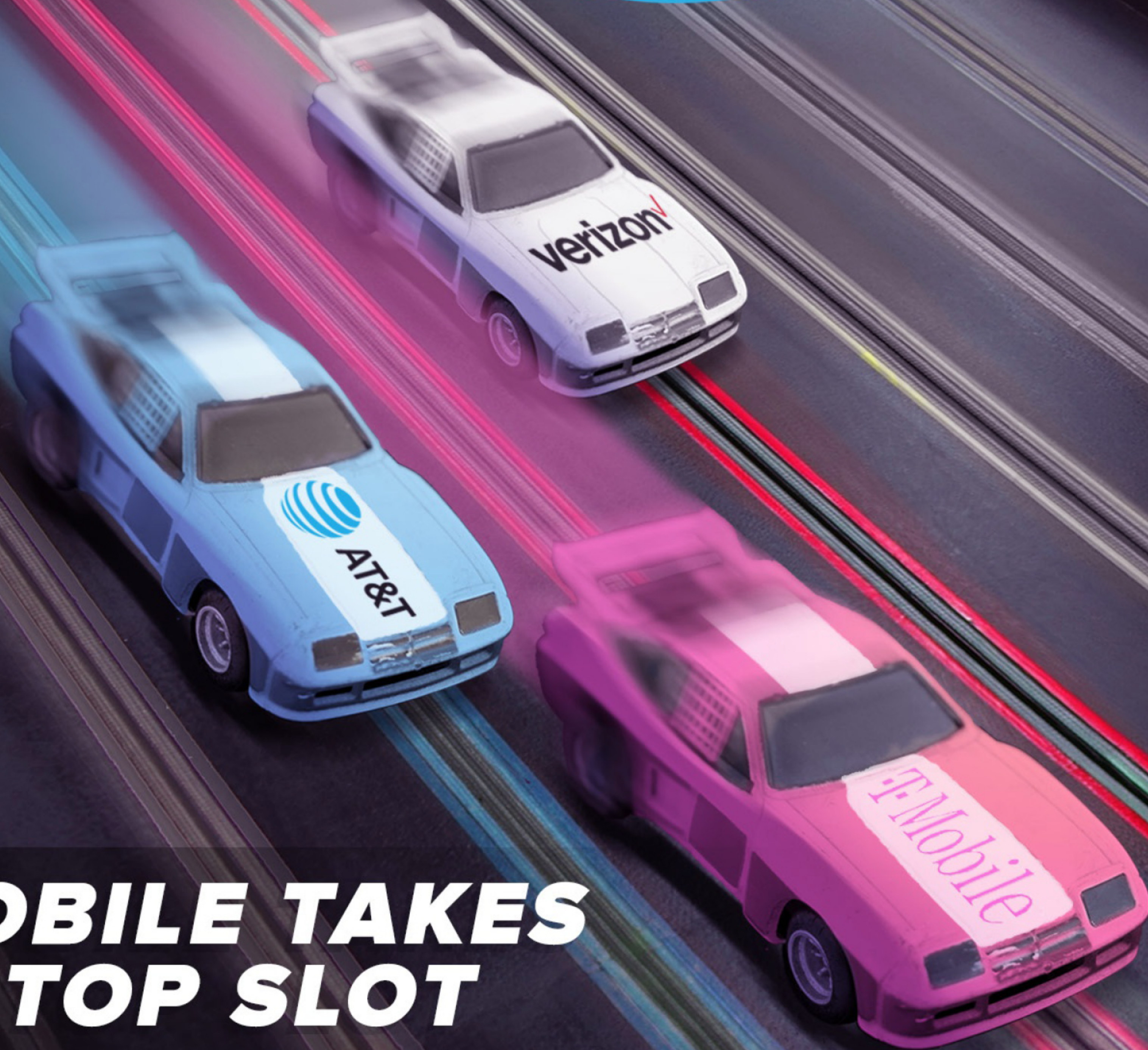


PC
MAGAZINE

***FASTEST
MOBILE
NETWORKS
2021***



***T-MOBILE TAKES
THE TOP SLOT***



COVER STORY

FASTEST MOBILE NETWORKS 2021

For our 12th annual drive test, we traveled over 10,000 miles, speed-testing AT&T, T-Mobile, and Verizon 4G and 5G networks in cities, towns, and rural regions all over the US. We found a radically new landscape—and a surprising winner.

WHAT'S NEW NOW



WTF IS THE METaverse?

We offer this quick primer to help you with the basics.

SPACEX PREPS 'RUGGEDIZED' STARLINK DISH FOR CARS, BOATS, AND PLANES

The 'high-performance' Starlink dish has also been designed to survive harsh environments, according to an application SpaceX filed with the FCC.

THE WHY AXIS

A survey shows people are trying to limit their nightly screen exposure, especially if they've been staring at pixels all day.



REVIEWS

CONSUMER ELECTRONICS

Samsung Galaxy Buds2

Sony ZV-E10



Samsung Galaxy Buds2

HARDWARE

HP Laptop 14-dq2020nr

Lenovo ThinkPad X1

AMD Ryzen 5 5600G

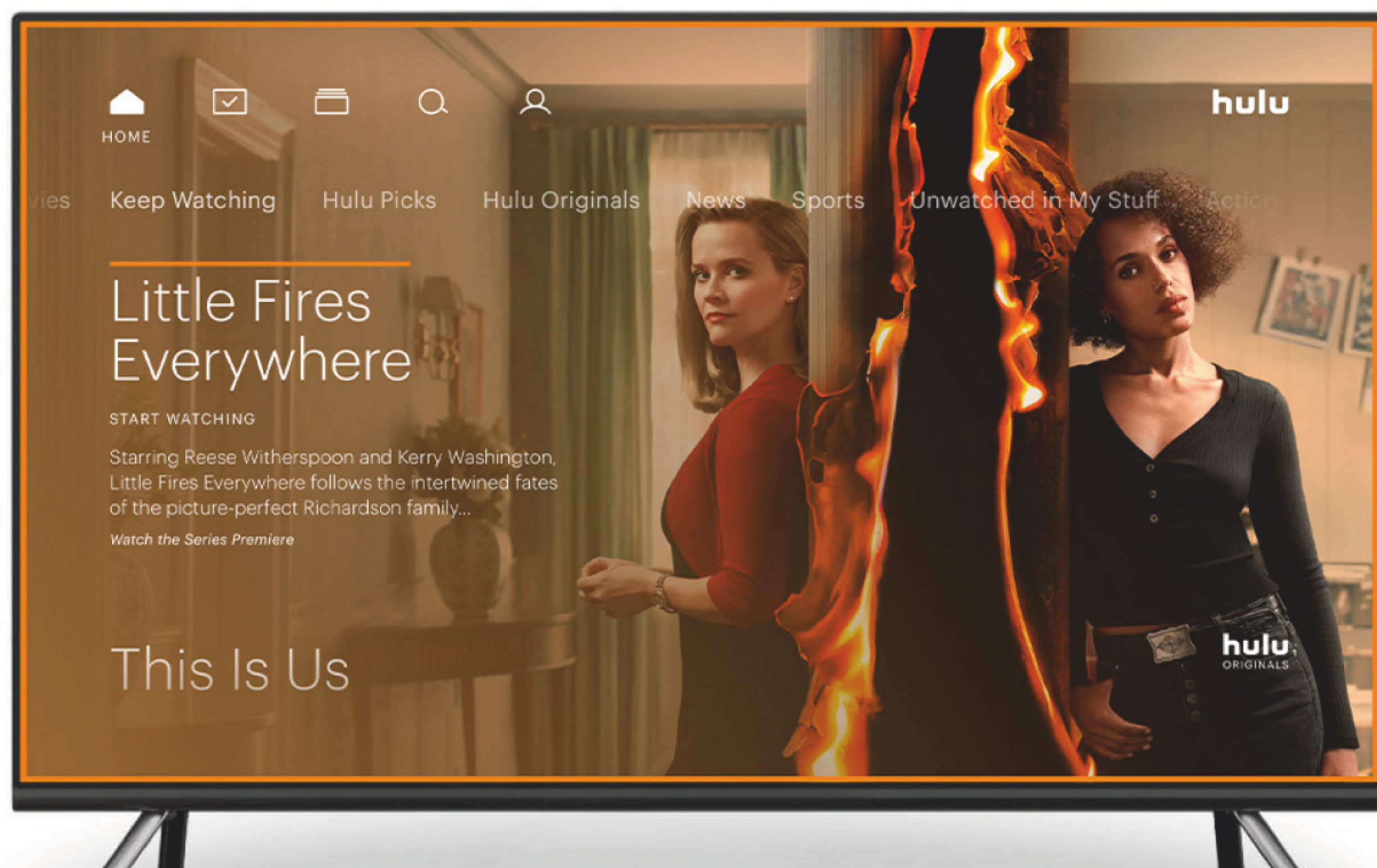


Lenovo ThinkPad X1

SOFTWARE & APPS

Hulu

Corel PaintShop Pro



Hulu

COMMENTARY

CAROL MANGIS

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Why 5G Desperately Needs the New Samsung Galaxy Fold

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COVID-19 Upended How We Test VPN Speeds

TIPS & HOW TOS



MASTER SOCIAL MEDIA WITHOUT SACRIFICING YOUR PRIVACY

Posting on social media is all about communication, whether it's chatting among a tight circle of friends or broadcasting your views to the public. Just take care that you don't give away too much information.

CLEAN UP APPLE MESSAGES TO FREE UP SPACE

Don't let videos, photos, GIFs, and stickers buried in text messages fill up your Apple devices' storage.



5G Clinches The Win for T-Mobile

@cmangis

Longtime readers, you'll know what time of year it is: Time for PCMag to take to the road and measure mobile-network speeds across the country. It's our twelfth annual Fastest Mobile Networks drive test, and that includes last year—we didn't let a pandemic slow us down.

This year, as 5G slowly takes over, one carrier shone brighter than the other two: T-Mobile won our national award for the very first time. As you'll read in our cover story, it accomplished that win by expanding 5G coverage into mid-band spectrum: "T-Mobile's new mid-band 5G network is the only nationwide 5G that's markedly faster than 4G, earning the carrier its first-ever PCMag award for America's fastest mobile network."

We also report the winning network for each of 50 major cities and for six regions of the US. So jump in to find out which carrier rules in your area and whether it's time to upgrade to a new 5G phone (depends on the carrier you use and where you live, but T-Mobile customers: heads up!).

And we caution those who live in rural areas, away from interstates, we found that 5G coverage is still sparse: We encountered far too many dead zones in those wide-open spaces. It'll be key for carriers to ensure everyone has equal access to fast, reliable mobile networks.

carol_mangis@pcmag.com



Your (Neil) Questions

Lead Analyst Neil J. Rubenking gets a lot of email from readers. Most are security-related questions, but some are just plain appreciation for his tech wisdom. Here are a few.

To Neil: I wonder if you have any suggestions as to which paid service is best to accomplish removing all of my public records data, and removing all of my email/phone data online. Any guidance will be most appreciated. —*Iris*

Neil's reply: Basically, you can't remove public records. They're public. In the movies, hackers dig into databases and erase data for individuals. Given that's an illegal act, a kind of vandalism, there aren't any services advertising this kind of treatment, at least not that I know of.

You can get your data removed from the data brokers that base their business on aggregating public data and packaging it for consumption by spouses, employers, or anybody who wants to know. Abine's DeleteMe is the primary provider of this type of removal. It's not cheap—\$129 per year. That's because the process isn't automated; human agents are required. If you have more time than money, DeleteMe offers an extremely comprehensive DIY guide to getting your data removed, at <https://joindeleteme.com/help/diy-free-opt-out-guide/>.

I don't know of services that can remove your email and phone data. The better bet there would

seem to be not letting that data be recorded in the first place. Using a privacy-focused email encryption service could help. Communicating using burner phones could help. Actually, there's an email equivalent to burner phones: disposable email addresses (DEA). With a DEA service, your correspondents don't receive your actual email. Each gets a different DEA, and you can cancel any DEA at any time. ManyMe, Burner Mail, and Abine Blur are examples. ManyMe has the virtue of being free.

.....

Mr. Rubenking: I appreciate your articles and need some guidance, please. At home, I'm running IDrive, to back up to the cloud; Malwarebytes Premium; and Webroot SecureAnywhere. (I'm unsure what my Fios router has on it.) My questions: Is ZoneAlarm redundant with the above? And what else can or should I use for home protection from ransomware? Also, I use Gmail—is some other email recommended for encryption?

—*Dr K*

Neil's reply: Webroot is antivirus software that includes its own protection against ransomware. It didn't do as well in my latest test as in previous ones, but my test really pushed the limits of as-if-real. Webroot wiped out all my ransomware samples instantly, so the only way I could test the ransomware ability was to hand-modify a dozen samples. The "bad guys" aren't going to take that kind of trouble. I don't think I'd add ZoneAlarm on top of what you've got.

With Gmail, most people can't access your communications, but Google can. For your own good, of course! If that doesn't give you a warm feeling, you can use an email encryption tool. Some require a brand-new email address, but others let you keep your existing address, and Gmail is a special favorite among those. You can see our reviews of these tools at our website: <https://www.pcmag.com/picks/the-best-email-encryption-services>.

To Neil: [I spotted your story in] today's news feed: "You Tossed Your Cookies But They're Still Tracking You; Here's How to Hide Your Browser Fingerprint." I was very happy to see your name. I just read your bio to my friend.

I told him I began reading PCMag in the mid-80s, when I was a word-processing operator. Back then, the only thing I understood were the advertisements. And sometimes, your articles. Since 1992, I've been a training and support specialist. Today, I was telling my friend that I wish that I had a mentor. Then, as I read your article, it occurred to me: I've had mentors all along. I just don't communicate with them directly. Until today.

Thank you for being my mentor. Thanks to you, and people like you, I have enjoyed and continue to pursue a great career, helping other people learn to use computers. I was thrilled to see your name today (you know why: cause we're both still kicking!). You were there at the start of my journey. And I thank God (Giver of Data) that you're still here today.

—*Veronica Lee*

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.



WTF Is the Metaverse?

BY CHANDRA STEELE



The metaverse is in the air. Mark Zuckerberg won't stop talking about turning Facebook into one. Zombie-strewn Fortnite says it's on the way to becoming one. Microsoft is going to develop an enterprise one, which sounds fun. But what is it?

If you've been nodding along and hoping that eventually people will stop talking about it, we have good news and bad news. Metaverse news is only going to increase. This is obviously the bad news. In better news, we have a quick primer to help you with the basics. So here are your questions (hopefully) answered.

Hi.

Hi.

This is going to sound weird, but are you really here?

Sure. Let's say yes.

I ask because I was just reading about Mark Zuckerberg and this metaverse thing, and it has thrown me into an existential loop. What exactly does he want to do?

Zuckerberg says he wants to create the “feeling that you’re really there with another person or in another place,” in part with avatars and digital goods.

But the only reason I’m on Facebook is so I don’t have to be with the people on there.

You see the problem then.

So what is supposed to happen in this metaverse?

People exist in it in avatar form and basically do what they would do in regular life, but virtually: socialize, attend events, shop, work.

According to Andrew Bosworth, VP of AR/VR at Facebook, the metaverse will “build the connective tissue” between devices like Portal and the Oculus headsets “so you can remove the limitations of physics and move between them with the

same ease as moving from one room in your home to the next.”

Where did this idea for the metaverse even come from?

The name and the idea came from the book *Snow Crash* by Neal Stephenson. The metaverse is a shared 3D virtual universe in which you can shed your corporeal form and step into an avatar that lives a pixel-created life of your own choosing.

So we’re all supposed to live inside VR headsets while our real lives take place in a rickety stack of trashed trailers like in *Ready Player One*?

Please do not ever mention that book again. But sort of.

Where is this metaverse going to be, then?

Everywhere, essentially. The idea of a metaverse encompasses it being persistent, so it would be available on every device that connects to the internet and some new ones, too. Facebook owns Oculus, so you can expect some headsets, like in that book we don’t talk about. But it is also releasing AR-powered smart glasses in partnership with Ray-Ban that Zuckerberg says are part of the company’s metaverse plans.

This sounds like Google Glass.

Facebook has never met an idea it hasn't tried to steal and, failing that, buy.

Are any other companies building a metaverse?

Lots. Online game platform Roblox has plans to expand to become a metaverse. Epic, the maker of Fortnite, just raised a billion dollars for its own metaverse. Microsoft thinks people will be working and shopping in one soon.

Shopping? Does this have anything to do with *whispers* cryptocurrency?

What doesn't?

OK. I'd like to just move on and not talk about that right now.

Fine with me.

You know, now that I'm thinking about the metaverse, I feel like it happened before. Is this déjà vu?

It did happen before. It was called Second Life.

Oh, that's right. Wait, are there still people in Second Life?

Yes.

Should we save them?

They're probably better off where they are than here, with climate change and the pandemic.

You're right. Is this metaverse thing happening because of the pandemic?

Some of these plans predate the pandemic, but a year and a half of living mostly virtually seems likely to have accelerated them. And certainly, come CEOs and investors now think of it as more of a possibility.

I didn't know I could hate the pandemic more.

It's always possible.

SpaceX Preps 'Ruggedized' Starlink Dish for Cars, Boats, and Planes

BY MICHAEL KAN



Photo Credit: Harris Wilson

SpaceX is working on a “ruggedized” version of its Starlink dish designed to work outside cars, boats, and planes and in harsh climates. The company filed an application with the FCC in August to operate the so-called “high-performance” Starlink dish.

The hardware still relies on a phased array antenna to receive the high-speed internet from SpaceX satellites in orbit. “But these high-performance (‘HP’) models will operate with higher gain and lower transmit power (thus maintaining a consistent EIRP compared to other SpaceX Services user terminals), a higher scan angle, and features that ruggedize the unit for use in harsh environments,” the company wrote in the application.

In March, SpaceX filed another application to operate Starlink in cars, boats, and vehicles, citing the need to bring high-speed satellite internet to trucks, freighters, and international flights. But at the time, the company proposed using the same “electrically identical” Starlink dish technology. The only apparent difference would be a mount to enable the dish to fit on a moving vehicle.

“**The hardware still relies on a phased array antenna to receive the high-speed internet from SpaceX satellites in orbit.**”

Photo Credit: Starlink, a division of SpaceX



The new application proposes upgrading the dishes to better withstand the environments outside the moving vehicles. “For example, it will be able to continue to operate at greater extremes of heat and cold, will have

**STARLINK'S
CURRENT DISH
TERMINAL**

improved snow/ice melt capabilities, and will withstand a greater number of thermal cycles,” the company wrote.

The application also requests clearance for the ruggedized Starlink dishes to use the 12.2GHz-to-12.7GHz radio spectrum. Doing so would give SpaceX greater flexibility to supply high-speed, low-latency broadband to users on the equipment.

“Granting this application would serve the public interest by authorizing a new class of ground-based component for SpaceX’s satellite system that will expand the range of broadband capabilities available to moving vehicles throughout the United States and to moving vessels and aircraft worldwide—and most particularly, to those in challenging environments where ruggedization is appropriate,” the company added.

A ruggedized dish would be good news for anyone worried about their Starlink dish breaking in extremely hot or cold weather. But it remains unclear how much the dish would cost; the current model goes for \$499.

SpaceX is calling for the FCC to grant the license as soon as possible. Other FCC applications from the company have indicated the company is working on another next-generation Starlink dish that will use a smaller antenna than the current model.

Why 5G Desperately Needs the New Samsung Galaxy Fold

One of my first real 5G experiences was chatting with my wife on a foldable phone in early 2020. When I opened a Samsung Galaxy Fold and set it on a table at a coffee shop in Seoul, the high bandwidth and low latency made me feel like she was right there with me having coffee, even though she was 7,000 miles away.

New folding phones and improvements to 5G could soon bring this experience to the US, if Samsung and the carriers play their cards right. Samsung announced its Galaxy Z Fold 3 and Galaxy Z Flip 3 on August 11, and the fate of 5G—especially T-Mobile’s 5G—rides in part on their success.

Price is going to be the biggest question around “bringing more people into the fold,” to quote Samsung Electronics president TM Roh. A \$2,000 phone like the Fold 2 just won’t be bought by many people, and the current chipset shortage could force Samsung to keep prices higher than it would otherwise prefer. Exciting 5G consumer applications might be the key to getting consumers to pony up.

The muddled condition of 5G in the US, where it’s sometimes better and often worse than 4G, has been holding back development. But as I talk to



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

carriers about what's coming with T-Mobile's mid-band 5G and Verizon and AT&T's upcoming C-band, they keep reminding me that it's about the floor, not about the peaks. It's about always having at least 25Mbps, not sometimes having 2Gbps. And foldables with big, beautiful displays are the perfect devices to showcase what a baseline of 25Mbps can do.

To give foldables and 5G a boost, Samsung and the carriers should heavily promote—and subsidize—three 5G-only experiences:

- **High-quality, razor-sharp video calling on a big screen, like I saw in Korea:** That requires a fast, stable connection.
- **4K and HDR video streaming, paired with a really good display:** Samsung needs phones that can bring out the shadow details in shows like *Loki*, where I found that the difference between 1080p and 4K HDR let me identify details about the production design of the show's fake PCs. T-Mobile and Verizon are both promoting 4K streaming in their new high-end service plans.
- **Google Stadia cloud gaming:** Samsung has been developing a stronger relationship with Google—Roh highlighted it in his blog post—and Stadia wants 25Mbps down for a top-notch experience.

Samsung's current Fold campaign seems to be mostly about the S Pen and creativity, which is great, but it isn't going to drive 5G adoption. Six months from now, though, when discounts kick in, a lower-priced Fold could be the flagship device for Verizon's C-band launch, if the carriers and Samsung find (and fund) applications that can work well only on 5G.

COVID-19 Upended How We Test VPN Speeds

We recently released a new batch of results from our VPN speed testing that contained a surprising result: One VPN appeared, on paper, to actually improve internet performance. As with most things, this miraculous result is probably too good to be true, but it gives us the chance to explain how we've been doing VPN testing during the COVID-19 era and what that means for the future.

OUR OLD TESTING METHODS

Back when standing less than six feet from another person still seemed like a good idea, PCMag tested VPNs very differently. At that time, VPN testing was a marathon of back-to-back sessions that ended with the results being released all at once. This approach to testing came from a desire to control for as many variables as possible, which is a pillar of all PCMag's analysis. For VPN testing, we used the same machine, the same network, and the same tools to evaluate performance.

Removing all the variables around speed testing VPNs has been an ongoing struggle, though. We've long dealt with outages, dropped signals, and having to restart the router for no reason. We did sequester the network from other devices, but it was always subject to an enormous amount of



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

interference from the hundreds of devices that were active in the PCMag Labs at any given time.

Of course, there were always issues too large for us to tackle. Variations in use from the entire population of New York City meant that we would see small but noticeable changes in baseline throughput at different times of the day. We also knew that different parts of even the same country likely had greater or fewer VPN servers, depending on demand. These are just a few of the reasons we say that your results will probably differ from ours.

Testing VPN speeds in one big batch was partly to account for all this. By grouping all the tests together, the data would have all come from the same timeframe. It was a snapshot of a particular time and place that let us compare individual products. All in all, testing usually took about 10 days split over two work weeks. Analysis and spot-checking would add another week, after which we'd publish an updated Fastest VPN article.

ADJUSTING TESTING FOR THE TIMES

In mid-March of 2020, the entire PCMag staff started working from home full-time. For me, that meant no more gigabit PCMag Labs test network. My own internet was too unreliable (especially under the initial WFH crunch), and thanks to our local ISP monopoly, no better alternative was available.

It was clear we needed the PCMag Labs to keep up our high standards, but even after we were allowed back in the office, it was on a case-by-case

basis and required coordinating with numerous people. Missing a time slot to go into the Labs meant waiting several days for another shot. That's not to mention how traveling on the subway in those early days meant wearing two masks and rubber gloves for two hours, worrying about infection along the way.

Our solution was to ditch an all-at-once model for testing. Instead of evaluating results from about 40 products over a few weeks, we tested products in batches and updated the results throughout the year. Most processes remained the same: same machine, same math, same tools.

We made two other changes. First, we decided that if a vendor could demonstrate that another round of speed testing was required, we'd do it as soon as practicable. While we were always open to retesting VPN speeds, we committed to lowering the bar for retesting. Second, we'd present all our results at once, wherever possible. For this, we moved from static graphs to interactive Infogram charts.

A SURPRISING RESULT

So far, we've been pleased with the results. Our data is fresher, easier to update, and hopefully, more useful to you, gentle reader.

This new timeliness also means that we can also comment on our work as it happens. One unusual result from the most recent batch of tests comes from HMA VPN. Typically, you should expect latency to increase when you use a VPN. Your web traffic has to go to an additional machine—the VPN server—before it can resume its normal



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Max Eddy

path through the internet. Your data's trip should be longer when the VPN is on, which means increased latency. But HMA VPN defied expectations by improving latency by -0.02%.

We use the Ookla Speedtest tool for all of our VPN testing, so I showed my results to Marc von Holzen, VP of Software Engineering at Ookla, to get his thoughts. Holzen agreed that the HMA VPN result isn't enormously significant. "Latency tends to have high variation," he said. "This can make it difficult to determine whether a small difference between two latency results is significant without a large sample size."

The final figure in our results is the percent change between two median results, to make comparisons between services clearer. We run 10 tests with the VPN and 10 without, with the percent change calculated from the median of the two sets. When you look at the actual results, the miracle disappears. At the time we tested HMA VPN, the connection had a median baseline latency of 4.66 milliseconds without the VPN and a median latency of 4.64 milliseconds with the VPN.

HMA VPN probably will not improve your internet speeds, but it seems clear that it's doing an excellent job of not making your speeds significantly worse. It definitely deserves credit for that, and it might be a top choice if latency is a major concern for you—if, for example, you're playing fast-twitch PC games.

SPEED ISN'T EVERYTHING

As I've written in every VPN review for many years, speed shouldn't be your only concern. It's hard to measure reliably and wildly different depending on when and where you measure it. Keep the results of our speed testing in the back of your mind, but look hard at the cost, the features, and the privacy protections that a VPN service puts in place. The fastest VPN in the world is useless if it's too expensive, not trustworthy, or a pain to use.

(Editors' Note: Ookla is owned by PCMag's parent company, Ziff Davis.)



\$149.99 | Rating: ●●●●○ GOOD

Samsung Galaxy Buds2: Good ANC for the Price

BY TIM GIDEON

Since introducing the Galaxy Buds in 2019, Samsung has iterated on the formula with the Galaxy Buds Live and the Galaxy Buds Pro. The company now has an official successor, the aptly named Galaxy Buds2. The biggest change here is the addition of active noise cancellation (ANC), and it's quite good for the price (\$149.99). The earphones also deliver a powerful, notably bass-forward sound with enough brightness to keep things balanced.

The on-ear controls can be a little clunky, and the earpieces are a bit small and slippery, while a low IP rating means they aren't the best choice for sweaty exercise. Anker's Soundcore Liberty Air Pro 2 earphones (\$129.99) remain our top pick for greater water resistance and slightly better ANC.

SLEEK BUT SLIPPERY

Available in black, lavender, olive, or white, the Galaxy Buds2 have a smooth exterior that looks sharp but can feel slippery. They're also small, which combined with the glossy finish can make them slightly difficult to handle. Although Samsung advertises the size as a selling point, we actually would prefer that the earpieces were a little larger so we could get a better hold on them.

That said, once these earbuds are in your ear and given a slight twist, the fit is quite secure; three pairs of silicone eartips are included to help you find the right size. Internally, dynamic drivers tuned by AKG deliver the audio. The earphones connect via Bluetooth 5.2 and support AAC and SBC codecs, as well as Samsung's proprietary Scalable codec.

Unfortunately, the Galaxy Buds2 have the same low water-resistance rating as the original model. IPX2 means the earpieces can withstand dripping water but nothing like actual water pressure or even a splash. Wearing them in the rain or for sweaty workouts isn't advisable. Most of the competing ANC models in this price range have an IPX4 rating, which we still consider fairly modest—IPX2 is perhaps the lowest rating we've seen in the last year or so.

Out of the box, the Galaxy Buds2's touch controls are limited—a single tap handles audio playback and call management, while a touch and hold switches between

Samsung Galaxy Buds2

PROS

Bass-forward sound signature with bright highs. Good noise cancellation for the price.

CONS

Weak water-resistance rating. Touch controls are easy to misfire. Small, slippery earbuds can be hard to handle.

BOTTOM LINE

Samsung's true wireless Galaxy Buds2 earphones improve upon the originals with the addition of active noise cancellation, but still carry the same low water-resistance rating.





ANC and Ambient modes. Fortunately, you can use the app to enable additional controls. For instance, double and triple taps can be set for track forward and backward, and touching and holding can be used to control volume or use voice assistants. The controls can be annoying to operate, as the surface is very sensitive (and small), so it's sometimes difficult to nail the difference between a tap and a press-and-hold. Several times in testing, I meant to activate ANC and instead unintentionally started music playback. Yes, you can assign different functions to the taps and touches, but misfires seem likely regardless.

The included charging case is a rounded square with a flip-top lid and a small status LED on the front. On the back is a USB-C port for the included charging cable. The case can also charge on wireless Qi-enabled pads.

Samsung estimates the Galaxy Buds2's battery life to be roughly five hours, with another 15 hours in the charging case with ANC on or 7.5 hours, with 21.5 hours in the charging case with ANC off. These numbers are pretty average for true wireless in-ears, and your results will vary with volume levels and ANC usage.

The Samsung Galaxy Wearable app for Android has useful controls for the Galaxy Buds2, including the aforementioned touch control management as well as ambient-listening-mode controls. There's adjustable EQ, though it's just a

list of presets (Bass Boost, Treble Boost, Clear, and so on), which feels like a missed opportunity given the bass-heavy tuning of the drivers. An Earbud Fit Test plays a little jingle to determine whether the in-canal fit is ideal.

Though designed to complement Galaxy phones, the Galaxy Buds2 can work with other Android phones as well as iOS devices, though the Galaxy Wearable app is available only for Android.

GALAXY BUDS2 NOISE CANCELLATION AND AUDIO PERFORMANCE

We checked the fit of the earphones using the app's Earbud Fit Test to make sure we had an optimal in-ear seal before testing the ANC and audio performance.

The Galaxy Buds2 offer solid noise cancellation for the price. Powerful low-frequency rumble, like you hear on a plane, is tamped down significantly by the earbuds. For mids and highs, one of the tests we run is playing a recording of a busy restaurant (with dishes and silverware clanging and lively conversations) at a high volume through near-field monitors. The Galaxy Buds2 dialed back the mids quite a bit, but the highs were more of a challenge. This is normal for noise cancellation in this price range, as only the top models tend to successfully



eliminate higher frequencies, especially those that vary dramatically.

Compared with the Anker Soundcore Liberty Air 2 Pro, the Galaxy Buds2 are a little less effective at dialing back powerful lows and similar in terms of highs. The Galaxy Buds2 also tend to emit a hiss when ANC is activated—it's not unpleasant, but it's the mark of affordable noise cancellation that can't quite wipe out the surrounding high-mids and highs. Still, for the price, this is above-average noise cancellation.

When it comes to audio, on tracks with intense sub-bass content, such as The Knife's "Silent Shout," the Galaxy Buds2 deliver a powerful low-frequency response. At top (unwise) listening levels, the drivers don't distort, and at moderate volumes, the bass still feels fairly intense. DSP (digital signal processing) ensures that even at low volume levels, there's always some solid thump in the mix.

“

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”



Bill Callahan’s “Drover,” a track with far less deep bass in the mix, gives us a better sense of the Galaxy Buds2’s general sound signature. The drums on this track get some seriously boosted bass depth—they sound almost thunderous but stop short of going over the top. Callahan’s baritone vocals get plenty of low-mid richness, and the high-mids and highs are present enough to lend the percussive hits some solid snap and the acoustic strum a bright-enough attack. This is, however, a bass-forward sound signature through and through. It’s not deprived of treble/high-frequency presence, but the brightness often takes a backseat to the low-frequency richness. If you use the app, you can try the various EQ presets to get a different level of bass depth, but it’s always going to lean toward the lows.

On Jay-Z and Kanye West’s “No Church in the Wild,” the kick drum loop receives enough high-mid presence for the attack to retain its punchiness in the mix. But the highest frequencies stand out more here—we hear the hiss and crackle of the vinyl that’s usually in the background take a step forward. This means there’s some sculpting, as the highest frequencies get some boosting while the high-mids are a little less boosted. The sub-bass synth that punctuates the beat is delivered with gusto, while the drum loop also gets some added deep-bass thump. The vocals are delivered cleanly and clearly, with no real added sibilance. At some higher volume levels, the vocals can feel like they’re battling with the pumped-up bass depth, but at moderate listening levels, things feel a bit more balanced.

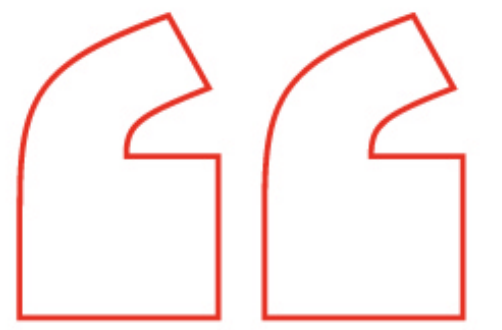


Orchestral tracks, like the opening scene from John Adams' "The Gospel According to the Other Mary," sound crisp, with some solid low-frequency anchoring for the lower-register instrumentation. The bass doesn't sound overdone here, and the higher-register brass, strings, and vocals have a bright, defined presence. So depending on the genre, the Galaxy Buds2 can sound a little more natural—but no matter what, this is a sound signature for bass lovers rather than audio purists.

The three-mic array offers strong intelligibility. Using a voice-recording app, we were able to understand every word we recorded. Background noise is tamped down nicely, and even with a smidge of Bluetooth distortion in the mix, the overall clarity is solid. Callers should have no issue understanding you even in louder environments.

BETTER GALAXY BUDS, BUT THERE'S STILL ROOM FOR IMPROVEMENT

The Samsung Galaxy Buds2 deliver solid noise cancellation and audio performance for the price, edging out the more expensive Galaxy Buds Pro. That said, the earpieces could be easier to handle, we'd like to see more granular EQ controls, and the low water-resistance rating is disappointing. For the best in true wireless noise cancellation, you'll have to spend more on the \$280 Bose QuietComfort Earbuds or Sony WF-1000XM4. For under \$200, Anker's Soundcore Liberty Air 2 Pro earphones deliver the best mix of sound quality and noise cancellation, along with better water resistance, earning our Editors' Choice award.



The three-mic array offers strong intelligibility. Using a voice-recording app, we were able to understand every word we recorded.





\$699.99, body only | Rating: ●●●●○ GOOD

Sony ZV-E10: A Camera for Vloggers

BY JIM FISHER

A year after introducing its first camera for vloggers—the fixed-lens ZV-1—Sony is bringing the concept to an interchangeable lens platform. The ZV-E10 is built around the same sensor as the stills-focused Sony a6100 but is made just for video. It has a quality in-camera microphone, a front-facing display, and some focus and metering modes tuned for vlog video. The 4K video it captures is crisp, but digital stabilization tightens

the angle of view when working handheld, and a weak battery means you'll want to carry some spares for all-day work.

MADE FOR VIDEO AND VLOGS

The ZV-E10 is built with the needs of video-first creators, particularly vloggers, in mind. As such, it drops the EVF, built-in flash, and Mode dial from the a6100. Instead, it uses a quality three-capsule microphone (a windscreen is included) and adds a swing-out, front-facing LCD. It's a slim, light camera—2.5 by 4.5 by 1.8 inches (HWD) and 12 ounces.

Sony is offering the camera in a black or white finish (we received a black model for review). If you're already in the E-mount mirrorless system, you can buy it as a body only. There's also a kit option with the E PZ 16-50mm for \$799.99, but if selfie vlogs are your thing, you may prefer a wider zoom. The camera relies on digital stabilization to supplement lens-based IS; it's quite effective, but it does crop the view of your lens. It's built around an APS-C sensor, smaller than the full-frame chips Sony puts in its a7 series.

You can use both full-frame (FE) and made-for-APS (E) lenses. There's typically some penalty of cost and weight

Sony ZV-E10

PROS

Excellent 4K video at 24 or 30fps. Best-in-class autofocus. Bright, front-facing LCD. Clear in-camera microphone. Supports add-on mic and headphone monitoring. Works as a USB webcam.

CONS

Battery drains quickly. Digital stabilization adds crop to video. Limited touch controls. In-camera charging slow for on-the-go use. Slow-motion limited to 1080p. No 4K60 recording.

BOTTOM LINE

Sony's ZV-E10 camera appeals to vloggers with a quality mic and support for swappable lenses, but it's held back by a weak battery and a so-so touch interface.



by opting for full-frame glass, but it's a plus if you're already in the Sony system. To get a wider view, I used the Sony E 10-18mm F4 and Tamron 11-20mm F2.8, and I tried it with the Tamron 150-500mm for telephoto shots.

The grip is way too small to use handheld with a big lens; it's too unwieldy to hold the lens while using the rear display to frame shots. A tripod came in handy for this, as well as for some long-exposure images. For the most part, I used the camera handheld along with the GP-VPT2BT Wireless Shooting Grip, available separately for \$150.

The grip connects to the ZV-E10 via Bluetooth and includes controls to record clips, adjust zoom, and toggle Background Defocus (more on that later). It's almost a required accessory for handheld use—you'll naturally hold the camera steadier with a pistol-style grip—and it folds out into a convenient tabletop tripod. Tilt and rotation are supported, too. If you're buying the camera, try to make room in your budget for the grip.



CONTROLS AND INTERFACE

The ZV-E10's controls are a departure from a stills-first camera. There's no mode dial on the top; instead, you set the capture mode via the menu. You do get a shutter release at the top of the handgrip. It has a rocker to drive zoom on power zoom lenses.

An On/Off switch, Record and Background Defocus buttons, and a control wheel are located on top. There's also a mode button to swap between still, video, and slow-motion (S&Q) capture. As mentioned, the camera has no traditional mode dial, so you'll need to go into the menu to change between auto, manual, shutter, aperture, and other exposure modes.

Background Defocus is a feature introduced on the ZV-1. Pressing the button opens the f-stop on the attached lens as wide as it will go. With the right glass, you'll net a blurred-out background behind your in-focus subject. When you want everything to be in focus, tap the button again: The lens aperture closes down to get more of the shot in focus. If you know your way around a camera, you can still set the f-stop manually, but this is a quick way for anyone to get the bokeh look regardless of level of expertise.

The center of the top plate houses the three-capsule mic. Sony bundles a windscreen with the camera—just slide it into the hot shoe to shield the built-in mic. The hot shoe also accepts Sony's digital on-camera mics and can mount a standard analog mic; the 3.5mm input is nearby on the left side panel.

The rear is dominated by the swing-out LCD. Physical controls are on the right side. The full Menu and on-screen Fn menu buttons are on top, while Play and Delete are at the bottom. The rear command dial sits between. It turns to adjust settings and includes four directional presses—Display, ISO, EV, and Drive.



Physical controls are supplemented via on-screen menus, but touch support is limited. You need to use buttons to navigate through the on-screen menus, which extends to the very useful Fn interface, an overlay menu with a two-strip design housing a dozen options. The menu is completely configurable (via the main menu), and it's worth taking the time to fiddle if you want quick access to a certain feature.

Sony has a better menu system with real touch controls on some of its high-end cameras, including the full-frame a7S III, but it's not included here. The ZV-E10 is built on an older processor and sensor platform, one that doesn't seem to support the new interface. This limits your control over the camera when you're both cinematographer and on-screen talent. You can tap the screen to set a focus point, but that's really it. When you're recording a selfie vlog and want to change some settings between clips, you'll need to get behind the camera and work with the rear buttons.

The display itself is excellent. The 3-inch 1.4-million-dot LCD is sharp enough to be your only viewfinder,



The menu is completely configurable, and it's worth taking the time to fiddle if you want quick access to a certain feature.





and it's plenty bright, especially when you turn on the Sunny Weather display setting, something that came in handy when working with the camera outdoors in early summer. A red outline shows around the frame when recording. There's also a tally light on the front panel, an additional visual confirmation that you're rolling footage.

POWER AND CONNECTIVITY

The camera includes Bluetooth and Wi-Fi to connect to a smartphone—you use the Sony Imaging Edge Mobile app for Android and iOS for remote control and file transfers. It also includes USB-C to connect to a computer for transfers or for use as a webcam. The camera complies with UVC and UAC standards, so it'll work with Macs, PCs, and Android 11 smartphones. Streaming is at 720p and includes an audio feed.

The ZV-E10 is powered by Sony's oft-lamented NP-FW50 battery. It's rated for about 80 minutes of record time or 440 photos, but your mileage will vary based on how you use the camera. On-the-go charging is available, but it's pretty slow. Recharging a nearly depleted battery with an 87W Apple charger took about three hours.

The hot shoe supports Sony digital microphones. You can also use analog mics via a 3.5mm input, attach a set of earphones for monitoring (also 3.5mm), or

send a clean 4:2:2 8-bit video signal out of the micro HDMI port to feed an Atomos Ninja V or external other recorder.



The autofocus is able to track subjects once they've been acquired, and it supports face and eye detection for people and pets.



Images and video are saved on SD memory. There's a single slot nestled into the battery compartment. The ZV-E10 supports UHS-I transfer rates and can also use Sony Memory Stick Duo cards.

QUICK, RELIABLE AUTOFOCUS

The ZV-E10 uses the same autofocus system as other recent APS-C models from Sony, including the a6100 and the step-up model in the line, the a6400. This system mixes phase and contrast detection, spreading coverage across the frame. The autofocus is able to track subjects once they've been acquired, and it supports face and eye detection for people and pets.

Some fine-tuned options are available for vloggers. One is Product Showcase, a one-touch setting for product reviewers and others who present items to the camera. Sony's face detection will typically stick with you no matter what gets in between subject and camera, but this prioritizes focus on objects close to the lens. It works quite well.



More related to metering than focus, the camera is also tuned to set exposure based on detected faces. This is especially useful when recording video with changing light—say, a walk-and-talk moving from sunlight to shadow or for scenes with a strong backlight. When you're starring in your own vlog, you'll want to be properly exposed.

Focus is fast, and the camera does as good a job of tracking action as others in the Sony series. We consider it to be among the best you can find in an APS-C camera, and it's backed up by a very speedy burst rate, 11fps. It manages 111 JPGs, 48 Raw, or 43 Raw+JPGs before the buffer fills, but if you do fill it all the way, you'll need to wait for all the photos to save to memory before you can switch to a video mode. We clocked it around 25 seconds for Raw, 37 seconds for JPG, and 76 seconds for Raw+JPG pairs.



IMAGING AND VIDEO

The ZV-E10 uses a 24MP CMOS sensor to snap photos, the same as in the a6100, and image quality is identical. If you stick to JPG capture, you'll enjoy photos with clear detail through the standard ISO range. Delving into manual settings lets you move beyond ISO 6400. Photo quality suffers when you move past ISO 12800 and is blurry at the highest ISO 51200 setting.

Raw capture is available, too. When you shoot in Raw, you have to use software to process images—we use Adobe Lightroom. I wasn't able to look at Raw photos from the camera, as Adobe hasn't yet added support. We know what to expect, though, which is the same level of clarity and flexibility you get from the a6100.

Sony's Raw files offer loads of room for creative photographers to edit exposure and color. They retain more detail at high ISOs but show a bit of a grainy look at high settings. It's still best to keep the camera at ISO 12800 or below when you can.

For video, the ZV-E10 is a little better than the a6100 in terms of specs. It records 4K footage at 24 or 30fps at the same 100Mbps recording rate but has a few additional color profiles, including a flat S-Log3 for grading and HLG for HDR playback. The video is captured at 8-bit quality, though, so you won't have as much room to adjust color as with 10-bit footage.

Off-speed recording is available, but only at 1080p, in the S&Q (Slow and Quick) shooting mode. You can record at 1, 4, 8, 15, 30, 60, or 120fps with 24, 30, or 60p playback options. It opens up some creative possibilities for cutaways and b-roll, as much as 60x speed fast motion and 5x slow motion. Pushing the camera to 120fps nets footage on the soft side, but the slow-motion effect is compelling enough to forgive. For comparison, the Fujifilm X-S10 and X-T4 go further with slow-mo, as far as 240fps at 1080p, and net clearer 120fps footage.

If there's a complaint to be made about the ZV-E10 as a handheld video camera, it's with stabilization. In-body systems (IBIS) are more and more common, but Sony chose to rely on a mix of lens-based stabilization and digital ActiveShot to achieve handheld footage that's free of jumps and jitters.



Pushing the camera to 120fps nets footage on the soft side, but the slow-motion effect is compelling enough to forgive.



With the handheld grip, ActiveShot is effective, but it comes at the cost of angle of view—it crops footage to get the job done. That makes a wide-angle lens a useful add-on, especially if you don't have long arms. The Sony E 10-18mm is a good fit, and it includes optical stabilization. ActiveShot is good enough that I'd recommend leaving it on when you're able to do so, as there's still some jumpiness with lens stabilization on its own.

If you're serious about handheld work, adding a gimbal isn't a bad idea. I paired the ZV-E10 with the Zhiyun Weebill 2, and it netted absolutely smooth footage. It comes at a cost—a few hundred dollars for a quality gimbal, and there's more to carry, charge, and configure.

A VLOG CAMERA WITH SWAPPABLE LENSES

Sony tells us it's going after creative vloggers with the ZV-E10, and the camera's design and feature set certainly appeal to that audience. The camera puts video features first, tunes controls to match, and captures clear in-camera audio without the need for an add-on mic. We'd love to see more cameras with microphones like this.

It's powered by the same sensor and processing engine Sony uses in its a6100 and a6400 stills models. It nets fast, accurate autofocus for stills and video, and

The Sony V-E10 gets more right than wrong. It's a compelling upgrade for creators currently using just a smartphone.



is smart enough to recognize faces and eyes. The 4K footage and 24MP stills are both up there with competing stills models: not quite best-in-class, but not too far behind.

There are some drawbacks to consider, too. Battery life is a big one; you'll want to grab a few spares to use the camera all day and get an external charger to recharge them. For handheld video, the lack of IBIS is palpable. ActiveShot delivers good results, but we hope the next version of this camera has a stabilized sensor.

I'm also disappointed by the touch interface—or lack thereof. There's very little you can do to change settings from the LCD itself, which is problematic, as it's sure to get a lot of selfie use. Other Sony cameras have a refreshed menu system with much better touch support.

That said, if you're all about your vlog or video in general, the ZV-E10 gets more right than wrong. It's a compelling upgrade for creators currently using just a smartphone, especially since one-touch features such as Background Defocus and Product Showcase are so easy to use. You don't have to know your f-stops to get the bokeh look.



You can change things up with different lenses. Sony has a big library of native autofocus lenses, and since this is a mirrorless camera, you can use nearly any vintage SLR or rangefinder lens via an adapter. Old lenses are good fit for creative video; many show a soft, glowing flare that you don't get with modern glass.

As for alternatives, Sony has the ZV-1 with a fixed 24-70mm zoom lens and smaller 1-inch class image sensor. It's very similar otherwise, and it's expensive. At \$750, it costs nearly as much as the ZV-E10 kit, but it's one to think about if you don't want to deal with lens changes. Panasonic has the Lumix G100, a Micro Four Thirds model with a quality internal mic, but its autofocus isn't nearly on the same level as Sony's.

We've yet to give an Editors' Choice award to a specialized vlogging camera. The category is nascent, and we haven't seen a model that knocks us off our feet. We'll keep looking, though. In the meantime, the ZV-E10 is a good way to go, as long as you're aware of its limitations—and buy some extra batteries.



**Old lenses
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for creative
video; many
show a soft,
glowing flare
that you don't
get with
modern glass.**





Price as tested, \$428.00 | Rating: ●●●○○ GOOD

HP Laptop 14-dq2020nr: A Limited Budget Laptop

BY ERIC GREVSTAD

You probably know that HP's Pavilion brand is for consumer PCs priced and positioned below its upscale Envy and Spectre lines. But Pavilion is only the second-lowest rung on HP's notebook-PC ladder. Its budget laptops have no brand at all, just a generic family name: "HP Laptop." Take the HP Laptop 14-dq2020nr: It's every inch an economy model, with just 4GB of RAM and a 128GB solid-state drive—half the memory and storage we consider today's minimum—but it's a workable introduction to Windows for those who don't want to consider a Chromebook.

FOUR CORES AND S MODE

Though some online listings say the 14-dq2020nr has a dual-core Intel Core i3-1115G4, our test unit actually clicks that up to a quad-core, 2.0GHz (3.7GHz turbo) Core i3-1125G4 processor with Intel integrated UHD Graphics. The 14-inch non-touch screen offers full HD resolution (1,920 by 1,080 pixels). The default operating system is Windows 10 Home in S Mode, which restricts software installations to programs from the Windows Store; a few clicks in the Store can perform an irreversible switch to regular Windows 10 Home, which we made in order to install our benchmark-test software.

Clad in silver plastic, the HP Laptop measures 0.71 by 12.8 by 8.9 inches and weighs 3.24 pounds, making it just a little bit heftier than the rival Asus VivoBook S14 (0.63 by 12.8 by 8.4 inches and 3.09 pounds). A chrome HP logo decorates the lid. There's a fair amount of flex when you grasp the screen corners or press the keyboard deck.

HP Laptop 14-dq2020nr

PROS

Surprisingly peppy processor. Good battery life. Fingerprint reader.

CONS

Skimpy storage and memory. Lackluster screen. Keyboard isn't backlit, or overly comfortable. Wireless networking supports Wi-Fi 5, not 6.

BOTTOM LINE

If you have less than \$500 to spend on a new Windows notebook, you could do worse than the HP Laptop 14-dq2020nr, but be prepared to live with its limitations.



The bezels on either side of the screen are fairly slim (HP quotes a 78% screen-to-body ratio), though the top and bottom borders are thicker. The webcam centered above the display has no privacy shutter or face-recognition capability. The keyboard is not backlit, though it contains a fingerprint reader in the palm rest for skipping passwords with Windows Hello.

The laptop's left side is bare except for an SD card slot. On the right are two USB 3.1 Type-A ports and one USB 3.1 Type-C port—all peaking at 5Gbps instead of the 10Gbps or 20Gbps of later variants—along with an HDMI video output, an audio jack, and the power connector. A Realtek controller provides Wi-Fi 5 (802.11ac) and Bluetooth, not the newer Wi-Fi 6.



THE BARE NECESSITIES

The 720p webcam captures reasonably well-lit and colorful soft-focus images with a bit of noise or static. Sound from the speaker grille above the keyboard is loud enough to fill a small room but is muddy and flat, with zero bass and almost no hint of overlapping tracks. HP Audio Center software offers music, movie, and voice presets, an equalizer, and microphone noise cancellation.

The 1080p screen is definitely an economy panel, with colors that don't pop—they look flat and bland—and minimal contrast. Viewing angles aren't as wide as you would expect from an IPS display, though fine details and the edges of letters are sharp enough. Brightness is barely adequate, and white backgrounds look dull.



We're always happy to see dedicated Home, End, Page Up, and Page Down keys instead of having to pair the Fn key with the cursor arrows. But otherwise, the keyboard doesn't impress. The Escape and Delete keys are puny, and the arrow keys are arranged in HP's usual unfortunate row. In that arrangement, half-size, hard-to-hit up and down arrows are stacked between full-size left and right arrows, instead of the proper inverted T.

Typing on the keyboard has a hollow, almost echoing feel that isn't enjoyable. The smallish, buttonless touchpad glides and taps smoothly but clicks stiffly.

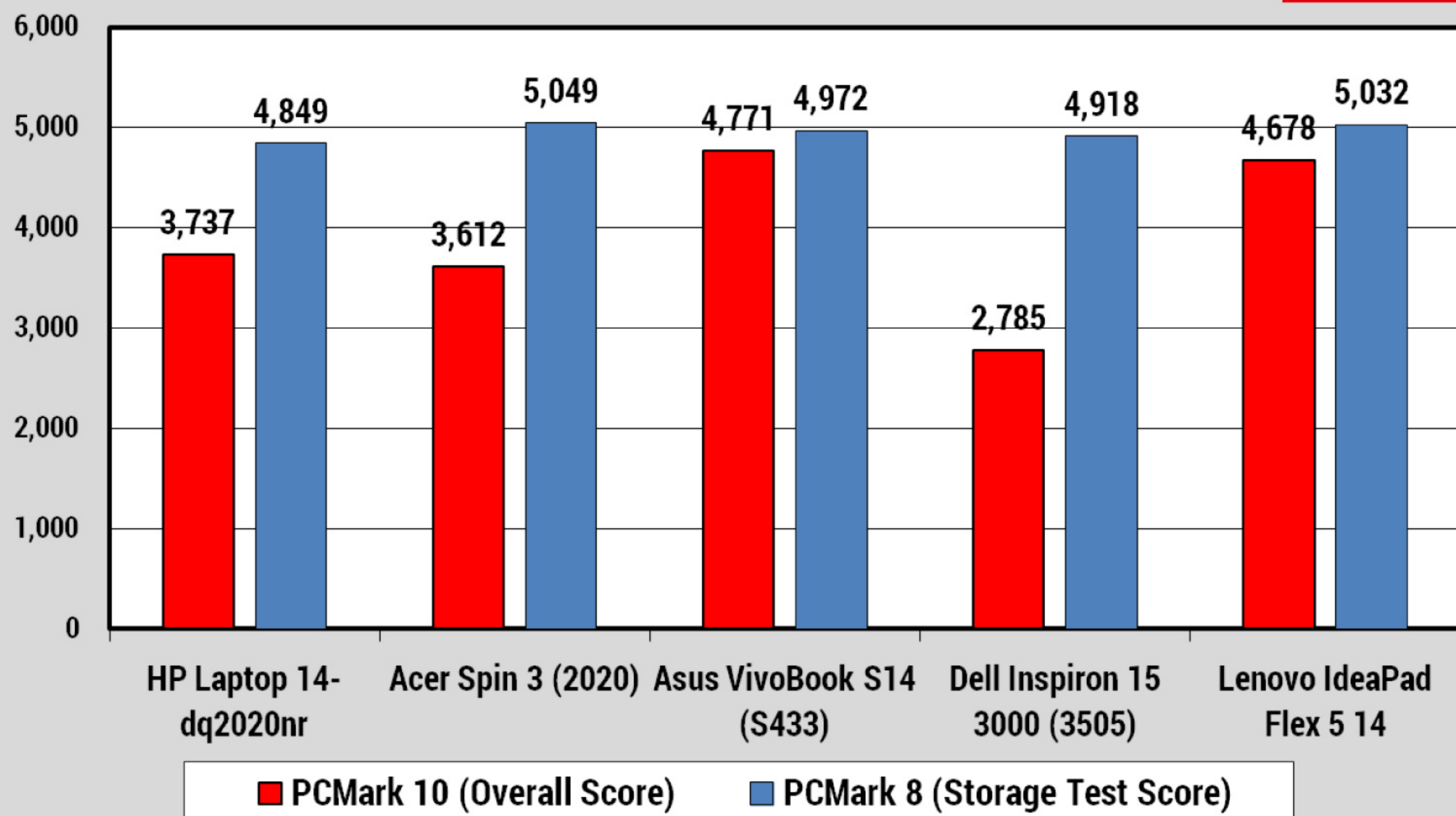
HP backs the laptop with a one-year warranty and preloads it with McAfee, LastPass, and Dropbox trials and a few useful utilities such as HP QuickDrop (for exchanging files with your smartphone) and HP Support Assistant (for centralizing software updates, diagnostics, and optimization).

PERFORMANCE TESTING: A FIVE-WAY BUDGET BATTLE

For our benchmark comparison charts, I stacked up the HP 14dq-2020nr against four other affordable laptops, ranging in price from \$369 for the 15.6-inch Dell Inspiron 15 3000 to \$699.99 for the 14-inch Asus VivoBook S14. Two 14-inch convertibles, the Editors' Choice-award-winning Lenovo IdeaPad Flex 5 14 and the Acer Spin 3, fall in-between at \$599.99 and \$649.99, respectively.

PCMark Productivity & Storage

(Higher Is Better)



Productivity and media tests: PCMark 10 and 8 are holistic performance suites developed by the PC benchmark specialists at UL (formerly Futuremark). The PCMark 10 test we run simulates different real-world productivity and content-creation workflows. We use it to assess overall system performance for office-centric tasks such as word processing, spreadsheet work, web browsing, and videoconferencing. PCMark 8, meanwhile, has a storage subtest that we use to assess the speed of the system's boot drive. Both yield a proprietary numeric score; higher numbers are better.

The HP fell short of the 4,000 points that indicates excellent productivity in PCMark 10, but it came close enough to satisfy everyday Microsoft Office or Google Docs users. Most of today's solid-state drives breeze through PCMark 8's storage measurement, though the HP's SATA M.2 drive is a tick slower than the PCI Express SSDs found in most modern notebooks.

Next is Maxon's CPU-crunching Cinebench R15 test, which is fully threaded to make use of all available processor cores and threads. Cinebench stresses the CPU rather than the GPU to render a complex image. The result is a proprietary score indicating a PC's suitability for processor-intensive workloads.

Cinebench is often a good predictor of our Handbrake video-editing benchmark, in which we put a stopwatch on systems as they transcode a brief movie from 4K resolution down to 1080p. It, too, is a tough test for multi-core, multi-threaded CPUs; lower times are better.

It's far from setting any speed records, but the HP's quad-core, 11th Generation Intel Core i3 is fairly perky for an economy CPU. You wouldn't want to use any of these laptops for workstation-class CAD or 3D rendering, but occasional content creation or touch-ups will be doable. The Dell AMD Athlon Silver was the exception, with truly pitiful performance—likely the reason that, since our review, that Inspiron has received a slight price hike, funding a more respectable Ryzen 3 processor. Our usual Adobe Photoshop image-editing benchmark is absent here because it won't run on systems with only 4GB of RAM.

Graphics tests: 3DMark measures relative graphics muscle by rendering sequences of highly detailed,



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gaming-style 3D graphics that emphasize particles and lighting. We run two different 3DMark subtests, Sky Diver and Fire Strike. Both are DirectX 11 benchmarks, but Sky Diver is more suited to laptops and midrange PCs, while Fire Strike is more demanding and lets high-end PCs and gaming rigs strut their stuff.

Next up is another synthetic graphics test, this time from Unigine Corp. Like 3DMark, the Superposition test renders and pans through a detailed 3D scene, this one rendered in the eponymous Unigine engine for a second opinion on the machine's graphical prowess. We present two Superposition results, run at the 720p Low and 1080p High presets and reported in frames per second (fps), indicating how smooth the scene looks in motion. For lower-end systems, maintaining at least 30fps is the realistic target, while more powerful computers should ideally attain at least 60fps at the test resolution.

The downcast Dell kept the HP from finishing in last place, while the Asus and Lenovo showed the most suitability for casual or browser-based games. But none of these integrated-graphics machines is within shouting distance of gaming laptops with discrete GPUs. Your after-hours entertainment will be limited to streaming media rather than arcade action.

Battery rundown test: After fully recharging the laptop, we set up the machine in power-save mode (as opposed to balanced or high-performance mode) where available and make a few other battery-conserving tweaks in preparation for our unplugged video rundown test. (We also turn Wi-Fi off, putting the laptop into airplane mode.) In this test, we loop a video—a locally stored 720p file of the Blender Foundation short film *Tears of Steel*—with screen brightness set at 50% and volume at 100% until the system quits.



**None of these
integrated-
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PC

All five laptops did pretty well here, showing enough stamina to get you through a day of work or school plus a few evening hours going online or watching Netflix. Elite ultraportables last longer still, but these results are just fine for budget systems.

THE LOWEST COMMON DENOMINATOR

The HP Laptop 14-dq2020nr does what it sets out to do, providing sufficient power for going online or doing homework in a reasonably attractive and portable package. Its quad-core Core i3 CPU positively pummels the Celerons and Pentiums still in the low-priced aisle, and it has a decent array of ports.

Still, there's no denying that spending \$200 or \$250 more will get you a much more capable notebook, one that both makes you happier with a nicer screen and keyboard, and makes Windows happier with more memory and storage. We'd recommend aiming higher if possible.



Starts at \$1,475; \$2,197 as tested

EDITORS' CHOICE Rating: ●●●●● **EXCELLENT**

Lenovo ThinkPad X1 Carbon Gen 9 (2021): A Superlative Aspirational System

BY ERIC GREVSTAD

We won't try to keep you in suspense. When we reviewed last year's model, we called the Lenovo ThinkPad X1 Carbon the best laptop in the world—though we later decided it shared that title with the Dell XPS 13 OLED—and it hasn't done anything in its latest revision to change that state of affairs. The X1 Carbon Gen 9 catches up with the Dell and other elite ultraportables by moving to an 11th Generation Intel “Tiger Lake” Core

processor and a slightly taller 16:10 rather than 16:9 screen aspect ratio. Its premium price and lack of an SD card slot still knock half a star off what would otherwise be a perfect five-star rating, but it effortlessly collects yet another Editors' Choice award as the most desirable executive notebook on Earth.

A MATTE-BLACK CLASSIC

Corporations that buy in bulk get discounts, but single-purchase pricing for the ThinkPad X1 Carbon is all over the map. Lenovo lists a base Core i5 model at \$1,475. Meanwhile, \$2,197 is the second-lowest price we found online for our test unit (model 20XW004DUS) with a Core i7-1165G7 processor, 16GB of RAM, and a 512GB NVMe solid-state drive. But other retailers have it for \$2,500 and up, and when we tried configuring one like it at [Lenovo.com](https://www.lenovo.com), it came to \$3,169 with a temporary coupon cutting it to \$1,901. When you look, the situation will likely be different still.

Lenovo gives you four screen choices, all with IPS instead of OLED technology and backed by Intel's Iris Xe integrated graphics. Three have 1,920-by-1,200-pixel resolution: our review unit's 400-nit non-touch panel, a touch screen with the same brightness, and a 500-nit touch display with a PrivacyGuard filter (meant to keep airline seatmates from snooping). The fourth is a 500-nit glossy panel with 3,840-by-2,400-pixel resolution. Lenovo says all but the PrivacyGuard screen feature reduced blue-light emission to ease eye strain.

Lenovo ThinkPad X1 Carbon Gen 9 (2021)

PROS

Flawless design and engineering. World-class keyboard. HDMI and USB-A ports, as well as Thunderbolt 4. Available 4G or 5G mobile broadband. Clever, sanitizing-friendly Quick Clean function. Excellent battery life.

CONS

Expensive. No OLED screen option. No SD or microSD card slot.

BOTTOM LINE

There's one ultraportable we admire as much (the Dell XPS 13 OLED), but there's no business laptop we admire more than Lenovo's latest ThinkPad X1 Carbon.





The keyboard has a snappy, slightly noisy typing feel. Cursor jockeys can use either the TrackPoint mini joystick at the intersection of the G, H, and B keys or the touchpad (a bit wider than Gen 8's), which has three comfortable buttons south of the space bar.

Is the 1,920-by-1,200-pixel screen the greatest we've laid eyes on? No, because we've seen high-resolution OLED laptop displays and HP DreamColor workstations, but it's very good. Brightness is ample, and contrast is high; white backgrounds are Clorox-fresh, and colors are vivid and well saturated. Fine details and the edges of letters are pleasingly sharp, and viewing angles are wide. The 16:10 aspect ratio fits a bit more content without letterboxing videos as 3:2 displays do. An anti-glare coating does a good job of fighting reflections.

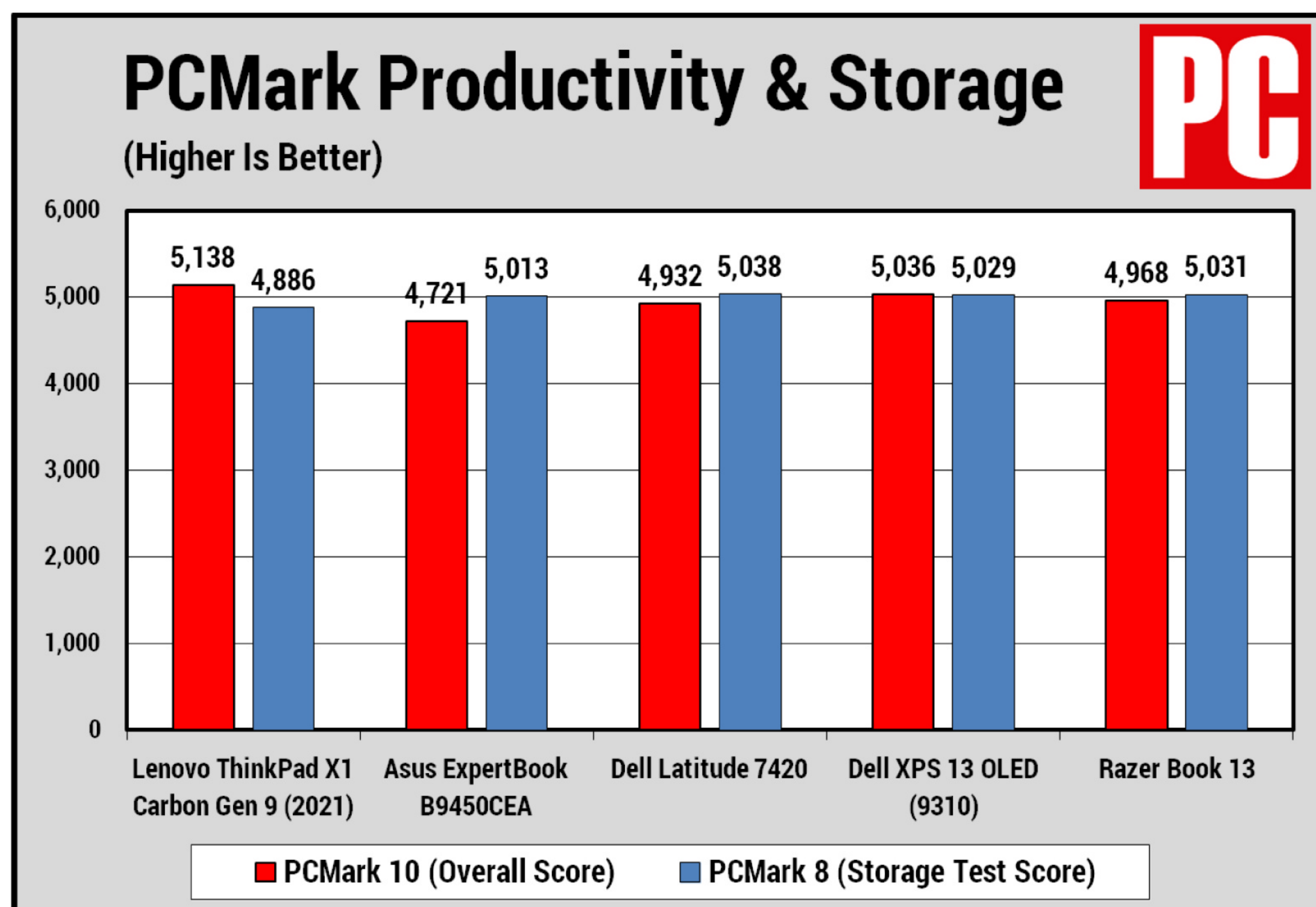
The 720p webcam captures reasonably well-lit and colorful images with slightly soft focus but almost no noise or static. Our test unit lacked the optional face-recognition webcam, which offers zero-touch logins via a proximity sensor, but a Windows Hello fingerprint reader is integrated with the power button above the keyboard.

Lenovo says the new Carbon has better sound thanks to speakers flanking the keyboard, plus two down-firing woofers and Dolby Access software that combines audio (with dynamic, music, movie, and game presets), display, and voice enhancements. It's loud enough to fill a conference room, with a bit of boom or echo when turned up. Bass is subdued but noticeable, and you can make out overlapping tracks. The Windows 10 Pro system is free of bloatware;

the only add-on I haven't mentioned is Lenovo Quick Clean, which temporarily locks the keyboard and touchpad while you apply a sanitizing wipe.

TESTING THE GEN 9 CARBON: CLASH OF THE CORE I7S

For our benchmark charts, I compared the ThinkPad X1 Carbon to two above-mentioned 14-inch business laptops (the Asus ExpertBook B9450CEA and the Dell Latitude 7420), plus two 13.4-inch ultraportables, the Dell XPS 13 and the Razer Blade 13. All except the Asus are Editors' Choice award winners, and all have Intel's freshest "Tiger Lake" Core i7 CPUs. You can see their basic specs in the table below.



Productivity and media tests: PCMark 10 and 8 are holistic performance suites developed by the PC benchmark specialists at UL (formerly Futuremark). The PCMark 10 test we run simulates different real-world productivity and content-creation workflows. We use it to assess overall system performance for office-centric tasks such as word processing, spreadsheeting, web browsing, and videoconferencing. PCMark 8, meanwhile, has a storage subtest that we use to assess the speed of the system's boot drive. Both yield a proprietary numeric score; higher numbers are better. All five laptops easily cleared the 4,000 points

that show excellent productivity in PCMark 10, but the Carbon led the way. It's a superb Microsoft Office or Google Workspace partner.

Next is Maxon's CPU-crunching Cinebench R15 test, which is fully threaded to make use of all available processor cores and threads. Cinebench stresses the CPU rather than the GPU to render a complex image. The result is a proprietary score indicating a PC's suitability for processor-intensive workloads. Cinebench is often a good predictor of our Handbrake video-editing benchmark, in which we put a stopwatch on systems as they transcode a brief movie from 4K resolution down to 1080p. It, too, is a tough test for multi-core, multi-threaded CPUs; lower times are better. The ThinkPad is no Core i9 or Xeon CAD or 3D rendering powerhouse, but it's got more than enough number-crunching cred for your toughest spreadsheets.

We also run a custom Adobe Photoshop image-editing benchmark test. Using an early 2018 release of the Creative Cloud version of Photoshop, we apply a series of 10 complex filters and effects to a standard JPEG test image. We time each operation and add up the total (lower times are better). The Photoshop test stresses the CPU, storage subsystem, and RAM, but it can also take advantage of most GPUs to speed up the process of applying filters. Photoshop yielded a photo finish—a five-way tie. Imaging professionals would probably pick the XPS 13's 3.5K OLED screen, but any of these systems can capably manage a photo collection.



Graphics tests: 3DMark measures relative graphics muscle by rendering sequences of highly detailed, gaming-style 3D graphics that emphasize particles and lighting. We run two different 3DMark subtests—Sky Diver and Fire Strike. Both are DirectX 11 benchmarks, but Sky Diver is more suited to laptops and midrange PCs, while Fire Strike is more demanding and lets high-end PCs and gaming rigs strut their stuff.

Next up is another synthetic graphics test, this time from Unigine Corp. Like 3DMark, the Superposition test renders and pans through a detailed 3D scene, this one rendered in the eponymous Unigine engine for a second opinion on the machine's graphical prowess. We present two Superposition results run at the 720p Low and 1080p High presets and reported in frames per second (fps), indicating how smooth the scene looks in motion. For lower-end systems, maintaining at least 30fps is the realistic target, while more powerful computers should ideally attain at least 60fps at the test resolution.

The Razer was barely quicker than the others, but none of these integrated-graphics slimlines is in the same ZIP code as a true gaming laptop with a discrete GPU. They're productivity machines, suitable for casual gaming and streaming media rather than fast-twitch shooters and esports titles.

Battery rundown test: After fully recharging the laptop, we set up the machine in power-save mode (as opposed to balanced or high-performance mode) where available and make a few other battery-conserving tweaks in preparation for our unplugged video rundown test. (We also turn Wi-Fi off, putting the laptop into airplane mode.) In this test, we loop a video—a locally stored 720p file of the Blender Foundation short film *Tears of Steel*—with screen brightness set at 50% and volume at 100% until the system quits.



If the Lenovo ThinkPad X1 Carbon Gen 9 had an OLED screen, we'd be tempted to shut down our laptop-review efforts.





The Dell ultraportable's high-res OLED display takes a toll on its battery life, though it still shows respectable stamina. The others are better yet, with the Lenovo outlasting the Latitude by two hours to claim the crown. You won't need to reach for its USB-C power adapter even after a long day at work or a transcontinental plane ride.

VERDICT: NICE (FOR) WORK, IF YOU CAN GET IT

If the Lenovo ThinkPad X1 Carbon Gen 9 had an OLED screen, we'd be tempted to shut down PCMag.com's laptop-review efforts for a while and say laptop technology had hit an unsurpassable peak. It's that good—a superlative aspirational system for anyone who can afford it. It leaves room for gaming notebooks and content-creation workstations to outperform it, but the Carbon Gen 9 virtually defines what a productivity PC or business ultraportable should be. This must be our least surprising Editors' Choice pick ever.



\$259.99

EDITORS' CHOICE Rating: ●●●●● EXCELLENT

AMD Ryzen 5 5600G: A Superb Value-Focused Option

BY CHRIS STOBING

As a six-core, 12-thread processor with great integrated graphics, the AMD Ryzen 5 5600G is the CPU that 2021 has been waiting for. A strong successor to older, budget-friendly, gaming-focused CPUs such as the AMD Ryzen 5 3400G, it puts up some of the fastest game frame rates to date from an integrated graphics processor (IGP). Cheaper than the IGP-less Ryzen 5 5600X (\$299) and layered in with the highly capable Radeon RX Vega

7 graphics engine, the AMD Ryzen 5 5600G is a serious threat to Intel's competing Intel Core i5-11600K on CPU grunt and really puts the hammer down once you factor in its gaming results and Radeon Software compatibility. Whether you're an esports hopeful aiming to get a gaming PC built for cheap or just want a solid IGP-equipped processor to drive low-lift daily computing, the Ryzen 5 5600G is a stellar 7nm AMD desktop processor. With yet another Editors' Choice award win, AMD's going to need a bigger trophy case.

MIDRANGE CHIPS JUST GOT MORE COMPETITIVE

The six-core, 12-thread AMD Ryzen 5 5600G is priced aggressively out of the gate against competing Intel options such as the Core i5-11600K (\$262), and it even undercuts its comparative cousin in the original, non-IGP Ryzen 5000 Series stack, the AMD Ryzen 5 5600X (\$299). But note that at the time of that review, we dinged AMD for the \$50 price creep we saw across many of its higher-end offerings, and the adjustment of the Ryzen 5 5600G back down to \$259 (just \$10 off from the \$249 debut price point of the Ryzen 5 3600XT) feels less like a good deal than a necessary return to reality.

Toss in a seven-compute-unit Radeon RX Vega 7 graphics engine, though, and the pot only grows sweeter. As a midrange chip with six cores, the Ryzen 5 5600G is perfectly positioned as the go-to choice for someone who wants to build a gaming PC capable of keeping up at high refresh rates in low-impact multiplayer games like Counter-Strike: Global Offensive or Valorant. The combination of six cores and the RX Vega 7 makes for some seriously potent integrated graphics gaming power.

AMD Ryzen 5 5600G

PROS

Strong gaming performance on integrated graphics. Priced aggressively in AMD's own CPU stack. Regularly beats out competition from Intel. Wraith Stealth cooler included in the box. Compatible with Radeon Software suite.

CONS

Slightly slower integrated-graphics gaming performance than Ryzen 7 5700G. Limited motherboard compatibility at launch.

BOTTOM LINE

Looking to play PC games without a graphics card? AMD's Ryzen 5 5600G CPU and its integrated graphics give cash-strapped gamers a superb, value-focused option that Intel can't match.



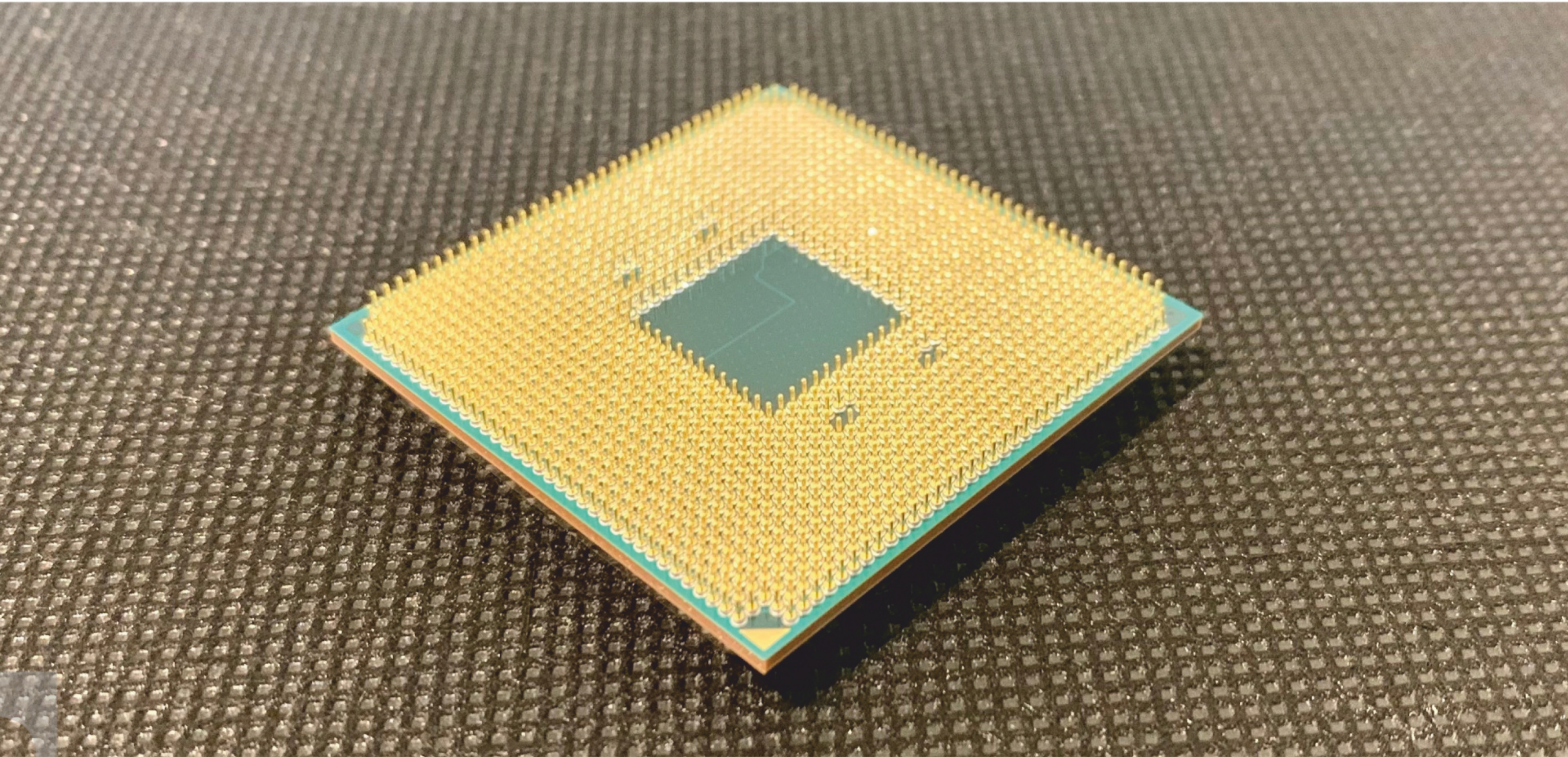
Based on the same Zen 3, 7nm architecture as the rest of the Ryzen 5000 stack, the Ryzen 5 5600G is compatible with AMD's venerable Socket AM4, though the motherboard compatibility list isn't remotely as expansive as we've come to expect from AMD over the past two generations of chips. Also, like the Ryzen 7 5700G and Ryzen 5 5600X, the 5600G is based on a unified eight-core CCD design (with two cores disabled in this model), one that differs from the Ryzen 5 3600X and Ryzen 5 3600XT. In those chips, the eight-core CCDs were divided over two four-core CCXs, which increased latency and decreased frame rates in both integrated-graphics and discrete-card gaming tests.

Since optimizing the new designs, midrange Ryzen options—first the Ryzen 5 5600X and now the Ryzen 5 5600G—have rocketed up the value-leader list, assisted by AMD's decision to include Wraith Stealth coolers with each. Like the AMD Ryzen 5 5600X, the Ryzen 5 5600G comes with a Stealth cooler in the box, though it's more expected when buying a midrange CPU like this than a high-end one to get this extra hardware in the bag.

Considering the price, specs, RX Vega 7 graphics, and inclusion of a cooler, it looks like AMD is ready to re-cement its position as the value (and performance) leader in midrange desktop PCs. But can it defend its title in our tests?

TESTING THE AMD RYZEN 5 5600G: AN UPSTART PC GAMER'S BEST BET

We tested the AMD Ryzen 5 5600G on an MSI Mortar B550 motherboard, with 16GB of Corsair Vengeance memory clocked to 3,200MHz (the new ceiling for



these “Cezanne”-based APU), and an Addlink S70 NVMe M.2 PCI Express 3.0 solid-state boot drive paired with a Samsung SSD 860 QVO SATA secondary drive. The Wraith Stealth air cooler included in the box cooled the processor.

All this was packed in a Be Quiet Pure Base 500 case fitted with an 850-watt Corsair RM1000X power supply. For our gaming tests, we used an Nvidia GeForce RTX 2080 Ti at Founders Edition clocks, as we have on all recent mainstream and high-end CPU reviews.

An important benchmarking-results and performance note: This is a different testbed than we’ve used with other Ryzens we’ve reviewed to date—as AMD points out, the Ryzen 5 5600G and Ryzen 7 5700G are compatible with only these four motherboards at the time of launch:

- Asus ROG Strix B550-E Gaming
- Asrock X570 Taichi
- Gigabyte X570 Aorus Master
- MSI MAG B550M Mortar

We test CPUs using a variety of synthetic benchmarks that offer proprietary scores, as well as real-world tests using consumer apps like 7-Zip, and 3D games such as Far Cry 5 and Rainbow Six: Siege. We compare a variety of like-priced competing and sibling AMD and Intel CPUs.

CPU-CENTRIC TESTS

Though the Ryzen 5 5600G isn't designed to be the star of AMD's productivity lineup in Zen 3 (that honor goes to the 16-core Ryzen 9 5950X, for now), let's see how it fared during various content-creation tasks and brute-force benchmarks like 7-Zip.

If you're spending lots of time creating video or other content with your next CPU, from both a value and a performance perspective, I'd recommend the eight-core/16-thread Ryzen 7 5700G instead of this one. That's not to say the Ryzen 5 5600G scored poorly on these tests. (In fact, the opposite is true when comparing directly to the Ryzen 5 5600X.) It's just that the 5700G is so good for what it is, that on these tasks specifically, it's the better choice overall.

Perhaps one of the most daunting tales for Intel in all of this comes in the productivity tests. In runs that tend to favor AMD's lightly threaded cores (say, 7-Zip or Cinebench) were instances in which the six-core 5600G challenged the eight-core "Rocket Lake" Intel Core i9-11900K. AMD has long since proven, post-Ryzen 5000 Series launch, that its current lineup of processors is better suited to modern content-creation workloads that hit as many cores and threads as possible. When a Ryzen 5 5600G starts to toy with Intel's mainstream top-gun chip in productivity benchmarks, you know things are heating up.

GAMING IN THE MIDRANGE

Let's focus on the area where the AMD Ryzen 5 5600G is tuned to perform at its best: PC gaming, especially at popular resolutions like 1080p, where the CPU comes to the fore in some titles.

Here's what we saw in our bank of gaming tests with our GeForce RTX 2080 Ti card running the show,



**It looks like
AMD is ready
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midrange
desktop PCs.**





overriding the Radeon IGP. This top-end consumer graphics card is the primary arbiter of performance at 4K. At 1080p, though, the card gets out of the way a bit more and lets the CPU differences shine.

Similar to what we saw in the CPU tests, the Ryzen 5 5600G doesn't make the most sense as a pick for anyone who will be gaming with a dedicated GPU, either. Its results paired with the RTX 2080 Ti, while on par with expectations, weren't faster than the similarly equipped Ryzen 5 5600X and were only slightly faster in most cases than the Intel Core i5-11600K. AMD already makes a stellar set of processors for gamers who own a good video card and play games on discrete graphics (the Ryzen 5 5600X and Ryzen 7 5800X), and although the 5600X is slightly more expensive at MSRP, its age over the Ryzen 5 5600G means it's already seeing discounts in some places. (At the time of this writing, the Ryzen 5 5600X was going for \$279.99 on Amazon and \$289.99 on Newegg.)

GAMING ON INTEGRATED GRAPHICS

We run lower-end CPUs that have IGPs through a series of games tuned to either near-lowest, or the lowest, settings at a 1,280-by-720-pixel resolution (720p), as well as at 1,920 by 1,080 pixels (1080p).

Finally, we come to the bread and butter of Ryzen's G line of chips over the past few years: integrated graphics performance. In this arena, AMD has proven it has no equal, and Intel's closest competition to the Ryzen 5 5600G, the Core i5-11600K, is regularly doubled here in performance by both the 5600G and

5700G chips. And while the Ryzen 7 5700G does generally outpace the Ryzen 5 5600G by a decent margin, it's not so substantial that anyone except people running benchmarks would notice under most circumstances.

When building a system, and especially one designed for multiplayer gaming, having the option to save on a GPU and instead put that money into a faster monitor could mean the difference between Gold and Diamond ranks next season (or between 60Hz and 240Hz, depending on the monitor model). At 1080p, the Ryzen 5 5600G was just about able to hit the 165Hz/165fps threshold in Counter-Strike: Global Offensive, a mark that could easily be exceeded with just one or two more in-game settings turned down.

Those settings could also be tuned using any number of tools available in the Radeon Software suite, including FSR, RIS, or CAS. Compatibility with Radeon Software gives Ryzen 5 5600G and Ryzen 7 5700G gamers access to the full array of tools that Radeon GPU owners have enjoyed for several years now, all of which help critically in multiplayer titles.

By adding compatibility with such tools as Radeon Boost, Anti-Lag, Smart Access Memory, and FreeSync, along with the rest of the acronym salad mentioned above, owners of the Ryzen 5 5600G can now tune their systems to give them frame rates and system performance that can keep them competitive with dedicated GPU/processor combos that cost much more. Players of competitive online multiplayer games don't always need fidelity; they just need speed. And according to our benchmark tests (which didn't even engage the Radeon Software), the Ryzen 5 5600G has more than enough to spare.

OVERCLOCKING AND THERMALS

In our testing, when overclocking or at stock, the Ryzen 5 5600G never went above 67 degrees C, which lands it just under the Ryzen 5 5600X, at 70 degrees C. This was recorded during a 10-minute stress-test run of 3DMark Night Raid on integrated graphics, and again, all achieved using the included Wraith Stealth cooler.

In our overclocking trials, we were able to achieve a stable overclock of roughly 120MHz on the boost clock and around 45MHz on the IGP. This is not far from the profile we achieved during tests of the Ryzen 7 5700G, though the power translation was slimmer, at just a slight percentage difference in frame rates



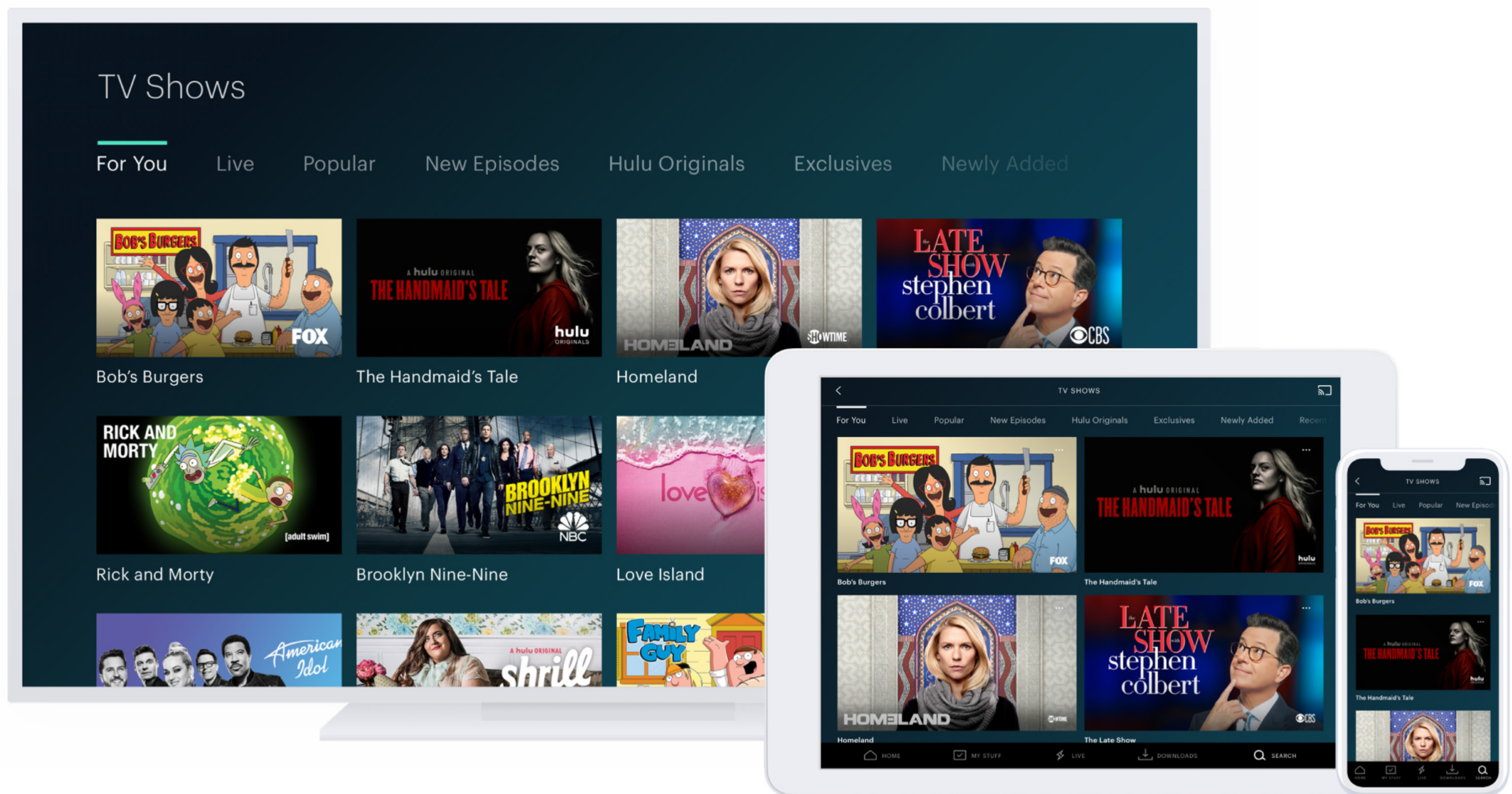
between the overclocked and non-overclocked runs. But as we said in that other review, overclocking on a stock cooler is not advised.

VERDICT: MORE MIDRANGE DOMINANCE

If you're a faithful player of Counter-Strike: Global Offensive, Rainbow Six: Siege, or Valorant, the AMD Ryzen 5 5600G makes it possible to build your next “good enough” gaming rig for much less than what it would cost with any other processor that's come before it. That's especially true if you would otherwise have had to buy a new graphics card, in the midst of the gruesome price inflation that GPU hardware has seen since 2020.

For bringing that relief alone, it earns our Editors' Choice award. But add a strong value proposition at \$259, and you have a six-core CPU that performs almost in line with where it should relative to the \$299 Ryzen 5 5600X—but with “free” integrated graphics.

Overall, the IGP-less Ryzen 5 5600X is a better choice if you plan to game with a dedicated GPU anytime in the near future, especially if it's on sale. But you can't use it without some graphics card in hand right now. For those who want an IGP-equipped chip that can reliably power many games above 60fps at low resolutions (a ceiling that could reach even higher, with some careful Radeon Software tuning), the Ryzen 5 5600G presents the perfect balance of price and performance, unlike anything Intel can offer in 2021.



\$5.99 per month

EDITORS' CHOICE

Rating: ●●●●○ EXCELLENT

Hulu: A Top Streaming Choice

BY BEN MOORE & KIM KEY

As the competition between video-streaming services intensifies, differentiation is ever-important. Hulu continues to offer both a strong on-demand streaming library and a robust live TV option. The service is an excellent option for watching popular TV shows, and we like its broad platform support, even if Hulu's original series are hit-or-miss. On the live TV front, Hulu's channel coverage is top-notch, and its DVR features compare well to the competition's. Despite a few missteps, Hulu keeps its Editors' Choice award, because no other service can quite match its combination of streaming content.

WHAT CAN YOU WATCH ON HULU?

Hulu's on-demand library has always been about TV shows, and that emphasis remains. The service offers hundreds of seasons and thousands of episodes from major networks. The rise of network-specific streaming services, such as Paramount+ and NBC's Peacock, has cut into this content library. But Disney's role in Hulu and its vast library of former 21st Century Fox content that doesn't fit Disney+'s family-friendly profile will likely keep Hulu afloat.

Hulu offers many cable TV shows. For fans of animation, there's *Archer*, *Adventure Time*, *Bob's Burgers*, and *Futurama*. Drama shows include *Bones*, *Killing Eve*, *The Orville*, and *The X-Files*. Comedy fans can watch *30 Rock*, *Broad City*, *Brooklyn Nine-Nine*, *Letterkenny*, *Malcolm in the Middle*, *Scrubs*, and *Seinfeld*. Note that *Parks and Recreation* has left for NBC's Peacock, and *Seinfeld* is going to Netflix in 2021. The good news is that Hulu's FX hub is live. FX shows such as *A Teacher*, *Devs*, and *Mrs. America* stream exclusively on Hulu. Full seasons of past FX shows, including *Archer*, *Atlanta*, *Better Things*, *It's Always Sunny in Philadelphia*, *Justified*, and *Snowfall* live there, too.

Like Netflix and Amazon, Hulu also creates original content. While its offerings have typically been a mixed bag and many shows don't get renewed, its track record is trending upward. Some of Hulu's best original releases include *Castle Rock*, *Harlots*, *Helstrom*, *High Fidelity*, *Little Fires Everywhere*, *Marvel's Runaways*, *The Handmaid's Tale*, and *Veronica Mars*. *Ramy* and *The Act* both won Golden Globe awards. Hulu is also one of our picks for the best video-streaming services for celebrating Black art.

HULU

PROS

Excellent selection of TV series. Extensive live TV channel lineup. Robust cloud DVR option. Available on nearly every media-streaming device.

CONS

Base on-demand plan includes ads. Offline-downloads feature requires premium account. Fewer high-quality originals than competitors. Missing most SportsNet and all Bally Sports RSNs.

BOTTOM LINE

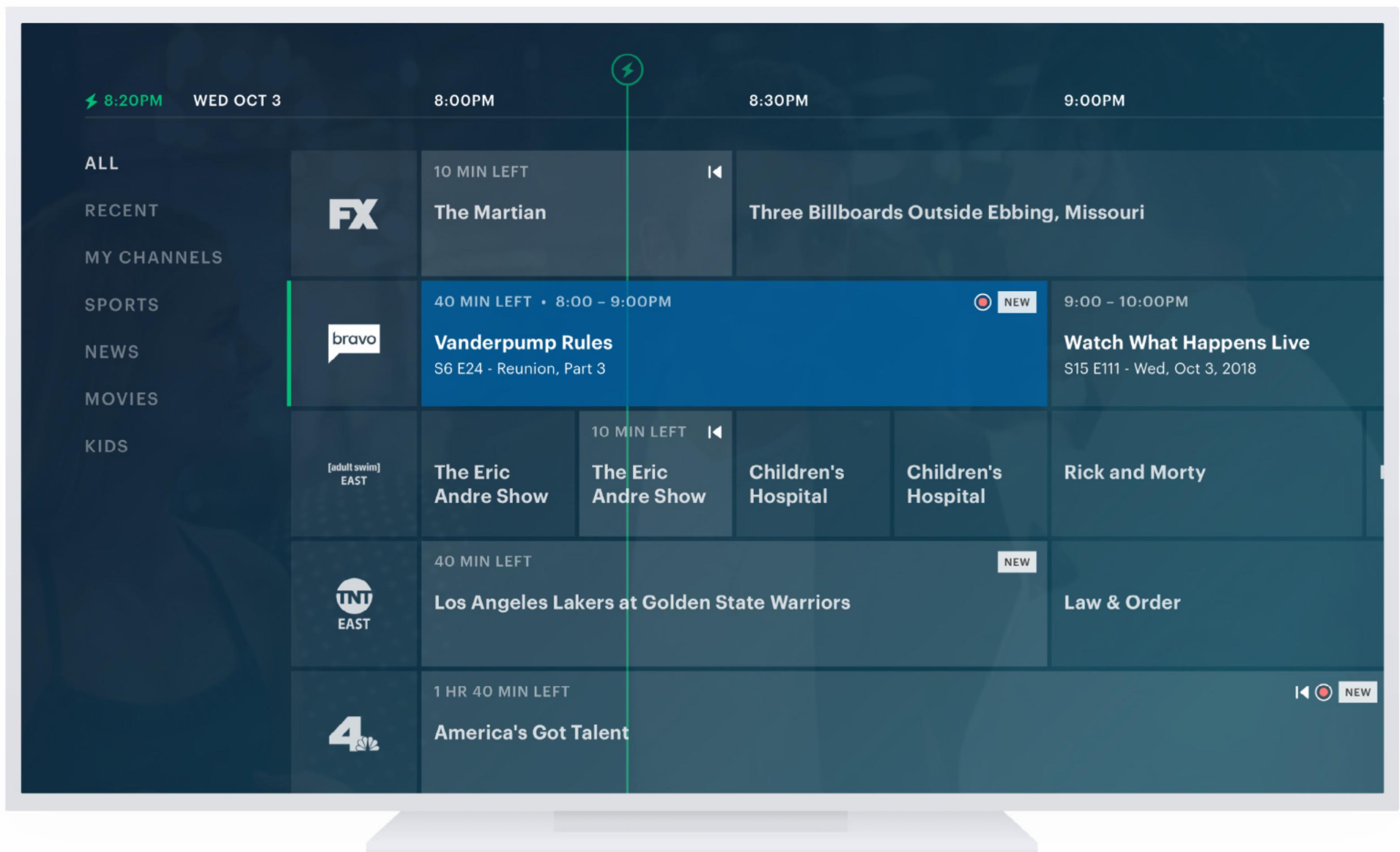
Hulu is a dependable option for streaming new and classic shows as well as live TV on nearly every platform. It's a top choice among video-streaming services.



Netflix's originals, including *The Crown*, *Bojack Horseman*, *Stranger Things*, and *The Witcher*, are generally more successful than Hulu's. Other streaming services also outclass Hulu. For example, Amazon has a growing list of top-notch originals, including *Bosch*, *Fleabag*, *Patriot*, *Hunters*, *The Boys*, *The Expanse*, *The Marvelous Mrs. Maisel*, and *Undone*. HBO Max offers a substantial catalog of quality past and current shows including *Barry*, *Big Little Lies*, *Deadwood*, *Silicon Valley*, *Six Feet Under*, *The Sopranos*, *The Wire*, *Westworld*, and *VEEP*.

Hulu's library of movies is decent, including mainstream movies such as *Parasite* and *Rocketman*. Things are looking up in 2021, though, with Hulu snagging the same-day release premieres of *Nomadland* and *The United States vs. Billie Holiday*, both of which won Golden Globe awards. That said, movie fans will likely want to subscribe to one of the available channel add-ons.

Hulu does produce some original movies, including *Happiest Season*, *Palm Springs* (which was nominated for a Golden Globe), and *Run*. Foreign films on the platform include *Shoplifters* and *A Breath Away*. Despite Hulu's efforts, though, Netflix currently offers the best movie library of any of the video-streaming services.

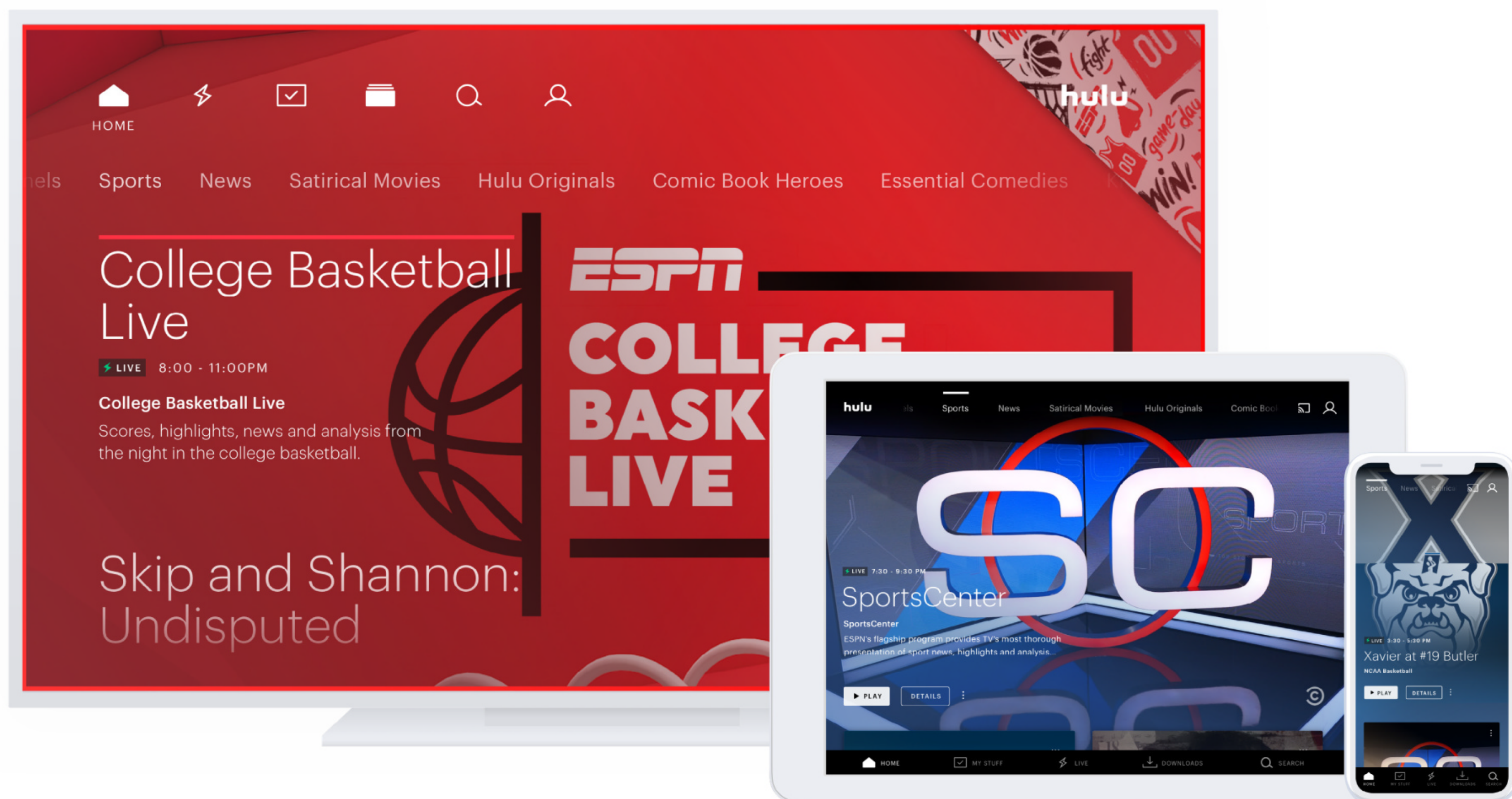


LIVE TV AND SPORTS

Hulu + Live TV's channel lineup should please most general audiences, with a deep lineup of content across the news, entertainment, and sports categories. News channels include ABC News, CBS News, CNBC, CNN, CNN International, Fox Business, Fox News, and MSNBC. Entertainment coverage is similarly varied with options such as Animal Planet, Cartoon Network, Discovery, Disney, Food Network, FX, HGTV, National Geographic, SYFY, TBS, Travel Channel, TLC, and TNT. You also get the movie channels FXM and TCM. In addition to live feeds of these channels, you can watch on-demand content from each of these networks. For fans of channels from Discovery Inc. (such as Animal Planet, Food Network, and HGTV), Discovery Plus is a much cheaper, albeit on-demand, streaming service.

Hulu has added live Viacom channels, such as Comedy Central, MTV, and Nickelodeon, to its lineup, too. If you are specifically interested in those channels, the much-less-expensive Philo includes them in its lineup.

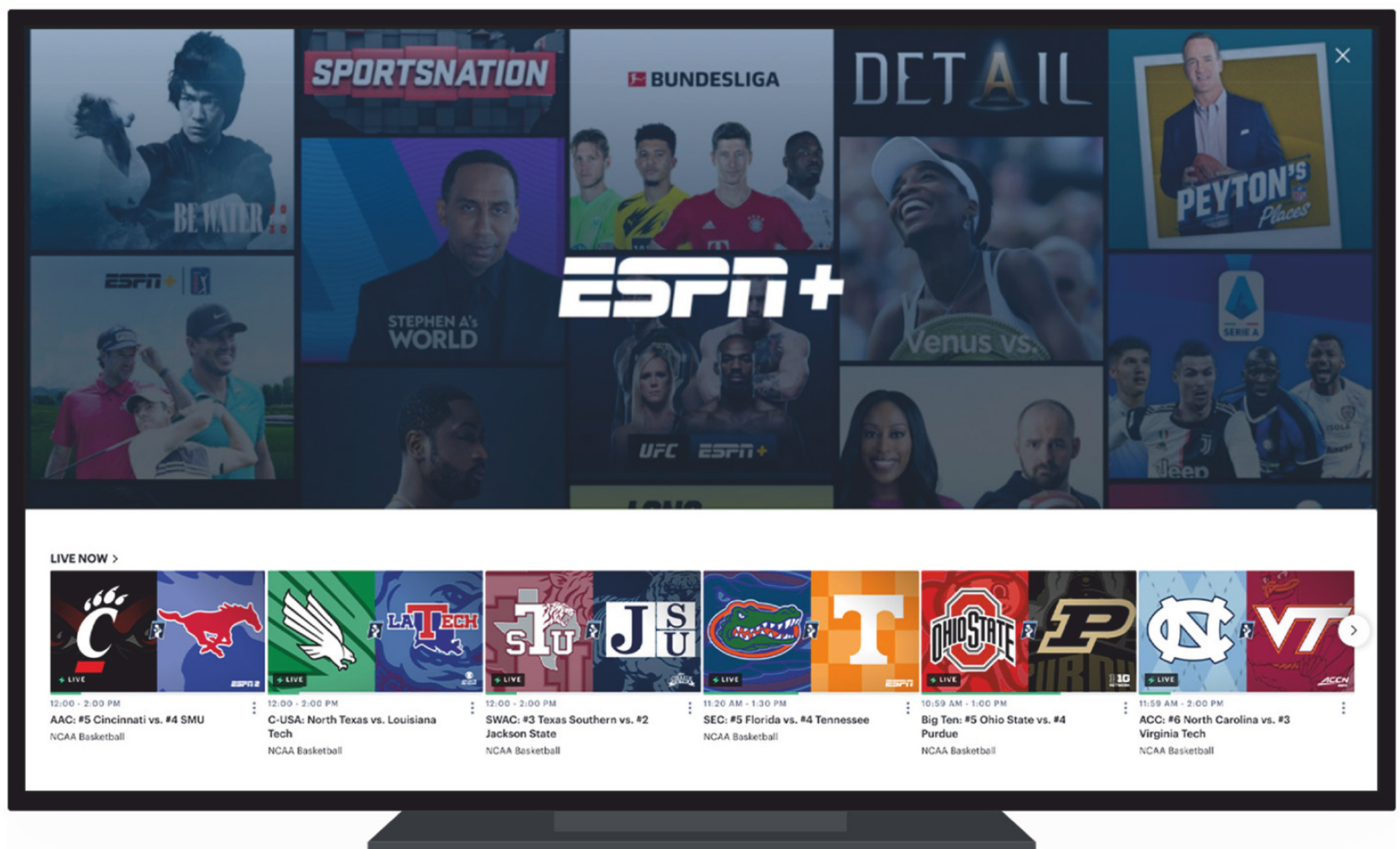
As for sports, Hulu's lineup includes BTN, CBS Sports, ESPN, ESPN 2, ESPNEWS, Golf Channel, and Olympic Channel. That's all in addition to local channels you get in your ZIP code, such as ABC, CBS, FOX, and NBC cable affiliates. Recently, Hulu added NFL Network to its channel lineup at no additional cost and launched the \$9.99-per-month Sports add-on, which includes the NFL RedZone channel (along with MAVTV, Outdoor Channel,



Sportsman Channel, TVG, and TVG2). These additions cement Hulu + Live TV as one of the top options for streaming NFL games. FuboTV, Sling TV, and YouTube TV all include the NFL Network channel in at least one of their plans and offer NFL RedZone as part of an add-on package.

While Hulu's lineup features NBC-owned RSNs (regional sports networks), it lacks most AT&T-owned RSNs (except for SportsNet NY) and every Sinclair-owned Bally Sports RSN (previously, these were FOX Sports RSNs). AT&T TV is the only live TV service we've reviewed that includes RSNs from AT&T, NBC, and Sinclair, though it is missing a few NBC Sports RSNs. Make sure to find out which RSN airs your local team's games before committing to any sports-streaming service.

Because regional restrictions and broadcast blackouts still apply for live TV streaming services (particularly for MLB, NBA, and NHL games), it's important that whatever service you choose has both the relevant national and regional sports channels you need to watch those games. Even if a game is airing on a national channel elsewhere in the country, you may not have access to said game on that same channel if it involves a local team. For instance, a Yankees game that airs on ESPN for subscribers in Miami might air on YES for residents of New York.



HOW MUCH DOES HULU COST?

Hulu's ad-supported, on-demand streaming plan currently costs \$5.99 per month. To avoid ads, you need to spring for the \$11.99-per-month plan. You can bundle Hulu (the ad-supported version), Disney+, and ESPN+ for \$13.99 per month or get the ad-free version of Hulu in that same bundle for \$19.99 per month. College students can get a discounted ad-free version of Hulu for \$1.99 per month.

The \$64.99-per-month Hulu + Live TV plan bundles the service's live TV component with ad-supported access to its on-demand library. Hulu's live channels and the ad-free on-demand package costs \$70.99 per month.

The No Commercials price tier still displays ads for a few programs per streaming rights, but to Hulu's credit, it is upfront about this limitation. Ads in the basic plan are no worse than those on regular television, but they are jarring and obnoxious for on-demand content. When we watched an episode of *Killing Eve*, the stream was interrupted five times for commercial breaks, some of which included several back-to-back ads. If you're getting rid of cable to avoid commercials, you'll want the No Commercials tier.

Hulu also offers Cinemax (\$9.99), HBO Max (\$14.99), Showtime (\$10.99), and Starz (\$8.99) as add-ons, which let you watch shows and movies from those networks along with their live feeds. Other add-ons specifically for the Live TV plans include Enhanced Cloud DVR (200 total hours of storage plus the ability to fast-forward through ads) and Unlimited Screens (no restrictions on simultaneous streams over your home network), which cost \$9.99 per month each or \$14.98 per month for both. You can also opt for the Entertainment (\$7.99 per month) or the Español (\$4.99 per month) Add-ons.

Netflix's base plan now costs more than Hulu's, at \$8.99 per month. Netflix doesn't run traditional ads on any of its content, but you need to pay more (at least \$13.99 per month for the Standard plan) to stream HD content and to stream on more devices simultaneously. Paramount+'s ad-free tier is \$9.99 per month, and HBO Max comes in at a much pricier \$14.99 per month. Amazon Prime Video is \$8.99 per month. Shudder, a horror-focused streaming service, matches the price of Hulu's ad-supported plan but doesn't show ads. Apple TV+ is cheaper than all of them, at \$4.99 per month.

As for cable-replacement services, Hulu + Live TV costs the same as YouTube TV (\$64.99 per month). Philo (\$20 per month) and Sling TV's Orange & Blue plans (\$35 per month each or \$50 together) are significantly cheaper. FuboTV also starts at \$64.99 per month, while AT&T TV's entry-level tier is \$69.99 per month. None of these services offer on-demand content libraries as complete as Hulu's.

Apart from streaming Hulu on the web, you can download apps for mobile platforms (Android and iOS), media streaming devices (Apple TV, Chromecast, Fire TV, and Roku), smart TVs, and game consoles



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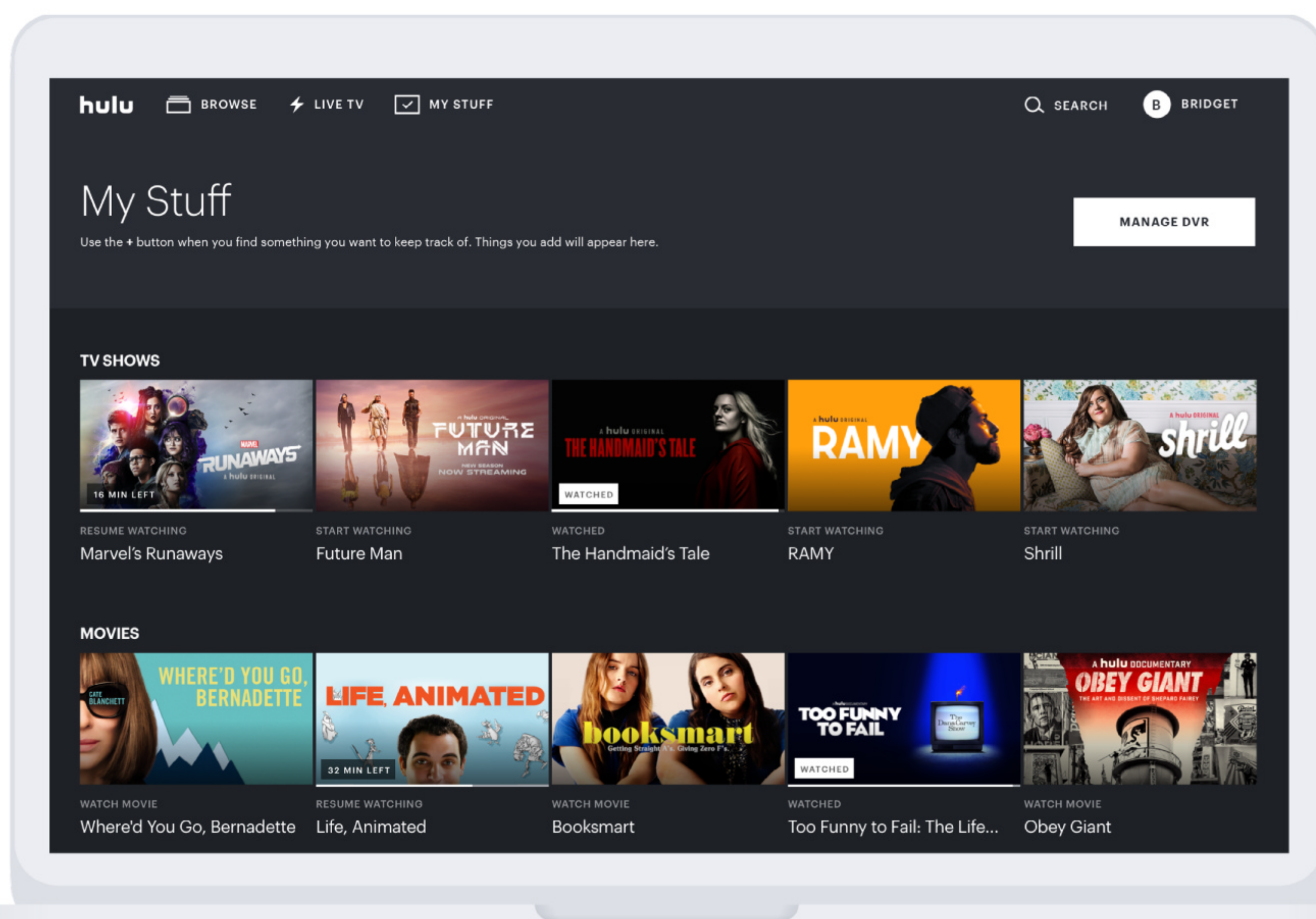
(PlayStation, Xbox One, and the Nintendo Switch). Hulu's live TV tier is available on the PlayStation 4, but PlayStation 3 users are still out of luck when it comes to live TV.

HULU'S WEB INTERFACE

When you log in to Hulu for the first time, the service walks you through some personalization options in which you choose channels, genres, and shows that appeal to you. Hulu uses this information to populate the My Stuff section of the web interface, a feature we'll discuss later.

Hulu's web interface for live and on-demand content looks much more modern now than in years past, with big, flashy sliders and easily discoverable content. Hulu is planning to make interface text more legible in a forthcoming update. The homepage highlights noteworthy shows with horizontally scrolling lists below for categories such as Live Now, My Channels, Sports, News, and Hulu Originals.

At the top of the page are categories for Live TV and My Stuff. Search and Account options live in the upper-right-hand corner of the screen. In the Account section, you can manage billing details and your subscription add-ons. You can also add profiles for individual users, a feature we appreciate. While you can restrict certain profiles to kid-friendly content only, that's not as flexible as other platforms' capabilities, which let you set restrictions by content ratings.

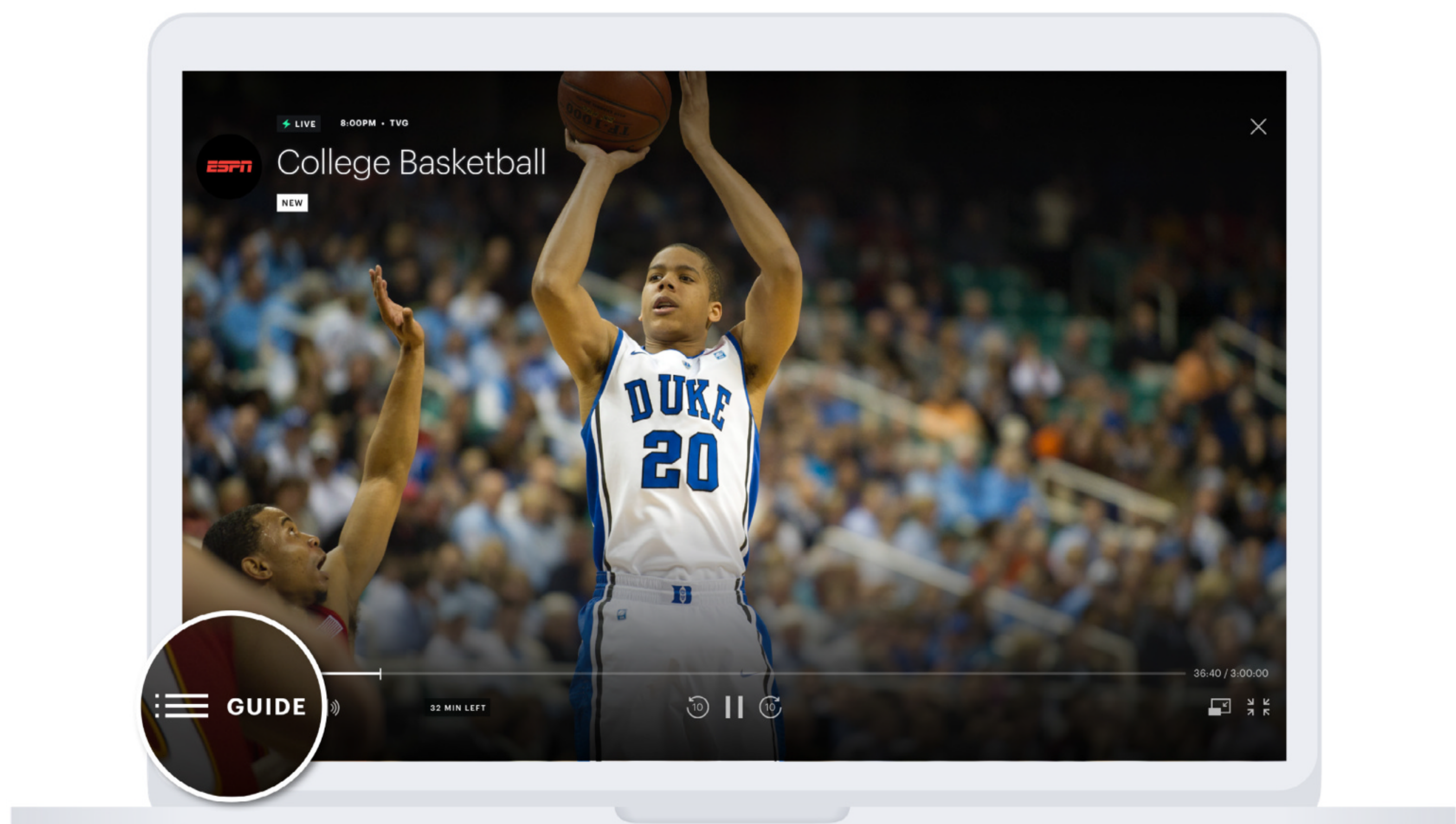


Browsing for content is straightforward. From the Browse menu, you can select from one of several top-level categories, such as Networks, TV Shows, Movies, Hulu Originals, and Sports, or dive deeper into one of the dozens of available genres, including Adventure, Comedy, Cooking & Food, Documentaries, International, and Science Fiction. Each one of those latter categories returns results from both Hulu's on-demand and live streaming library. Detail pages for content display available episodes, upcoming broadcast schedules, recommended shows, and a brief description.

To browse live TV streams specifically, click the Live TV button in the top menu. You can filter the channel list by Recent Channels, News, Sports, Kids, and Movies. The web interface supports a windowed picture-in-picture mode, so you can keep your eye on the current stream while browsing for new content.

You can store and track shows and channels in the My Stuff section. To add anything to this section, simply hit the + icon next to any programming and choose any available recording options: new episodes only, new and reruns; and do not record. You can also follow specific sports teams: For example, you could add the Miami Dolphins to My Stuff to record and keep track of all upcoming games.

We tested Hulu's performance on the web over an Ethernet connection (200Mbps download). The streaming performance was mostly solid, with a few random stutters. Hulu requires speeds of only 3Mbps for on-demand shows and 8Mbps for live streams, so most connections should be sufficient.



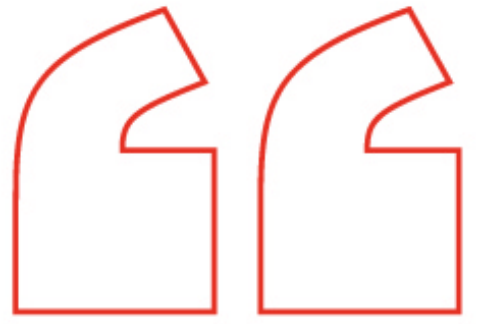
FEATURES AND STREAMING EXPERIENCE

Hulu now lets premium subscribers download select TV shows and movies for offline viewing, including its original programming. Eligible users can download up to 25 videos across five devices. Downloads expire after 30 days and you get two days to finish watching a video after you begin playback. Netflix, Prime Video, Paramount+, HBO Max, and Showtime all offer offline download capabilities, too.

Hulu + Live TV's DVR functionality compares well to other services. With Hulu, you can record up to 50 hours of content and keep those recordings for as long as you subscribe. Users can pay an extra \$9.99 per month to increase that limit to 200 hours and for the ability to skip ads in recordings. For comparison, YouTube TV offers unlimited DVR storage and keeps titles for nine months. FuboTV allows you to record 30 hours' worth of content by default, while Sling TV users get 50 hours' worth of storage. AT&T TV limits subscribers to 20 hours' worth of storage and keeps recordings for up to 90 days.

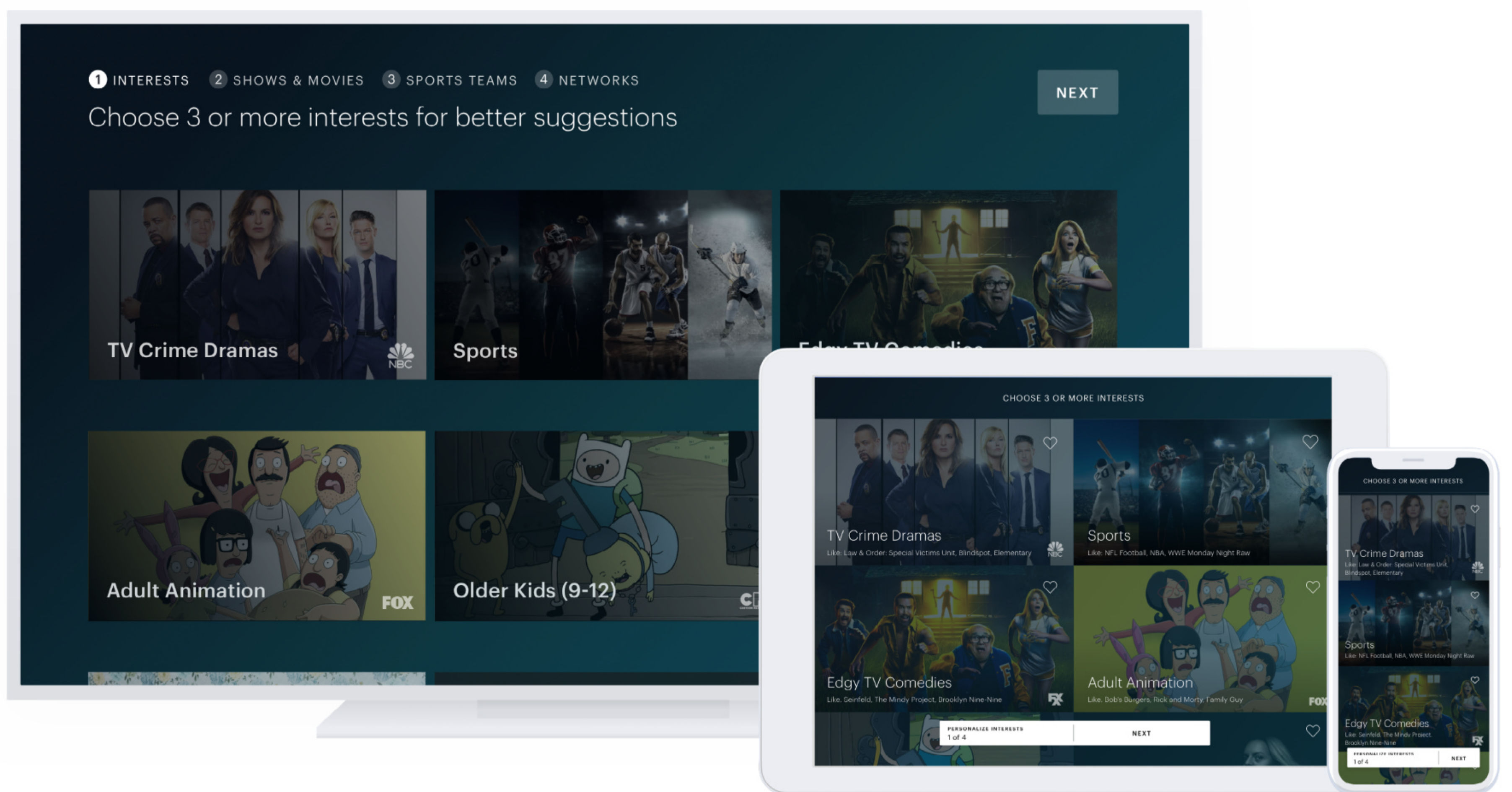
Hulu may not offer every show in HD, but many of its shows are simply not available anywhere in a high-quality format. Many of Hulu's recent original shows are available to stream in 4K on a select number of devices. Amazon Prime Video, Apple TV+, and Netflix have fairly robust libraries of new shows and movies in 4K. Select on-demand titles on Hulu support Dolby Digital Plus 5.1 surround sound, but Apple TV+ offers the most consistent support for high-end audio and video standards.

In terms of live TV streams, Hulu and YouTube are among the few that support 1080p/60fps streams for select channels on select platforms. Some of Paramount+'s local CBS station streams reach that



**Hulu now
lets premium
subscribers
download
select TV
shows and
movies for
offline
viewing.**





same standard, too. FuboTV is currently the only service that offers 4K live streams, though YouTube TV has announced plans to offer live streams at that resolution in the future.

Hulu's base plan supports two simultaneous streams, which is about average for on-demand services. As mentioned, you can pay for the Unlimited Screens add-on to get rid of that limit for devices on your home Wi-Fi network, though this is available only for Hulu + Live TV subscribers. Hulu allows you to create up to six profiles per account.

Hulu includes standard closed-captioning options, but relatively few titles support audio descriptions, an accessibility feature that provides audible narrations of on-screen actions that would not be discernible through dialog alone. For any show or live broadcast, you can change the color, size, and style of the subtitle text. Acorn TV offers similar customization options directly on the playback screen.

When you want to prevent your children from watching inappropriate shows, Hulu lets you designate a profile as a Kids Profile. Doing so restricts that profile to a kid-friendly hub of content. Netflix and Prime Video offer more substantial parental control options that enable you to lock content by rating, though.

MOBILE APPS

Hulu offers apps for both Android and iOS. We previously tested the Android app on a phone running Android 10. Hulu's iOS variants are practically identical to their Android counterparts. The app looks very elegant with large media elements and transparent navigation elements and icons. We didn't notice any lag when moving between menus and launching content.

The new app uses a text-based menu system with five persistent icons across the bottom: Home, My Stuff, Live, Browse, and Account. Within each content section, you can scroll horizontally between broader categories and vertically to see all associated content. Movies and TV shows pop out into full-screen overviews, which look really slick. The individual pages also have side-scrolling options for viewing episode lists (for TV shows) as well as recommendations for other content.

We tested Hulu's mobile app by streaming from our test device, which was connected to PCMag's Wi-Fi network (50Mbps download). Streaming performance is strong, and content started playing at full quality after a few seconds. We were able to watch a live stream of ESPN's SportsCenter without any problems.

The My Stuff section of the app works as it does on the desktop, and you can manage items in your DVR storage here as well. The account section is somewhat bare, though. The only app-related preferences are for customizing subtitles/captions and toggling Hulu's Autoplay feature. Although you can manage your plan settings from this section, the Help section just redirects to the web version.



HULU AND VPN

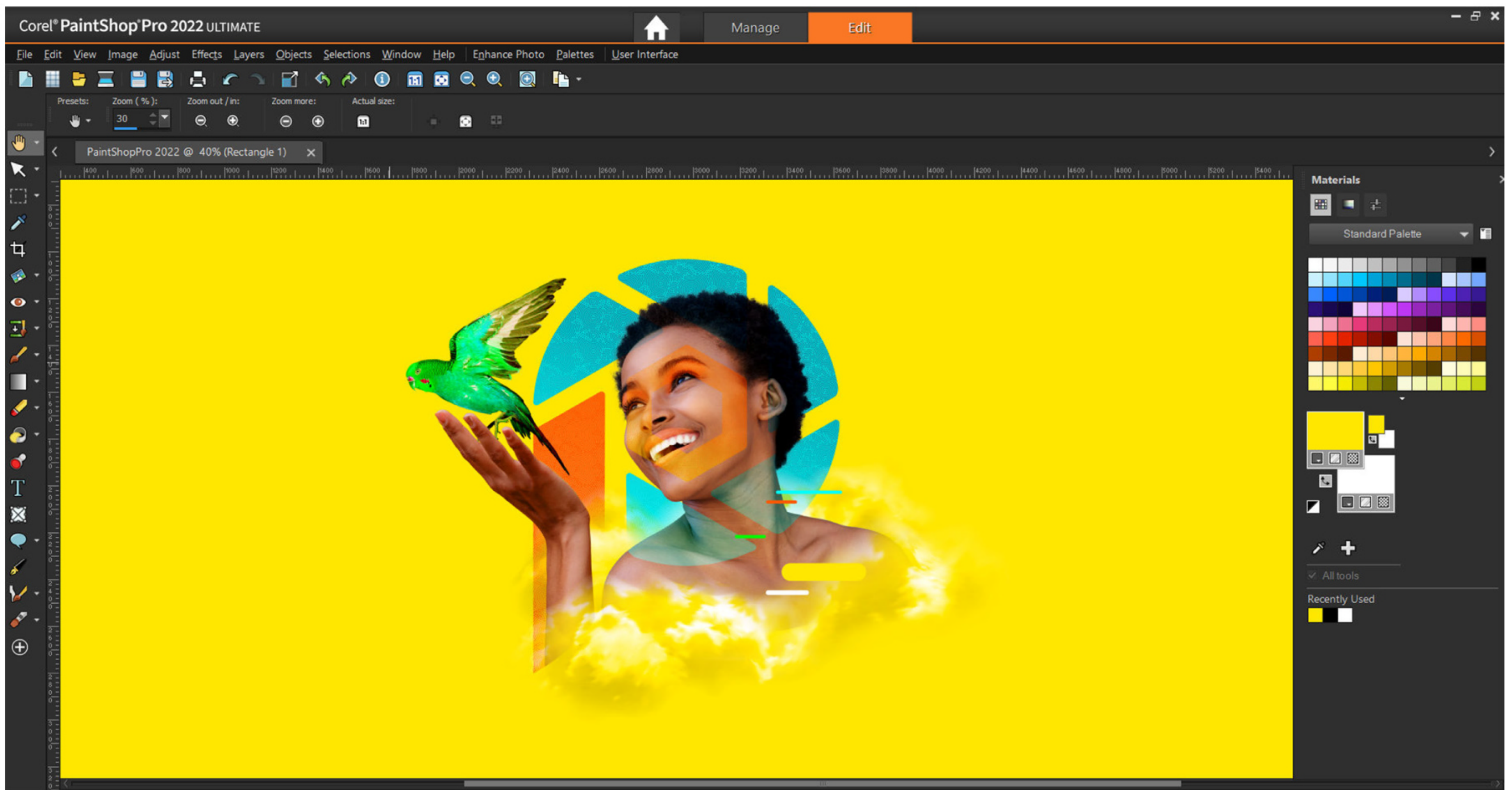
You should strive to use a VPN on every one of your devices and for every internet-based activity. Note, however, that some video-streaming services, including Hulu, will attempt to block you from streaming content when you're connected to a VPN or proxy. Section 15.1 of Hulu's terms of service, for example, states: "We are a company based in the United States and offer our Services to users in the United States. Hulu's goal is to bring you as much Content as is legally available. That said, we are limited by the rights that our content programmers grant to us." With a VPN, Hulu likely cannot pinpoint your real location.

We tried streaming Hulu content after connecting our test devices to US-based Mullvad VPN servers with no luck. Even if your VPN and video-streaming service work without issues for now, they may not in the future. You are better off choosing a VPN for its security and performance.

ALL-IN-ONE ENTERTAINMENT

If you're getting only one streaming service, Hulu is an excellent choice for its combination of on-demand content and live TV, even if its original shows are not as consistent in quality as competitors'. On the technical side, Hulu's offline downloads are restricted to higher-tier plans and it lacks substantial 4K content, though it does support 1080p live channels on some platforms. The strength of its respective on-demand and live TV offerings outweigh those flaws, even despite the latest price hike to its live TV plan.

Netflix offers a better selection of on-demand shows and YouTube TV features better live TV coverage, but Hulu's combination of both content types makes it an Editors' Choice pick alongside those services.



\$79.99 | Rating: ●●●●○ EXCELLENT

Corel PaintShop Pro: A Worthy Photoshop Alternative

BY MICHAEL MUCHMORE

Photoshop is a magnificent tool, but many of its users could do everything they need to in Corel's photo-editing software, PaintShop Pro, without having to pay a monthly tribute to Adobe. PaintShop Pro supports layers and lets you edit both raster and vector image formats—something you'd need two of Adobe's Creative Cloud apps to do. You miss out on some of the Adobe flagship photo editor's most advanced tools, however, including 3D modeling,

detailed typography, and face liquefy. PaintShop Pro's Performance is faster than in earlier versions, but in some photo-editing operations, it lags Photoshop. Likewise, while PaintShop Pro's interface has improved greatly over the years, it's still not quite as polished and unified as Photoshop's. If you're a Windows user who's not committed to the Adobe ecosystem, PaintShop Pro is a worthy alternative, especially given its low cost.

PRICING

PaintShop Pro 2022 is available directly from Corel or via retail for \$79.99 (or \$59.99 as an upgrade from any previous version); it's frequently discounted. The Ultimate edition (\$99.99, \$79.99 upgrade) throws in more software—AfterShot (Corel's photo workflow app for importing and organizing digital photos), Corel Painter Essentials, PhotoMirage Express (converts still shots to animations) and more brushes and backgrounds. You'll need Ultra to get the AI HDR Studio and Sea-to-Sky Workspace (see below), PhotoMirage animation, and more brushes.

PaintShop Pro is available from the Microsoft Store app on a subscription basis at \$7.99 per month. This gets you all updates but no cloud storage, such as you get with Adobe's subscriptions.

The one-time purchase options are a good fit for those who still resent Adobe's move to a subscription-only model for Photoshop, Lightroom, and Illustrator. For \$9.99 per month, you get both Photoshop and Lightroom, but Illustrator starts at \$19.99 per month, when you prepay for a year. Photoshop Elements (\$99), Adobe's consumer-level photo editing software, requires no subscription, but it has more of a hobbyist feel as opposed to the company's pro-level offerings.

Corel PaintShop Pro

PROS

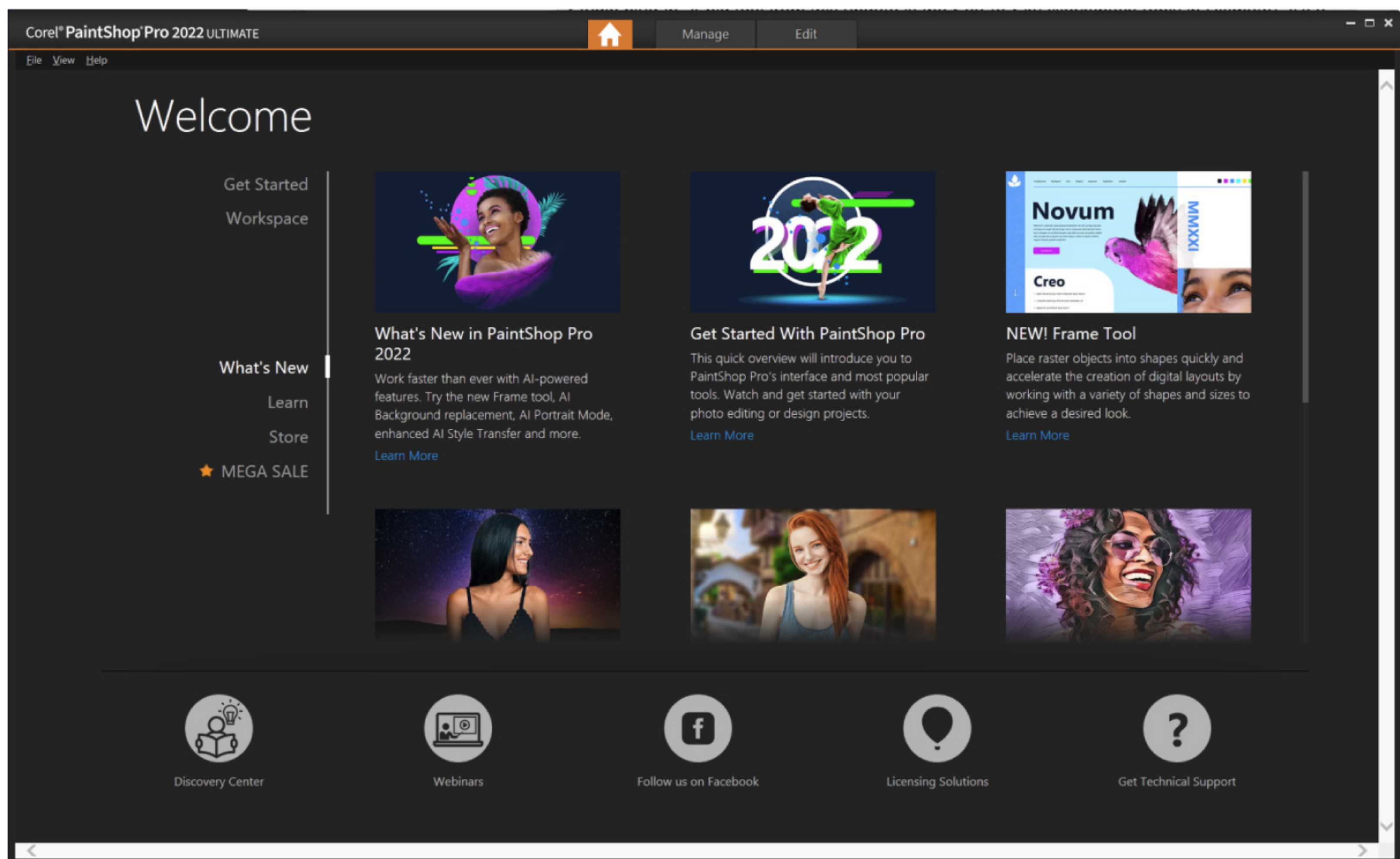
Photoshop-like features at a lower price. Powerful effects and editing tools. Extensive help and tutorials. Good assortment of vector drawing tools. Automatic noise removal.

CONS

Inconsistent interface. No macOS version. Some operations slow.

BOTTOM LINE

Corel continues to add new photo-editing possibilities to its PaintShop Pro software, making it a worthy Photoshop alternative on Windows for a budget-conscious, one-time price.



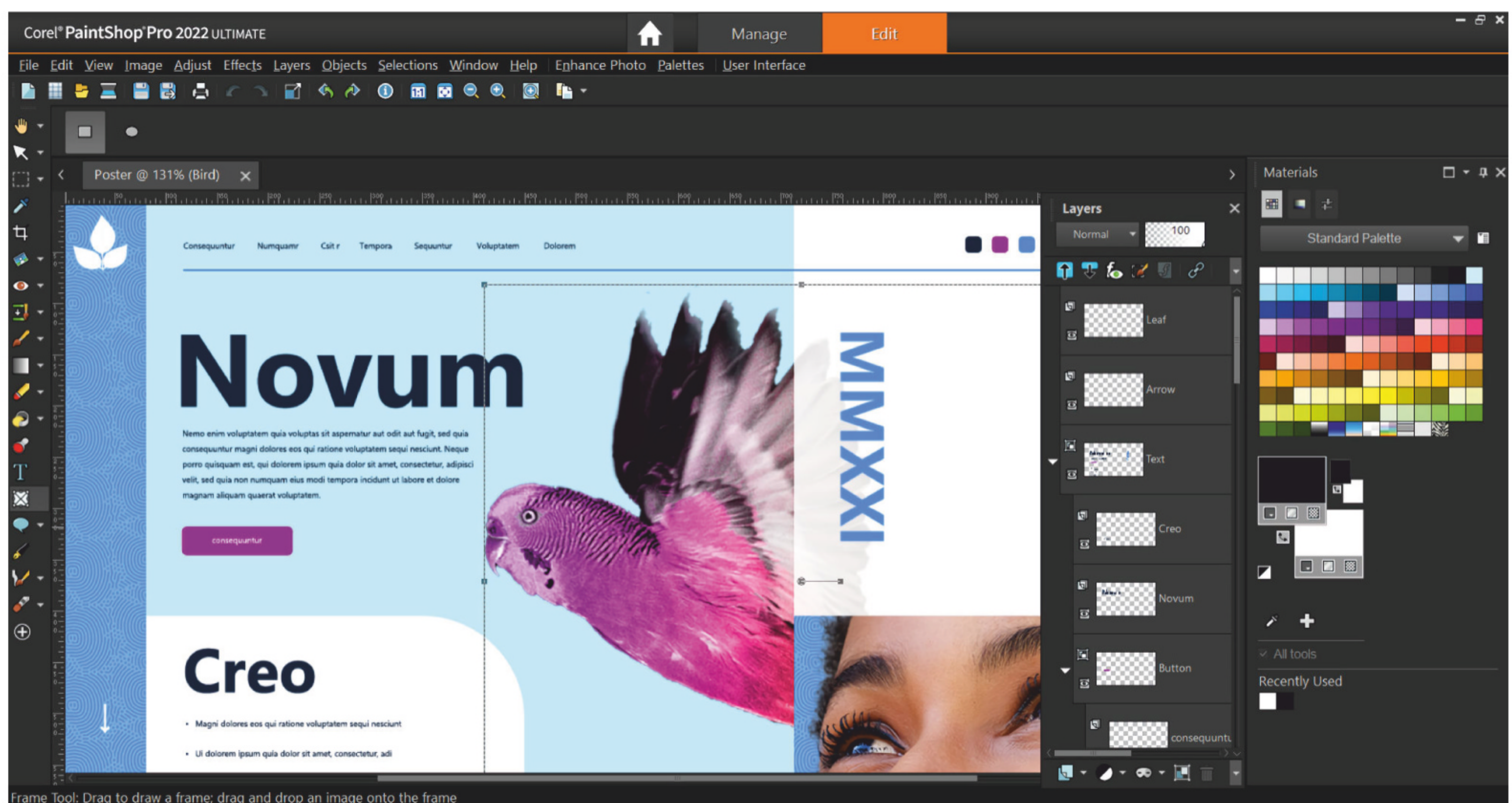
GETTING STARTED

PaintShop Pro runs on Windows 10 (recommended version 1903 or later with the latest Service Pack (64-bit editions)). You first install a small downloader program that completes the installation. You have to choose whether you want 32-bit, 64-bit, or both—the last means you'll be compatible with both 32-bit and 64-bit plug-ins. After this step, the program asked me to enter an email to create an account, which only requires confirmation by responding to an automatically generated email.

Corel offers downloadable effect packs, too, such as ParticleShop brushes and ColorScript color effects (for \$14.99 and \$4.99, respectively). I installed PaintShop Pro on my test PC running Windows 10 Pro with a Core i7 6700 CPU, 16GB RAM, and an Nvidia GTX 1650 graphics card.

WHAT'S NEW?

Corel puts a lot of effort into improving and adding features to the venerable image-editing software, taking feedback from user advisory boards and program telemetry to decide what people want. New features for the 2022 version include AI Background Replacement, AI Portrait Mode, and a much-improved AI Style Transfer. Corel also added support for the HEIC and HEIF file types that iPhones use and an updated Welcome and startup experience. New brushes, color palettes, gradients, patterns and picture tubes, and a Frame tool for placing images inside shapes round out the updates.



The Ultimate version adds a Highlight Reel video slideshow-creating feature (similar to the one in Corel VideoStudio), MultiCam Capture Lite for screen and webcam video presentations, and Painter Essentials 8 for simple drawing, sketching, and painting on the PC.

In 2021, PaintShop added a touch-friendly photography mode that includes a split before-and-after view, handy for seeing the effects of your edits. (I'd still like to see a side-by-side option like Lightroom's.) Also arriving in that version were AI Upsampling, AI Denoise, AI Artifact Removal, AI Style Transfer, and the HDR Studio plug-in. A big tool from this update is the Sea-to-Sky Workspace (only in Ultimate). It applies appropriate fixes to underwater and aerial shots, such as those from a drone.

Other recent updates include a slew of tools. The 2020 version added SmartClone, for blending multiple image selections; Refine Brush, for selecting complex objects like hair or tree lines; new brushes, color palettes, gradients, patterns and picture tubes; Text tool enhancements; and an improved Depth of Field tool. Available within the Crop tool, Depth of Field lets you position the focus area with a five-by-five grid of squares. The 2019 version added 360-Degree camera support, an improved crop toolbar, stylus and tablet support, and a more-customizable UI.

THE PAINTSHOP INTERFACE

PaintShop's Welcome screen shows your recent files, product news, tutorials, and add-ins for purchase. Pick an image to work on, and the program starts up

in one of four workspaces you choose: Photography, Essentials, Complete, and Sea-to-Sky. Only three tabs grace the top of the Complete program window: Home, Manage, and Edit. Aside from the simple Photography workspace, the others each take you through an interface tour wizard to show you what's what.

The Photography workspace is simple and touch-friendly. You find basic tools including Rotate, Crop, Brightness, Color adjustments, One Step Photo Fix, and White Balance. You also get some of the fancier tools, including AI Upsampling, AI Denoise, AI Artifact Removal, and AI Style Transfer. An arrow offers even more tools, such as Local Tone Mapping, High Pass Sharpen, Fill Light/Clarity, Vibrancy, and Fade Correction. I'd like to see adjusters for highlights and shadows here, too, but they're MIA. You can adjust the text and icon size and workspace colors.

Another thing I'd like to see in this Photography mode interface is an easier, one-button way to get to the program's more advanced workspaces—Essentials and Complete. You can switch to any mode from the File > Workspace menu, but buttons would be quicker. A minor interface feature I like to see in photo apps is having sliders snap to the default position when you double click.

From Welcome, you can also start with project templates. PaintShop's templates are similar to the Create dialog that appears when you first run Photoshop. The New Image dialog's Blank Canvas tab is rich with choices, including Photo, Paper, Web, Mobile, and Social. One thing I don't see, which Photoshop has, is a Clipboard choice that sizes your new project to an image you've copied. The New From Template tab, like Photoshop's, offers several document types, including calendars, collages, cards, business reports, and social



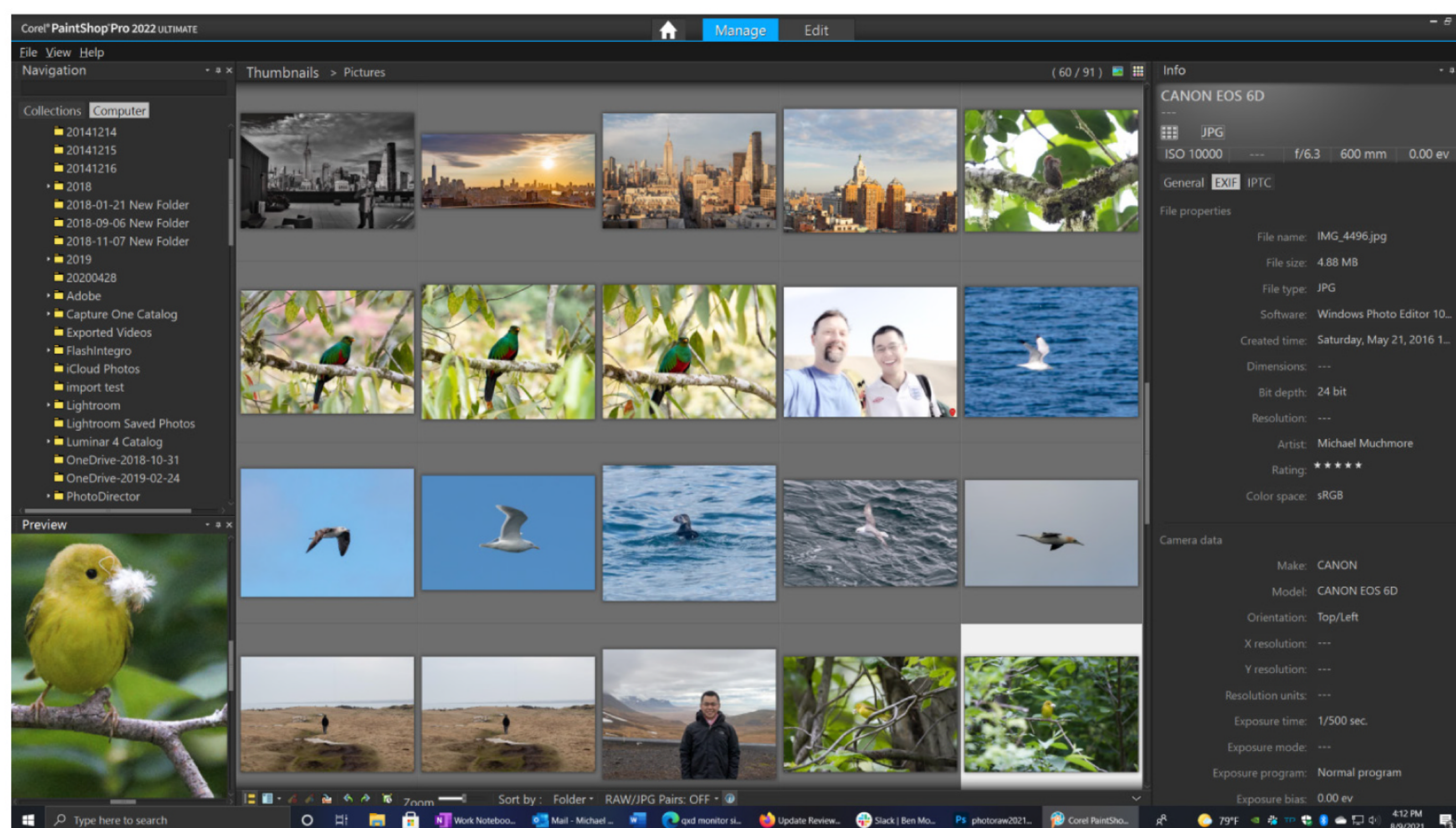
Aside from the simple Photography workspace, the others each take you through an interface tour wizard.



media. Most of these are in-app purchases—in both programs—though you can create your own custom templates.

The interface is customizable when it comes to color and the size of elements such as icons and scroll bars. These options get their own main menu option: User Interface. From here, you can, for example, enlarge menu text so that it doesn't look tiny on a 4K monitor. (It also worked well for my QXD 2560x1440 display). The main window's side panels can also be undocked or dismissed. The program includes sample images, so you're not starting from zero. Additionally, the Complete workspace still includes the right-panel Learning Center, which helps you along with many image-editing procedures.

Unlike in Adobe Photoshop Elements, which has a separate Organizer app, you do everything in PaintShop in the same window, but you switch modes for different functions.



MANAGE MODE

As its name suggests, Manage mode is where you organize your photo collection. Like Photoshop, PaintShop is not a photo workflow application, even though it includes tools for organizing and outputting. This is especially evident when importing photos; it's more a matter of simply opening photos rather than importing them. PaintShop lacks the big Import button you find in workflow

apps such as Adobe Lightroom. You can import content from a scanner, webcam, or previous versions of PaintShop, including not only photos but also brushes, gradients, and Picture Tubes—as long as it's stored in the standard folders.

For organization and management, you can add star ratings to photos as well as tags for keywords, people, and places. You can also create collections, including Smart Collections of photos that meet specified criteria, such as date, name, or tags. Smart Collections let you specify criteria, such as text in the file name or image size to automatically create a Collection.

On the left panel is source navigation, with folders and collections. In the center is your main content view—thumbnails, full image, or a map showing photo locations based on GPS data. You can double-tap a thumbnail for a quick full-screen preview with options for rating, rotating, deleting, or launching the image in the editor. Images aren't overwritten when you save edits; rather, they are saved in PaintShop's own PSP format.

You can also save in Adobe PSD format (though you lose vector layers and other features), along with dozens of other standard image formats. When you open a PSD file created in Photoshop, layers are preserved, and you can edit them separately to taste. Afterward, your edits are fully editable when you open the resulting PSD in Photoshop. What this means is that if you're working with someone who uses Photoshop, you'll be able to edit compatibly in PaintShop, but if you start in PaintShop, they'll see only a flattened version of your file.

ESSENTIALS WORKSPACE

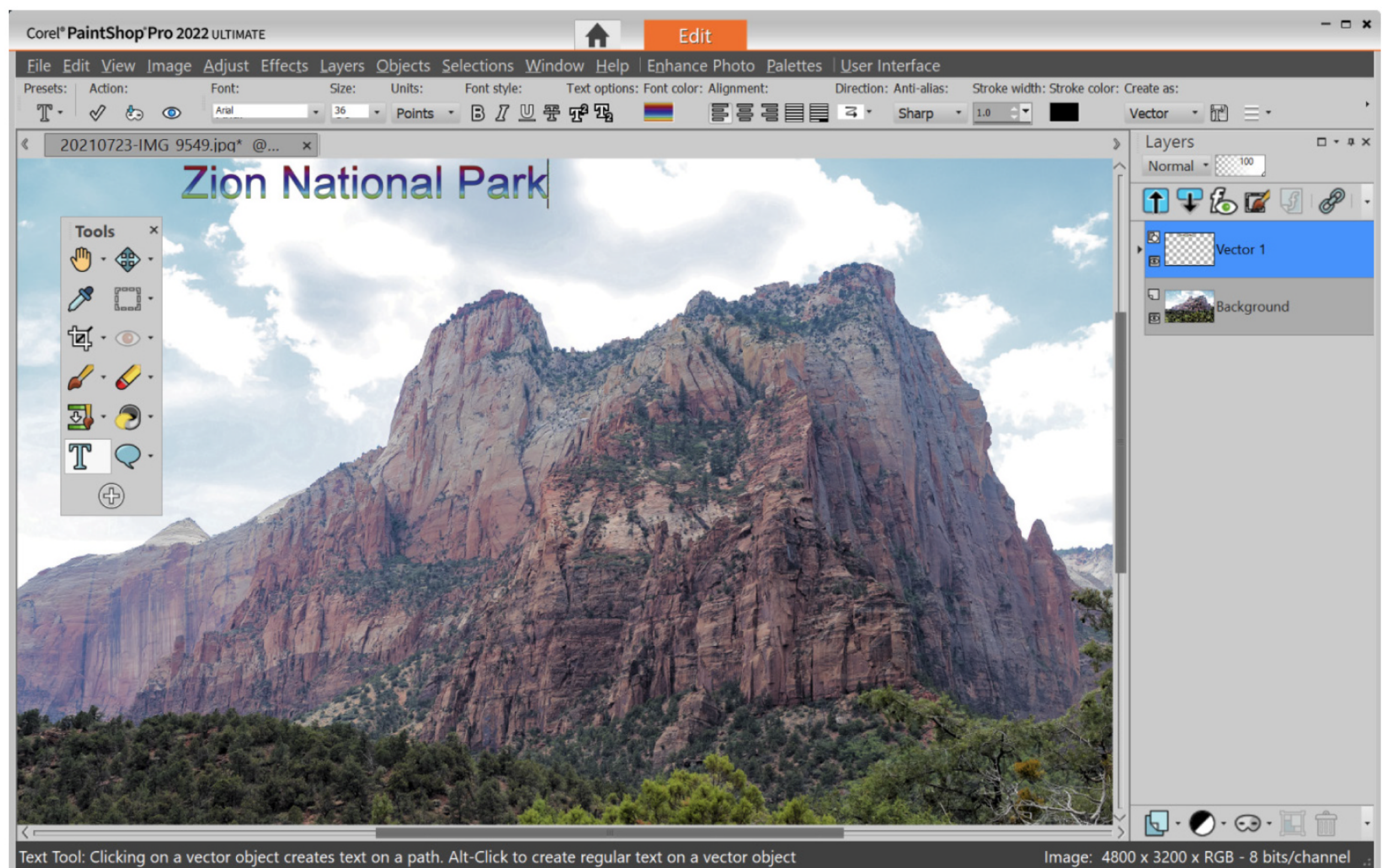
Though the Essentials workspace is drastically simplified, it retains frequently needed features, and



For organization and management, you can add star ratings to photos as well as tags for keywords, people, and places.



you can add and remove tools to suit your needs. There are still quite a number of menu choices along the top—14 compared with Photoshop’s 11 and Photoshop Elements’ 10. Like Photoshop, PaintShop lets you create custom workspaces, though the Adobe product offers six options by default compared with PaintShop’s four. Photoshop Elements has Quick, Guided, and Expert modes, which can be thought of as workspaces.



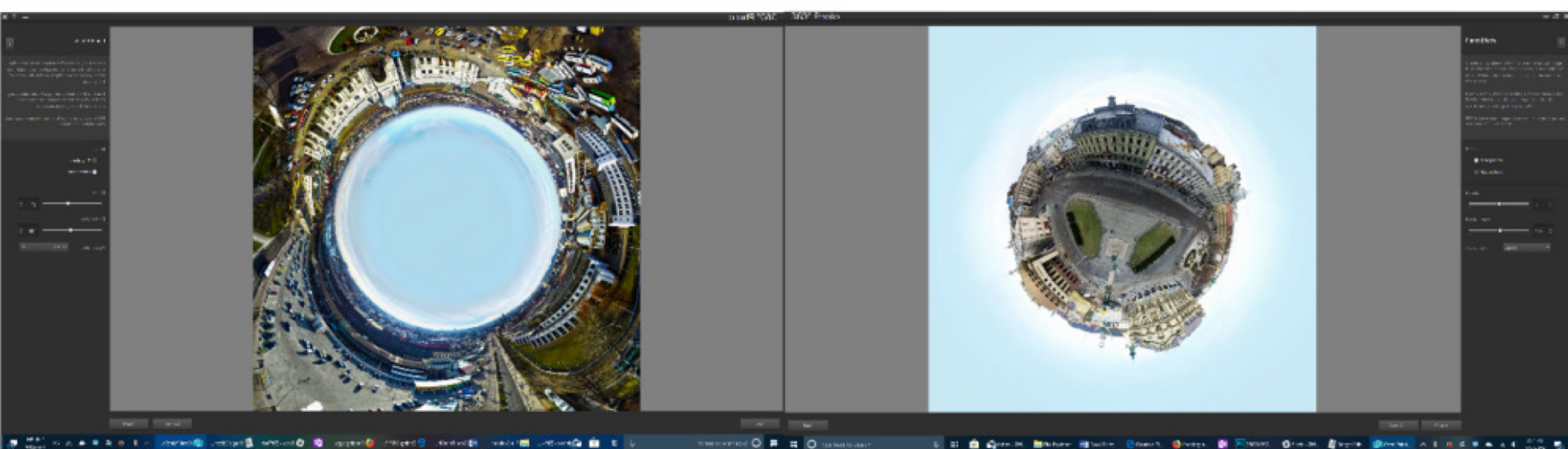
360-DEGREE PHOTO EDITING

When you first try to open a 360-degree image file shot on a camera like the GoPro Max, a dialog asks whether you want to edit it as 360-degree image or to open for adjustments and effects. The latter doesn’t affect the geometry of the photo. Instead, you can manipulate just the lighting and color effects, as though it were a warped 2D photo. Doing so keeps it in 360 format with your lighting corrections, so you can still upload it to Facebook or other 360 viewers. Corel helpfully includes a few sample 360 files for experimentation.

Opening an image in 360-degree mode presents a separate editing window and an explanatory dialog showing what you can do with the file type. There are four editing options: Straighten, Remove Tripod, 360-to-Panorama, and Planet effects. The last two options convert the image from 360 to a standard format, such as JPG.

The most useful tool is Straighten, which worked well in my testing. This option removes the unnatural curves of your 360-degree photo and lets you pick a viewing angle for the resulting image. You can pan around with the mouse or use slider controls for Pan, Tilt, Field of View (zoom), and Rotate. Then you save your work as a standard 2D photo in the format of your choice.

Remove Tripod switches your view to facing down, where a tripod normally would appear. You select the tripod with a circle, a free selection tool, or a square, and then apply Magic Fill to match the surrounding terrain. The Panorama option is mostly just a crop tool—it didn't convert the image to a natural looking panorama, as the Straighten tool does.



One minor annoyance with the 360-degree editing window is that hitting Cancel after one operation takes you out of the editor. I often wanted to switch from, say, Straighten to Panorama, but I had to start over instead.

BASIC PHOTO CORRECTION

PaintShop Pro has auto-correction, along with tools including a histogram with lighting and color controls. The One Step Photo Fix (available in all editing workspaces) corrected lighting problems in many of my test photos. The Smart Photo Fix dialog gives you a lot more control. You can click a neutral spot to correct the white balance and use a Levels slider to balance a lopsided histogram. Smart Photo Fix also shows before and after views so you can see the results of your adjustments and edits.

PaintShop's Effects menu goes leagues past the familiar Instagram choices, but it does offer Instant Effects that mimic those. The Time Machine tool lets you see how your photo would look if taken in 1839 through 1960. There are lots

and lots of effects—Artistic, Film, B&W, scene lighting, and more. Clicking on an effect, shows a preview of the selected effect side by side with your original image. If the slew of effects isn't enough for you, you can download even more.

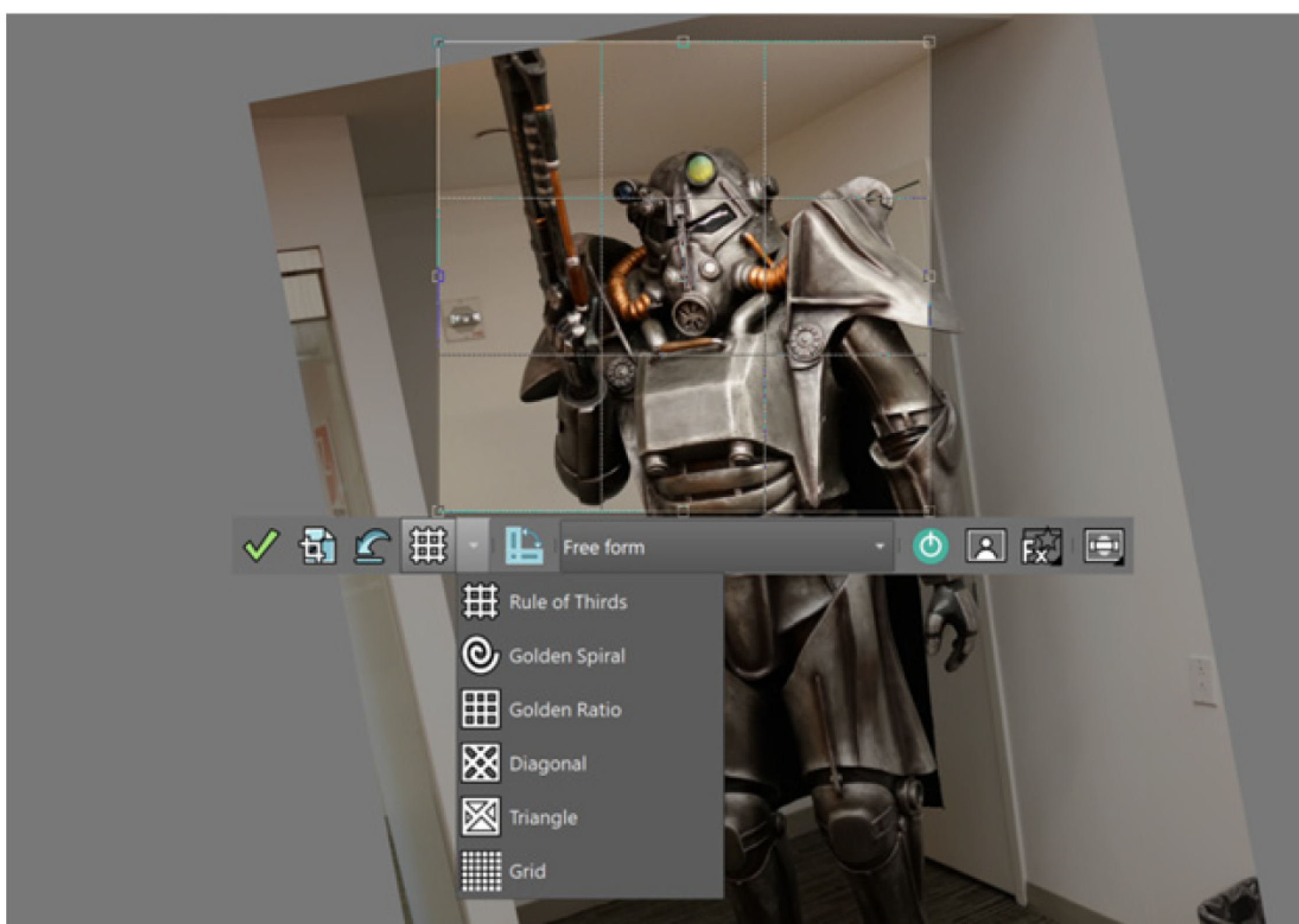
Another gap is the lack of control over the effects. Sometimes you want to tone it down a bit, as I found with the Instant Film effect. Photoshop Elements' instant effects are adjustable, but PaintShop's aren't. Of course, you could fuss with the image using the app's other adjustments for lighting and color, but it's nice to have a slider that simply controls the effect's strength, as even Instagram does.

CROPPING IMAGES

The most commonly used photo editing tool by far is the crop tool. It may seem that there's nothing to it, but Adobe has supercharged Photoshop's crop tool, even adding AI-powered auto-suggested cropping (now also found in Photoshop Elements). Corel's tool gives you a better idea of your final result by darkening the rest of the image. It offers overlays for composition guides, including golden spiral, golden ratio, and rule of thirds. When you rotate with the tool, the crop box stays put while the image rotates, so you can see the result without tilting your head.



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These overlays are more than Elements offers (it lacks the golden spiral, for example), and that program rotates the crop box instead of the image. But Elements adds some cool-cookie cutter crops such as hearts and animal shapes, and Adobe's cropping tools generally feel more responsive and precisely controllable than Corel's.

My favorite option on the Crop toolbar—not found in Photoshop—is the Crop as New Image choice, which instantly creates another image using the crop. The 2020 update added a blur grid for the depth-of-field tool.

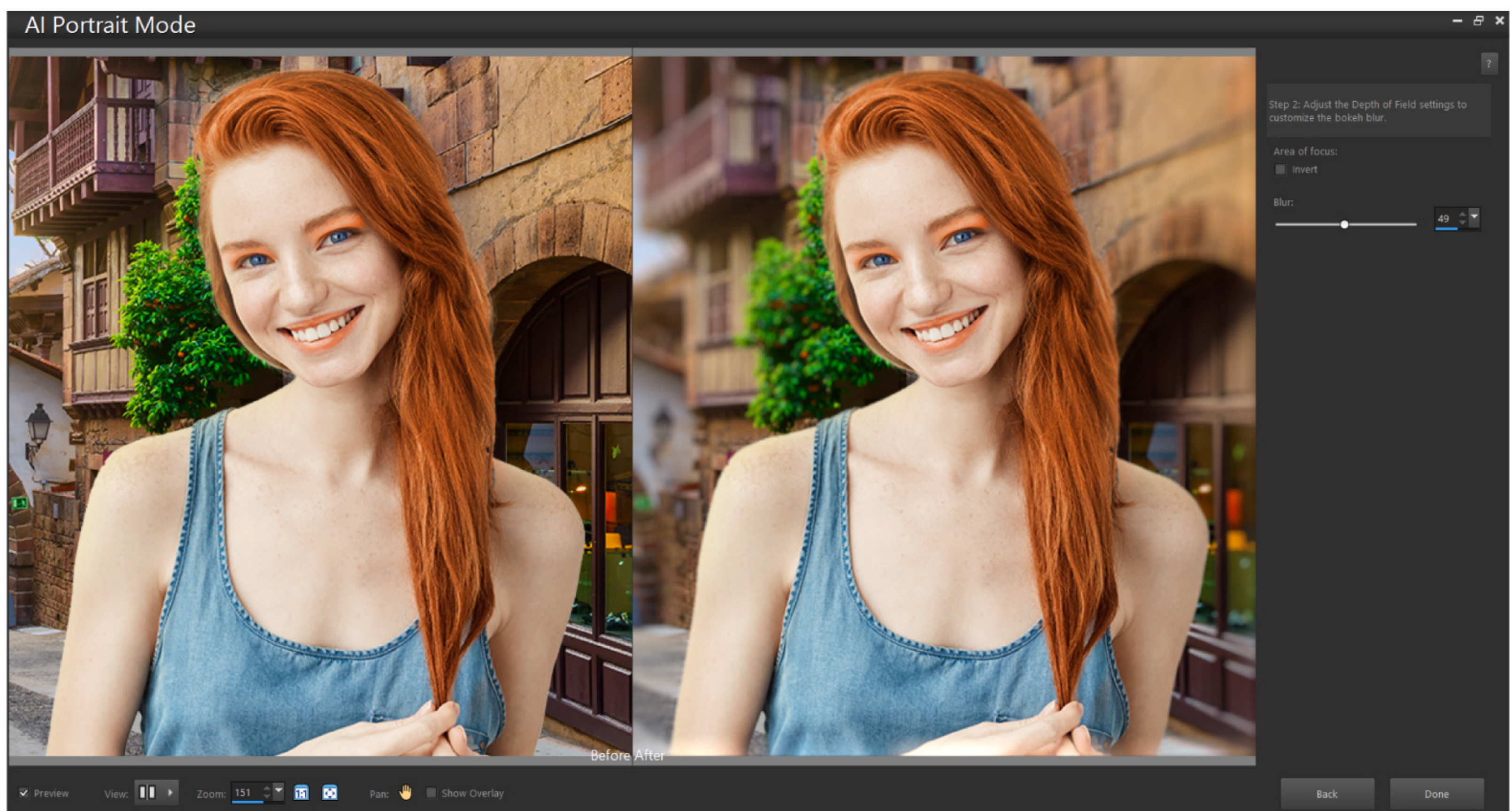
COOL IMAGE EFFECTS AND TOOLS

Let's take a more in-depth look at a few of PaintShop Pro's newer, cooler tools, many of which employ AI machine learning. I'll look at the newest of these that arrived in the 2022 version first.



AI Background Replacement. Replacing a photo's background used to be a many-step, hit-or-miss process in Photoshop. That program and PaintShop have both flipped the script, making it a one-click affair. The AI Background Replacement tool in PaintShop works with human subjects, while Photoshop and Skylum Luminar now have tools for changing background skies in landscapes, too. The latter is still missing from PaintShop.

AI Portrait Mode. I was expecting AI face manipulation tools like those in ON1 and Photoshop, but this tool is really just for selecting a subject and adding background blur. It works much like the iPhone's Portrait mode. The quality of the result depends on the accuracy of the selection. The selection wasn't perfect for my test shot, but luckily you can tweak it. Since the effect is simulating lens bokeh, it's interesting that you can choose between round and hexagonal apertures. I found that using the latter with less feathering worked best.



Frame Tool. This is like a collage tool, though it doesn't include preset layouts into which you can drop photos and other kinds of images. It's more of a custom frame tool that handles layer groups for you. After tapping its toolbar button, you draw rectangles and ellipses and then drop the images onto them. Then, the tool creates the appropriate layer groups automatically. If you're looking for totally pre-designed frames, head to the File > New from Template menu option.

AI Denoise. This tool assuages one of my peeves about photo editing—having to fiddle with multiple sliders to remove noise. The Corel tool analyzes the image, and though this takes time, the result is impressive. You can drag the background around to position it to taste.

AI Upsampling. We've all had to deal with an image that was just too small or low-resolution for the purpose at hand. This tool does a remarkable job of

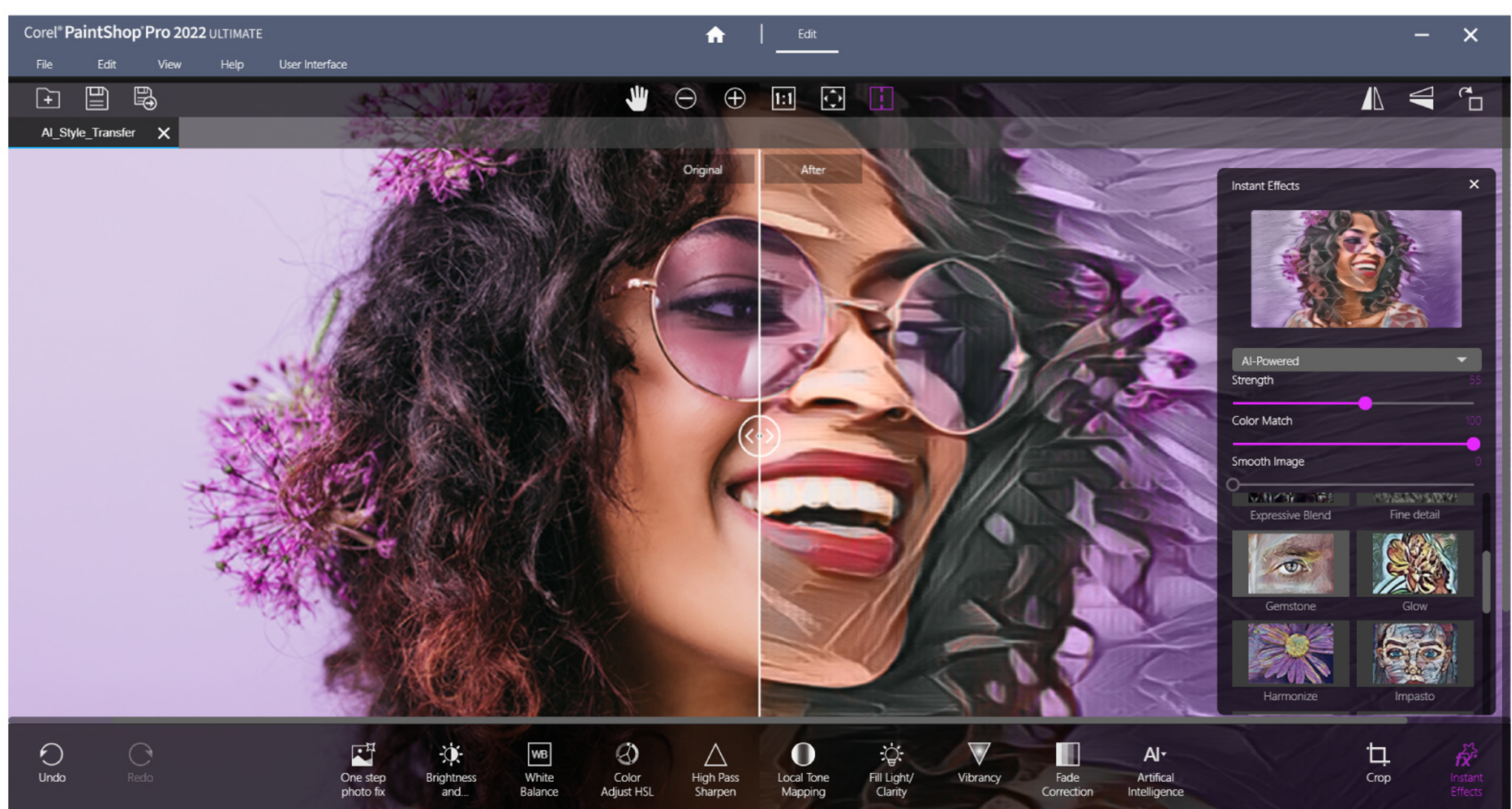
removing that blocky effect when you enlarge such photos. The tool offers denoising at the same time, but I was able to get this result without using any. Photoshop offers several sampling options for enlargement, but when I used them on the same image, none of them produced as good a result.

AI Artifact Removal. Designed particularly for JPG image compression, this tool seems to use similar technology to the AI Upsampling tool above. Like AI Denoise, this is a one-click tool that shows a creative full-screen animation while it's working. In my testing, the tool worked with only one kind of distortion—blocks resulting from JPEG compression.

AI Style Transfer. This is an effect that an earlier version of PaintShop called Pic-to-Painting. It's available only in the minimalist Photography workspace along with other effects in an Instant Effects panel. These effects resemble the Prisma-app craze of a few years ago and have appeared in many photo apps, notably the competing CyberLink PhotoDirector. They use AI technology to generate art from your photos that resembles the work of specific painters, such as Picasso or Van Gogh.

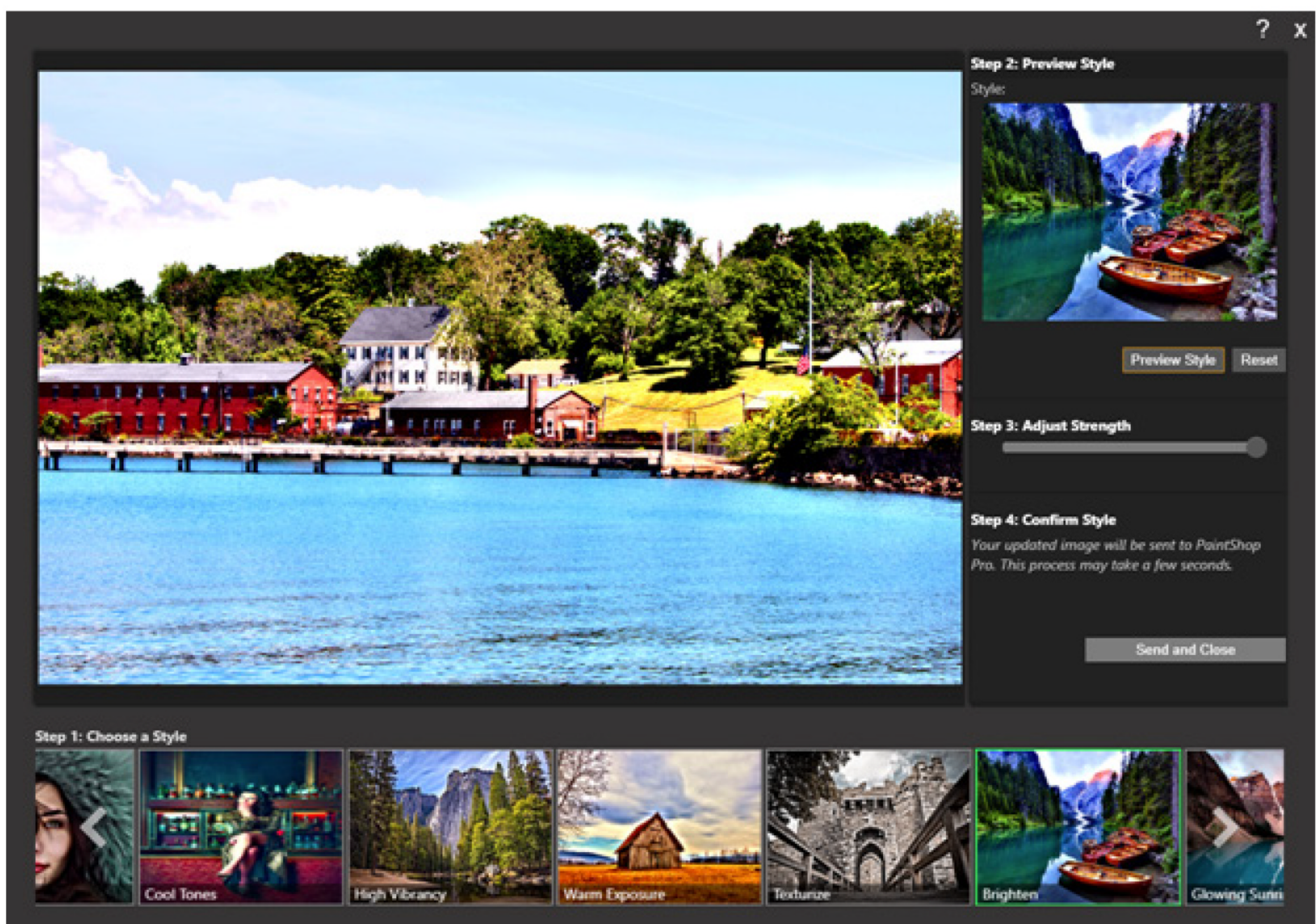


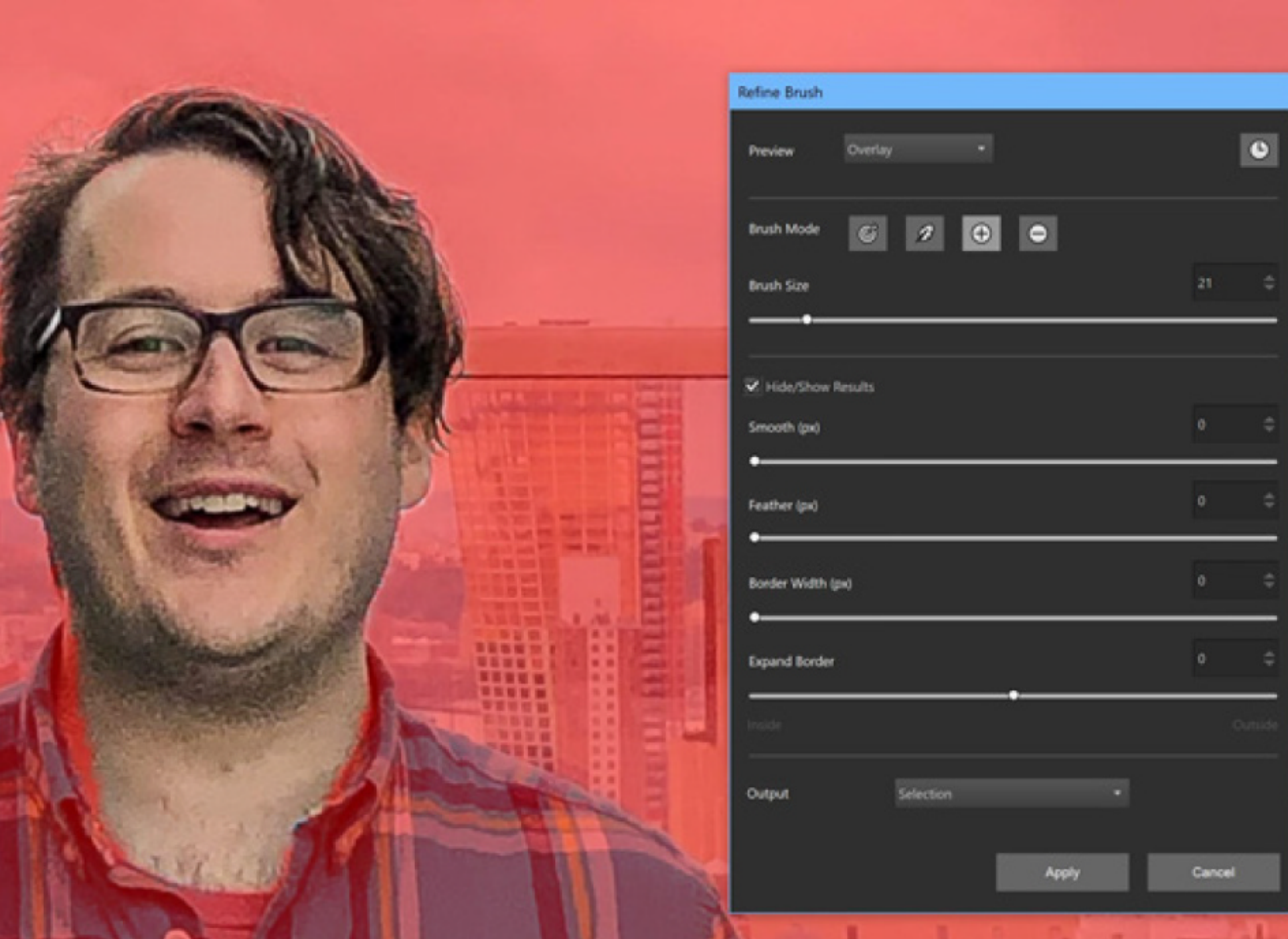
Like AI Denoise, this is a one-click tool that shows a creative full-screen animation while it's working.



Sea-to-Sky. This module looks exactly like the Photography workspace, but it starts by showing just four buttons: Corrective, Scenic, Low Light, and Creative. It's available only at the Ultimate level. Pretty much every option improved my underwater film shot, even though the effects don't specifically say "This one is for underwater, and this one is for drone shots." A drone shot I tested with was less successful—the effects were mostly just applied to the objects on the ground, not to the sky. It did a decent job of a hazy drone shot, though some color cast was added.

AI HDR Studio. This tool is available only with the Ultimate edition of PaintShop Pro. Corel decided not to fully integrate it with the outer program. It's only accessible as a plug-in from the **Effects > Plug-ins** menu, and its interface design is different from the rest of the program. It lets you do single-shot HDR effects, though the program supports traditional multi-shot HDR as well. As with AI Style Transfer, you simply choose a look from a selection of 16 sample thumbnails and adjust the effect to taste. For me, the effects are somewhat extreme, but drawing down the strength slider can get you a more realistic enhancement.





ADVANCED PHOTO EDITING

Once you move into Edit mode, the full assortment of tools comes into play. Just as in Photoshop, you can add layers, manipulate grouped objects, and adjust curves and levels. Layers are much better done than in ON1 Photo Raw, with a more Photoshop-like, clear view of each layer in an optional panel. You can create Vector, Raster, Art Media, Mask, and Adjustment layer types, with all the blending modes you'd expect.

The Curves tool is particularly powerful—it allows up to 16 control points, which let me create some crazy effects. The Retro lab makes up for Instant Effects' lack of adjustability in a big way. It lets you adjust blur, diffuse, glow, color, and more.

Two selection tools, Smart Selection and Auto Selection, are similar to Photoshop's magic wand. The first did a decent job of letting me brush to create an edge-detected selection. But the Auto Selection is more impressive. You draw a box, and the tool selects an object inside it. In my testing, this only worked with very uniform backgrounds (a clear sky, for example) and objects with well-defined edges. Still, it's a useful tool for plucking a head off and using it against a different background. In the right circumstances, it works quite well.

The Refine Brush tool can fine-tune any selection you've made. It's effective on difficult subjects like hair or tree lines. After you make a selection, a Refine Brush button appears at top right. This opens an adjustment panel that lets you set the tool's size, smoothness, feathering, and border. You can show a red, black, or transparent background to better see your selection. When you're done, output options include selection, mask, new layer, and new mask layer.

Content-aware object removal and moving is a recent addition. This lets you improve composition by moving or removing an object within a photo, often a human, while maintaining the background.

The Smart Clone tool lets you choose a shape from the top toolbar to select an area for cloning, and then choose a blend mode (Blend, Original, or Black and White) to determine how the cloned image will appear when you stamp it on something else.

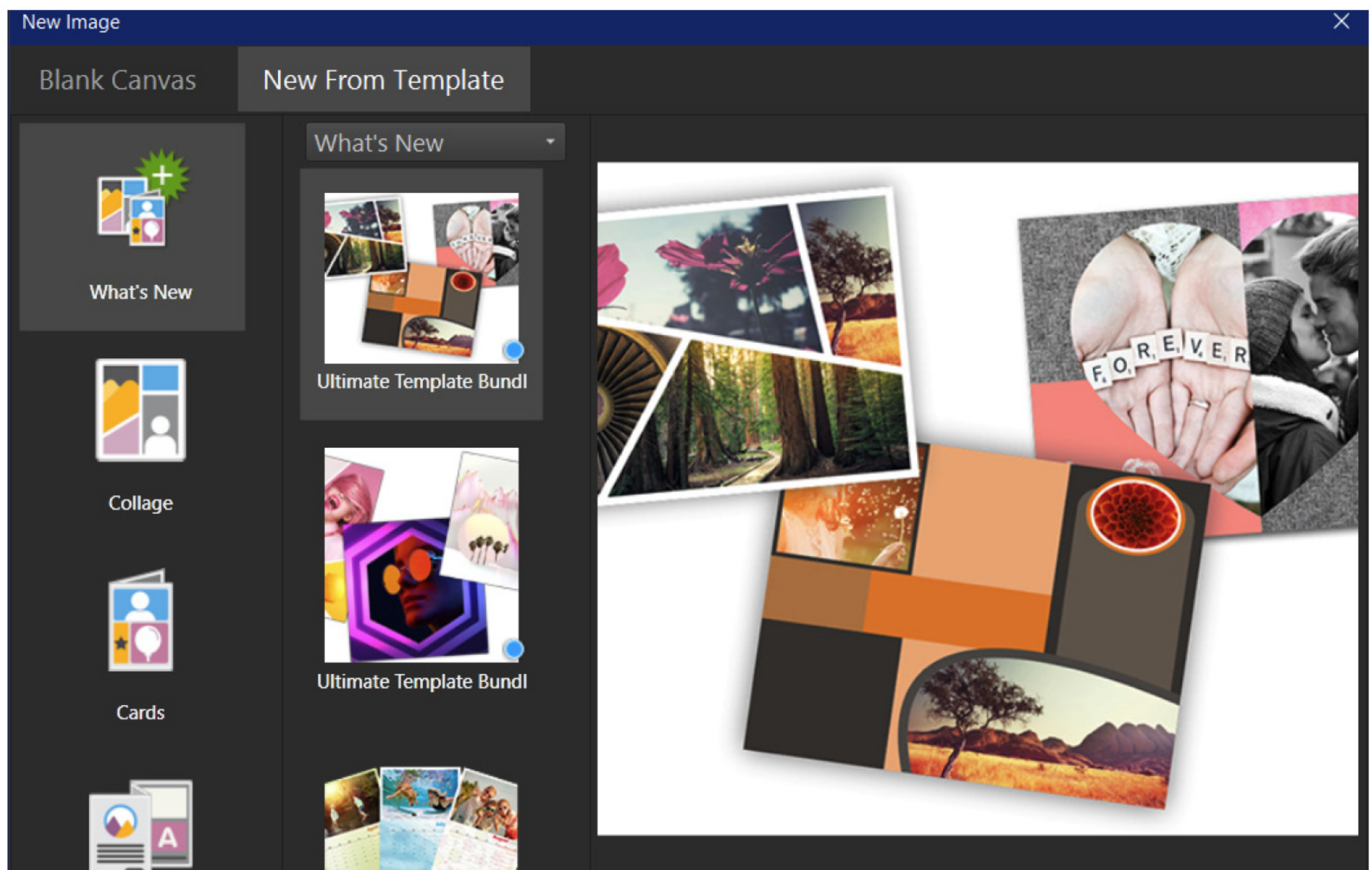
PALETTES, BRUSHES, AND GRADIENTS

For creative types, PaintShop Pro offers more reasons not to pay Adobe monthly subscription fees, with its many color palettes, brushes, gradients, picture tubes, and textures. These are accessible from the Materials panel and editable in the Materials Properties dialog. You get patterns and textures as well as gradients, and you can download more from Corel. It's at least as good as what you get with Adobe Photoshop Elements, but not quite as infinitely tweakable as Photoshop.

One cool capability in PaintShop is the ability to create your own custom brush tips. I used a small image of the flag of Canada for this. Another capability that will be welcome to users of graphics design software is the program's support for vector graphics, including SVG files (import only). You can even mix vector and raster image layers in the same file. But don't expect all the dazzling tools you get in Adobe Illustrator, such as the Puppet Warp tool for intelligently and automatically transforming drawing proportions and positions.

When you start Edit mode with a raw camera file loaded, PaintShop opens the Lab interface, which is a lot like Photoshop's equivalent Camera Raw window. Here you can not only change the white balance and recover highlights but also apply lens-profile-based corrections for chromatic aberration and vignetting. I'm not impressed with PaintShop's version of lens profile correction; I didn't see any correction of geometric distortion, and vignette correction overcompensated in some test photos. Chromatic aberration wasn't removed automatically, but the program has a good tool for this in the Complete Editing interface. Most lens profile correction depends on people creating the profiles, so it's not an exact science.

Some of the adjustments in this part of the program—particularly noise reduction and Balanced Highlight Recovery—are still slower than the equivalents in Lightroom and Photoshop. In recent releases, Corel has made an effort to speed up a lot of the program’s most common functions and in its startup time, and it does feel more responsive.



MORE HELPFUL TOOLS

Project Templates. PaintShop’s templates are a boon to non-designers who just need to create a card, collage, or brochure. They’re really just predesigned layer groups, into which you drag your own images. The downside is that many cost a few bucks, though some are free.

Screen Capture. I usually use Shift–Windows key–S for my screen capturing with the Snip & Sketch tool. Corel’s lets you use a hotkey and a timer delay, which I consider essential, but unlike SnagIt’s, it doesn’t work in the background. You have to open the program and tell it to prepare to take the screenshot. It offers several capture styles, including one that lets you select the rectangular area you want to shoot with the mouse.

Text Tools. Entering text was delay-free in my testing. Text capabilities include superscript, subscript, and justification. The nifty Paste-to-Fit option lets your text match a shape in your image. You can hollow out text and create raster cutouts, which is a powerful effect. But for really impressive font work, PaintShop can't compete with Photoshop, which lets you mess with the actual character shapes using glyphs and apply effects like 3D extrusion.

Windows Stylus. PaintShop Pro supports Windows Real-Time Stylus (WinRTS) and WinTab-based devices, such as the pen that comes with the Surface line of convertible PCs. I tested this on a Surface Book, and I was able to draw, complete with pressure sensitivity. You can also use the pen for any menus and settings.

OUTPUT AND SHARING

From Edit mode's File menu, you can export to all the expected formats; JPEG, GIF, and PNG optimizers and an image slicer are useful extras for web producers. Printing options abound, too, with CMYK separations, and standard layout presets.

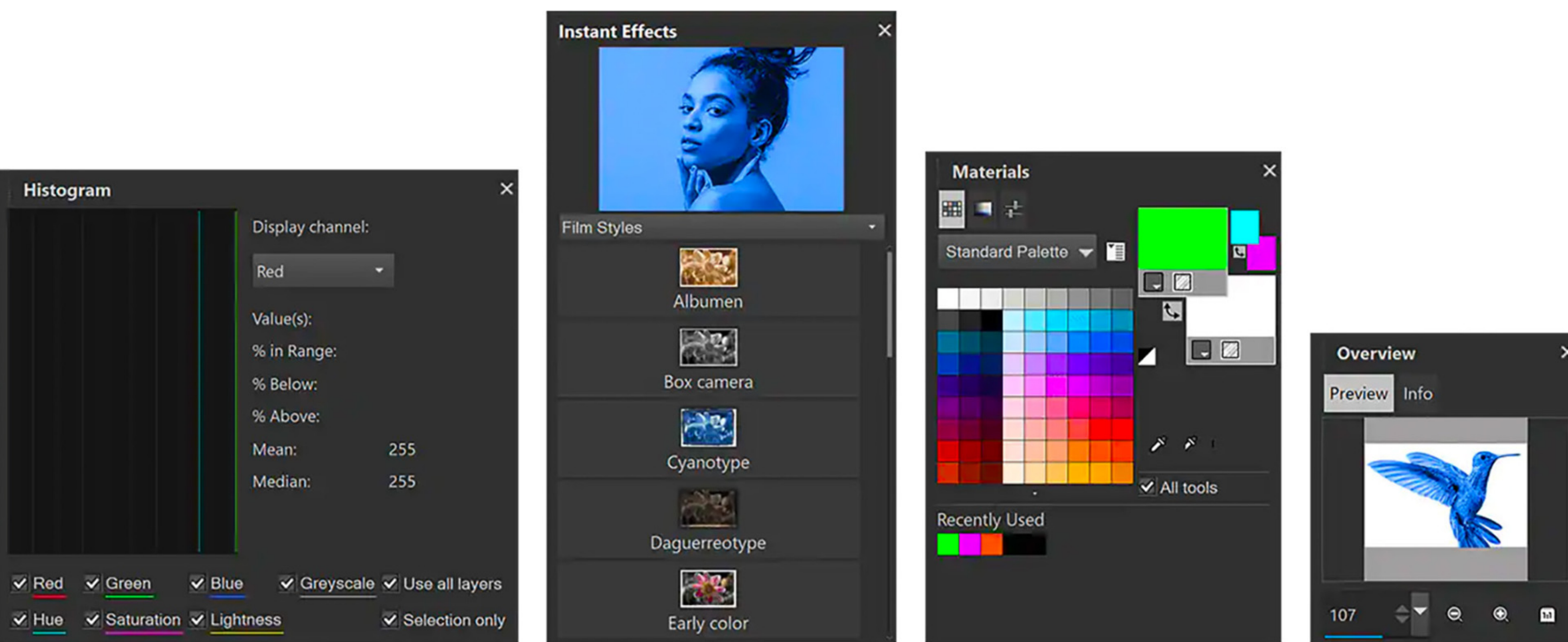
For online sharing, PaintShop can open your email client and attach your image. Corel has removed the direct social sharing features since the social networks keep changing their APIs.

Help and tutorials for the application are worthy of mention. The help section has moved to the web, so you can't access it if you're working offline. But it covers every feature in the app and lets you easily find the topic you're looking for. Video tutorials do a good job of showing you how to use all the new features and perform popular edits, and a Learning Center panel takes you through features right in the program.



**Entering text
was delay-free
in my testing.
Text
capabilities
include
superscript,
subscript, and
justification.**





A FULLY STOCKED SHOP

Corel PaintShop Pro is a high-bang-for-the-buck Photoshop substitute, requiring no monthly subscription. The app gets points for its sheer number of tools, many of which acceptably mimic their Photoshop counterparts—even some advanced tools like content-aware move, gradients, and effect filters. PaintShop also lets you create and edit both raster and vector images, which requires two Adobe apps.

For photographers less interested in visual arts and crafts, our photo workflow Editors' Choice winner, Lightroom Classic, is a better choice. Adobe Photoshop Elements (\$99.99), our Editors' Choice pick for enthusiast photo software, offers many of Adobe's unmatched photo-manipulation tools and a great selection of guided edit effects. Because it still is the state of the art, Photoshop remains PCMag's image-editing Editors' Choice winner, but Windows-using pros who need that program's more common tools are likely to be satisfied with this budget option.

FEATURES

An aerial view of three mobile network cars racing on a track. The cars are white with red and blue stripes, blue with white stripes, and red with white stripes. They are moving from the top left towards the bottom right. The track has yellow and red lane markings. The background is a dark, blurred landscape.





FASTEST MOBILE NETWORKS 2021


BY SASCHA SEGAN

For our 12th annual drive test, we traveled over 10,000 miles, speed-testing AT&T, T-Mobile, and Verizon 4G and 5G networks in cities, towns, and rural regions all over the US. We found a radically new landscape—and a surprising winner.

It's T-Mobile's year at last. T-Mobile's new mid-band 5G network is the only nationwide 5G that's markedly faster than 4G, earning the carrier its first-ever PCMag award for America's fastest mobile network.

In our 12th annual test, our drivers traveled a total of 10,626 miles, surveying 30 major US metro areas and six rural regions to find out the state of 5G from AT&T, T-Mobile, and Verizon. T-Mobile took a commanding lead in 5G, winning 24 cities and rural regions to AT&T's eight and Verizon's two; we also saw one tie between T-Mobile and Verizon and one tie between T-Mobile and AT&T.

	 AT&T	OVERALL WINNER  	
DOWNLOAD SPEED			
Maximum (Mbps)	1090.9	1134.4	2216.7
Average (Mbps)	98.1	162.7	93.8
% Above 25Mbps	78%	72%	70%
UPLOAD SPEED			
Maximum (Mbps)	89.5	140.5	102.8
Average (Mbps)	21.1	28.3	21.6
% Above 3Mbps	83%	81%	80%
AVERAGE LATENCY (ms)	27.7	28.2	25.4
NETWORK AVAILABILITY	97%	95%	97%
SPEED SCORE	89	96	86

 **FASTEST MOBILE NETWORKS 2021**

Why go to all this effort? Because people need to choose smartphones and carriers, and the best choice for you depends heavily on where you are.

Almost every adult American now has a smartphone. According to Statista, there were just about 294 million smartphone users in the US in 2020; for comparison, that year, the US Census estimates there were 258 million adults in the country.

All of those phones have to connect to networks. Since the merger between T-Mobile and Sprint, we now have three giant players in the US. All of them are slapping up billboards promoting their 4G and 5G networks with words like “biggest,” “fastest,” and “most reliable.” Back in 2010, as smartphones started to become popular, we began our independent gauge of the mobile networks to help people choose carriers based on facts, not ads.

Since then, plenty of other tests and awards have cropped up. They all have their advantages. Ours are consistency and transparency. We use the same devices, in the same places, at the same times, to make sure the network is the only difference. Then we tell you exactly where we go to run our tests, down to the neighborhood, and what we did there. Sometimes we even tell you what we had for dinner. We want to help you make a carrier choice you feel confident about, based on solid local data.

This year, for the first time, that choice is likely to be T-Mobile. T-Mobile’s winning secret isn’t much of a secret: It’s mid-band spectrum, which T-Mobile calls “ultra-capacity” 5G. Now covering more than 165 million people in cities large and small, these airwaves (bought with the Sprint acquisition) let T-Mobile’s network give consistent results between 150Mbps and 500Mbps of download speed. That’s far better than AT&T and Verizon’s 5G can do in most areas, and it secured T-Mobile’s win.

Faster download speeds signal more capacity on a network. T-Mobile’s widespread added capacity has also let it launch Magenta Max, the nation’s first truly unlimited, no-deprioritization 5G plan, and its \$60-per-month unlimited home-broadband service.

If you’re a T-Mobile customer and not seeing results like these, it’s probably for one of two reasons. First, to get on T-Mobile’s new wild ride, you need a 5G

phone; T-Mobile 4G still falls short of the competition. Looking at 4G-only results, AT&T dominated nationwide as surely as T-Mobile did overall. If you're using a 4G phone, then your T-Mobile service will likely be unremarkable.

And if you're out in the countryside and don't often head to the city, T-Mobile might not be the best carrier for you. It's doing great in the nation's biggest metro areas, but in small cities and areas away from interstate highways, especially in the western US, it's clear that T-Mobile has to do more work to get better coverage. In those regions, once again, AT&T dominated.

The map below shows everywhere our drivers went this year, from sea to shining sea.



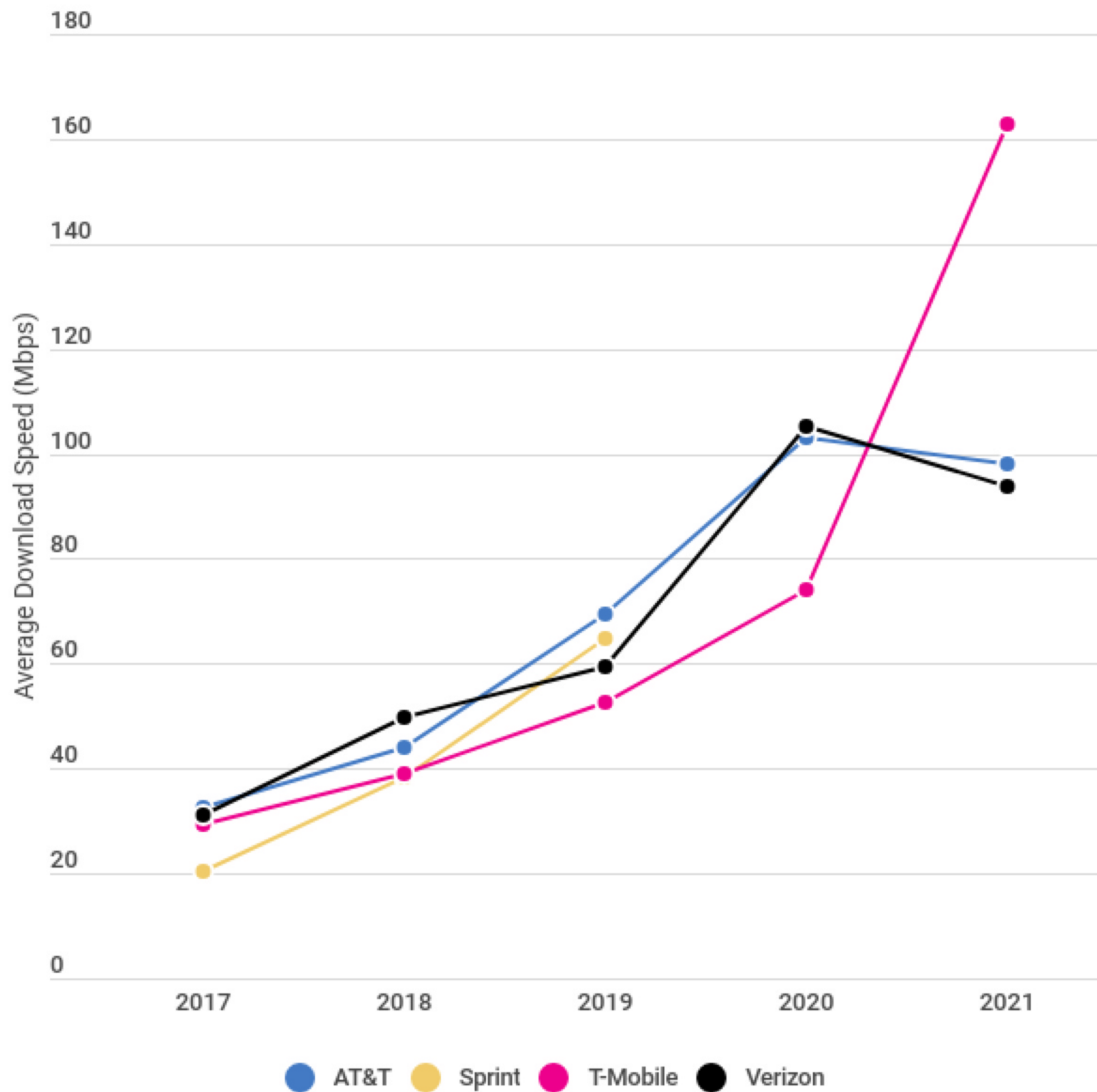
T-Mobile's winning secret isn't much of a secret: It's mid-band spectrum, which T-Mobile calls 'ultra-capacity' 5G.



T-MOBILE SKYROCKETS, OTHERS FLATLINE

If you haven't upgraded your phone or looked at your plan in the past few years, you're going to be blown away by how different the world is in 2021.

Download Speeds Over Time in PCMag Tests



To put it simply: T-Mobile was behind the competition when using 4G and low-band 5G. Then mid-band completely changed the game, *just in the past year*.

T-Mobile's Mid-Band Milestones

The carrier's win this year came entirely from its mid-band 5G network. Here's what you may have missed in the past year.

April 2020: First mid-band 5G networks launch in Philadelphia and New York.

July 2020: Our Fastest Mobile Networks 2020 tests don't find much mid-band 5G.

October 2020: The mid-band network reaches more than 400 cities.

July 2021: The network now covers 165 million people. We run our Fastest Mobile Networks 2021 tests.

May 2020: Mid-band tests in NYC show speeds over 1Gbps, but coverage is still spotty.

September 2020: T-Mobile expands mid-band to 18 states.

April 2021: The network covers 125 million people.

Even in the cities it covers, T-Mobile 5G isn't everywhere. But it covers enough area in those cities to make a real difference, and coverage is improving every month. Our T-Mobile 5G phone made use of 5G in each of the cities and regions we tested—from 90% of the time in Chicago down to only 36% in New Orleans. (But T-Mobile still won in New Orleans, because 5G is generally sparse there.)

5G availability from the other carriers doesn't really matter—yet.

Verizon's millimeter-wave 5G is the fastest 5G in America. We saw peak speeds over 2Gbps on Verizon's network. But there just isn't enough Verizon mmWave to make a difference for most customers, and it's growing too slowly. Verizon says it's been expanding its coverage, but our tests found about the same amount of mmWave as last year: 3.27% of metro-area tests in 2021 compared with 2.82% in 2020. (We ran our tests in a somewhat different set of cities in 2020, due to pandemic restrictions on travel, so these numbers aren't completely comparable.)

Without any dedicated mid-band or low-band 5G airwaves, Verizon's "nationwide 5G" uses a technology called DSS (dynamic spectrum sharing) that borrows 4G channels to serve 5G. Last year, we found that it actually damaged Verizon's 5G performance, because the DSS system was inefficient and poorly configured. This year, Verizon worked out the kinks, and its 5G connections are generally slightly faster than its 4G ones. You don't need to turn off 5G any more, as we suggested people do late last year.

Verizon's overall speeds declined a bit from 2020 to 2021, though, possibly because of congestion. Nationwide, Verizon appears to have less capacity than



**Our T-Mobile
5G phone
made use of
5G in each
of the cities
and regions
we tested.**



the other two carriers at the moment, which might be why it hasn't joined T-Mobile and AT&T in offering truly unlimited plans. This just emphasizes how critical it is that Verizon go big with its rollout of C-band 5G next year.

AT&T's complex 4G network also doesn't have much of a 5G component. In most places, AT&T layers a slim channel of 5G on top of its 4G to give you that 5G icon. We also found tiny patches of AT&T mmWave coverage in some cities, but not enough to be notable.

AT&T won our 2019 Fastest Mobile Network award based on its excellent 4G network. It just barely lost in 2020 because Verizon's mmWave 5G gave that carrier a slight boost. In our 2021 tests, we found that AT&T's 5G network results were often slower than its 4G network, so we generally used its 4G results as its best-network scores. AT&T's 4G network is still excellent, but it didn't show real improvement in the past year.



A New Phone: Now or Later?

If you're on T-Mobile or Metro and you don't have a phone capable of accessing mid-band 5G, you should get one now. The good news is that every 5G phone sold by the carriers supports mid-band, and many of those phones are inexpensive. Anything from an Apple iPhone 12 or a Samsung Galaxy S21 all the way down to a OnePlus Nord N200 will access the best speeds on T-Mobile's network.

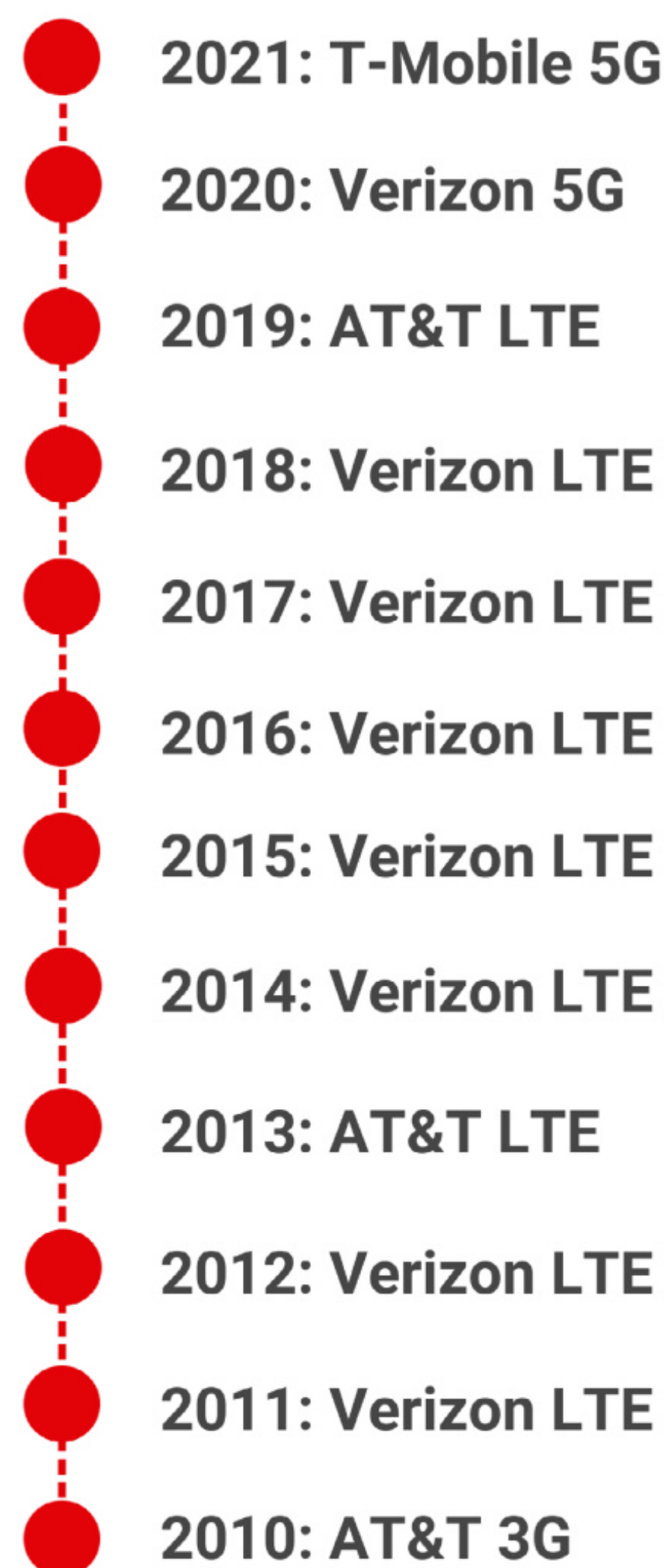
For those using AT&T or Verizon, the switch is less urgent. On both carriers, existing 4G phones will give you solid coverage and speeds nationwide. If you're buying a new phone anyway, though, make sure to get one that has C-band, the mid-band 5G system that could make a big difference for both AT&T and Verizon starting next year.

Why T-Mobile Won

In 2017, carriers placed their bets on the future of 5G. And T-Mobile placed the right one.

We saw something similar happen with 3G and 4G. AT&T dominated the 3G era because, unlike Verizon, it selected a globally standard technology (GSM) that had a solid advancement path. Verizon then pushed all its chips onto the table for 4G LTE and won our Fastest Mobile Network award almost every year from 2011 through 2018.

Fastest Mobile Network Winners



Then Verizon got distracted, or misled, by the promise of mmWave 5G in 2018. This wasn't entirely its fault; mmWave was what the FCC was selling at the time. But mmWave has turned out to have very short range and to be difficult to build out. It's a great network if you can get it, but you just can't get it very often. I've generally seen radiuses of 800 to 1,000 feet per tower with mmWave.

T-Mobile, on the other hand, had a smarter (and luckier) play. It bought Sprint to take advantage of that company's massive cache of largely unused mid-band airwaves and turned them all over to 5G. Since launching that mid-band 5G network in mid-2020, T-Mobile now covers more than 165 million people.

Though we couldn't tell mid-band 5G from low-band 5G results on T-Mobile, about 75% of our tests with T-Mobile 5G in metro areas showed speeds over 100Mbps, which is a good sign of mid-band. Mid-band is the 5G that makes the most difference for the most people. (T-Mobile has a little bit of mmWave too, but it doesn't make a big deal about that.)

Verizon and AT&T will have a chance to catch up. They both went in big purchasing C-band, mid-band airwaves similar to T-Mobile's, and those airwaves become available to use next year. They'll have to build fast to match T-Mobile's head start, though.

The two older carriers have a potential advantage over T-Mobile: backhaul. When I recently praised T-Mobile's excellent 5G performance in my own neighborhood, wireless watchers correctly responded that T-Mobile's airwaves are capable of much greater speeds, but they're restricted by the fiber going down into the internet from T-Mobile's towers. AT&T and Verizon, which are landline ISPs, own many fiber lines; T-Mobile doesn't. So AT&T and Verizon need to add airwaves to their fiber networks, and T-Mobile needs to improve its fiber connections to make the most of its airwave advantage.

A DIGITAL DIVIDE

In our scoring, only 40% of the rating is for absolute speed. The other 60% goes to various measures of reliability, including whether a network hits certain minimum performance thresholds and whether it's available at all. On that front, things become a little more complex for T-Mobile.

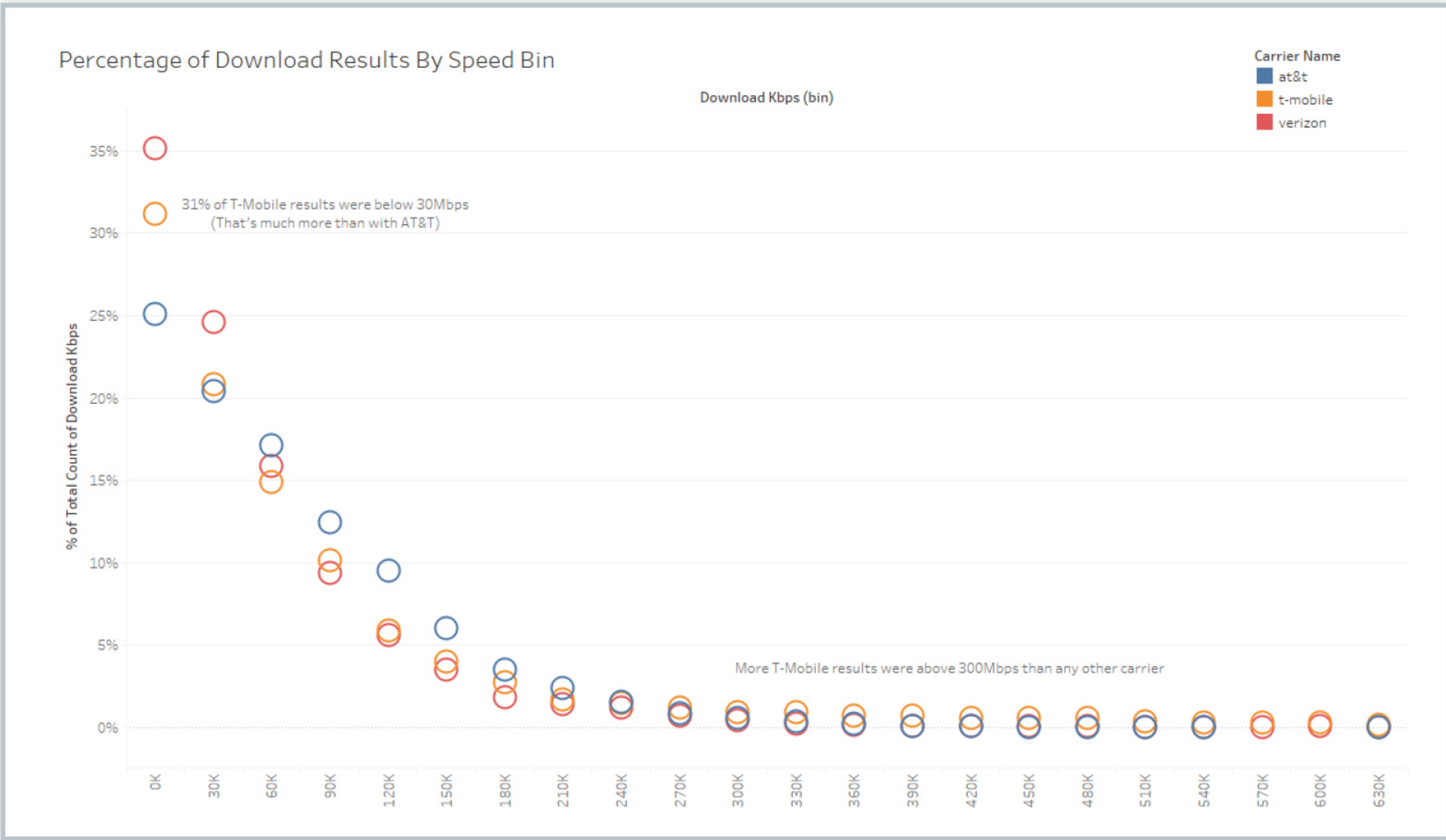
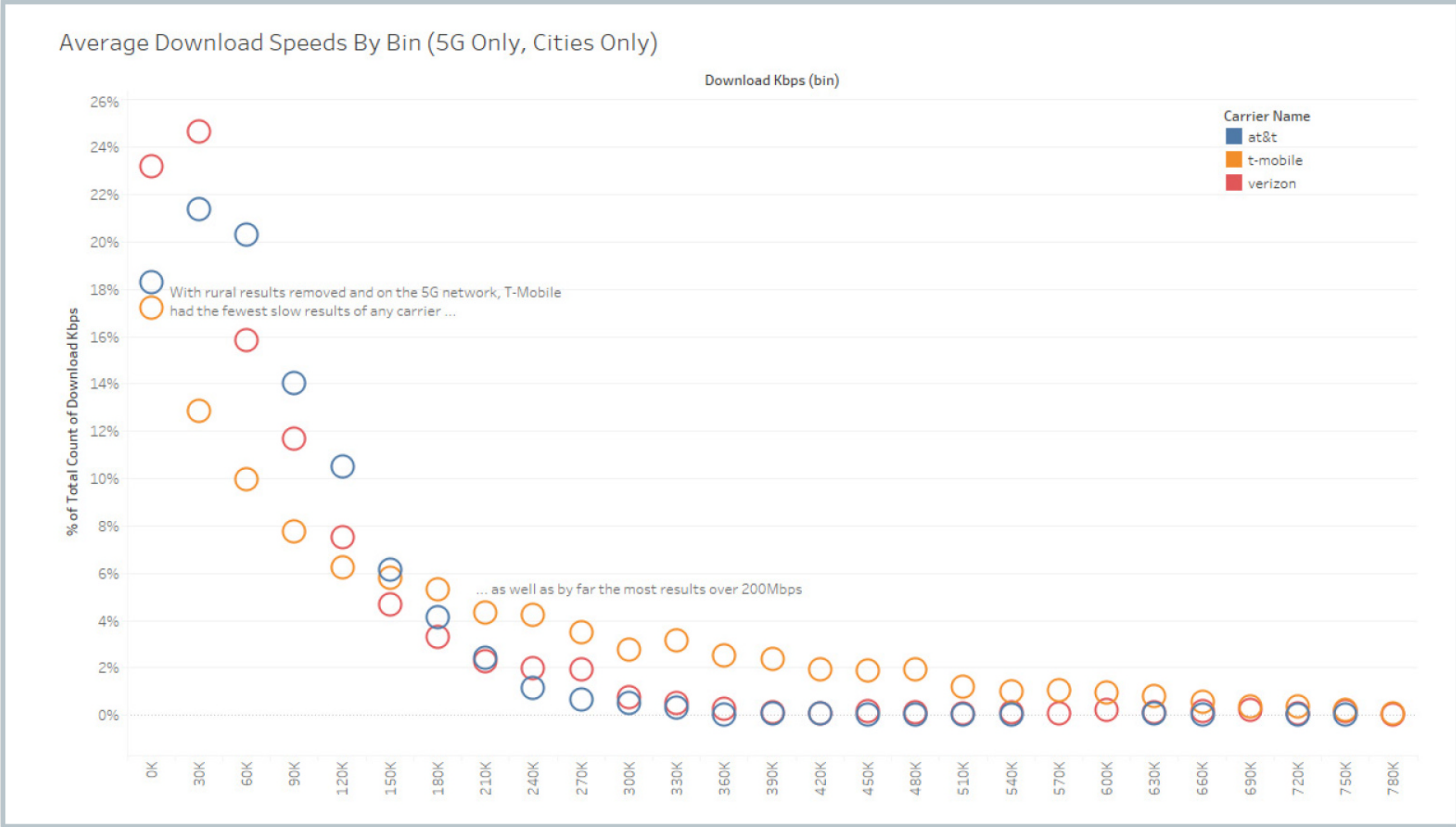
T-Mobile showed the highest percentage of fast results (270Mbps to 700Mbps). But it also showed a higher percentage of slow results (0Mbps to 30Mbps) than AT&T did.



Verizon and AT&T both went in big purchasing C-band, mid-band airwaves similar to T-Mobile's.



Pulling apart some of the variables here shows what T-Mobile needs to do. The gap is primarily on 4G results and shows up most outside of cities. If we look only at 5G results in the 30 cities we visited, T-Mobile’s weakness goes away.



The charts above show what percentage of our tests were, essentially, slow versus fast. Looking only at 5G tests in our 30 core cities, T-Mobile had the fewest slow results of any carrier, as well as by far the most results over

200Mbps. But when we included all tests (both 4G and 5G) and the rural areas, T-Mobile had far more tests below 30Mbps than AT&T did, although it also showed more results over 300Mbps than any other carrier.

In a July 27 blog post, T-Mobile president of technology Neville Ray said the carrier is headed for 200 million people being covered by its higher-quality “ultra-capacity” 5G network by the end of this year. That’s still only 60% of the US population, though. The rest will be covered by T-Mobile’s lower-speed low-band 5G network. In rural areas (where mid-band is less likely to be available), T-Mobile showed more slow-5G results than AT&T did. Closing that gap—making sure all T-Mobile users get the sort of performance that its 5G users in cities are getting—is key.

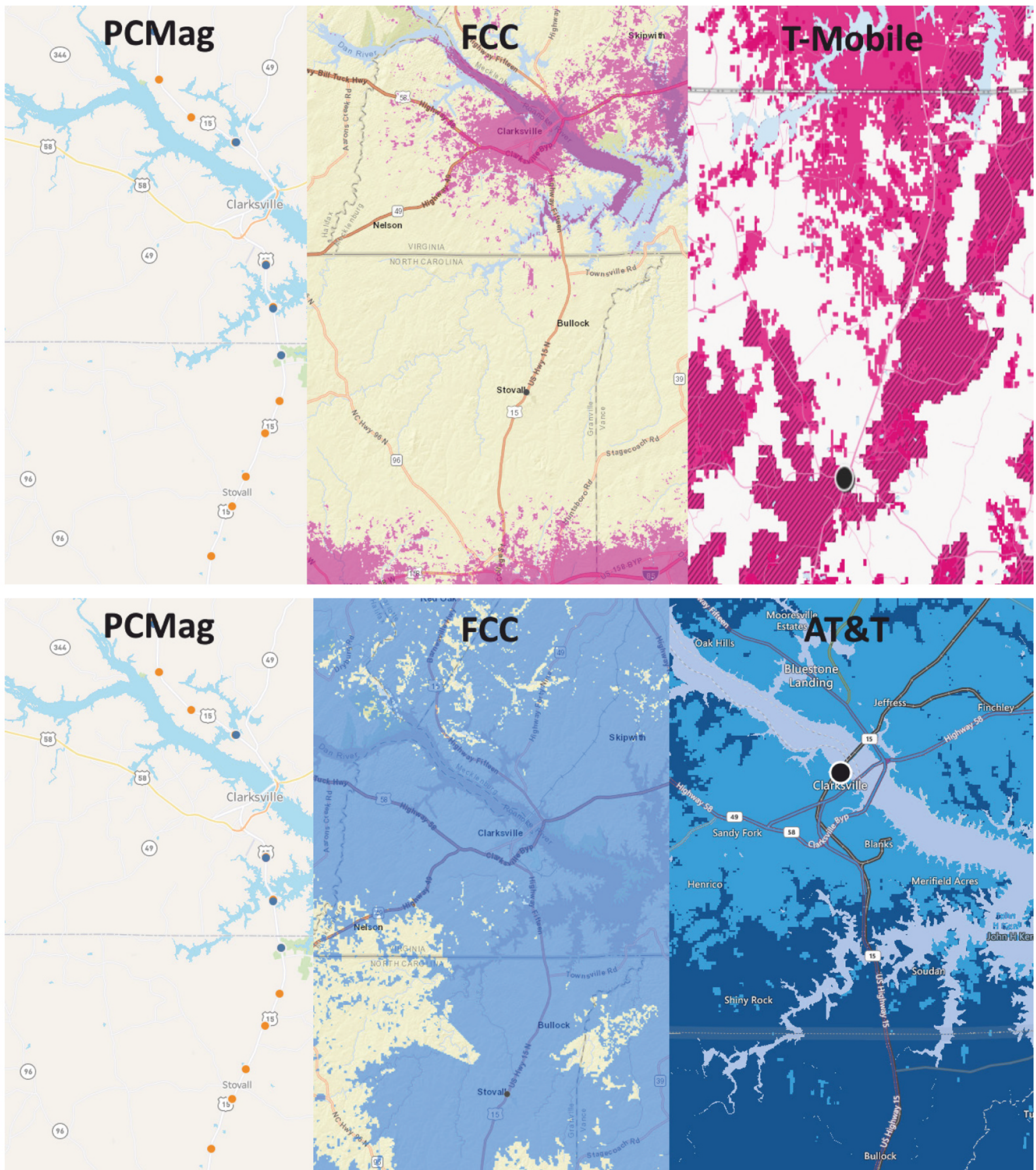
LOOKING MORE CLOSELY AT RURAL 5G

Our results focus primarily on large urban areas. About 17% of our score is devoted to results outside the major cities, which is pretty close to the 19.3% of the US population living outside major metro areas, according to the US Census. Of our 10,626 total miles traveled, 7,175 were outside major metro areas. The more rural the area, the better AT&T did and the worse T-Mobile did. AT&T won four out of six of our rural regions, particularly crushing T-Mobile on coverage in the Northwest and the Carolinas.

As we drove, we found that T-Mobile has done a good job of expanding coverage even to midsize cities and towns and along interstate highways. It’s in the rural stretches between the towns where T-Mobile still tends to fail.

The FCC recently released new independent coverage maps that provide a counterbalance to the official carrier maps. The two sets of images below show our own results compared with the FCC and carrier maps for an area around Clarksville, Virginia, and Stovall, North Carolina. On the left, the orange dots show T-Mobile dead spots, and the blue ones show AT&T dead spots.

The FCC’s map pretty much mirrors ours in terms of T-Mobile dead spots; T-Mobile’s map seems more optimistic. But the FCC’s and AT&T’s maps didn’t always reflect the dead zones we saw in AT&T’s network. This may be because AT&T network drops came from reasons other than pure coverage—network saturation, for example.



We also took a closer look at six smaller cities:

- Allentown, PA (pop. 120,905)
- Crescent City, CA (pop. 6,676)
- Laramie, WY (pop. 32,381)
- Lake Charles, LA (pop. 77,283)
- Rehoboth Beach, DE (pop. 1,606,
but visited by thousands in the summer)
- St. Augustine, FL (pop. 14,515)

SAMSUNG GALAXY S21

They ended up splitting between AT&T and T-Mobile. T-Mobile took Allentown, Rehoboth Beach, and St. Augustine—all along the Eastern seaboard—while AT&T took Crescent City, Laramie, and Lake Charles.

Network availability was dramatically lower in small cities and rural regions than in larger cities. Where all three networks were equally available, T-Mobile generally ruled. But in Laramie, for instance, T-Mobile's network covered only 51% of the area to AT&T's 71%, and in Lake Charles, T-Mobile had 90% coverage to AT&T's 100% coverage. When you can't get on a network at all, it doesn't matter how fast that network is. To win at the network-speed game in these regions, T-Mobile needs to keep putting up towers.

TESTING METHODOLOGY

To conduct our tests, we used a pair of Samsung Galaxy S21 phones on each network. The S21 is available for every carrier and supports all of the carriers' latest network technologies. For each pair, one phone was locked to 4G using the Samsung Band Selector app; the other phone was allowed to use 4G or 5G as available. The phones all had SIM cards supplied by the carriers, which don't slow their connections based on any kind of data cap. Each phone ran a speed test every two minutes. The 4G and 5G phones staggered their tests so two phones weren't hitting the same network at once.

We drove around 30 cities, stopping in at least 12 locations per city for 15 minutes each. To get results for our six rural regions, we drove on a mix of interstate highways and smaller roads.

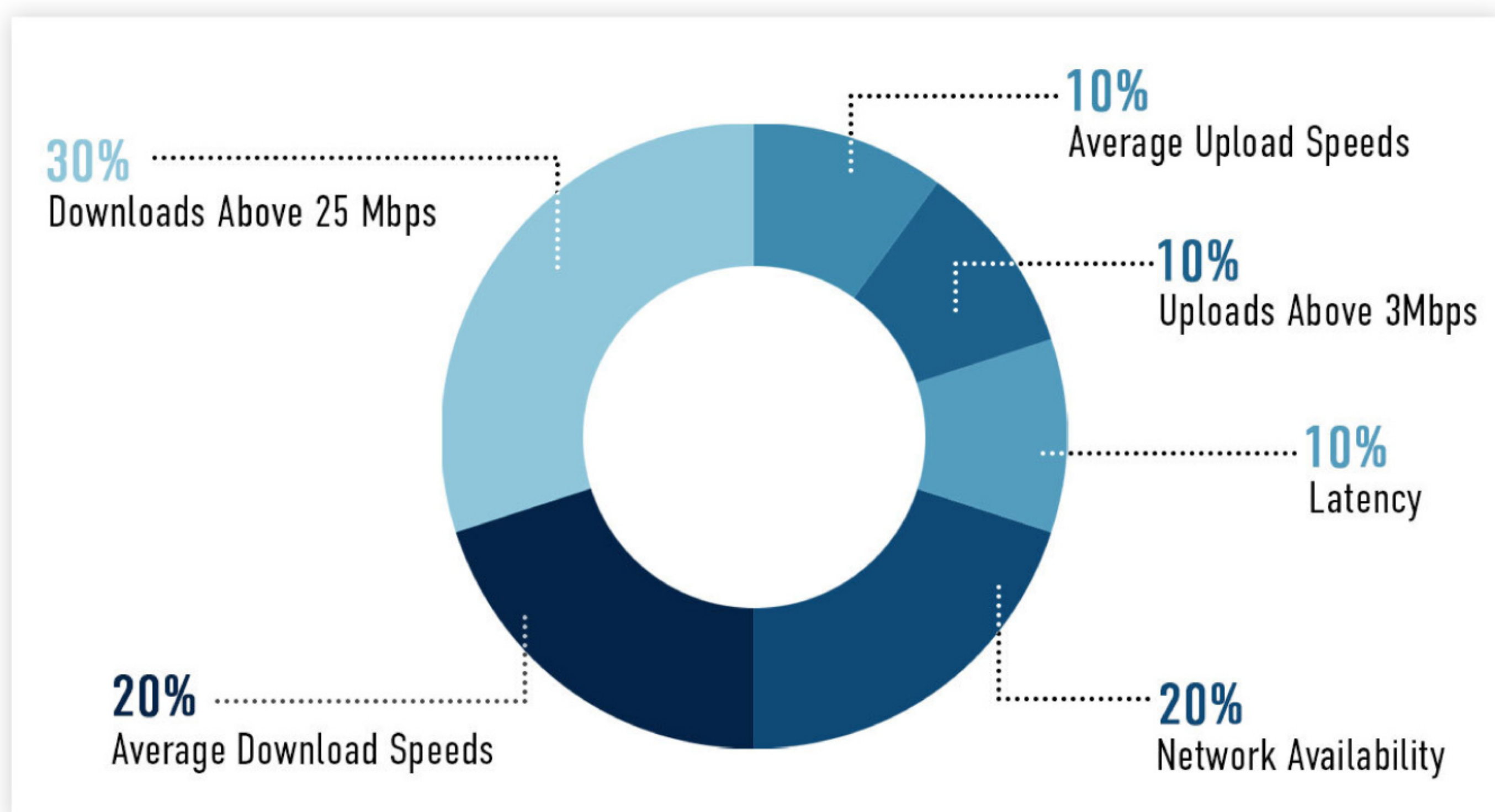
In analysis, for each test stop, we picked the best result between the 4G and 5G devices. With so much overlap between 4G and 5G and so many people still using 4G



phones, it doesn't make sense to ding 4G just for being 4G. Raw speed matters more than whether your phone has a 4G or 5G icon in the corner. Test results at each location were averaged into an overall result for that location. Then, results for all locations were averaged into an overall city score, with all of the traveling results collected between stops being averaged into two virtual "locations."

Consistent, usable data speed is more beneficial to the average consumer than spectacular peak speed. That's why 40% of our score is given over to whether data transfers consistently met the FCC's minimum threshold for broadband: 25Mbps down, 3Mbps up.

We used a weighted average with the following variables:



MID-BAND 5G IS THE FUTURE

I'm thrilled that T-Mobile has started to show its mid-band 5G coverage on its official coverage map, because it's clear that this technology is the future of 5G for most people. The carrier's range and capacity will only grow as it continues to build and add equipment, and AT&T and Verizon will have to hustle to catch up. The FCC could play a role, too, making more mid-band spectrum available for 5G networks.

We're going to keep paying attention to the rural-urban digital divide in coverage. Our rural regions had dramatically lower speeds than our cities did, and we saw regular dropouts in coverage in some of those areas, though we never did in the larger cities. As we speed along to new services and ideas, no one should be left behind.



REGIONAL WINNERS

NORTHEAST SUBURBAN/RURAL: T-MOBILE

This drive took us from Boston to Washington on a mix of interstates and state highways. In Connecticut, that included I-84, Route 8, and the Merritt Parkway; in Pennsylvania, I-80 and Route 29; and we added a jaunt to the Delaware shore and back across the eastern shore of Maryland. T-Mobile's 4G and 5G networks shone in this highly populated region, without the signal dropouts we experienced in other parts of the country. (AT&T had the least reliable network in the area.)

We took in two smaller cities along the way: Allentown, Pennsylvania, and Rehoboth Beach, Delaware. T-Mobile won in both cities with the best 4G performance of the three carriers.

T-Mobile isn't always this good in areas further north; in upstate New York, for instance, I've had trouble with T-Mobile coverage in the Finger Lakes region. But in the I-95 corridor, T-Mobile is the way to go.

SOUTHEAST SUBURBAN/RURAL: AT&T AND T-MOBILE (TIE)

This drive went from Washington, DC; to Raleigh, Charlotte, and Atlanta; and then to St. Augustine, Miami, and Tampa, using a mix of interstates and smaller roads. Hitting the smaller roads in this region was really important, because that's where AT&T's coverage advantage in the South becomes clear. T-Mobile just kept dropping out—on US-15 in southern Virginia, Route 49 in North Carolina, and Route 72 in Georgia.

T-Mobile's 5G network was faster than AT&T's and had good coverage when we were actually passing through towns. In St. Augustine, for instance, it was T-Mobile all the way, with massively better speeds than either of its competitors. But the rural signal dropouts hurt T-Mobile's score, and AT&T had much more consistent coverage, dropping out only occasionally. That led us to call it a tie.

NORTH CENTRAL SUBURBAN/RURAL: AT&T

Our journey took us from Detroit to Indianapolis, and then to Chicago, St. Louis, and Kansas City, using a mix of interstates and state highways. As we saw in our other rural regions, there's a split between T-Mobile (faster but less reliable) and AT&T and Verizon (more reliable but slower). In this region, AT&T's mix of reliability and solid speeds made it the overall winner. T-Mobile had some troubles on rural roads in Indiana and especially on a tricky stretch of road east of Jefferson City, Missouri. AT&T was considerably more consistent on those stretches.

SOUTH CENTRAL SUBURBAN/RURAL: AT&T

This drive took us from Kansas City to Oklahoma City, Dallas, Austin, Houston, and New Orleans, on a mix of interstates and (in Oklahoma) local roads. We also made a stop in Lake Charles, Louisiana, to test smaller-city performance.

As we saw in other rural regions, AT&T's reliability made the difference for the win. T-Mobile showed the best speeds, and if we'd stayed on the interstates, it might have won; but T-Mobile dropped out noticeably more than the other two carriers when we hit small rural roads around Ada, Oklahoma. AT&T's been

building a network in this area since the 1980s, originally as Southwestern Bell—the default phone company in Oklahoma and Texas—and can be relied on consistently.

Our tests found almost no 5G of any kind in Lake Charles. With 5G missing in action, AT&T's far superior 4G network was the clear choice.

NORTHWEST SUBURBAN/RURAL: AT&T

Our route took us from Seattle to Portland, avoiding I-5, then down the Oregon and California coasts, stopping in Crescent City, California. Later, we took I-15 up through Utah and I-80 across Wyoming with some side trips on non-interstate highways.

You won't be shocked to hear that cell phone coverage in a lot of these areas is abysmal. In Oregon, from Salem to Newport and Yachats, both T-Mobile and Verizon were weak. Between California's Crescent City and Arcata, and then on Route 101 from Fortuna down to Willits, all three carriers had issues. T-Mobile just gave up in a lot of Wyoming. AT&T did the best at providing consistent coverage across this region. It was also the fastest—but the Northwestern competition was primarily decided based on who had coverage at all.

SOUTHWEST SUBURBAN/RURAL: AT&T

Our drive here went from southern California across the desert into Arizona, past Yuma to Tucson, up to Phoenix, across to Lake Havasu City, and then to Las Vegas. AT&T is the fastest and most consistent network in this area, with best average speeds and the most consistent broadband experience.

Coverage-wise, Verizon and T-Mobile each had some trouble south of Havasu, AT&T died on a stretch of route 79 south of Phoenix, and T-Mobile was pretty useless in eastern Nevada. The three carriers traded off on locations where they failed, though, giving a less consistent region-wide measure of reliability than we saw in some of the other rural areas. With all three sharing reliability issues, AT&T's superior speed won the day.



CITY WINNERS

ATLANTA: T-MOBILE

Mid-band 5G made the difference in Atlanta, a city where all three major carriers are putting forth great network efforts. Atlanta was one of our best cities for millimeter-wave 5G. We caught mmWave on both Verizon and AT&T, with nine AT&T samples around Five Points peaking at 850Mbps and 23 Verizon samples throughout downtown, midtown, and Buckhead peaking at nearly 2Gbps.

But that availability was overwhelmed by T-Mobile's mid-band 5G. Of our 12 stationary test locations, AT&T had one strong test location with high 5G speeds, and Verizon had two. T-Mobile delivered average speeds over 200Mbps at four different locations, making it more likely that you'll get a 5G experience throughout Atlanta's sprawl with T-Mobile.

We were disappointed by AT&T's performance in Atlanta this year. AT&T is generally strong in the Southeast, but its 4G performance in particular seemed to be hitting some capacity issues.

AUSTIN: T-MOBILE

There's no question: T-Mobile is leading in Austin right now. T-Mobile had the fastest 4G, 5G, and mixed networks in Austin, with its mid-band 5G vaulting the carrier to triple the average speed of the next competitor.

We saw T-Mobile really show what mid-band can do at several locations throughout the Austin area. In Crestview, the Triangle, and Cherrywood, T-Mobile 5G pushed 700Mbps, a speed that implies plenty of capacity. AT&T had one strong spot in the Triangle, but by and large, the speeds we saw on AT&T and Verizon in Austin didn't seem like they were part of the 5G era.

BALTIMORE: T-MOBILE

T-Mobile's mid-band 5G delivered solid results across 15 Baltimore locations, with download speeds over 200Mbps at five of them and a peak of 670Mbps. This was one city where upgrading to 5G really made a difference. Purely looking at 4G results, AT&T did considerably better than T-Mobile—but once we kicked it up a notch to 5G, T-Mobile more than doubled its download speeds, while AT&T's didn't change. (I'd be wary of calling AT&T's "5G" experience here 5G at all.)

As we saw in many other cities, Verizon's millimeter-wave 5G delivered the fastest individual results in Baltimore; there was just nowhere near enough of it to make a difference. Verizon showed speeds over 1.5Gbps in Inner Harbor and near the Old Town Mall, but in many of the outlying residential parts of the city, T-Mobile ruled.



BOSTON: T-MOBILE

Boston is one of the many cities where T-Mobile moving from 4G to 5G made a big difference. The carrier's 5G results showed double the download speeds of its 4G network, meaning that upgrading to a 5G phone with T-Mobile in Boston is a very smart idea.

Availability was key to T-Mobile's success here. We saw a few spots of Verizon's ultra-fast millimeter-wave 5G in Fenway, the Financial District, and Beacon Hill. But T-Mobile was faster than Verizon and AT&T in more locations and more often.

T-Mobile was also more consistent. Verizon hit some weak spots in the western suburbs with average download speeds below 10Mbps during our test, whereas neither T-Mobile nor AT&T averaged below 20Mbps at any of our 12 stationary test locations.

CHARLOTTE: T-MOBILE

T-Mobile's wins in North Carolina cities really threw me for a loop. This is AT&T country—and indeed, in the rural areas between the cities, AT&T still rules. But T-Mobile's mid-band 5G delivered performance in Charlotte that none of the other carriers' technologies could consistently match.

T-Mobile had the highest 5G availability in town, with 71% of our tests coming in as 5G to Verizon's 50% and AT&T's 28%, and T-Mobile's 5G quintupled the speed of its 4G network. Upgrading from 4G to 5G here will be like night and day. Charlotte also shows Verizon and AT&T's latest strategy with their high-



speed but short-range millimeter-wave systems. We found both networks had mmWave clusters around the Spectrum Center, ready for basketball crowds. When you attend events there, carrying a 5G phone means you're less likely to experience network congestion.

CHICAGO: T-MOBILE

Verizon's ultra-fast millimeter-wave 5G couldn't overcome T-Mobile's massive 5G coverage advantage in Chicago, where 93% of our T-Mobile tests hit the carrier's 5G network. T-Mobile's 5G in Chicago had more than triple the carrier's 4G download speeds, making an upgrade practically mandatory for anyone using a 4G phone on T-Mobile's network.

Verizon and AT&T's 5G approaches really struggled in Chicago. Our AT&T 5G speeds were slower than our AT&T 4G speeds, making this one city where you should actually turn off 5G on AT&T for better performance. We saw mmWave 5G with both AT&T and Verizon in Chicago, but once again, it wasn't enough to overcome T-Mobile's broader coverage advantage. Verizon mmWave broke a gigabit near the Water Tower, in the Loop and West Loop, and near Wrigley Field. But it showed in only 5.2% of our Chicago test samples. Unlike last year, that wasn't enough to push Verizon into the lead.

DALLAS: T-MOBILE

A major wireless-industry hub and home to Samsung's US mobile operations, Dallas has long been one of the most competitive mobile markets. This year, we saw some of the highest average citywide speeds on Verizon's and T-Mobile's networks in Dallas.



We encountered Verizon's millimeter-wave 5G over a much wider area in Dallas than in other cities—it's not clustered near downtown but rather scattered over the central and northern areas of the city. But T-Mobile's 5G network covers much more of the city than Verizon's does. We saw 62% 5G availability with T-Mobile compared with 39% with Verizon, split between its mmWave and low-band forms.

Dallas was also unusual in that T-Mobile led definitively in 4G coverage and performance, with the fastest and most consistent 4G network in the city.

DETROIT: T-MOBILE

Detroit was a squeaker this year. AT&T had the best 4G network, and Verizon got surprisingly good results in 5G mode. T-Mobile pulled out a win averaged over our 13 stationary points, but ultimately it was a narrow one, largely based on better upload speeds and slightly lower latency.

The three carriers did well in different parts of the metro area. AT&T performed well at our stops in Grosse Pointe, while T-Mobile did better in northern suburbs, and Verizon was best in center-city areas. We didn't see much millimeter-wave in Detroit; we stumbled upon it in Dearborn but nowhere else. T-Mobile had the broadest 5G coverage in the city, with 70% of our tests coming in as 5G.

DENVER: VERIZON

Verizon pulled off a very narrow win over T-Mobile based on network reliability and latency in Denver. The interesting data here is in the maximum 4G speeds. Both Verizon and AT&T are pushing 400Mbps maximums on their 4G



networks, showing (as we've seen in Canada) that it's perfectly possible for 4G networks to deliver the sort of performance we're getting from mid-band 5G.

Verizon's win came despite our testers hitting only one indisputable spot of its millimeter-wave 5G, at Garfield St and E 13th Ave. Verizon says it has mmWave all over downtown, but we're not sure we saw it. T-Mobile was often faster than Verizon downtown, where T-Mobile's clear mid-band presence delivered many results over 400Mbps. But high reliability and low latency make up 30% of our score, and in those qualities, Verizon was supreme.

HOUSTON: T-MOBILE

Solid 4G performance combined with good 5G performance to give T-Mobile the win in Houston. T-Mobile had the fastest 4G network in town, with uploads the fastest by a large margin, and it also had the best 5G availability. T-Mobile's 5G network was about 80% faster than its 4G system.

We saw a lot of Verizon millimeter-wave 5G in Houston, basically all through Montrose and then along Westheimer Road to Uptown. But as we saw in many other cities, that didn't overcome T-Mobile's coverage advantage: It had 52% 5G availability compared with Verizon's 38%.

Houston was also a city where AT&T's 5G approach didn't seem to be having much of an impact. AT&T had good 4G performance, but its 5G was a thoroughly 4G experience here—only a little bit faster, maybe not even enough to notice.



INDIANAPOLIS: AT&T

Averages aren't everything. One thing we discovered in our tests, including in Indianapolis, was that sometimes T-Mobile's results were clustered at the high and low ends of the scales. And for a solid mobile experience, you need consistent speeds.

T-Mobile had the most 5G availability in Indianapolis at 60% to AT&T's 47%, but T-Mobile's 4G network was so wobbly that when you fell off 5G, it was a big fall. This is where AT&T's superior 4G network came into play. Older phones need a good 4G system, and newer phones want one to fall back on while 5G networks are still patchy. That makes AT&T the winner in Indianapolis.

KANSAS CITY: T-MOBILE

A terrific mid-band 5G experience makes T-Mobile the winner in Kansas City this year. T-Mobile had by far the best 5G availability (77% to AT&T's 49% and Verizon's 19%) and speeds (double the download speeds of the competition), making this barely a competition at all.

Highlights included 750Mbps down on State Line Road at W 50th, 643Mbps downtown, and 534Mbps in Kansas City, Kansas. As in other cities, though, you need a 5G phone to take advantage of T-Mobile's excellence. AT&T had the best 4G in Kansas City, but AT&T's 5G performance looked just like its 4G performance. Only on T-Mobile did 5G make a major speed difference.

LAS VEGAS: AT&T

The best 4G performance won Las Vegas for AT&T. The carrier's 4G speeds were so much better than Verizon and T-Mobile's that it made for citywide success, even though T-Mobile had more 5G coverage.



AT&T, T-Mobile, and Verizon all have millimeter-wave 5G in Las Vegas; it's a technology designed to work best in areas packed with people. Crowds can overwhelm 4G networks (and often do), but mmWave 5G has much more headroom. We saw gigabit mmWave speeds outside Bally's and the Las Vegas Convention Center. (In the past, I've tested them at Caesar's, along Paradise Road, and at the Thomas & Mack Center.)

That's more for tourists than for locals, though. If you live in Las Vegas, AT&T's network is best. AT&T also did best outside Las Vegas, in the rural areas both southwest and north of the city.

LOS ANGELES: AT&T

AT&T won in several of our Western cities as well as both of our rural Western regions because of a much more consistent 4G network than T-Mobile's. Although T-Mobile is our national leader, the company needs to do some work shoring up its coverage in the West.

As in some of our other cities, we saw an issue in LA where T-Mobile speeds clustered at the high and low ends of the range. When it worked, it was great, but when it didn't, it fell off a cliff. AT&T's 4G and 5G modes were much more consistent, delivering more results in the 25Mbps-to-75Mbps range.

The key promise of 5G isn't breathtaking peak speeds in a few places but consistent minimum speeds of 25Mbps everywhere, so you can consistently rely on features such as cloud storage and cloud gaming. In LA this year, AT&T is the network you can rely on.



MIAMI: T-MOBILE

Miami was a slow city all around this year. T-Mobile won the crown based on the best 5G availability and 5G performance, but all the carriers had pretty sluggish speeds across our 14 tests in Miami.

Performance varied in different parts of town, too. T-Mobile did well west and south of the city center, while Verizon's super-fast millimeter-wave popped up in Wynwood, and two spots of AT&T mmWave appeared downtown.

We found T-Mobile to be the best carrier in central and south Florida right now. It won in both Miami and Tampa and had solid coverage in the cities, the suburbs, and the roads between.

NEW ORLEANS: T-MOBILE

T-Mobile had both the most reliable network and the fastest 5G network over our 12 tests in New Orleans this year. But the big story in New Orleans is that it's well behind other locations when it comes to 5G being present at all. No carrier achieved more than 36% 5G availability, a lower number than in most other places.

Overall network performance wasn't so hot in New Orleans, either. Verizon and T-Mobile both hit impressive peak speeds (we saw Verizon millimeter-wave by the Ernest N. Morial Convention Center), but citywide, performance was lackluster all around.



NEW YORK CITY: T-MOBILE

This one is personal. Over the past two years, I've seen T-Mobile's mid-band 5G take this city by storm. My neighborhood in Queens has enough capacity now that T-Mobile can offer solid home-internet service. With 92% 5G availability across the city, it's safe to say that T-Mobile in New York is a fully 5G experience, and it's head and shoulders over both of the other carriers' mostly-4G networks.

I had a lot of hope when Verizon's millimeter-wave 5G arrived, but only 3% of our citywide tests hit mmWave, and Verizon's low-band 5G experience here is basically 4G.

T-Mobile isn't perfect: There's one spot, by Queensboro Plaza, where the carrier has had a dead zone for the past fifteen years. But with the rise of mid-band 5G, T-Mobile is unequivocally the best choice in New York City.

OKLAHOMA CITY: T-MOBILE

Oklahoma City isn't great for 5G; it had some of the lowest 5G availability we saw in the nation. T-Mobile led with 40% 5G availability, but that isn't very much.

With so little 5G around, 4G comes to the fore. And in Oklahoma City, T-Mobile had the best and most consistent 4G network. Our tests had T-Mobile winning on all counts, with the highest average speeds, most consistent broadband experience, and fastest 5G network. Verizon, especially, had very little 5G here, and AT&T's network fell to slow speeds at three of our 21 stopping points.



PORTLAND, OREGON: T-MOBILE

T-Mobile moved into the lead in Portland this year, combining a strong and reliable 4G experience with the best 5G network. T-Mobile's mid-band 5G was the only upgrade to show a noticeable difference between 4G and 5G, with its 5G speeds more than double its 4G speeds.

We were also impressed by T-Mobile's consistency: It had a higher rate of downloads over 25Mbps than other carriers in Portland. None of the carriers showed the spectacular gigabit-plus speeds we saw in some other cities, but T-Mobile 5G will provide a significant boost for anyone in Portland not already on that network.

Outside Portland, the story changes. Going down the Oregon coast south of Newport, both T-Mobile and Verizon cut out quite a lot. AT&T did best in rural Oregon.

PHILADELPHIA: VERIZON

Verizon notched a relatively rare win for this year in Philadelphia, in part because we saw its short-range millimeter-wave 5G in more places than in other cities. We caught Verizon's highest-speed form of 5G in Center City, in University City, near the Lincoln Financial Field, and by the Philadelphia Museum of Art—all places where you'd expect crowds to congregate, so they're ideal for a high-capacity short-range network. Blistering 1.7Gbps download speeds pulled Verizon's averages up.

T-Mobile showed much better 5G availability than Verizon did—73% to 26%—but T-Mobile's mid-band 5G performance in Philly was surprisingly poor,



delivering what we'd consider to be 4G speeds all around. That let Verizon stand out in Philadelphia with differentiated 5G performance this year.

PHOENIX: T-MOBILE

If you're with T-Mobile in Phoenix, you must upgrade to 5G. The difference between 4G and mid-band 5G in Phoenix was striking this year, with T-Mobile's 5G performance massively faster than its 4G scores. Shifting up to 5G almost tripled our average download speeds on T-Mobile and doubled our upload speeds. Considering that 5G was available in 83% of our Phoenix tests, that's a notable advantage for T-Mobile subscribers.

Both AT&T and Verizon turned in fine 4G performances in Phoenix, but they were definitely 4G, with average speeds of 100Mbps or lower. Next year's C-band rollouts may give AT&T and Verizon a chance to rise up to T-Mobile's 5G level.

RALEIGH: T-MOBILE

T-Mobile won in both North Carolina cities this year, which is striking considering that this is historically AT&T country. The carrier's new 5G buildout is the key: T-Mobile showed 79% 5G availability across the Triangle, compared with 22% for Verizon and 15% for AT&T.

AT&T still has the fastest 4G network in the area, and its network is reliable and consistent. But in the growing area where T-Mobile has 5G coverage, the carrier has leapfrogged AT&T on both uploads and downloads. T-Mobile showed 5G coverage at 11 out of our 13 stationary locations; AT&T had only four.

Raleigh currently has 5G from AT&T, although as of this writing, it's by invitation only. We expect it to become publicly accessible soon.



SALT LAKE CITY: T-MOBILE, VERIZON (TIE)

Salt Lake City showed some of the best Verizon millimeter-wave 5G availability we saw in any city, helping Verizon tie T-Mobile for top network in this area.

We saw Verizon's super-high-speed, short-range mmWave 5G at several sites north of 80 and east of 15, while T-Mobile's 5G had better performance in the Fairpark area and toward the airport. Verizon had the better 4G network, with upload and download speeds considerably ahead of T-Mobile's; T-Mobile had more 5G coverage citywide.

All three carriers had fine coverage down the I-15 corridor through Provo and Nephi. In Wyoming, though, T-Mobile tends to cut out.

SAN DIEGO: T-MOBILE

T-Mobile grabbed the crown in San Diego this year with a mid-band 5G network that averaged more than double the speed of its nearest competitor.

A T-Mobile 5G connection in San Diego is far more likely to give you a broadband experience than any other network's 5G. And T-Mobile had far more 5G availability than its competition, with 79% of our tests on 5G as opposed to 69% for AT&T and 46% for Verizon. San Diegans should make sure to upgrade their phones, though, as T-Mobile's 5G experience here is much better than its 4G experience.



Last year, we encountered some spectacular Verizon 5G speeds in San Diego on its millimeter-wave network. For whatever reason, we didn't hit Verizon mmWave in San Diego this year. Looking at Verizon's coverage map, its mmWave is still pretty sparse.

SAN FRANCISCO: AT&T

Our tests in the Bay Area took us from San Francisco down to San Jose and over to the East Bay. Ultimately, AT&T won in a very competitive marketplace.

Pulling the results apart, the reason for AT&T's win becomes clear. AT&T's 4G performance absolutely dominated this year in San Francisco, and with no carrier showing more than 60% 5G availability, that 4G performance was key to AT&T's overall win. (AT&T's 4G was also better than AT&T's own 5G, a phenomenon we saw in many cities. AT&T has really good 4G.)

T-Mobile needs to do a better job of extending its mid-band 5G across the complex landscape of the Bay Area to surpass AT&T 4G.

SEATTLE: T-MOBILE

It's taken a long time, but T-Mobile finally rules in its home town. T-Mobile's mid-band 5G network makes all the difference in Seattle, and it's now available practically citywide, with 87% of our tests turning up on T-Mobile 5G.

AT&T's 4G network is very reliable, and Verizon's 5G system has low latency. But T-Mobile is using its new mid-band airwaves well here, greatly boosting downloads and offering highly competitive upload speeds.



We tested more locations around Seattle than in most cities, 20 in all. T-Mobile showed its best speeds overall in Bellevue and Redmond—which makes sense, because that’s where the company headquarters are.

ST. LOUIS: T-MOBILE

T-Mobile’s 5G network made the difference in St. Louis. In the 55% of tests where we saw T-Mobile 5G, download speeds were 3.8 times what we saw on 4G, and upload speeds were double. Though AT&T had a better 4G network, upgrading to 5G opened up performance on T-Mobile that AT&T just couldn’t match. As we’ve seen elsewhere, both AT&T and Verizon had very 4G-like performance on 5G here.

St. Louis has Verizon’s millimeter-wave 5G, and we saw an incredible result of 2.2Gbps on that network. But we saw that just once, outside the Enterprise Center. This may point to the future of mmWave: Rather than trying to cover whole cities, Verizon and AT&T are focusing on entertainment venues and other places where crowds gather. With plenty of room, mmWave is great for overcoming capacity challenges.

TAMPA: T-MOBILE

T-Mobile’s 5G network makes the difference in Tampa, where it elevates the carrier above its competition. Though Verizon showed the fastest 4G network, we saw in the 81% of tests where T-Mobile had 5G that it more than doubled the carrier’s speeds. Verizon and AT&T’s 5G, on the other hand, felt just like their 4G—no noticeable improvement.



We got some of our highest T-Mobile speeds in the Tampa region, too. At one of our tests in Clearwater, we saw speeds of more than 836Mbps, a level of speed and capacity that could be mistaken for millimeter-wave. In general, T-Mobile is a strong bet in central and south Florida. T-Mobile won in both Miami and Tampa, and T-Mobile's network was reliable all the way down the state's east coast and even across the midsection of Florida on route 27 past Clewiston.

TUCSON: T-MOBILE

T-Mobile's 5G network gave it just the boost it needed to win in Tucson. All three carriers turned in excellent 4G performance and coverage in the Tucson area, but T-Mobile's 5G was available nearly citywide and doubled its 4G speeds. Note that this improvement has happened almost entirely over the past year. If your idea of T-Mobile coverage or performance in Tucson is more than 12 months old, the situation is completely different now.

Our AT&T phone didn't find any 5G coverage at all in Tucson, but honestly, that's not a big deal; across the country, AT&T's "5G" is basically just 4G with a cherry on top, and AT&T's wins have come based on its excellent 4G performance. AT&T is the best choice for 4G-only devices in Tucson.

WASHINGTON, DC: T-MOBILE

As we saw in many other cities, T-Mobile's mid-band 5G network made all the difference in Alexandria, Arlington, and DC proper, vaulting T-Mobile to much better speeds and performance than those of the other two competing carriers.

Verizon's ultra-fast millimeter-wave 5G is on in DC, but we found it in only two spots, in residential southeast and northeast DC. That gave Verizon some great peak speeds, but T-Mobile's blanket 5G availability (71% of our T-Mobile tests were on 5G) gave us better citywide performance.

As in many other cities, the gap between T-Mobile 4G and 5G is much greater than that of the other carriers. Verizon and AT&T's 4G performance was often better than their 5G performance, while T-Mobile's 5G performance was far better than its 4G performance. AT&T and Verizon subscribers in this area should consider turning off 5G until the carriers launch C-band next year.

WHAT IS AVAXHOME?

AVAXHOME-

the biggest Internet portal,
providing you various content:
brand new books, trending movies,
fresh magazines, hot games,
recent software, latest music releases.

Unlimited satisfaction one low price

Cheap constant access to piping hot media

Protect your downloadings from Big brother

Safer, than torrent-trackers

18 years of seamless operation and our users' satisfaction

All languages

Brand new content

One site



AVXLIVE ICU

AvaxHome - Your End Place

We have everything for all of your needs. Just open <https://avxlive.icu>

Master Social Media Without Sacrificing Your Privacy

BY NEIL J. RUBENKING



Some people have no filter. They'll conduct the most personal phone conversations at maximum volume on the subway. Or they'll regale perfect strangers with the excruciating details of their latest medical procedures. Most of us, though, have a better idea of how to maintain privacy for ourselves and our friends. But do you take the same attitude on social media? It's easy to notice that you're too loud on the phone in public, but it's less easy to realize that your settings let any schmo read your social media

posts. And yet protecting your privacy on social media is important, in more ways than you may realize.



**Unless you're
a Kardashian,
you don't want
to share your
every brain-
blip with
everyone in
the world.**



Perhaps you already know this. Perhaps you keep your privacy settings tuned and never overshare on social media. How about your friends? If they're careless about their own privacy, their heedlessness can slop over and affect you. Show them this article—post it on your virtual walls! Maybe they'll shape up.

CIRCLES OF FRIENDS

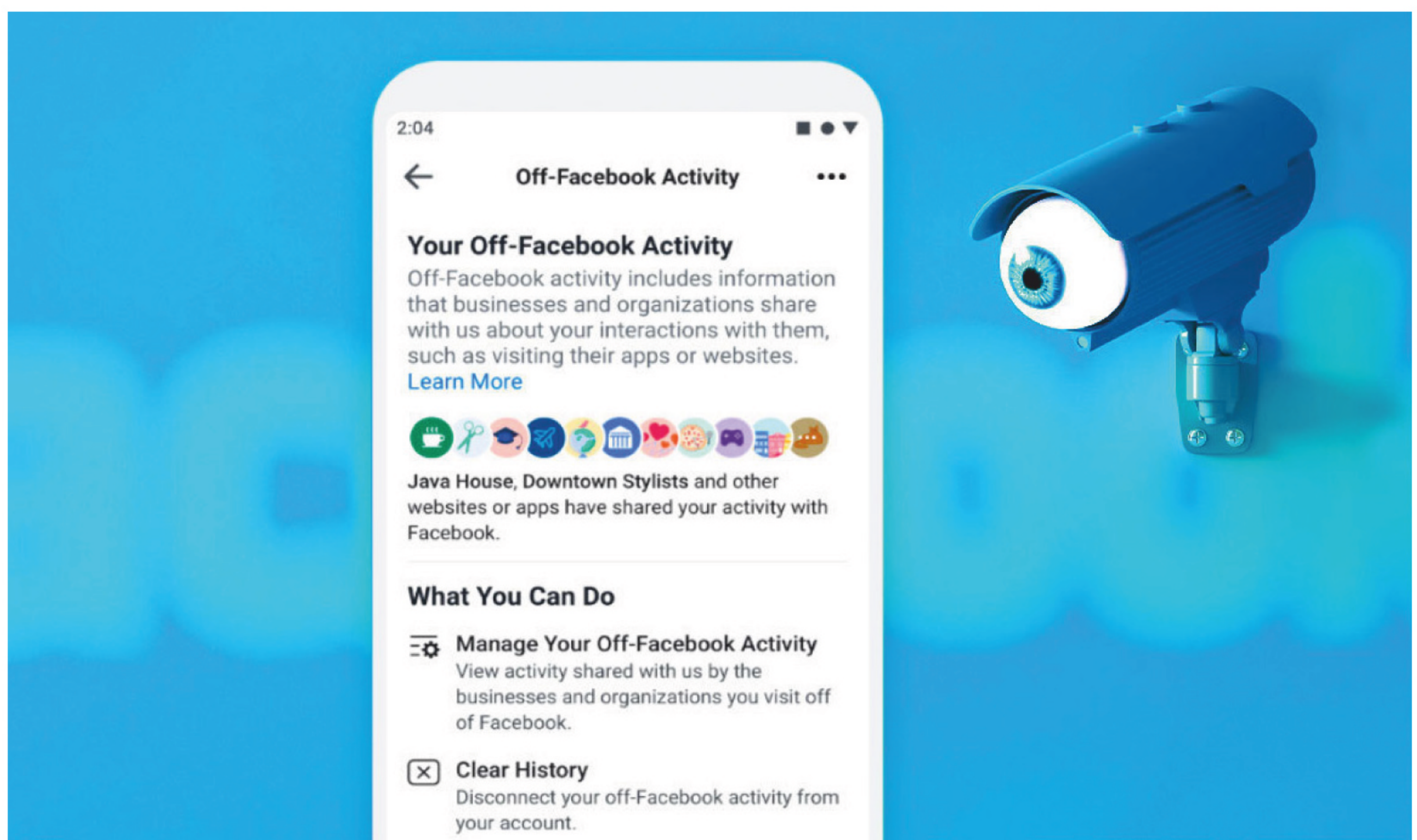
Social media sites like Facebook and Instagram are designed to let you share your thoughts, interests, and pictures with your friends. Unless you're a Kardashian, you don't want to share your every brain-blip with everyone in the world, so privacy settings are important. Maybe you feel you have nothing to hide: Consider the fact that if you don't control access to your posts, they're fully available to advertisers, spammers, cyber-stalkers, and other undesirables.

Unfortunately, your privacy isn't a priority for social media companies. After all, they make money by selling ads and personal information about their members. Proper privacy can interfere with a social media company's ability to monetize the time you spend on its site. You need to put yourself in charge of your social media privacy.

You want the “Goldilocks” settings—private enough to keep out the hoi polloi but not so private that you can't share with friends. Just how you achieve that balance depends on which platform you're using. And bear in mind that on any platform, the implementation of privacy settings can change. What you need to do is walk through the options offered by the platform and use some common sense.

The most important privacy setting is the default audience for your posts. If this is set to public, you have zero privacy. Configure it so only your friends can see what you post. You may be able to fine-tune the audience even further: For example, you might limit access to a subset of your friends or exclude specific friends. These options are all typically available on a per-post basis, so if you want to defy the default for an individual post, you can.

Shutting down the firehose that's spewing your posts out to the world is a good first step, but there's more to consider. Who can see your friends list—just friends, friends of friends, or anybody? Who can tag you in photos or posts? If Cousin Eddie tags you as a photo of a blobfish, do you get a chance to veto the tag? Who can share your posts? That last one's especially important if you have impulsive friends with poor security habits.



OFF-FACEBOOK ACTIVITY

Your social media provider may offer privacy help. It's a win for the company, really. Its press releases can tout its commitment to privacy, while in the back room they know that not many people will take advantage of privacy help. You can tighten your Facebook privacy using the company's Privacy Checkup and Off-Facebook Activity tools, for example, and Twitter's Privacy Center offers videos on privacy.

You don't have to worry about the privacy of your Google+ account anymore, since the service shut down in 2019. Chances are good that you interact with Google in many other ways, though. While you're thinking about social media, checking the privacy of your Google account couldn't hurt.

Even when you're confident you've got the perfect balance of sharing and privacy, don't rest on your laurels. Make a quick pass through the settings now and then, in case the provider has made an unexpected change.

SOCIAL BROADCASTING

For most users, Twitter is a social broadcast medium rather than a closed network. When you post a tweet, you want people to see it. Yes, there's a setting that can limit the visibility of your tweets to people who already follow you, but that's not a typical Twitter use case. Other settings let you control how people can find you on Twitter, who can send you DM requests, who can tag you in photos, and so on.

At the start, LinkedIn was strongly focused on forming and growing your network of contacts. Someone who wanted to reach you through LinkedIn could do so only by wangling an introduction from a person who was already in your network. That's still the default and the best choice for most people. You can also use LinkedIn to broadcast posts, just as you do with Twitter, but a tweet generally has much more impact.

Even with broadcast-type services, it's worthwhile to step through the privacy settings. Do you want location information added to every post? Do you let just anybody send you a direct message or only people to whom you're connected?

WHAT NOT TO SHARE

Most social networks let you fill in a vast amount of profile information about yourself. Where you grew up, your favorite band, your high school mascot, your favorite color—you can fill in all of these and more. But you shouldn't.

The big problem lies in the vast number of websites that use simplistic security questions to verify a password reset request. They'll ask for your mother's maiden name, the town where you were born, or your pet's name. A fully fleshed-out social media profile supplies the answers to most such questions. Even if you keep your profile details private, just one security slipup could give the bad guys all those answers.

Yes, filling in profile details can make it easy for people with similar interests to find you, but it's just not worth the risk. If you haven't thought about this before, now would be a good time to check your profile and delete anything that sounds like the answer to a security question. You could even change the profile data to imaginative answers. Nothing drastic will happen if you claim to be a Pastafarian living in Dniepropetrovsk who enjoys skydiving, and it may amuse your friends.

If you've got your privacy settings squared away, mentioning vacation or travel plans to your social media friends may not be such a bad thing, but think twice before you broadcast a tweet about your upcoming trip to Dubai. It's like putting a sign on your door saying, "Nobody's home—please rob me!" Really, you should think twice before ever putting anything in a post that would cause you trouble if it went public.

DON'T PLAY THE GAME

Any social network wants to be your one-stop online location. Sure, you can view and share posts and exchange private messages, but additional services, such as buying, selling, and joining interest groups, are common. Also: playing games. Facebook, for example, offers a teeming marketplace of games and other connected apps. My advice—don't touch them. These third-party apps and games gain access to your profile and posts, and their own security isn't guaranteed. In fact, I'd advise entirely turning off the platform that allows games and apps to share your data.

The established social media games, Farmville-style, are relatively low-risk (though they may generate posts that annoy your friends). Simple, silly quiz games like Which 'Game of Thrones' Character Are You? or What Country Should You Live In? can actually be more pernicious. If you click one of these and it asks for



If you haven't thought about this before, now would be a good time to check your profile and delete anything that sounds like the answer to a security question.



access to your account, shut it down, fast. You have no idea what data the quiz pulls, and it may not even use that data as input before identifying you as Daenerys Targaryen. There's no central clearinghouse, no place to pin the blame for any misuse of your data. Just skip it!

Then there are the simple-seeming “getting to know you better” posts that get shared and re-shared. Typically, one of your less informed friends shares the post, which includes a passel of fun facts and includes a prompt to post a copy of the list, replacing the facts with your own. If you do, chances are good you've exposed the answers to many popular security questions. Maybe your posts are visible only to friends, but that doesn't mean your friends will take proper care of that private information.

Where did you grow up:	DON'T
Your favorite color:	GIVE
Your first pet's name:	AWAY
Street where you grew up:	YOUR
First child's name:	PERSONAL
Favorite sports team:	INFO
High school mascot:	TO
Favorite food:	IDENTITY
Your first car:	THIEVES
Moms name as a child:	AND
First job:	PASSWORD
Favorite band:	SCAMMERS

To be fair, a good number of social media users have come to understand that these quizzes are more dangerous than fun. Some folks fill out the quiz with good advice rather than giving any personal data away. I've encountered versions like the one above quite a few times and shared them as well.

KEEP YOUR FRIENDS CLOSE

How many friends do you have in your social media circles? How many would you recognize if you met them on the street? It's only human to feel that the more friends you have, the better off you are. But accepting friend requests

willy-nilly can poke holes in your carefully curated privacy.

When an apparent stranger asks to friend you, do your due diligence. Click to view the person's profile and see how many friends you have in common. Chances are good that doing so will reveal whether you have an actual connection to the person. If the wannabe friend has filled in profile data like hometown, jobs, and schooling, these items may also serve to jog your memory. But if exploration leaves you scratching your head, just say no, or ignore the request and let it age out of your notifications.

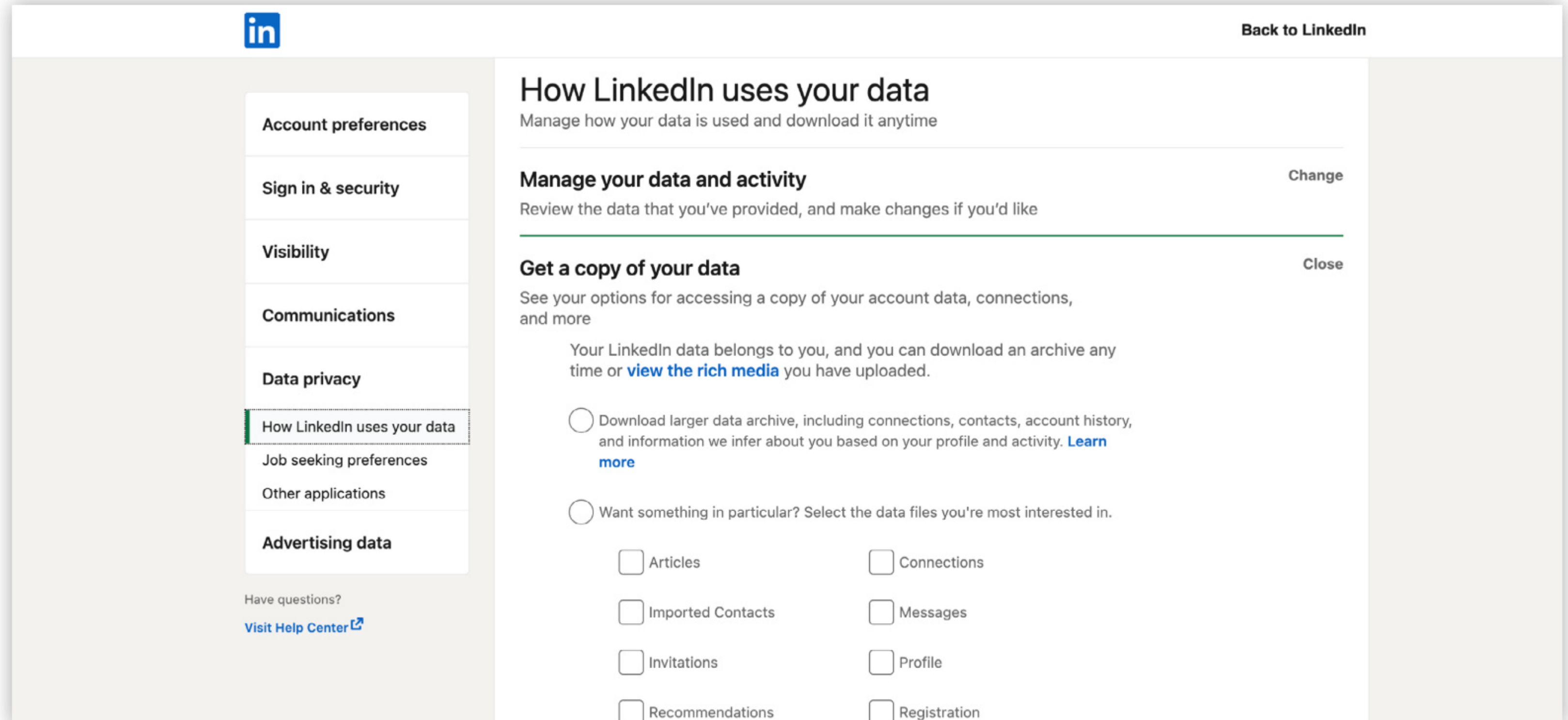
Even when the request comes from someone you do know, it doesn't hurt to double-check the profile for legitimacy. It's easy enough to scrape someone's picture from the web and fake up a profile. Make a quick sanity check, looking for friends in common, recent posts, and anything else to verify that this really is someone you know.

EXAMINE YOUR PRIVATE INFO

When you're getting something for free, you yourself are the product, or so the saying goes. Social media sites hold immense quantities of information about you, your likes, your connections, and your very life. But what exactly do they know about you? In many cases, you can find out.

Downloading the personal data held by Facebook takes a little effort, in part because nobody except you should be able to get it. Everything that's in your profile is here, naturally, along with every group you belong to (active or otherwise), pages you've liked, and favorite music, books, movies, and such that you've named. The Friends list may be a bit daunting, as it includes every friend request you've accepted, rejected, or ignored, as well as those you've unfriended and those you follow without being a friend. The data dump also includes every post you've ever made, though without included images. All photos show up in their own list. Stripped-down versions of videos, Messenger conversations, events, and pokes... It goes on and on.

Twitter's privacy settings page includes an option to download an archive of your data. LinkedIn calls it "Get a copy of your data." For each social network you use, set aside some time to obtain and examine the archived data. It can be an eye-opener.



THE KEYS TO THE KINGDOM

Takeover by a hacker is the worst thing that can happen to your social media accounts. The hacker can send false tweets or posts that seem to come from you. The consequences can include offending friends, spreading malware, or even sending the stock market into a nosedive. And if the attacker changes your password, you'll have a challenge getting your account back. At least two of my social media friends have had to abandon their hacked profiles, warn all their friends to drop the old profile, and start fresh.

Things get even worse if you've used the same password across multiple social media sites. You can be sure that a crook who's taken over one of your social accounts will try the same credentials on other sites. You need a different, strong password for each of your social media accounts; a password manager will help you keep them straight.

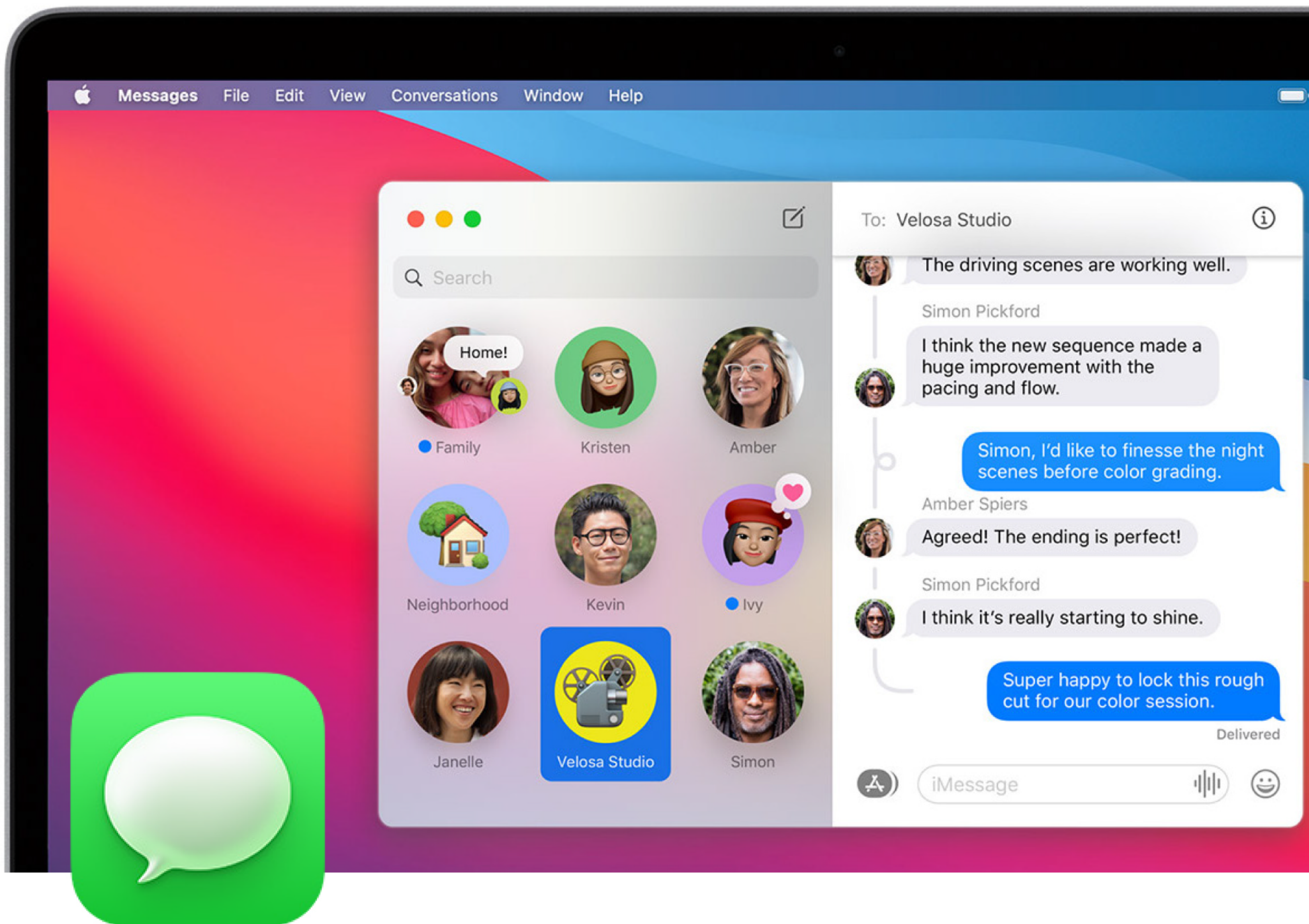
A FINE BALANCE

The point of using social media is communication, whether with your tight circle of friends or with whoever wants to follow your broadcast posts. What you need to do is maintain the proper balance between sharing and oversharing and make sure you've got your privacy settings configured just right.

What if you just can't square the risks to your privacy to the benefits of sharing with your friends? If you decide social network access just isn't worth the risk, you can always delete your account. You won't totally vanish. Facebook won't pull your comments from every place you've left them, for example. But you will remove social media as a potential entry for attacks on your privacy.

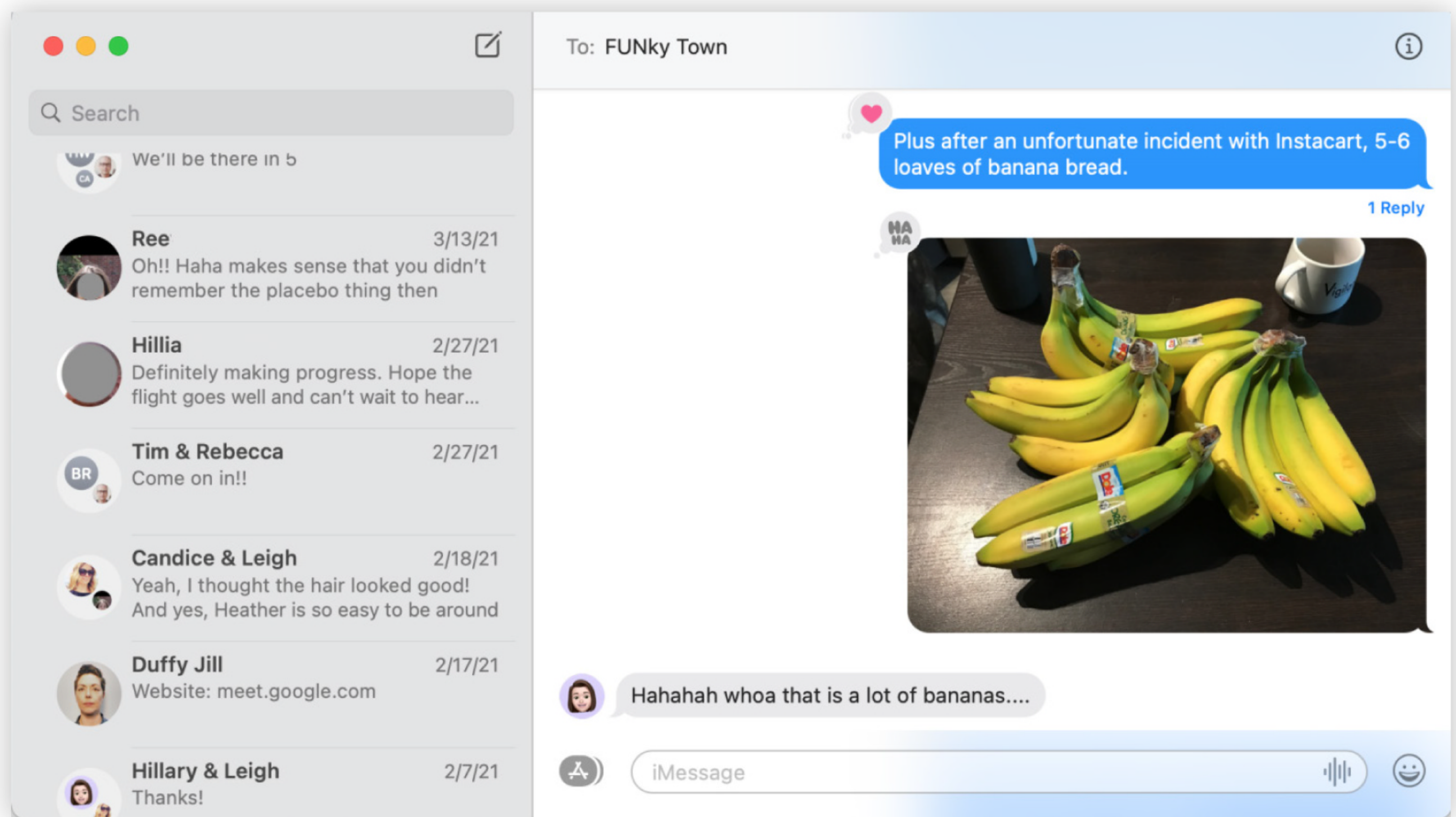
Clean Up Apple Messages to Free Up Space

BY JILL DUFFY



My family and I love to share pictures and videos in an Apple Messages group text. Since COVID-19 struck, we've mostly shared pics and videos of dogs, babies, food, snow, hiking, and the 20-plus bananas I accidentally bought in an online grocery order. Most of them aren't photos and videos that I want to keep forever. And even if I save my own copies, I don't necessarily want them buried in a text thread.

In addition to backing up and organizing photos from your iPhone or iPad, which you should do first, you might also want to delete them from your Apple Messages app. Doing so will help you free up space on not only your mobile devices but also on any computers where you use Messages. Below are instructions for how to do it—but first, you need to know about three strange things you might encounter while removing images and videos from your Apple devices.



WATCH OUT FOR THESE 3 QUIRKS

When I've deleted videos and images from Messages, I've noticed three quirks. First, even though I sync Messages between macOS and mobile devices, deleting the images and videos from one location doesn't delete them from the other. In other words, I can delete videos sent over text from my phone, but they still appear when I open Messages on my computer. If you're tidying up, be sure to do it in all the places where you use Messages.

The second quirk happens on iPhone specifically. When I select multiple videos or images to delete from the Messages app, a button appears confirming that I want to Delete X Messages, and the X number is often wrong. For example, I deleted one video (and it didn't have any reactions on it, such as a heart or

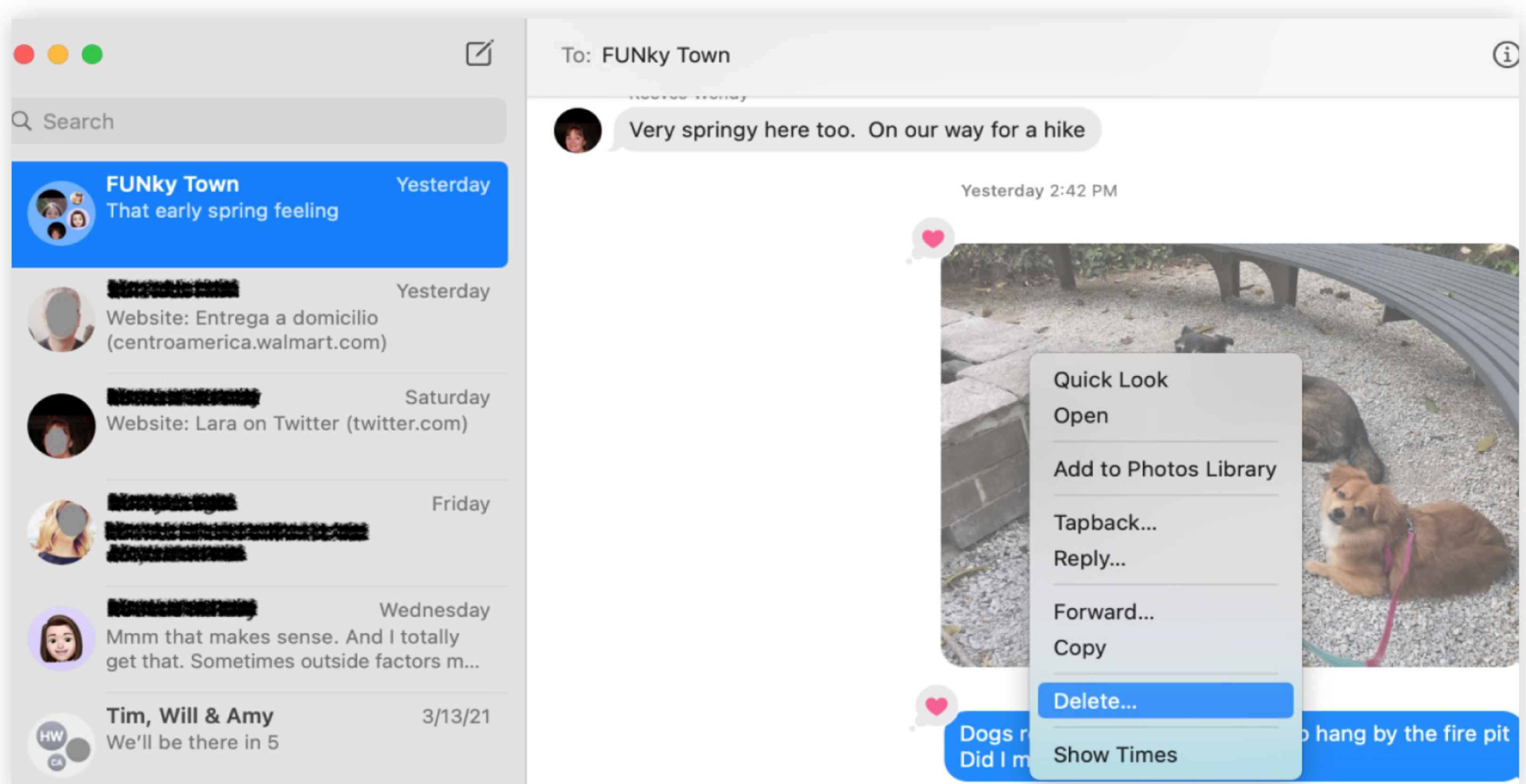
thumbs up) and the confirmation message said Delete 3 Messages. I don't know why this occurs, but it's never caused an unwanted deletion.

Third: On mobile devices, when I try to scroll through the message thread to select multiple images and videos at once, the app often cannot handle it. Scrolling gets jittery, and the app jumps around, making it impossible to see what I selected. This problem doesn't occur when I select multiple images and videos that are close to one another, but it does happen when I'm scrolling through the message history. It's best to delete a few pieces of media at a time rather than scrolling back and forth to find more.

DELETE VIDEOS AND IMAGES FROM MESSAGES ON A MAC

There are two ways to delete videos and images from your Messages app on a Mac. One way lets you delete them on the spot, one by one, and is best for clearing media right away. The other way lets you delete content in bulk; this method also enables you to sort items by size or date. This second option is best for when you want to free up space quickly and get rid of a bunch of photos, videos, bitmoji, or other visual content all at once.

You can also delete entire conversations, meaning get rid of the entire text history in addition to all the media within the message thread. It's a much more extreme option. To do that, just right-click on the conversation and select Delete Conversation.

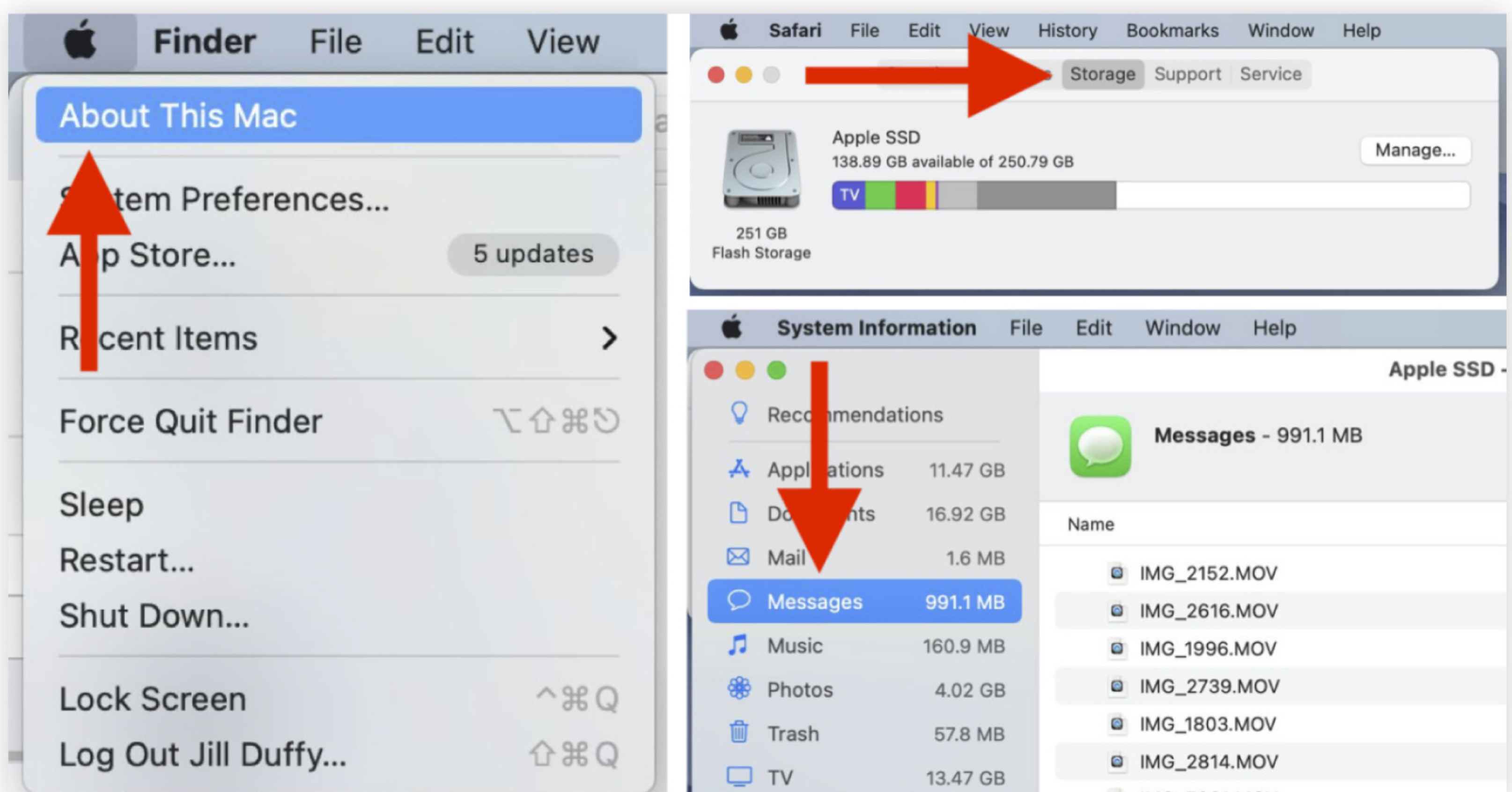


Method 1: Delete Videos and Images from Apple Message on the Spot

1. Open Messages on your Mac
2. Navigate to the conversation where you received or sent the content you want to delete.
3. Find the image or video.
4. Right-click (click with two fingers) on it and select Delete.
5. Repeat for each video and image.

Method 2: Delete Videos and Images from Apple Message en Masse

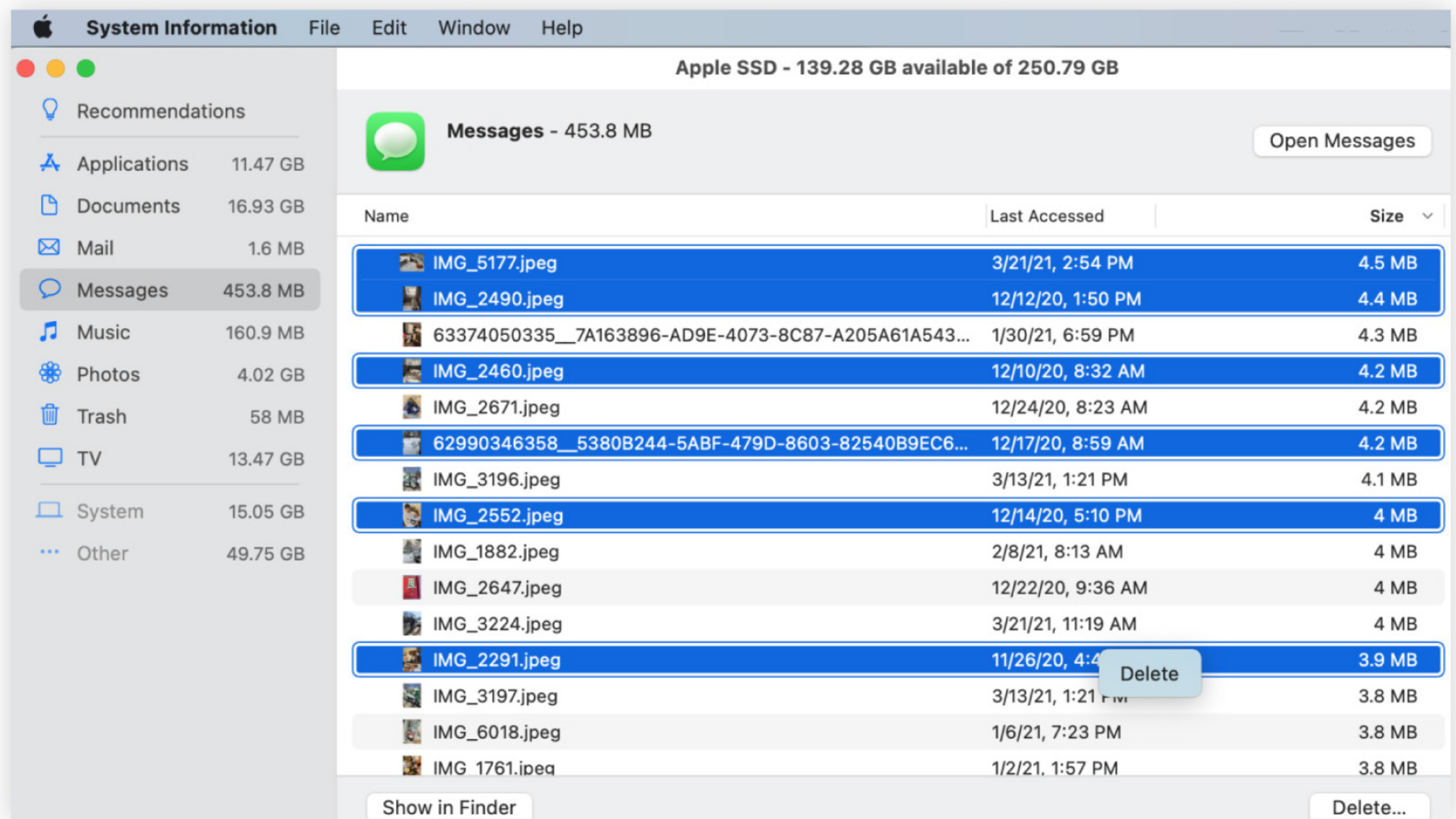
1. Click the Apple icon at the upper-left corner of your screen.
2. Select About This Mac.
3. Select Storage, and wait for your computer to calculate the storage usage. This can take a minute. When it's done, the gray storage bar becomes multicolored and you see a numerical summary of your storage use.
4. Click Manage.
5. Navigate in the left rail to Messages.



6. Now you have a Finder-style window showing videos, photos, stickers, and other image content that you've sent or received in Messages.
7. I recommend filtering the content by size. Click on the Size column until it displays from largest to smallest.
8. Review the content. Click any file to open it and see it in a larger view.
9. You can bulk select the items you want to delete by selecting the first one,

holding the shift key, and selecting the last one. Or you can press and hold Command while you select images to delete in bulk.

10. Then, either click Delete at the bottom right or right-click and select Delete.



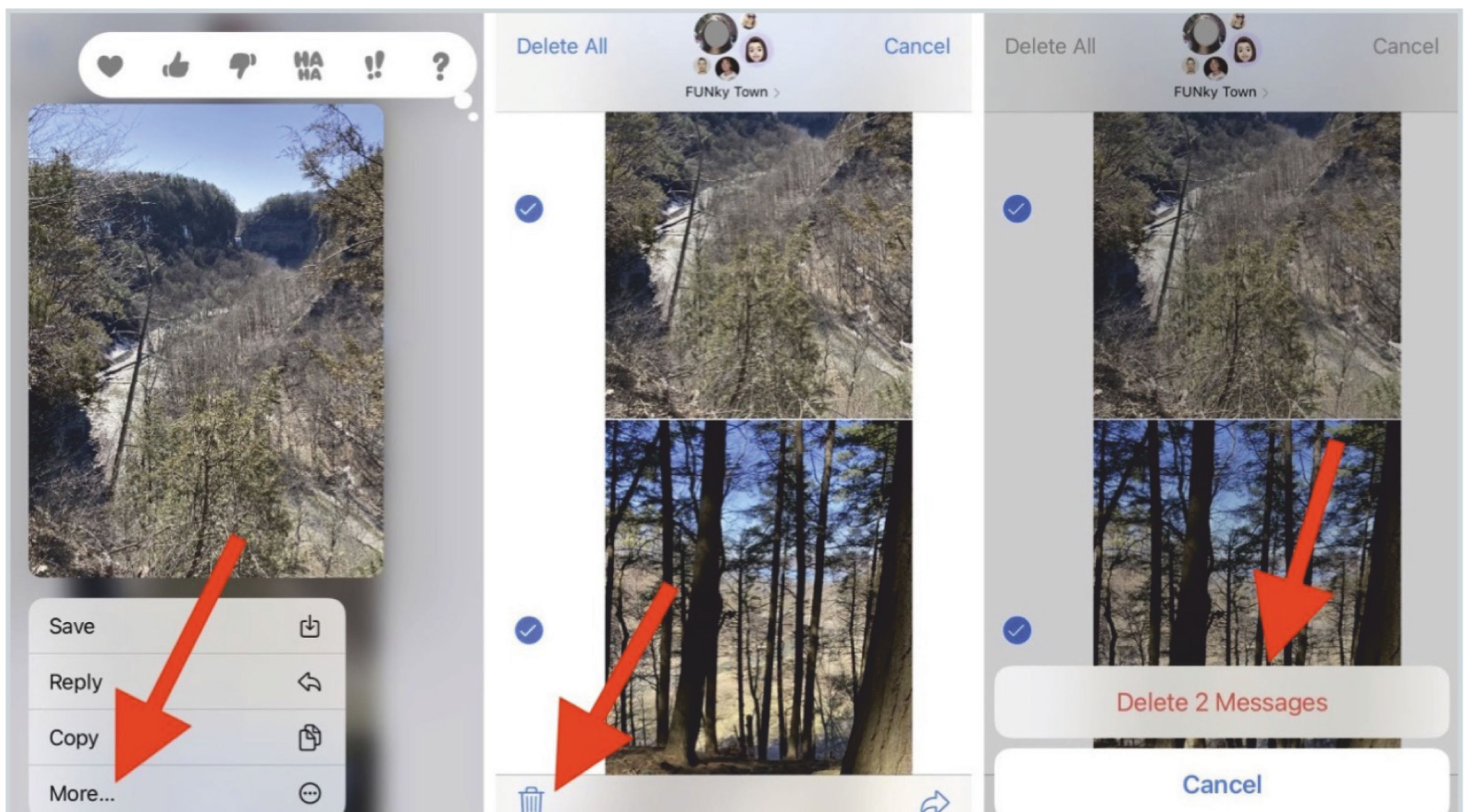
DELETE VIDEOS AND IMAGES FROM MESSAGES ON AN IPHONE OR IPAD

Once again, you have two options for deleting videos and images from an iPhone or iPad. One is to do it from the Messages app. The second is to do it from Settings, which allows you to focus on attachments and images that take up the most space.

Method 1: Delete Videos and Images Directly from the Messages App

1. Open the Messages app.
2. Navigate to the conversation with the videos and images you want to delete.
3. Find the content you want to delete, and then press and hold it.
4. A small menu with options appears. Choose More.
5. Now you can select multiple pieces of media by tapping the circle to the left of them. (Keep in mind the quirk mentioned earlier; scrolling may become jumpy, so stick to what's in view or close by.)

6. Tap the trash icon at the bottom-left and confirm the deletion. (Keep in mind the quirk mentioned earlier; the number may not be accurate.)



Method 2: Delete Video and Messages From the Settings

1. Go to **Settings > General > iPhone/iPad Storage**. Give this page a moment to load.
2. Find Messages and tap it.
3. This next page lets you see how much data is taken up by conversations, photos, videos, GIFs and Stickers, and other data. There's also an option to Review Large attachments, which is what I recommend. Tap Review Large Attachments.
4. Tap Edit. You can now select any of the images and videos in this list to delete them in bulk. Tap the trash icon when you're ready to delete them.

HOW TO SAVE A PHOTO OR VIDEO FROM APPLE MESSAGES

When you find an image or video that you want to save, you can make a local copy on your device and then back up the image or video. Here's how to save a copy:

- On a mobile device, press and hold the image or video. Tap Save and a copy will be saved in your Photos app.
- On a macOS computer, right-click the image or video. You can select Add to Photos Library to save it there. Alternatively, you can select the Copy the image option and then paste it wherever you want to store it.

People Spend an Average of 5.5 Hours a Day Staring at Screens

BY ERIC GRIFFITH

August 9 was National Book Lovers Day, which is not a day you'd expect PCMag to cover, considering we haven't been in print for 12 years. But it occurred to the folks at SecondSale.com—a used-book seller—that the real competition for books are the many screens in our lives (yes, even screens showing ebooks). SecondSale conducted a survey with OnePoll of 2,000 people in the US to ask about their daily screen habits. The results are in the infographic below.



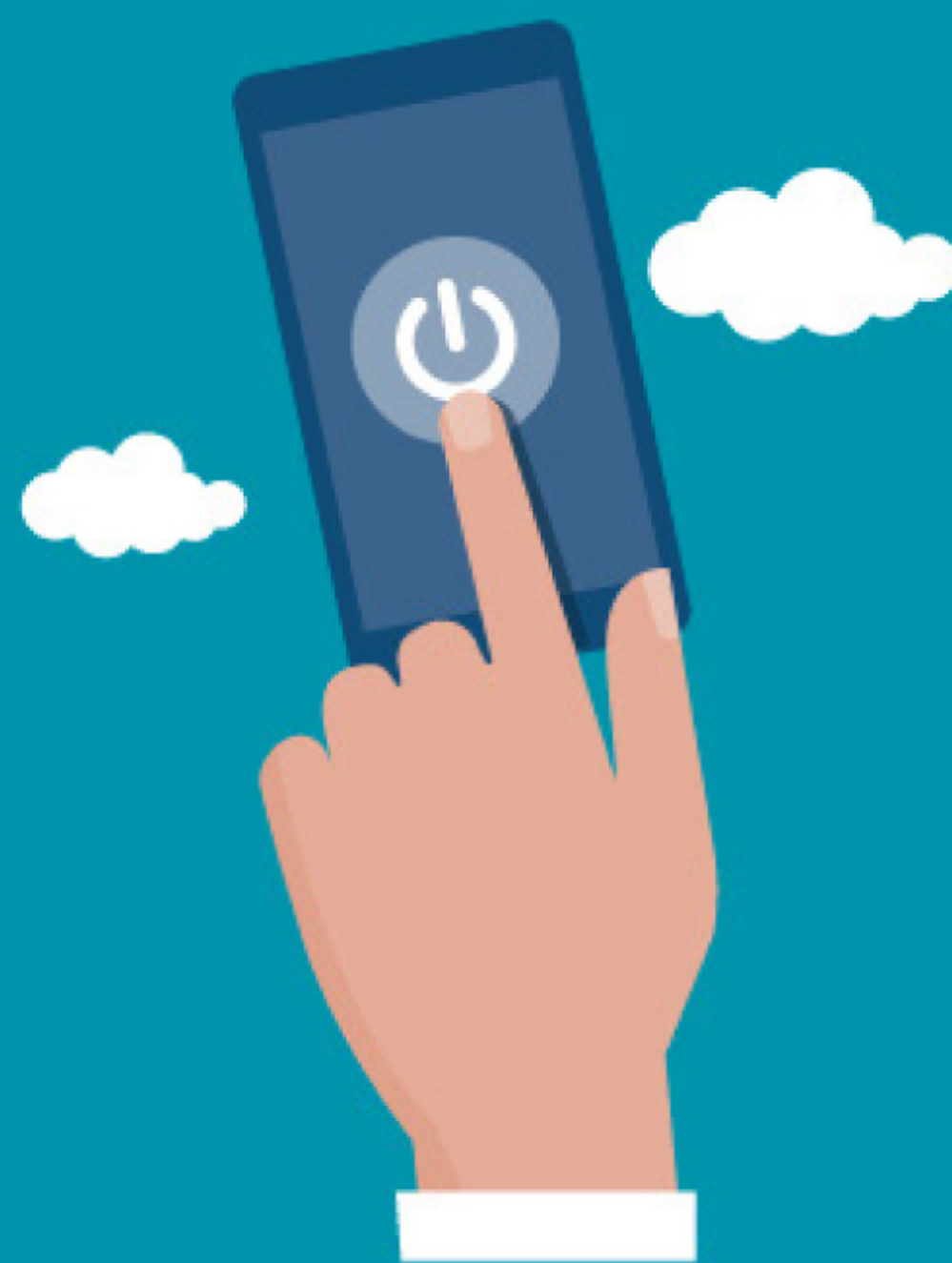
Turning Down Tech

A new survey of 2,000 Americans found...

56%

More
than half

of those who spend their entire
day glued to a screen try to limit
using their devices as much as
possible at night



After unplugging from
their tech, Americans feel:



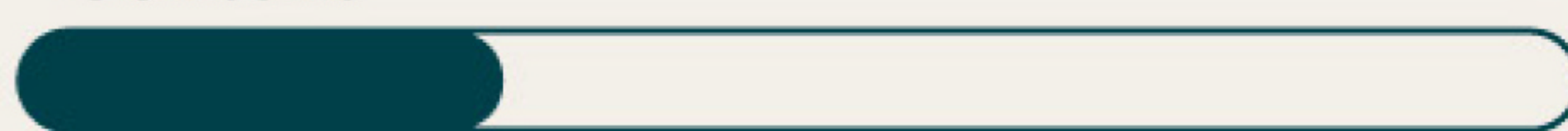
Relaxed



54%



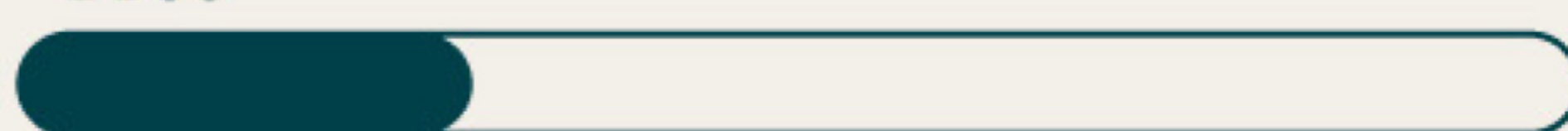
Content



31%



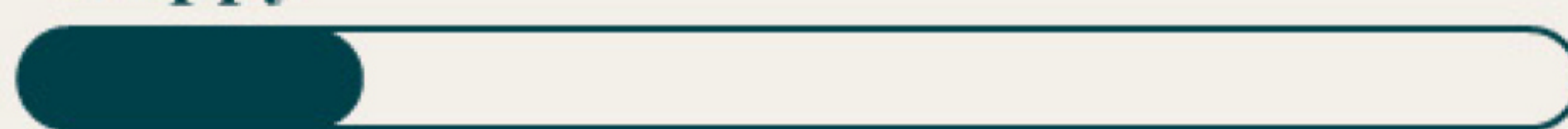
Free



29%



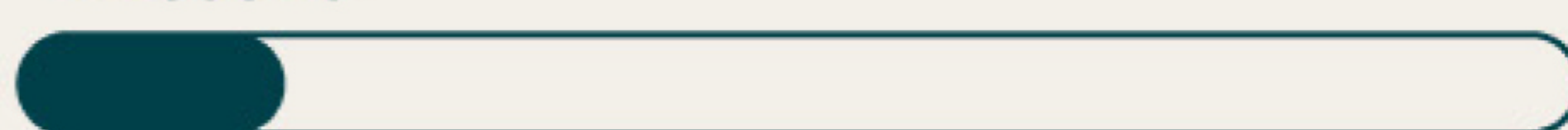
Happy



22%



Present



17%



47% say they have limited time for other activities because of how much time they spend using technology every day



and

63% want to spend more time doing non-technology activities at the end of the day

2 in 3



said reading is one of their favorite pastimes

54% still prefer to read a printed copy of a book

86% of those who prefer physical books said that it helps them feel like they're escaping to somewhere else



Perhaps a good omen for selling real paper books, more than half the respondents to the survey said they're trying to limit exposure to screens after hours. The average time online people spend before unplugging is five and a half hours. Some have even set rules at home to stay away from the dreaded sleep-inhibiting blue light before bedtime.

Despite the fact that the survey was conducted for Book Lovers Day, reading books wasn't the non-digital pastime most respondents looked forward to. Those were cooking (56%), music (62%), and spending time with family and friends (64%). A full 63% want to spend more time at the end of the day being unplugged.

What about books? While 54% said they'd rather read a physical book than an ebook on any device, only 30% said they want to dedicate more time to reading. Even less encouraging, seven out of 10 said they get carried away with playing games on their phones during leisure time.



**More than
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EDITOR-IN-CHIEF, PC MAGAZINE NETWORK Dan Costa

EDITOR Wendy Sheehan Donnell

MANAGING EDITOR, DIGITAL EDITIONS Carol Mangis

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INVENTORY CONTROL COORDINATOR Joseph Maldonado

ART, MEDIA, & PRODUCTION

SOCIAL MEDIA MANAGER Pete Haas

STAFF PHOTOGRAPHER Molly Flores

PRODUCER Emily Zoda

SENIOR VIDEO PRODUCER Weston Almond

VIDEO PRODUCER Raffi Paul

CONTRIBUTORS

John R. Delaney, Jill Duffy, Tim Gideon, Ben Z. Gottesman, Eric Grevstad, William Harrel, Edward Mendelson, Stephanie Mlot, M. David Stone, Lance Whitney, Kathy Yakal



ZIFF DAVIS LLC

CHIEF EXECUTIVE OFFICER (J2 GLOBAL) Vivek Shah

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