasn't quite as impressive as you might have expected. The Core i7-6950X once again bested the previous Extreme Edition CPU here, but it couldn't outpace the higher-clocked Core i7 and Core i5 6000-series "Skylake" chips, which also benefit from architecture that's a generation ahead of the Broadwell-based Core i7-6950X.

FAMILY COMPARISON (2016)										
Intel® Core™ i7 Processor number	Base Clock Speed (GHz)	Intel® Turbo Boost Max Technology 3.0	Intel® Turbo Boost Technology 2.0 Frequency* (GHz)	Cores/Threads	Cache	PCI Express* 3.0 Lanes	Memory Support	TDP	Socket (LGA)	Pricing (1K USD)
6950X NEW	3.0	Enabled	Up to 3.5	10/20	25MB	40	4 channels DDR4-2400	140W	2011-v3	\$1723
6900K NEW	3.2	Enabled	Up to 3.7	8/16	20MB	40	4 channels DDR4-2400	140W	2011-v3	\$1089
6850K NEW	3.6	Enabled	Up to 3.8	6/12	15MB	40	4 channels DDR4-2400	140W	2011-v3	\$617
6800K NEW	3.4	Enabled	Up to 3.6	6/12	15MB	28	4 channels DDR4-2400	140W	2011-v3	\$434
6700K	4.0	Not Supported	Up to 4.2	4/8	8MB	16	2 channels DDR4-2133 DDR3L-1600	91W	1150	\$339
6600K	3.5	Not Supported	Up to 3.9	4/4	6MB	16	2 channels DDR4 2133 DDR3L-1600	91W	1150	\$242

IT'S ALL IN THE FAMILY

This chart shows the specs for the Core i7-6950X, as well as for the trio of other Broadwell-E parts, direct from Intel.

Next, we ran the POV Ray benchmark using the “All CPUs” setting. This test challenges all available cores to render a complex photo-realistic image using ray tracing. The Core i7-6950X climbed back atop the performance heap here.

OVERCLOCKING

We were pressed for time with this chip when testing overclocking. But still, we were able to achieve a stable overclock of 4.06GHz with the Core i7-6950X. That’s a generous speed boost that helped the chip look more competitive with the Haswell-based Core i5-6600K on tests like iTunes. The overclocked Core i7-6950X finished our test in 1 minute and 43 seconds, a second ahead of the Core i5 chip, though the Core i7-6700K still finished sooner, at 1:36.

Arguably more impressive were the results in fully threaded tasks when we overclocked the Broadwell-E Core i7-6950X chip. In Cinebench 15, the Core i7-6950X’s score jumped from 1,798 at stock to 2,122, about an 18 percent boost. Likewise, in our 4K Handbrake test, the overclocked chip shaved an extra 11 seconds, or 15 percent, off the time of our POV Ray test, finishing in just 62 seconds. That’s well more than twice the speed of the Core i7-6700K, which took 2:17 to finish the same benchmark test.

As always, overclockability varies from chip to chip. So your clock-speed achievements may vary, and overclocking isn’t covered under the warranty.

CONCLUSION

The Core i7-6950X is undoubtedly the most powerful consumer processor you can buy, and it seems to be readily overclockable, much like the previous-generation Extreme Edition chip. This mitigates some of the issues with the chip’s fairly low base clock speeds. But \$1,000 is a lot to pay for a processor, unless you’re a professional who needs all the CPU muscle you can get. And since the 10-core option is expected to cost closer to \$2,000 than \$1,000, that argument is doubly true. But if you’re building a new workstation for serious high-resolution video editing, VR content creation, or other time-intensive computing tasks that will benefit from all the cores and threads a modern computer can muster, the Core i7-6950X is certainly worth considering.

MATT SAFFORD



Tenda's Budget-Priced Router Delivers a Lot



The latest crop of wireless routers offers high-speed data rates, multiple radio bands, and revolutionary signal-processing technologies such as Beamforming and Multi-User Multiple Input, Multiple Out (MU-MIMO) data streaming. But not everyone cares about those technologies, so not everyone will need the latest model. Enter the Tenda F3 N300 Wireless Router.

**Tenda F3 N300
Wireless Router**

\$29.99



The F3 is a single-band 802.11n router that's easy to install and configure, with three wired LAN ports and lots of management settings. Its throughput will hardly wow you, but if you maintain a simple one- or two-client home Wi-Fi network and don't stream a lot of online videos, play a lot of online games, or transfer large chunks of data between clients, the Tenda F3 N300 is an amazing bargain—and our new Editors' Choice for budget wireless routers.

Tenda F3 N300 Wireless Router

PROS Inexpensive. Easy to install. Three LAN ports. Robust management settings.

CONS Old, single-band technology. Middling throughput.



DESIGN AND FEATURES

The F3 uses a 300MHz Broadcom MIPS 74K System on a Chip (SoC) processor that enables 802.11n wireless networking over the 2.4GHz band, with a maximum (theoretical) throughput speed of 300Mbps. You don't get a second 5GHz band at this price, nor do you get the faster 802.11ac Wi-Fi technology and the accompanying Beamforming and MU-MIMO technologies.

At 1.1 by 7.3 by 4.7 inches (HWD), the F3 is relatively small, at least when compared with a full-featured dual-band model such as the Asus RT-AC88U Dual-Band Router, which measures 3.3 by 11.8 by 7.4 inches. It has a white finish; three removable, adjustable antennas; and eight LED status indicators for System (Power), Wi-Fi, each of the three LAN ports, Transmit, WAN (Internet), and Wireless Protected Setup (WPS). Around back are three LAN ports, a WAN port, and a WPS/Reset button, but this router lacks USB ports. Moreover, the LAN ports are Fast Ethernet (10/100) ports, rather than the faster Gigabit Ethernet (10/100/1000) ports.

The F3's Web-based management console offers a generous array of basic and advanced settings. The Wireless page provides basic SSID and network mode settings, as well as Security (WPA/WPA2/WPS) and Access Control settings. On the Quality of Service (QoS) page, you can specify upload and download bandwidth ranges for certain devices, and track network traffic statistics. The Security page offers ways to restrict website access using URL and MAC Address filtering. The menus are easy to navigate and offer tips and descriptions for each setting.

INSTALLATION AND PERFORMANCE

The F3 is easy to install. I plugged in the power cord, connected my Internet cable to the WAN port, and used my laptop to connect to the router's SSID. I entered the router's IP address (192.168.0.1) into my browser's address bar, which launched the management console's Home page. From there I selected an Internet connection type (DHCP or PPOp) and entered a custom Wi-Fi password. I clicked OK and was ready to go.

The Tenda F3's throughput performance was pretty much in line with (but slightly slower than) another N300 single-band router that we recently reviewed, the Peace Wireless Router (\$99). The F3 managed 48.5Mbps on our close-proximity (same-room) test, while the Peace Router measured 64.5Mbps. At a distance of 30 feet, the Tenda F3 provided a throughput speed of 40.6Mbps, compared with the Peace Router's speed of 41.3Mbps.

To give you an idea of how much faster 802.11ac routers can be in comparison, our Editors' Choice for midrange routers, the Linksys EA7500 Max-Stream AC1900 MU-MIMO Gigabit Router (\$169.99), scored 97.3Mbps on the 2.4GHz close-proximity test and 52.1Mbps on the 2.4GHz 30-foot test, and it delivered 495Mbps on the 5GHz close-proximity test and 298Mbps on the 5GHz 30-foot test.



GOOD THINGS IN A SMALL PACKAGE

It may not deliver the fastest throughput, but for a simple one- or two-client home Wi-Fi network, the Tenda F3 N300 is an amazing bargain.

CONCLUSION

If you want to connect lots of devices to your home network—Smart TVs, Blu-ray players, home automation devices, smartphones, and so on—you need a powerful router equipped with all the latest technologies. The dual-band, 802.11ac-supporting Linksys EA7500 is a fine tool for that job, delivering blazing throughput along with plenty of features and ports. But if that strains your budget, and you're happy with running a small Wi-Fi network that will be used primarily for Web browsing and light file transfers between a couple of clients, you can't get the job done less expensively than with the Tenda F3 N300 Wireless Router. It limits you to older, single-band 802.11n Wi-Fi, which means you don't get the highest throughput possible today, but it's easy to set up, and its performance is more than good enough to justify its price. For that reason, we're happy to give the Tenda F3 our Editors' Choice award for budget wireless routers.

BY JOHN R. DELANEY



Dell's Excellent, Reliable Business All-in-One Desktop



The Dell OptiPlex 24 7000 Series All-In-One (7440), which starts at \$849 and costs \$1,654.50 as tested, is a terrific business all-in-one desktop with a vivid 4K screen and tons of I/O ports, and is a strong

performer on the kinds of tasks that will matter most to you at work. It's expensive, but if your business is in need of reliable new desktops that won't give your IT technicians headaches, the OptiPlex 7440 is an ideal choice. It replaces the HP EliteOne 800 as our Editors' Choice for business all-in-ones.

**Dell OptiPlex 24
7000 Series
All-In-One
(7440)**

\$849 and up



DESIGN AND FEATURES

The OptiPlex 7440 is corporate-black in color, measures 15.5 by 22.6 by 2.5 inches (HWD), and weighs 15.9 pounds. Like the Lenovo ThinkCentre E93z, it looks like just a lone monitor—our review unit shipped with the basic height-adjustable stand, although you can order the system with an articulating stand. It's thick, black, and brushed matte to match the monitor, and there's a large hole in its middle for a little fit of design fancy. You can adjust the stand to view the monitor at a slight

Dell OptiPlex 24 7000 Series All-In-One (7440)

PROS Crisp 4K display. Strong multimedia performance. Many I/O ports.

CONS Pricy. Recessed I/O ports in back.



**YOUR IT TECHS
WILL LOVE IT**
The Dell OptiPlex 7440 AIO is an excellent business all-in-one desktop with a 4K screen, good performance, and plenty of ports.

angle (about 30 degrees), and it allows you to swivel the monitor and switch between Landscape and Portrait modes. Our review unit also shipped with a chiclet-style wired keyboard and wired mouse, which both performed smoothly; a wireless keyboard and mouse set is optional.



The screen is one of the main selling points of the OptiPlex 7440. It's a 23.8-inch panel that's bright and crisp, with a 3,840-by-2,160 (4K) resolution (the first we've seen on a business all-in-one) and an antiglare coating. As with the Apple iMac 27-Inch with Retina 5K Display, it's a non-touch display, but touch-screen customization is available for around \$50 more than the base price. You can also outfit the all-in-one with a 1080p HD display, similar to the one you'll find on the less expensive Dell OptiPlex 3240, and pay about \$500 less. At the top of the monitor is a 2-megapixel full-HD camera for video calls, and surrounding the screen is a thick black bezel that juts out slightly. Under the screen is an LED that blinks when the monitor is asleep and glows steadily when it's awake.

Most of the I/O ports are located in a recessed area on the back of the desktop, beneath where the stand connects to the monitor. The ports are a little difficult to reach, but the above-average number of them on the desktop is a definite plus. In addition to the jack for the AC adapter, there are four USB 3.0 and two USB 2.0 ports, an HDMI 1.4 In/Out port, and a DisplayPort connector. On the left side are two more USB 3.0 ports, a smart card reader, and a headphone jack. On the right edge you'll find the optical drive, plus the Power button, the Sleep button, and two buttons for controlling screen brightness.



PERFORMING LIKE A PRO

The OptiPlex 7440 excelled in our multimedia tests, likely because of its Core i5 CPU. In graphics testing, it performed decently but was mostly beaten out by other all-in-ones.

Dell has made the OptiPlex 7440 as simple to repair and upgrade as the Dell OptiPlex 9030 Touch: Just pop off the stand from the monitor to access the hard drive and memory. Our review unit shipped with a 256GB SSD and 8GB of RAM, which should be enough internal storage and memory for most business users. Added security features on the system include Trusted Platform Module (TPM) 1.2 and a chassis lock support slot. For wireless connectivity, you get dual-band 802.11ac Wi-Fi and Bluetooth 4.1. The system comes with Windows 10 Pro and only a few preinstalled utilities. Dell covers the OptiPlex 7440 with a three-year limited warranty.

PERFORMANCE

The OptiPlex 7440's 3.3GHz Intel Core i5-6600 processor and integrated Intel HD Graphics 530 combine to give the desktop solid performance overall. On the PCMark 8 Work Conventional test, which tests a system's ability to handle day-to-day computing tasks, the OptiPlex 7440 scored a solid 2,911. That's a little behind the HP Sprout (3,381) and the OptiPlex 9030 Touch (3,150), though not enough to make much of a difference.

One area where the OptiPlex 7440 particularly excels is multimedia, likely due to the presence of the current-generation Core i5 CPU. The system finished our Photoshop CS6 test in 3 minutes 16 seconds—quicker than the Apple iMac with Retina 5K Display (3:19) and the Dell OptiPlex 9030 Touch (3:25). The only desktop faster than the OptiPlex 7440 in the test was the HP EliteOne 800 (3:05). On the Handbrake video encoding test, the OptiPlex 7440 finished in 1 minute 14 seconds, barely edging out the Apple iMac with Retina 5K Display (1:15) and just behind the HP Sprout (1:13). The Dell's score of 591 in CineBench R15 was just ahead of the Dell OptiPlex 9030 Touch's 496 but behind the HP Sprout's 687.

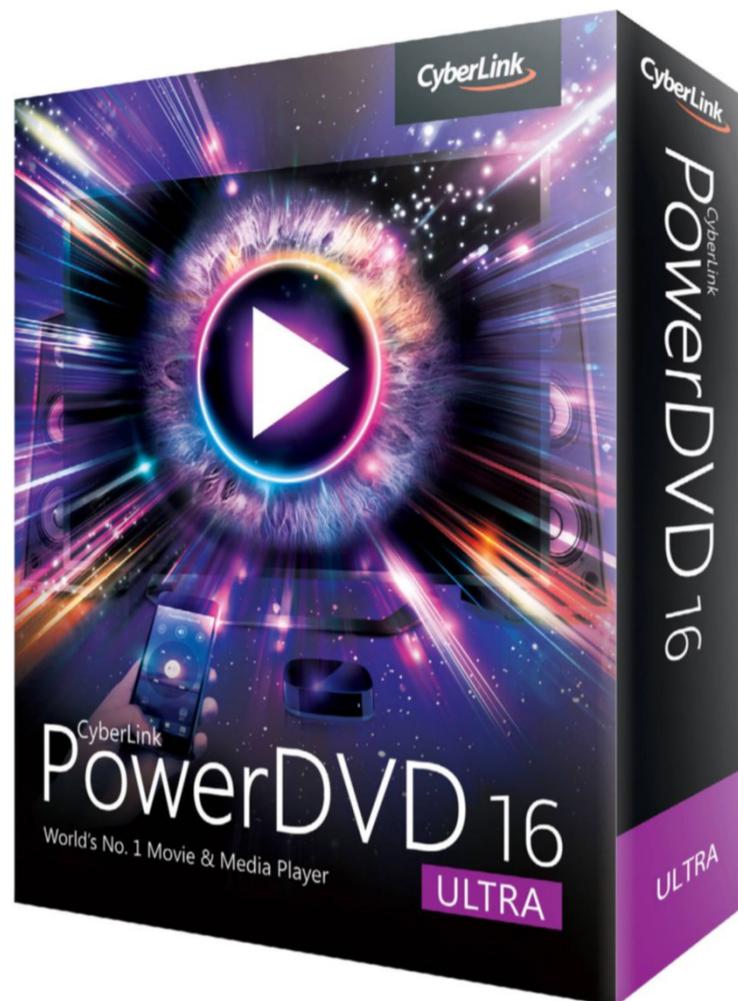
In graphics testing, the OptiPlex 7440 performed decently but was mostly beaten by other all-in-one PCs. On the 3DMark Cloud Gate test, using Medium settings, the desktop scored 6,441—by no means a bad result. But other desktops, such as the HP Sprout (9,390), performed better. On the Heaven test, the OptiPlex 7440 similarly managed a decent 20 frames per second (fps) on Medium settings, the same as the Lenovo ThinkCentre E93z (20fps), but still fell far short of the impressive 62fps of the Apple iMac with Retina 5K Display. Graphics capabilities are usually a secondary consideration in business settings, however, so don't let these results discourage you if you need an all-in-one for other purposes.

CONCLUSIONS

The Dell OptiPlex 24 Series All-In-One (7440) is a fine business all-in-one, and the first we've seen with a 4K display, which gives workers more screen space. It has a fast Intel Core i5 processor along with plenty of usable storage on a speedy SSD and enough I/O ports to meet all of your needs, and it performs work and multimedia tasks admirably. The \$1,600 price is hefty, but all told, we think this system is worth it. We recommend the Dell OptiPlex 7440 over the HP EliteOne 800 for its newer hardware and competent performance.

BY BEN RADDING

MATTHEW BUZZI



PowerDVD 16 Ultra Is a Home Theater Server Too



Most people don't think much about watching DVD or Blu-ray movies on their PCs these days. Though CyberLink's PowerDVD Ultra started life with that purpose, it does a lot more now. Its non-disc features include playing cloud-based content and working as a home theater server. In fact, the highlight of Version 16 is Big Screen Mode, which offers media casting to HDTVs, premium audio playback, and an improved PowerDVD Remote app. The update also adds more file-standard support, speeds up startup, and reduces the load on system resources.

**CyberLink
PowerDVD 16
Ultra**

\$99.99



PRICING AND STARTUP

PowerDVD is available for Windows 10, 8.1, and 7. It's a 32-bit application, but of course runs on 64-bit PCs.

Three levels are available for purchase: The full PowerDVD 16 Ultra (\$99.99) that comes with all features; Pro, which lacks Blu-ray, TV Mode, and other features (\$79.95); and Standard (\$59.95) for basic DVD playing. You can also opt for a subscription to PowerDVD Live (\$44.99 per year), which gets you all features and updates. A full-featured, free 30-day trial version is available for those who don't want to commit before trying. And if you've bought a PC with an optical drive recently, there's a good chance you have a free basic version of PowerDVD already, though it will lack most of the advanced features discussed below.



Once you've entered the license key, you'll want to set up your media library and sign up for a cloud storage account. A link from the setup wizard takes you to the cloud storage webpage, where you simply create or sign into an online account. The PowerDVD installer also places a tray icon in the notification area of the taskbar, which pops up to import media when you insert a USB drive.

CyberLink PowerDVD 16 Ultra

PROS Big-screen TV mode. TrueTheater image enhancement. Image stabilization. Customizable interface.

CONS No media store. Casting doesn't work with protected media. Displayed video from a phone upside down on a 4K monitor in testing.

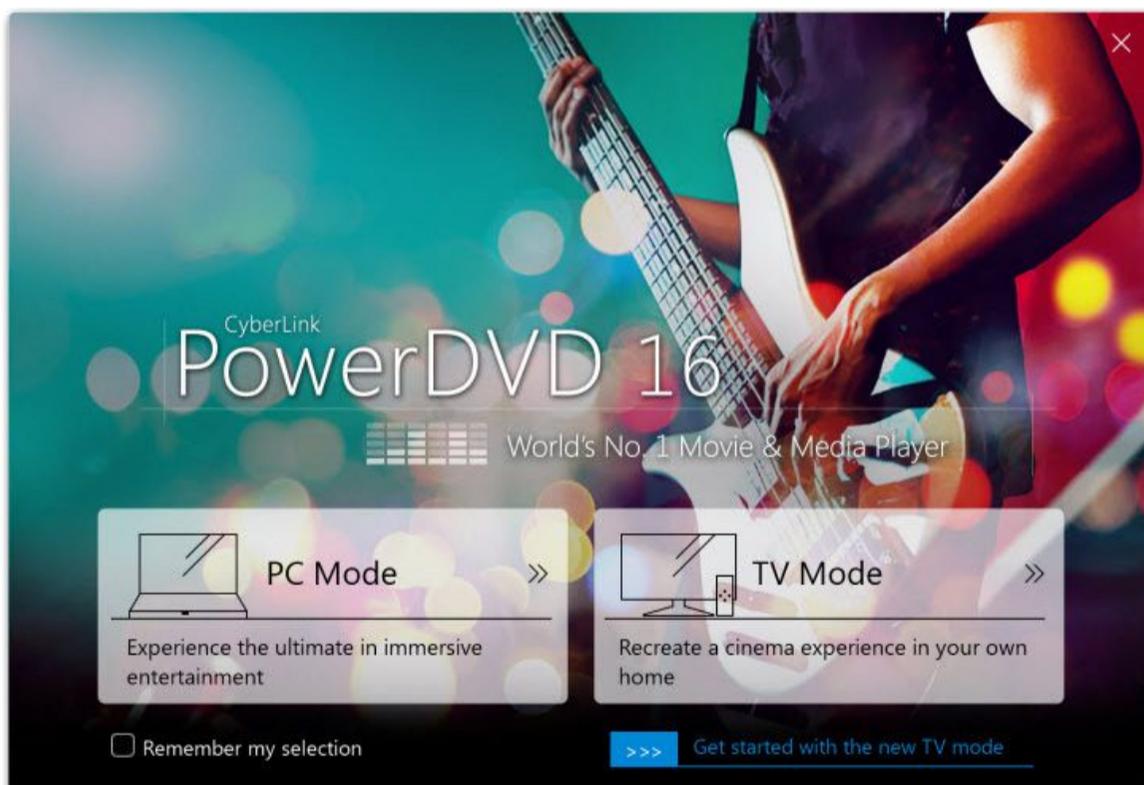
SETUP'S A WHIZ

PowerDVD walks you through setting up your media library and creating and accessing your cloud storage account.

INTERFACE

PowerDVD's interface is more modern than that of its closest competitor, Corel WinDVD. But it's less simple than that of another important competitor, Microsoft's Movies & TV, which also plays your local video files and offers a movie and TV store—also, it's free and comes with every copy of Windows 10. PowerDVD's starting splash screen offers just two big option buttons: PC Mode and TV Mode. You can set it to always go to one or the other if you prefer, and you can switch to the one you're not using at any time.

Far more than just a player of disc-based video, PowerDVD handles all your media, including locally and remotely stored music, photos, and videos. And those are all accessible from a left panel in the PC interface. If you prefer one app to rule all your media, as opposed to Windows 10's separate Movies & TV, Photos, and Groove Music apps, then PowerDVD will appeal to you.



There are sections for added media, CyberLink Cloud-stored media, local folders, playlists, online video (from YouTube and Vimeo), and Devices (including DLNA-connected devices and attached storage). You can customize the menus so that only options you use



PowerDVD handles all your media, including locally and remotely stored music, photos, and videos.



A LA MODE

You can set up PowerDVD to open either PC or TV Mode by default, and easily switch between the two.

frequently are displayed. As you'd expect, the TV layout features much larger buttons, and they're in a horizontal menu instead of the PC version's vertical layout. This view made playing a Blu-ray easy.

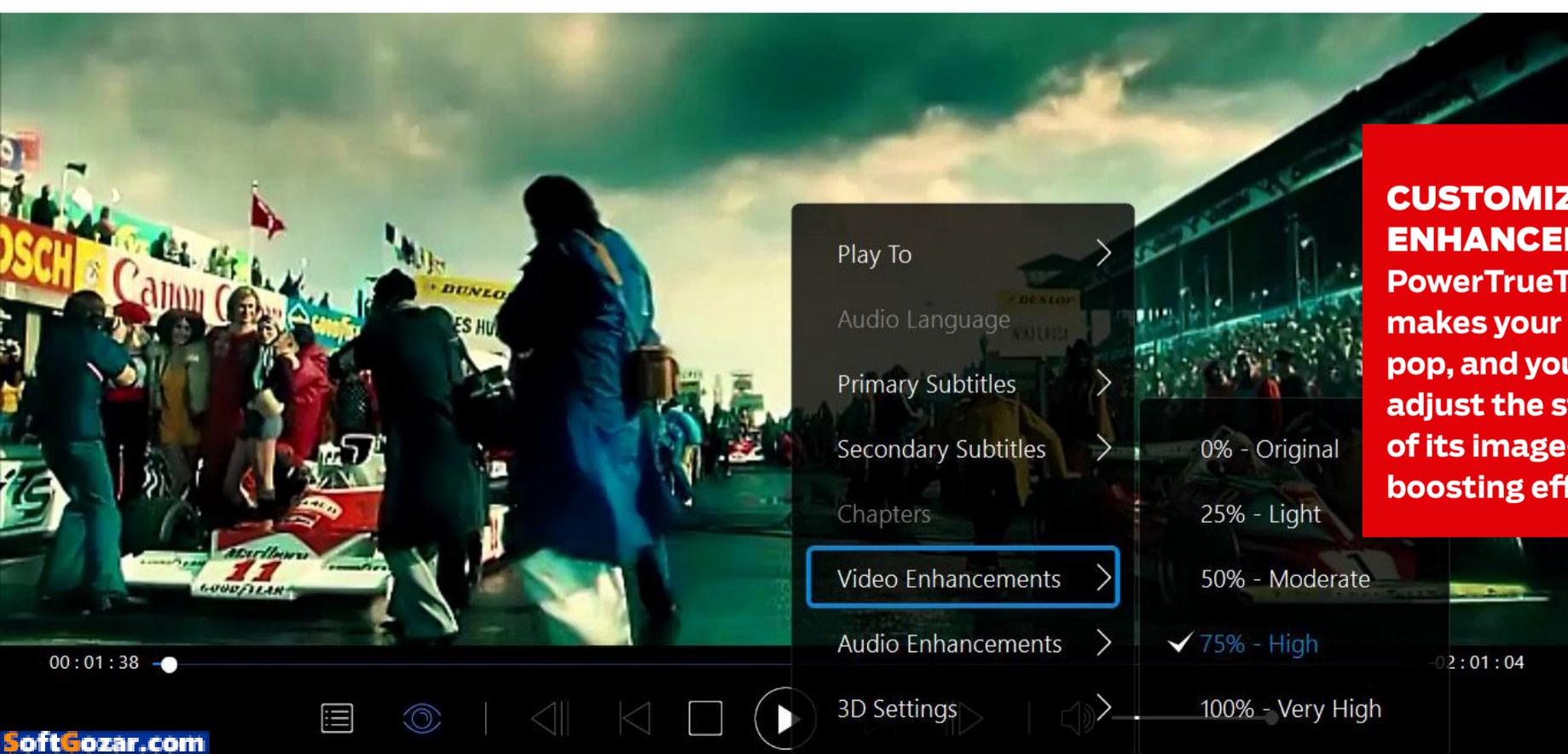
When you're using TV Mode, you can't use the mouse for playback controls—you can use only the keyboard, an on-screen remote, or the mobile remote app. The mere existence of mobile apps, by the way, is a big differentiator between PowerDVD and the Corel and Microsoft software, which lack remote control (or viewing) apps.

FEATURES

The Corel and Microsoft applications can play video files sitting on your drive or on disc, but PowerDVD adds TrueTheater image correction and enhancement. This can really heighten the watching experience and give more intensity and clarity in both video and audio. WinDVD offers lighting and color correction but not an automatic picture improver like TrueTheater. Both also offer image stabilization, though I found PowerDVD's more proficient. It doesn't fix large camera movements but works well for jittery shaking.

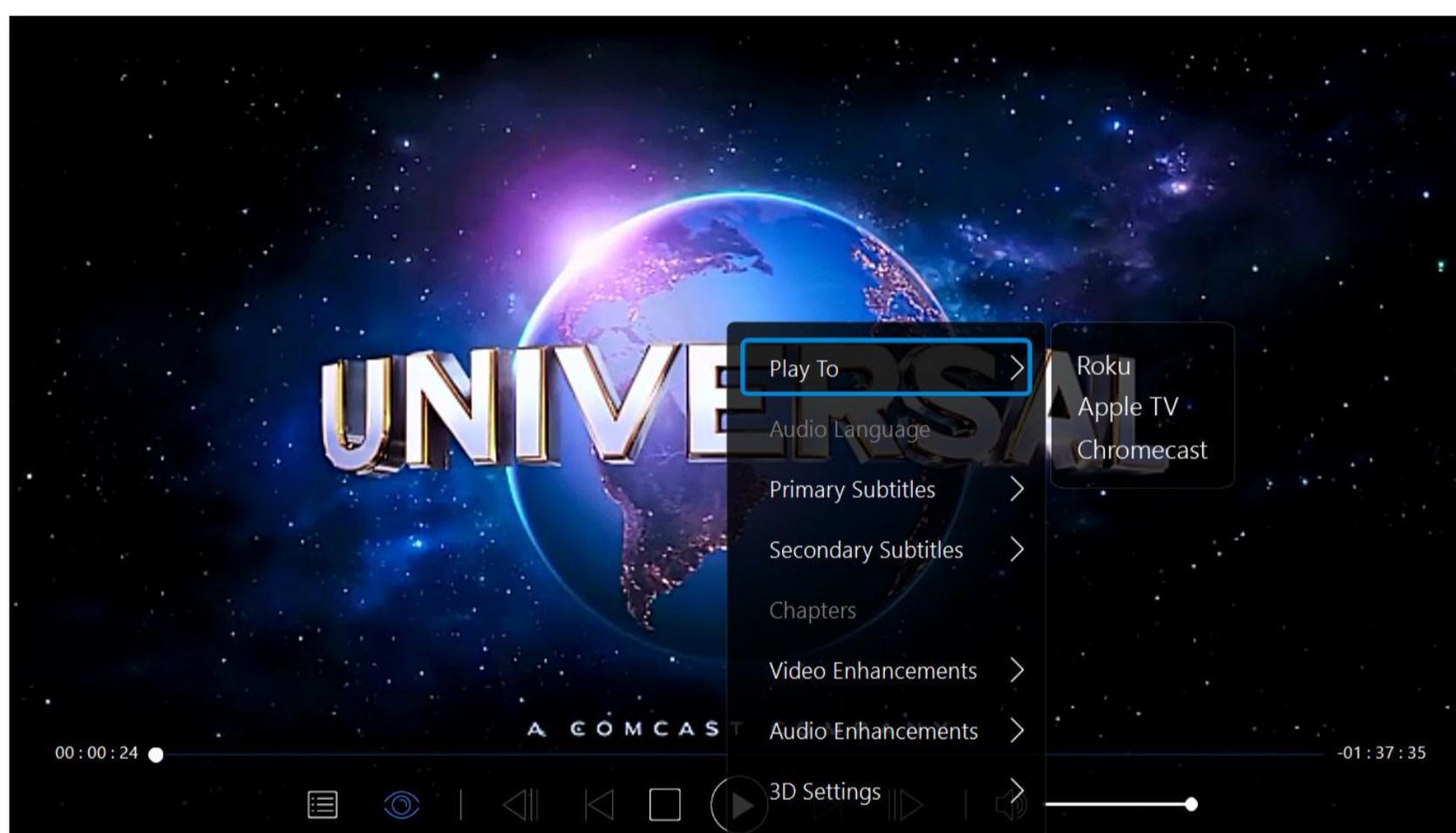
Another TrueTheater enhancement is Motion, which up-samples video to make motion smoother. These two features certainly make watching shaky home footage easier on the eyes. TrueTheater also corrects color, lighting, and sharpness, and you can adjust the strength of these effects with slider controls. You get to these simply by tapping the eye icon below the video. You can even use a split-screen view to compare the effects with the original video.

One issue I ran into with PowerDVD was that it played my Windows Phone video upside down, even though the thumbnail was right-side up. CyberLink staff told me that this was because of a bug with UHD displays like the one I test



on. Microsoft Movies & TV and iTunes don't have this issue, but CyberLink assured me that the bug would be fixed in short order. If you're not viewing on a 4K monitor, it won't affect you.

One new feature that's tied to the new TV mode (and shared with Microsoft Movies & TV) is the ability to cast video and audio to an external device such as an HDTV, either wired or wirelessly using Wi-Fi and Miracast or through DLNA. An unfortunate limitation of this technology, however, is that it doesn't let you stream Blu-ray discs, DVDs, movie folders, or ISO files. One surprising capability is that it can stream your video to an Apple TV. But PowerDVD isn't the only PC media-playing software that can do that: Apple iTunes can too, even with big Hollywood movies you buy from Apple's content store.



Unlike iTunes and Windows Movies & TV, PowerDVD doesn't include a content-buying option: You've got to download your movies and shows through some other means and then organize and play them back in PowerDVD. It does let you watch trailers, rate titles, and interact with the MoovieLive online fan community.

PowerDVD Ultra includes a year of 30GB of CyberLink Cloud storage. If you're a CyberLink Live subscriber, that amount continues as long as you subscribe. If not, you can buy online storage at \$9.99 for 10GB for a year, up to 100GB for \$100 per year. It's not the cheapest storage around, compared with iCloud, Google Drive, or OneDrive, but it ties in with your CyberLink products. You can upload photos and video from the program as well as from the mobile apps and then play the content from any device.

MOBILE APPS

PowerDVD's mobile apps set the product apart from the competition.

PowerDVD Remote and PowerDVD Player work both as remote players for content stored on the PC and as remote controls for playback on bigger PC and HDTV screens. They also tie in with the CyberLink Cloud: Any content stored there is playable in the mobile apps, though that's also true of the Apple iTunes store and Windows Movies & TV and Groove for audio.

Setting up the remote app is a simple matter of making sure the phone is connected to the same Wi-Fi network as the computer running PowerDVD and then entering a code from the Devices page. The app shows an overlay of its functions, which are pretty clear even without this mini-tutorial. It's a nicely designed app that includes keyboard and mouse functions, volume buttons, and skip buttons. But the remote app would be easier to use if you didn't need three modes—Navigation, Playback, and Mouse. The same problem with the PC mouse of not being able to click on-screen buttons exists for the app. You can click on the PowerDVD play controls at the bottom of the screen, though.

The Media Play app has a home page with choices for Music, Video, and Photo. I was able to load and play video from my PC running PowerDVD, and after logging into a CyberLink Cloud account, I could play videos from that source, too, for when I'm not on the same Wi-Fi network as the PC. The video doesn't play until it's completely downloaded, though. Video stored on OneDrive can stream to the service's mobile apps before full download.

CONCLUSIONS

If you download a lot of media to your PC and want to play it on a big screen, CyberLink PowerDVD 16 Ultra is a good way to go. The Microsoft Movies & TV app and iTunes offer playback with casting to larger screens, too, as well as stores for purchasing commercial video and music, but they lack PowerDVD's TrueTheater image improvement and mobile remote-control and media playing apps. Meanwhile, PowerDVD's closest competitor, Corel WinDVD, hasn't been updated in several years and also lacks mobile apps and a cloud storage option. All of this earns CyberLink PowerDVD our Editors' Choice.

MICHAEL MUCHMORE



Hopper Mobile App Helps You Get the Best Flight



The very best travel apps don't just help you get around once you land in a foreign place. They also help you plan, organize, and book travel. Mobile app Hopper (available for Android and iPhone) has been gaining attention recently for its ability to track and alert travelers about the lowest price for flights and the best time to buy. And the attention is quite deserved. The app is well designed, responsive, simple, and extremely adept at monitoring airfare prices and predicting when they'll change and by how much. For travel price tracking on a mobile device, it's better than even the very capable Kayak.

Hopper
(for Android)

Price: free download



DESIGN

One big reason I like Hopper as much as I do is because its design is clean, straightforward, and very user-friendly. Hopper pulls up a color-coded calendar when searching for flights. Red days are the most expensive, green are the least pricey, and you understand that without having to look at a more detailed key. There is a key, though, and it tells you each color's price cap for a particular search.

Say you want to fly from Miami to Bogota. To start, you tap on a magnifying glass icon to search. Next, you type the first few letters of the city or airport code until options appear that let you select your departure and arrival points. For cities with multiple airports, such as New York, options include all nearby airports, including JFK, LGA, and EWR.

Next, you look for either a one-way or roundtrip flight. The screen that appears shows monthly calendars for the next six months with color-coded days. For travelers with flexible travel dates, this interface does a fantastic job of helping you see price differences. You can tell at a glance, for example, that flying to Bogota is very expensive in October, but it's cheap during most of July. If your potential travel dates are further out, you can click to reveal more months.

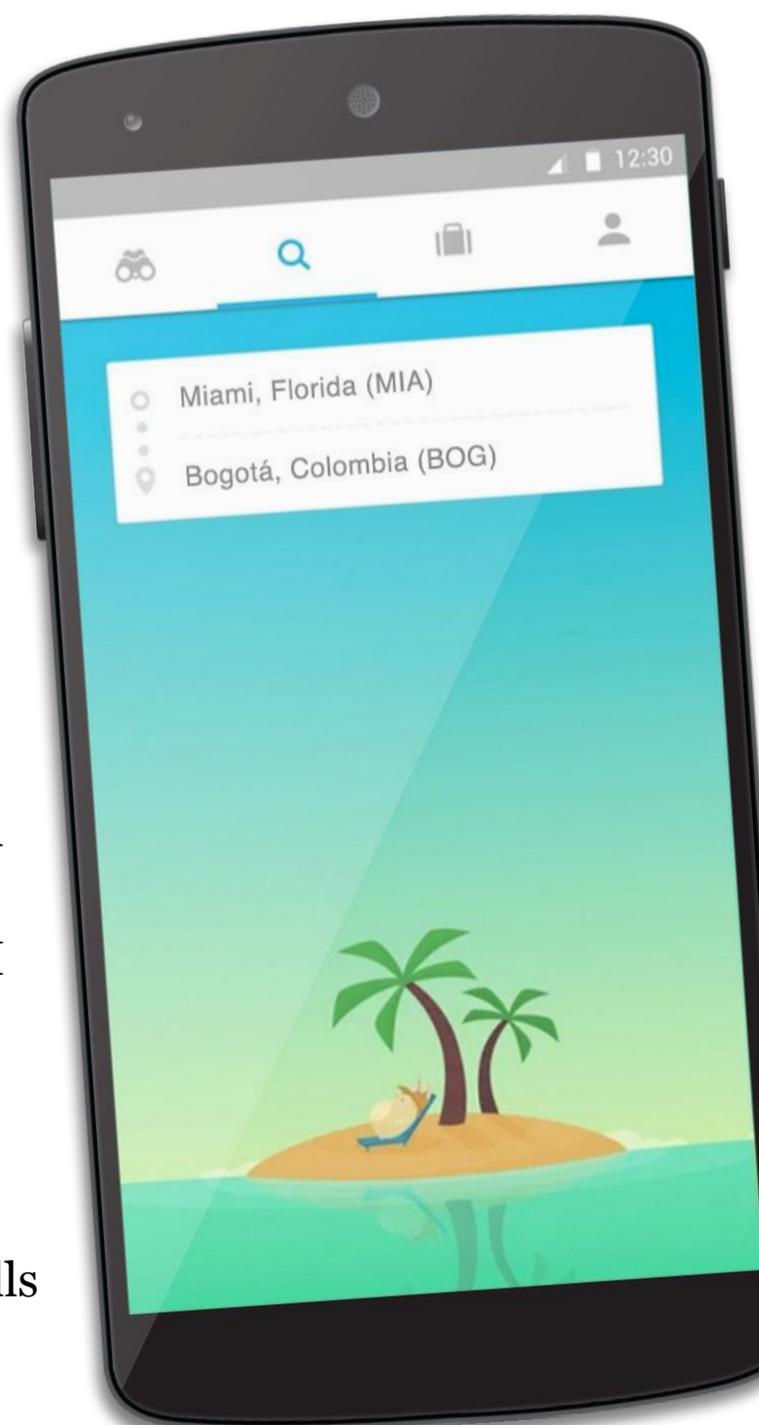
Tap the dates you want to travel, and Hopper starts looking for the best flights. A prediction screen then advises you whether to buy now or wait. In my case, I was told that the current price was \$455, but I could save \$187 if I wait for the right time to buy. I love the specificity, but so far it's pretty similar to what you'll find in some other travel tracking and prediction tools.

Here's where Hopper gets even more specific. It tells you when prices are low, when they're expected to increase again, and by how much. For the Miami-Bogota trip, Hopper anticipates the price will vary over

Hopper (for Android)

PROS Tracks and predicts flight prices. Wonderful interface. Responsive. Solid notifications.

CONS No Web app. Searches only flights. Filters aren't the most advanced.



the next four months, but it could drop to \$268. Then, sometime around September 25, Hopper expects the price to rise by \$36.

Those details are handy for times when you aren't sure whether your travel plans will change. Can I afford to spend more if I'm not ready to buy and the price goes up? In this case, yes. If I rush to buy a ticket that I ultimately won't be able to use, the change fee alone could be twice as much as the price increase. I'd rather wait and pay \$36 more for a ticket than \$100 in change fees. (That's an example and isn't based on any particular airline's fee, although for what it's worth, the last time I paid such a fee, it was about that much.)

Here's another example: I searched for a flight from New York to Trinidad. Hopper told me that a good price on a nonstop round-trip ticket is \$450, and adding a layover drops the price by only about \$25. I'll take that direct flight, please!

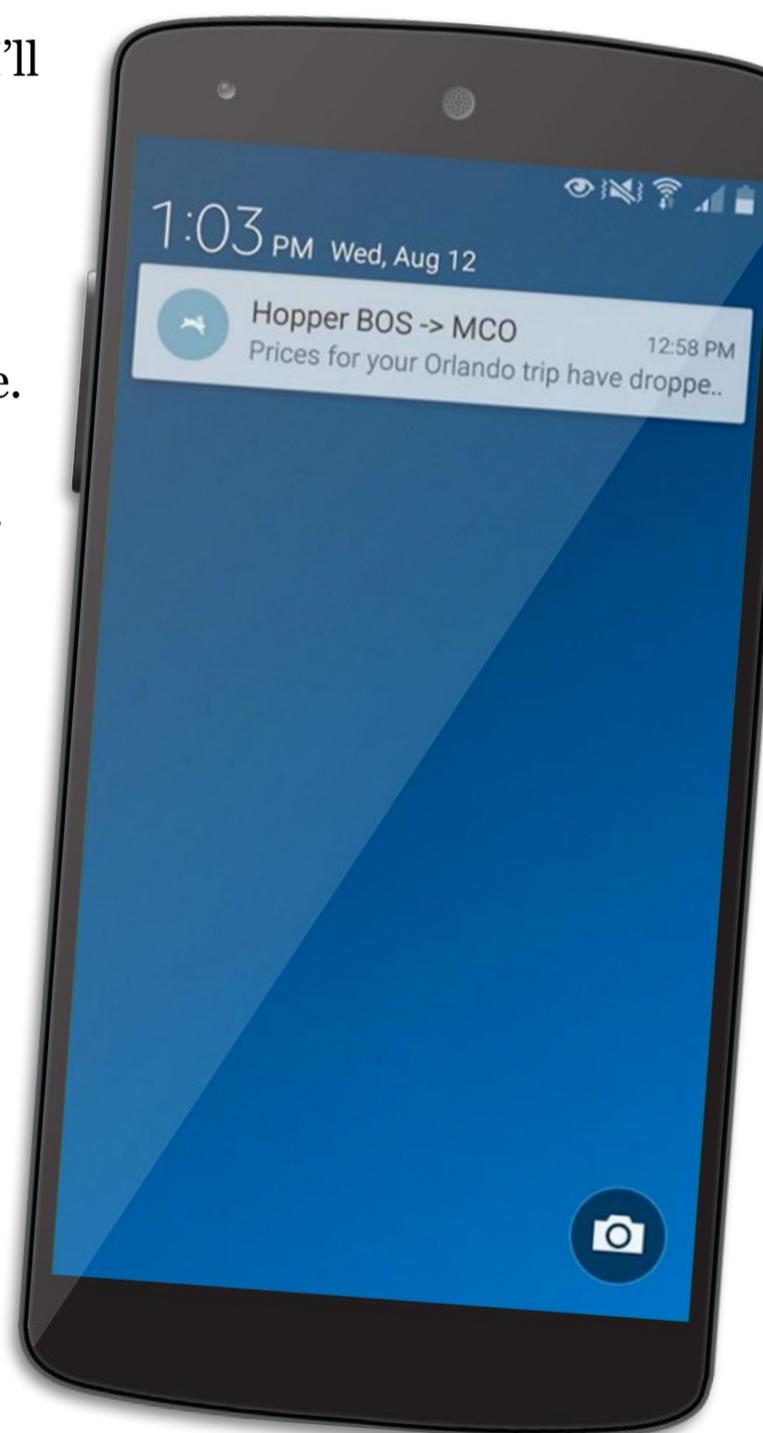
ALERTS

A button on the bottom of the page lets you Watch This Trip, meaning Hopper keeps an eye on the price. When it finds a good price, it tells you via push notification. You can watch up to 99 flights at a time. Any time Hopper is tracking prices, it updates you periodically with the current price and advice on whether you should buy or wait.

In the app's settings, you can turn off the alerts and choose whether to silence them overnight, between 11 p.m. and 7 a.m. You can also change the currency. The settings are fine, but I'd like to see them built out in future updates. For instance, I'd love to be able to tell Hopper my home airport and get alerts about amazing flight deals leaving from it. Bonus points if I can opt into notifications about, say, amazing deals from my home airport for the month of January.



For travelers who have flexible travel dates, this interface does a fantastic job of helping you see the price differences.



BUYING

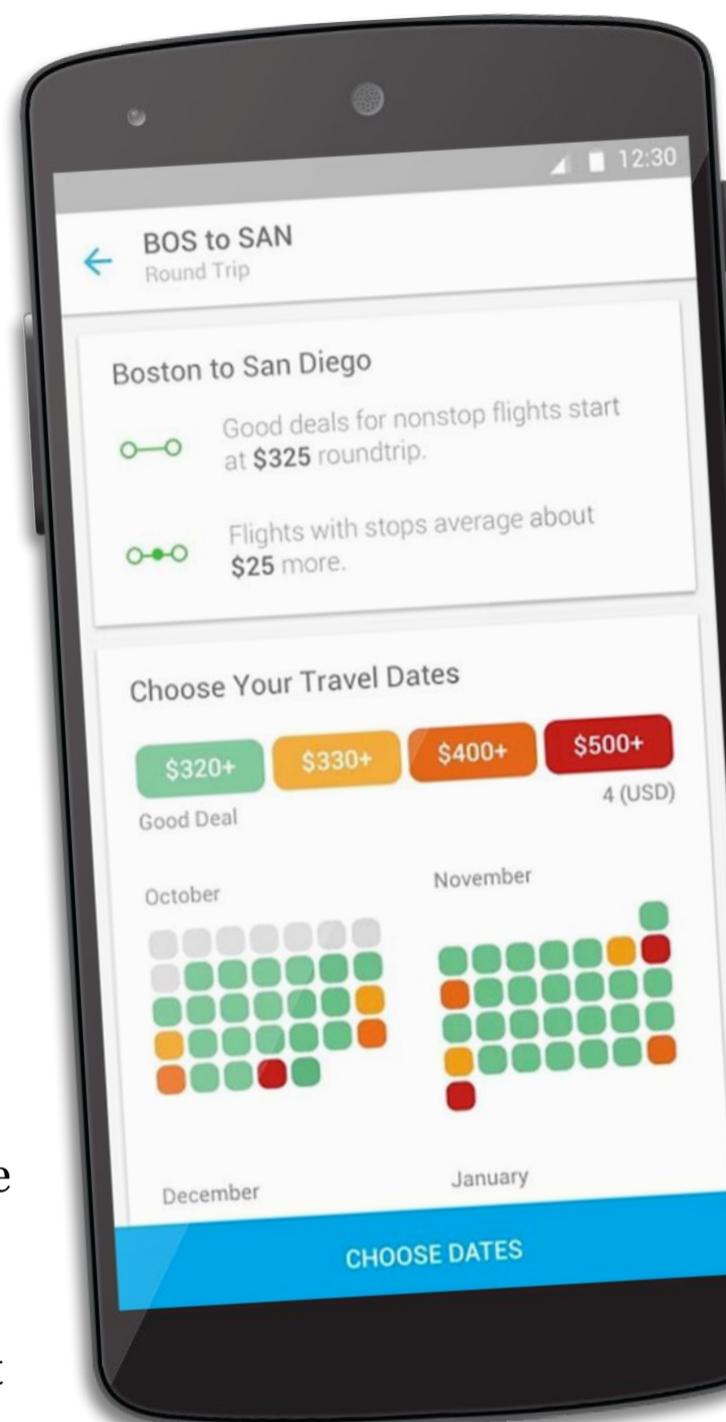
You can choose the flights you want from a clean and organized list of summaries of each flight, easily seeing the carrier, departure and arrival times, and flight duration. A sorting tool at the top of the page helps you narrow in on the shortest flights to find the ones that were nonstop. You can also sort by departure time, arrival time, and number of stops. If you're ready to jump on a good price for a flight, Hopper takes you all the way through the point of purchase. Hopper makes the booking for you directly with the airline. As you reach the final payment page but before you enter your credit card, Hopper shows you a breakdown of the fare, which includes a commission. On a roughly \$400 flight, the fee was \$6, and it was completely transparent: clear, labeled, and easy to see.

A company representative explained that the commission is based on the route. For most flights, the fee is about \$5. International flights that cost more than \$900 are charged an \$8 commission.

I also asked the spokesperson for more details about who owns the booking when you pay through Hopper. With most third-party booking sites, such as OrbitzFree at iTunes Store and ExpediaFree at iTunes Store, you have to deal with that company rather than the airline or hotel directly if you need to change your booking. Same with Hopper; it has an email address and phone number for customer support. Hopper doesn't charge any change fees, but the airline probably would, and those will be passed on to you.

WHAT'S MISSING

I already wrote that there are features I'd love to see in Hopper that don't currently exist, like a Deals page. The app isn't crammed with features; it's a mobile app, and there's something to be said for simplicity on a mobile device. Some features might be better left to a Web app, but Hopper doesn't have one. Google Flights and Kayak do have Web apps, and they have more options for rolling the dice and finding a cheap flight to any destination.



When I need the most filtering tools during a search, Kayak (the Web version) is always my first stop. I like that I can look for flights to and from a major city, such as San Francisco, and exclude any nearby airports that I don't want while including the rest (for example, SFO and OAK, but not SJC). On mobile, however, Hopper beats Kayak for price tracking and alerts. The interface is cleaner and easier to use.

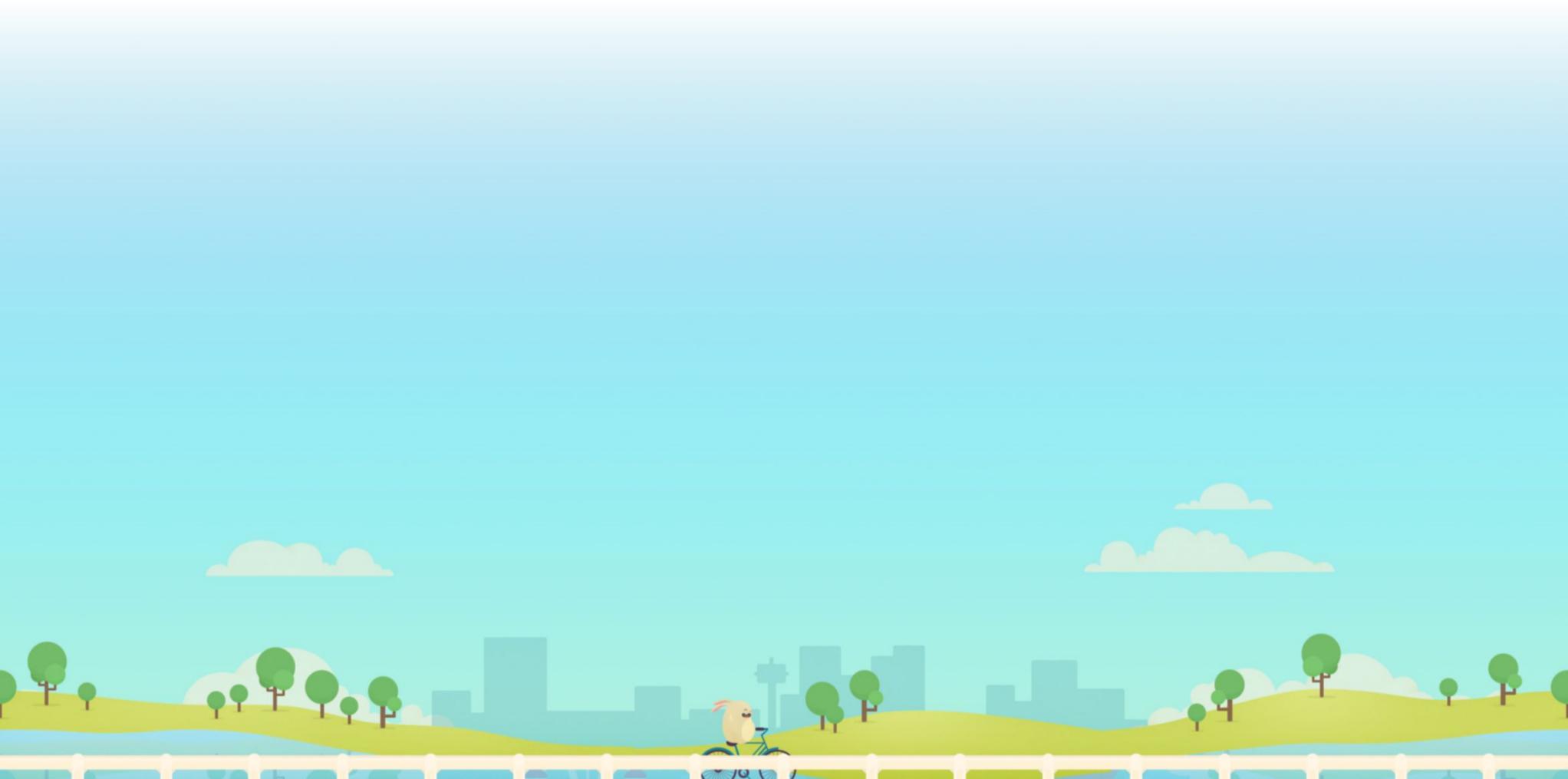
CONCLUSION

Hopper sticks to flight search and price prediction—and it does a fantastic job. Considering Hopper is a mobile app, it's stellar. It doesn't go overboard with features and offers extremely clear information. Still, I'm excited to watch this little app grow, and I hope its next step is to add a full Web app.

JILL DUFFY



The app isn't crammed with features; it's a mobile app, and there's something to be said for simplicity on a mobile device.



Features

**FASTEST MOBILE
NETWORKS
2016**

FEATURES

**FASTEST
MOBILE
NETWORKS
2016**

BY SASCHA SEGAN

Verizon Wireless notched its third successive win as the nation's Fastest Mobile Network, with T-Mobile hot on its heels. The two carriers have staked out the premium and value positions in our huge smartphone market. Much of the difference comes in Verizon's still far-superior reliability outside of major cities—although T-Mobile is doing better there, too.

For our seventh annual drive test, we visited 30 major U.S. cities and the countryside in between, testing six networks: all four major LTE networks, along with AT&T and T-Mobile 3G. (For more on those last two, see *Whatever Happened to 3G?*) We drove Audi A4 cars from Silvercar with Samsung Galaxy S6 Edge+ phones and custom field-test software written by Ookla, the folks behind Speedtest.net. We collected more than 178,000 data points. (Read about how we tested in *Methodology*.)

Either Verizon or AT&T has won our national award every year since 2010. Verizon deserves kudos for staying in the lead, and it has implemented impressive technologies to do so. The real drama has been watching T-Mobile and Sprint come back from their doldrums of a few years ago. T-Mobile is either first or second in most cities, a change that really took effect last year.

This year's story is that Sprint is finally back. We saw the beginning of this last year, but it really kicked into gear in 2016 with Sprint's new LTE Plus system, which uses two merged 20MHz channels to massively boost download speeds. Sprint's network is much more geared to downloads than to uploads, but the company argues that most smartphone users' lifestyles are, too. Sprint won three cities this year, and while it's still in fourth place nationwide, it placed third or second in many cities. Considering how cheap Sprint's service plans are right now, you should start thinking about Sprint as a carrier again.



This year's story is that Sprint is finally back. We saw the beginning of this last year, but it really kicked into gear in 2016 with Sprint's new LTE Plus system, which uses two merged 20MHz channels to massively boost download speeds.



Sprint and T-Mobile's improvements over the past few years emphasize something very important that every American needs to stay vigilant about: Having four competitive, nationwide networks is not only perfectly possible, it's good for America.

First with AT&T and T-Mobile in 2011, then with Sprint and T-Mobile in 2014, greedy wireless companies said they simply couldn't survive, much less improve their networks, without merging. This year's results show once again that's not true. Just as T-Mobile became the "Uncarrier" and engineered a comeback after the first failed merger, Sprint's focus on building a network rather than trying to gobble up a competitor really seems to be turning things around.

WINNING STRATEGIES

Verizon continues to lead through a combination of deep pockets, forward thinking, and a focus on building a network rather than trying to find quick-fix wins through corporate mergers. The company added to its spectrum bank with a \$10 billion purchase in 2015, giving it 40MHz of the most commonly used LTE spectrum in 92 of the top 100 US cities. This year, it brought 2x20MHz carrier aggregation and 4x4 MIMO antennas to the table, technologies which sped up its network without requiring it to build or lease new towers or airwaves.

T-Mobile is also using 2x20MHz carrier aggregation for speeds, something the company calls "wideband LTE," but its real focus is on expanding coverage. T-Mobile built out LTE in many suburban and rural areas this year and is poised to expand its reach much more, as the carrier starts to build out a bunch of low-frequency 700MHz licenses that it's currently in the middle of getting FCC approval for. T-Mobile now covers many areas where it had 2G or no coverage at all last year: For example, along the US 64 corridor in eastern



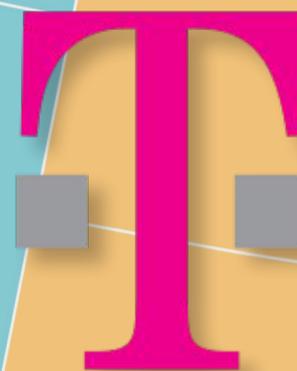
North Carolina and in the northwest suburbs of the New York City metro area.

With Verizon and T-Mobile winning the smartphone wars for the moment, AT&T and Sprint are positioning themselves for the next battles.

Sprint has a gigantic swath of high-capacity, high-frequency spectrum that doesn't have much range. It recently rebranded this spectrum LTE Plus, devoted most of it to high download speeds, and has deployed it in larger cities. The plan is working: Sprint's speeds are now competitive, and the carrier's network is no longer the laughingstock it was in danger of becoming. But that's not Sprint's long-term strategy. John Saw, Sprint's current CTO, came from Clearwire, where he was a wizard of WISPs, which are wireless ISPs for primary Internet access. Sprint's necessarily dense 2.5GHz buildout positions it well for the super-high-speed urban millimeter-wave networks of the future—and potentially for busting open the tired old wired ISP monopolies.

Since appointing Glenn Lurie, the head of its emerging devices business, as CEO in late 2014, AT&T Mobility has been positioning itself as the premiere carrier for smart cities and the Internet of Things. This requires a different kind of network than something designed to be an ISP or for mobile video streaming: A smart city network should focus on reliability, broad coverage, and low latency, and if you look at our AT&T results, that's exactly what it's doing.

How much of this is necessity versus strategy? You could very well argue that AT&T's strategy fits with its spectrum layout of lots of fragmented little bits and bobs, while Sprint's is forced by the fact

The Verizon logo, consisting of the word "verizon" in a bold, black, sans-serif font with a red checkmark above the "n".

that most of its bandwidth only goes short distances from towers. Spectrum may still be destiny in the wireless world. So now we get to the two big things that may change our networks in 2017.

THE FUTURE: 600MHZ AND 5G

This year, the FCC is auctioning off its biggest swath of spectrum since 2008, a monstrous 126MHz of nation-spanning 600MHz that used to be old TV channels. Some of it is still used by TV channels, which would have to move. That means those chunks would take years for wireless carriers to take over.

AT&T, T-Mobile, U.S. Cellular, and Verizon are all bidding in the auction, along with a bunch of smaller rural wireless carriers. Sprint is sitting it out, whether from lack of cash (as some analysts say) or from a strategy that focuses on higher frequency bands (as Saw says).

The auction will run through June, and T-Mobile has said it will start to be able to deploy networks in rural areas by the end of 2017. Combined with T-Mobile scooping up unused 700MHz spectrum this year, that could really open up rural Americans' wireless options.

Meanwhile, the 5G race has truly begun. What is 5G, anyway? The answer depends on who you ask, but it's looking like the term describes a combination of super-high-speed, super-high-frequency, relatively short-distance wireless networks with towers every few blocks, along with ways to seamlessly integrate Wi-Fi and cellular.

As I was writing this, I got a press release about Sprint demonstrating 2Gbps speeds at a soccer field. T-Mobile's CTO Neville Ray has said 5G won't be a big consumer deal until 2020 or so, but Verizon and AT&T are both looking at fixed wireless 5G applications within the next two years. Along with its obvious applications as a home ISP alternative, I wouldn't be surprised to see 5G used as supplementary backhaul to lessen choked-up 4G networks during conventions and sports games.



THE DETAILS
Testers used Samsung Galaxy S6 Edge+ phones and custom field-test software from Ookla.

For 2016, though, Verizon is the nation's fastest mobile network. That said, it won only about half of our cities, and the competition is catching up, which is great news for users. Page through our city profiles to see which of the four major carriers won in your city or region, and also take a look at our national and regional summaries.

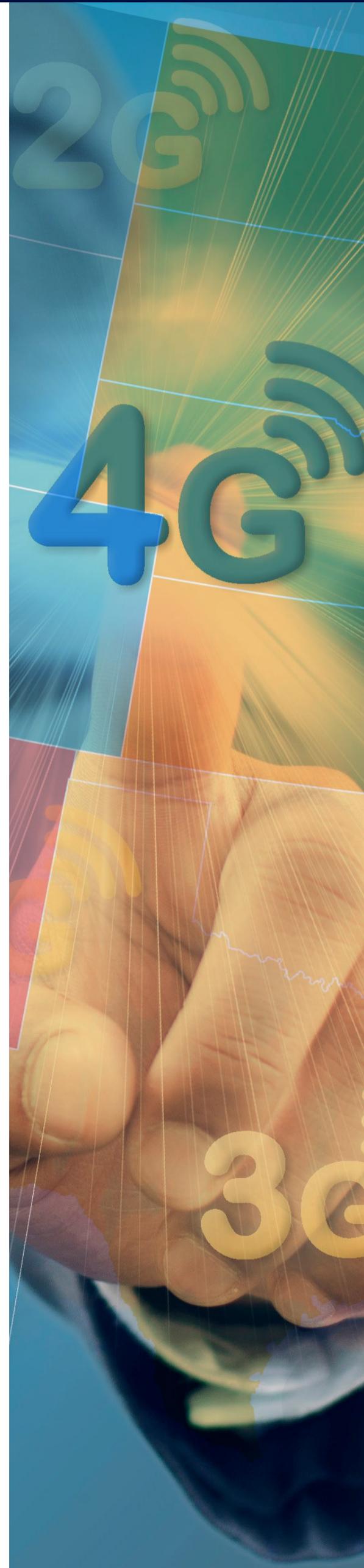
Whatever Happened to 3G?

Our nation's 3G networks are now about ten years old. It's time to start saying goodbye.

Third-generation cellular technologies, including HSPA and EVDO, ushered in the modern age of smartphones. But in the past three years, they've been outpaced by 4G LTE, which offers far greater speed and capacity for the same spectrum usage. Low-cost phones were the last bastion of 3G-only capability, but now you see even budget, prepaid smartphones, like the \$100 T-Mobile Catalyst, porting LTE. That leaves voice-first "safety" phones, such as AT&T's SpareOne Emergency Phone, as the primary users of 3G networks.

AT&T and T-Mobile's 3G networks can offer decent speeds of 3Mbps to 5Mbps, although they've declined over the past few years as the carriers have devoted formerly 3G airwaves to LTE. Verizon and Sprint's 2G and 3G CDMA networks haven't changed measurably in several years. They're used almost entirely for voice and text, not data, and their sub-1Mbps data speeds wouldn't satisfy anyone in this broadband era. Verizon and Sprint agreed with us that it's not worth running speed tests on those networks any longer.

Carriers are looking at turning off 2G, but 3G will stay alive for many years. AT&T is entirely shutting down its 2G network by January 2017, making it a purely 3G/4G carrier. T-Mobile hasn't announced an actual shutdown date for 2G, but said it's reducing both 2G and 3G network capacity to the absolute minimum and



focusing on LTE. You can see that in our test results. T-Mobile used to run HSPA+ 42, with real-world speeds up to about 20Mbps, but now it's by and large back to HSPA 14.4.

The primary reason 3G and 2G are staying alive doesn't have to do with phones. It's because of machine-to-machine modules, which transfer very small amounts of data, have long lifespans, and don't need high speeds. The little gadgets in vending machines, water meters, and smart public trash cans will eventually be replaced by LTE or even 5G modules, but the carriers are giving their business customers another decade or so to make that transition.

There are still areas where 3G—and even 2G—are important. We mapped out our drives, and of the four major carriers, Sprint by far still relies the most heavily on 3G. We got 3G hits on Sprint in most of Utah and Nevada; a startling amount of California; long stretches of Alabama, Kentucky, and central Pennsylvania; and the mountains of Virginia, for example. That puts Sprint at a severe disadvantage in rural areas, as its 3G network doesn't provide acceptable data performance.

We found that all of the carriers had long stretches of 2G and 3G in far Northern California and central Idaho. T-Mobile dropped back to 2G in rural Virginia, Idaho, and far Northern California. AT&T had big swaths of 3G in Northern Arizona, Southern Oregon, central Utah, central Pennsylvania, and both Virginia and West Virginia.

Because T-Mobile came late to LTE, for a while it had an extremely fast 3G network. But now its 3G has slowed down as its airwaves are redirected to LTE. T-Mobile has also always had long 3G ping times, part of a power-saving move where its phones rest in a low-power mode, taking a longer time to negotiate with towers about their maximum 3G speeds than AT&T phones do. That makes AT&T's 3G network the faster one nationwide.

Testing Methodology

For our seventh year of testing, we switched both software and car providers. This year, we used custom field-test software designed by Ookla, the folks who brought you Speedtest.net. (Ookla is owned by PC Magazine's parent company, Ziff Davis.) The software was loaded onto six Samsung Galaxy S6 Edge+ phones, which were driven around in three Audi A4 cars rented from Silvercar.

Ookla's software ran every three minutes. It tests HTTP uploads and downloads, as well as ping times to a nearby, randomized, neutral (non-carrier) server. The software locked the phones together so they were all pinging against

the same server in any given test.

We stopped at between 12 and 15 locations, for at least 15 minutes each, in our 30 cities. We averaged the data in each location, then averaged the locations together for an overall city result. The aggregated data from traveling between the test locations counted into the overall averages as two more locations.

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

We tested mostly during business hours, from May 2 through May 23, 2016. We visited different cities on different days. We ended up with about 178,000 data points, which we processed through a MySQL database and summarized on an Excel 2010 spreadsheet.



Northeast

Boston, MA
New York, NY
Philadelphia, PA
Pittsburgh, PA
Washington, D.C.

Southeast

Atlanta, GA
Charlotte, NC
Miami, FL
Nashville, TN
Raleigh-Durham, NC

North Central

Chicago, IL
Columbus, OH
Detroit, MI
Kansas City, MO
St. Louis, MO

South Central

Austin, TX
Dallas, TX
Houston, TX
New Orleans, LA
Oklahoma City, OK

Northwest

Seattle, WA
Portland, OR
San Francisco, CA
Salt Lake City, UT
Boise, ID

Southwest

Las Vegas, NV
Los Angeles, CA
San Diego, CA
Phoenix, AZ
Tucson, AZ

The PCMag Speed Score

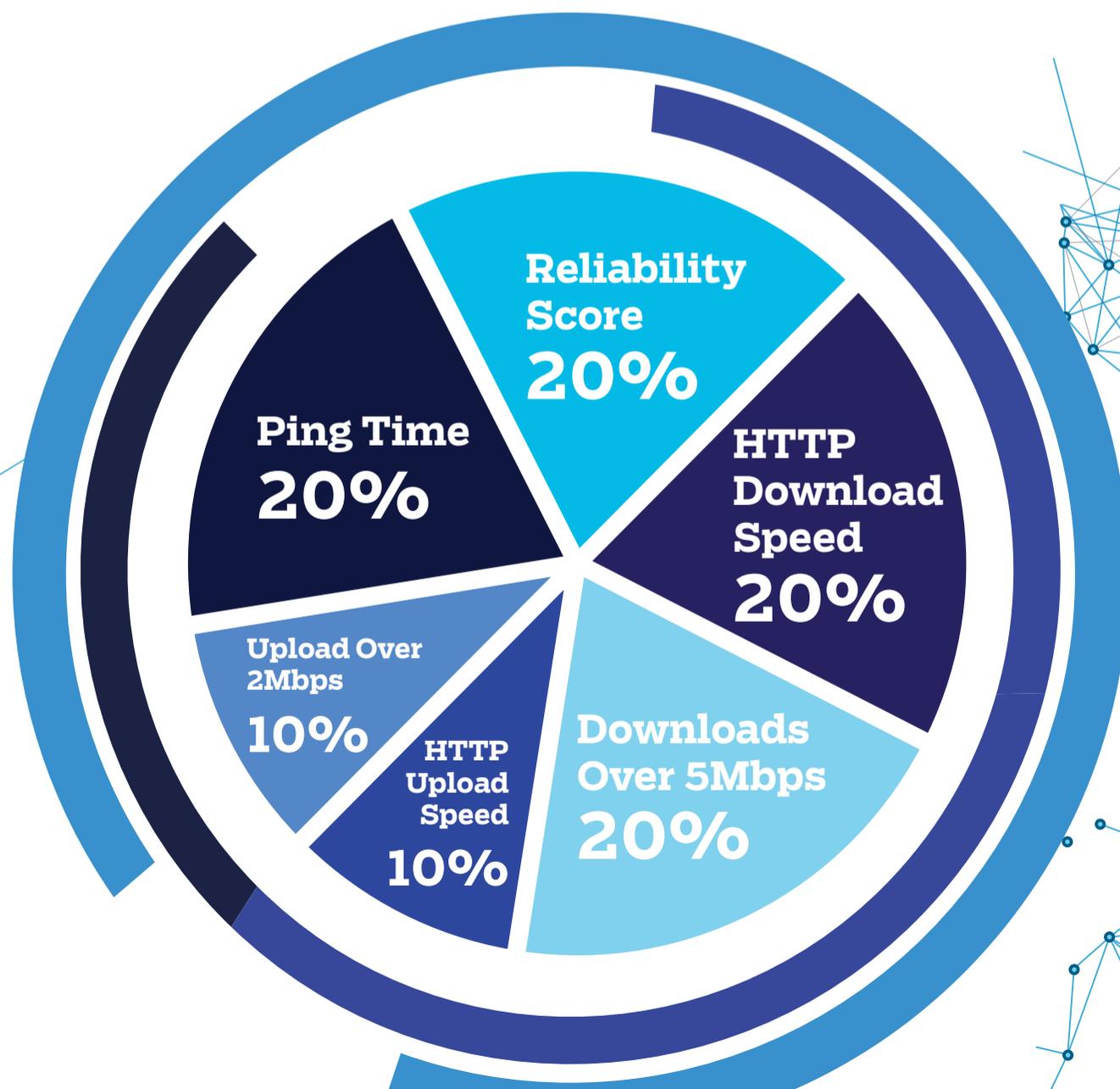
The PCMag Speed Score is a weighted average that looks at six components of the mobile data experience.

Since we're using different software this year, we took a fresh look at the components of our speed score. This year, we decided to amp up download consistency from 10 percent to 20 percent, but we left most of the other components the same.

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

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

Here's how it all came together:



Renting With Silvercar

This year, we partnered with Silvercar for our vehicles. Silvercar is a car-rental firm with many of the kinks smoothed out. It's not a taxi service, and it doesn't require a subscription. You do all of your renting and management through an app, so you never have to deal with high-pressure sales staff. You always get a silver Audi A4 with Sirius XM satellite radio and a Wi-Fi hotspot. And your bill is clearer and simpler than you'll get from a traditional car rental place.

The major takeaway: You get a silver Audi A4. Over the past several years, we have driven many cars for FMN. We drove Ford cars, GM cars, and random rental cars. Nothing charged up our drivers like these A4s. Two of our drivers said they were unprepared for the smooth acceleration and sharp handling, and one said the responsive brakes kept him out of a hairy situation with a truck in Pennsylvania.

Our drivers really liked the cars' built-in GPS and easy radio controls. Silvercar's customer service was also miles beyond what we normally expect of a car rental company. When one of our drivers couldn't start the car, she got a customer service rep on the phone very quickly to talk her through the process.

Silvercar's locations can be a bit hard to find, though. They are typically off-airport, and in the case of the company's Manhattan location, hidden deep in an apartment building's parking garage. You have to call or text Silvercar at most of its locations so someone can come and get you. When you drop off your car, a Silvercar employee will drive you back to the airport terminal.

You can find less expensive car rentals than Silvercar. The company's experience is about



SIMPLY LUXURIOUS

This year our testing drivers hit the road in Silvercar vehicles, which all happen to be silver (of course) Audi A4s. The car-rental company isn't the most inexpensive option out there, but we were impressed by the cars' smooth handling and also by Silvercar's excellent customer service.



WHAT YOU GET WITH SILVERCAR...

...besides an Audi A4: GPS, a Wi-Fi hotspot, Sirius XM Satellite Radio, and a toll transponder are all included in the rental fee.

packaging together a bunch of luxury experiences simply, not about being the cheapest. Rentals in Chicago are \$69 per day plus taxes and fees. In LA, it's \$79 per day. In Brooklyn or Dallas, you pay \$89 per day.

The base rate for a midsize car from Budget at the Dallas/Fort Worth International Airport for the same dates is \$61, and you can get smaller cars for as little as \$41 per day. But with other companies, GPS costs extra (usually around \$6 per day), toll transponders cost another \$4 per day, and if you can get a portable Wi-Fi hotspot with your rental car, that can be another \$10 per day. All those things are included with Silvercar.

Also, your average rental car isn't a silver Audi.

FEATURES

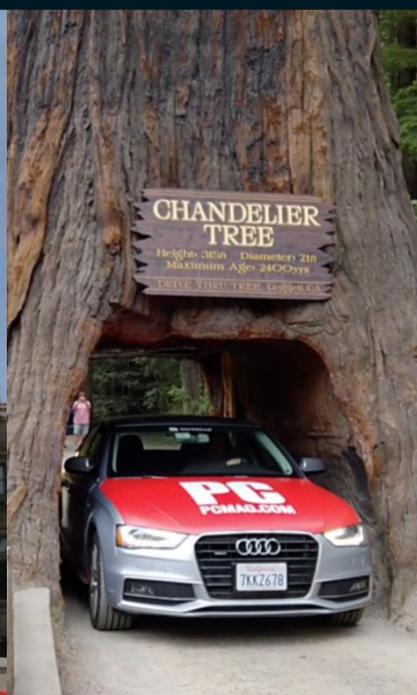
**FASTEST
MOBILE
NETWORKS**

**AND THE
WINNERS
ARE...**

National Overall Winner VERIZON

Verizon Wireless won more of our cities and rural areas than any other carrier, which makes it the Fastest Mobile Network nationwide. The nation's largest wireless carrier had the fastest and most consistently broadband-like download speeds in testing, as well as some breathtaking peak speeds. As long as you're using a recent phone that's capable of carrier aggregation, you're likely to get a speedy result on Verizon's well-built 4G network.

National	AT&T 4G	Sprint 4G	T-Mobile 4G	Verizon 4G
Download Speed (Mbps)				
Maximum	119.16	122.60	125.65	160.47
Average	19.01	20.58	19.88	27.79
Downloads Above 5Mbps (%)	76%	72%	74%	79%
Upload Speed (Mbps)				
Maximum	29.19	23.83	43.66	47.70
Average	9.18	6.90	18.02	14.74
Uploads Over 2Mbps (%)	82%	77%	88%	83%
Average Ping (ms)				
	64.69	64.75	60.12	60.97
Reliability (%)				
	95%	93%	93%	91%
Speed Score				
	86 out of 100	84 out of 100	93 out of 100	97 out of 100

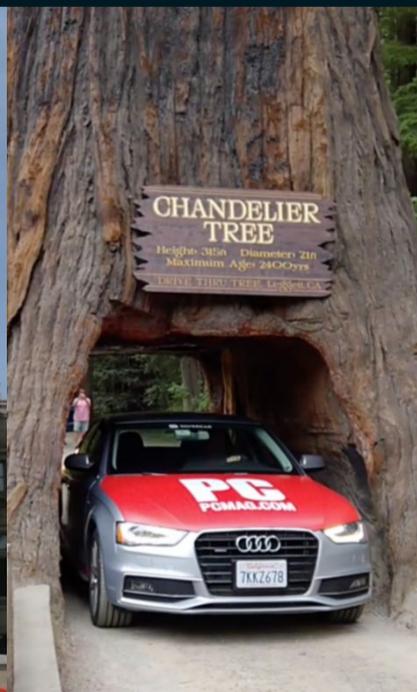


Northeast Region Winner

T-MOBILE

Within the Northeast, T-Mobile took New York, Philadelphia, and Boston, while AT&T took Pittsburgh, and Verizon took Washington DC and our suburban/rural areas. T-Mobile has done an undeniably impressive job of lighting up the Boston-Washington corridor, its dense cities and suburbs, with fast 4G LTE, and it's made New York City a showcase for what it can do. The winner weakened only when it got farther west into Pennsylvania and especially West Virginia, which it doesn't cover at all.

NE Region				
	AT&T 4G	Sprint 4G	T-Mobile 4G	Verizon 4G
Download Speed (Mbps)				
Maximum	95.69	104.04	94.83	129.88
Average	20.56	22.90	19.97	26.98
Downloads Above 5Mbps (%)	86%	75%	76%	82%
Upload Speed (Mbps)				
Maximum	28.94	16.75	43.40	39.53
Average	9.85	6.92	17.94	15.75
Uploads Over 2Mbps (%)	89%	75%	90%	83%
Average Ping (ms)				
	43.99	53.92	40.75	53.17
Reliability (%)				
	97%	92%	94%	93%
Speed Score				
	89 out of 100	80 out of 100	92 out of 100	92 out of 100

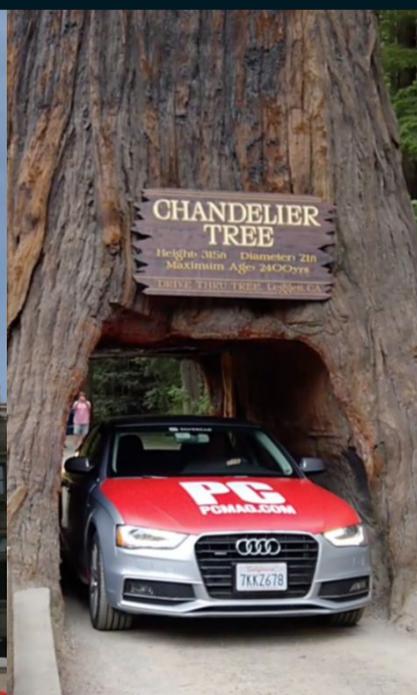


Southeast Region Winners

AT&T/T-MOBILE/VERIZON

It's a three-way tie! We've never seen that before in our seven years of testing. In our Southeast region, T-Mobile won Raleigh and Nashville, AT&T won Charlotte and the rural areas, and Verizon won Atlanta and Miami. The real news here is T-Mobile taking Raleigh away from AT&T, as North Carolina has long been an AT&T stronghold. T-Mobile has been greatly improving its North Carolina coverage recently, even without the help of its 700Mhz Extended Range LTE service. We'd still rely on AT&T for comprehensive coverage across North Carolina, though.

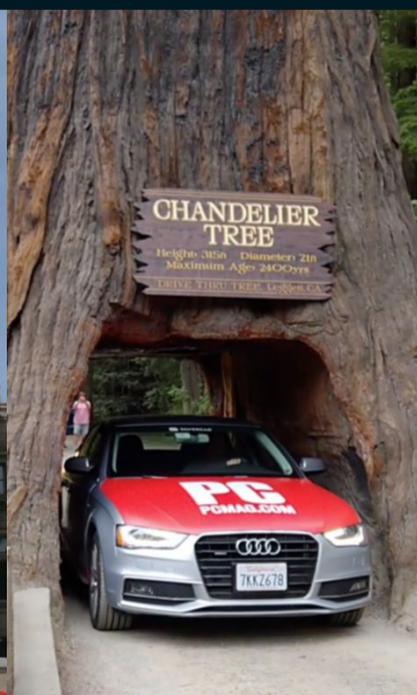
SE Region	AT&T 4G	Sprint 4G	T-Mobile 4G	Verizon 4G
Download Speed (Mbps)				
Maximum	90.39	118.03	110.30	141.45
Average	21.88	17.02	18.58	31.73
Downloads Above 5Mbps (%)	74%	69%	77%	77%
Upload Speed (Mbps)				
Maximum	28.27	17.36	36.62	46.59
Average	10.06	5.78	18.39	17.30
Uploads Over 2Mbps (%)	79%	73%	89%	81%
Average Ping (ms)				
	71.65	64.83	67.02	59.82
Reliability (%)				
	93%	92%	94%	88%
Speed Score				
	84 out of 100	78 out of 100	90 out of 100	97 out of 100



North Central Region Winner VERIZON

In the North Central region, Sprint won Columbus while Verizon took Chicago, Detroit, St. Louis, Kansas City, and the rural drives. Verizon's dominance here is pretty complete, with maximum speeds regularly over 100Mbps.

NC Region	AT&T 4G	Sprint 4G	T-Mobile 4G	Verizon 4G
Download Speed (Mbps)				
Maximum	83.30	119.18	122.17	151.30
Average	19.26	24.26	17.35	38.12
Downloads Above 5Mbps (%)	81%	83%	69%	85%
Upload Speed (Mbps)				
Maximum	29.18	23.83	38.89	47.70
Average	8.25	8.52	17.95	18.85
Uploads Over 2Mbps (%)	86%	85%	89%	84%
Average Ping (ms)				
	73.00	62.77	59.26	52.21
Reliability (%)				
	97%	94%	95%	92%
Speed Score				
	78 out of 100	82 out of 100	82 out of 100	98 out of 100



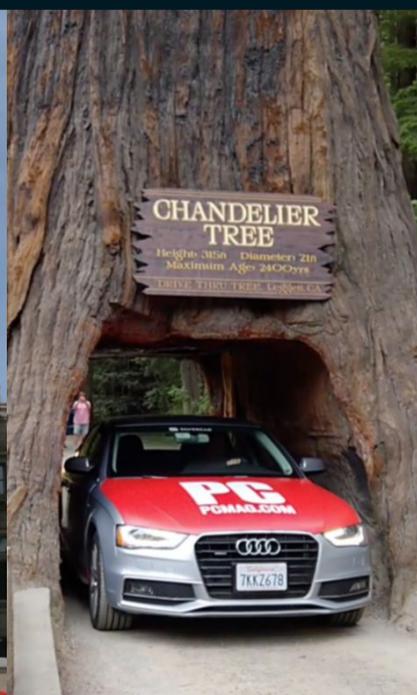
South Central Region Winner

AT&T

AT&T's heartland is the South Central part of the country. In this region, T-Mobile took Austin and Verizon took Dallas, but AT&T took Oklahoma City, New Orleans, Houston, and the rural areas.

AT&T didn't win a lot of cities this year, but its network in states including Texas and Oklahoma is excellent. I'd point out the carrier's relatively low ping times here, which play a big role in making Web pages feel responsive but are also key for the kind of smart city initiatives that AT&T wants to lead on.

SC Region	AT&T 4G	Sprint 4G	T-Mobile 4G	Verizon 4G
Download Speed (Mbps)				
Maximum	119.16	119.04	83.81	104.45
Average	19.65	19.91	16.10	22.49
Downloads Above 5Mbps (%)	78%	65%	72%	83%
Upload Speed (Mbps)				
Maximum	29.00	15.59	35.81	36.18
Average	11.14	6.82	16.32	9.89
Uploads Over 2Mbps (%)	88%	79%	89%	91%
Average Ping (ms)				
	56.56	63.10	61.27	64.45
Reliability (%)				
	98%	97%	95%	93%
Speed Score				
	93 out of 100	84 out of 100	89 out of 100	93 out of 100



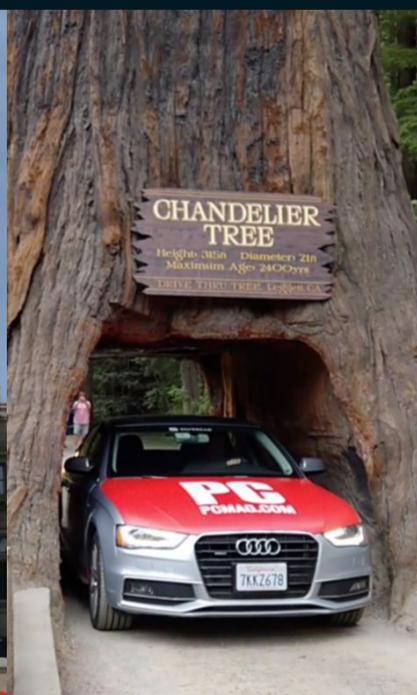
Northwest Region Winner

VERIZON

In the Northwest region, Sprint won Seattle, T-Mobile won Portland and Boise, and Verizon won San Francisco, Salt Lake City, and the rural areas. In the Mountain West, coverage really matters, and we found that Verizon has a much broader, more reliable network than its competitors. It's no shirker on speed and capacity either.

Sprint's win in Seattle augurs a much more competitive experience in the Northwest. And next year, T-Mobile will back up its excellent Boise speeds with broader coverage in Idaho thanks to a spectrum purchase currently under review by the FCC.

NW Region	AT&T 4G	Sprint 4G	T-Mobile 4G	Verizon 4G
Download Speed (Mbps)				
Maximum	95.01	122.60	125.65	160.47
Average	14.86	25.29	26.92	25.84
Downloads Above 5Mbps (%)	66%	79%	80%	76%
Upload Speed (Mbps)				
Maximum	28.70	20.64	43.53	45.59
Average	6.61	7.56	20.29	13.67
Uploads Over 2Mbps (%)	75%	76%	86%	80%
Average Ping (ms)				
	77.88	73.27	67.54	67.32
Reliability (%)				
	93%	91%	91%	89%
Speed Score				
	77 out of 100	89 out of 100	99 out of 100	93 out of 100



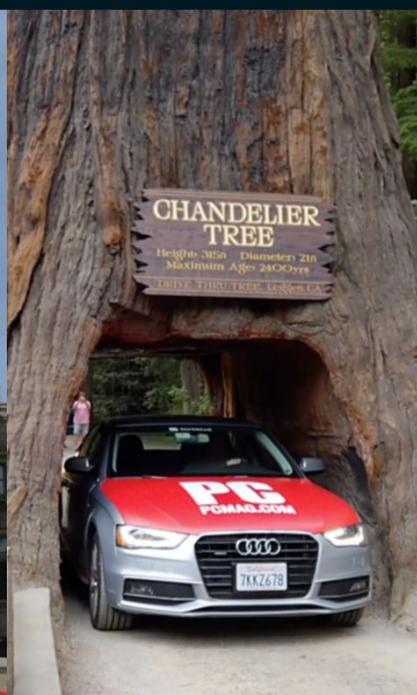
Southwest Region Winner

VERIZON

Sprint took Las Vegas, T-Mobile took Phoenix and San Diego, and Verizon took Tucson, LA, and the rural areas.

This was a tough call, but we're giving it to Verizon, three to two. Arizona and Southern California are highly competitive between Verizon and T-Mobile, and T-Mobile's coverage is a lot better than it used to be thanks to its new Extended Range LTE. Verizon's LA performance was stellar. While Sprint won in Las Vegas, it hasn't deployed its latest technologies in Tucson or San Diego, which held it back in the regional results.

SW Region	AT&T 4G	Sprint 4G	T-Mobile 4G	Verizon 4G
Download Speed (Mbps)				
Maximum	93.85	102.91	123.63	143.35
Average	17.88	14.10	20.35	21.57
Downloads Above 5Mbps (%)	74%	61%	70%	72%
Upload Speed (Mbps)				
Maximum	29.19	18.79	43.66	47.21
Average	9.17	5.83	17.23	12.96
Uploads Over 2Mbps (%)	75%	73%	83%	78%
Average Ping (ms)				
	65.05	70.60	64.87	68.88
Reliability (%)				
	89%	89%	91%	92%
Speed Score				
	90 out of 100	80 out of 100	98 out of 100	95 out of 100



Northeast



Suburban/Rural Northeast **VERIZON**

Our Northeast drive took a different route than past years. We covered both the I-95 and I-84 corridors between New York and Boston, as well as I-80 across most of Pennsylvania; a good chunk of the NJ-PA border; Lancaster and York, PA; and Westminster, MD. We drove around the highly populated suburbs of New York and Boston and also much more rural areas of Pennsylvania and Maryland.

That's why Verizon triumphed: Nobody beats Verizon's network reliability. AT&T came in second for similar reasons, but T-Mobile got socked by weak areas in rural PA and MD, and Sprint's new LTE Plus doesn't reach far outside the major cities. If you live in a city or a relatively nearby suburb in the Northeast, you have several good carrier choices. But if you're heading out into the sticks, Verizon is clearly the fastest mobile network in the rural Northeast.



Northeast



Boston, MA T-MOBILE

Boston was a tight race among AT&T, T-Mobile, and Verizon, with T-Mobile pulling out the win thanks to high upload speeds and low latency. Both AT&T and T-Mobile outpaced Verizon in the upscale suburbs of Brighton and Newton. But T-Mobile wasn't strong everywhere, guttering out a bit in South Boston. It's worth noting that the carrier has deployed its 700MHz Extended Range LTE throughout Massachusetts, Rhode Island, Connecticut, and southern New Hampshire, dramatically improving coverage.

Sprint's high-speed 40MHz carrier aggregation buildout doesn't seem to be as complete in Boston as in some other cities. Looking at our speed heat map, Boston has a pattern of islands of good speed for Sprint surrounded by seas of lower speeds, showing that its Spark towers aren't quite reaching far enough to knit the citywide high-speed network together.



Northeast



New York, NY T-MOBILE

New York City has been a battleground between T-Mobile and Verizon for a few years, and the two carriers are now in a virtual tie. Verizon showed better download speeds in New York, but T-Mobile's slightly better upload speeds and overall network consistency let it edge out a win.

T-Mobile's advantage over last year probably comes thanks to its 700MHz Extended Range LTE, which it turned on in New York City in December. While that doesn't push top download speeds higher, it smooths out the network and fills in the gaps, resulting in T-Mobile's perfect reliability score across the city in our tests. Sprint's new LTE Plus network can achieve blistering download speeds and suffered only because it's designed to privilege downloads over uploads, which make up 20 percent of our score.



Northeast



Philadelphia, PA T-MOBILE

Philadelphia was a slow city for all carriers, but let's talk about ping for a moment. Ping is how long it takes for a device to first hear back from an Internet server. It plays a big role in how fast Web pages feel to load. Ping is 20 percent of our score, and T-Mobile's shorter ping times are how it won in Philadelphia, even though it had the lowest average download speeds of the four major carriers.

AT&T came in second place, once more without terribly inspiring download speeds. But like T-Mobile, AT&T delivered a reliable experience without any failures and had a good balance between upload and download speeds. Sprint had surprisingly good download speeds but fell short on uploads. Verizon, meanwhile, beat T-Mobile on downloads but suffered on both ping times and reliability, giving us shaky connections at test locations in Manayunk and at Penn.



Northeast



Baltimore, MD VERIZON WIRELESS

Verizon absolutely dominated the Northeast this year, which shouldn't be a big surprise for anyone living in the region; it's Big Red's home territory. Verizon led in nearly every category with consistent, fast uploads and downloads.

Although Sprint came in fourth in Baltimore, it gets the "most improved" award. Sprint's speeds have languished there for several years, but this year we finally saw its Spark upgrades throughout the city, with an impressive 70Mbps down in Greenmount Cemetery. That said, Sprint still has some gaps to fill, and we were quite disappointed when we saw our Sprint phone drop to 3G both in Canton and north of John Hopkins University.



Northeast



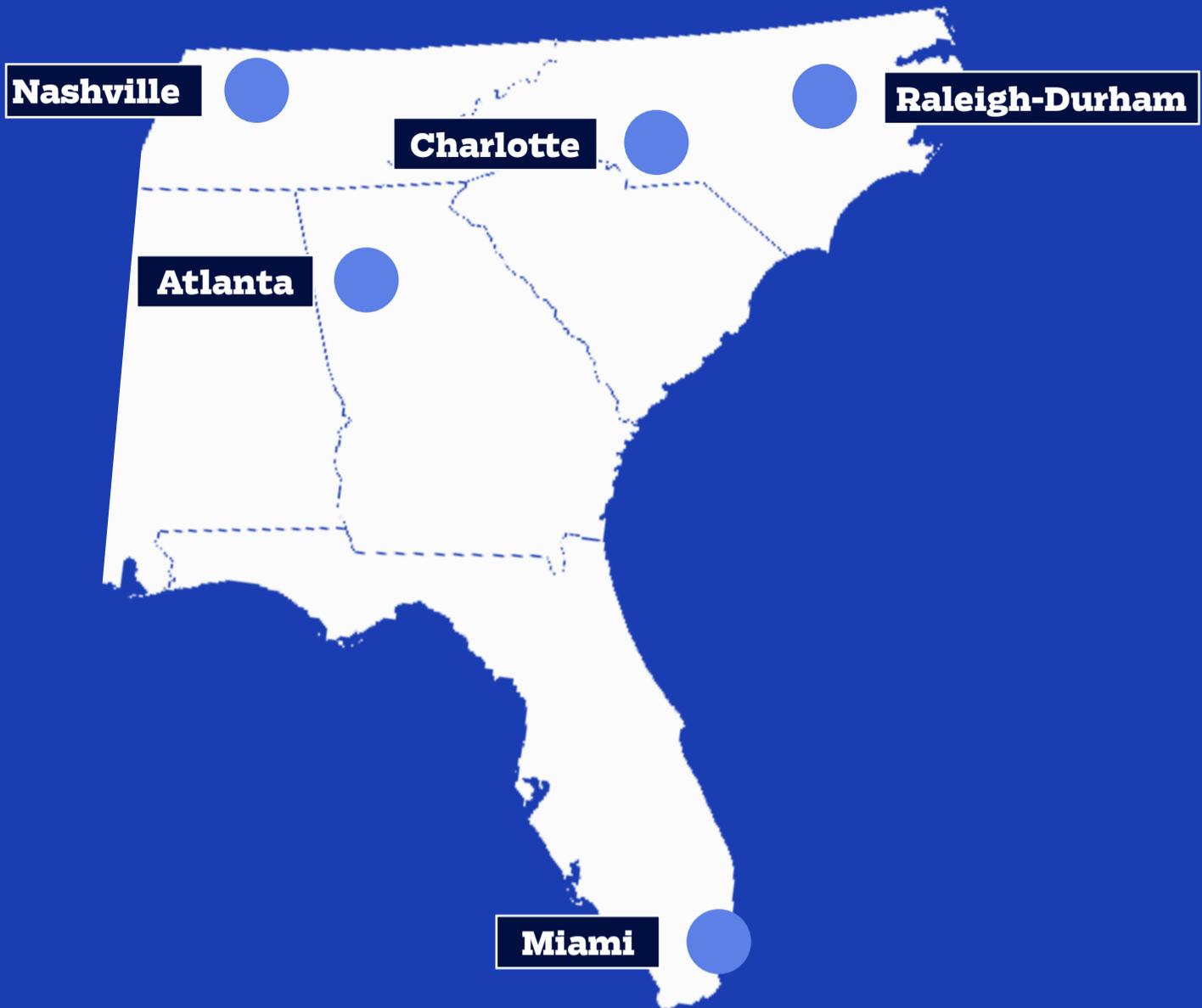
Washington, D.C. VERIZON

Symmetry made the difference for Verizon in Washington, D.C. While AT&T and Sprint also delivered high download speeds, Verizon's superior upload speeds brought it to victory. Upload speeds count for 20 percent of our score, reflecting all of the Snapchat and other image- and video-based social media going around. Sprint consciously decided to devote more of its spectrum to downloads than to uploads, reasoning that people become more impatient when their Web pages don't load than when their Snapchats don't immediately send.

Washington was a tough town for T-Mobile this year, even though the carrier has greatly improved its suburban coverage with its 700MHz Extended Range LTE. The pairing of slightly slower download speeds and nearly perfect reliability suggests congestion is the cause: T-Mobile is just a victim of its own recent success.



Southeast



Suburban/Rural Southeast AT&T

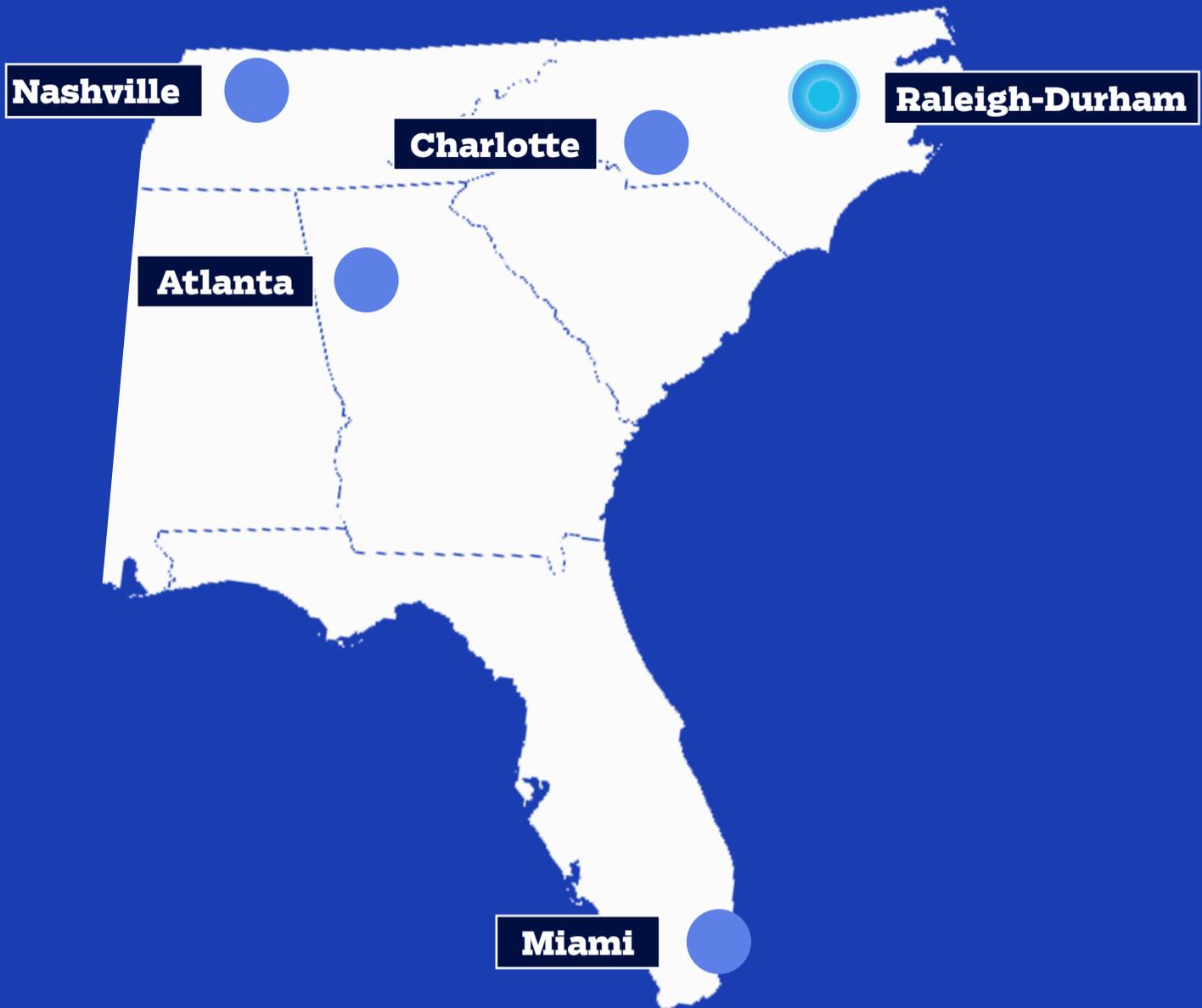
AT&T coverage and reliability ruled both our Southeast and South Central drives. We drove from Nashville to Atlanta, through Alabama to New Orleans, and from Washington, DC through Charlottesville to Raleigh and Charlotte.

No carrier offered perfect coverage on these drives. But we found AT&T to be the best choice in the Southeast outside the major cities.

AT&T has been building a reliability-focused network in the past few years, and our Southeast drive results show it. While T-Mobile and Verizon both had higher peak speeds, AT&T more consistently delivered downloads above our 5Mbps minimum threshold and gave us the quickest pings against a range of nearby, neutral servers. That positions AT&T well to power the upcoming smart cities of the Southeast.



Southeast



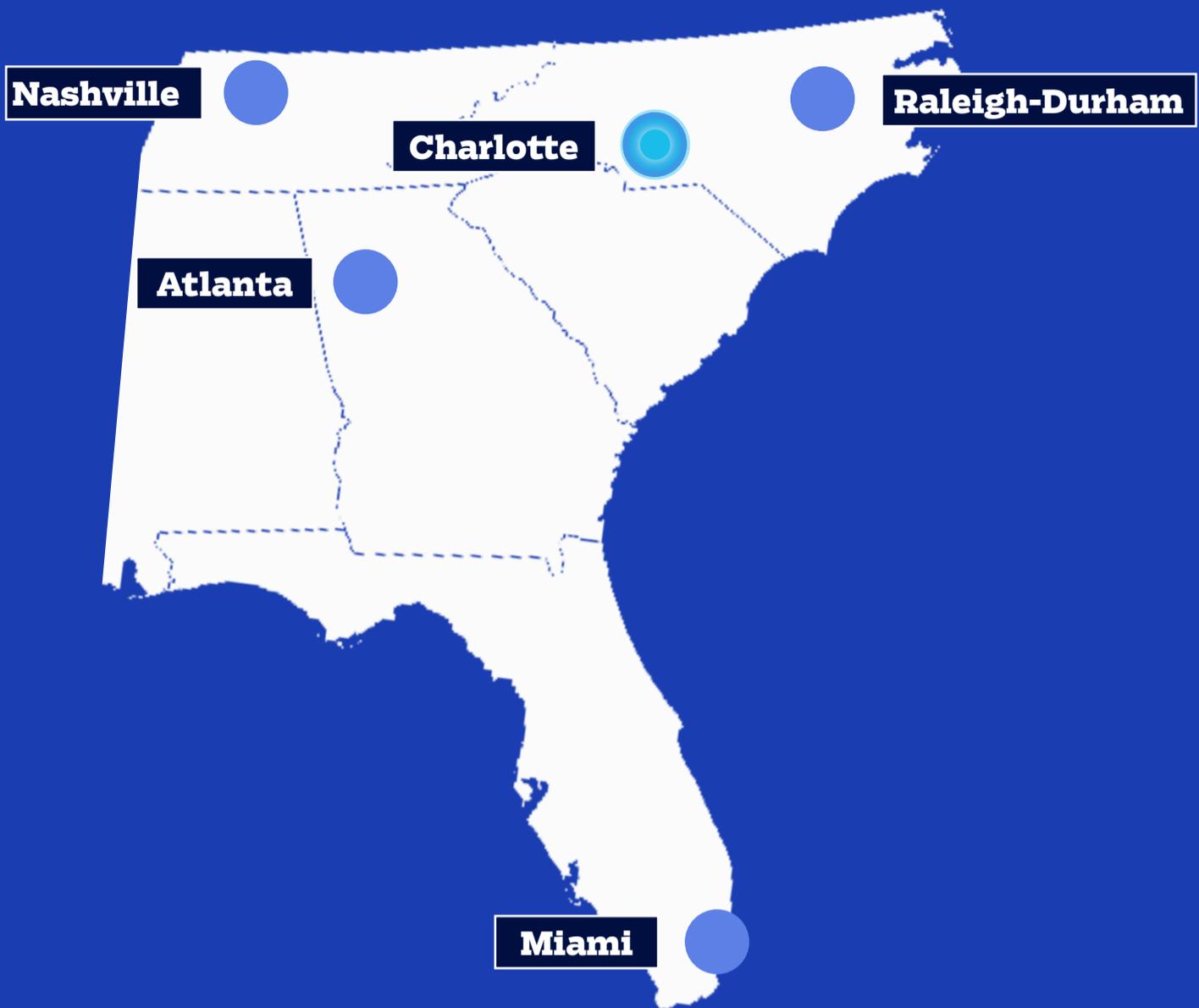
Raleigh-Durham, NC T-MOBILE

T-Mobile didn't show the best peak speeds in the Raleigh-Durham area, but it achieved good speeds much more reliably than any competing carrier. That's a little surprising, because T-Mobile's coverage in North Carolina isn't the best: The carrier lacks its 700MHz Extended Range LTE spectrum here, which helps penetrate the thick tree cover you'll find in more suburban areas such as Cary.

If coverage concerns you, AT&T is the way to go in Raleigh, and it fought T-Mobile to a near standstill. AT&T had not only very fast download speeds, but it also had access to 700MHz spectrum. Your part of the metro area may also play a factor in your carrier choice. AT&T did better than T-Mobile in suburban North and East Raleigh, but T-Mobile did better in downtown Durham and Chapel Hill.



Southeast



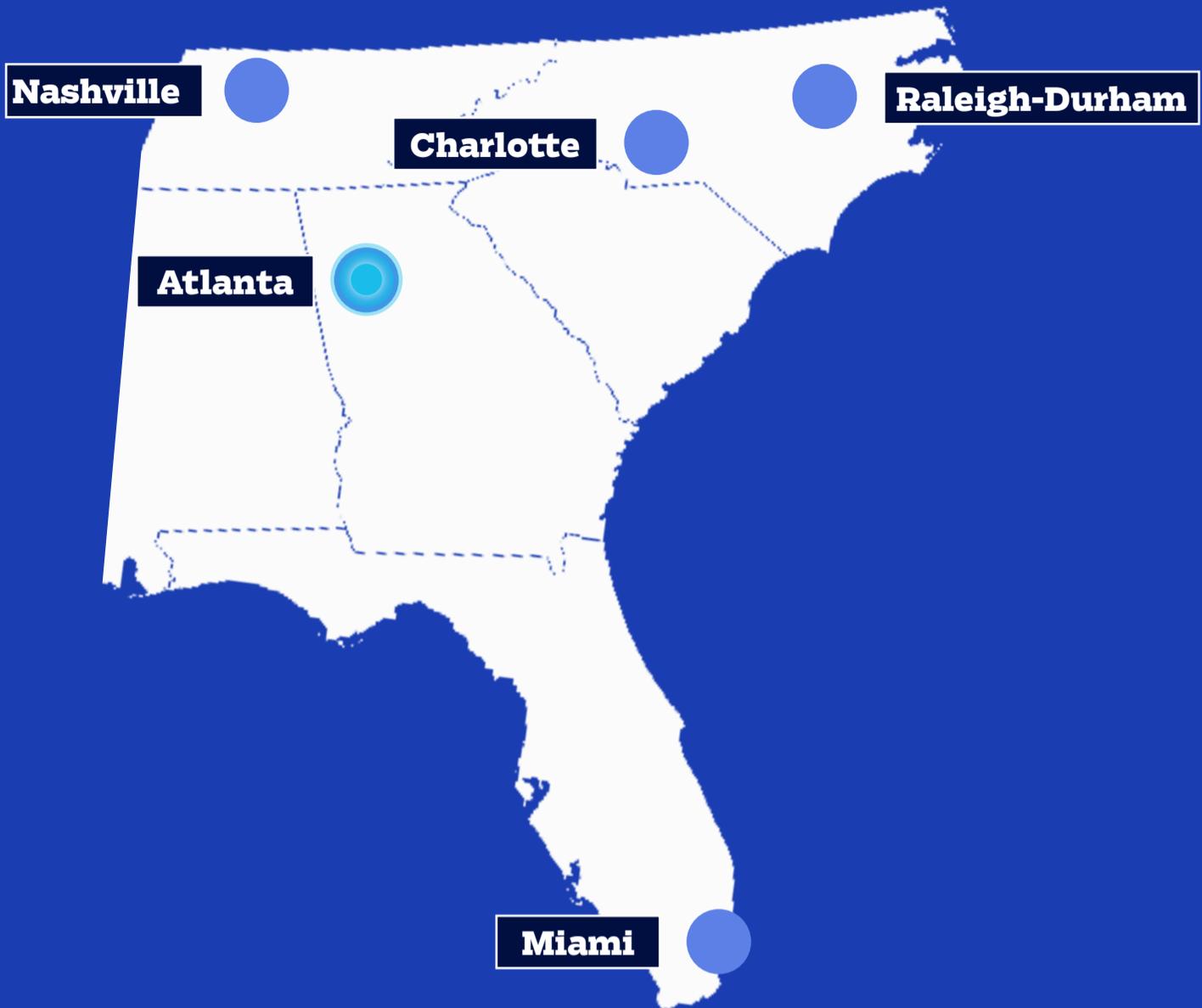
Charlotte, NC AT&T

AT&T may always have Charlotte. The company has won the Charlotte area time and again, and as before, it has backed up its Charlotte performance with strong results across North Carolina. Second place in Charlotte goes to the newly resurgent Sprint, which had even greater maximum speeds than AT&T did. But AT&T secured a firm win with a more consistent network offering more similar speeds and lower latency across the city. T-Mobile's strength on uploads couldn't fix its weakness on downloads.

Zooming out, we saw excellent coverage for AT&T through North Carolina and Virginia, especially in rural areas and past smaller cities.



Southeast



Atlanta, GA **VERIZON**

Verizon wrested back Atlanta from T-Mobile thanks to extremely strong performance at several of our test sites. At a long stop at the Perimeter Center, we consistently got download speeds over 100Mbps, which is very unusual.

T-Mobile's network was slightly more consistent and reliable in Atlanta and dominated other competitors on the east side of the metro area, near Decatur. As we saw in several other cities, Sprint's high-frequency network did best at some of our test sites in Atlanta's densest areas. We also found no Sprint dead spots citywide.

AT&T, which once dominated the South, showed the weakest speed performance of the four major carriers. While our AT&T phone connected reliably, it had the largest number of tests coming under our threshold for good speeds, showing a congested network where the number of bars you see doesn't actually reflect performance.



Southeast



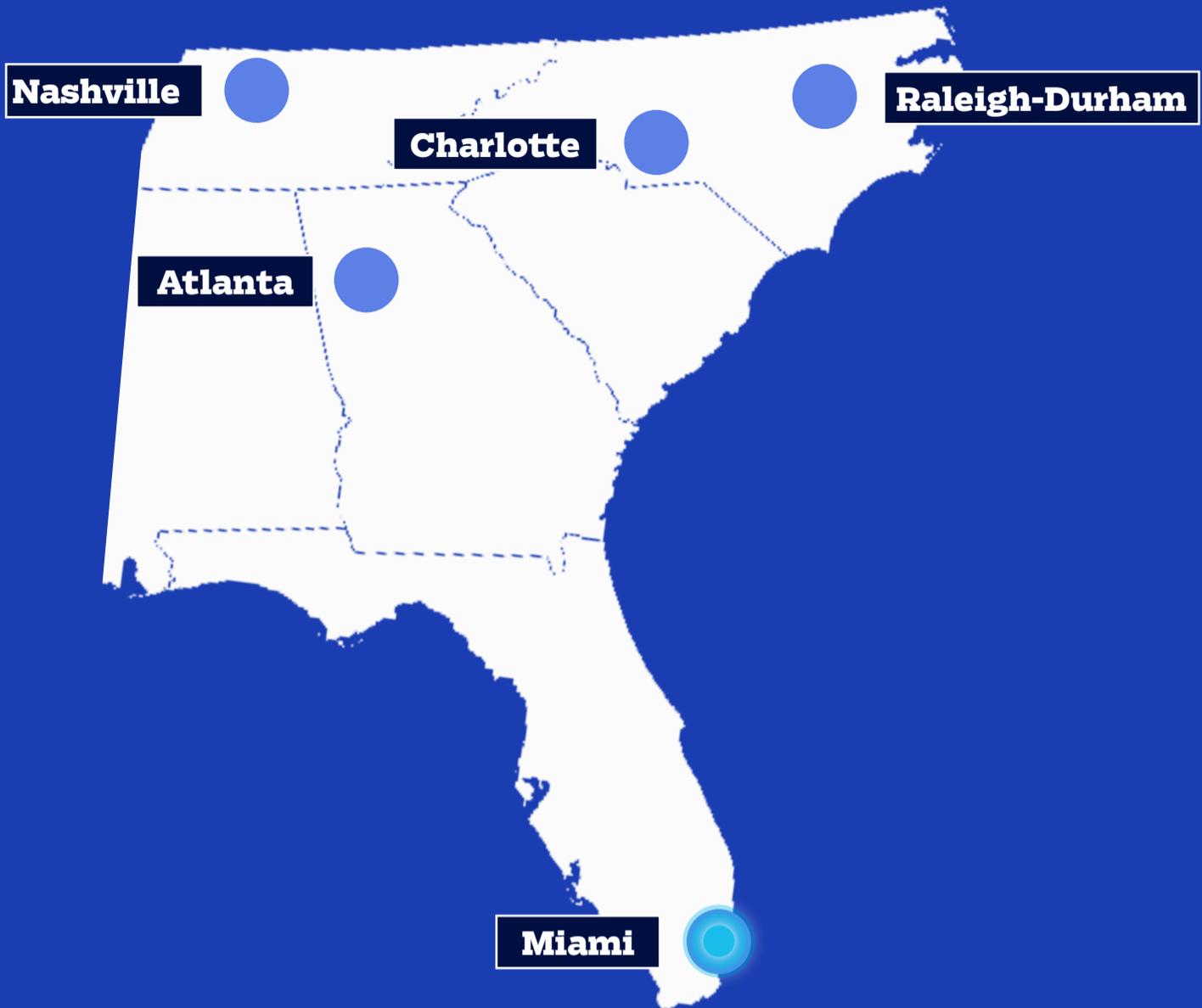
Nashville, TN T-MOBILE

Our measures of consistency made all the difference in Nashville. The city has slow networks compared with places in Texas and the Northeast, and only Verizon broke 50Mbps as a peak; typically, all four carriers do. But Verizon's speeds were balanced out by greater consistency from T-Mobile. Verizon's speeds had higher peaks but lower troughs, while T-Mobile more consistently delivered speeds over the 5Mbps we judge as a true mobile broadband experience.

If you travel much out of the city, you should go with Verizon, though. T-Mobile's coverage in Tennessee is better than it used to be—we found nonstop LTE all along the I-24 and I-75 corridors—but the carrier's official coverage map still has big dead spots northeast of Lebanon and across a long stretch of US-64. T-Mobile's coverage may get dramatically better later this year when it turns on 700MHz spectrum it recently acquired from C Spire. That frequency band covers rural areas well.



Southeast



Miami, FL VERIZON WIRELESS

Verizon blew away all the other carriers in Miami on both upload and download speeds, hands down.

Taking a close look at the results, all of the other carriers had at least one location where they nearly zeroed out. Verizon had none. It hit 100Mbps in North Miami Beach, a nice, flat area where signals transmit well. In that very same location, Sprint struggled along at basically 3G speeds. AT&T and T-Mobile both had trouble in one of our downtown tests.

It's clear that if you live in Miami and speed matters to you, you have to go with Verizon.



North Central



Suburban/Rural North Central **VERIZON**

Verizon's dominance of the North Central region extended to our drive through suburban and rural areas. From Oklahoma City, we drove past Wichita to Kansas City and St. Louis before heading down to Paducah. We also drove from Columbus, OH to Indianapolis, Chicago, and Detroit, and went past Toledo and Cleveland.

On those long drives, Verizon's speed outweighed AT&T's better reliability. (For more on how we calculated our winners, see our Testing Methodology [LINK]). Verizon scored the best average upload and download speeds in the more populated areas of our drive, while AT&T had more consistently reliable if slower speeds. Sprint's strong performance this year surprised us, with spectacular download speeds, but both Sprint and T-Mobile still haven't filled in some of the rural gaps that Verizon and AT&T cover.



North Central



Detroit, MI VERIZON WIRELESS

We saw some killer peak speeds on three of the major carriers in Detroit, but Verizon gave us by far the best speeds citywide. Verizon's average download speeds, nearing 50Mbps, were some of the fastest we saw anywhere in the country, and the carrier combined that with industry-leading ping times to make for a very clear win throughout Detroit.

Once average speeds become this high, the ability to deliver them reliably becomes even more important than hitting big numbers occasionally. Verizon led there too, with far more downloads above our 5Mbps threshold than we saw on other carriers. T-Mobile actually hit the highest peak speeds in Detroit with a scorching 122Mbps, but it was held back by a slow result on the Wayne State campus, among a few other places. This fits with the reports we've heard about the carrier struggling a little this year under its own popularity.



North Central



Chicago, IL VERIZON WIRELESS

Verizon blows away the competition in the Windy City. Its peak speed of 151Mbps in Chicago was so high I had to double check it, but yep, it's real. Speeds downtown were especially strong for Verizon, with a consistent 125Mbps on the Near North Side. AT&T came in a respectable second, but a close look at its numbers shows that it's focused on ping, which is critical for smart cities, where AT&T's future really lies.

T-Mobile looks to be suffering from congestion in Chicago. While its reliability was nearly perfect, speeds were very slow, pushing below our 5Mbps download threshold too often. It doesn't have its 700MHz Extended Range LTE in Chicago, but it's deploying the system next year, which may ease congestion. Sprint showed high peak speeds, but its network doesn't cover everywhere in the city. Its use of high-frequency 2500MHz spectrum for its speediest network means it needs to set up more antennas to reach peak speeds, and it may still be building out in Chicago.



North Central



Columbus, OH SPRINT

In Columbus, Sprint's lower-than-average ping times really made a difference. Sprint also had the most consistent 4G experience, with the most download over 5Mbps. While the carrier won only a few cities this year, it showed spectacular peak download speeds nationwide with its new LTE Plus carrier aggregation scheme. If our scores were geared more toward downloads, Sprint would have won even more; its weakness is that it has relatively slow upload speeds. But as Sprint execs have pointed out to me, we do a lot more downloading than uploading anyway.

T-Mobile's second-place finish is impressive considering its Extended Range 700MHz spectrum isn't live in Columbus yet. T-Mobile has been historically weak in Ohio and Indiana, but it looks like the carrier has finally shaken that spell. Verizon had some of the best peak speeds in Columbus, but they weren't as reliable as T-Mobile or Sprint's speeds citywide.



North Central



Kansas City, MO VERIZON WIRELESS

Kansas City has quietly become one of the best-connected cities in the nation. Not only is it a major wireless carrier battleground, but it also has Google Fiber and a municipal broadband provider, as well as a network of free-to-use Internet kiosks.

Verizon has really turned up its LTE network recently, with download speeds bordering on what you normally get from cable Internet. We saw a consistent 100Mbps at the Uptown Theater on Broadway. Verizon's amazing download speeds make it the clear winner for the fastest mobile network in Kansas City.

But Sprint's no shirker here, and heavy data users may find the carrier's unlimited data plans hard to resist. Sprint showed very good download speeds in Kansas City, although the carrier has designed its network to privilege downloads over uploads, so content creators will find it a less speedy experience than video streamers.



North Central



St. Louis, MO VERIZON WIRELESS

The difference between Verizon's network and Sprint's really becomes clear when you look at our St. Louis numbers. Both are now using carrier aggregation to deliver positively epic peak speeds that could let you download a movie in a matter of minutes. But Sprint does that at the cost of upload speeds, while Verizon provides a more balanced network. That gained Verizon the win in St. Louis.

St. Louis is one of those cases where considerations other than our speed score should come into play when choosing a carrier, though. Sprint's speeds are fast and reliable. More important, the carrier still offers unlimited data, which means you'll be able to take advantage of those high download speeds more frequently than you would with Verizon.



South Central



Suburban/Rural South Central AT&T

Our South Central region this year took in Louisiana, Texas, and Oklahoma. That's traditionally been AT&T territory, since AT&T inherited Texas-based SBC, and AT&T still provides the best service all around when you get out of Texas and Oklahoma's major cities. In much of the rest of the country, we saw AT&T isn't focusing on speed, but on this drive, it outpaced the competition on every measure, whether speed, reliability, or consistency.



South Central



Oklahoma City, OK AT&T

AT&T showed the strongest performance overall in our 12 tests in the Oklahoma City area. While we didn't see stunning speeds from any carrier, AT&T had the best-balanced network, with higher upload and download speeds more often than any of the others.

Sprint's poor performance in Oklahoma City is like a flashback to two years ago. The problem here is that OKC lacks Sprint's new LTE Plus network, which is giving the carrier all of its recent gains. Until that gets installed, Sprint won't be a viable competitor.



South Central



Dallas, TX VERIZON WIRELESS

Dallas has always been a fast, competitive city in our tests, as its flat geography and suburban layout tends to be kind to 4G networks. We saw positively blazing download speeds from both Sprint and Verizon here, with Verizon topping out at a reliable 100Mbps by the Market Center. Looking deeper into the results, Verizon's numbers were marked by solid reliability and high speeds all over the city, while Sprint wobbled a lot more, with incredible speeds at SMU but slow results in Casa Linda.

T-Mobile's slow speeds in Dallas surprised us, because Dallas has long been a core market for T-Mobile, where the company tests new technologies. Again, T-Mobile's speedy customer growth may be causing some growing pains.

AT&T suffered because of long ping times, which is surprising, since AT&T has been building its network to avoid just that problem.



South Central



Austin, TX T-MOBILE

A solid, well-balanced network with low ping times gave T-Mobile the win in Austin over competitors with noticeably higher download speeds. Austin wasn't one of our fastest cities; we didn't see the 100Mbps peak speeds we saw in some other metro areas. But each of the carriers has a different strength here. If you're looking for consistent download speeds citywide, Verizon did better than the other 4G carriers. If all you want is to stream your head off at high download speeds, Sprint's peak downloads outpace anyone else. But for Web page downloads (which are heavily reliant upon ping) and social media uploads, T-Mobile rules.

Texas in general has been a highly competitive market for our carriers, and we see that with the different winners in our various Texas cities: T-Mobile won Austin, while Verizon took Dallas, and AT&T grabbed Houston.



South Central



Houston, TX AT&T

AT&T's peak performance in Houston is definitely something to crow about. We got 119Mbps down on Main Street south of the Texas Medical Center, showing that AT&T's network improvements are all coming together in Houston, most notably carrier aggregation and 2.3GHz WCS spectrum. AT&T's network also had very short ping times, which makes for speedy Web page downloads and prepares the network well for self-driving cars and other smart city technologies.

Other carriers have their strengths, too. The highest average download speeds actually went to Sprint, which has juiced up its LTE Plus network in Houston to a startling extent. We got speeds over 100Mbps down with Sprint at multiple locations in Houston, making it a great choice for heavy downloaders who are looking for unlimited data. Social media mavens might prefer T-Mobile for its low ping times and high upload speeds, which are ideal for posting Snapchats.



South Central



New Orleans, LA AT&T

The region we call South Central has been an AT&T heartland since the Southwestern Bell days. We're definitely seeing that in our 2016 results, where AT&T took New Orleans, Houston, and Oklahoma City, and took second place in Austin.

AT&T's win in New Orleans isn't about peak download speeds—Sprint had the highest download averages—but about balancing all the components that make for a fast network. Most notably, AT&T had the lowest ping times, and its coverage in the area is also terrific. We saw unbroken LTE throughout our Louisiana drive, but T-Mobile and Sprint cut out from time to time.

Let's not underestimate Sprint's improvement in recent years in the New Orleans area, though. Sprint matched AT&T and T-Mobile on reliability and beat them on average download speeds with its new LTE Plus network.



Northwest



Suburban/Rural Northwest **VERIZON**

We took a new route through the Mountain West this year, one that really showed off Verizon's hard work building out LTE in rural areas. After driving up the coast from San Francisco to Portland, we took I-5 to Seattle, then headed west to Spokane, past Lewiston, through some national forests to Boise, and then over to Salt Lake City and down I-15 through the middle of Utah.

If you're looking for 4G LTE, especially in eastern Washington, Idaho, and Utah, Verizon is the primary choice. We saw major gaps and blackouts on all three of the other networks—far northern California, central Idaho, and northern Utah can be brutal on network coverage. But Verizon? It just kept on plugging.



Northwest

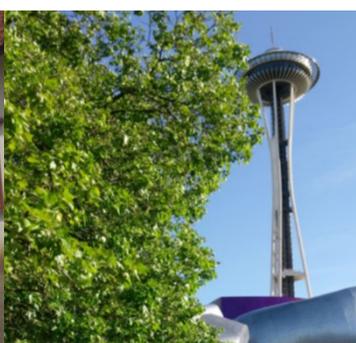


Seattle, WA SPRINT

Sprint pulled out a surprising win in Seattle, T-Mobile's hometown, and it's sure to leave the local heroes fuming. In fact, T-Mobile is in third place in Seattle this year.

Sprint, T-Mobile, and Verizon all showed spectacular peak download speeds, well over 100Mbps, so it's clear that their latest, greatest technologies are all in full effect in Seattle. But Sprint's average download speeds blew everyone else away, and its upload speeds were much better than we saw in other cities. That made Sprint by far the superior choice.

Why is this happening? I suspect Sprint's network is very lightly loaded in Seattle, especially its new LTE Plus airwaves, which aren't usable on older, less expensive phones. So potentially, we're looking at pretty heavily used (and still quite impressive) T-Mobile and Verizon networks, and a just-out-of-the-box new Sprint network with almost nobody on the lanes yet.



Northwest



Portland, OR T-MOBILE

T-Mobile has had a strong position in the Pacific Northwest for a few years now, and it continues to dominate Portland with epic speeds. It screamed across most of our city center test sites, with the only slow spot by the airport. We got a solid 102Mbps down in Northwest Portland. And if you count out that one slow spot, all 13 of our other primary test locations had perfect reliability for downloads over 5Mbps.

Sprint's performance looks good until you realize we socked it for weak uploads. Sprint made a conscious choice to devote more of its network to downloads than uploads, figuring that people spend more time consuming content than creating it. We agree—40 percent of our score is downloads and 20 percent is uploads—but the difference was just too much for Sprint to overcome in our scores. That said, if you're more of a downloader than an uploader, it's time to look at Sprint's inexpensive service plans.



Northwest



Boise, ID T-MOBILE

T-Mobile had by far the best upload and download speeds in our tests in Boise, Meridian, and Eagle, no question about it. In the urbanized parts of the Boise metro area, T-Mobile is the fastest mobile network by a long shot. That said, Idahoans are stuck choosing between speed and coverage. Both T-Mobile and Sprint cling to the I-84 corridor; our T-Mobile drive testing map shows no LTE coverage outside Boise, Twin Falls, and Mountain Home, nor in the national forests. If you're looking for comprehensive coverage in Idaho, you probably already know you need to go with Verizon—the slowest of the four major carriers in urban Boise.

Good news is coming for T-Mobile subscribers in Idaho, though: Much of the state is covered either by existing T-Mobile 700MHz licenses or by the new licenses the company just bought from three smaller carriers, and it should be rolling out broader LTE coverage by next year.



Northwest



Salt Lake City, UT **VERIZON WIRELESS**

Verizon Wireless scorched the other players in Salt Lake City, with download speeds 80 percent higher than the competition and an insane maximum of 125Mbps down. Verizon also has broad coverage in the populated parts of Utah, so if you go with Verizon, you're getting the best network on the Silicon Slopes.

T-Mobile comes in a solid second, as it does in urban areas nationwide. It'll get even more competitive next year when a new license purchase for 700MHz spectrum closes, giving the carrier better coverage. Sprint continued its meteoric rise in the ratings with download speeds that beat T-Mobile's but relatively slow uploads. And AT&T focuses on reliability rather than speed. The fastest Verizon speeds, with a series of download tests consistently over 100Mbps, came right on the corner of Temple Square downtown. Apparently that location has a very good wireless connection to powerful networks.



Northwest



San Francisco, CA **VERIZON WIRELESS**

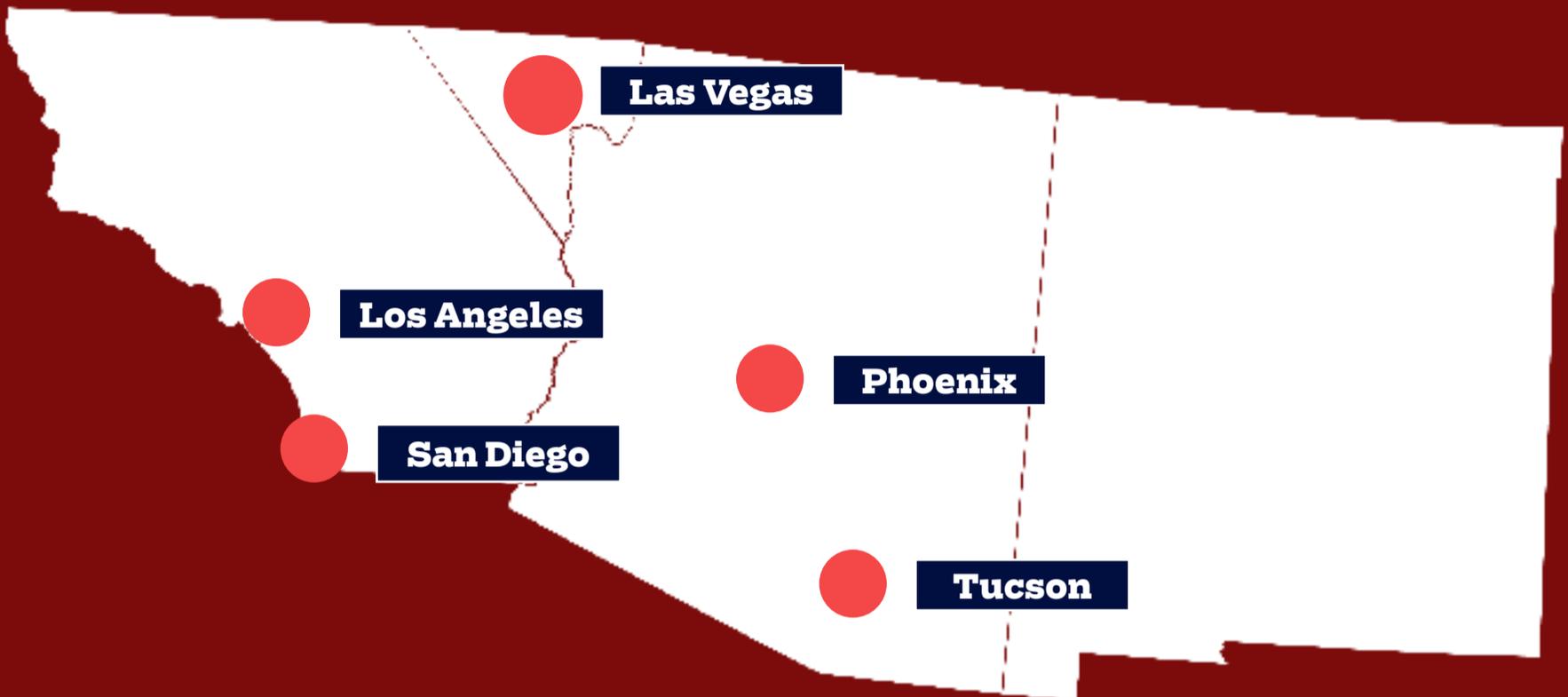
In the San Francisco Bay area, Verizon, T-Mobile, and Sprint are all delivering the speeds that Silicon Valley demands. We saw some of the fastest peak speeds and lowest ping times in the country in San Francisco, showing that it actually matters when you're physically close to the servers that run your favorite Internet sites.

Verizon scored a clear win with the fastest upload and download speeds, delivering more than 100Mbps down in five locations near the center of San Francisco.

AT&T was the weakest overall, but all the networks had slightly soft spots among our 13 test locations. Verizon hit one in western San Jose. T-Mobile hiccupped in the Financial District. Sprint wasn't so great in the Haight. AT&T was downright appalling in North Beach. That said, Verizon is the way to go in SF this year.



Southwest



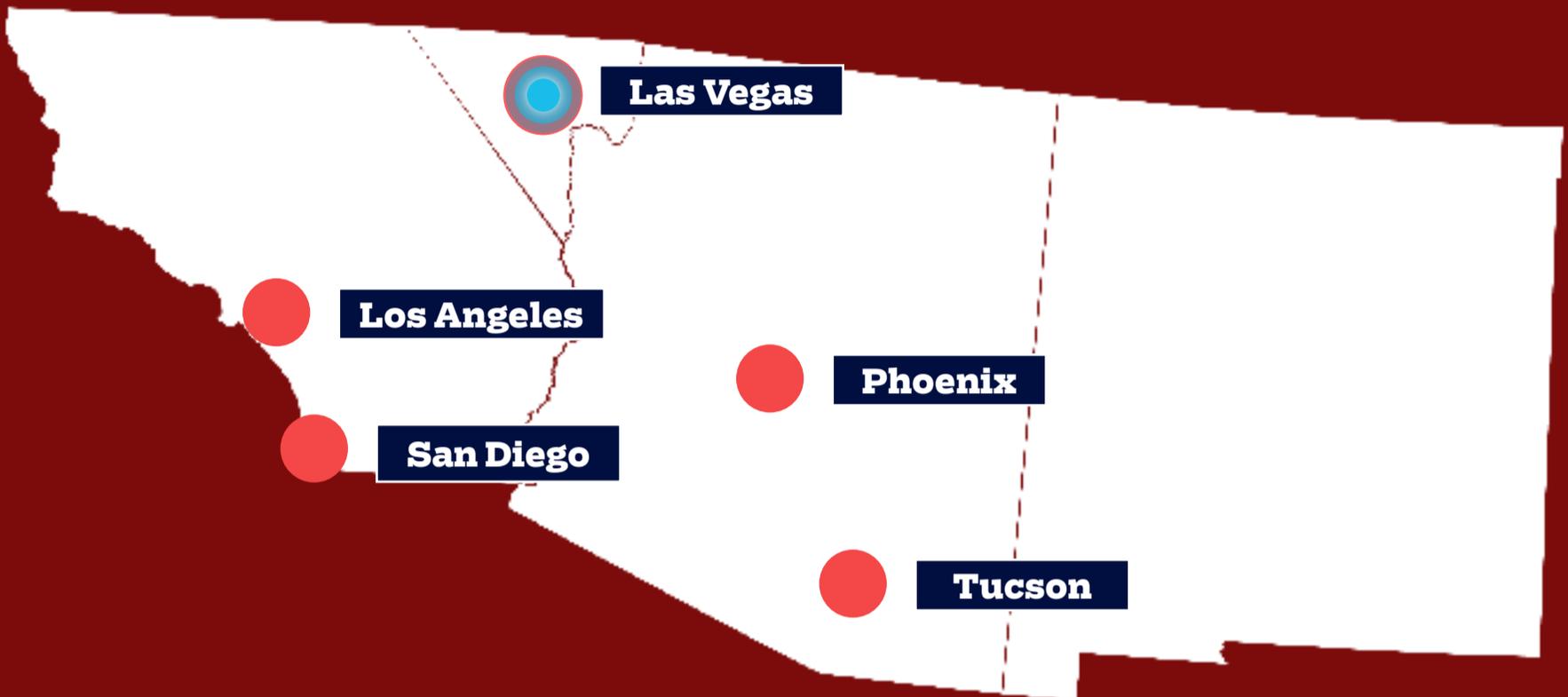
Suburban/Rural Southwest **VERIZON**

We followed the same route through the Southwest as we have the past few years: Las Vegas down to Phoenix, Tucson, then San Diego, and up to Los Angeles. As we saw in our other rural regions, the leader here really differentiated itself by reliability. That's Verizon for you.

That doesn't mean Verizon was slow. On the contrary, it had faster average download speeds than any of its competitors. But it does mean that if you're stuck on a long, dark road outside Yuma or in the forest east of San Diego (where various other carriers had trouble), Verizon has your back. Combine that with Verizon's wins in Tucson, San Diego, and LA, and you'll find Verizon is the preferred carrier on this side of the border.



Southwest



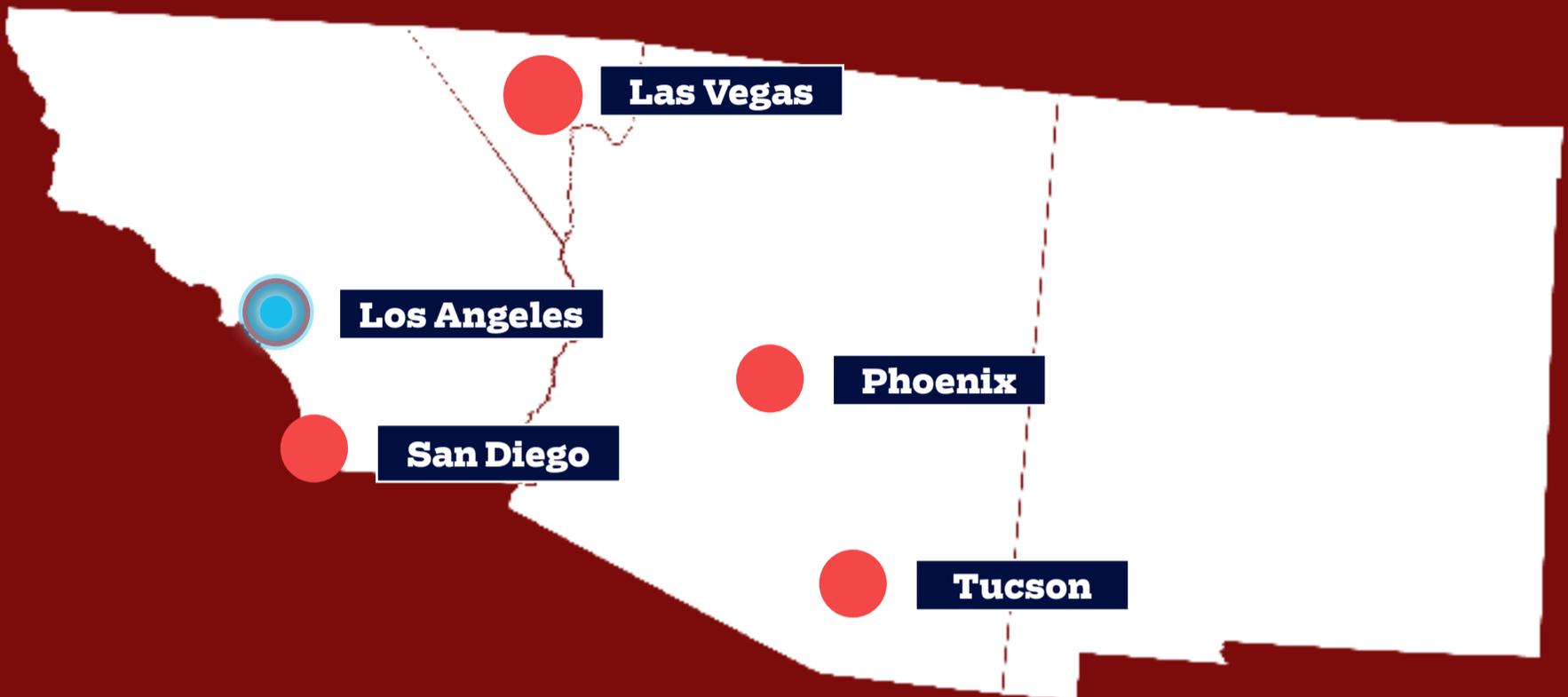
Las Vegas, NV SPRINT

Sprint finally wins Las Vegas after its dramatic improvement last year. The difference this year is LTE Plus, its high-speed, relatively short-distance network, which works well when it's laid down densely. It looks like Sprint indeed laid LTE Plus down densely in Las Vegas: Our maps showed solid, continuous LTE coverage around the main body of the metro area, dropping down to 3G only in Boulder City. That makes Sprint a great bet for Sin City.

None of the major carriers showed spectacular speeds in Las Vegas this year, and they all had some slow spots. But T-Mobile fell to earth the hardest, to an extent where I had to double-check that our tests at the Stratosphere and on Sunset behind the airport were indeed on LTE. But they were, just on apparently totally saturated LTE. As we saw in several other cities, T-Mobile may be suffering from its massive recent success in Las Vegas.



Southwest



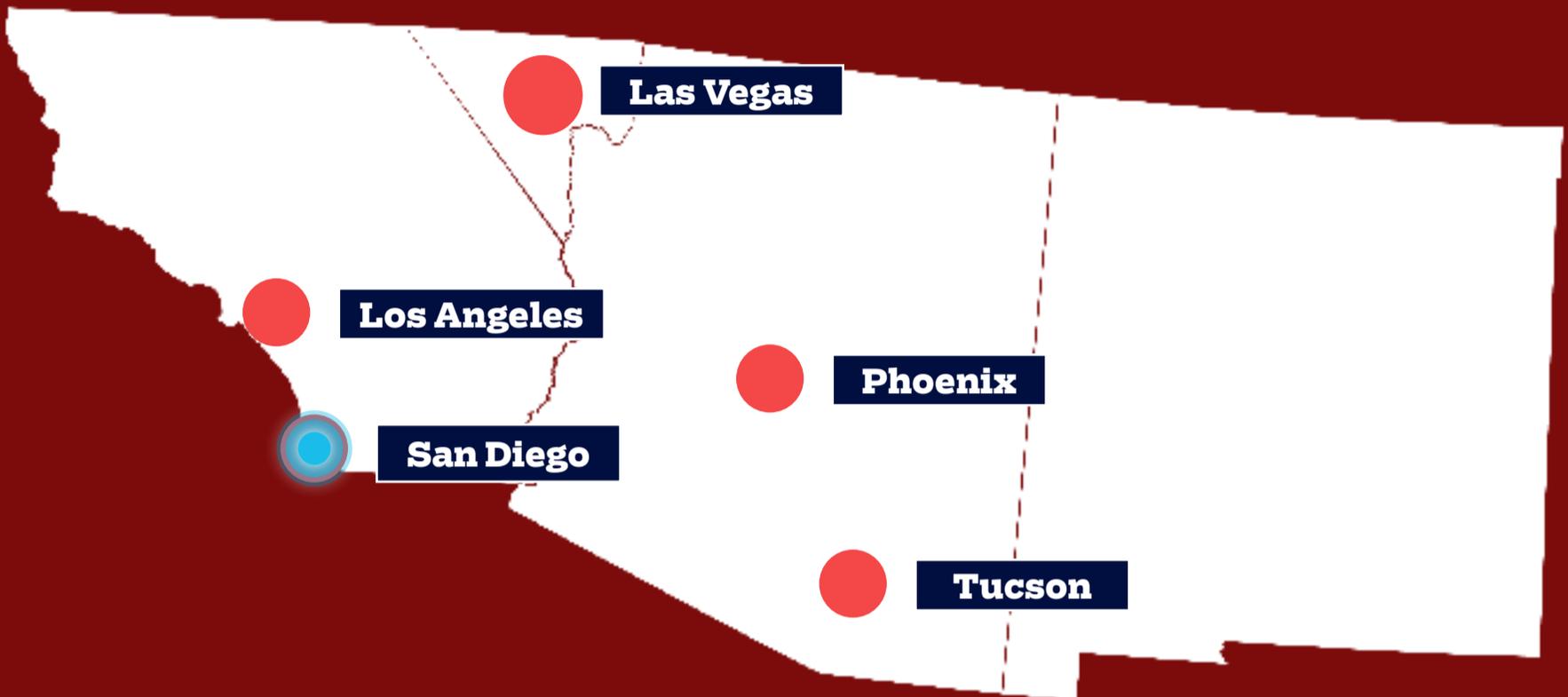
Los Angeles, CA **VERIZON WIRELESS**

Verizon established a commanding lead in Los Angeles, with the best download and upload speeds and the lowest ping times, making it a clear winner. While other carriers showed high peak speeds, only Verizon could maintain them consistently over our 18 tests in this sprawling metro area. Both Sprint and T-Mobile, which showed some extremely fast speeds, had trouble connecting at multiple locations in the county.

Verizon scored its best speeds in Beverly Hills and at Kaiser Permanente Medical Center, while Sprint did well down in Inglewood, and T-Mobile was fastest up by Universal City. With so much area to cover, though, Verizon's comprehensive network really pays off.



Southwest



San Diego, CA T-MOBILE

T-Mobile beat its competitors on nearly every measure in San Diego, with the fastest uploads, and downloads and among the best reliability at providing a broadband experience. The northern part of SD County was particularly good to T-Mobile: One of our fastest download speeds, an amazing 123Mbps, came in La Jolla, and we also saw excellent speeds in Torrey Pines.

Second-place finisher AT&T didn't have the kinds of spectacular peaks we saw with T-Mobile in San Diego, but did give a consistent, reliable, and strong broadband experience all across our test areas, with very low ping times. This fits with AT&T's current corporate strategy, which is to set up a reliable, low-latency network to enable the next generation of connected cars and smart city technologies. It's still a good choice for your smartphone, as well.



Southwest



Phoenix, AZ T-MOBILE

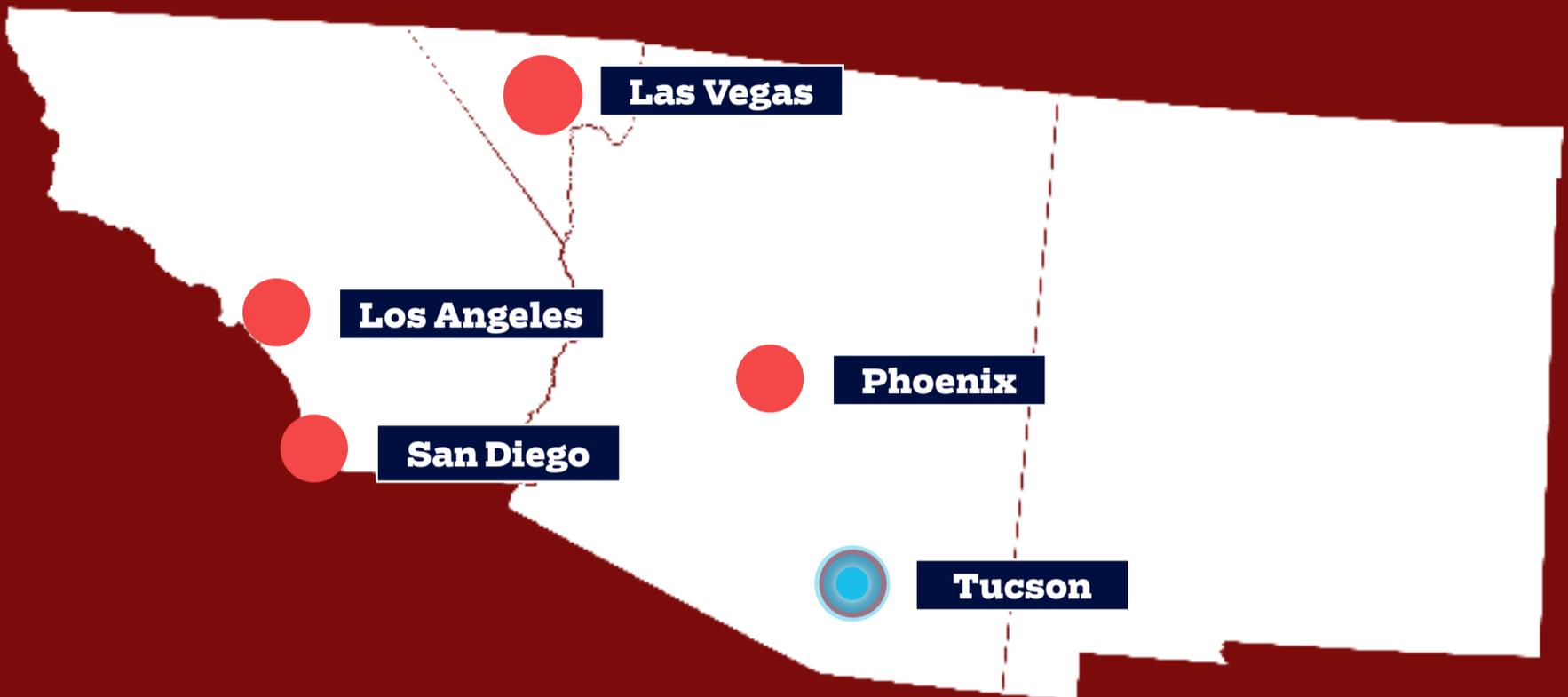
T-Mobile established a commanding lead in Phoenix, with the fastest upload and download speeds, as well as the most reliable downloads. If you intend to stream, shoot, or Snapchat, T-Mobile's network will give you the best experience in Phoenix.

T-Mobile would have actually done even better had it not been for a dead spot in Glendale that introduced a near-zero value into our citywide average. That got smoothed out over our 11 other test locations, but the fact that T-Mobile won even while hitting that patch speaks to how fast its Phoenix network is right now.

AT&T came in a solid second, suffering primarily from slower downloads but offering a good alternative for those who find T-Mobile's in-building coverage lacking. T-Mobile is currently forbidden from using its 700MHz spectrum in the Phoenix area, so AT&T will have an advantage there.



Southwest



Tucson, AZ VERIZON WIRELESS

Verizon beat out T-Mobile in Tucson this year with faster download speeds and better reliability than the smaller carrier. Our fastest Tucson result, 116Mbps down, was on the aptly named Speedway, near Wilmot. Verizon triumphed by having no particularly slow spots, but T-Mobile struggled in our test up at the Tucson Mall.

Sprint is hurting hard in Tucson, because it hasn't yet laid in its LTE Plus network, leaving its speeds down at the practically 3G levels we saw two years ago. It's not worth signing up for Sprint, Boost, or Virgin in Tucson right now, with the much faster T-Mobile-powered MetroPCS as an alternative.



Carrier and Network Profiles

AT&T has focused on building a consistent, reliable network rather than achieving blistering top speeds. Without a single broad swath of spectrum on which to park giant LTE channels, the company has been devoting various new frequency bands to making sure that its network never stalls out or feels overloaded. If you're experiencing extreme slowness on AT&T, look for a new phone with LTE bands 29 and 30, which combine with others to make sure your connections don't gutter out. AT&T's focus on reliability and its lack of very broad LTE channels means that in most of the cities where it won, such as Charlotte, Oklahoma City, and New Orleans, it did so by dominating the consistency-focused parts of our speed score measurement.

The carrier's sales pitch for machine-to-machine and smart-city applications also requires a strong 3G network, and AT&T is doing a good job of maintaining 3G as it prepares to turn off its 2G network in January.

Sprint is this year's big surprise. The carrier spent 2010 to 2014 in the doghouse, started to come back in 2015, and now actually has a competitive LTE network, winning awards in Columbus, Las Vegas, and Seattle. Sprint's network isn't designed like any other: It's heavily biased for downloads over uploads. If we were talking about download speeds only, Sprint would have won San Francisco as well, which is just crazy. Since Sprint leans heavily on very-high-frequency spectrum for its LTE network, it still has some coverage issues, and it hasn't accelerated to its maximum speeds nationwide. But it's great to see the carrier's comeback.

T-Mobile has maintained its runner-up spot from last year, although its performance declined a bit from 2015. We're chalking that up to the paradox of success: T-Mobile



has been gaining customers by the millions, and all of their unlimited BingeOn video streaming and Music Freedom audio streaming has been clogging things up a bit. That said, performance was still excellent, and T-Mobile beat Verizon in nearly half of our cities. The carrier has also dramatically extended its suburban and rural coverage using its 700MHz spectrum, and looks to be doing a lot more of that next year, including notorious weak spots like the Mountain West.

Verizon continues to do basically everything right. While T-Mobile and Sprint have been crowing their heads off about network improvements, it turns out that Verizon has been quietly implementing many of the same advances. Verizon's 2x20 carrier aggregation and 4x4 MIMO match what T-Mobile has been trumpeting, and we see the results with Verizon's nationwide win. The only concern is that Verizon does not have a deep bench of unused spectrum; Sprint has a huge amount of 2500MHz available, and T-Mobile has been buying up 700MHz around the country. Verizon could start to see congestion if usage continues to increase.



Most of the other carriers you hear about use one or several of these networks. The only exception is U.S. Cellular, which runs its own network but doesn't cover enough of our testing area to be evaluated properly. Here's a quick cheat sheet:

Boost Mobile:	Sprint
Consumer Cellular:	AT&T
Cricket Wireless:	AT&T
Google Project Fi:	Better of Sprint, T-Mobile, and U.S.
H2O Wireless:	Cellular
Lyca Mobile:	AT&T
MetroPCS:	T-Mobile
Net10:	AT&T or T-Mobile
Page Plus:	Verizon
Republic Wireless:	Sprint or T-Mobile
Ringplus:	Sprint
Simple Mobile:	T-Mobile

Straight Talk:	Could be any, depending on device
TextNow:	Sprint
Ting:	Sprint or T-Mobile
The People's Operator:	Sprint
TracFone:	Could be any, depending on device
Ultra Mobile:	T-Mobile
Univision Mobile:	T-Mobile
US Mobile:	T-Mobile
Virgin Mobile:	Sprint
Walmart Family Mobile:	T-Mobile
ZIP SIM (was Ready SIM):	T-Mobile

GET ORGANIZED

**Stop Fighting Email with
More Email**

HOW TO

**How to Take a Screenshot
on Any Device**

TIPS

**12 Tips for Successful
Roku Streaming**

CONNECTED TRAVELER

When to Prepay for Travel

Digital

Life

Stop Fighting Email With More Email

BY JILL DUFFY



EMAIL AVALANCHE

Workplace email is growing, according to market research firm Radicati Group: It predicts that by 2018, workers will send and receive over 139.4 billion emails per day.

Email overload is a huge productivity problem in the workplace. I meet people all the time who complain about email, saying it's overwhelming them, wishing there were an off switch for all the new messages pouring into their inboxes.

Many of these same people, however, fixate on email in such a way that they end up exacerbating the problem. People try to combat email with more email, which in turn generates ever more email. Because they're mired in email misery, they usually can't see what's happening clearly, so they have no idea that they're making it worse.

Here are a few ways I've noticed people shoot themselves in the foot while trying to deal with email overload.

INBOX AS A TO-DO LIST

The first example of people who make their email problems worse are “to-do listers,” as I like to call them. They leave emails in their inboxes when the message either contains a task or triggers the memory of an assigned task. In other words, they use the inbox as a to-do list.

Think about how people usually assign tasks via email. Rarely is the task clearly stated in the subject line. The receiver has to open and read the email to know the details of the task. More likely, though, the message won't have all the information the receiver needs, such as a deadline or other details about the task. An exchange of messages back and forth clarifies the task, and it ends up creating a new piece of email every time it happens. In short, Email inboxes make very poor to-do lists.

Another problem is that to-do listers must check each incoming mail to see whether it contains a task. And if it doesn't, they get rid of the email promptly. To-do listers end up weeding incessantly.

Worse, to-do listers become accustomed to checking their inboxes for their daily tasks—and often, they end up emailing themselves reminders of other things they want to get done. If email is a problem, why would you create more email?

In the thick of things, however, to-do listers can't see how their system is making the matter worse. They often argue that using their inbox as a to-do list is the only thing that works. But if this same person feels overwhelmed by email, clearly it's not working. There are a few solutions, and I'll get to them in a moment.



TIMING IS EVERYTHING

You may feel pressured to respond right away if you see unread emails piling up in your inbox. but often, waiting to reply is the most logical and productive way to handle it.

NUDGEEMAIL

I spoke at a corporate retreat recently about email management. To prepare for the talk, I spoke to some employees and learned that a lot of them were managing huge volumes of email, sometimes 1,000 messages per day, using Nudgemail. They thought this was a perfectly sane way to manage the flow.

Nudgemail is a freemium tool that lets you essentially “snooze” email by setting a time when it will reappear in your inbox as a new message. “Essentially” is a very important word here.

Most snooze functions, like those in SaneBox or some of the best email apps, hide the original message from your inbox and then make it reappear as a new unread piece of mail at the time you choose. Nudgemail works a little differently. When you use it to snooze email, the original email stays in your inbox and a new message appears at the top of your inbox, with the entire thread of the original message cited.

Don't get me wrong: Nudgemail is a fine tool, and it's a great solution in some circumstances. Anyone who views the inbox as a stream of information rather than a collection point for communication that needs to be processed might do well to use it. But when workers tell me that the sheer number of messages in their inboxes leaves them unable to do their jobs, and 20 percent of their messages are repeated messages in the form of Nudgemails, that's a problem.

Much as to-do listers can be in denial about the fact that their system is broken, some Nudgemail users turn it into a crutch. They're so stuck in their current habits that they can't envision a better solution.

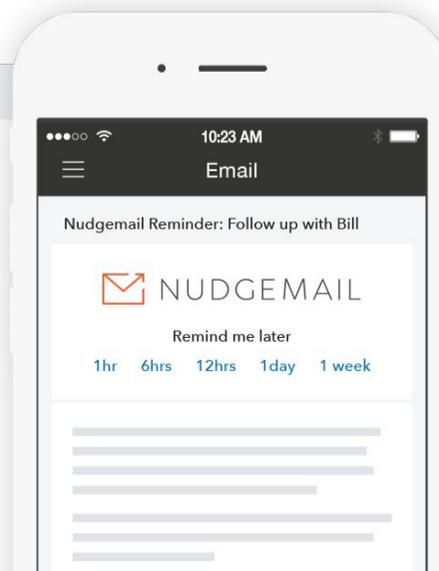
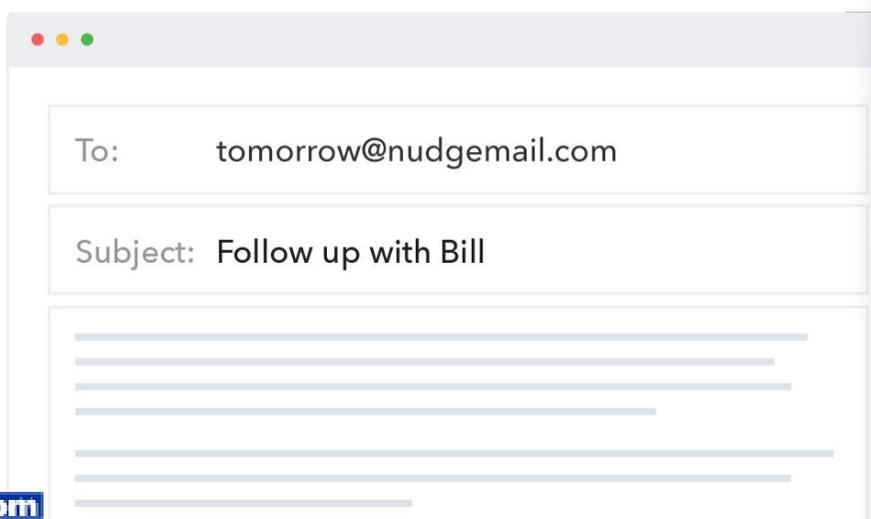


The first example of people who make their email problems worse are “to-do listers.”



A LITTLE NUDGE

Nudgemail is a freemium tool that lets you “snooze” email by setting a time when it will reappear in your inbox as a new message.



REPLYING QUICKLY

Very often, replying to an email is a way of acknowledging someone else's message without actually moving the conversation forward. Imagine a coworker emails to ask your opinion of a presentation. You haven't looked at the presentation yet. Depending on your workplace, it might be more acceptable to reply quickly with, "I don't know. I haven't looked yet," than to wait two hours until you have looked and formed an opinion. When you jump to reply quickly, though, even if the message isn't substantive, you're generating excess email. If company culture pushes you toward that behavior, you'd better believe other people are doing it to you, too.

A person who is slow to reply to email may be seen as lazy or not being a team player, even if waiting to reply to an email is a much more logical and productive way to go about it. But it's completely backward, and you need to break away from it if you feel inundated by email.

What ends up happening is that people reply to messages just to pass the buck. Let's say Raj asks Sarah's opinion of something, and she replies, "Not sure. What do you think?" Now the ball is back in Raj's court, and the onus is on him to reply if only so that Sarah will have a new unread message in her inbox reminding her to actually answer this time.

Another example that's common for folks in support departments, such as IT, is that they will set up a generic email address for employees to file help tickets, like IT-help@company.com. When an employee is freaking out that her computer is broken, however, and she needs to get help quickly, she might forget about the generic email and instead email the person she knows in IT. Should that IT person take care of the problem? Ignore the email? Reply and tell the employee she needs to use the correct IT-help address? CC her boss? What's the right thing to do?



A person who is slow to reply to email may be seen as lazy or not being a team player.



Often the response, fueled by panic and frustration, just generates more email (and creates tension). Again, it's an example of company culture creating expectations of a quick response that's at the root problem. But you can break away from this pattern without disturbing the peace and generate fewer emails as a result.

SOLUTIONS TO EXCESSIVE EMAIL

How do we stop generating excessive emails? Some solutions are simple and quick, and an individual can do them without the support of the company. In the previous example, the IT staff person could probably nip the problem in the bud by having a face-to-face conversation (or phone call with a remote employee), rather than replying by email. If the IT person replies by email, the coworker in need probably won't read it very closely anyway. Remember, she's already stressed out about her computer problem. It may sound very low-tech but confronting the coworker face-to-face, calmly and professionally, will help her remember the right protocol for filing help tickets in the future, especially if the IT person explains whatever other jobs were taking priority at the moment. Explaining in person goes a long way.

Another way to stop generating excessive email for yourself is to find email assistant tools that help you cut back on the email in your inbox rather than propagate it, as Nudgemail does. SaneBox (about \$7 per month) is the solution I recommend. And Mailbird is an email client app that comes with a snooze option and other features that might help.

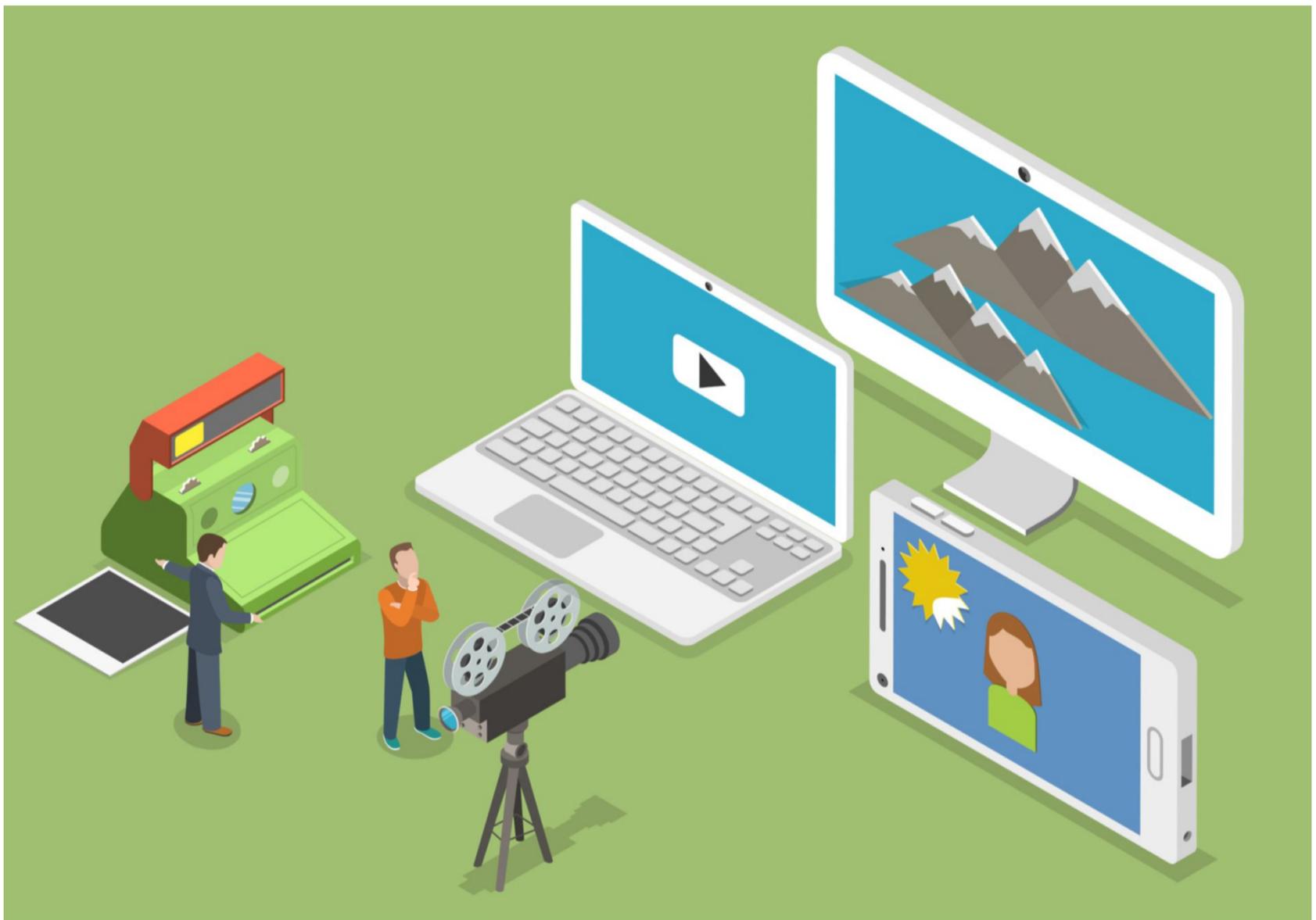
Stop using your inbox as your to-do list, both for personal tasks and work-related tasks. There are so many great tools now that are much better at assigning tasks, tracking them, updating the details about them, and so forth, that don't rely on email. I like Todoist, although Wunderlist is also a great app. If you can convince your work team or department to pick up a better tool for task assignments, you'll really be in much better shape.

Aside from full-force project management apps, other collaboration apps are lightweight, easy to use, and quicker to set up, and they may be a better solution to your team's challenges.



How to Take a Screenshot on Any Device

BY ERIC GRIFFITH



We write a lot of stories here at PC Magazine that are meant to help you with your computers and smartphones. To do that, we have to show you what's on the screens of those devices—a lot. Capturing these images, interchangeably called screenshots, screen captures, or screen grabs, is just an everyday part of what we do. But taking screenshots isn't the norm for everyone. In fact, there may be some of you out there who aren't even aware you can do it. But it's easy. In this story, we run down everything you need to know about capturing screenshots, no matter the platform—including Windows, MacOS, iOS, Android, and other mobile operating systems.

Most methods require nothing more than the operating system itself—they've all got built-in methods of capturing a screen. But many third-party software tools can take your screen-grab game up a notch. We'll even show you some of the tools that make it simple to take an image within the Web browser, which is arguably the most used software on any desktop or laptop PC anyway.

SCREENSHOTS ON SMARTPHONES

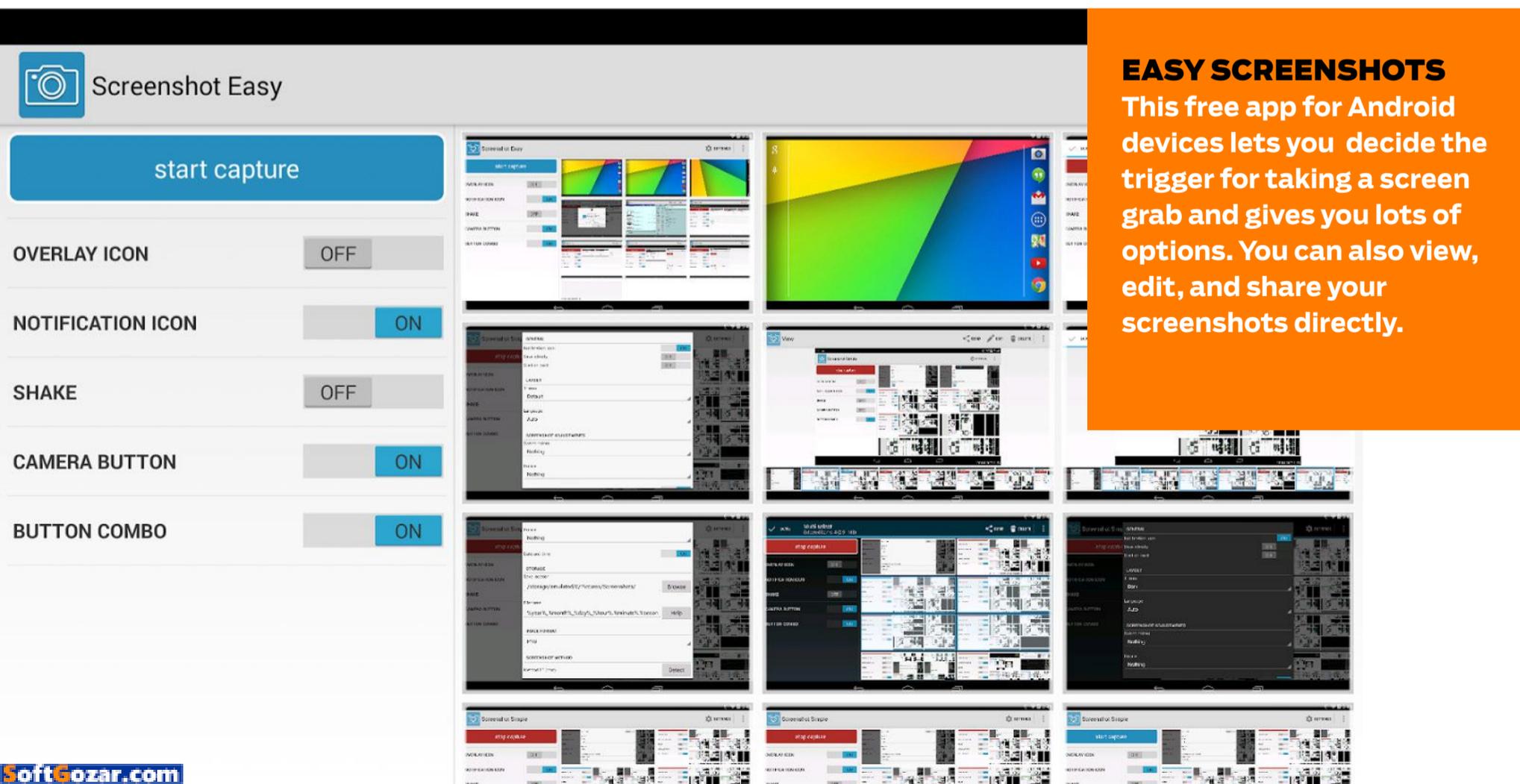
You probably take a lot of pictures with your smartphone, but you can also take a picture of what's already on the screen. The tools to do so are built right in.

ANDROID

Google's mobile operating system has a built-in screenshot option (Android 4.0 or later). Hold the power button and volume down for a second or two. The screen flashes white, and the image is saved to your photo gallery.

Except that it doesn't always work. Since Google doesn't have strict control over Android the way Apple does over iOS, things can get weird. You can also try pressing the Home and power buttons at the same time. If that doesn't work, you've got to go with an app.

At least Android users have the option of using an app—iOS users do not. The problem is that there are way too many Android screenshot apps to count. Some are free, some are paid. The top-rated app, with over 160,000 users, is Screenshot Easy. It uses the same basic triggers as Android does, and you can also customize it to take a screenshot just by shaking your phone, for example.



EASY SCREENSHOTS
This free app for Android devices lets you decide the trigger for taking a screen grab and gives you lots of options. You can also view, edit, and share your screenshots directly.

SoftGozar.com

IOS

Apple iOS for iPhone, iPad, and iPod touch has only one option for taking a screenshot: Hold the Sleep/Wake button (on top or the right side of the device, depending on the model), then click the Home button. You'll hear a camera shutter and see a flash. The screenshot appears in your Camera Roll; it's that simple. You can try holding the buttons the other way around, but devices with the Touch ID fingerprint scanner could mess things up, depending on what you want to capture—like, say, your Lock screen.

WINDOWS PHONE 8 AND WINDOWS 10 MOBILE

Windows Phone makes screenshot capture a simple process as well: Press and hold the power and Volume Up buttons (if you hold Volume Down, the phone will reboot). Screenshots go right into the Photo Hub—look for Pictures, then an album marked Screenshots. They're stored as PNG files.

You can't take a screenshot with Windows Phone 7 without unlocking it.

If you're using Windows 10 Continuum, doing this keystroke still takes a shot only of your mobile screen, not any external display; for that you still use the Windows desktop key-commands (see below).

BLACKBERRY

With BlackBerry devices, press the Volume Up and Volume Down keys simultaneously. The camera noise should occur, and the image will be in your Camera folder (not on the SD card). Open the File Manager to find them. If that doesn't work, download CaptureIT OTA by visiting the link. It'll spell out how to change some permissions, but after that you should be set.

SCREENSHOTS ON PCS

WINDOWS

The absolute simplest way to take a screenshot in Windows is to use the PrtScn (PrintScreen) button. You'll find it on the upper right side of most keyboards. Click it once, and it'll seem like nothing happened. But Windows just copied an image of your entire screen to the clipboard. You can then hit Ctrl-V to paste it into a program, be it a Word document or an image-editing program.

The problem with PrtScn is that it's not discerning—it grabs everything that's visible on your monitor or monitors (if you've got a multi-monitor setup, it'll grab all the displays as if they're one big screen). To narrow things down, open a window, make it the focus of attention, and then tap Alt-PrtScn. That also

appears to do nothing, but it's in fact taken a screen grab of just that window and copied it to the clipboard.

One more built-in helper is Snipping Tool. It's been around since the days of Windows Vista, so you may have to search to find it (a breeze to do in Windows 10). Once launched, it provides a tiny window with menus that make it easy to capture multiple types of screenshots. Grab just the area you want (in rectangle or free-form), a window, or the whole screen. Snipping Tool shows you the captured image instantly so you can choose what to do with it: Save it, copy it, email it, annotate it, or highlight sections of it. It's an old workhorse program, though, and not up-to-date enough to offer sharing via social networks.

Windows has a spectacular array of great screen-capture utilities available. Top of the line is Snagit—which costs a whopping \$50. Of course, it'll do it everything you can imagine, even take video of what's happening on your screen (that's called a “screencast”).

You can find plenty of screenshot apps for free, though. Jing, by the maker of Snagit, also does screencast videos and makes sharing what you capture easy. LightShot is a small, nifty utility that takes over the PrtScrn key and makes it easy to capture and share. Both are also available for Mac.

MacOS

As with iOS, Apple has a tight grip on its desktop/laptop operating system. With a MacOS-based PC, however, you get a few more screenshot options than you get with Windows (since Mac keyboards lack a PrtScn key).

Here are the easy steps: To capture the entire screen, tap Command+Shift+3 (all three keys at once). A PNG image file of the screen will appear on your desktop. If you want only part of the screen, tap Command+Shift+4; it turns the cursor into a crosshair. Select the section of screen you want to capture. Or press the space bar, and the cursor turns into a

“
At least
Android device
users have
the option of
using a
screenshot
app—Apple
iOS device
users do not.”



camera—click with it on any open window to highlight it. Click again and just the window itself is captured.

If you like the Windows method—where what you capture is saved to the clipboard instantly—try Command+Control+Shift+3 for the whole screen, or Command+Control+Shift+4 for a section. Adding the Control key to the keystroke ensures the image isn't saved to your desktop. Then use Control+V to paste it in to any app.

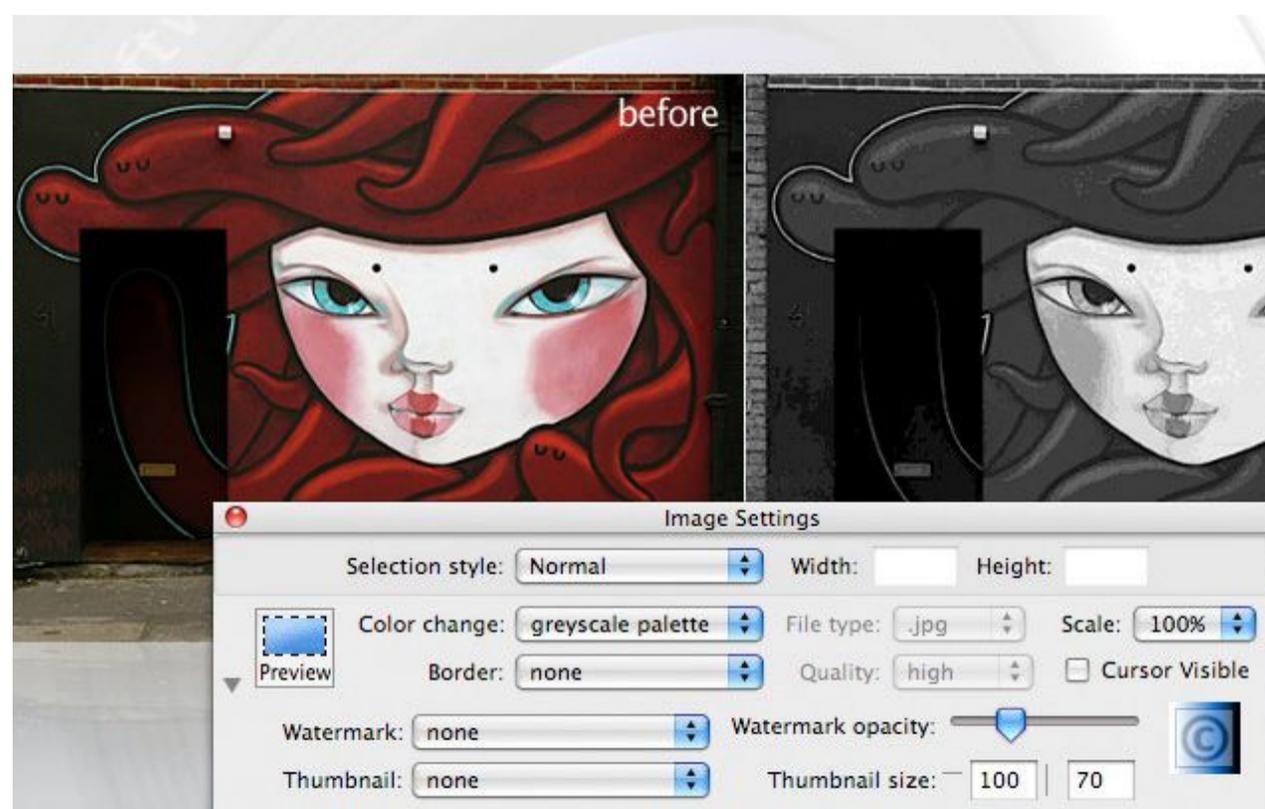
On a Mac with a Retina display, a screenshot of the entire screen can be huge in PNG format, as big as 5MB to 7MB. If you'd rather the Mac save in JPG or some other format, change the settings. You need to open a terminal window on the Mac in question and type:

defaults write com.apple.screencapture type jpg

If you're asked for your password, enter it. Restart your system, and future screenshots should be in JPG format. Change it back the same way, but replace "jpg" with "png."

Prefer an app that will take care of screenshots? Apple still includes Grab in its Applications > Utilities folders (search with Spotlight to find it quickly). Grab's effectiveness is limited in that it captures images only in TIFF format, but it can take a shot of the whole screen, a window, or a selected section, and it has a timer, so you can capture items like drop-down menus. The shortcuts to do so are the same as you'd use for the OS itself, so really, don't bother with Grab unless you work only with a mouse.

Macs can also take advantage of free, third-party utilities for screenshots. These include Jing, Skitch, LightShot, and others. For those who feel it's better to pay, the venerable, award-winning SnapzProX is an option that costs a jaw-dropping \$69.



WAY MORE THAN SCREENSHOTS
SnapzProX lets you save videos too, save screenshots in myriad formats, and edit your shots. It also offers built-in watermarking for your original creations.

LINUX

There are almost as many ways to take a screenshot in Linux as there are flavors of Linux. Let's take a look at Ubuntu in particular.

You can go right to Applications > Accessories > Take Screenshot to start. PrtScn works—hit the button on the keyboard and it'll shoot the entire screen. Hit Alt-PrtScn to grab just the active window.

True Linux heads will appreciate the ability to take a screenshot from that most un-screenshot-worthy window, the terminal.

Maybe the best thing you can do is to take a screenshot from within a program where you can edit the screenshot after, and there's no better candidate than GNU Image Manipulation Program, or GIMP. Within the program, select File > Acquire > Screen Shot. You'll get a few options, such as taking the entire screen, a window, or using a time delay. The captured image is then opened up in GIMP for editing.

SCREENSHOTS IN WEB BROWSERS

Many Web browsers, Google Chrome and Mozilla Firefox in particular, support add-ons that extend the usability of the browsers. Here are a few such extensions that put screen-capture utilities right into the browser.

LightShot (Free; Chrome, Firefox, IE, Opera): It's available for Mac and Windows desktops, but also on almost every browser across all operating systems.

FireShot (\$39.95; Firefox, Chrome, IE, SeaMonkey, Thunderbird, Opera): Beyond the browser, FireShot even works with mail programs. It captures and allows instant edits, allows sharing via social media, instantly saves to the computer, and sends images to Microsoft OneNote.

Awesome Screenshot (Free; Chrome, Firefox, Safari): Capture a whole page or a section and then quickly annotate it (or blur out the naughty bits) before sharing instantly.

12 Tips for Successful Roku Streaming

BY CHANDRA STEELE

Whether you're a cord cutter or not, you're probably going to want a streaming device for your TV, and the Roku remains more most popular than the Apple TV, Google Chromecast, and Amazon Fire TV Stick, according to Parks Associates.

Part of that popularity may be due to the variety of Roku devices—five in all. There's the original Roku, Roku 2, Roku 3, Roku 4, and Roku Streaming Stick, and they range from \$49.99 to \$129.99. They all work pretty much the same way, once you've got them installed.

Whether you just got a Roku or you've had one for years, there's more to know beyond the basics of watching Netflix and catching up with “Comedians in Cars Getting Coffee” on Crackle. We've put together 12 ways for you to get more out of your Roku, and stream on.

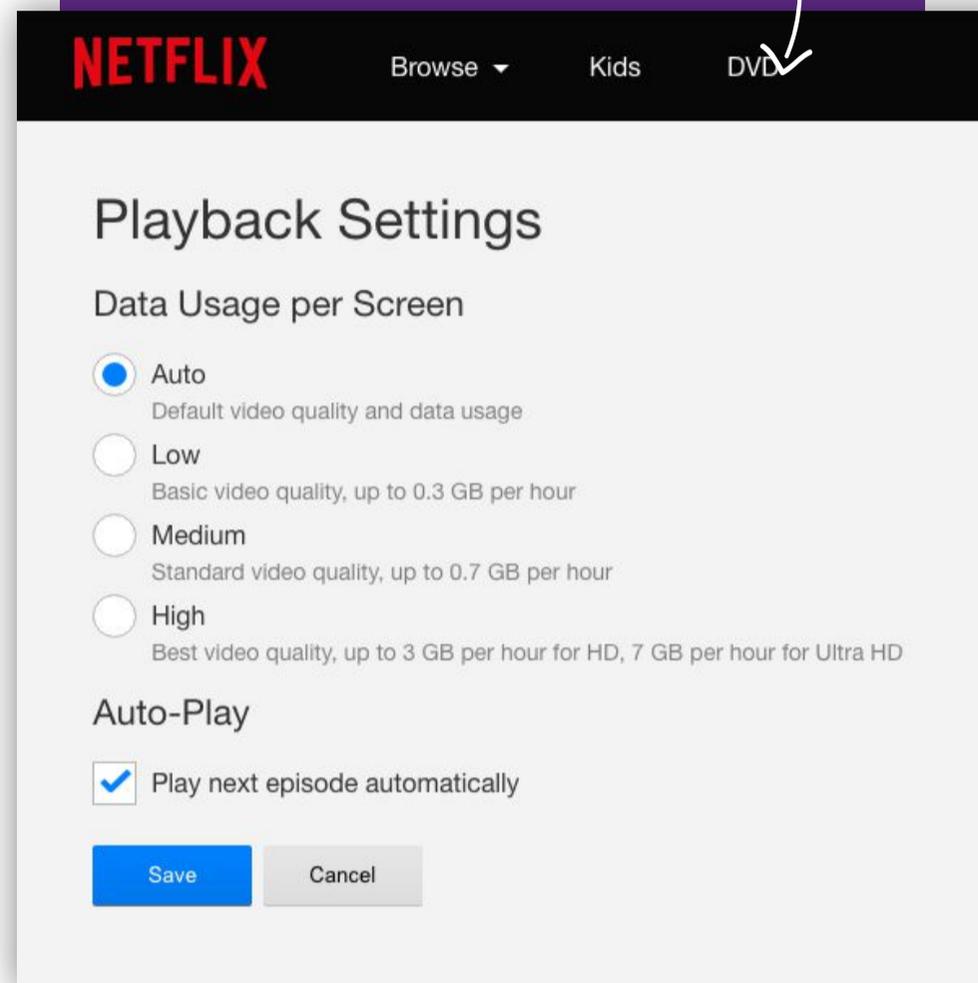


1. HIDDEN CHANNELS

Not all available Roku channels are listed in the Roku Channel Store. To find the “secret” ones—which include Apocalyptic TV, Israeli Channel 10, and 3D Crave, among many others—check out the online Roku Guide (www.rokuguide.com/private-channels). Click the link you want, then Add Channel, and you’ll be taken to a Roku account page. Log in and add the code for the channel, and you’re set.

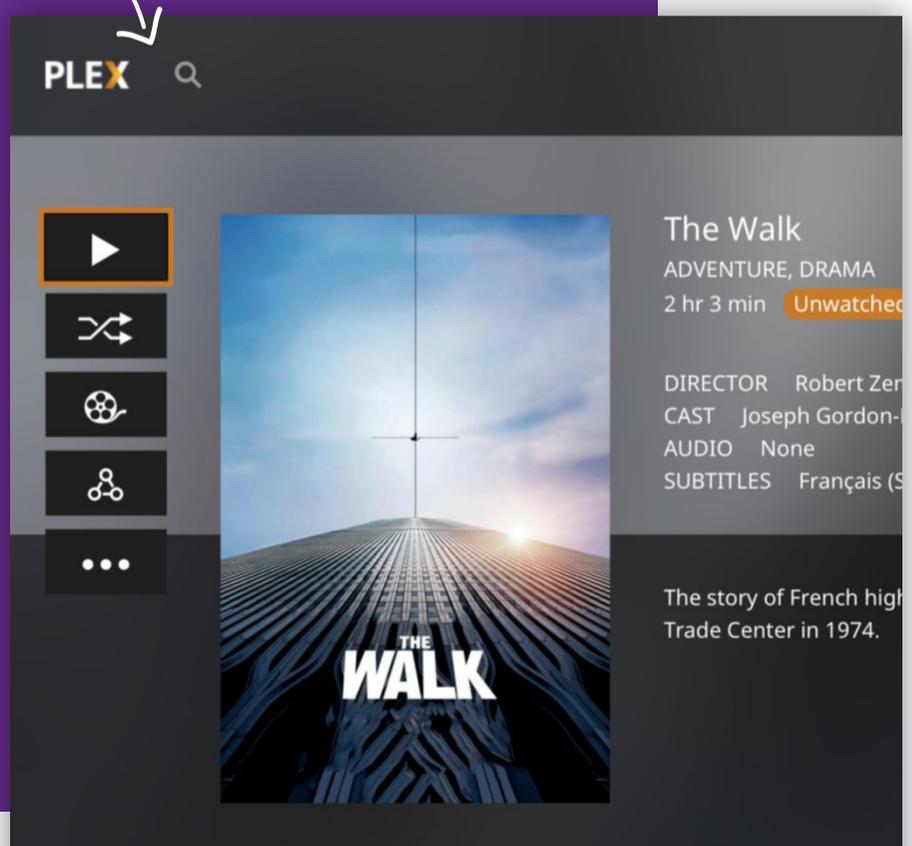
3. QUALITY CONTROL

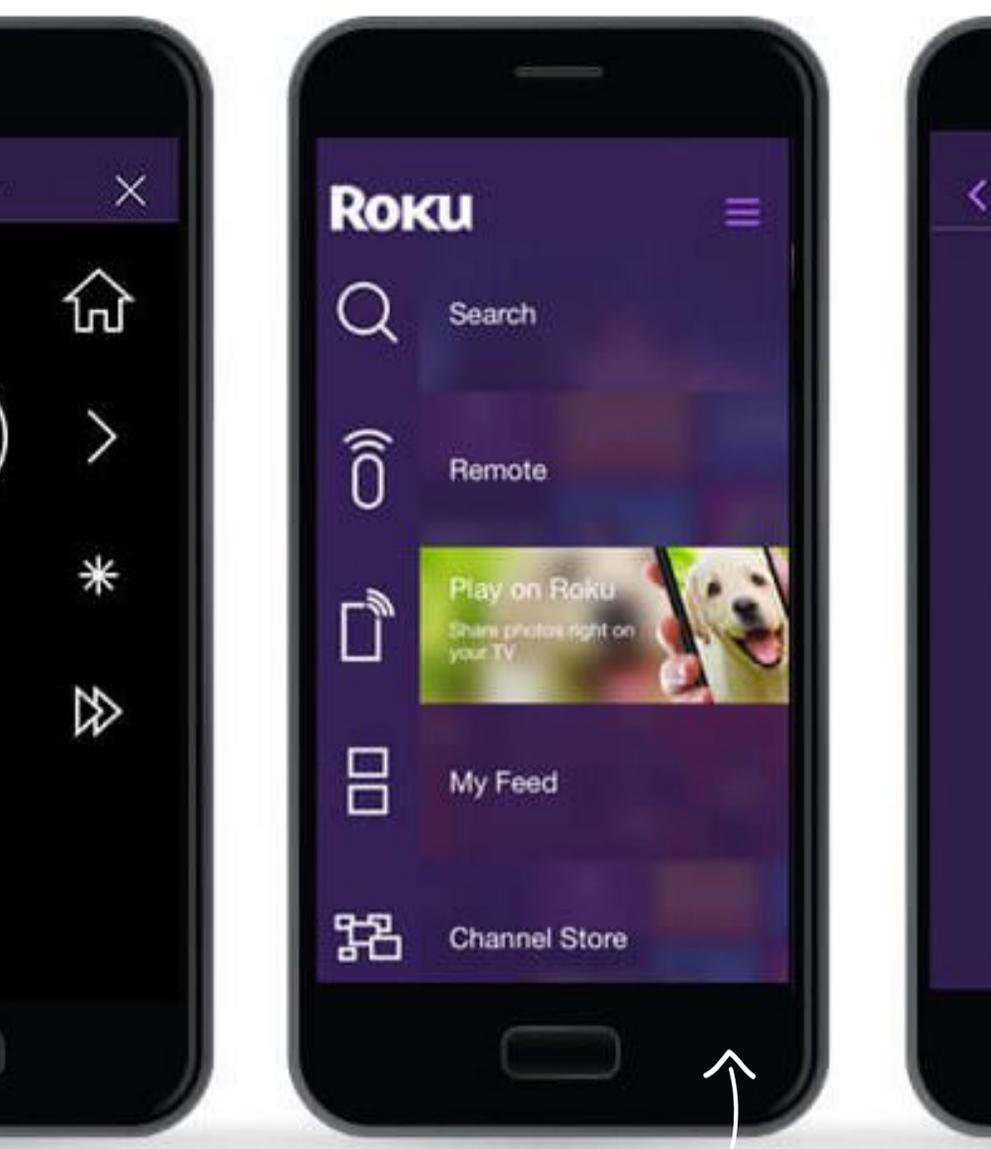
You can control the quality of Netflix streaming on your Roku, whether you want to see things more clearly or you need to stay within a data cap. Log in to Netflix’s website, then go to Your Account > My Profile > Playback Settings.



2. STREAM YOUR STUFF

Though Roku has a ton of things to watch, you’ll probably still want to access your own stored content. Plex (\$4.99 per month, \$39.99 per year, or \$149.99 for a lifetime) organizes your scattered content and lets you watch it on tablets, TVs, phones, and more, and share it with friends and family. Sign up for the service, then download the Plex app. Plex also has a Roku interface: In the Roku app, go to Preferences > Connect Plex account, and follow the instructions to verify the PIN code to connect the app with your Plex account.





4. FEWER CLICKS

As great as the Roku is, navigation via the remote could be better. Download the Roku app (for iOS, Android, Windows) and get the benefit of a keyboard, easy searching, and streaming from your phone or tablet. Screen mirroring is available on the Roku 4, Roku 3, Roku 2 (Model 4210), and the HDMI version of the Streaming Stick for some Android and Windows Phone devices.

5. SAVE THAT SCREEN

Maybe you've paused whatever you're watching and walked out of the room. Or you slept through streaming and now the Roku logo is just bouncing around, the flying toasters of the new millennium. Give yourself something nice to look at with Roku's screensavers. Select Screensavers & Apps from your Roku, and you can gaze at an art gallery, hang out by a crackling fire, or keep an eye on the weather.

6. BIG GAME

It's not an Xbox One or a PS4, but your Roku is still in the game. Go to Games, and you can go retro with Pac-Man, race to save an emperor's daughter in Chop Chop Runner, or test your smarts with Jeopardy. The Roku 4 and Roku 3 have a motion controller for gaming built into the remote.



7. YOU'VE GOT OPTIONS

The Roku displays your channels in the order in which you added them. That is, unless you select Options using the asterisk key from the Home screen and reorder them so that your most frequently watched channels are at the top.

8. FEED ME

To find out which movies and shows are coming soon to Roku channels, go to the main menu, select My Feed, and then browse what's new. Select the ones you want to follow, and when they're available, the details on where and how to watch will appear in the Watch It section under the menu.

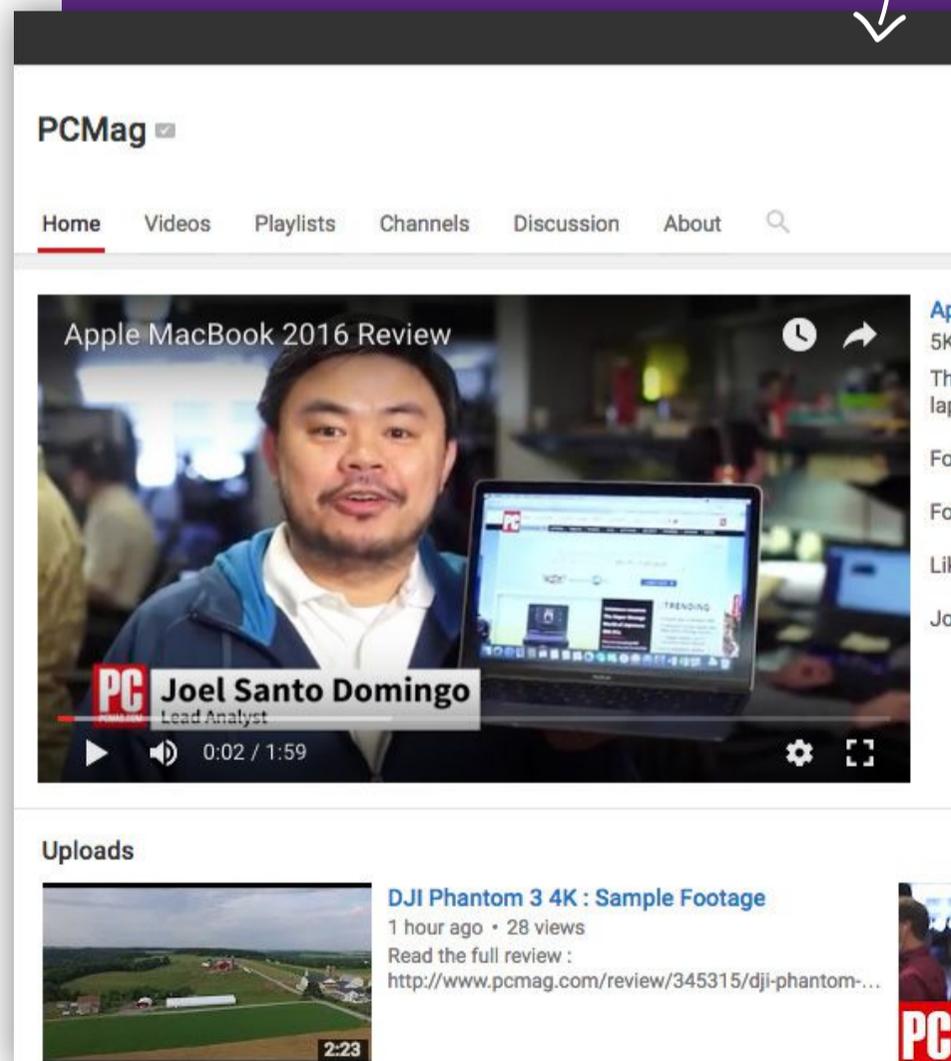


9. UP, UP, AND AWAY

If you have a non-streaming-stick Roku, it's taking up some real estate next to your TV. Move it out of the way by buying the Roku Mounting System for \$9.99, which attaches to the back of your TV.

10. CAST AWAY

If you've passed on the Google Chromecast in favor of the Roku, you can still cast YouTube videos from your mobile screen to your TV. Go to the YouTube channel on Roku > Settings > Pair Device. You'll see a string of numbers to enter. On your mobile device, open a browser window, go to youtube.com/pair, and enter the code. Now when you're in the YouTube app on the mobile device you paired, you can send video to your TV screen by clicking the Cast icon, provided both devices are on the same Wi-Fi network.





Tucson, Arizona

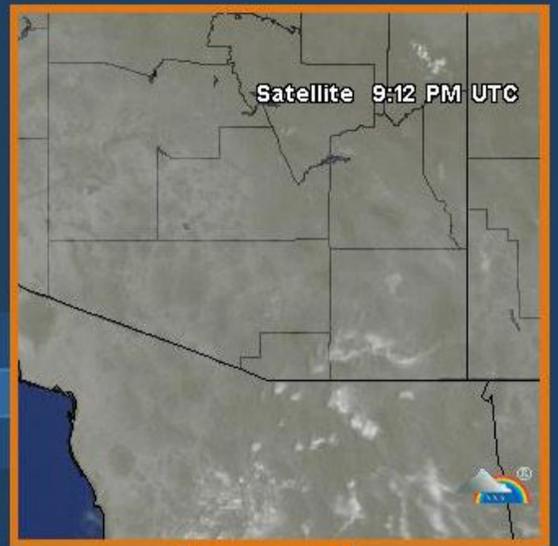
2:19 PM MST on March 13, 2012

°F °C

84.2 Clear

Feels like: 81
Wind: 6.9 mph from the North
Humidity: 10%

Today is forecast to be warmer than yesterday



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Tuesday	Wednesday	Thursday	Friday	Saturday
84 / 52	81 / 52	82 / 55	81 / 54	77 / 48
0%	0%	0%	0%	0%

11. LOCAL HEROES

Cutting the cord doesn't have to mean cutting yourself off from televised local news. NewsOn (available at channelstore.roku.com) gives you access to local news broadcasts from outlets nationwide. If you're just looking for a weather report, you can get it via Weather Underground or WeatherNation.

12. SAY WHAT?

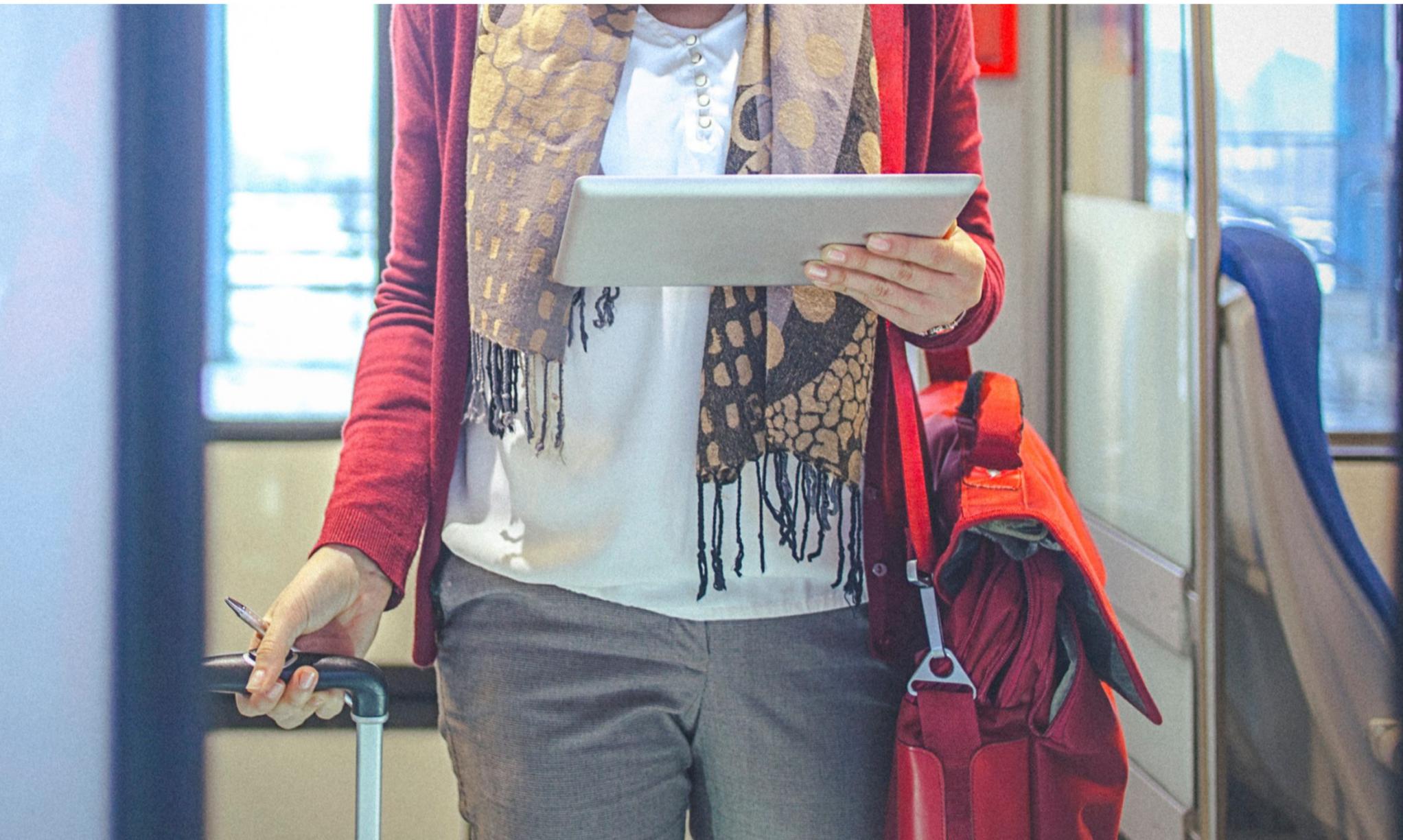
If you missed those last few lines in a show or movie, there's a quick way to catch up. Set up instant replay by going to Settings > Captions > Instant Replay so that when you hit the Instant Replay button on the remote, you also see the text on the screen.

A'ight.
Boy's learnin'.

When to Prepay for Travel



BY JILL DUFFY



Travel-booking websites and apps usually promise you a deal: Pay in advance for hotels and flights, and save a chunk of money. But paying in advance doesn't always pay off, as I've discovered. I'm planning a month-long trip to the U.S. (I live in India), with a few days' stopover in London at the end. A month is too long a trip for a tight itinerary, so I've had to think through all my booking options to make sure I can be flexible and make changes as I go. But it's also going to be an expensive trip, and I want to save money where I can.

In planning and organizing travel, there's a tradeoff I always end up making between saving money now and potentially saving money in the future. Here's how I think about the choice.

PREPAY, SAVE NOW

Third-party booking services make it really easy to save money now: apps and websites that both help you find travel options and offer to book them for you. Some are Orbitz, Kayak, Booking.com, and Hotels.com, and there are many more. These sites and apps give you great search tools for finding the right flight, hotel, vacation package, cruise, car rental—whatever—and then they offer to book it for you on the spot if you prepay.

Prepaying on one of those sites means you usually get the greatest savings in the moment—but that doesn't mean you'll end up saving the most money in the long run. When a third party books a flight or hotel reservation for you, that company generally holds the booking. If you need to change a flight, for example, you typically have to go through the travel site rather than talk to the airline directly. It's extremely inconvenient and a waste of time, and you could get hit with more change fees than if you had paid the airline directly.

Another problem is that many hotels don't honor reward programs when you prepay through a third party. (Airlines, however, let you earn frequent flier points no matter how you booked.) If you're savvy about hotel loyalty programs and travel enough to earn free nights, free upgrades, or elite status, you could be missing out on earning these benefits when you prepay for a hotel just to save \$15 or \$20 a night. Some booking sites offer their own rewards programs, such as loyalty discounts or a free night's stay after a certain number of completed reservations. So if you're going to use third parties for bookings, it's usually worthwhile to find one you like and stick with it.

So if your plans might change, as in my case with a month-long trip, prepaying isn't always the best option.

SAVE WHEN YOU PREPAY

When you book your trip through third-party websites or services, such as Kayak, Booking.com, Orbitz, and Hotels.com, you can get great discounts. But it's not the best option if you might have to change your travel plans.

RESERVE ONLY, POTENTIALLY SAVE LATER

Some third-party sites give you the opportunity to reserve a travel booking without paying for it right away, though you usually have to give them your credit card number as a guarantee. For hotels, this is my preferred method for booking. The reserve price never is as low as the prepay price, but it's usually not all that much more. And it generally lets you change the reservation somewhere between a week and 48 hours before the check-in date.

Here's an example. I reserved a hotel room for four nights in San Francisco, but I did not prepay. I had the option to change it until about a week before my arrival. Then I learned that I can stay with a friend for two nights. I was able to change the booking and cut hotel expenses in half for that portion of the trip. If I had taken the prepay deal, I would have saved only about \$80 over the reserved price for four nights. By changing the itinerary and staying with friends, I saved hundreds of dollars.

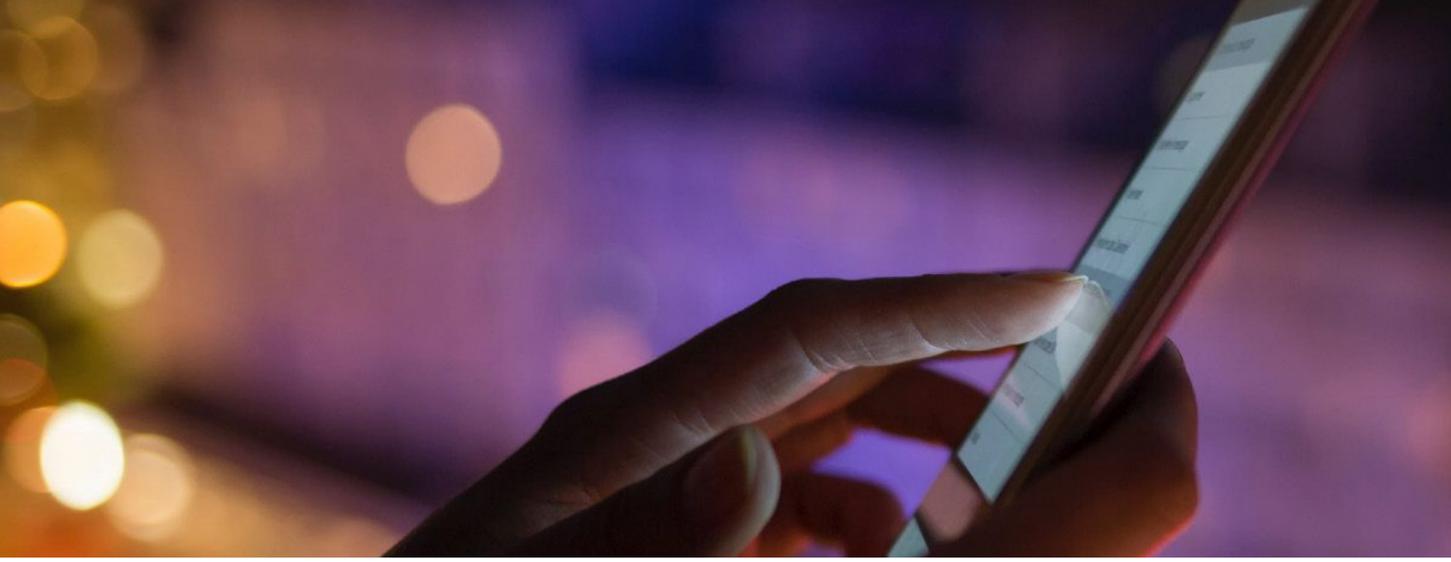
Some airlines let you reserve a good price that you find for a flight without prepaying, though the option isn't always apparent until you reach the payment screen. I recently had some potential business travel and found a great deal on Qatar Airways, for example. The contract for the job hadn't been finalized, but the trip was getting closer, and I didn't want to wait too long and see prices soar. Still, I didn't want to pay for an expensive flight until I had that signed contract in hand. On Qatar Airway's site, I followed the prompts to book the flight, and before the credit card collection point, saw the option to hold the ticket at the quoted price for 48 hours. In the end, the job didn't work out, and I didn't lose a dime.

GO TO THE SOURCE, GET MORE FLEXIBILITY

When you find a great deal on a third-party travel site, it's worth checking with the provider (the airline or hotel) to see whether it will match that rate. I often use flight search sites such as Kayak and Google Flights to look for the best deal, and then check the airline's site to see if their price matches the one I saw. Often it does, and sometimes it's off by less than a dollar.

If the difference is more than that, sometimes you can call the provider to ask whether it will match the quote you found.

As I mentioned previously, there's often an advantage of dealing directly with the provider if you have to make a change to the booking. You pay only its change fees, and you deal with the company directly rather than a middleman.



KEEP YOUR OPTIONS OPEN

Savvy travelers know they have loads of choices in how they make travel reservations. Consider what kind of trip you're taking, and book accordingly. You could save a bundle.

WAIT UNTIL THE LAST MINUTE, GET DEEP HOTEL DISCOUNTS

Not everyone can wait until the last minute to book accommodations, but you'll often find the best rates when you do. When a hotel hasn't booked enough of its rooms to break even or turn a profit (I'm oversimplifying how hotels operate, but you get the point), then it's in the hotel's interest to drop prices and give travelers an incentive to book and help to fill rooms. That's in large part how third-party booking businesses started.

If you wait until the day you'd be checking in to find a hotel, that's when you'll find the best deals. Apps such as Hotel Tonight, Hotwire, and Roomer specialize in taking advantage of that last-minute panic to fill rooms. Hotel Tonight and Hotwire help hoteliers liquidate room that weren't reserved. Roomer does that, too, but it also lets people who can't use a prepaid room sell it to someone else.

Let's say I had made the mistake of prepaying for those four nights in San Francisco, and in the end, I decided to stay with friends the entire time. I could sell my hotel booking on Roomer by setting a competitive price, even lower than the one I paid, and hoping someone else who uses the site snaps it up.

When you use Roomer to search for rooms, you can also find good discounts a few days and weeks in advance, since not all changes and cancellations happen at the last minute. You can't always find a stellar deal in the location you need; still, Roomer is a great app to have in your back pocket.



MORE OPTIONS MEANS BETTER TRAVEL

Prepaying for travel usually saves you a little money, and if your plans are unlikely to change, it's often a good choice. But it's best to know that other options exist and to think through how you might be able to spend less. There are plenty of ways to lock in good rates while still earning hotel points and maintaining your ability to change a reservation with either no fee or at least only the fees the provider charges.



The Internet of Things Is Not for You

The Internet of Things (IoT) could impact the global economy to the tune of \$6.2 trillion by 2025, according to a report from McKinsey&Company. But what does it mean? A simple definition of the IoT (from Oxford Dictionaries) is “a proposed development of the Internet in which everyday objects have network connectivity, allowing them to send and receive data.” This definition uses the term in a sentence, which could also serve as a disclaimer: “If one thing can prevent the Internet of Things from transforming the way we live and work, it will be a breakdown in security.”

I’ve written negatively about some aspects of the IoT, especially the home-automation pipe dreams, which I’m not convinced people actually want. It’s kind of cool to control appliances and temperatures and music distribution around the house, but is it necessary? It’s a glorified Clapper.

I will admit that in the 1970s, I was all-in on the BSR X10 home automation gear. But I eventually determined it was ridiculous. And that gear was probably not as hackable as today’s products. If I were a goofy kid with a penchant for hacking, I would go after home automation systems. Imagine coming home and seeing the sprinkler system going at full blast, while the garage door opened and closed, and the lights flashed, and the stereo blared “Surfin’ Bird.”

But that’s not same as the Internet of Things, which isn’t going to do much more than skirt the home. A couple of cool camera-equipped remote doorbells can ring your phone and turn on the

camera when someone comes by. And how about Internet-connected meat thermometers? These are IoT ideas that are actually useful.

A lot of people think the IoT will have nothing to do with these handy household uses. It will all go into industry, with computerized controllers talking to other controllers and doing creative things, most of which have yet to be imagined.

Companies are working on elaborate traffic-signal-management systems involving intense sensors and software that keeps traffic flowing, for example. I don't know about you, but I find it nuts that I have to sit at a light when there are no other vehicles in sight. This is easily solvable.

We can get a hint of what kinds of devices will be connected. Newer cars, for example, have micro-sensors that tell you when a tire needs air or the tank needs gas. If this were part of the IoT, it could report to AAA when you have a flat tire or your car runs out of gas. The IoT will have an impact on the automobile industry in all sorts of ways. I suspect it will be used to issue traffic citations.

The surveillance aspect will only be brought online once the technologies are commonplace enough so as not to excite the public. But even with a little optimism, I find it hard to imagine that the IoT will have a multi-trillion dollar impact within nine years. This report does alert me to the possibility. Now I'm alerting you.

A handwritten signature in black ink that reads "John Dvorak". The signature is fluid and cursive, with a large loop at the end of the last name.

john_dvorak@pcmag.com

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