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MODDER Q&A:  
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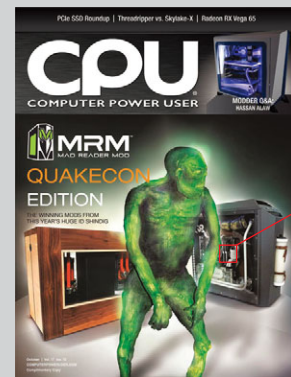
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## ENERMAX Launches PLATIMAX D.F.

ENERMAX has launched a new series of highly efficient power supplies called PLATIMAX D.F. The initials stand for “Dust Free,” a technology the company developed for its fans that spins the blades in reverse for a few seconds on startup to help keep them free from dust. The PLATIMAX D.F. models have a manual switch that allows users to activate the reverse fan spin whenever they wish. The new series has four wattage capacities: 750W, 850W, 1050W, and 1200W, but only the three higher wattages are available in North America. ENERMAX says the 1200W PLATIMAX D.F. is the smallest 1200-watt power supply to carry the 80 PLUS Platinum efficiency rating. An extremely dense circuit board design allows the 1200W model to have a depth of only 160mm, compared with the 180-225mm depths found in other comparably powered units. MSRPs for the new PLATIMAX D.F. models sold in the U.S. are \$209.99 for 850W, \$249.99 for 1050W, and \$269.99 for 1200W.

## Corsair Cranks Out Vengeance LPX DDR4 Kit That Reaches 4600MHz

Corsair announced a new kit under its Vengeance LPX series that is its fastest DDR4 memory to date. The Vengeance LPX 16GB kit is rated at 4,600MHz. The new Vengeance memory is all black with a black heatsink. It has timings of CL19-26-26-46 and runs at 1.5V. Corsair says the kit is able to reach such high speeds because the company hand-sorts and bins the fastest Samsung chips. The company designed the new kit specifically for the X299 chipset and says it partnered with motherboard manufacturer ASRock to develop the memory. The companies used ASRock’s X299 OC Formula motherboard as the development platform. Corsair’s Vengeance LPX 16 GB (8GB x 2) 4,600MHz memory kit carries an MSRP of \$599.99. The speedy memory joins other new Vengeance LPX DDR4 kits from Corsair with capacities ranging up to 128GB.



### WATCHING THE CHIPS FALL

Here is the pricing information for various AMD and Intel CPUs.

CPU	Released	Original Price	Last Month's Price	Online Retail Price*
AMD Ryzen Threadripper 1950X (Zen)	8/10/2017	\$999.99	\$1,019.99	\$999.99
AMD Ryzen Threadripper 1920X (Zen)	8/10/2017	\$799.99	\$799.99	\$799.99
AMD Ryzen 7 1800X (Zen)	3/2/2017	\$499	\$459.99	\$449.99
AMD Ryzen 7 1700X (Zen)	3/2/2017	\$399	\$359.99	\$359.99
AMD Ryzen 7 1700 (Zen)	3/2/2017	\$329	\$299.99	\$299.99
AMD Ryzen 5 1600X (Zen)	4/11/2017	\$249	\$239.99	\$239.99
AMD Ryzen 5 1600 (Zen)	4/11/2017	\$219.99	\$214.99	\$214.99
AMD Ryzen 5 1500X (Zen)	4/11/2017	\$189	\$189.99	\$179.99
AMD Ryzen 5 1400 (Zen)	4/11/2017	\$169	\$164.99	\$164.99
AMD A10-7890K (Godavari)	3/1/2016	\$164.99	\$149.99	\$149.99
Intel Core i9-7980XE (Skylake-X)	9/25/2017	\$1,999	n/a	\$1,999
Intel Core i7-6950X (Broadwell-E)	5/31/2016	\$1,723**	\$1,599.99	\$1,577.89
Intel Core i7-7940X (Skylake-X)	9/25/2017	\$1,399**	n/a	\$1,399
Intel Core i9-7900X (Skylake-X)	6/26/2017	\$999.99**	\$999.99	\$969.99
Intel Core i7-7820X (Skylake-X)	6/26/2017	\$599.99**	\$599.99	\$599.99
Intel Core i7-7800X (Skylake-X)	6/26/2017	\$389.99**	\$375.99	\$379.99
Intel Core i7-8700K (Coffee Lake)	10/5/2017	\$359**	n/a	n/a
Intel Core i7-7700K (Kaby Lake)	1/3/2017	\$350**	\$349.99	\$309.99
Intel Core i5-8600K (Coffee Lake)	10/5/2017	\$257**	n/a	n/a
Intel Core i3-8350K (Coffee Lake)	10/5/2017	\$168**	n/a	n/a

\* As of September 2017

\*\* Manufacturer's estimated price per 1,000



## GeIL Adds RGB To SUPER LUCE DDR4

GeIL announced multiple versions of its SUPER LUCE gaming memory are on the way that feature RGB lighting. The SUPER LUCE RGB SYNC gaming memory starts at 2133MHz and goes up to 3200MHz. Kit capacities are 4GB/8GB/16GB/32GB and individual modules come in either 4GB or 8GB. The RGB SYNC memory can be purchased in single, dual, or quad channel and has latency settings of CL15 - 17. The memory supports ASUS AURA light management software. GeIL says it is aiming this memory at hardcore gamers. The SUPER LUCE RGB LITE is for mainstream users and entry-level gamers who don't want to mess with software settings. This memory comes in 2133MHz - 3000MHz frequencies. Kits come in the same total capacities, but are only available for single- or dual-channel systems. As with SYNC modules, capacities include 4GB and 8GB, but 16GB is also available. Both types of SUPER LUCE RGB kits will be available in black or white versions optimized for Intel and AMD.

## OWC Ships Thunderbolt 3 Dock

OWC (aka Other World Computing) has shipped its Thunderbolt 3 Dock, a compact product that loads up a full baker's dozen of connectivity options for users, including:

- 5 x USB 3.1 Gen 1 (1 front, 4 back)
- 1 x S/PDIF
- 1 x FireWire 800
- 1 x Gigabit Ethernet
- 2 x Thunderbolt 3
- 1 x mini DisplayPort
- 1 x SD Card Reader (front)
- 1 x Expanded Analog Audio In/Out (front)

With Thunderbolt 3, users can transfer data at up to 40Gbps. OWC says the extreme bandwidth enables users to drive two Ultra HD 4K displays or even a 5K display. The additional ports just increase the utility of the Dock, letting users move photos and other large files around with ease. The MSRP for the new OWC Thunderbolt 3 Dock is \$299.



## Lian Li's New PC-Q50/V320/V720 Chassis Models Avoid Glass & RGB

Lian Li announced three new aluminum chassis lines that lack the tempered glass panels and RGB lighting that most manufacturers are touting these days. Instead, the PC-Q50, PC-V320, and PC-V720 go with a classic, minimalist look. The cases are towers that have removable feet and can quickly be converted for use as desktop systems and HTPCs, which also explains why glass sides and lighting aren't really necessary. The three models have a similar layout and construction, but they target different sizes of motherboards. The PC-Q50 is for Mini-ITX systems, and it requires an SFX power supply. The PC-V320 is for microATX builds, while the PC-V720 is for ATX systems. The PC-V320 and PC-V720 cases can use ATX PSUs. All three case lines offer a color choice of either black or silver. The PC-Q50 has an MSRP of \$149, while the PC-V320 goes for \$189 and the PC V720 sells for \$219.

## CaseLabs Adds BH-8 Chassis Model To Bullet Line For EATX Systems



The BH8 measures 12.6 x 14.3 x 15 (HxWxD, in inches). CaseLabs says it added a couple of inches to the height and depth of the BH7 case in the Bullet series to make it easier for users to install longer graphics cards and beefier liquid-cooling setups in EATX builds. The BH8 also has a 5.25-inch drive bay. The case holds as many as six 3.5-inch HDDs or 14 2.5-inch SSDs. The dual-chambered chassis of the BH8 looks similar to other models in the Bullet line, with windows on two sides and a top that can be either half vent/half window or full vent. With front fans installed, the BH8 can handle GPUs up to 332mm long. It also can accommodate CPU air coolers up to 193mm. Despite its compact size, the case can handle multiple radiators for users who opt for liquid cooling. The MSRP of the Bullet BH8 EATX is \$249.95 for the black, white, or gunmetal versions. You also can order it in red, but it will cost you another \$10.

### HARDWARE MOLE



## Deepcool Adds White 360 RGB AIO

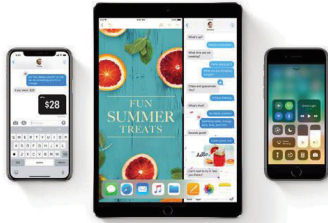
In August, Deepcool announced it was coming out with a white version of its Captain 240 EX RGB liquid cooler. Now the company plans to add the Captain 360 EX WHITE RGB to the Captain lineup. As with the other Captain EX RGB models, the Captain 360 EX WHITE RGB is an all-in-one kit. The RGB lighting in the kit is certified to work with the light syncing software used by ASUS, GIGABYTE, and MSI motherboards. The cooler comes with two LED strips, plus there is a lighting strip integrated in the cooling block. Deepcool says you can adjust all the lighting using either the wired cable controller that is included in the Captain package or the light syncing software. The Captain 360 EX WHITE RGB will carry an MSRP of \$149.99. Deepcool says the new model will arrive at retail sometime in October.

## ASUS Brings Bling To ROG Horus

ASUS announced it has added RGB capabilities to the ROG Horus GK2000 mechanical gaming keyboard. The new ROG Horus GK2000 RGB is the company's third keyboard model to support Aura Sync light synchronization software. The new keyboard has a brushed aluminum frame and Cherry MX Red mechanical keyswitches. Special gaming-friendly features include 100% anti-ghosting and full N-Key rollover (NKRO), and there's a 32-bit processor and 8MB of onboard memory that allow you to set up macros and customize individual keys. You can store up to 10 individual user profiles. The Horus GK2000 RGB also functions as a dual-port USB hub, and it has a detachable wrist rest. ASUS has not yet released an official price, but the new plank will likely be available at retailers soon.



iOS 11  
Available now.



## Apple Releases iOS 11, Its Next Version Of OS For iPhones & iPads

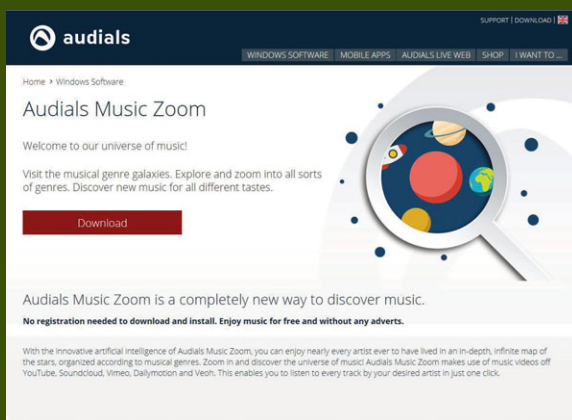
Along with the big reveal of the iPhone 8, 8 Plus, and X models, and the news about Apple Watch Series 3 and Apple TV's support for 4K HDR video, Apple made other news recently with the release of iOS 11. The latest version of the company's operating system for mobile devices includes a number of new features, starting with a more customizable Control Center. The new OS also makes it easier to multitask. There's a new Dock you can customize that makes it easier to launch apps, and a new way to switch between two open apps (yes, you can keep a second app active). A new Files app makes it easier to find and organize your files, and you now can use Apple Pay with Messages to send and receive money. You can learn about other new features in iOS 11 and get Apple's step-by-step instructions for downloading and installing the software at [www.apple.com/ios/update](http://www.apple.com/ios/update).

## The 15SOF App Will Help You Save & Replay Your 15 Seconds Of Fame

So you're at the big ball game on Saturday, jumping and cheering for your favorite team, when the person next to you taps you on the shoulder and says, "Hey, you're on the big screen!" Yup, it's your 15 seconds of fame. Now there's an app that lets you save that moment so you can replay it later for friends and family. Just download the 15SOF app to your phone and take a selfie. When you go to any major sporting event that has partnered with 15SOF, you check in via the app. Then the 15SOF app uses facial recognition technology to identify and save any footage of you taken at the game, and it delivers the video to you in a format you can share on various social media platforms. 15SOF works with dozens of sports teams and leagues, including many college teams, the NFL and MLB. You can download the app and learn more about how it works from [www.15sof.com](http://www.15sof.com).



### SOFTWARE SHORTS



## Audials Music Zoom Wants To Change How You Listen To Music

Audials Music Zoom is software that helps you find music. The program uses a combination of artificial intelligence and audio "fingerprinting" to search for tunes and categorize results. Audials has a database of more than 300,000 artists and millions of tracks, plus it lets you search music videos on well-known websites such as YouTube, SoundCloud, Vimeo, and others. The software also actively scans more than 50,000 Internet radio stations. Just pick an artist and the software will "zoom in" to the artist on a visual representation of a global music map. Solo artists and groups located nearby on the map produce similar types of music. You can also search for tunes by genre. The download is free and it works with Windows 10/8/7. You can find Audials Music Zoom online at [music-zoom.com](http://music-zoom.com).





## Chatbot Market Forecast To Be Worth \$1.25 Billion By 2025

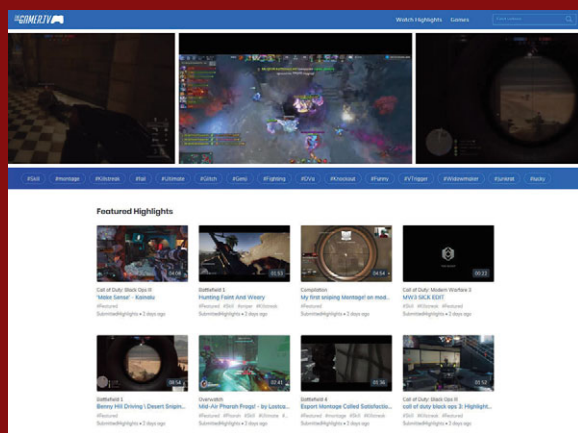
Chatbots, virtual assistant software that often takes the form of those little boxes that pop up on websites to interact with customers, answer questions, and guide people through a decision-making process, are becoming a big business. Market research firm Grand View Research has forecast that the chatbot market will be worth more than \$1.25 billion by 2025. Already there are chatbots to help you find the right home or act as a personal coach for physical and mental fitness. There's even a chatbot under development that will help people make end of life decisions about wills and funeral arrangements. Grand View Research expects the chatbot market to have an average growth rate of more than 24% annually over the next eight years as companies combine chatbots with new technologies such as artificial intelligence and the Internet of Things so they can handle more customer service chores that previously required human interaction.

## Now You Can Ask Alexa What's Available At Your Local Redbox

An interesting mix of old and new tech is represented in a new skill that has been created for Amazon's Alexa. Redbox, the company that rents physical copies of movies and video games at more than 40,000 locations around the country, says you can now use Alexa to find out what titles are available at your local Redbox kiosk. Redbox kiosks can be found near drug stores, malls, and other heavily trafficked areas. The company continues to thrive in the streaming era by making its rentals ubiquitous, inexpensive, and easy to use. You can reserve Redbox movies and games by going online or through a Redbox app. Expanding on that theme, now you can download a new skill for Alexa that lets you query the device to find out where the closest Redbox kiosk is located, what movies and games are currently available, and what new movie and game releases will be coming in the future.



## SITE SEEING



## eSports Broadcasting Company Launches Site For Videogame Clips

Level Up Media, the young London-based company behind the professional eSports video site Dingit.tv, has launched a new website called TheGamer.tv that is aimed at mainstream users. The site features clips of gameplay from a number of popular titles such as FIFA, World of Tanks, Rocket League, Grand Theft Auto, and Overwatch. You can search the site by entering terms in a traditional search box or you can click hashtag categories on each page to see videos grouped by terms such as #killstreak, #glitch, and #funny. The home page shows a group of Featured Highlight videos as well as the Most Popular videos. All of the videos on the site are curated by moderators, and you can browse the site for free.



## Job Of The Month

The company we're featuring this month may make animated movies for families, but this job isn't child's play. Pixar, the first company to produce a completely computer-generated animation sequence in a full-length feature film, is looking for a Research Scientist at its offices in Emeryville, Calif. This person should have a Ph.D. or equivalent in data science or math, and be able to demonstrate a history of publishing original research. Pixar is looking for someone who can spot research opportunities and lead related projects that benefit the immediate organization as well as the parent company (uh, that would be Disney). The Research Scientist needs to stay at the forefront of technical developments that affect creating, producing, and disseminating computer-generated media and related areas. This person also works closely with artists, technical directors, and others at Pixar. If you think you have the technical chops to identify and help develop new tech that keeps Pixar on the cutting edge, apply at the site below.

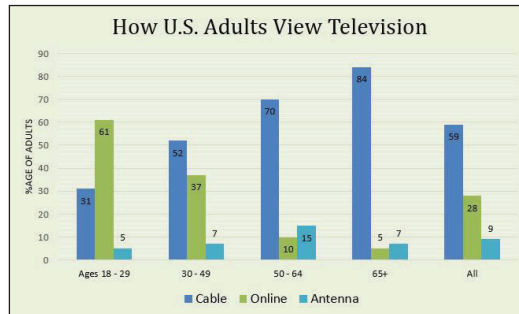
Source: [www.pixar.com](http://www.pixar.com)

## Cable vs. Streaming

It wasn't all that long ago that there were two ways to get a TV signal: by antenna or by cable. The internet changed all that, of course. For years, the growth of online streaming services such as Netflix has been eroding the installed base of cable users. A recent study of TV viewing habits from Pew Research Center shows a clear correlation between

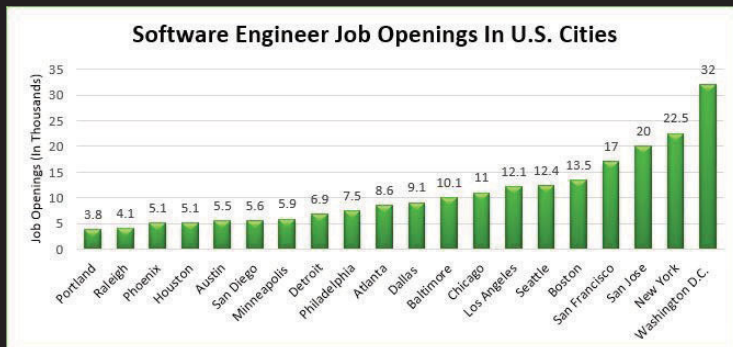
age and how Americans get their TV content. Their survey results in the chart above show that the older you are, the more likely you are to have cable, while the younger you are, the more likely you are to use a streaming service. In fact, the cable usage stats (shown in dark blue) decline with age at a rate that is nearly mirrored by the growth of streaming services (shown in green). As for the small percentage of people in all age groups who still get a signal by using rabbit ears, well, at least they're saving money.

Source: [Pew Research Center](http://Pew Research Center)



## No, Not That Washington. The Other One.

Not all tech jobs are located in Silicon Valley. CodeMentor.com recently analyzed data from a number of sources in an attempt to find the best cities for Software Engineers. In terms of sheer number of job openings, Washington D.C. and New York City led the way in the U.S. While they might have the most jobs available, CodeMentor doesn't rank the cities at the top in terms of desirability, though. They



gave that distinction to Seattle, due to higher than average salaries and lower rental rates.

Source: [CodeMentor](http://CodeMentor)

# RAW Numbers:

## 500

The number of megabytes of roaming data that the average person globally will use during 2017. This estimate is forecast to increase to nearly 1.6GB by 2022.

*Juniper Research*

## 2.1 billion

The estimated total number of add-in boards, meant for use in computers using a Microsoft operating system, that have shipped since the first IBM PC was introduced in 1981. This estimate includes AIB shipments from that date through the end of 2017.

*Jon Peddie Research*

## \$14 billion

The amount that is forecast to be spent annually on transportation cybersecurity by the year 2022. Always-on Internet connections and autonomous driving technology are creating rapid changes and the need for more security in the transportation industry.

*ABI Research*

## \$37.76 billion

The amount invested in 3,876 startup companies by venture capitalists during the first six months of 2017. VCs invested a total of \$71 billion in startups last year.

*National Venture Capital Association*

## \$93.1 billion

The forecast value of the global lithium-ion battery market by the year 2025. Lithium battery usage is growing rapidly in electric cars, power grid energy storage, and portable consumer electronics.

*Grand View Research*

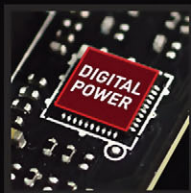


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# Ride The Lightning

## These PCIe SSDs Beat Up Our Benchmarks

Every builder has a component they favor over all the rest, and usually for good reason. Hardcore gamers plow a big portion of their budget into a screaming graphics card or two. If you're into intense video editing or all-night hackathons, prioritizing the CPU will likely yield the greatest benefit. Maybe you're a modder, or someone who just wants a pretty PC—there are plenty of power users who buy their case first and figure out what to put in it later.

Clearly, certain parts are suited for certain jobs, but we've learned that one component can give your system a boost in virtually any task. Almost as soon as they arrived on the scene, solid-state drives established themselves as all-around MVPs. Once we watched a previously sluggish system boot to Windows in seconds, we realized just how much of a liability magnetic storage had become.

Also obvious is the fact that SSDs have gone mainstream with a capital "M." All

of our systems have one, even if it's merely a small, entry-level, TLC-based drive installed in the kids' Minecraft box. We're putting them in the PCs we build for our parents and grandparents, and we pity the families who don't have at least one geek with the presence of mind to do the same.

Of course, we're keeping the good stuff to ourselves. By that, we're referring to the solid-state drives that rule all others: PCIe NVMe SSDs. Where early solid-state drives were forced to subsist on technologies developed for the dinodrives of antiquity, today's crop of high-end SSDs have a bus with abundant bandwidth and a tailor-made interface. In short, the drives we've gathered for this roundup are virtually unshackled, ready to burn up the test track.

### Don't Sleep On 6Gbps SATA SSDs

As fun as it is to salivate over the latest and greatest PCIe drives, development continues in other arenas, as well. After

all, although the top-shelf SSDs are our caviar, we can't deny that manufacturers are also interested in making affordable, long-lasting, and capacious SSDs, too. (Hint: Even if you don't use them as boot drives, SATA SSDs certainly still have a place in most systems.)

Naturally, one of the easiest ways to make bigger, cheaper SSDs is improving the NAND. Recently, Western Digital (you may know them best for making excellent hard drives, decade after decade) released its family of WD Blue 3D NAND SSDs. They use the 6Gbps SATA bus, which keeps them from achieving the top-end speed of WD's faster Black PCIe SSDs, but their TLC 3D NAND makes them value kings. Using new 64-layer NAND from subsidiary SanDisk (which has a series of SSDs that also use the new flash chips), WD Blue 3D NAND SSDs deliver performance you'd expect from a 6Gbps SATA SSD with a cost per GB ranging from \$0.38/GB to \$0.31/GB. WD also gives buyers a choice in form factor—M.2 or 2.5-inch.

Another manufacturer with new SSDs that are spurring the mainstream segment is Crucial. The company's BX300 SSDs are 2.5-inch drives available in capacities of 120GB, 240GB, and 480GB. Despite a delicious \$0.30/GB for the 480GB unit, the BX300s use a complement of 3D MLC NAND. You'll find a Silicon Motion SM2258 controller under the hood. Like many of Crucial's other offerings, its BX300 SSDs also include a free copy of Acronis True Image, making them a smart option for an aging laptop in dire need of an upgrade or an inexpensive boot drive for a budget build.

Samsung, one of the pioneers in 3D NAND (which the company brands "V-NAND"), has packaged its latest stacked NAND in aluminum enclosures



**XPG SX8000 512GB**  
\$319.99 | ADATA | xpg.com



**Specs:** Interface: PCIe 3.0 (NVMe); Controller: Silicon Motion SM2260; Maximum sequential read/write: 2,500MBps/1,100MBps; Random 4KB read/write: 140,000 IOPS/150,000 IOPS; Write endurance (total bytes written): 320TB; Form factor: M.2; Warranty: 5 years

**CPU RANKING** 0 = ABSOLUTELY WORTHLESS 2.5 = ABSOLUTELY AVERAGE 5 = ABSOLUTELY PERFECT

and sent them into the world as portable powerhouses. Like the WD Blue 3D NAND SSDs, Samsung's Portable SSD T5s use 64-layer 3D NAND. The T5s are available in capacities of 250GB, 500GB, 1TB, and 2TB; the first two get a blue enclosure, while the latter two are swathed in black. They move data over the USB 3.1 Gen. 2 interface, giving them a 10Gbps highway to cruise along. The T5s natively use a USB Type-C connection, but Samsung also provides an adapter cable for USB Type-A ports. As a result, the T5s are among the fastest forms of removable storage.

Flashy PCIe SSDs grab most of the ink, but savvy power users know that well-rounded systems benefit from other types of solid-state storage. Once NAND shortages subside, expect to find 6Gbps SATA SSDs at even better prices than they are now.

### The Main Event

For our PCIe SSD battle royale, we gathered up a bunch of gumsticks (for the uninitiated, solid-state drives that use the M.2 form factor) and one add-in card and threw them into our meat grinder of benchmarks. Our tests consist of CrystalDiskMark 5.2.1 and AS-SSD 1.6.

The machine we used contains an arsenal of elite hardware. Our test system's CPU is a brand-new Intel Core i7-8700K, a 3.7GHz hexacore workhorse. We dropped it into an MSI Z370 GAMING PRO CARBON motherboard and then surrounded it with 16GB of Corsair Vengeance LPX DDR4-3000. The OS drive was a 240GB Intel SSD 730, and the system's graphics card was EVGA's GeForce GTX 1080 Ti FTW3 GAMING.

### ADATA XPG SX8000 512GB

Alongside the path of progress toward better, faster SSDs you'll see the remains of all the manufacturers who tried and failed. Once solid-state drives proved to be a viable (read: profitable) option for a majority of power users, company after company was eager to stake a claim and try to strike it rich. Alas, there are no

**CPU RANKING** 0 = ABSOLUTELY WORTHLESS 2.5 = ABSOLUTELY AVERAGE 5 = ABSOLUTELY PERFECT



**Neutron Series NX500 400GB**  
\$319.99 | Corsair | [www.corsair.com](http://www.corsair.com)



**Specs:** Interface: PCIe 3.0 (NVMe); Controller: Phison PS5007-E7; Maximum sequential read/write (ATTO): 3,000MBps/2,400MBps; Random 4KB read/write: 300,000 IOPS/270,000 IOPS; Write endurance (total bytes written): 698TB; Form factor: PCIe x4 AIC; Warranty: 5 years

participation trophies in this game, and success is far from guaranteed.

ADATA, obviously, continues to prevail. Recently the company has roared into the PCIe market with a batch of SSDs designed for the superior bus. In fact, from our view ADATA's XPG group puts equal focus on cutting-edge SSDs and DRAM. We're here to focus on the XPG SX8000, which arrived wearing a slick heat spreader. Previously, ADATA produced the SX8000 as a "bare drive," in other words, without the heat spreader. Our test drive was a 512GB unit, but ADATA makes the XPG SX8000 in three other capacities—128GB, 256GB, and 1TB.

Look underneath the SX8000's heat spreader, and you'll find a Silicon Motion SM2260 storage controller. This is the same controller that calls the shots in Intel's SSD 600p series of mainstream PCIe SSDs, but instead of lining the SX8000's PCB with 3D TLC NAND

the way Intel did (thus making a clear distinction between its SSD 600p and SSD 750 families) ADATA equipped the SX8000 with 3D MLC NAND, a superior performer.

Thanks to the MLC NAND, ADATA is able to rate all of the SX8000 drives' sequential performance (with the lone exception of the 128GB drive) beyond 1,000MBps. Specifically, the 512GB SX8000 manages sequential reads and writes of 2,500MBps and 1,100MBps, respectively, in CrystalDiskMark, putting it on the same level as the 1TB SX8000 in terms of raw performance. It concedes a little to the biggest SX8000 in random 4KB reads (140,000 IOPS vs. 160,000 IOPS) but is a little faster with random 4KB writes; in the latter workload the 1TB SX8000 tops out at 140,000 IOPS, while the 512GB drive is a notch faster—150,000 IOPS.

ADATA has at least one trick up its sleeve that it uses to give the SX8000

... there's no denying the NX500's 698TB TBW (total bytes written) is heads, shoulders, a maybe even a sternum above the other SSDs in this roundup.

a performance edge. It uses a cache of SLC NAND, something ADATA has implemented in a number of its other drives. Essentially, some of the NAND behaves like SLC, theoretically giving the SX8000 a little extra juice. Now, smart enthusiasts know that things like SLC caching won't magically transform the SX8000—or any SSD—into a miracle drive that destroys all challengers, but we'll still take every little performance advantage we can get.

In our benchmarks, the XPG SX8000 largely lived up to ADATA's billing. Perhaps the biggest surprise here is the drive's 4K random write performance at a queue depth of 1, which tends to be one of the most important workloads for power users. The XPG SX8000 turned out to be the best of the bunch in AS-SSD's 4K random write tests at QD1, and it nearly took the crown in CrystalDiskMark's corresponding test. Beyond that, ADATA's drive was consistently good in QD1 testing, with the notable exception of lagging somewhat in 4K reads.

Take a gander at the XPG SX8000's \$320 MSRP, and then put your eyeballs back in their sockets. In truth, the drive sells for much less online, where we were able to find the 512GB version with the new heat spreader for around \$210. You'll pay even less if you opt for the older version

that doesn't include a heat spreader. Either way, that's a great value.

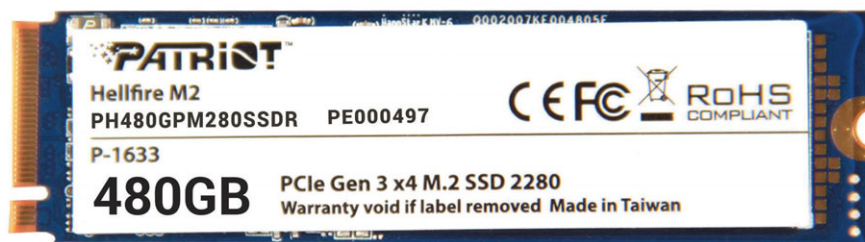
### Corsair Neutron Series NX500 400GB

If you want a case study in judging books by their covers, look no further than a side-by-side of Corsair's new Neutron Series NX500 and Patriot's Hellfire. The former arrives in a nice-sized box with a big picture of the drive, plus a brag line of its throughput in various workloads; the drive itself is tucked inside a thick cardboard box. The latter is contained with a humble blister pack, similar to the packaging used in all varieties of impulse aisle knick-knacks. The NX500 includes a massive heatsink enclosure that runs the length of the PCIe add-in card. The Hellfire is essentially a bare drive, dressed up only in a product sticker that informs users of the basics (model number, capacity, and so forth). Based on this information, we'd forgive you for thinking these SSDs are from different galaxies, much less planets.

Strip away all the finery, though, and you're left with two PCIe SSDs with a remarkably similar genetic makeup. The underlying controller for both of these drives is the same. You're getting a Phison PS5007-E7 chip regardless of how you choose to swear allegiance. The NX500 and Hellfire also have the same type of NAND, 15nm Toshiba MLC in this case. Now the script has flipped, and it's Patriot that gives you all the essentials at a lower cost, while Corsair attaches a pretty housing (admittedly, there are practical benefits to using a heatsink on these drives) and jacks up the cost.

If only matters were that simple. In truth, Corsair has remixed the Phison controller and Toshiba NAND to the point where we have to consider the NX500 and Hellfire as definitely similar but distinctly different SSDs. For example, you were right to wonder about the NX500's 400GB capacity. (An 800GB version is also available.) Corsair has overprovisioned a much larger chunk

of NAND in pursuit of higher performance. Further, the NX500 has a double serving of DRAM cache, sporting 1GB compared to the Hellfire's 512MB. Write endurance tends to be a bit of an overhyped metric, but there's no denying the NX500's 698TB TBW (total bytes written) is heads, shoulders, a maybe even a sternum



**Hellfire 480GB**  
\$259.99 | Patriot | [www.patriotmemory.com](http://www.patriotmemory.com)



**Specs:** Interface: PCIe 3.0 (NVMe); Controller: Phison PS5007-E7; Maximum sequential read/write (ATTO): 3,000MBps/2,400MBps; Random 4KB read/write (aligned): 170,000 IOPS/210,000 IOPS; Form factor: M.2; Warranty: 3 years

**CPU RANKING** 0 = ABSOLUTELY WORTHLESS 2.5 = ABSOLUTELY AVERAGE 5 = ABSOLUTELY PERFECT

**OCZ RD400 512GB**\$239.99 | Toshiba | [www.ocz.com](http://www.ocz.com)

**Specs:** Interface: PCIe 3.0 (NVMe); Controller: Toshiba TC58NCP070GSB; Maximum sequential read/write: 2,600MBps/1,600MBps; Random 4KB read/write: 190,000 IOPS/120,000 IOPS; Write endurance (total bytes written): 296TB; Form factor: M.2; Warranty: 5 years

above the other SSDs in this roundup. Now things are getting interesting.

On paper, it seems as though Corsair's approach gives it an edge. Based on Corsair's internal testing, the NX500 is a world-beater. In ATTO, sequential reads/writes can be as high as 3,000MBps/2,400MBps. Corsair's CrystalDiskMark sequential results are nearly as impressive—2,800MBps and 1,600MBps for sequential reads and writes, respectively. In Iometer, the NX500 can reportedly achieve staggering throughput, with Corsair claiming random reads and writes of 300,000 IOPS and 270,000 IOPS, respectively.

Packaging and specs sheets start the narrative, but benchmarks finish it. Corsair's drive consistently excelled when it could chew on a heavy workload at a high queue depth. Indeed, nothing beat it in any of CrystalDiskMark's QD32 tests, and it also outraced the competition in AS-SSD's 64Thrd tests. Take your foot off the gas, to speak, and test at a queue

depth of 1, though, and the NX500's lead shrinks considerably in most tests when compared to the Hellfire drive. With the exception of CrystalDiskMark's sequential tests, the NX500 and Hellfire essentially ran neck and neck in QD1 testing. Some enthusiasts want the best of the best, but there are many, many others who are more than content with "close enough." You know who you are; make the call yourself.

At long last, we come to end of our story of Phison vs. Phison, Toshiba NAND vs. Toshiba NAND. As usual, online prices for the NX500 were lower than Corsair's MSRP. We had the chance to buy a drive for 300 bucks, but you might be more successful. Either way, the NX500 is the most expensive drive of the bunch. There's no doubt it looks fantastic, and for the most part it delivers performance to match. Now that you know a little more about books, and their covers, you can decide accordingly how much that matters.

**CPU RANKING** 0 = ABSOLUTELY WORTHLESS 2.5 = ABSOLUTELY AVERAGE 5 = ABSOLUTELY PERFECT

**Patriot Hellfire 480GB**

Since its earliest solid-state drives, Patriot has played with fire. Rather than making questionable and/or risky design decisions, though, Patriot has given its SSDs incendiary names. Recall early offerings such as the Blaze, Inferno, Pyro, and Wildfire. The company's current lineup consists of the Spark, Torch 2, and Ignite, but none of these can manage the raw power of the flagship Hellfire PCIe SSDs. Available in two capacities, 240GB and 480GB, the Hellfire SSDs have been on the market for a year and change, but they're no less potent now than they were at launch.

With a few exceptions, a lot of companies have formed partnerships with fabless semiconductor companies to deliver high-end SSDs. (Remember the reign of SandForce during 6bps SATA SSD glory days?) The Hellfire certainly fits this description. Phison's PS5007-E7 storage controller acts as the brain of this SSD; the chip yields top-end throughput without driving prices through the roof. It's a great decision for Patriot, as it makes the Hellfire a solid competitor in a market that will only grow more competitive over time. (Unlike 6Gbps SATA, the PCIe bus offers plenty of headroom for future SSDs to take advantage of.)

Toshiba 15nm NAND, another popular industry choice, fills up the M.2 stick. We noticed that Patriot installed Toshiba's NAND on both sides of Hellfire's PCB. We highly doubt this will be an issue for desktop users installing the Hellfire in a motherboard's M.2 slot, but you might want to double-check that the physical footprint won't be a problem for a potential laptop upgrade. It's unlikely but not impossible. Patriot rounds out the package with a 512MB cache of DDR3L.

The Phison controller and Toshiba NAND combine to give the 480GB Hellfire smokin' performance. According to Patriot's internal testing, the Hellfire sizzles in CrystalDiskMark, reading data sequentially at up to 2,550MBps and writing it at 1,260MBps. Random performance is also great. Patriot's top-of-the-line solid-state drive can turn in

random 4K writes up to 210,000 IOPS and 4K reads up to 170,000 IOPS.

As far as performance in our testing goes, if you come for the highs, you also have to stay for the lows. In AS-SSD's sequential read test, it crushed the field with a throughput of 2,335.64MBps, almost 250MBps faster than the runner-up. In a handful of other tests, the Hellfire itself was the clear runner-up, and it was consistently good in 4K write testing. However, in several tests the Hellfire finished at the back of the pack, so you'll have to be willing to accept a few tradeoffs. However, don't equate "last" with "bad." Patriot's PCIe SSD is very fast, even if the results are somewhat uneven.

Patriot sells the 480GB Hellfire in its online store for \$259.99. With some diligent searching, you should be able to score one slightly cheaper from a third party, but 260 bucks is a pretty hot deal for this solid-state drive.

### Toshiba OCZ RD400 512GB

Many, many power users grew up alongside OCZ. They were there when the company rolled out its earliest kits of high-performance, overclockable DRAM. More than a few of that same crowd also snatched up OCZ power supplies after OCZ acquired PC Power & Cooling in 2007. (Fun fact: PCP&C is once again an independent entity, but that's another story for another day.) And when OCZ introduced its first Vertex solid-state drives, you'd better believe that loyalists lined up to get their hands on one or two.

During its heyday, OCZ had an uncanny knack for finding the right IP and bringing under its roof. In addition to PCP&C, OCZ, realizing early on that taking over as much control as possible over solid-state drive R&D could yield big benefits, put Indilinx in its crosshairs in order to make its own storage controllers. It's rather fitting, then, that Toshiba spotted OCZ's enthusiast cachet and grabbed the San Jose, Calif. company in early 2014, as the latter proceeded through bankruptcy. Now, OCZ lives on as Toshiba's enthusiast brand.

So call the RD400 whatever you want—the OCZ RD400, the Toshiba OCZ RD400, we don't care—it's a damn good SSD from two companies that have plenty of history making damn good drives. For evidence of that expertise, look no further than the RD400's advertised specs: According to Toshiba, this 512GB SSD is capable of 2,600MBps and 1,600MBps sequential reads and writes, respectively, when testing with ATTO. Using Iometer to measure the RD400's random 4KB performance, Toshiba recorded reads up to 190,000 IOPS and writes up to 120,000 IOPS. Depending on the capacity you choose (the RD400 is available in capacities of 128GB, 256GB, 512GB, and 1TB), most of those numbers will vary, but all of them are terrific.

The RD400 achieves these lofty numbers with a lot of Toshiba silicon beneath the OCZ branding. The controller is Toshiba's TC58NCP070GSB, which gets the benefit of Windows drivers aimed at optimizing it for desktop use, and the NAND is, unsurprisingly, 15nm Toshiba MLC. In the increasingly rare event that you don't have an M.2 slot to spare for the RD400, Toshiba has you covered with the RD400A, which includes a PCIe x4 adapter card. That'll increase the cost of the package by about 20 bucks or so, but the tradeoff is increased flexibility when installing the SSD.

In our benchmarks, the RD400 was always good, regularly great, and a few times unbeatable. In CrystalDiskMark, its QD1 I/O was almost the best across the board. It lagged a little in the 4K read test, but only by a couple MBps. Considering it was also near the top of the heap in all of CDM's

other tests, that's the kind of consistent performance we love. It also dominated AS-SSD's sequential and 4K write tests. The RD400 battled Corsair's NX500 punch for punch, each one taking turns landing haymakers.

The RD400 was the one SSD that sells online at the MSRP Toshiba specifies. You might even call its official \$239.99 price the "Amazon MSRP." However, don't you dare think you're not getting a good deal by paying full price. Here we are, eight years after the first OCZ Vertex drive, and its solid-state drives are still outstanding.

### Western Digital WD Black PCIe SSD 512GB

Imagine you're one of the best swordsmiths in town, maybe even the best if you listen to the chatter of the warriors you've impressed with your work. Before long, everyone is using your blades, and it stays that way for years. Then, one day you notice your foot traffic isn't quite what it used to be, so you step away from your anvil, take a peek out of your shop window, and see the same people who used to line up for your weapons instead lined up outside another shop.



WD Black PCIe SSD 512GB  
\$194.99 | WD | www.wdc.com



**Specs:** Interface: PCIe 3.0 (NVMe); Controller: Marvell 88SS1093; Maximum sequential read/write: 2,050MBps/800MBps; Random 4KB read/write: 170,000 IOPS/134,000 IOPS; Write endurance (total bytes written): 160TB; Form factor: M.2; Warranty: 5 years

**CPU RANKING** 0 = ABSOLUTELY WORTHLESS 2.5 = ABSOLUTELY AVERAGE 5 = ABSOLUTELY PERFECT



That shop sells guns.

A few years ago, Western Digital faced a similar predicament. Remember its Raptor hard drives? These were the boot drives you bought before solid-state drives. Now, WD has recognized that magnetic storage has had its time in the spotlight. Obviously, the company still makes hard drives and will continue doing so for the foreseeable future, but we love that WD has diversified its portfolio. As we mentioned earlier, the WD Blue 3D NAND SATA SSDs are an intriguing IPO. However, WD's blue-chip stock remains the WD Black PCIe SSD, which is available in two capacities: 256GB and 512GB. We took the half-terabyte unit for a spin.

Last year, WD wrote a \$19 billion check to buy SanDisk, instantly setting itself up with the means to crank out SSDs (a neat trick that SanDisk itself pulled off a few times, with acquisitions of Fusion-io, SMART Storage Systems, etc.). The WD Black is one of the first fruits of the purchase, as its PCB is lined with SanDisk's 15nm TLC NAND. It boasts Marvell's 88SS1093 as its storage controller, a popular choice we've seen other high-end SSDs use to good effect.

As far as rated performance goes, the WD Black PCIe SSD straddles the line between top-of-the-line and friendly-on-your-pocketbook. As far as read operations go, the WD Black is impressive, with sequential reads up to 2,050MBps and random reads topping out at 170,000 IOPS. However, take a gander at WD's advertised write performance, and you'll see the limitations of the WD Black's TLC NAND. It musters a sequential write throughput of 800MBps, and random 4KB writes peak at 134,000 IOPS. We're still solidly beyond the boundary of what you can achieve over 6Gbps SATA, but be sure to remember that alluring sub-\$200 price tag does come with a few disclaimers.

How much you believe the WD Black is the budget hero we deserve depends largely on how much you value write performance. If you focus only on this SSD's read performance, you might convince yourself that every

other manufacturer in this roundup is trying to sucker you into paying too much for a PCIe SSD. For example, the drive was surprisingly good at 4KB reads in CrystalDiskMark, posting the highest QD1 random read. When you inspect those write scores, however, the performance limitations of TLC NAND are clear. WD was wise to specify an 800MBps write threshold, because that appeared to be its upper limit when we tested it.

But like every observation in this roundup, context is key. At just over \$0.38/GB, Western Digital's flagship PCIe SSD comes dangerously close to 6Gbps SATA SSD prices, and that's a very good thing. Not every power user has a blank check at their disposal when the time comes to build a new system or

upgrade an old one. For these buyers, WD can step in and offer them a very compelling option. We think your \$195 will be money well spent.

### Gumstick Goodness

Collectively, these drives show the wide range of options available to power users picking out a new PCIe SSD. In particular, we're starting to see a middle ground emerge between powerful, but expensive, PCIe SSDs and value-oriented 6Gbps SATA SSDs. As a result, if your budget doesn't quite let you reach for the top shelf, there are lots of options that still give you the blazing-fast throughput that makes PCIe SSDs all-around all-stars. ■

BY VINCE COGLEY

## Life In The Fast Lanes

Benchmark Results (All results in MBps)	ADATA XPG SX8000 512GB	Corsair Neutron Series NX500 400GB	Patriot Hellfire 480GB	Toshiba OCZ RD400 512GB	Western Digital WD Black PCIe SSD 512GB
<b>CrystalDiskMark 5.2.2</b>					
Sequential Read (QD32)	2459	2839	2659	2604	1941
Sequential Write (QD32)	1144	1555	1081	1604	827.2
4K read (QD32)	533.2	829.3	518.9	776.2	663.3
4K write (QD32)	579.6	708.4	614.5	594.9	547.9
Sequential Read	1380	1342	1104	1527	1249
Sequential Write	1067	1187	725.6	1291	827.4
4K read	40.33	47.91	43.74	46.42	48.70
4K write	184.1	167.2	161.9	187.2	154.7
<b>AS-SSD 1.6</b>					
Sequential Read	1758.72	2088.91	2335.64	1751.02	1337.29
Sequential Write	1104.24	1212.61	1222.36	1309.91	767.56
4K Read	24.17	55.78	55.85	32.77	29.61
4K Write	151.92	120.82	121.65	137.07	122.30
4K Read (64 Thrd)	632.24	882.88	779.17	853.51	651.69
4K Write (64 Thrd)	710.08	739.54	671.38	632.31	523.86
<b>Test system specs:</b> CPU: Intel Core i7-8700K; Motherboard: MSI Z370 GAMING PRO CARBON; RAM: 16GB Corsair Vengeance LPX DDR4-3000; Graphics card: EVGA GeForce GTX 1080 Ti FTW3 GAMING; OS drive: Intel SSD 730 Series 240GB; OS: Windows 10 Enterprise					

**CPU RANKING** 0 = ABSOLUTELY WORTHLESS 2.5 = ABSOLUTELY AVERAGE 5 = ABSOLUTELY PERFECT



VS.



## AMD Ryzen Threadripper 1950X vs. Intel Core i9-7980XE

We just got our hands on the high-end enthusiast-grade flagship processors from Intel and AMD, so rather than doing two standalone reviews, we're throwing them into the ring and letting 'em slug it out to the bitter end. Because let's face it, if you can conceivably mega-task enough to justify a 16-core processor, an 18-core chip wouldn't go underutilized either.

you're using a high-quality aftermarket CPU cooler, AMD's Extended Frequency Range (XFR) technology kicks in to give those four cores another 200MHz bump in clock speed.

All told, there are two pairs of CCX (CPU Complex) units that consist of four cores, each capable of handling two threads, connected to 8MB of 16-way L3 cache, made up of four slices. According

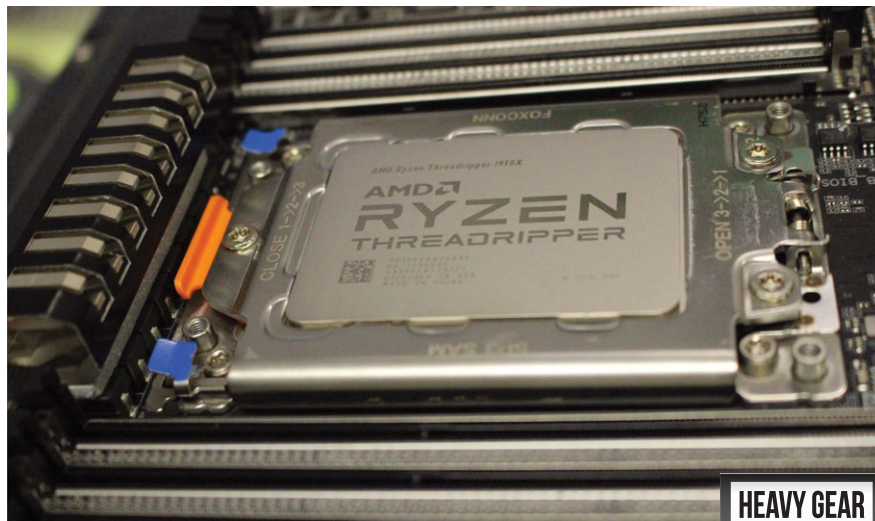
to AMD, each core can access every cache with the same average latency. The 96KB of L1 cache dedicated to each core is split, with 2/3rds for instructions, and the remaining 1/3rd for data. The L2 cache is a 512KB block of 8-way associative memory that is strictly inclusive of the instruction and data caches. The ever-important L2 cache has 32-byte interfaces between it and the L1 and L3 caches. In

### Ryzen Threadripper 1950X

When the Ryzen 7 processors launched, the Threadripper little more than a rumor. But looking at how the highly modular Zen cores were designed, in tandem with Infinity Fabric—the purpose-built interface and do-it-all bus—we really should've seen it coming.

The Ryzen Threadripper 1950X, the flagship processor for AMD's new X399 platform, is manufactured on the same 14nm FinFET process as the rest of the Ryzen family. Its 16 cores have Simultaneous Multithreading (SMT) enabled for handling up to 32-threads. This chip is essentially two 192mm<sup>2</sup> Summit Ridge Ryzen 7 dies on an Infinity Fabric foundation; 9.6 billion transistors in total. Under the heatspreader, these two modules are paired with two more nonfunctioning dies to help stabilize the IHS on this gargantuan 72mm by 55mm chip.

The 1950X's base clock is set to 3.4GHz, and the processor can increase clockspeed in 25MHz increments up to a max Precision Boost clock of 4GHz, applied to up to four cores at a time. If



### Ryzen Threadripper 1950X

\$999 | AMD | [www.amd.com](http://www.amd.com)

HEAVY GEAR  
4.0 OUT OF 5  
CPU

**Specs:** Clock speed: 3.4GHz (base), 4GHz (4-core P. Boost), 4.2GHz (4-core XFR); 16-cores; unlocked multiplier; Socket TR4, Quad-channel memory; 32MB L3 Cache; SMT; 64 PCIe lanes; 14nm FinFET; 180W TDP

**Test System Specs:** Processor: AMD Ryzen Threadripper 1950X; Motherboard: GIGABYTE AORUS X399 Gaming 7; Graphics Card: EVGA GTX 1080 Ti FTW3; RAM: Corsair Dominator 32GB DDR4-3200; Storage: 480GB Patriot Hellfire m.2 SSD; OS: Windows 10 Enterprise 64-bit

**CPU RANKING** 0 = ABSOLUTELY WORTHLESS 2.5 = ABSOLUTELY AVERAGE 5 = ABSOLUTELY PERFECT

total, the Threadripper 1950X has 32MB of L3 cache, and 8MB of L2 cache.

Each half of the Threadripper gets access to its own pair of memory channels, on up to four DIMMS. That's quad-channel memory we're talking about here, and each pair of CCX units can still tap into the other's bank of memory if needed. If Infinity Fabric has one chink in its armor, it's that it requires fast memory to perform optimally. Near memory fetches can be performed in 78ns whereas far memory fetches occur in just 133ns. There's 102.22GBps die-to-die bi-directional bandwidth, and the processor can run in Distributed Mode (UMA) for applications that prefer wide DRAM access, or Local Mode (NUMA) for applications that prefer fast DRAM access.

There are 64 PCIe lanes available on the 1950X, 1920X, and 1900X Threadripper SKUs, with four set aside for the chipset, the remaining 60 can be used for graphics cards, NICs, SSDs, and other I/O devices. But what are you going to do with all of those lanes? AMD's suggested configuration consists of 48 lanes dedicated to 4-way SLI or CrossFireX (16/16/8/8), and the remaining 12 lanes for M.2 slots for 3-way x4 NVMe devices. We recently learned that Threadrippers on X399 will get access to bootable RAID 0, RAID 1, and RAID 1+0 with up to ten devices.

Although this is a 180-watt processor, Zen was built to be power-efficient from the word go. Features that bear this out include aggressive clock gating with multi-level regions, a large micro-op cache capable of limiting power-sucking faraway fetches, and a stack engine that results in low power address generation into the dispatcher. Another trick up Infinity Fabric's sleeve is support for sophisticated command and control capabilities, such as the ability to read real-time core voltage, temperature, power draw, and clockspeed as well as make granular adjustments to all of the above on-demand.

In the benchmarks, Threadripper's single-core performance is right on par with the Ryzen 7s, but in instances where memory bandwidth was a limiting

factor, the 1950X pulls significantly ahead. When it comes to multi-core performance, Threadripper's forte, it's clear this chip will take whatever you throw at it with aplomb. AMD told us that the cores that make up Threadripper are the top 5% of the Zen cores to come off each wafer, and it shows. Overclocking also produced good improvements across the board, narrowing the Intel Core i9-7980XE's advantage at stock, even with its two fewer cores.

### Intel Core i9-7980XE

If there's one thing we lament in all of Intel's recent processor launching frenzy, it's that the true star of the show, the Core i9-7980XE, the processor that shows just how plucky Intel can be when backed into a corner, was released with little to no real fanfare. The Skylake-X media blitz was months ago and Coffee Lake's launch was abruptly brought forward thanks to

yet another leak. We liked the Core i9-7900X when it launched in June, but this processor is all of that and more.

Architecturally speaking, we already know what's under the IHS of Intel's new HEDT flagship. This is an 18-core processor that can handle up to 36 concurrent threads at once thanks to Hyper-Threading technology. Intel's 14nm Tri-Gate transistor-based process yields a die that, impressively, fits into a processor that's the same size as the 10-core Core i9-7900X we tested a few months ago.

Compared to the original Skylake processors that came out in late 2015, this monster can handle a good amount more clock frequency when it has the thermal capacity to spare. While base clock on this processor looks low, at 2.6GHz, when we were running our benchmarks, this speed seemed the exception more than the rule. This number is more like a worst-case



#### Core i9-7980XE

\$1,999 | Intel | [www.intel.com](http://www.intel.com)

HEAVY GEAR

3.5 OUT OF 5

CPU

**Specs:** Clock speed: 2.6GHz (base), 4.2GHz/4.2GHz/4GHz (Turbo Boost single-core/dual-core/quad-core), 4.4GHz (Turbo Boost Max 3.0); 18-cores; unlocked multiplier; Socket R4 (LGA 2066), Quad-channel memory; 24.75MB Intel Smart Cache; Hyper-Threading; 44 PCIe lanes; 14nm; 165W Max TDP

**Test System Specs:** Processor: Intel Core i9-7980XE; Motherboard: ASRock X299 Taichi; Graphics Card: EVGA GTX 1080 Ti FTW3; RAM: Corsair Dominator 32GB DDR4-3200; Storage: 480GB Patriot Hellfire m.2 SSD; OS: Windows 10 Enterprise 64-bit

**CPU RANKING** 0 = ABSOLUTELY WORTHLESS 2.5 = ABSOLUTELY AVERAGE 5 = ABSOLUTELY PERFECT

guarantee, but all eighteen cores tended to bottom out at 3.4GHz a majority of the time. Turbo Boost Technology 2.0 lets the Core i9-7980XE clock up to 4GHz for four cores, and 4.2GHz for one or two cores. When it has sufficient power and thermal headroom, Turbo Boost Max 3.0 will single-out a pair of the chip's best-performing cores and let them run up to 4.4GHz.

Intel's answer to the Threadripper has 44 PCIe lanes. That's a full four more than the Broadwell-E supported on the CPU, but 20 fewer than are on AMD's Threadripper processors (16 if you don't count the four AMD dedicates to the chipset). Although 44 lanes is plenty for most enthusiasts, you are somewhat limited on what you can do with them out-of-the-box. If you want to get a bootable NVMe RAID 1, 1+0, or 5 going with two or more devices, you'll need to invest in a VROC (Virtual RAID On CPU) key, starting at \$100. Bootable RAID 0 is supported by default, however.

The memory controller in the Core i9-7980XE has also been updated to support DDR4-2666, just like the rest of the Skylake-X processors launched in June. Back in our review of the Core i9-7900X, we talked about the shuffled cache hierarchy, away from a large pool of shared LLC (Last Level Cache), to a sizeable chunk of private MLC (Mid-Level Cache), to the tune of 24.75MB accessible to each of the processor's 18 cores. This is one way in which Skylake-X gains ground on the original Skylake processors.

Another new feature of this series of processors is the AVX-512 instructions set, which is designed to improve performance for scientific simulations, financial analytics, AI, deep learning, and more. When you look at the benchmarks, this feature is largely responsible for Intel's massive advantage over the Threadripper 1950X in SANDRA's Processor Multimedia tests. There's also support for Intel SpeedShift technology, which lets the processor change P states in as little as 1ms. All told, Intel improved the front-end, made the out-of-order buffers deeper, increased

the execution unit count, and raised the load/store bandwidth.

We overclocked the Intel Core i9-7980XE to 4.5GHz, across all cores, with a 1.22V core voltage, but when we ran POV-Ray, the processor package was reportedly drawing 357-watts and a few of the cores were running at over 100 degrees C. At stock, this thing stays at a cool 61 degrees with an AIO liquid cooler, and draws a mere 187-watts at most.

The Intel Core i9-7980XE is undeniably a massively powerful processor, and if you have the stomach for it, it's an overclocking

champ. It's also a \$2,000 processor, and Intel is no longer competing against itself. The Threadripper 1950X, with its plethora of PCIe lanes and near multi-thread performance parity, costs half as much. With the money left over, you could actually afford to fill a couple of those PCIe slots. This generation, the playing field has changed, and Intel's radical response just wasn't radical enough to win us over. Buy the Threadripper, and you won't regret it. ■

BY ANDREW LEIBMAN

	Threadripper 1950X	Threadripper 1950X @ 3.9GHz	Core i9-7980XE	i7-7980XE @ 4.5GHz
<b>3DMark Fire Strike Ext.</b>	13,302	13,349	13,344	13,514
Graphics Score	13,750	13,744	13,826	13,754
Physics Score	26,336	27,575	26,247	33,513
Graphics Test 1	71.72fps	71.99fps	72.68	71.78
Graphics Test 2	51.26fps	51.08fps	51.25	51.25
Physics Test	93.61fps	87.54fps	83.32	106.39
Combined Test	31.14fps	31.21fps	31.05	31.03
<b>PCMark 10 Score</b>	5,435	5,611	6,570	7,430
<b>Sandra 2017 Platinum</b>				
Dhrystone Integer Native AVX2 (GIPS)	538.74	634.6	688.72	870.21
Whetstone Single-float Native AVX (GFLOPS)	369.9	397.35	406.68	511
x128 Multi-Media Integer AVX512/BW (Mpixels/sec.)	978.12	1,090	2,310	2,800
x64 Multi-Media Long-int AVX512/DQW (Mpixels/sec.)	327.46	361.66	850.26	1,000
x1 Multi-Media Quad ALU (Gpixels/sec.)	7.12	8	8.16	9.78
Integer Memory Bandwidth B/F AVX512/512 (GBps)	61.23	61.4	58.34	58.83
Floating Memory Bandwidth B/F AVX512/512 (GBps)	60.7	60.81	59.72	59.79
<b>Cinebench 15 (Points)</b>	2,960	3,341	3,334	4,240
<b>POV-Ray 3.7 (Pixels/sec.)</b>	5,707	6,495.14	6,639.58	8,519.19
Sniper Elite 4 (Vsync Off, Ultra, DX12)	143.56fps	146.39fps	108.08fps	108.6fps
The Witcher 3 (Vsync off, Unl.fps, Ultra)	109.17fps	112.95fps	138.08fps	131.78fps

**CPU RANKING** 0 = ABSOLUTELY WORTHLESS 2.5 = ABSOLUTELY AVERAGE 5 = ABSOLUTELY PERFECT

# Z11 NEO

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## GIGABYTE AORUS X399 Gaming 7

When reviewing AMD's Ryzen processors and the X370 chipset, we bemoaned the lack of PCIe lanes, which limited support for enthusiast builds with multiple GPUs and PCIe SSDs. We have no such concerns with the Ryzen Threadripper processors and the X399 chipset. Astoundingly, every Threadripper chip includes 64 PCIe 3.0 lanes, and 60 of the lanes can be allocated to PCIe devices. X399 also introduces support for quad-channel memory to match the memory bandwidth of Intel's Skylake-X processors and X299 chipset. GIGABYTE's AORUS X399 Gaming 7 is currently one of the more expensive X399 options on the market at \$389.99, but GIGABYTE justifies the price by filling out the PCB with performance and aesthetic enhancements.

Designing a motherboard for the X399 platform has to be a bit of a challenge for motherboard manufacturers. The TR4 socket is huge—nearly as long as the DDR4 DIMM slots on either side

of the socket. The fact that most X399 motherboards include eight DDR4 DIMM slots further compounds the problem, as almost the entire top half of the mainboard is reserved for the processor and memory, there's not a great deal of space for VRM and heatsinks. Still, GIGABYTE manages to install server-class level chokes and fairly substantial VRM heatsinks. The AORUS X399 Gaming 7 also powers Threadripper with an 8-pin and 4-pin CPU power connector.

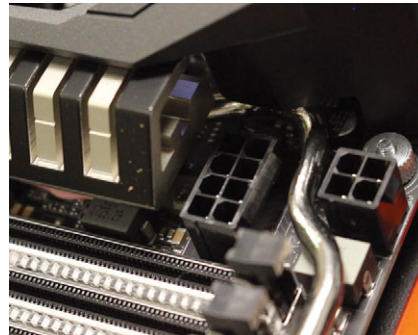
The layout on the bottom half of the board is just as tight as the top. There are four PCIe 3.0 x16 slots, as well as one oddball PCIe 2.0 x16 slot. GIGABYTE allocates 48 of Threadripper's 60 lanes to the PCIe 3.0 expansion card slots, so you can install up to 4-way (x16/x8/x16/x8) and 3-way (x16/x8/16) GPU configurations. For 2-way SLI or CrossFire, you'll want to install the GPUs into the first and fourth slots.

The aforementioned PCIe x16 2.0 slot, which is wired for x4 speed, sits

in the middle of the expansion slots. We don't imagine there are many configurations where you'd need this slot, considering most people could use one of the free PCIe x16 3.0 slots—barring a 4-way SLI or CrossFire build. GIGABYTE might have been better off allocating the PCIe 2.0 slot's resources to add another USB 3.1 port or two USB 3.0 ports.

Three M.2 slots use up the 12 remaining Threadripper PCIe 3.0 lanes—giving each M.2 slot up to 32Gbps of bandwidth for PCI, NVMe SSDs. Two M.2 slots (located under the first and fourth PCIe 3.0 x16 slots) can work with 2260/2280/22110 form factors. The other M.2 slot is a bit shorter, supporting type 2242/2260/2280, and is positioned under the PCH heatsink. All the M.2 slots boast built-in thermal guards to prevent throttling. We also like that GIGABYTE uses captive screws in the thermal guard, so you won't lose the tiny screws during installation.

**CPU RANKING** 0 = ABSOLUTELY WORTHLESS 2.5 = ABSOLUTELY AVERAGE 5 = ABSOLUTELY PERFECT



GIGABYTE provides a few other tricks to help you keep heat under control. The board features nine temperature sensors, as well as two headers where you can install two of the included thermistor cables. Within GIGABYTE's Smart Fan 5 software utility, you can control fan speed based on a given thermal reading. The eight fan headers support both PWM and voltage mode, and the latter is ideal for use with liquid-cooling pumps.

Anyone familiar with GIGABYTE's motherboards won't be surprised by the onboard audio and networking additions. Creative's SoundBlaster 720 audio engine is included to enrich the audio experience, which is run by Realtek's ALC1220 codec. WIMA and Nichicon audio capacitors are onboard to deliver high-fidelity lows and highs. The wired NIC is Killer's E2500, while Intel's AC 8265 brings support for dual-band Wi-Fi.

Given the stellar appearance of every AORUS board we've reviewed, we're not surprised that the AORUS X399 Gaming 7 has exceptional aesthetics. There are RGB LEDs between each DIMM slot, on each PCIe x16 slot, the PCB, the rear I/O panel, and the audio cover. Additionally, GIGABYTE provides two RGB LED strip headers and one digital LED header for third-party RGB components. We also like

that GIGABYTE provides two RGB LED extension cables to help you ideally position LED strips.

AMD's Ryzen Threadripper 1950X is an absolute powerhouse of a CPU, and we installed it on the AORUS X399 Gaming 7 to show off what kind of benchmark scores you might see with this mainboard. In 3DMark's Physics test, for example, our test build produced a score of 26336. AMD's Ryzen 1800X, by comparison, generally only scores around 18000. Our test rig only has one GPU—GIGABYTE's AORUS GeForce GTX 1080 Ti 11G—but it did well with gaming tests with more than 100fps in all of our tests. Even with our power-hungry hardware and strenuous benchmark tests, the AORUS X399 Gaming 7 had no problems.

GIGABYTE continues to do excellent work with its AORUS motherboard lineup. The \$389.99 price tag reflects the high-end additions, such as the M.2 thermal guards, RGB lighting, and abundant expansion slot and storage options. And with current X399 motherboards starting at around \$350, you aren't paying a great deal more for the power user extras. ■

BY NATHAN LAKE

**Specs:** Max memory: 128GB (DDR4-2667; Max OC: DDR4-3600); Slots: 4 PCIe 3.0 x16 (2 at x16, 2 at x8), 1 PCIe 2.0 x16 (wired at x4); Storage: 3 M.2 (1 type 2242/2260/2280, 2 type 2260/2280/22110), 8 6Gbps SATA; Rear I/O: 2 USB 3.1 (1 Type-A, 1 Type-C), 8 USB 3.0, 1 PS/2, 1 Ethernet, audio I/O, 1 S/PDIF, two antenna connectors; Form factor: ATX; Warranty: 3 years

**Test System Specs:** Processor: AMD Ryzen Threadripper 1950X; GPU: GIGABYTE AORUS GeForce GTX 1080 Ti 11G; Memory: 32GB Corsair Vengeance LED 32GB DDR4-3200MHz; Storage: 480GB Patriot Hellfire; OS: Windows 10 Enterprise

**CPU RANKING** 0 = ABSOLUTELY WORTHLESS 2.5 = ABSOLUTELY AVERAGE 5 = ABSOLUTELY PERFECT

Benchmark Results	GIGABYTE AORUS X399 Gaming 7
3DMark Fire Strike	13302
Graphics Score	13750
Physics Score	26336
PCMark 10	5435
Essentials	8302
Productivity	6966
Digital Content Creation	7533
SiSoftware Sandra 2017	
Dhrystone AVX2 (GIPS)	538.74
Whetstone AVX (GFLOPS)	369.9
Multi-Media Integer AVX2 x32 (Mpixels/s)	978.12
Multi-Media Long-int AVX2 x16 (Mpixels/s)	327.46
Multi-Media Quad ALU x1 (Mpixels/s)	7.12
Floating B/F AVX/128 (GBps, mem bandwidth)	60.7
CrystalDiskMark 5.1.2 (MBps)	
Sequential Read (Q32T1)	2777
Sequential Write (Q32T1)	1301
Random 4K Read (Q32T1)	445
Random 4K Write (Q32T1)	3672
POV-Ray 3.7 (Pixels/s)	5707
Cinebench 15 (Points)	2960
Games	(2,560 x 1,400)
Metro: Last Light (Very High, 16xAF, SSAA off)	106fps
Sniper Elite 4 (VSync off, Ultra, DX12)	144fps
Witcher 3: Wild Hunt (Vsync Off, Unl. FPS, Ultra)	109fps



**Radeon RX Vega 64  
Liquid Cooled Edition**  
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## AMD Radeon RX Vega 64 Liquid Cooled Edition

For Team Red fans, or just fans of competition, it has been a very long wait for AMD's response to NVIDIA's GeForce 10 Series. But in the weeks and months leading up to the August 14th launch of AMD's first high-end GPU since the likes of the Radeon R9 Fury X, the company's Ryzen, EPYC, and Threadripper processors have all helped the beleaguered chipmaker effectively pull the rug out from underneath Intel in a way that few could have predicted just a year ago. To see if AMD's Radeon Technology Group can pull off the same come-from-behind win with Vega, we're testing the Radeon RX Vega 64 Liquid Cooled Edition.

Before we delve into what makes this card special, let's take a closer look at the GPU under its shiny brushed aluminum shroud. The RX Vega 64 features the fifth generation GCN (Graphics Core Next) architecture, which consists of Next-Generation Compute Units. Compared

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to 4th Gen GCN, these GPUs were built to support higher IPC (instructions per clock), faster clock speeds, HBM2 (High Bandwidth Memory 2, capable of twice the bandwidth per pin compared to the HBM in Fury), and the HBCC (High Bandwidth Cache Controller). According to AMD, this last feature improves Vega's memory management to raise both minimum framerates and average framerates in games. AMD made improvements to the Rasterization and ROP units, added support for Rapid Pack Math technology, and designed Vega's new Draw Stream Binning Rasterizer to optimize the GPU's energy efficiency.

The GPU in this card is manufactured on Global Foundry's 14nm process, and there are 12.5 billion transistors on a die that measures 486mm<sup>2</sup>. This card features 64 NGCUs, 4,096 Stream Processors, 256 Texture Mapping Units, and 64 ROPs. The Radeon RX Vega 64 comes in two configurations; the air-cooled version

that has its base and boost clocks set to 1,247MHz and 1,546MHz, respectively, and the liquid-cooled version we tested, which has expectedly higher 1,406MHz base and 1,677MHz boost clocks. The bus attached to the Infinity Fabric backbone of the Vega die is 2,048-bits wide and the 8GB HBM2 memory is clocked at 1,890MHz, for up to 483.8GBps memory bandwidth.

Total board power for this card is astonishingly high, at 345-watts, and there is a pair of 8-pin PCIe power ports on the top of the card to help supplement the power this card draws from the slot. Make no mistake, the only way you can get your hands on Vega as we went to press is by buying one of these reference design cards. But as a liquid-cooled version, this card is going to perform closer to the overclocked cards from AMD's AIB partners, which should become available sometime in late September or early October.





This card's built-in closed-loop liquid cooler (courtesy of Cooler Master) isn't the only way this card differs from the other Vegas on the market. There is a limited quantity of these that will be made available, and you can only get it with the Radeon Aqua Pack, which bundles the card with two Bethesda-published games (Prey and Wolfenstein II: The New Colossus), a \$100 off coupon for a Ryzen 7 processor and one of three AM4 motherboards, as well as a \$200 off coupon for a high-end FreeSync monitor from Samsung.

In the benchmarks, we pitted the Radeon RX Vega 64 Liquid Cooled Edition against the overclocked GIGABYTE GeForce GTX 1080 Xtreme Gaming. In all of the game benchmarks, AMD's flagship was between 2 and 7 frames per second behind the GTX 1080, which means it falls somewhere between the Founder's Edition GTX 1080 and the factory overclocked 1080s. Vega has a handful of features that require game developer optimization,

and this could be why the synthetic benchmarks seemed to show Vega in a better light.

We're ecstatic that AMD has finally delivered a card that competes at the high end. We're less ecstatic that it consumes so much more power than its nearest rival, the GTX 1080, yet only manages to get close to the same performance. While this card's limited edition status artificially inflates the price, the Vega 64 air-cooled version, which won't perform quite as well, is a solid buy at a \$499 MSRP. ■

BY ANDREW LEIBMAN

**Test System Specs:** Processor: Intel Core i7-7820X; Motherboard: ASRock X299 Taichi; Memory: 16GB HyperX Predator DDR4-3000; Storage: 480GB Patriot Hellfire M.2 SSD; OS: Windows 10 Enterprise

Specs & Scores	AMD Radeon RX Vega 64 Liquid	GIGABYTE GTX 1080 Xt. Gaming
Core/Boost clock	1,406MHz (Base) 1,677MHz (Boost)	1,759MHz (Base) 1,898MHz (Boost)
Memory clock	1,890MHz	2,500MHz
Memory interface	2,048-bit	256-bit
Memory	8GB HBM2	8GB GDDR5
<b>3DMark Fire Strike Ex.</b>	10,484	10,514
Graphics Score	11,280	11,041
Physics Score	21,922	21,546
Graphics Test 1	59.02fps	58.63fps
Graphics Test 2	41.96fps	40.64fps
Physics Test	69.59fps	68.4fps
Combined Test	21.1fps	23.01fps
<b>Unigine Superposition</b>	4,294	4,142
1080p Ext. (Avg/Min/Max)	32.12/26.58/37.18	30.98/25.74/36.64
<b>Games</b>	<b>1,920 x 1,080</b>	
HITMAN (DX12, Vsync Off, Ultra)	136.3fps	143.93fps
Metro: LL (DX11, V. High, 16XAF, V. High Tess.)	130.33fps	146.67fps
Sniper Elite 4 (DX12, Vsync Off, Ultra)	117.14fps	128.83fps
Witcher 3 (Vsync Off, Unl. FPS, Ultra)	144.3fps	140.4fps
	<b>2,560 x 1,440</b>	
HITMAN (DX12, Vsync Off, Ultra)	109.52fps	114.98fps
Metro: LL (DX11, V. High, 16XAF, V. High Tess.)	95.33fps	102.67fps
Sniper Elite 4 (DX12, Vsync Off, Ultra)	79.44fps	86fps
Witcher 3 (Vsync Off, Unl. FPS, Ultra)	99.23fps	102.24fps
	<b>3,840 x 2,160</b>	
HITMAN (DX12, Vsync Off, Ultra)	63.38fps	67.04fps
Metro: LL (DX11, V. High, 16XAF, V. High Tess.)	50fps	58.33fps
Sniper Elite 4 (DX12, Vsync Off, Ultra)	40.26fps	43.79fps
Witcher 3 (Vsync Off, Unl. FPS, Ultra)	51.39fps	55.47fps

## Rosewill Nebula GX Series Gaming Headsets

Rosewill was kind enough to send us two new models from their Nebula GX Series Gaming Headsets line. Enthusiasts who are looking for a new set of cans frequently compare the

available models in a product family, so we combined our two reviews into one article to make it easier for you to see how the particular feature sets on these two headsets match up.

### Nebula GX10 Stereo Gaming Headset

The entry-level Nebula GX10 is a stereo headset with large over-the-ear cans. Each one is attached to the foam padded headband by a rigid doubled-up wire that lets each can slide independently to fit virtually any sized melon. There's an N logo on the center of each can, but a large mesh circle lights up with diffuse blue light when you connect the optional USB plug. The cans are padded with a soft blue foam and covered in a pliable faux leather. This helps keep the headset's considerable sound output between the drivers and your ears, where it belongs.

The mic is on a fixed beam that you can rotate up and out of the way, and minor adjustments can be made with the mildly flexible tip. The cords that run to each can from the headband are covered in blue nylon, as is the thick cable that terminates with 3.5mm phono plugs. There are dedicated mic and line-out plugs for PC use, but the headset ships with a Y-adaptor cable that makes it suitable for use with portable devices, game consoles, and laptops.

The sound field you'll enjoy with this headset is pretty respectable, with a wide mid-range, punchy bass, and an only slightly muted high-end. Due to its lightweight construction, the Nebula GX10 wears easy and is a comfortable headset. The overall build quality was impressive, especially considering the affordable price. If you don't have a lot of cash to spend on a gaming headset, the Rosewill Nebula GX10 is an easy recommendation. The fact that it looks great is just icing on the cake.

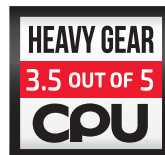
### Nebula GX30 RGB Gaming Headset

The next sibling in the Nebula Series, the GX30, is a mere \$10 more than the GX10, but there are a few features



#### Nebula GX10 Stereo Gaming Headset

\$24.99 | Rosewill | [www.rosewill.com](http://www.rosewill.com)



**Specs:** Drivers: 40mm driver, 20Hz to 20kHz; Input Impedance: 32 ohm @ 1kHz; Mic: Noise canceling, fixed, 50Hz to 10kHz; Sensitivity: -38dB (+/-3dB); Controller: In-line volume/mic mute; LEDs: blue; Connector: Separate 3.5mm plugs for mic & line out, USB for LED power; Y-cable adapter

**CPU RANKING** 0 = BELOW AVERAGE 2.5 = AVERAGE 5 = PERFECT

that extra Hamilton affords you. Before we get to that, though, the overall design of this headset is a big departure from the GX10. The cans here are more oblong in shape, though they are large enough that only the very outer edge of your ears will be compressed. Again, the lightweight construction of the GX30 makes wearing the headset a comfortable experience, even for extended periods. Although the plastic of the headset has the same matte black almost rubberized feeling, and the

The design of Rosewill's GX30 is a big departure from that of the GX10.

same faux leather adorns the cushions and headband, Rosewill switched up the foam in the GX30. This headset's cushions are considerably firmer, and they squeak whenever you adjust the headsets position on your head. It isn't a deal-breaker by any means, but we wonder why Rosewill switched up the foam type for this unit.

The mic is removable, but it's also considerably more flexible than that of the GX10. The cables are braided nylon again, but this time they're black in color. The in-line volume controller on the GX30 features a volume dial, mic mute switch, and an on/off switch for the LEDs. Like on the GX10, the LEDs, which are backlighting a large N on the cans, are powered by the optional USB plug. There's no driver software for the GX30, so the

RGB LEDs merely cycle through the color spectrum.

Sound quality of the GX30 is virtually identical to that of the GX10, and we could discern no difference between the two. That said, we did play games, listen to music, and watch movies with the headset and came

away with a positive impression. If the detachable mic and RGB LEDs are important to you, then Rosewill's Nebula GX30 RGB Gaming Headset is worth this modest price premium. ■

BY ANDREW LEIBMAN



#### Nebula GX30 RGB Gaming Headset

\$34.99 | Rosewill | [www.rosewill.com](http://www.rosewill.com)



**Specs:** Drivers: 40mm driver, 20Hz to 20kHz; Impedance: 32 ohm @ 1kHz; Mic: Noise canceling, detachable, 50Hz to 10kHz; Sensitivity: -37dB (+/-3dB); Controller: In-line volume/mic mute/LED on-off; LEDs: RGB color cycling; Connector: Separate 3.5mm plugs for mic & line out, USB for LED power; Y-cable adapter

**CPU RANKING** 0 = BELOW AVERAGE 2.5 = AVERAGE 5 = PERFECT



**Z370 GAMING PRO CARBON**  
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## MSI Z370 GAMING PRO CARBON

Intel 8th Generation desktop processors are full of notable improvements over the previous generation (Kaby Lake). The new mainstream flagship chip, the Core i7-8700K, is a 6-core CPU with Hyper-Threading, and with this generation Intel also introduces its first 6-core i5 model and first 4-core i3 CPU. The 8th Generation desktop chips only work with motherboards running Intel's Z370 chipset—which frankly isn't as exciting of an upgrade. New chipsets typically come with some goodies beyond support for new processors, such as more PCIe 3.0 lanes or additional storage options, yet the Z370 chipset is surprisingly similar to the Z270 chipset. According to Intel, “the new Intel Z370 chipset provides improved power delivery needed for the new 6-core processors to reach their maximum performance as well as enhanced package power delivery for overclocking and memory routing support.”

Improved power delivery, in short, is the key enhancement on Z370. More processor cores means the chipset is dealing with more current, so Intel simply had to

expand the power I/O. The changes to Z370's power handling, unfortunately, mean that you won't be able to use previous generation Intel Kaby Lake or Skylake processors. The Z370 GAMING PRO CARBON is one of MSI's initial Z370 models and comes with all memory, audio, and connectivity enhancements we've come to expect from the mainboard maker.

MSI has produced a GAMING PRO CARBON model for most every recent Intel and AMD chipset, including Z270, X370, X299, and X399. All of these boards feature carbon fiber detailing on the heatsinks and rear I/O panel—along with a black PCB that nicely sets off MSI's Mystic Light RGB lighting. For additional LED synchronization, MSI includes two 5050RGB LED 12V headers, a WS2812B individually addressable RGB LED header, and a Corsair individually addressable RGB LED header. The variety of RGB LED headers assures that the Z370 GAMING PRO CARBON should work with just about any third-party RGB LED components you purchase.

Other than support for Intel 8th Generation processors, hardware support on the Z370 GAMING PRO CARBON on the board is nearly identical to the Z270 GAMING PRO CARBON we reviewed earlier this year. We suspect the same will be true with other motherboard makers, because nothing has changed with the CPU PCIe 3.0 lanes (16) and chipset PCIe lanes (24) from Kaby Lake and Z270. Because the GAMING PRO CARBON lineup was already well designed, we have no problem with the similarity.

The Z370 GAMING PRO CARBON includes four DDR4 slots that support up to 64GB of memory. MSI has qualified DDR4 modules as fast as 4,000MHz. There are three PCIe x16 slots (one wired at x16, one at x8, one at x4) to support up to 3-way CrossFire or 2-way SLI GPU configurations. MSI also includes a high bandwidth SLI bridge, ideal for gamers who play at resolution 2,560 x 1,440 or above. The bottom PCIe x16 slot (wired at x4) is powered by the chipset, but MSI smartly engineers it not to share bandwidth with the M.2 slots, opting

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instead to turn off select SATA ports if you install an M.2 drive.

Speaking of M.2 support, the Z370 GAMING PRO CARBON features two of the slim profile storage slots. The top M.2 slot features MSI's M.2 Shield, a heat spreader that helps to keep M.2 drives within thermal limits, and supports 2242/2260/ 2280/22110 form factors. The bottom M.2 slot lacks the M.2 Shield, and supports 2242/2260/2280 form factors. You can create a RAID 0 or 1 configuration with two M.2 PCIe SSDs using MSI's M.2 Genie. For conventional 2.5-inch SATA SSDs and HDDs, there are six 6Gbps SATA ports.

MSI adds support for USB 3.1 by installing ASMedia's 3142 controller, which powers a USB 3.1 Type-A and USB 3.1 Type-C port on the rear panel. MSI also uses Intel's Z370 chipset to deliver eight USB 3.0 ports (four on rear panel, four internal) and six USB 2.0 ports (two on rear panel, four internal).

Realtek's ALC1220 codec is the driving engine behind the audio on the Z370 GAMING PRO CARBON. MSI's Audio Boost 4 hardware also provides a dedicated headphone amplifier for high-fidelity quality. You're able to customize sound via the Nahimic 2 audio processing software.

We tested the Z370 GAMING PRO CARBON with Intel's new Core i7-8700K, and as you might imagine, the chip handily outperforms the Core i7-7700K. In Cinebench 15, points at the stock speed were 1,236, and going with overclock of 4.7GHz on all six cores pushed the system to 1,525 points. Z370 is a dual-channel memory platform, and our test rig produced 29.2GBps in SiSoftware Sandra's Memory Bandwidth test. Game scores, when paired with EVGA GeForce GTX 1080 Ti FTW3 GAMING, were 97fps in the Witcher 3 and 145fps in Sniper Elite 4.

We've reviewed a number of models in MSI's GAMING PRO CARBON series, and the Z370 version is a fine addition. MSRP for the Z370 GAMING PRO CARBON (\$189.99) is a bit higher than the Z270 model (\$174.99), which is a tad disappointing, but we'll have to see where other Z370 motherboard are priced before rendering judgment. Overall, we think enthusiasts and modders will continue to like the board's aesthetic, and Intel's 8th Generation processors look to be a real step up. ■

BY NATHAN LAKE

**Specs:** Max memory: 64GB DDR4 (DDR4-2667; Max OC: DDR4-4000); Slots: 3 PCIe 3.0 x16, 3 PCIe x1; Storage: 2 M.2 (slot 1 supports 2242/2260/2280/22110, slot 2 supports 2242/2260/2280), 6 6Gbps SATA; Rear I/O: 1 HDMI, 1 DisplayPort, 2 USB 3.1 (1 Type-C, 1 Type-A), 4 USB 3.0, 2 USB 2.0, 1 PS/2, 1 Ethernet, 1 S/PDIF, audio I/O; Form factor: ATX; Warranty: 3 years

**Test System Specs:** Processor: Intel Core i7-8700K; GPU: EVGA GeForce GTX 1080 Ti FTW3 GAMING; Memory: Corsair Vengeance LPX 16GB DDR4-3000MHz; Storage: Patriot Hellfire 480GB; OS: Windows 10 Enterprise

Benchmark Results	MSI Z370 GAMING PRO CARBON
3DMark Fire Strike	13412
Graphics Score	14362
Physics Score	18413
PCMark 10	5317
Essentials	7303
Productivity	7790
Digital Content Creation	7172
SiSoftware Sandra 2017	
Dhrystone AVX2 (GiPS)	242.42
Whetstone AVX (GFLOPS)	173.25
Multi-Media Integer AVX2 x32 (Mpixels/s)	847.72
Multi-Media Long-int AVX2 x16 (Mpixels/s)	304.35
Multi-Media Quad ALU x1 (Mpixels/s)	4.87
Floating B/F AVX/128 (GBps, mem bandwidth)	29.2
CrystalDiskMark 5.1.2 (MBps)	
Sequential Read (Q32T1)	2659
Sequential Write (Q32T1)	1081
Random 4K Read (Q32T1)	518.9
Random 4K Write (Q32T1)	614.5
POV-Ray 3.7 (Pixels/s)	2514
Cinebench 15 (Points)	1236
Games	(2,560 x 1,440)
Metro: Last Light (Very High, 16xAF; SSAA off)	124fps
Sniper Elite 4 (VSync off, Ultra, DX12)	145fps
Witcher 3: Wild Hunt (Vsync Off, Unl. FPS, Ultra)	97fps

**CPU RANKING** 0 = ABSOLUTELY WORTHLESS 2.5 = ABSOLUTELY AVERAGE 5 = ABSOLUTELY PERFECT



**Core i7-8700K**  
\$359  
Intel  
www.intel.com



## Intel Core i7-8700K

It was just nine months ago when we said the Kaby Lake flagship was the chip we've been waiting for. Now, just three quarters later, Kaby Lake has effectively been wiped off the map. The king is dead. Long live the king!

The Intel Core i7-8700K, formerly known as Coffee Lake, looks like a minor Kaby Lake refresh, except for one major deviation; it has six cores, and with Hyper-Threading enabled, it can handle up to a dozen threads at once. The base clock of this processor is 3.7GHz, which is considerably lower than the 7700K's 4.2GHz base clock. The additional cores and Intel's likely desire to keep the 95-watt TDP of this processor at least close to the 7700K's 91-watt TDP are likely to blame. Turbo Boost 2.0 technology lets the processor clock a single core to up to 4.7GHz, which is 200MHz faster than Kaby Lake's flagship.

The manufacturing node for these processors is still 14nm, which Intel says they've improved, but at press time they still had not provided us with any details on how they made it better. Intel upped the Intel Smart Cache from 8MB on the 7700K to 12MB on the 8700K to account for the additional pair of cores. There are still just 16 PCIe lanes, but when combined with the compulsory Z370 chipset-based motherboard, you'll have up to 40 to dedicate to NVMe storage, graphics cards, NICs, and other devices. The on-die Intel

HD Graphics 630 looks like it was copy-pasted from Kaby Lake and given a 50MHz dynamic clock boost to 1,200MHz. Intel calls this the "BEST gaming processor ever," but this statement assumes you have a discrete graphics card installed.

One of the main improvements compared to Kaby Lake is a handful of overclocking features, including the ability to manually set a multiplier for each core. Intel also added overclocking features designed for extreme LN2 overclockers, such as a higher maximum memory ratio of 8,400MTps, real-time memory latency control, and extended PLL Trim controls. One of the primary reasons this family requires a new chipset is due to the need for improved package power delivery for 6-cores, but this also makes life a little easier on overclockers.

Intel Optane Memory support is back, but its system responsiveness, productivity optimizing, and high capacity storage benefits are moot in the face of modern NVMe SSDs and affordable 1TB SATA SSDs. The onboard memory controller is dual-channel, and Intel supports speeds up to DDR4-2666. Of

course, your Z370 motherboard will support XMP, and as such you'll be able to clock your memory considerably higher.

Getting a 6-core processor for close to the price of the quad-core 7700K less than a year later is a boon for anyone who waited to upgrade, but it's a punch in the gut for Kaby Lake buyers. If you're one of the former, and the prospect of a similarly-priced eight-core Ryzen 7 1700X doesn't sway you, then the Intel Core i7-8700K is a very solid foundation for your next build. ■

BY ANDREW LEIBMAN

	Core i7-8700K	Core i7-8700K @ 4.7GHz, 1.35V
<b>3DMark Fire Strike Ext.</b>	13,412	13,451
Graphics Score	14,362	14,335
Physics Score	18,413	19,331
Graphics Test 1	76.41fps	76.65fps
Graphics Test 2	52.8fps	52.52fps
Physics Test	58.45fps	61.37fps
Combined Test	32.78fps	32.61fps
<b>PCMark 10 Score</b>	5,317	5,669
<b>Sandra 2017 Platinum</b>		
Dhrystone Integer Native AVX2 (GIPS)	242.42	266
Whetstone Single-float Native AVX (GFLOPS)	173.25	190.83
x32 Multi-Media Integer AVX2 (Mpixels per second)	847.72	929.69
x16 Multi-Media Long-int AVX2 (Mpixels per second)	304.35	335
x1 Multi-Media Quad ALU (Gpixels per second)	4.87	5.35
Integer Memory Bandwidth B/F AVX/128 (GBps)	29.36	30
Float Memory Bandwidth B/F AVX/128 (GBps)	29.2	30.19
<b>Cinebench 15 (Points)</b>	1,236	1,525
<b>POV-Ray 3.7 (Pxls)</b>	2,514	3,297.33
Sniper Elite 4 (Vsync Off, Ultra, DX12)	145fps	156fps
The Witcher 3 (Vsync off, Unl.fps, Ultra)	97fps	115fps

**Specs:** Clock speed: 3.7GHz (base), 4.7GHz (Turbo Boost 2.0); 6-cores; unlocked multiplier; dual-channel DDR4 memory; 12MB Intel Smart Cache; Hyper-Threading; Turbo Boost; 14nm; 95W TDP

**Test System Specs:** Motherboard: MSI Z370 GAMING PRO CARBON; GPU: EVGA GeForce GTX 1080 Ti FTW3; Memory: Corsair Vengeance LPX 16GB DDR4-3000MHz; Storage: Patriot Hellfire 480GB; OS: Windows 10 Enterprise

**CPU RANKING** 0 = ABSOLUTELY WORTHLESS 2.5 = ABSOLUTELY AVERAGE 5 = ABSOLUTELY PERFECT



## ENERMAX MaxTytan 800W



**MaxTytan 800W**  
\$209  
ENERMAX  
[www.enermaxusa.com](http://www.enermaxusa.com)

ENERMAX introduced several innovations to its PSU lineups over the course of the past year, including a self-cleaning fan mode and individually sleeved, modular cables. The MaxTytan 800W takes advantage of ENERMAX's premium amenities, while also meeting the 80 PLUS Titanium certification. To earn this badge, the MaxTytan 800W had to reach minimum efficiency levels of 90/92/94/90% at 10/20/50/100% loads. Achieving 90% efficiency at 10% load (PSUs are less efficient below 50% loads) is particularly difficult. The MaxTytan 800W is a power user PSU.

In addition to the MaxTytan 800W, ENERMAX offers 750W, 1050W, and 1250W power options. All models support SLI or CrossFire graphics configurations, and we like that the 750W and 800W models include six 6+2-pin PCIe cables. The 1050W and 1250W power capacities boast two more 6+2-pin PCIe cables, but based on current AMD and NVIDIA support for 3-way and 4-way GPU configurations, the higher wattage PSUs might prove more useful for mining rigs, or a set of highly overclocked GPUs.

Maybe more important than the number of 6+2-PCIe connectors, when it comes to modern builds, is the number

of CPU power connectors. Many of the X299 and X399 motherboards we've reviewed boast an extra CPU power connector to deliver plenty of juice to the high core count Intel and AMD processors. The MaxTytan 800W, as well as the other MaxTytan models, includes both an 8-pin and a 4+4-pin EPS12V connector. To power storage devices, fans, and other internals, ENERMAX also provides 12 SATA, 4 Molex, and one FDD connector—plenty for most enthusiast systems.

All of the cables are modular and the individually sleeved wires are covered with a soft braided fabric. The sleeves' aesthetic is suitable for the majority of power user rigs with white, rectangular marks dotted over a black fabric. ENERMAX also includes cable combs, so you can dress the cables and make visually attractive bends.

Previous ENERMAX power supplies with the DFR (Dust Free Rotation) feature only allowed the self-cleaning mode (reversed fan action to blow away debris) upon system startup. But on the MaxTytan lineup, ENERMAX provides a button to let you activate the DFR whenever you please. The MaxTytan 800W is a semi-fanless design with the fan only spinning up after system load

surpasses 55%. During our time with the unit, the fan only kicked on under our GPU torture tests.

Our X399 test bench, which features an AMD Ryzen Threadripper 1950X and two NVIDIA GeForce GTX 1080 Ti's in SLI, is a good example of the type of premium hardware the MaxTytan is designed to work with. We simultaneously ran Unigine's SuperPosition benchmark at 4K and Prime95's In-place torture test to simulate an extreme load. The MaxTytan 800W didn't blink at the challenge. Typically, the power supply produced around 500 watts during testing with an excellent power factor falling between .988 and .995.

80 PLUS Titanium certified power supplies are still somewhat scarce, so it's notable that ENERMAX now has an entire lineup of options. It takes a bit of extra engineering (and quality power handling) for a PSU to reach 80 PLUS Titanium, and the MaxTytan's price (\$209) reflects that. ENERMAX's fan and cabling additions help to make the MaxTytan 800W worth the extra cost, especially for enthusiasts in the market for a premium power supply. ■

BY NATHAN LAKE

**Specs:** Maximum wattage (continuous): 800W @ 50 C; 12V rail: 1 66.5A; +5V max: 20A; +3.3V max: 20A; Efficiency rating (advertised): 80 PLUS Titanium; Fan: 139mm; Connectors: 1 x 20+4-pin ATX, 1 x 4+4-pin EPS12V (CPU), 1 8-pin EPS12V (CPU), 6 x 6+2-pin PCIe (GPU), 12 x SATA, 4 x Molex, 1 Floppy (adapter); Warranty: 5 years

**Test System Specs:** Processor: AMD Ryzen Threadripper 1950X; Motherboard: AORUS X399 Gaming 7; GPU: NVIDIA GeForce GTX 1080 Ti (x2, SLI); Memory: HyperX Predator DDR4-3000; Storage: 480GB Patriot Hellfire; OS: Windows 10 Enterprise

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# RIG

## OF THE MONTH

### ORIGIN PC GENESIS



The GENESIS series is well-known as Origin PC's flagship gaming desktop. And while the GENESIS models we've seen are often raging beasts of speed and power, few can match the muscle of October's Rig Of The Month. There's an Intel Core i9-7900X with all 10 cores (and 20 threads) running at 4.3GHz, as well as two overclocked NVIDIA GeForce GTX TITAN Xp graphics card in SLI. Beyond

raw performance, the builder installed a custom hardline loop and painted the interior and exterior of the rig. The exterior chassis paint job, which Origin PC calls "Honeycomb Circuit," might be even more buzzworthy than the interior hardware.

#### Have It Your Way

One of the best reasons to go with a boutique builder, rather than putting

#### GENESIS

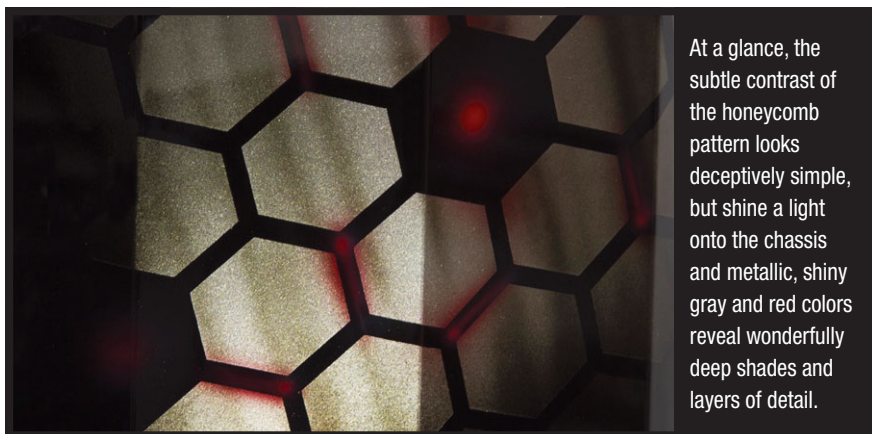
\$9,266 as tested

ORIGIN PC

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everything together yourself, is the craftsmanship and bold artistry you'll get that would be extremely time-consuming and difficult to produce on your own. The level of detail, for example, of the Honeycomb Circuit paint job is something only a professional painter can accomplish. The painter blends the gray honeycomb pattern into a dark metallic backdrop with red accents, as if there's a spotlight briefly illuminating parts of the pattern across the front and side panels. As you shine a light over the case, the reflective metallic in the honeycomb seems to come to the forefront. Origin PC tells us the custom paint adds \$500 to the cost of the rig.

The inside of our GENESIS test rig showcases an elaborate liquid-cooling system with dark red Koolance coolant that visually



At a glance, the subtle contrast of the honeycomb pattern looks deceptively simple, but shine a light onto the chassis and metallic, shiny gray and red colors reveal wonderfully deep shades and layers of detail.

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transitions from the bright red case interior to the black motherboard and components. The massive cooling setup includes a 120mm radiator on the rear exhaust and three 360mm Koolance radiators—one in the top panel and two below—that keep the overclocked Core i9-7900X (not the coolest of CPUs to start with) and TITAN Xp cards well within thermal limits. During our 4K game testing, for instance, the GPUs never went above 75 degrees Celsius. Origin PC overclocked each TITAN Xp using EVGA's Precision XOC software, adding 150MHz to the core clocks and 300MHz to the memory clocks.

### Invisible Touch

Origin PC's hardline cooling loop is well executed with clean, straight lines and bends only where necessary. Interestingly, Origin installed a 5.25-inch dual-loop reservoir in the front panel, although the system has a single loop. A curved fitting in between the two reservoirs lets coolant pass through both tanks and pumps. Origin says the two pumps help to keep coolant moving through the long loop and multiple components. Installing the res in the front panel also makes space for installing extra drive bays and adds some visual spark behind the front panel. Individually sleeved EVGA wiring, a standard feature of the GENESIS, also keeps things orderly.

Our test build features the motherboard mounted in the standard orientation, but there are several other options when configuring your unit. Origin's chassis supports inverted mounting (this option flips the side-panel window to other side), a standard 90-degree turn (ideal for pushing hot air out the top of the case with blower-style GPUs), and an inverted 90-degree orientation. However you want the interior to look and function, the GENESIS case will support it. You can also customize the color of the system with Origin's Sentinel lighting option. Origin says that by the time you'll read this, the company will offer a new case with RGB lighting that syncs with the motherboard lighting.

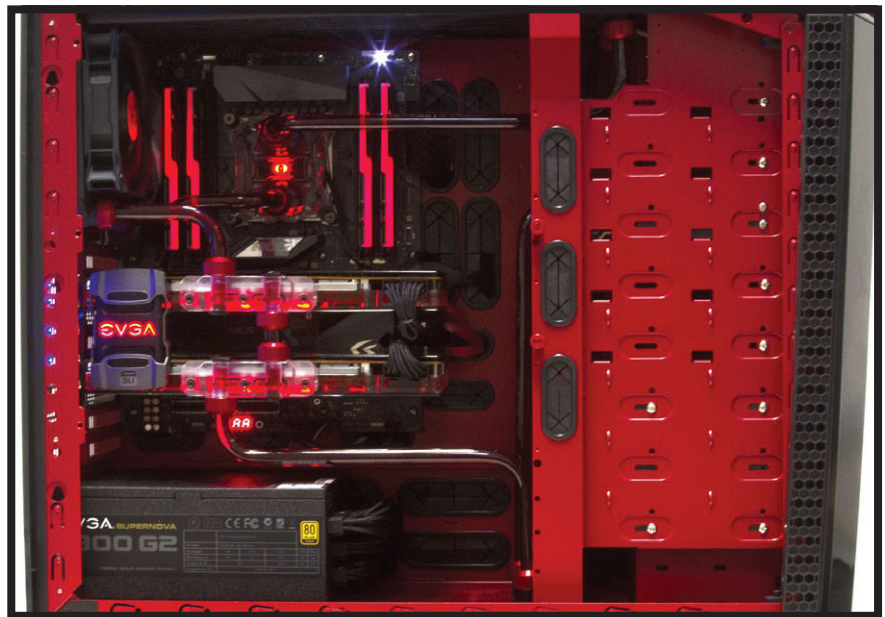
### In The Cage

As you can probably tell, there's a lot to like about GENESIS' aesthetics. But

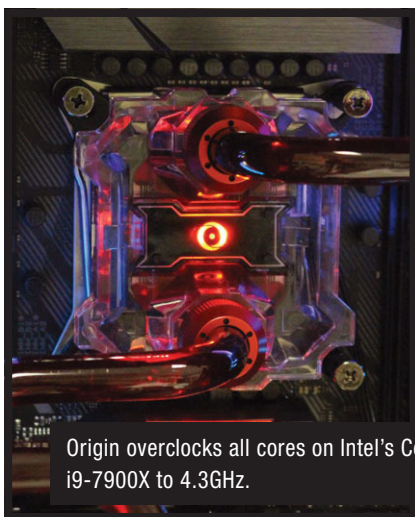
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The GPU blocks feature the same incredible paint job as the exterior.



Origin PC uses both tanks and pumps in this 5.25-inch dual loop reservoir to maintain steady water pressure through the multiple components and radiators.



Origin overlocks all cores on Intel's Core i9-7900X to 4.3GHz.

anyone spending more than \$9,000 on a PC will want the best hardware available. We've already covered the overlocks on the CPU and GPUs, but the rest of the components are also speedy. On our test system, Origin PC installs 32GB of G.Skill Trident Z RGB DDR4-3000 memory. This kit can sync with the lights on the ASUS STRIX X299-E GAMING motherboard. Origin PC also takes advantage of ASUS' high-end audio (SupremeFX), networking (Intel i219-V wired and dual-band 802.11ac), and storage improvements (ROG RAMCache II).

RAMCache II might be the most interesting feature for performance enthusiasts. Essentially, RAMCache II takes advantage of system memory not currently in use and allocates the memory as a high-speed cache. The speed boosts in CrystalDiskMark with RAMCache II were dramatic. Without the feature enabled, read and write speeds for Samsung's 512GB 960 Pro hit 2953MBps and 2110MBps, respectively. With RAMCache II on, reads and write speeds were 6685MBps and 8700MBps, respectively. Random read and write rates were about the same, but you can see how RAMCache II would be especially helpful when loading your favorite game or other commonly accessed application.

#### Specs:

Processor: Intel Core i9-7900X @ 4.3GHz; Motherboard: ASUS ROG STRIX X299-E GAMING; GPU: NVIDIA GeForce GTX TITAN Xp (x2 SLI); Memory: 32GB G. Skill Trident Z RGB DDR4-3000; Storage: 512GB Samsung SSD 960 Pro, 8TB HGST Ultrastar; PSU: EVGA SuperNOVA 1300 G2; OS: Windows 10 Home

The GENESIS chassis is designed to accommodate lots of storage. Origin PC installs a hot-swap bay in the front panel that supports up to five 2.5/3.5-inch storage drives, and our test build features a single 8TB HGST Ultrastar for file storage duties. The hot-swap bays are easily accessible behind the front panel door. Origin PC can also create a RAID with the hot-swap drive bays, if you're looking for a redundant file storage system. Those requiring even more storage can swap out the radiator in the base of the case for a lower bays that can support up to 24 2.5-inch HDDs.

#### Turn It On Again

Like most of the PCs in Rig Of The Month, the GENESIS had no problem with our benchmark tests. But even compared to those lofty standards, the GENESIS put on quite a show. Take, for example, our game tests where both Metro: Last Light and Witcher 3 topped 100fps with the resolution cranked to 3,840 x 2,160 and settings maxed out. Even the demanding 3DMark's Fire Strike Ultra graphics tests couldn't push the GENESIS below 60fps. Hitting 4.3GHz with Intel's Core i9-7900X also let the GENESIS trash the highly threaded workloads of Cinebench 15 (2265 points) and POV-Ray 3.7 (4780 pixels per second).

#### That's All

The exterior of this GENESIS is absolutely a work of art, highlighted by the metallic elements of the Honeycomb Circuit design. The interior, while more austere, is still visually appealing without being a distraction. Our build is clearly a benchmark destroyer, but if you're looking for something a bit more affordable, Origin PC can build a GENESIS using Intel's mainstream platforms or AMD's X399 chipset. ■

BY NATHAN LAKE

Benchmark Results	GENESIS
<b>3DMark Fire Strike Extreme</b>	
Overall Score	23253
Graphics Score	30543
Physics Score	24055
<b>PCMark 10</b>	
Score	6087
Essentials	8481
Productivity	7276
Digital Content Creation	9920
<b>SiSoftware Sandra 2017</b>	
Dhrystone AVX2 (GIPS)	406.86
Whetstone AVX (GFLOPS)	290.6
Multi-media Integer AVX2 x32 (Mpixels/s)	1550
Multi-media Long-int AVX2 x16 (Mpixels/s)	602.4
Multi-media Quad-ALU x1 (Mpixels/s)	5.64
Floating B/F AVX/128 (GBps, mem bandwidth)	55
<b>CrystalDiskMark 5.12 (MBps)</b>	
Sequential Read (Q32T1)	2953
Sequential Write (Q32T1)	2110
Random 4K Read (Q32T1)	610.4
Random 4K Write (Q32T1)	477.8
<b>POV-Ray 3.7 (Pixels/s)</b>	4780
<b>Cinebench 15 (Points)</b>	2265
<b>Games</b>	2,560 x 1,440
Metro: Last Light (Very High, 16xAF, SSAA off)	181fps
Witcher 3: Wild Hunt (Vsync Off, Unl. FPS, Ultra)	165fps
<b>Games</b>	3,840 x 2,160
Metro: Last Light (Very High, 16xAF, SSAA off)	114fps
Witcher 3: Wild Hunt (Vsync Off, Unl. FPS, Ultra)	107fps

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# The Glowing One

As we have for several years now, we received a gracious invitation from the guys at Modders-Inc.com to join them in judging the mod contest at the biggest LAN event of each summer, QuakeCon. So we traveled to Dallas on August 24 and helped out with the Modders-Inc.com 2017 U.S. Case Modding Championship. As in the past, lots of modders entered large numbers of incredible mods in the contest, which was divided into three categories: id/Bethesda-themed Mods, Case Mods, and Scratch Builds. And as in the past, we had a couple repeat winners, including Ethan Prus, who won the id/Bethesda category for the second year in a row with The Glowing One.

## War Never Changes

“I really enjoy the world of Fallout, and I wanted to see if I could top my mod from last year,” Prus says. “While most people were psyched about [Nick Valentine, Prus’ winning mod from QuakeCon 2016], there were a couple comments online that said things like, ‘big deal, he just put a computer in a mannequin.’ So this year I wanted to build it from scratch, partly to see if I even could, and partly to go bigger and better than last year. I love learning new things, and I learned a lot during this, so I consider it a success.”

A graphic designer by trade, Prus built The Glowing One in the art department of his alma mater, Southeastern Oklahoma State University. “They were nice enough to let me use one of the rooms while there were no classes in it over the summer,” Prus says. “I thought of this mod last year at QuakeCon, so between planning, learning mold-making, and testing, the process included a full year of work. Hands-on began I think in March.”



### Building The Perfect Mutant

Prus sculpted each piece in clay, then made silicone molds of each piece. He poured clear liquid resin (dyed greenish yellow) into each mold and used a process called “rotocasting” that required him to continuously rotate each piece so the plastic hardened on the sides, leaving the piece hollow. “This kept the pieces lighter and left room for my computer,” Prus says. “Afterward, I put each piece together using PVC pipe and epoxy dough. Most of the materials I used were from Smooth-On.”

He began the process with an ATX tower’s back panel and fixed that into the chest cavity using epoxy dough. “The graphics card gave me the most trouble because I didn’t plan for how big it was,” Prus says. “Midway through making this mod, I had a watercooling crisis and fried my GTX 970 and had to get a new card. Microcenter only had 10-series cards in stock and I thought, ‘Well, if I have to upgrade, I might as well get the 1080 Ti,’ and I spent way too much money. The new card is also drastically larger than my old one, and I had already built most of the body. The card had to sit parallel to the mobo using a PCI extender, and the mobo itself had to be upside down so I could just rest the GPU on my CPU cooler. I know that’s insanely ill-advised, but I didn’t have many options at that point. Most of my modding is the product of a ‘whatever works’ mentality, and I can’t in good conscience recommend my methods to anyone.”

Aside from its silicone-molded body, The Glowing One consists of an Intel Core i7-6700K on an MSI Z170A SLI PLUS motherboard, 32GB of DDR4, an MSI GeForce GTX 1080 Ti, a small form factor Corsair 600-watt PSU, a Noctua CPU cooler (“and a six-dollar 80mm fan I bought at Fry’s during QuakeCon”), a 500GB SSD, and NZXT’s HUE+ lighting system.

### Still Falling Out

The Glowing One is Prus’ fourth mod. His first was a Nuka Cola Quantum mod from 2012 (entered in the 2013 QuakeCon contest),

second was a super-cool Eyebot mod in 2014, and Nick Valentine was his third. He says he’s still trying to decide what to do next.

“I might try to go bigger and crazier, or I might do a 180 and build something more subtle and detailed,” Prus says. “I’m always blown away by the people who have very clean mods that fit together seamlessly.” ■

## We Want Your Mod

Have a PC mod that will bring tears to our eyes? Email photos and a description to [madreadermod@cpumag.com](mailto:madreadermod@cpumag.com). If we choose your system as our “Mad Reader Mod,” you’ll win \$1,500! (U.S. residents only, please.)



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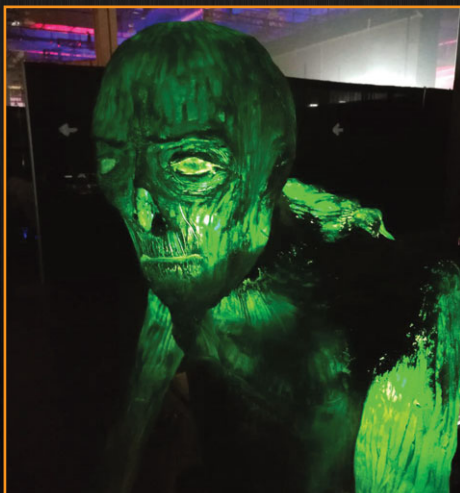


Photo courtesy of Nate Lamb



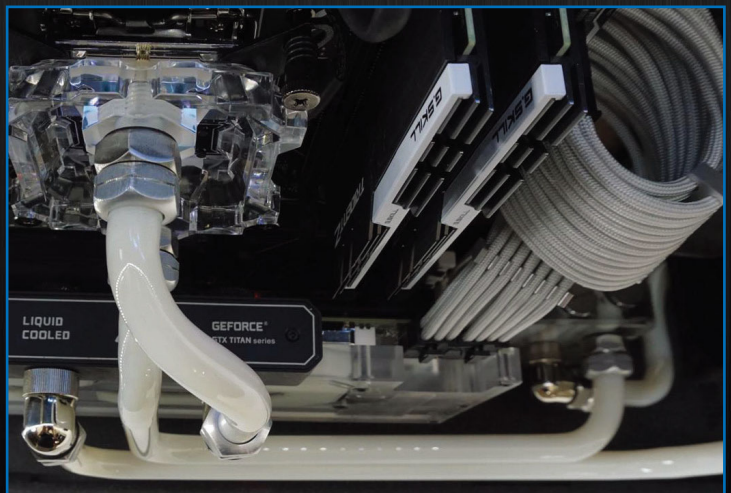
# The Gunslinger

Is there any LAN party Dave “Insolent Gnome” doesn’t attend? The Missouri modder attended our very own CPULAN back in September 2016, he is becoming a regular at LANFest NETWAR in Omaha, and he also headed down to Dallas for QuakeCon this summer. Oh, and while he was there, he won another mod contest: The Case Mod category of the Modders-Inc.com 2017 U.S. Case Mod Championship.

## I Do Not Cut With My Dremel

Cathey’s mod, The Gunslinger, was inspired by Stephen King’s “Dark Tower” novel series, which begins with a book called “The Gunslinger.” “The mod is based on Roland Deschain, the Gunslinger from the books,” Cathey says. “Most things worked out the way I wanted, although the exterior was a last-minute compromise. I wanted a brick or rock wall look, but the case’s lines just don’t work with that.”

Was the completion of this mod around the same time as the theatrical release of a Dark Tower movie a coincidence? In a word, no. “I really wanted to do this case and its counterpart [Cathey also built a companion mod to this one called—naturally—The Man In Black] to tie in with the release of the ‘Dark Tower’ movie,” Cathey says. “I’m a huge fan of the books, and this was a way for me to revisit the story and fanboy the series a bit. I spent the four months I was working on them listening to the audiobooks of the series, and wound up finishing the cases at the same time I was finishing the books. It was perfect timing.”



### I Do Not Paint With My Airbrush

Most of the mod is built from pretty standard stuff, although Cathey did source a couple of pretty unusual parts: “The motherboard tray is covered in leather to give it a western look, and to tie in with the “Dark Tower” story I made a working Horn of Eld using a real ox horn that I picked up,” Cathey says.

Cathey gutted the Cooler Master MasterCase Maker 5 almost completely, then built a new motherboard tray and back panel, which let him move things around a bit. He put the motherboard at the bottom of the tray instead of up top and mounted the graphics card vertically, while flipping the power supply on its side so that it fits behind the motherboard tray. “This tidied up the layout for me and gave me room to throw in some details from the story,” Cathey says. Those details include the aforementioned Horn of Eld, as well as a western-style revolver in a leather holster and more.

“The rig is watercooled with a 360mm radiator mounted in the front to the stock fan mounts, but then the reservoir is mounted in front of it and shows through the front panel to liven up the exterior of the case,” Cathey says. “To add a bit more flair and help with airflow, I CNC’d the rose on the top fan cover and symbols from the story (Ka and the Deschain family symbol) in the back panel. Then the real work began.”

Cathey airbrushed and weathered the back side of the mobo tray and the PSU and drives to give them an aged appearance, and weathered the wires, as well. “One thing I think people overlook sometimes is the wiring,” Cathey says. “I’m really proud of the weathering and the look of the wires on the back side, and then those wires switch to sleeved extensions in the junction box on the back so that the other side looks nice and clean.”

### I Mod With My Heart

The Gunslinger is an Intel Core i5-6600K on an ASUS Z170 Pro Gaming Aura motherboard, 16GB of G.Skill Trident Z DDR4-3000, an NVIDIA GeForce GTX 980 Ti, a Cooler Master V1000 PSU, two

Samsung 840 EVO SSDs (one 240GB and the other 500GB), and the MasterCase Maker 5. Cathey’s cooling subsystem includes Swiftech waterblocks and a Swiftech pump, Mnpctech fittings, a Bitspower 360mm radiator, a PrimoChill CTR reservoir and PrimoChill PETG tubing, Corsair and other assorted fans, and Mayhems Pastel fluid.

Cathey says he thinks The Gunslinger is his eighth or ninth mod. “Up next is a new personal rig based on In Win’s H-Frame case, by my take on it,” he says. As usual, we’re looking forward to seeing what he comes up with. ■



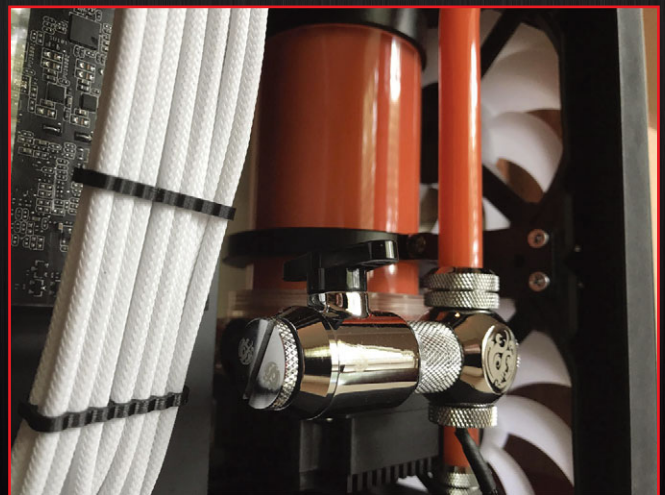
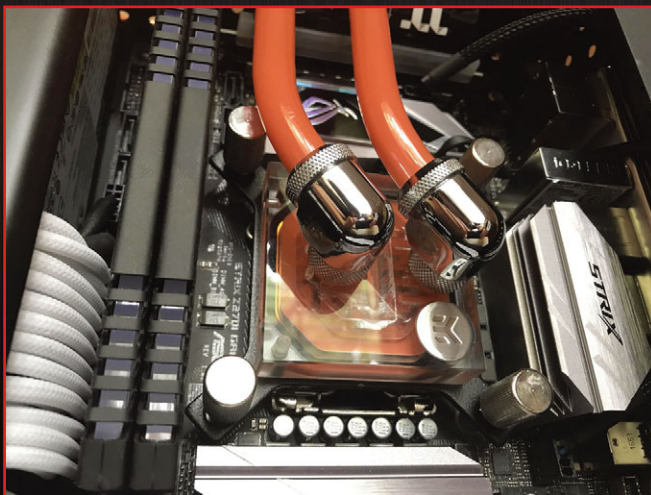
# Project Breadbox

**W**e had two repeat winners at this year's Modders-Inc. com U.S. Case Modding Championship; one was Ethan Prus and his The Glowing One mod winning the id/Bethesda-themed mods category, and the other was Brandon "gnarkillin" McCarthy, who won last year's Case Mod category with his White Widower mod. This year, McCarthy switched things up and entered the Scratch Build category, but the result was the same: McCarthy took home top honors in his category with Project Breadbox.

## Where's The Bread

"The name came to me during the build process," McCarthy says. "My theme was to make the smallest enclosure possible. I had to advance my understanding of lower-powered circuits and relied heavily on breadboards to build and test my circuitry for prototyping. This case is my prototype/proof of concept that I would possibly like to take to market; it is like my breadboard, but in this case it's a box. And if you really wanted to, I guess you could use it as an actual breadbox." [Smiles]

McCarthy says he still gets inspiration from Singularity Computers in Australia, but that in this case most of his inspiration came by way of an old hobby: woodworking. "When I was in high school, I used to build custom cabinets and wine cellars to save for college," he says. "I've been wanting to get back into it for a while, and it hit me that I should merge the two hobbies and build a custom computer case from scratch out of wood. It was definitely a huge influence, and the skill set that came from my past experiences helped to accelerate the





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learning curve during this build. That said, there was a lot to be learned along the way. I have hardly any metal fab experience and certainly have never worked in wood joiner techniques, so this entire process was extremely educational.”

Some lessons are harder-learned than others, though, and McCarthy says one he learned the hard way this time was the importance of putting safety first. “I nearly severed my index finger working on this project,” he says. “It cost me a good chunk of change, and if I’m going to continue to mod and build, I decided it was worth the investment to properly tool my shop so that I can work in a safer environment.”

### **BFM**

“This project spent a lot of time in the development phase, but just as much time in what I call ‘Brute Force Modding,’” McCarthy says. You can only design so much on the computer, and when you start the build process, you face challenge after challenge that you didn’t foresee and that you have to overcome. But that’s my favorite part, as it lets my creativity run wild. What is so interesting about a scratch build is that everything you do is quite literally a mod.”

One aspect of the mod that evolved during the build was Project Breadbox’s cooling loop. “I remember I was in the shower (I know, total cliché!) and trying to think of a way to route the loop,” McCarthy says. “I knew from the beginning that I wanted to be able to see the build from both sides and the top. And then the idea of a manifold on the top to route the loop popped into my mind. I wanted it to be symmetrical, so I sat down and worked up the flow direction, and sure enough, it would work.”

McCarthy built Project Breadbox using sheet aluminum and aluminum angle, acrylic, tempered glass, walnut, and maple. He milled and processed the wood over the course of four months. “Working with rough-sawn stock requires you to give the wood time to acclimate to your temps and humidity, otherwise the wood can warp and become difficult to work with,” he says.

### **Next Category Up**

Project Breadbox consists of an Intel Core i7-7700K overclocked to 5GHz, an ASUS ROG STRIX Z270I GAMING motherboard, 16GB of Corsair Vengeance RGB DDR4-3200, an ASUS ROG STRIX GTX 1080 OC Edition graphics card, a Corsair SF600 PSU, and a Samsung 960 EVO 500GB M.2 NVMe SSD. The cooling loop includes EK waterblocks and radiators, a Singularity Computers pump/reservoir config, and Bitspower fittings and PETG tubing.

McCarthy says he designed this project to be something he could replicate if there’s interest in the community, so if you’re interested in getting a Breadbox of your own, hit him up at the next QuakeCon. Speaking of which, what’s next for a guy who has won two of the three mod contest categories at the big LAN?

“Now that I’ve won in both the Case Mod and Scratch Build categories, I have one more category to try my hand at, which is an id/Bethesda-themed build,” McCarthy says. “I’ve been thinking of various ideas for next year’s competition, so it’ll be something in that scope.” ■



# QuakeCon 2017

## Now That's What We Call A LAN Party

QuakeCon 2017 was, once again, a reminder of just how much fun can be had when gamers emerge from the basement and congregate en masse. In late August, more than 2,500 people hauled their PCs into the cavernous convention center of the Gaylord Texan Hotel in Grapevine, Texas. Unseen smoke machines made the air hazy and spotlights occasionally pierced the dimly lit hall. There was gaming here, for sure. But so much more.



There were several upcoming Bethesda and id games on display and even a few indies for attendees of the BYOC or general-admission attendees, who could get in for free. Aisles overflowed with cases of BAWLS energy drinks, bags of snacks, and a plethora of pizza boxes; sponsors' booths thumped with music and bustled with activity; and a gigantic stage pulsing with light played host to a white-knuckled Quake Champions competition.



Many of the event sponsors had booths where attendees could get some hands-on time with the products and talk face-to-face with company representatives. Corsair's booth, near the BYOC, was showing off some RGB-backlit keyboards and a handful of the impressive Void gaming headsets. We also saw Lee Harrington's Bulldog Pontiac GTO mod once again.



During QuakeCon's annual three-day event, we're routinely reminded that there's an amazing community of people behind all of the RGB LED-infused PCs. On hand were exhibitors for a range of non-profits, including 1UpOnCancer ([www.1uponcancer.org](http://www.1uponcancer.org)), Dallas Pets Alive ([dallaspetsalive.org](http://dallaspetsalive.org)), Extra Life ([www.extra-life.org](http://www.extra-life.org)), nonPareil Institute ([npitx.org](http://npitx.org)), and GameChanger ([gamechangercharity.org](http://gamechangercharity.org)). While we celebrated all things gaming, Hurricane Harvey was just beginning to wreak havoc along the coast, so the American Red Cross was also sponsoring a blood drive on the third floor. And from what we saw, there were a lot of people walking around with arm wraps all weekend.

## Booths, Prizes & Panels



AMD also had a large booth at QuakeCon this year, with a dozen high-end gaming systems created by some of the world's top boutique builders, many of whom you've read about in the pages of our own "Rig Of The Month" feature. Most of the gaming systems were equipped with Radeon RX 580 and 570 graphics cards and Ryzen processors, but one very special system off to the side was sporting a Threadripper 1950X and a Radeon RX Vega 64 graphics card.



A full-fledged gaming convention isn't complete without a series of panels in which attendees can take a break from the games to learn something new or meet someone cool. The gents from Modders-Inc. com invited CPU along to speak at a panel on Thursday night focused on helping first-timers try their hand at building a PC.



Nothing draws a crowd quite like Josh Smith of Fractal Design dabbing. Or maybe he's tossing an AIO liquid cooler into the assembled throng and cringing at the resulting head trauma. Surely he's not tossing cases. Those Define R5s are heavy.

All of the vendors at QuakeCon had prizes for attendees, but MSI's booth had something—or should we say someone—very special. Rod Rosenberg, the taller half of the dynamic duo that is BSMods ([www.bsmods.com](http://www.bsmods.com)), was on hand to talk shop and show off his In Win case inspired by the Medieval Metal mod from Computex in 2016. Rod's rig was outfitted with the MSI X299 GAMING M7 ACK motherboard and the MSI GTX 1080Ti Duke 11G graphics card, so it's hardcore inside and out.

According to Rod, "The biggest highlight for me was talking to so many modders, both at the MSI booth and in the BYOC."



## QuakeCon Case Mod Runners-Up

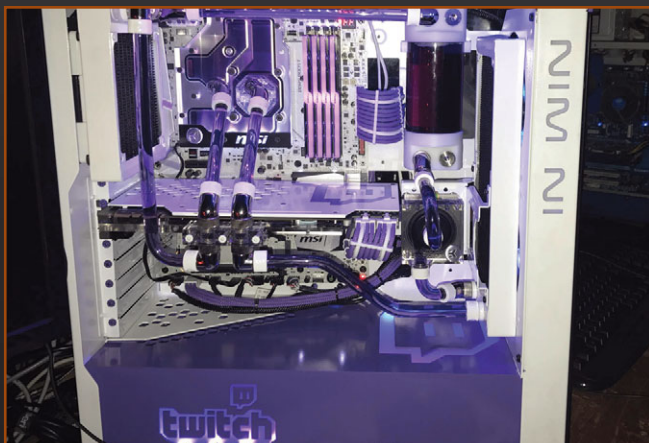
This year, as in years past, the QuakeCon mod contest, also known as the U.S. Case Modding Championship, had a judging panel with decades of collective experience in modding and judging mods. The panel of judges included CPU Magazine, Modders-Inc.com, and even a couple veteran QuakeCon mod contest winners. The first category was the traditional case mod, where entrants started with an off-the-shelf case.



Second place in the case mod category is three-time QuakeCon mod contest champion Adam Owen, with his visually stunning Dragon Spawn. Adam has been in the pages (and on the front cover) of CPU magazine enough times that we've come to refer to him as "the modder with the 3D printer." But it takes a lot more than a 3D printer and a few dozen kilos of PLA to construct the impressive works that Adam concocts year in and year out.



Dragon Spawn elicits dropped jaws at first glance, but Adam truly took his creation to the next level by integrating a homemade button-activated smoke machine that pumps a vaporized glycerin solution from the Dragon's fierce maw.



The builder of our third-place mod, Nick "Outspoken Pizza" Lopez, is undoubtedly a fan of the streams, as he based his mod's theme on the omnipresent Twitch.

Nick started with the gorgeous In Win 805, and purple-fied it inside and out. Highlights include the sharp-looking Twitch-logoed PSU shroud, the slick purple and white cable sleeving, the painted and logoed MSI graphics card backplate, the silver PCB of the MSI motherboard, and the attractive symmetrical hardline cooling loop.

## QuakeCon Scratch Build Runners-Up

The QuakeCon scratch build category is designed for modders who can't be constrained by off-the-shelf enclosures. As such, this category typically sees a number of creative and unexpected entrants, and this year's contest was no exception.

The second runner-up for the scratch build category was Hailfire, a technical marvel created by Cameron Watkins. This system is a two-in-one LAN machine that marries form and function like few mods we've ever seen. There is a dual-monitor bracket on the back side, and the two monitors fold against the side panels to form a compact, ready-to-travel unit. When unfolded, the system lets two gamers sit side by side and game using a virtual machine with two GPUs and two OSes.



The combination of piano black and white acrylic makes for a classy finish, and the sun and snowflake laser-cut clear side panels prove that Hailfire's got nothing to hide. The meticulous watercooled interior is just plain impressive.



The third-place finisher in this category was Pearce Dunlap with his eye-popping Bastion, a massive remote-controlled 3D-printed tank from everybody's favorite class-based arena shooter, Overwatch.



At first glance, a big reason Pearce's mod is so instantly recognizable for fans of the game is due to the fantastic paint job, complete with game-accurate decals, scorch marks, weathering, and dark paint used to add extra dimension to the mod. The cute plushy bird also really sells Bastion's character, and we love that the barrel is rifled.

# PAX West 2017

## Labor Day Weekend, Perfected

The expansion of PAX (Penny Arcade Expo) venues has boosted the shows' impact on the gaming industry—with many publishers timing their game launches on or around PAX convention dates. Yet there's still something special about the event in Seattle, where PAX originated in 2004. Once again this year, the expo halls of the Washington State Convention Center were abuzz with enthusiastic gamers, booths stocked with new game titles, and PC hardware vendors.



Here be dragons (and Capcom's Monster World Hunter).



Several of Corsair's new product lineups were on display at demo stations where you could try them out, including the new VOID PRO headsets, K68 keyboard (a mechanical keyboard that's dust- and spill-resistant), GLAIVE RGB gaming mouse, and T1 RACE chair. Did we mention that the Corsair ONE compact gaming PC also powered the experience? Corsair really does have a product for everyone these days.



There were a lot of interesting products inside the ASUS ROG booth, but we were most intrigued by the new ROG ZEPHYRUS laptop. This gaming notebook is just 0.7 inches thick and is available with an Intel Core i7-7700HQ and NVIDIA GeForce GTX 1080 graphics (the GX501V configuration).

# HARD HAT AREA

## PC MODDER

Cooler Master has a lot of new products coming out this fall, including a new lineup of power supplies, CPU coolers (both liquid and air), keyboards, and cases. Maybe the most impressive of the group is the COSMOS C700P, a remake of the iconic COSMOS series with a modular interior, tempered-glass side panels, and lots of built-in lighting. The MK750 mechanical keyboard also turned some heads.

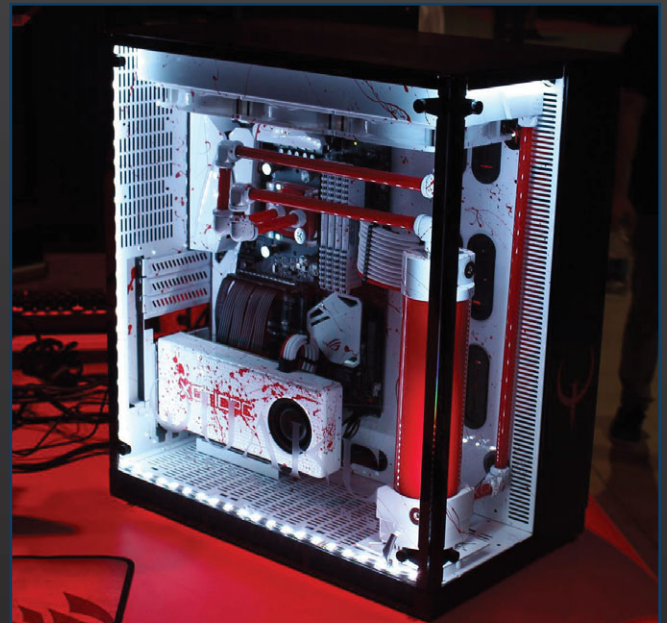
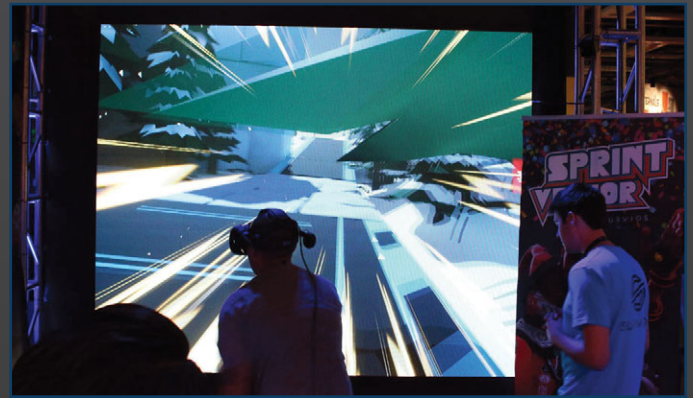


Ever wondered what the GIGABYTE's new AORUS logo is supposed to be? Maybe this figure, who greeted people entering the booth, gives a better clue. Attendees also got to check out the AORUS K7 keyboard, M3 gaming mouse, and H5 headset (left).

## HARD HAT AREA PC MODDER



Sprint Vector is a VR game from developer Survios that's based on a "fluid locomotion system" where you use arm- and head-based motions to run, drift, leap, fly, climb, duck, and dodge. It's a much different experience than the majority of VR games, where blinking or teleporting to somewhere is how people get around—as first-person locomotion tends to make players nauseous. Sprint Vector overcomes this problem by allowing you to propel yourself forward by swinging your arms backward as you release the trigger. Go fast enough and you'll fly over hills. The demo we tested out allowed us to race a live opponent and was, in a word, thrilling.



AMD's booth displayed many custom Quake Champions-themed rigs built by top PC boutiques. XOTIC PC went with a blood-red liquid coolant, and splattered the inside with a matching red. The splatter effect is rather dramatic over the otherwise clean white interior. The Quake logo on the front of this Maingear system is masterfully done, and its red interior is clearly visible through the case's tempered-glass window.



HARD HAT AREA  
PC MODDER



The HP Omen X resides in a cube-shaped chassis, and the builder took advantage of the system dimensions to create a mod based on the Overwatch Loot Box. The rig even includes small details such as the barcode and number 20 near the top corner of the “box.”



This “Guardians Of The Galaxy Vol. 2” mod, complete with baby Groot’s hand poised over the death button, was one of the attractions in ASUS’ booth. Conveniently, the buttons on top of the case also serve as the power and reset buttons. The front of the chassis looks like an old-school stereo, and of course, there’s a tape deck containing Star-Lord’s Awesome Mix Vol. 2.

CPU had a booth at PAX West, and we enjoyed chatting with the gamers and PC enthusiasts who stopped by. Of course, we also had some goodies to show off, including AVADirect’s Z270 Scorpio (below left) and lots of prizes to raffle off. This line (below right) is about half of the folks who waited for their shot to win prizes from Supermicro, Patriot, Zalman, Rosewill, and ENERMAX.



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# Mod Project: Undervolting

## Turn The Underdog Into The Alpha Dog



While we like the RX Vega 64, it's hot and power hungry at stock, making it an ideal candidate for undervolting.

If you're in the market for a graphics card, then you're probably pretty peeved at the masses of Ethereum and alt-coin miners buying up every last card in an attempt to make mad crypto-bucks. It's easy to deride these enthusiasts as greedy non-gamers, but there is at least one good thing to come from all the hysteria besides record-breaking graphics card sales for AMD and NVIDIA: it's the rise of undervolting.

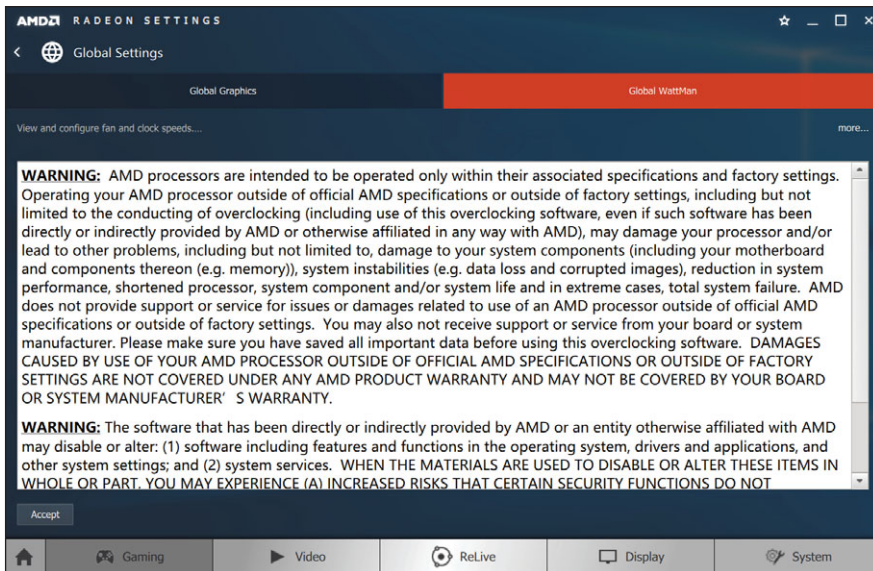
Undervolting is the practice of decreasing the input voltage of a component, such as a CPU or GPU, in order to decrease the device's overall power consumption and heat output. But before you go to our forums and

post about how you used to undervolt your TRS-80 during the Carter Administration just to afford cocktail wieners and Yoo-hoo, we know that undervolting isn't a new technique. We're simply saying that miners, by focusing so much on maximizing energy efficiency to optimize their profit margins, have flooded the Internet with How-Tos, tips, FAQs, and countless forum threads about all the ways to perform the technique. But is there a case for gaming enthusiasts to undervolt? As we'll show you in this article, the seemingly paradoxical answer is, yes, in certain situations, undervolting can actually improve performance.

### Get Over Overclocking

For those new to enthusiast computing, the idea of taking a PC component such as a CPU, DRAM kit, or graphics card, and raising its voltages, timings, and multiplier may seem like a really bad idea. We don't rewire our microwaves in an attempt to get them to cook food faster, tweak our light bulbs to burn brighter, or mod the firmware to our smart TVs in an attempt to raise the refresh rate. Well, we don't unless we like to eat our food raw, live in the dark, and blow up the TV.

The PC components that are most commonly overclocked ship with preset power and thermal limits designed to maximize lifespan and deliver consistent and



Although AMD seems to support overclocking, if you burn out your graphics card, it's on you.

reliable performance for as long as you'll foreseeably own the parts. Overclocking ignores those limits, and as a result, damage can occur, whether that means an instantly fried processor or GPU, or a less pronounced clockspeed drop off that crops up only months down the road. We consider AMD to be an "overclocking-friendly" company due to their support for the Ryzen Master Utility for overclocking processors and the Radeon Software's WattMan tool for overclocking its GPUs, as well as the company's long-held practice of unlocking the multipliers on many of its processors. But the firm doesn't mince words when it comes to damage incurred by feeding your chip too much voltage because you wanted to play *Crysis* on a 4K monitor or crack 3,000 on *Cinebench 15's* multithreaded test.

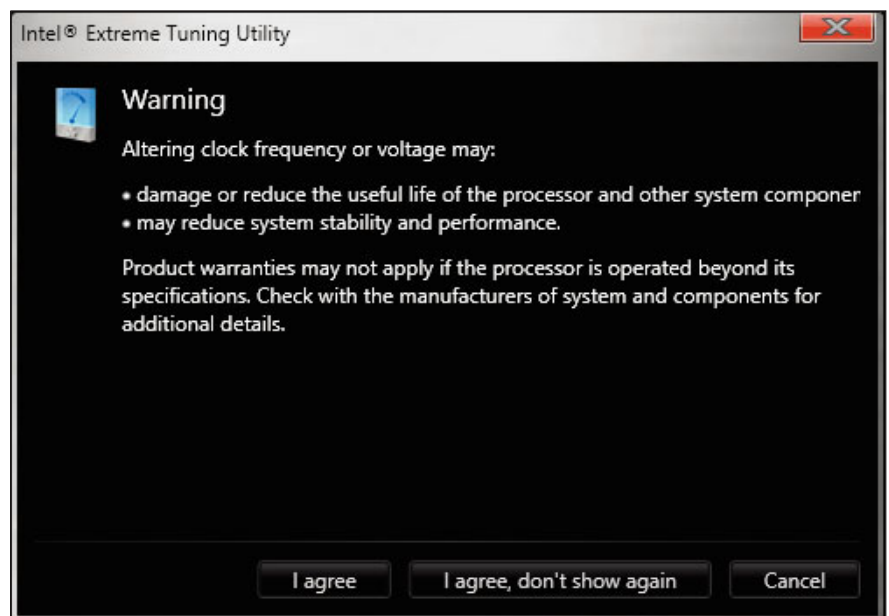
In the not-so-fine print of their driver download pages, you'll find a warning that states, "damages caused by use of your AMD processor outside of official AMD specifications or outside of factory settings are not covered..." Intel's XTU (Extreme Tuning Utility) disclaimer, which appears when you click the Advanced Tuning menu item, makes similar statements about warranty coverage evaporating the moment you take your voltages and clock speeds into your own hands.

Despite the warnings, both AMD and Intel make it rather easy to overclock their CPUs. Third-party graphics card makers, including GIGABYTE, MSI, SAPHIRE, EVGA, ZOTAC, and ASUS also make utilities that are designed to help you push the limits of their hardware. Memory

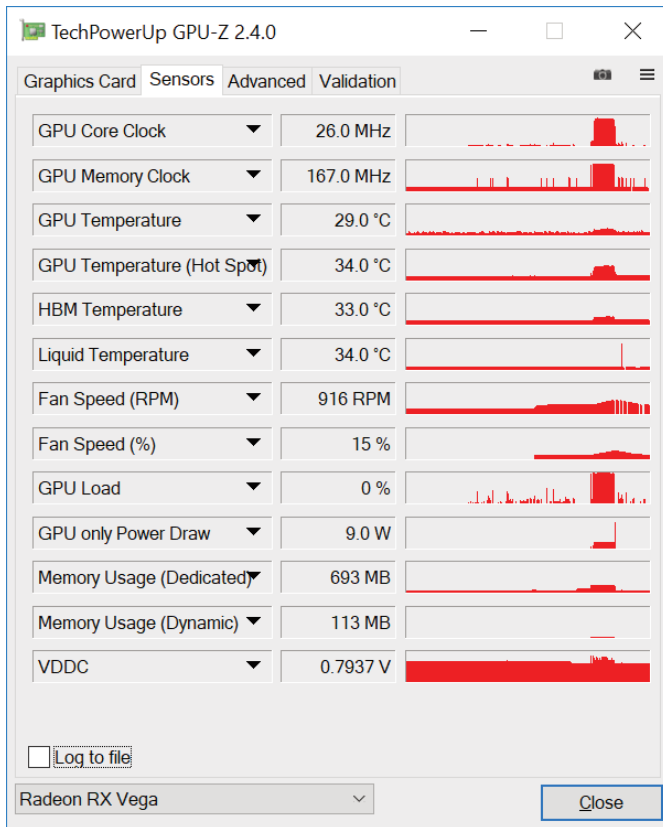
overclocking, although less common, is one of the safer ways to increase the performance of your PC, however it can be touchy and success is a lot less assured.

For those squeamish about the prospect of navigating the BIOS or running third-party overclocking utilities, the manufacturers mentioned above all sell "factory overclocked" graphics cards, which tend to have higher memory clocks, faster core frequencies, and heatsinks and fans specially tuned to handle the increased demand.

Which brings us to the real problem with overclocking: excessive heat and power consumption. When you raise the core clock—even a little bit—you're forcing the transistors to switch at a higher frequency, which calls for more power and increases temperatures. For most enthusiasts, the purpose of overclocking is to increase performance tangibly, so that you achieve visibly higher framerates in games and perceptibly faster performance in the various computing tasks you perform. More often than not, this requires an increase in the operating voltage. As long as you take it slow, increasing voltage in small increments and



Intel is less adamant about refusing to cover damages brought on by operating its processors at anything but stock settings.



GPU-Z is a handy tool for logging power draw, temperatures, and core frequencies.

setting realistic goals, overclocking can be a rewarding endeavor.

Achieving superior performance through overclocking is never assured. Although you can commonly get between 5% and 10% or better performance with a minimal amount of effort in the BIOS, to realize the most impressive overlocks, you'll need to have invested in a hearty aftermarket cooler when overclocking a CPU or have purchased a graphics card with a cooler with plenty of cooling capacity. Your motherboard choice can also factor into how easy it is to enjoy the benefits of a solid overclock.

So in short, overclocking requires better cooling to handle the extra heat, but adding voltage has a massive impact on the wattage the component draws under load. For instance, when you raise the voltage on a processor from 1.1V to 1.2V, the power draw increase is not

linear, you can expect to see increases by as much as 44%. This is merely a mathematical calculation, and doesn't account for leakage, which manifests as additional heat. But there's another factor that has a huge bearing on the upper limit of your overclocking successes.

### Spin The Wafer

The so-called "silicon lottery" plays a tremendous role in how much you'll be able to squeeze out of a given component. This refers to the individual chip's ability to tolerate

increases in frequency and voltage without producing excessive amounts of heat.

When a 300mm wafer of GPU or CPU dies emerges from the chemical mists of TSMC, Global Foundries, or one of Intel's numerous fabs, not every die cut from it will perform the same. Even if yields are great, and few of the chips produce critical errors that would send them straight to the garbage heap during the functional testing phase, it's during the subsequent binning phase that the chips are ranked based on their performance capabilities. The chips that exhibit less current leakage and tolerate operating at higher frequencies are ranked higher, and those that get hot and run slower fall toward the bottom of the scale. The highly ranked chips are often set aside or "binned," factory clocked higher, and sold at a premium.

For instance, a 14nm FinFet Zeppelin wafer from Global Foundries can yield approximately 290 dies. Of those that are classified as useful, the top 5% that emerge from the binning phase are used in AMD's Ryzen Threadripper processors—not counting the dead ones that get paired up with working dies under Threadripper's massive IHS—and all the rest end up in Ryzen processors.

The next step in the process is to assemble these dies into products with thermal, frequency, and voltage limits coded into the firmware. Those limits are set such that the hottest and slowest chip can maintain reliable consistent performance for well beyond its warranty period. Sometimes there's not much difference between the hottest and slowest chip in a run and the fastest and coolest, other times there's a lot. If you've won the silicon lottery, as it were, then you've found a CPU or GPU that can run at considerably higher frequencies than stock, without adding much extra voltage, or achieve record-breaking speeds with exotic cooling and plenty of voltage.

For undervolters, these overclocking-friendly chips are also winners due to their ability to operate at close-to or higher-than stock frequencies when running at a lower voltage. You can increase the chances of getting such a chip by simply buying the highest-end version of the product, but it's always exciting when you stumble upon a real champ that you picked up for a song.

### Playing Limbo With Your Voltages

Traditionally for enthusiasts, the substantial increase in performance has been worth the higher power consumption that overclocking brings. But when you're a miner, you need to subtract the cost of energy from the profits you're pulling in to determine whether your efforts are worthwhile. That 20% voltage increase we mentioned previously will result in a 44% increase in power consumption, but if that gets you just 10%, 20%, or as much as 30% better performance, it is simply not viable. Decreasing the voltage, however, can have a dramatic impact on your power

consumption, while only minimally impacting your scores, hashrates, or framerates.

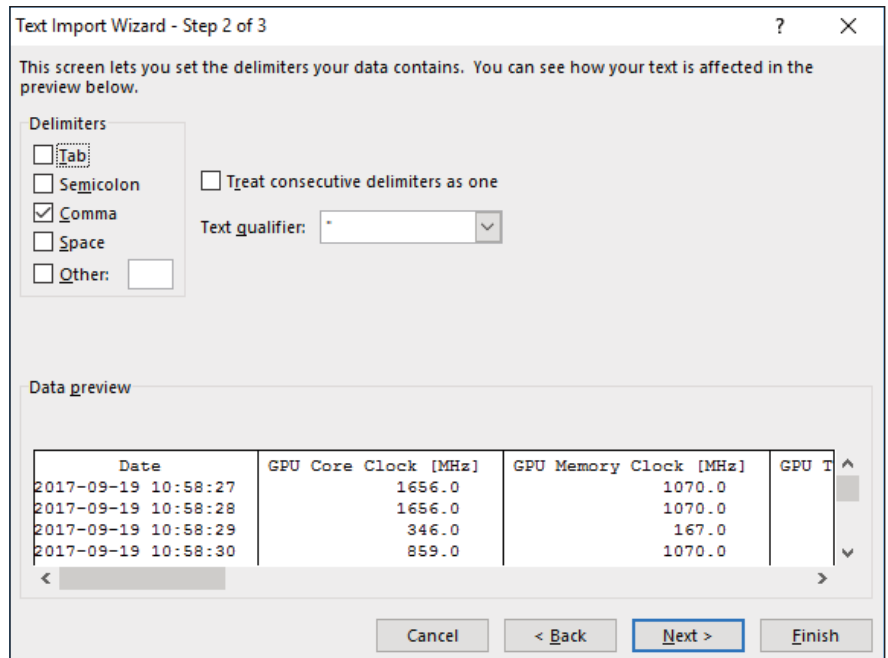
When overclocking, you generally hit your first wall where frequencies won't increase without adding voltage, and then you'll tend to hit another wall where you need to add a significant amount of voltage to get the system running stable with a miniscule frequency bump. This second wall is about where we tend to back off and call our overclock good. But when it comes to undervolting, you won't run into a wall that tells you when enough is enough. In theory, you can continue to drop voltage down to just 100mV (for reference, the highest P State voltage for the RX Vega 64 is 1,200mV) so that your graphics card is drawing just a dozen watts under load, but your performance will be accordingly dismal.

Because we're enthusiasts and not miners, our goal for undervolting will be a little more performance-focused. We'll be attempting to trade a drop in voltage with a moderate increase in core frequency, so that we can keep our undervolting power consumption at least in the neighborhood of the stock draw.

## Parts List

Not all components make good undervolting candidates. For instance, mid-range and entry-level graphics cards and processors tend to be optimized for low energy consumption out-of-the-box. For this article, we're using what we consider to be an ideal candidate for undervolting, the AMD Radeon RX Vega 64 Liquid Cooled Edition. This model features base and boost clocks that are a fair bit higher than those of the air-cooled variants of the Vega 64, to the tune of 1,406MHz and 1,677MHz, respectively. As you can see from the review in this issue, the card is capable of some solid performance, but it does so at the cost of an excessive power draw.

The rest of our test system consists of a Skylake-X Intel Core i7-7820X processor in an ASRock X299 Taichi motherboard. It has 32GB of Corsair Dominator DDR4-3200 memory, a 480GB Patriot Hellfire NVMe m.2 SSD, and an 80



Importing the CSV text document log generated by GPU-Z into Excel let us easily compare performance numbers.

PLUS Platinum 1,200-watt GIGABYTE XP1200M power supply.

## How We Tested

One of the most important tools you'll need if you plan to try undervolting (or overclocking for that matter) is a solid stable of benchmarks and utilities that you can use to collect data on how your graphics card or CPU is performing.

To see how Vega 64 was performing from a heat and power standpoint, we used TechPowerUp's GPU-Z version 2.4.0 (<http://bit.ly/2ym0wPk>), which was released on September 7th. This version was recently updated to correct for a bug that was displaying the incorrect number of shader units in RX Vega graphics cards. We like GPU-Z because it's a resource-light utility that lets us log frequencies, power draw, temperatures, and voltages in the background while we run benchmarks. The charts in this article were compiled from the GPU-Z's logged data.

To save the GPU-Z logs to a file, launch the utility, click the Sensors tab, click the checkbox beside Log To File, then choose a location for the text file.

The moment you click Save, logging begins, and it doesn't stop until you go back to GPU-Z and uncheck the box. We took the resulting TXT file, loaded it into Microsoft Excel as a CSV (Comma Separated Value) file, and then selected commas as the delimiter during the import process. GPU-Z logs values in each category once per second, and in Excel, we were able to graph the performance of the Vega 64 under load while running various applications. We generated logs for the stock settings and again for each of our undervolting attempts.

Because we were relying on the output of GPU-Z's logging so heavily, especially for reading power draw, we also hooked up the system to our EXTECH Power Analyzer, which reports the total system power draw. Using this, we were able to compare the power load at the wall against the numbers GPU-Z was generating, and because we could see corresponding peaks and valleys under load and at idle, we could verify that the software was reporting accurately.

For making adjustments to the Radeon RX Vega 64, we relied on AMD's own WattMan, a utility built into the Radeon



The WattMan utility, built into Radeon Software, was our undervolting weapon of choice.

Software that lets you tap into voltages and frequencies, adjust the power limit, and tweak the fan behavior. The driver version we're using is the Crimson ReLive 17.8.2, released August 24th. We also performed some testing on the 17.9.1 version, and results were consistent between the two. The previous version of the Radeon Software exhibited some quirks, including failing to apply overclock states on Radeon RX Vega series graphics cards, but these appear to have been ironed out in the two driver versions we tested. We are also aware of reports that WattMan's Memory Voltage setting actually refers to overall voltage floor, and that setting the State 6 and State 7 frequencies to the same values can unexpectedly limit the RX Vega 64's frequency scaling, but we didn't encounter this behavior with either the 17.8.2 or the 17.9.1 drivers.

Graphics card drivers, especially for cards that feature a new architecture, can be buggy in their infancy. WattMan is not a perfect utility, but it served our purposes well. Another undervolting utility you may want to try out is WattTool ([www.underclock.net/t/1609782](http://www.underclock.net/t/1609782)). We haven't tested it ourselves, but we've heard that it is a viable alternative to WattMan.

To fine tune our undervolt, we needed a graphically-demanding benchmark that would run in the background and give us a very quick look at how the RX Vega 64 was performing under load. 3DMark Fire Strike Extreme is the perfect option. We ran the Combined Test, which is the most demanding of the four Fire Strike scenes, but only takes about 20 seconds to complete. By looping it, we could see how the card performed in real-time by looking at the GPU-Z and WattMan graphs. We also use this benchmark to validate GPU-Z's accuracy with regard to power draw.

Once we found our ideal undervolt settings using 3DMark, we used GPU-Z's logging function once again while playing a five minute section of *The Witcher 3: Wild Hunt*. This time, we were interested in seeing core clock and power draw both at the stock settings and at our undervolted settings.

We also ran our suite of gaming benchmarks at a handful of the undervolt

settings to determine whether we were getting solid gains across the board. In addition to the aforementioned *Witcher 3*, we also ran *HITMAN* and *Sniper Elite 4*, both in DX12 mode, and *Metro: Last Light*, which is still quite demanding despite its age. All games were tested at 2,560 x 1,400, with the same maxed-out settings we use for benchmarking graphics cards, motherboards, and processors. We used FRAPS ([www.fraps.com](http://www.fraps.com)) for logging framerates in *The Witcher 3* and *Sniper Elite 4*, the remaining two games have built-in benchmarking utilities.

## Undervolting Process

If you've made it this far, you may be surprised to discover that the actual process of undervolting is fairly simple and straightforward. There are only a handful of the settings in WattMan that you need concern yourself with. But before we dig into how to change those settings, we need to run the benchmarks and perform our logging for everything at the stock settings.

With our RX Vega 64, we opted to keep the BIOS switch at the default 200-watt power limit setting, both for stock and undervolting testing. The card's power draw with the 220-watt BIOS increased too much to justify the modest performance improvement. Remember, our goal is to keep power consumption to a minimum here.

With the stock testing complete, access WattMan by right-clicking any free space on the desktop and clicking the AMD Radeon Settings item in the menu. Next, click the Gaming button in the top-left corner, click Global Settings, and then click Global WattMan. At this point, you may encounter a disclaimer warning that you will imperil your warranty should you choose to use the software to change the card's operating parameters. Next, you'll need to move the Performance/Watt Profile slider over to the Custom position.

There are a total of five settings we tweaked for our various undervolting runs. The first thing you should do is look at the bottom of WattMan for the Power Limit % setting. Move this slider all the way up, to 50%. This effectively takes the training wheels off of the RX Vega 64 Liquid Cooled Edition.

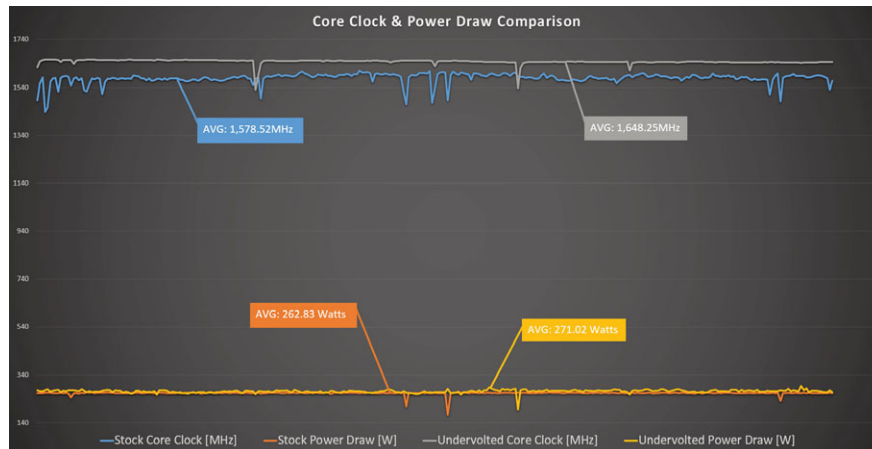
Next, we turned off Frequency (MHz) Dynamic setting, which let us set State 6 and State 7 frequency limits. By default, these settings are 1,667MHz and 1,752MHz, respectively. The real undervolting begins with the Voltage Control (mV) setting, so you'll need to switch it from Automatic to Manual to get started. The default State 6 setting is 1,150mV and the State 7 setting is 1,200mV.

It's not necessary for a pure undervolt, but we also tapped into the memory settings by switching the Frequency (MHz) to Dynamic mode. As previously stated, some users believe that the Voltage Control setting under the memory control is actually a minimum voltage setting for the whole GPU. Assuming this was the case, we left it at 1050mV, which is the lowest voltage we tried while undervolting. Note, this is 100mV higher than the stock 950mV setting. Despite the higher-than-stock voltage here, we didn't notice much impact on system or GPU power draw.

When our settings were all where we wanted them to be, we clicked Apply from the top of the screen and closed the utility to begin our testing. Below are the three settings we settled on that each have various benefits and drawbacks.

**LOWEST:** For our lowest power setting, we wanted to see how close we could get to the stock performance in the games while dropping voltage significantly. For this, we set both State 6 and State 7 to 1,667MHz, and set the Voltage Control (mV) of both States to 1,070mV. We managed to really slash this card's power consumption with 1,065mV, and 1,050mV, but the card performed worse than stock in the various games. Our average GPU-only power draw at this setting was 248.94-watts. Compare this to the stock 1,200mV settings, at which this card draws 263.68-watts, a 5.6% drop in overall power consumption under load.

**FASTEST:** In an attempt to demolish the stock benchmark scores, we decided to run with a slightly lowered voltage, but with a much higher frequency limit. We set State 6 to 1,667MHz and State 7 to 1,702MHz,



The WattMan utility, built into Radeon Software, was our undervolting weapon of choice.

but to maintain these frequencies, we had to raise our undervolt to 1,070mV for State 6 and 1,150mV for State 7. We also clocked up the memory to 1,050MHz and set the Memory Voltage Control to 1,000mV. We also raised the Fan Target from 2,300RPMs to 2,700RPMs because the card's aluminum shroud and radiator were getting very hot. Unsurprisingly, our power consumption under load was 305.33-watts, which is 15.8% higher than stock. Needless to say, this ended up being more of a traditional overclock than an undervolt. With these settings, we enjoyed around 9% better performance in *The Witcher 3* and *Metro: Last Light*.

**BEST ALL-AROUND:** To reign-in wattage and temperatures, we dropped back the State 6 and State 7 Voltage Control settings to 1,070mV and 1,100mV, respectively. For the Frequency settings, we chose 1,667MHz and 1,687MHz, largely because during testing, we never once saw scores climb above 1,700MHz, even with plenty of voltage and power at hand. We raised the Memory Frequency up to 1,050MHz and the Voltage Control to 1,050mV. Under load, the card was only consuming 272-watts, a mere 3.16% increase. In the benchmarks, however, we managed to raise our scores by 4.36% in *HITMAN*, 8.75% in *Metro: Last Light*, 7.3% in *Sniper Elite 4*, and 7.29% in *The Witcher 3*.

When running *The Witcher 3* while testing for this article, we experienced some rather significant coil whine on the RX Vega 64. Surprisingly, after undervolting, the coil whine became significantly less pronounced. We also noticed a more consistent clock rate, with the card holding a largely steady 1,648MHz clock during our extended gaming tests. At stock, the core clock bounced around significantly more, between 1,475MHz and 1,608MHz. By default, the RX Vega 64's dynamic frequency fluctuates based on power load and temperatures, but once we put some hard limits on these aspects, we achieved a normalizing in clock frequency.

## Vega ReVolved

Like we said from the get go, undervolting is all about tradeoffs. You can decrease power draw significantly, but your performance will suffer. As you begin to raise the core frequency, power consumption will climb. There is a middle ground, and with the RX Vega 64, we believe undervolting offers some tangible benefits that don't take a ton of effort to unlock. Although we don't expect to forego overclocking—at least as long as energy is cheap in the U.S.—we do plan to continue undervolting when and where it makes the sense. ■



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## Modder Q&A: Hassan Alaw

# Gamer Turned Modder Turned Mod Shop Owner

Hassan Alaw is a modder, PC builder, and entrepreneur who owns and operates V1 Tech, a company that makes and sells all manner of case mods and case-modding supplies online at [www.v1tech.com](http://www.v1tech.com). Alaw has appeared on Intel's #ExpertMode: Rig Wars, and his Golden Age mod appeared in our September issue's coverage of SAN LAN Summer Splash, a San Antonio LAN party in July.

**Q**: We saw you in a video from DreamHack where you said you got started modding through gaming and, more specifically, QuakeCon. How many QuakeCons have you been to now, and how does this year's LAN compare to the others you've been to?

**HA**: I've been attending QuakeCon since 2012; this year was especially different, considering it's the first time I've been to QuakeCon in the Gaylord Hotel vs the Anatole where I'm used to. I liked that the exhibit area, BYOC area, and main stage were almost in the same place vs. being very much separated at previous events. There were a lot of shortcomings, though, with the changeover that I feel are probably growing pains for what will hopefully become a greater QuakeCon experience in the coming years.

**Q**: In the same video, you said that you used to load Halo onto a flash drive and take it to your school library so you could play on all the networked PCs with your friends. Did you ever get caught, and if so, was it worth it?

**HA**: We never got caught because the gentleman's agreement was to not brag about putting the games on there or tell anyone outside our little group about it. We also only really got to do this during lunch hours, so it didn't conflict



Alaw standing next to his first-place-winning Alienware 20th Anniversary mod contest project.

with school conduct in any way. It was just lighthearted fun.

**Q**: How many mods would you say you've built at this point?

**HA**: It's hard to say, but for CES and QuakeCon alone I do two to four builds per year. Off the top of my head, I can think of 10 mods over the years I'm really proud of that took a lot of time. Maybe more than twice as many pretty

good mods, and more average pc mods than I can count.

**Q**: What would you say is your favorite mod out of all the ones you've done over the years, and why?

**HA**: Well, it's like they say, "You're only as good as your last at bat." So my favorite mod changes as they get better. The QuakeCon PC from 2013 was special because it was a turning point in being



#Expertmode, Alaw's project from Intel #ExpertMode: RIG WARS.

recognized as a pro. The following year, I built the Elder Scrolls Online PC, which was the same time I started my company, V1 Tech. Last year's Alienware 20th Anniversary project is a favorite for sure. We won first place with that one, and it's probably one of the most fun pieces to look at that I've done.

**Q** : Which of your mods has been the most challenging to complete?

**HA** : The Elder Scrolls PC I finished the day it was due in my hotel room with a screen built into the bottom of the case that was something I had never done before. The Alienware PC I was able to completely re-create the hieroglyphics art from scratch in a few hours, which was quicker than getting an email back containing the original files. I got them done just in time to engrave the designs on the custom panels for the mod. The number 20 spelled into the watercooling loop in Golden Age took some creativity and a few tries to do. Perhaps not coincidentally, the most challenging parts of any project are always the best parts.

**Q** : We've heard that you're a big Counter-Strike guy, so two questions:

**First, what's your rank in Competitive, and second, can you come to LANFest NETWAR next month and help us in the CS:GO tournament? Our team needs between one and five more solid players.**

**HA** : I'm not ranked, actually I haven't played competitively since CS Source. I thought I was still pretty good, since I played with my friends here and there, but when I joined my friends at SAN LAN to compete in the tournament we got destroyed. That being said I'd love to join you guys!

**Q** : When did you start V1 Tech, and how did you decide to start your own business?

**HA** : I believe anyone should be able to express themselves through their builds, and I started V1 Tech to help builders make their PCs truly, uniquely their own with our official launch in July 2014 at QuakeCon. I can't really tell you when I decided I would start my own business, this was more of a pivot.

Before V1 Tech, I was doing all kinds of freelance IT jobs from security

cameras, virtualization, and networking B2B, to all your computer repair services B2C. That started before middle school, when my dad, a CCIE networking engineer, taught me to fix up his co-workers' PCs so he wouldn't have to do it. Next thing I knew, I was re-balling soldered-on server CPUs, changing expensive printer daughterboards, and migrating servers in high school for a decent chunk of hobby change.

No surprise, I did a lot of PC gaming and built myself a beast of a PC spec-wise, but it didn't look the part. I discovered PC modding about the same time I discovered QuakeCon. I got really into the scene, participating in Facebook groups, reading all the *CPU* magazines, and trying out anything cool I found in the top modders' build logs. After I got the ball rolling, I decided to brand myself and came up with V1 Tech. I turned to social media to share my modding work and services to reach a larger crowd. My first minimum viable product was a backplate I made using hand tools, a sanding block, and some spray paint. After selling a few, I wondered if I could make them faster to bring the cost down and make them for more people, so I looked into automation techniques and design. I started designing better products in-house while outsourcing the manufacturing to a local laser trophy and engraving shop. This allowed me to scale up, so I officially launched at QuakeCon 2014, where we combined a giveaway with a big tech influencer and the press onsite to kick things off. Although I enjoy building high-end PCs, I knew the bigger picture was that everyone else does, too, and I can help them do that. We now have a steadily growing following and a few employees, we've diversified our services and product line, and we have two big lasers in our shop, where we make everything.

**Q** : What does "V1" stand for?

**HA** : V1 stands for Version one; this fits us well as anything we make or do is one-of-a-kind—new and unique.

**Q:** The VI Tech web store has a bunch of pretty cool case mods and modding accessories for sale. Do you build custom mods for customers, as well? What other kinds of products and services does VI Tech offer?

**HA:** We do build mods for customers, however we currently are limiting the projects we accept to one per month with hopes to expand to one per week in the future. These projects are really high-end builds with the highest level of customization. To get a spot, you can simply contact us through our website form. The majority of our day-to-day business comes from DIY users looking to get themed custom parts from our shop to easily and affordably build their own unique, trade show-ready builds.

**Q:** We enjoyed watching you on Intel's #ExpertMode: Rig Wars; what was it like being on the show and competing with Travis and Marc?

**HA:** I had not been on a Hollywood set before then, so it was

definitely eye-opening. I loved how it was all well set up. Marc and Travis are not only the coolest guys, being very talented and experienced, but probably also the most fun to compete with considering the lighthearted jokes they make while building and being really helpful and caring when it comes to sharing tools or not hesitating when someone needs help with a leak or tricky situation—both of which occurred on the set. It really felt like everyone, from the modders to the film crew, had each other's best interests at heart. The whole thing was a ton of fun and not something you get to do every day.

**Q:** Are you working on anything special right now, and if so, what can you tell us about it?

**HA:** I am doing a build currently called Molecular Data with EVGA and Swiftech watercooling. It's going to be a very flashy mirrored chrome and red build that you won't want to miss.

**Q:** It's time for Five Quick Questions!

#### 1) Skylake-X or Threadripper?

Definitely Threadripper. I've been loyal to Intel for a few years now, but I have to say I'm very impressed with the new AMD lineup. I do a lot of CAD and render work that Threadripper just chews through and for the price it's pretty incredible.

#### 2) Laser cutter or Dremel?

You can do more with a Dremel and, if you have the time, produce similar results as with a laser, but I have to say laser cutter. You just can't get the same amount of detail and quality finish in the same time frame as a laser. And for anyone who thinks using a laser takes no skill, I would say it's actually a lot harder to learn to do great design work and operate a laser creatively than to use a Dremel. That being said, I love my Dremel and hope I never have to be without it.

#### 3) M4 or AWP?

Although I enjoy using them both depending on the mood or role, I have to say AWP. It costs more for a reason.

#### 4) SSDs: M.2 or PCIe?

M.2 because it's so nice to have a super-fast storage unit, cable free, and out of the way in a build, making it easier to build a good looking pc.

#### 5) Matte or metallic?

I like matte materials because they're easier to use and take care of, but I have to choose metallic or high-gloss, because I think it just looks better. Metallic colors pop more, tend to turn more heads, are more enjoyable to look at, and are well worth having to take care of in my opinion. Of course, both have their place, and you can use mediums to create a better visual experience in some cases. For example, in the build I'm working on now, the red is a matte finish, which adds contrast to the mirrored silver finish color I'm using. ■



Alaw's Golden Age mod.

# In The Loop

## A Fitting Discussion

When it comes to liquid-cooling odds and ends, there are so many options out there that even liquid-cooling gurus can have a hard time picking parts. In this installment of “In The Loop,” we once again spoke with Elliot Shiver, PrimoChill’s Senior Technical H2O Specialist, to get the lowdown on fittings.

**Q** : We’re most familiar with barb fittings, but what’s the deal with compression fittings, what makes them ideal for various builds?

**ES** : Compression simply refers to the way the fitting secures the tubing. Be it in PC watercooling or other industries, compression fittings use some kind of O-ring or collar that is pressed up against the tubing (or compressed) by a cap. This provides a seal and secures the tubing. This is how rigid compression fittings work. Compression fittings for soft tubing work exactly the same way, but the tubing itself serves as the compression collar, and the “barb” in the middle of the fitting serves as the rigid bit against which the tubing is compressed.

As far as which is ideal, they are both great. Soft tubing is easier to work with and can be moved around if you need to swap out a component, while rigid tubing can be bent to any amazing design you want. A new watercooler may want to start with soft tubing, as it is more user-friendly.

**Q** : True or false, do rotating joint fittings and extenders tend to leak?

**ES** : Rotary fittings do not tend to leak, they are overall very safe and secure. With that being said, they can leak, it’s just not common. The one out of thousands of fittings that leaks gets posted on forums while the others all just live happily in their loops. You can prevent a leak, though, by testing each fitting before you install it. If a fitting is brand-new or has been in storage for a long time, turn each rotary joint to see if it is either



PrimoChill’s RSX fittings are compression-style fittings, which work well for a variety of watercooling builds.

stuck or very loose. If there is a lot of play in a rotary fitting, seal it with a stop fitting and blow into the other end, if it’s not airtight, it sure isn’t water-tight. If it passes the air test, you should be ready to go. To be safe, air-test your entire loop the same way before you start filling.

**Q** : Most basic custom loops employ straight fittings, but can you describe a scenario where one might need to use couplers like those featured on PrimoChill’s website?

**ES** : I can’t think of a scenario where you can’t get away with simple fittings and good bending skills with

rigid tubing. Sometimes flex tubing requires angled adapters because there is a max bend radius beyond which flex tubing will kink. However, watercooling is as much an art form as it is anything else. Couplers are one more tool with which a watercooler can create his or her masterpiece. They can be used in creative ways wherever a user wants to install them just for looks, or they can serve a utility purpose; perhaps you want to insert a reservoir or radiator into a loop where there wasn’t one before. Instead of redoing the entire bend, you can cut it at the right spot and insert a coupler and make another bend to install the new component.

**Q:** Is it possible to crush an O-ring while only hand tightening?

**ES:** Not in my experience. A well designed compression fitting is designed for full compression, where the size of the tubing, cap, base, and O-ring are all very carefully matched so that when the compression cap is threaded down all the way, there is the ideal amount of pressure on the O-ring and tube.

**Q:** Is it possible to overtighten a compression and barb fitting that uses flex tube?

**ES:** Yes it is; PrimoChill flex fittings follow that same design and are meant to be at the ideal compression when the cap is threaded all the way down, but some other flex tubing compression fittings are not that way. Many flex compression fittings are good and tight up against the tubing when the cap is only threaded halfway, or even less. If you crank on these fittings it is entirely possible to

crush or cut the tubing and potentially cause a leak or damage the fitting. Also, exposed threads aren't a good look.

**Q:** Are some types of fittings easier to work with than others?

**ES:** Absolutely. In contrast to compression fittings, there are also push-in fittings, which have a fixed base with a captive O-ring that you push the tubing into. The tubing must be beveled and smooth or it cuts the O-ring or won't go in at all, and they are never as secure as compression fittings can be. In my opinion, these are more trouble than compression fittings, but there is no compression cap so they may be easier to use in tight spaces. Another fitting type incorporates elements of push-in fittings and compression fittings, using both a captive O-ring in the base—sometimes even two captive O-rings—and also a compression ring or collar and cap. While these types of fittings can be very secure, they are also much more difficult to get tubing into and aren't a lot of fun to build with.

PrimoChill RSX fittings are easy to use because you can get insane bends into them and still get the compression cap and O-ring on nice and securely. The push-in or combo fittings require a relatively long straight end to go into them. I did a build called "Cheap and Cheerful" to see how cheaply I could build a full watercooled PC, and to keep costs down I reused and modified a bunch of discarded PETG bends from other builds. Some of the bends just barely made it into the fittings; I wouldn't have been able to do it without our RSX fittings.

**Q:** Is there a type of fitting that works better for a system that will be travelling a lot?

**ES:** I would avoid push-in fittings and any couplers or other fittings such as 90-degree fittings, which people use to avoid bends and keep all the tubing straight. As long as you are using a compression fitting and all fittings are threaded into a solid surface, such as a component or a bulkhead fitting, you should be safe as long as you are careful. If you are going to be shipping a build, I suggest draining it first. On one build that got destroyed during shipping, all the side panels were wrenched off, but our RSX fittings stayed true and were the only thing holding the PC together.

**Q:** Prior to filling, is there anything we can do to prevent leaks?

**ES:** Look at the O-rings for any damage or dry rot. Replacement O-rings can be purchased if needed. Air-test rotary fittings before installing and then air-test the entire loop before filling, just to be on the safe side. This involves sealing the loop with one run of tubing off the reservoir or anyplace you can install a fitting and tubing and blowing into it. If you hear a hiss, you have a leak. If not, you are good to go. ■



Want your PC to be a masterpiece? Fittings are as important to the end result as brushes are to a painter.




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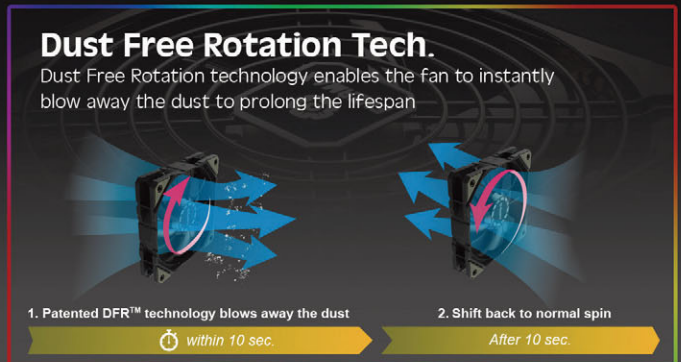


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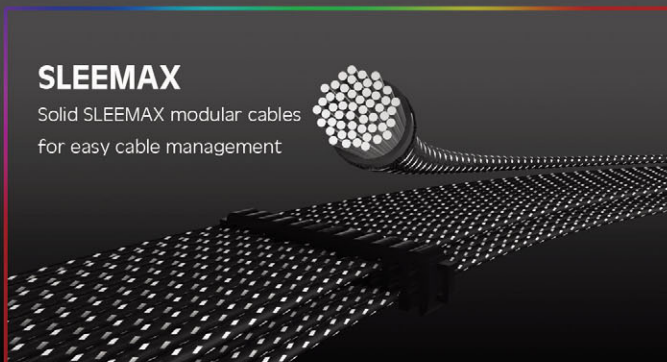
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2. Case Fan
3. Case Fan
4. CPU Cooler Fan

# Perfect Your Precision

Customization is the name of the game with modern mice.

Most gaming mice offer ways to change or adjust the grip style, assign macros to every button, and take advantage of custom DPI settings on the fly. And to go along with the RGB craze taking over the hardware inside your case, many mice also feature RGB lighting. The goal of all the adjustment options, of course, is to give you ways to optimize accuracy and maximize your gaming experience. Almost all of the mice in our guide are exceedingly customizable, and the few that aren't 100% adjustable are targeted to a single type of grip style or game genre.

### DPI Over 9000

Actually, many of the mice in our buyer's guide boast a maximum DPI of 12,000, and one is up to 16,000. The majority of the time, you won't need to have your mouse DPI set so high, but having a wide resolution range does mean you'll be able to test out virtually any usable DPI speed and configure the mouse to ideally function with your style of play. Maybe just as important is the lower end of the DPI range, especially if you like to play sniper and require pinpoint precision. Many gaming mice can be set as low as 100dpi. We list the mouse's DPI range at the bottom of each profile in the guide.

### Get With The Program

Continuing on the theme that no two gamers are exactly alike, most mice now feature at least six buttons you can remap or program with custom macros. And it's not uncommon for high-end mice to feature 10 buttons or more. Right-handed mice generally include the left and right mouse buttons, as well as two buttons above the thumb rest. But there are no customary positions for other buttons. If you're big on macros, take a long look at button placement and consider how accessible those buttons will be with your grip style.

### Tale Of The Tape

The profiles that follow showcase each model's most important design choices to help you decide which mouse might be best suited to your play style. Want to compare the various features of a few models? Check out our chart at the end of the guide.



## Creative Sound BlasterX Siege M04

\$64.99

[us.creative.com](http://us.creative.com)

**Why You'll Dig It:** Creative is a relatively new player to the mouse market, yet the Sound BlasterX Siege M04 is in no way a fumbling first attempt. The SoundBlasterX Siege M04 is built around a PixArt PMW3360 optical sensor with a minimum 200dpi and maximum 12,000dpi (without interpolation). You can program three DPI levels, which you can quickly select using the mouse's DPI switch. There are seven fully programmable buttons onboard, and the mouse's internal memory can store the settings, so you can use your custom remaps on any PC. Creative adds Aurora Reactive LED lighting to the base of the mouse for RGB goodness. The right-handed mouse body features a fingerprint-resistant surface and rubberized side grips.

**Who Should Apply:** Right-handed gamers primarily concerned with mouse precision and customization.

Sensor (DPI): Optical (200 to 12,000)

Body Type: Right-handed

Buttons: 7 programmable



## Patriot Viper V570 RGB Laser Gaming Mouse

\$59.99

[www.patriotmemory.com](http://www.patriotmemory.com)

**Why You'll Dig It:** There are 13 programmable buttons on the Viper V570 RGB Laser Gaming Mouse—with a row of seven buttons that span the left side of the mouse, above the thumb. At the top of the thumb's resting position is a sniper button, which dramatically reduces the DPI setting (to 400dpi) for those times when you need pinpoint accuracy in games. You can snap off a top portion of the mouse housing to access the hidden weight compartment, letting you add up to 34.2 grams. That's enough to make this fairly light mouse feel solid in your hand. Under the housing, Patriot equipped the Viper V570 RGB Laser Gaming Mouse with an Avago 9800 laser sensor, letting you adjust the DPI to up to 12,000. The switches are zero-delay Omron switches.

**Who Should Apply:** This is a full-featured mouse sold at a reasonable price, so it's a good value for gamers on a budget.

Sensor (DPI): Laser (50 to 12,000)

Body Type: Right-handed

Buttons: 13 programmable



## GIGABYTE AORUS M3

\$39.99

[www.aorus.com](http://www.aorus.com)

**Why You'll Dig It:** The AORUS M3 is designed for all types of right-handed grip styles. Split left and right mouse buttons, for example, work well with claw and fingertip grips because both sides of the mouse feature rubber grips. Palm grip users, meanwhile, can rest their hand along the mouse's shallow, long curving back. GIGABYTE equips it with a PixArt 3988 optical sensor that can function anywhere from 50 to 6,400dpi—at 50dpi increments. The AORUS M3 also uses Omron switches with a rated lifespan of 20 million clicks. Those with a GIGABYTE or AORUS motherboard should also like that the AORUS M3 can sync with RGB Fusion to match up system lighting effects.

**Who Should Apply:** Gamers who want a mouse that's built to handle a wide variety of grip styles.

Sensor (DPI): Optical (50 to 6,400)

Body Type: Right-handed

Buttons: 7 programmable



## Cougar Revenger S

\$49.90

[www.cougargaming.com](http://www.cougargaming.com)

**Why You'll Dig It:** Do you game at 4K? Cougar's Revenger S features an optical sensor with a DPI range up to 12,000 for quick, precise control at higher display resolutions. Even if you don't game at high resolutions, Cougar has you covered, because you can set the Revenger S's sensor as low as 100dpi. Cougar also ups the polling rate to 2,000Hz on the Revenger S—double what you see on most gaming mice. Twice the refresh rate helps to smooth quick mouse movements and works especially well in combination with a high performance optical sensor. The Revenger S boasts the two main buttons, a clickable wheel, a DPS button, and two flank buttons.

**Who Should Apply:** Power users looking for a mouse that can deliver smooth tracking and a wide range of DPI choices.

Sensor (DPI): Optical (100 to 12,000)

Body Type: Right-handed

Buttons: 6 programmable



## Razer Basilisk

\$69.99

[www.razerzone.com](http://www.razerzone.com)

**Why You'll Dig It:** Razer targets the Basilisk at FPS players by including several on-the-fly customization features. To start, Razer provides the mouse with a 5G optical sensor that's capable of providing a true 16,000dpi. It's the same sensor in Razer's DeathAdder Elite, and on the Basilisk, Razer also includes a DPI clutch that can change to a preset DPI level, such as a low DPI for sniping. The Basilisk comes with two clutches (one long and one short) to suit different hand sizes. The scroll wheel also boasts some unique technology, as there's a dial on the underside of the mouse where you can tweak the resistance of the scroll wheel. Razer says the customized resistance is ideal for gamers who bind a "Jump" function to their scroll wheel.

**Who Should Apply:** FPS players who want a way to switch between two preset DPI modes.

Sensor (DPI): Optical (up to 16,000)

Body Type: Right-handed

Buttons: 8 programmable



## SteelSeries Sensei 310

\$59.99

<https://steelseries.com>

**Why You'll Dig It:** SteelSeries uses its TrueMove 3 sensor on the Sensei 310 to provide "1-to-1" tracking, so the sensor is free of smoothing, angle snapping, and other imprecise movements. With TrueMove 3, the Sensei 310 provides 1-to-1 tracking, without jitter reduction, at CPI (counts per inch) settings between 100 to 3,500cpi. At CPI levels above 3,500 (the Sensei 310 can go as high as 12,000), the Sensei 310 makes use of a custom SRAM to reduce jitter and further extend 1-to-1 tracking. The Sensei 310 is an ambidextrous mouse with a body type suited to both claw and finger-tip grip styles. There are eight buttons and SteelSeries allows you to save CPI settings, button remappings, and lighting effects to the Sensei 310.

**Who Should Apply:** eSports gamers looking for impeccable accuracy and 1-to-1 tracking.

Sensor (CPI): Optical (100 to 12,000)

Body Type: Ambidextrous

Buttons: 8 programmable



## Patriot Viper V570 Blackout Edition RGB Laser Gaming Mouse

\$69.99

[www.patriotmemory.com](http://www.patriotmemory.com)

**Why You'll Dig It:** The Blackout Edition of Patriot's Viper V570 comes with full spectrum RGB lighting through seven color zones, so you can completely customize the look to match your rig's theme. Similar to the standard V570, Patriot provides the Blackout Edition with 13 programmable buttons, an adjustable weight system, and zero-delay Omron switches. Patriot's Viper software utility allows you to program the V570 Blackout Edition's four DPI levels, which are adjustable on-the-fly via two DPI buttons on top of the mouse. The underside of the Viper 570 Blackout Edition RGB Laser Gaming Mouse features ceramic footpads for smooth movement. Patriot designs the V570 Blackout Edition with a hybrid FPS and MMO ergonomics to ideally function in a variety of games.

**Who Should Apply:** Power users in the market for a high-performance gaming mouse that's also extremely customizable.

Sensor (DPI): Laser (50 to 12,000)

Body Type: Right-handed

Buttons: 13 programmable



## HyperX Pulsefire FPS

\$49.99

[www.hyperxgaming.com](http://www.hyperxgaming.com)

**Why You'll Dig It:** This right-handed mouse is lightweight (95 grams) and boasts responsive OMRON switches for snappy feedback. HyperX also provides the mouse with a relatively high arch, and when combined with the textured rubber side-grips, it's clear Pulsefire FPS is a good option for the claw-grip style. For smooth gliding (a key concern with claw-grip users), the Pulsefire FPS also boasts long and wide skates on the front and rear of the mouse. HyperX equips the Pulsefire FPS with a PixArt 3310 optical sensor and four DPI presets (400/800/1600/3200). A single DPI button above the thumb wheel is how you'll switch among the DPI resolutions.

**Who Should Apply:** People who favor the right-handed claw grip and want a mouse with arching contours and a smooth glide.

Sensor (DPI): Optical (400 to 3,200)

Body Type: Right-handed

Buttons: 6



## Corsair Glaive RGB

\$69.99

[www.corsair.com](http://www.corsair.com)

**Why You'll Dig It:** Corsair designs the Glaive RGB to be comfortable for right-handed grip styles by including three interchangeable thumb grips that magnetically attach to the mouse's body. The default grip is a smooth, soft-touch piece that is more or less flush with the left side of the mouse, but you can swap that out for one that is textured rubber; the latter grip is a good option for the fingertip grip because it matches the right side of the mouse and has a little more contour to it. The third option is a large textured-rubber piece that provides a full thumb rest and is best suited for the palm grip style. The Glaive RGB is a six-button mouse (all programmable) with a sturdy scroll wheel and a DPI selector. Using the latter, you can cycle through five DPI settings on the fly. The Glaive RGB also supports Corsair's CUE software to customize the mouse's LED lighting.

**Who Should Apply:** Gamers looking for an extremely customizable mouse for long-term comfort and ultimate precision.

Sensor (DPI): Optical (100 to 16,000dpi)

Body Type: Right-handed

Buttons: 6 programmable



## Cooler Master MasterMouse MM530

\$49.99

[www.coolermaster.com](http://www.coolermaster.com)

**Why You'll Dig It:** The MasterMouse MM530 features a large, long body with sizeable rubber grips to optimally fit palm grip styles. The side grips also make the MasterMouse MM530 a decent option for claw grip styles. Cooler Master installs a PixArt 3360 optical sensor that allows for a DPI range between 100 and 12,000. You can set up to four separate DPI settings in 100 DPI increments within the huge DPI range. The onboard DPI buttons allow you to quickly switch among your chosen DPI settings. You can also program the seven mouse buttons within the Cooler Master software utility and save up to five profiles. Three RGB LED zones on the mouse provide some additional aesthetics—without being too flashy or distracting.

**Who Should Apply:** People who prefer the palm grip and want a mouse specifically designed to enhance the palm grip experience.

Sensor (DPI): Optical (100 to 12,000)

Body Type: Right-handed

Buttons: 7 programmable



## Logitech G603

\$69.99

[www.logitech.com](http://www.logitech.com)

**Why You'll Dig It:** Gamers have traditionally shied away from wireless mice due to potential tracking lag and battery life problems. Logitech's G603 is a wireless gaming mouse that attempts to solve both issues. High-quality wireless performance is covered by Logitech's LIGHTSPEED technology that creates an optimized wireless signal—said to have a 1ms report rate. The wireless design, of course, means you won't need to deal with cable drag. The G603 also features advanced power management to provide peak (LIGHTSPEED 1ms reporting) performance for up to 500 hours. When not gaming, you can switch to a LO mode (8ms reporting) for up to 18 months of use with two AA batteries. The G603 includes all the conventional gamer goodies, including an optical sensor with a 200dpi to 12,000dpi range and six programmable buttons.

**Who Should Apply:** Gamers in the market for a wireless mouse that delivers precision and speed, in addition to respectable battery life.

Sensor (DPI): Optical (200 to 12,000)

Body Type: Right-handed

Buttons: 6 programmable



## Zalman Knossos ZM-GM4

\$59.99

[www.zalman.com](http://www.zalman.com)

**Why You'll Dig It:** Zalman lets you customize the weight, size, and shape of the Knossos ZM-GM4. You can adjust the length and the width of the mouse to the shape of your hand using the included tuning tool, which conveniently stows away inside the mouse. To modify the ZM-GM4's heft, Zalman provides six 3.5g weights that insert into the center of the mouse's body. The Knossos ZM-GM4 also makes it easy to adjust the Avago A9800 laser sensor's DPI. There's a dedicated DPI quick switch to move among four DPI levels on-the-fly. The laser sensor features a max resolution of 8200dpi. Ten programmable buttons are spread along the top and sides of the mouse. You can program each and every button using Zalman's software. For instant response and durability, the Knossos ZM-GM4 features OMRON buttons.

**Who Should Apply:** Enthusiasts who want to adjust the physical shape of the mouse, as well as DPI, sensitivity, button functions, and polling rate.

Sensor (DPI): Laser (800 to 8,200)

Body Type: Ambidextrous

Buttons: 10 programmable



## Zalman ZM-M600R

\$29.99

[www.zalman.com](http://www.zalman.com)

**Why You'll Dig It:** Considering its \$29.99 MSRP, the ZM-M600R is a surprisingly capable gaming mouse. Zalman installs an AVAGO 3090 optical sensor with a DPI that can be as low as 400 (when set via custom firmware) and as high as 4,000. An onboard DPI button also lets you quickly move between the mouse's 600/1000/1600/4000dpi levels, and there are more DPI options if you want to manually update the mouse's firmware. You can also customize the lift-off distance, polling rate, and angle-snap, if you wish. The ZM-M600R boasts a fairly simple design with three buttons and a scroll-wheel. It's also lightweight and offers an ambidextrous body type.

**Who Should Apply:** Gamers looking for an affordable mouse with a customizable DPI, lift-off distance, polling rate, and angle-snap.

Sensor (DPI): Optical (up to 4,000)

Body Type: Ambidextrous

Buttons: 3



## Corsair SCIMITAR PRO RGB

\$79.99

[www.corsair.com](http://www.corsair.com)

**Why You'll Dig It:** Designed for MMO and MOBA gamers, the SCIMITAR PRO RGB boasts 12 mechanical side macro buttons. Best of all, Corsair allows you to reposition the macro buttons, up to 8mm side-to-side, to let you customize your grip and thumb placement. Once positioned, you can securely lock the macro buttons in place. Corsair also preloads the mouse with three macro profiles with macro shortcuts for MMOs, MOBAs, and productivity duties, respectively. Within Corsair's CUE software, you can remap each of the mouse's 17 buttons. Any macros will be saved to the mouse's onboard memory, so the custom shortcuts you've loaded will run on any PC. For extreme accuracy, the SCIMITAR PRO RGB features a PixArt 16,000dpi optical sensor with DPI levels you can custom tune.

**Who Should Apply:** MMO and MOBA players who want to improve their gameplay using mouse macros.

Sensor (DPI): Optical (1 to 16,000dpi)

Body Type: Right-handed

Buttons: 17 programmable



## Rosewill NEON M53

\$24.99

[www.rosewill.com](http://www.rosewill.com)

**Why You'll Dig It:** The NEON M53 is one of the more eye-catching mice you'll find. Rosewill designs the mouse with seven bright, rainbow backlit effects, and you can select which effect runs through fingerprint-like lines across the body. Under the hood, the NEON M53 is similar to other models in Rosewill's NEON lineup. The mouse features an AVAGO A3050 optical sensor with a customizable DPI from 1,000 to 4,000. The DPI button on the top of the mouse lets you switch among 1000/1500/1750/2000/2500/3000/4000dpi levels. The variety of on-the-fly DPI settings makes it easy to tweak the mouse to your preferred precision level. The NEON M53 also has a polling rate switch where you can move between 500 and 1000Hz polling rates.

**Who Should Apply:** Gamers looking for an affordable mouse with gaming chops that makes a bold aesthetic statement.

Sensor (DPI): Optical (1,000 to 4,000)

Body Type: Ambidextrous

Buttons: 6



## E-Blue Auroza Expert

\$45

[www.e-bluegaming.com](http://www.e-bluegaming.com)

**Why You'll Dig It:** E-Blue's Auroza Expert features a grip designed to enhance MMO and MOBA gameplay. The ambidextrous bodied mouse features six programmable buttons, including two buttons on the left side. For quick DPI control, there's a button on top of the mouse that, by default, switches among the optical sensor's 400/800/1600/5000dpi levels. Within E-Blue's software, you can configure the mouse with six custom DPI ranges. An LED on the DPI button flashes to indicate the current DPI setting. E-Blue also lets you switch the polling rate (125/250/500/1000Hz), RGB light settings, and general click and scroll speed. You can save your custom mouse macros among five profiles. LED lighting shines through the satin underbody and scroll wheel for a nice glowing effect.

**Who Should Apply:** Enthusiasts who want a shallow profile mouse that ergonomically fits the palm grip style, while also supporting customization controls for MMO and MOBA gameplay.

Sensor (DPI): Optical (400 to 5,000)

Body Type: Ambidextrous

Buttons: 6 programmable





## Rosewill NEON M57

\$22.99

[www.rosewill.com](http://www.rosewill.com)

**Why You'll Dig It:** The NEON M57 has a shallow, ergonomic profile for long-term comfort while gaming. Rosewill also adds soft rubber on the right and left side of the mouse body to easily maintain your grip. To improve your gaming experience, the NEON M57 features six programmable buttons that boast software support for macros. The DPI switcher above the mouse wheel lets you cycle among five presets that you can configure in the software, between 500 and 4,000dpi. Within Rosewill's software, you can also pick from four backlight modes in three color zones. The RGB LED backlighting inside the mouse allows you to match the mouse's appearance to the color theme of your rig.

**Who Should Apply:** Gamers in need of a solid gaming mouse that won't wreck your wallet.

Sensor (DPI): Optical (500 to 4,000)

Body Type: Ambidextrous

Buttons: 6 programmable



## MSI Interceptor DS300 GAMING Mouse

\$44.99

[us.msi.com](http://us.msi.com)

**Why You'll Dig It:** Considering MSI's expertise in motherboards, it's no surprise that the company has found lots of ways to add value to the Interceptor DS300 GAMING Mouse. For example, you can reprogram all of the mouse's six buttons and the software utility also supports macros. The laser sensor can be set as low as 100dpi and as high as 8,200dpi, and you'll be able to switch among four preset DPI levels—based on the DPI settings you define. MSI includes four profiles, so you can switch among your specialized configurations. Designed for right-handed users, the Interceptor DS300 GAMING Mouse features ergonomic contours with a large thumb rest. Three 4.5 gram weights are included to let you adjust the mouse's heft and balance.

**Who Should Apply:** Gamers who want a high-quality laser mouse that allows for a lot of fine tuning.

Sensor (DPI): Laser (up to 8,200)

Body Type: Right-handed

Buttons: 6 programmable



**MICE COMPARISON CHART**
**BUYER'S GUIDE**

Model	MSRP	Sensor (DPI)	Body Type	LEDs	Buttons (* Programmable)	Macro Support	Onboard Memory
Corsair SCIMITAR PRO RGB	\$79.99	Optical (1 to 16,000)	Right-handed	4 zone RGB	17*	Yes	Yes
Corsair Glaive RGB	\$69.99	Optical (100 to 16,000)	Right-handed	3 zone RGB	6*	Yes	Yes
Patriot Viper V570 Blackout Edition RGB Laser Gaming Mouse	\$69.99	Laser (50 to 12,000)	Right-handed	7 zone RGB	13*	Yes	Yes
Logitech G603	\$69.99	Optical (200 to 12,000)	Right-handed	None	6*	Yes	Yes
Razer Basilisk	\$69.99	Optical (up to 16,000)	Right-handed	Razer Chroma	8*	Yes	Yes
Creative Sound BlasterX Siege M04	\$64.99	Optical (200 to 12,000)	Right-handed	Creative Aurora Reactive LED	7*	Yes	Yes
Zalman Knossos ZM-GM4	\$59.99	Laser (800 to 8,200)	Ambidextrous	None	10*	Yes	Yes
Patriot Viper V570 RGB Laser Gaming Mouse	\$59.99	Laser (50 to 12,000)	Right-handed	7 zone RGB	13*	Yes	Yes
SteelSeries Sensei 310	\$59.99	Optical (100 to 12,000)	Ambidextrous	SteelSeries PrismSync	8*	Yes	Yes
Cooler Master MasterMouse MM530	\$49.99	Optical (100 to 12,000)	Right-handed	3 zone RGB	7*	Yes	Yes
HyperX Pulsefire FPS	\$49.99	Optical (400 to 3,200)	Right-handed	None	6	No	No
E-Blue Auroza Expert	\$45	Optical (400 to 5,000)	Ambidextrous	RGB	6*	Yes	Yes
MSI Interceptor DS300 GAMING Mouse	\$44.99	Laser (100 to 8,200)	Right-handed	RGB MSI logo	6*	Yes	Yes
GIGABYTE AORUS M3	\$39.99	Optical (50 to 6,400)	Right-handed	AORUS RGB Fusion	7*	Yes	Yes
Zalman ZM-M600R	\$29.99	Optical (600 to 4,000)	Ambidextrous	2 zone RGB	3	No	No
Rosewill NEON M53	\$24.99	Optical (1,000 to 4,000)	Ambidextrous	7 rainbow effects	6	No	No
Rosewill NEON M57	\$22.99	Optical (500 to 4,000)	Ambidextrous	3 zone RGB	6*	Yes	Yes

# Upgrades That'll Keep You Humming Along

We don't discriminate on the basis of age 'round these parts; software young and old have a chance to shine. This month, we're featuring a pair of programs that are only a few months old, as well as one that celebrated its 16th birthday this year.

## SOFTWARE UPDATES

### Backlog 1.3.0

Evernote is clearly the go-to program for most note takers, but sometimes its features can get in the way of users who desire simplicity. Available for Windows, Mac OS, and Linux, Backlog is a lightweight app that helps you keep track of that ever-growing to-do list using Boards. (It doesn't require an internet connection, either.) Less than a month old, Backlog's developer has been cranking out updates to whip Backlog into fighting form. With version 1.3.0, the software presents you with a confirmation dialog box before deleting a Board. Tooltip placement is improved, as well, and a little polish to the UI should make it more readable.

<https://github.com/czytelny/backlog>

### Inntal Software PRIMA Image Racer 4.0

Designed to be a fleet-footed image viewer, PRIMA Image Racer is especially useful when accessing images on removable media. Touchscreen users should be especially pleased with the 4.0 update (the second major update this year), which adds gesture support. You can now send "some" images via email, and Image Racer now has the power to encrypt and decrypt images. Navigation should also be "a little bit faster," according to the app's developer.

[www.inntalsoftware.de/en](http://www.inntalsoftware.de/en)

### Rainmeter 4.1 Beta r2873

One of the most popular desktop customization apps, Rainmeter has been

around since early 2001. Despite its age, updates still come on a regular basis, changing this or fixing that. Revision 2783 adds character reference variables, which gives enterprising modders the ability to code Unicode characters and symbols in plain text. Rainmeter's development team indicates "major improvements" to the Skins panel in revision 2873, plus the update takes care of a "long-standing" issue with Rainmeter's NowPlaying [sic] feature misbehaving when iTunes' shuffle and repeat states change.

<https://www.rainmeter.net>

### Smart PC Soft Easy Convert 2.0.0.0

Easy Convert converts your media files . . . easily. Now that we have that out of the way, let's dig into all of the cool new things the software can do following its big 2.0 release in September. In addition to converting, the new-and-improved Easy Convert also splits, cuts, and merges audio and video files, so you can chop up and stitch together media as you see fit. Version 2.0.0.0 also adds the capability to yank the original audio from a video and replace it with different audio. Last but not least, Easy Convert's GUI gets a fresh coat of paint.

[smartpcsoft.com](http://smartpcsoft.com)

### Sushi Browser 0.3.1

Multi-panel browsing is the standout feature of this tasty new web browser. Check it out—you won't realize how inefficient your browser was in terms of space and usability. This update gives the context menu a page translation capability and cuts down on the number of files using the .ASAR archive. According

to the developer, Sushi Browser's performance should be snappier after opening a new window, as well.

<https://sushib.me>

### TweetDuck 1.9.2

Most prolific tweeters—whether that's tweetstorms, multiple accounts, or both—are eminently familiar with TweetDeck, we'd reckon. If you want to take your tweets to the next level, take a look at TweetDuck, a FOSS TweetDeck desktop client. A couple of UI tweaks headline the release of version 1.9.2. Now, you have the option to add search columns before the first column. (Previously added search columns were tacked on at the end.) You can also drag links onto any column and open the linked tweet in TweetDuck's Detail view. More notably, version 1.9.1, released a few days earlier, abandoned Twitter's t.co link shortening service after the company ceased its support for the DNT (Do Not Track) privacy setting.

<https://tweetduck.chylex.com>

## DRIVER BAY

### Intel NUC Kit NUC6i5SYK BIOS 0062

The new BIOS also applies to the following three NUC PCs: NUC6i5SYH, NUC6i3SYK, and NUC6i3SYH. According to Intel, BIOS 0062 contains unspecified security enhancements, so it's a good idea to grab the BIOS as soon as you can. It also fixes issues related to the "Wake On USB From S5" and "Wake On LAN From S4/S5" options

[www.intel.com](http://www.intel.com)

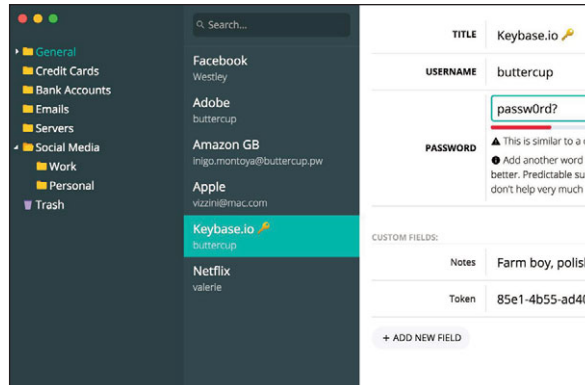
## Inside The World Of Betas

### BUTTERCUP 0.20.0

Listen, we're not going to insult you by rehashing the basics of good password habits. We know your password isn't "password," or even "passw0rd." Sadly, that doesn't change the fact that supposedly secure sites are hacked on a regular basis. So, you change your passwords, then you change them again. The process is so tedious that a password manager is essentially a must-have.

Keep an eye on Buttercup, a free, cross-platform password manager that's currently under development in Helsinki, Finland. After brewing in alpha since January 2016, Buttercup officially entered beta roughly a month ago.

A big part of the Buttercup's beta debut is a shiny new UI. As you might suspect, simplicity is the name of the game, making Buttercup consistent with other streamlined password tools, such as LastPass and 1Password. Fire it up, create



#### Buttercup 0.20.0

**Publisher and URL:** The Buttercup Team;  
<https://buttercup.pw>

**ETA:** TBD

#### Why You Should Care:

Buttercup could be a sweet password manager once it's out of beta.

a new Buttercup password archive, and fill it up with the login and password info for all of your accounts. And if you want to defect from one of the major players in the industry (more on that in a minute), Buttercup helpfully lets you import archives from LastPass, 1Password, and KeePass. To make matters easier, Buttercup already has a Chrome extension available,

and mobile versions (iOS and Android) are nearing completion; we're not too far away from a complete ecosystem, kids.

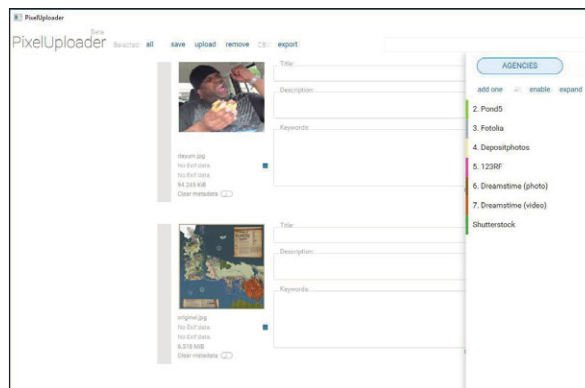
Despite its ease of use and polished interface, Buttercup is still in beta, and for software like password vaults, we always recommend plenty of caution. That said, we expect to be first in line for the 1.0 release. ■

### PIXELUPLOADER 0.8.12

In the iPhone Age, photo storage ain't hard to come by. Cloud after cloud will give you plenty of gigs to dump your pics, and you shouldn't have to spend a dime if you don't want to. Most of these services are easy to use, too, particularly if all you need to do is rocket your smartphone snapshots to the internet.

Pixelstocks' Pixeluploader is (mostly) effortless photo uploading in desktop app form. Launch it, and the very center of the program's UI practically screams at you, "Drop files or double-click here"; only flashing neon lights would make it more obvious. Do so, and PixelUploader quickly populates a list of the files you selected and lets you add basic metadata, including title, description, and keywords. Alternatively, you can also clear a file's existing metadata.

Obviously, though, the main attraction is PixelUploader's ability to upload all those pixels. To do that, you'll need to do



#### PixelUploader 0.8.12

**Publisher and URL:** Pixelstocks; [www.pixelstocks.com](http://www.pixelstocks.com)

**ETA:** TBD

#### Why You Should Care:

Upload your photos in a flash.

a little setup work. PixelUploader starts you off with a handful of services, such as Shutterstock, Pond5, and Fotolia, which will take your images once you provide your login credentials. For other sites, you'll need to have their FTP info at hand. Once you have it, PixelUploader takes care of the rest.

Despite PixelUploader's relative ease of use, we recognize that it will likely be a

niche app (not that there's anything wrong with that). Prosumers who are serious about getting their image library online in a hurry stand to benefit the most, while Snapchatters will get along fine without it. Also keep in mind that many popular online storage sites don't offer an FTP server, another restriction. For what it does, though, PixelUploader is solid. ■

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Game Of The Month

Yeah, we know you have blogs to post, video to encode, reports to write, and code to compile. We do, too, but you have to take a break once in a while (and maybe blow some stuff up). That's why each month we give you the lowdown on what to expect from the latest interesting games.

# DESTINY 2

Like many who played Bungie and Activision's first *Destiny* game in 2014, I loved some things about the game and hated others. For instance, I loved the trademark Bungie FPS action; the Golden Triangle of guns, grenades, and melee was every bit as crisp, responsive, and fun in *Destiny* as it has always been in *Halo*, and the game's environments, enemies, music, and sound effects were equally top-shelf. But the game had a confusing, broken story and a loot system that felt like punishment for sins in a past life.

*Destiny 2* is out now, and after completing the campaign, levelling a Titan to 20, and dipping my armored toe into nearly all of the content types the game has to offer (as of press time I haven't played the first raid, *Leviathan*), I can confidently say this sequel is a huge improvement.

Bungie wisely didn't try to fix what wasn't broken—the alien races you'll face, the controls you'll use in opposing them, and numerous other aspects of the game are largely copied and pasted into *Destiny 2*. PvP has been tweaked, and is still good. But there's a lot more for players to do in the game now, and the accompanying narrative is a vast improvement over the skeletal framework of a story we got in *D1*; your guardian interacts a great deal more with the Vanguard triumvirate and other characters of note. In this regard, *Destiny 2* feels even more like *Halo* than the original did, in that you have a real sense of your character's connection to the people and events in the game.

Another night-and-day improvement is found in *Destiny 2*'s map screen; it gives you much more helpful information than did its predecessor, including your position and orientation relative to points of interest in the world you're currently visiting. Yes, this seems like a no-brainer, but *Destiny*'s original map screen was one of the worst I've ever seen in a game.



## Second Time's A Charm

BY CHRIS TRUMBLE

\$59.99 (PC, XOne, PS4) • ESRB: (T)een • Activision  
[www.destinythegame.com](http://www.destinythegame.com)

Other big improvements will be familiar to the stalwarts who hung around through the first game's "The Taken King" expansion: the loot system has been completely overhauled, including items whose rarity always matches the rarity indicator of the engrams (*Destiny*'s version of loot boxes) they come in. It's also easier to hold onto weapons and armor that you like, thanks to *Destiny 2*'s item infusion system, which lets you fold the power of newer gear into items you really like but that you might be outgrowing as your power level increases.

Unfortunately, not all the news is glowingly positive. I have run into a couple glitches, and as of press time, reports from the first raid, *Leviathan*, indicate that it contains some pretty momentum-crushing bugs. In addition, a considerable number of players have expressed concern over the addition of microtransactions in the form of vanity items players can purchase with Silver, *Destiny*'s other in-game currency that is only obtainable by spending RL money.

Where bugs are concerned, the dev team has proven that it can and will respond when the player community has significant issues, especially with important stuff like end-game raid content. And the microtransactions are purely elective; in their current form, they don't affect gameplay or the competitive balance in PvP, so players who want to can safely ignore them.

None of the issues I've run into have seriously impacted my enjoyment of the game so far. *Destiny 2* is one of those rare games that grabs your interest immediately and then holds it, potentially for a very long time. Bungie has announced the planned release of two expansions, one in late 2017 and another in early 2018, and if what we've seen so far is any indication, we're in for quite a ride. Best of all, the game is scheduled to hit PCs on the 24th. ■



# LIGHT UP THE WAY



## VIPER V570 BLACKOUT RGB GAMING LASER MOUSE



**RGB**  
LIGHTING  
PROFILES



FPS+MMO  
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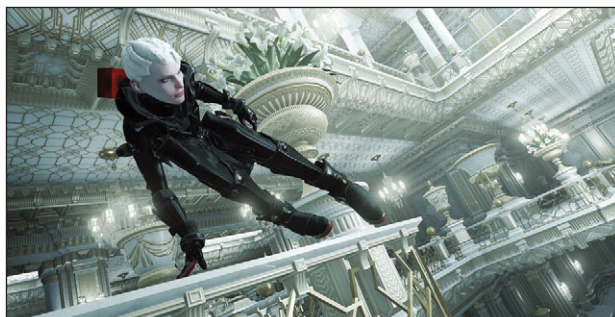


How many times have you outmaneuvered your opponents in Counter-Strike, Overwatch, or PLAYERUNKNOWN'S BATTLEGROUNDS and thought that the only challenger who could really give you a run for your money is you? ECHO, from Danish indie ULTRA ULTRA, is ready to grant you your wish.

ECHO is a stealth action game from a small, relatively new team that's not new to the genre. The majority of the crew came from IO-Interactive, the developer behind the HITMAN series. You can occasionally see a fingerprint of that here and there, but ECHO is definitely its own game, trading HITMAN's gritty underworld of assassinations and espionage for a far-flung space adventure.

The game begins as En, who belongs to an advanced humanoid (possibly transhuman) race known colloquially as "Resourcefuls," awakens from stasis on a spacecraft bound for a planet of myth, a destination that has either faded from memory or was known to only a small number of people. (We equivocate, but with purpose.) Prior to her hibernation, En was liberated, to an extent, by a chill dude named Foster, who was mortally wounded in the process. Whether she loves him or not, En feels deep indebted to Foster, so she "translates" him into a cube and sets off to find the planet that holds the Palace, a quasi-Shangri-La that En and her fellow Resourcefuls believe holds the power to resurrect the dead. She receives grudging assistance from London, your typical impertinent AI that was also good buddies—as much as an AI can be a good buddy—with Foster before En came along. It's complicated.

ECHO doles out all this information in spoonfuls. The game does all of its worldbuilding in dialogue between En (Rose Leslie, "Game of Thrones" Jon Snow's dead ex-girlfriend Ygritte and Jon Snow actor Kit Harrington's alive fiancée) and London (prolific videogame voice actor Nicholas Boulton). To ECHO's credit, the exposition flows naturally from En's and London's cordially hostile conversations, rather than massive infodumps other sci-fi games deliver in the form of journals, voice recordings, and mission reports conveniently strewn about each level for your character to "stumble upon." However, the tidbits of information you receive at various points in the game lead to all sorts of questions, and En and London ain't got time for that. ECHO's plot is the child of "long story short" and "yada, yada, yada."



## 19 Clones & Counting

BY VINCE COGLEY

\$24.99 (PC, PS4) • ESRB: (M)ature • ULTRA ULTRA  
echo-game.com

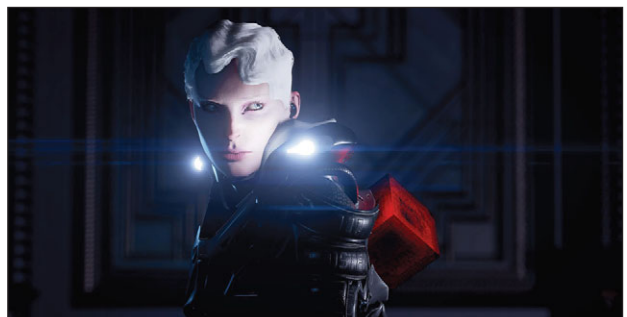
So, long story short and yada, yada, yada, En finds the Palace, which is a planet-sized superstructure with an interior that is, for all intents and purposes, a massive baroque mansion. The Palace itself is simply stunning; ULTRA ULTRA has done fine work here. At first, it seems like En is attending the most lavish party for one in the history of civilization, but she isn't alone.

Soon enough, En activates the Palace's defenses, which is ECHO's hook. The Palace creates hundreds of copies of En with one directive: murder you. To do this, the Palace periodically uses "blackout phases" to update the clones based on your playstyle. If you choose to blast a handful of clones with your sidearm, in short order you'll have dozens of copies taking head shots at you. In other words, the better you become at killing your clones, the better they become at killing you.

However, the Palace's defenses are exploitable. First, nothing you do during the brief blackout phases is incorporated into the clones' new firmware. You can mow them down in a shooting spree, and the clones won't reboot with the ability to shoot back. You can also erase what the clones learn. If they've learned from you to sprint, go a full interval without sprinting, and the Palace will "erase" the ability in the next update.

On occasion, this mechanic adds a challenging puzzle element to the stealth genre. Outsmarting the Palace's AI can be very satisfying. However, En's toolkit is somewhat limited, so your tactics often default to "do these two or three things before a blackout phase, then do these two or three other things until the next blackout phase. Then, reverse and repeat." Add some less than fluid controls, and ECHO ends up leaving some of its potential back on the spaceship.

"Points for originality" is usually a throwaway phrase, but ULTRA ULTRA deserves credit for innovating beyond the typical gimmicks of the stealth genre. ECHO is decent; ULTRA ULTRA's next game could be outstanding. ■



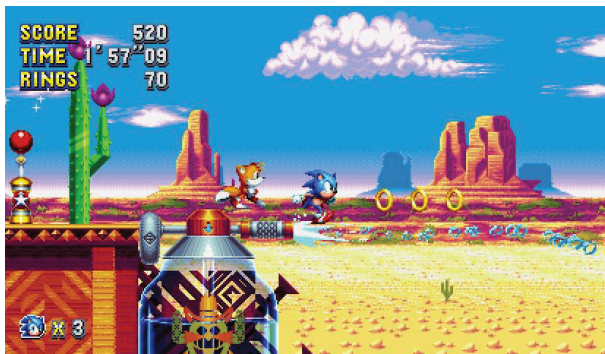


# SONIC™ MANIA

Sonic the Hedgehog is one of those rare gaming franchises that has reinvented itself so often and for so long that multiple generations of gamers have opposing views about what incarnation is the most iconic. For me, Sonic's heart and soul are 2D and he's most at home inexorably spinning from the left side of the screen to the right. And that's why Sonic Mania brings back the same level of wonder and raw amusement that I felt in the early '90s, when I first shoved the black plastic Sonic The Hedgehog cartridge into my Sega Genesis. Sonic was my first gaming love, and to see it so faithfully reimagined and expanded upon as Sonic Mania is pure joy.

After you move past the retro splash screen with a highly animated sonic wagging his finger from behind a furiously rippling red and white banner, you'll find Sonic, just as you remember him, standing on the striped grass and checkerboard dirt of Green Hill Zone 1. Initially, the only changes you notice are subtle enough to be almost missed, especially if it's been a while since you played the original. The gameplay is a solid 60 frames per second, the screen is a 16:9 aspect ratio, and the music has gotten a modern synthesizer-fueled facelift.

Miles "Tails" Prower is there, occasionally hovering, occasionally dying repeatedly in the background. He's merely a reminder that, yes, just as in his first appearance in Sonic The Hedgehog 2, a second player can pick up a controller (or keyboard) and begin lending a helping—or harmful—hand. Knuckles the Echidna is a playable character as well. Sonic can spin dash throughout Sonic Mania, even though the move was another of Sonic 2's innovations.



## The Sonic You Love Is Back & Better Than Ever

BY ANDREW LEIBMAN

\$19.99 (PC, Switch, PS4, Xbox One • ESRB: (E)veryone • PagodaWest Games and Headcannon • [www.sega.com](http://www.sega.com))

It isn't long before you start to encounter the major changes that the developers Christian Whitehead, PagodaWest Games and Headcannon have woven into the fabric of the classic games. There's the new move, for one, called the drop dash, which lets Sonic begin a spin-revving move in mid-air to land and sprint ahead in a ball. This mechanic, once mastered, feels like something that should've been in the original, and it practically eliminates the awkward slow pauses that Sonic makes when you need to change directions or build up more speed to make it up an incline.

Most of the old levels have been so thoroughly remixed, peppered with new devices and movement mechanics that you never feel like you're just playing a retro remake. The level design of the classic Sonic games has always been delightfully counterintuitive, but the new levels are just bonkers, and just when you think you couldn't possibly be progressing, you're staring down the barrel of another Dr. Ivo "Eggman" Robotnik-contrived boss battle. There are multiple paths to clearing each of the thirteen levels, secrets to uncover, and of course a mix of old and new bonus stages that you can use to earn Chaos Emeralds and rack up medallions.

There's a plot, something about a powerful Phantom Ruby, a handful of sentient rogue robots, and Eggman caught in the middle trying to reclaim his villainhood. It's on par with an episode of the terrible cartoon, but it's also not the reason you'll want to play Sonic Mania again and again.

I don't think of Sonic Mania as a remake or remaster; this is the pitch-perfect follow-up to my favorite Sonic games, just a little over two decades late. ■



# DISHONORED

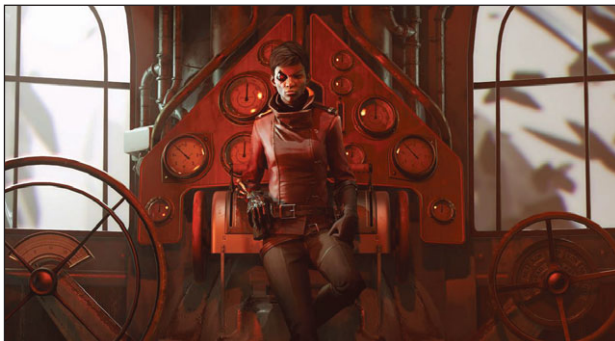
— DEATH OF THE OUTSIDER —

*CPUs* "At Your Leisure" Game Of The Month in the December 2016 issue was Dishonored 2, and the original Dishonored game was a hit among the staff back in 2012, as well. So as you can imagine, I was really looking forward to heading back into the super-cool Empire of the Isles for the latest Dishonored game, Death of the Outsider. This release is an interesting case, because it's not a full game but it's not exactly DLC for Dishonored 2, either; you don't need to have Dishonored 2 installed to play it. Bethesda priced DOTO at \$29.99, and that feels about right.

The game puts you in the role of Megan Foster, aka Billie Lurk, and takes place after the events of Dishonored 2. Lurk, whose missing arm and eye were restored during the second game's time-travelling shenanigans, is having dreams where she loses the arm and eye (she's of course unaware that she ever lost them, because time travel), and both the intensity and the after-effects of the dreams are growing. She also continues to suffer from a strong sense of guilt from having betrayed her former mentor, the master assassin Daud, in Dishonored's "The Knife of Dunwall" DLC. For both reasons, she decides to seek Daud out and reconcile with him, and tracks him to an underground fight club in Karnaca.

Daud is being held there against his will and forced to fight by a cult called the Eyeless who worship the Outsider and make and sell void-powered bone charms as part of their criminal enterprise. The Eyeless have devised a cage that cancels Daud's supernatural abilities, which were given to him by the Outsider many years ago prior to his assassination of Empress Jessamine Kaldwin. Daud bears the mark of the Outsider just as Corvo Attano did, and his abilities make him a formidable cage fighter; the Eyeless are making a killing from taking bets on his fights.

In the game's first mission, you find a way to release Daud from his prison, and Daud (whose health is failing) enlists your help for one last job: You must kill the Outsider. Daud reckons the Outsider is to blame for



## Hello From Karnaca

BY CHRIS TRUMBLE

\$29.99 (PC, XOne, PS4) • ESRB: (M)ature • Bethesda  
dishonored.bethesda.net

many if not most of the biggest problems facing the Empire, and makes a pretty compelling argument for this case. The rest of the game is about finding a way to accomplish that task—no mean feat, seeing as how the Outsider is powerful enough to essentially be a god to mortal men.

Gameplay is very similar to Dishonored and Dishonored 2, although Arkane whipped up a batch of new-ish abilities for you to use in your quest. Billie doesn't Blink, exactly, but she does have a similar ability called "Displace" that lets her create a marker, or replica of herself fashioned of void energy, and then change places with it. The distinction is subtle but interesting, because Displace lets Billie move through gates and fences as long as she has a clear path to place her marker prior to moving. The game's tutorials explain this and her other powers quickly and simply, and show you examples of how you can use them. Another key new ability is "Semblance," which lets Billie render any person unconscious and disguise herself with their face. This can be used to gain entrance to places Billie Lurk can't go, and is lots of fun. There are other fun abilities to use, and of course Billie uses a short assassin's sword, which is the staple weapon of all Dishonored games, as well as pistols, spring razor traps, and more.

The game takes place in Karnaca, the capital city of Serkonos and the site where Dishonored 2 took place. The game looks very similar to Dishonored 2 as a result, but the new areas are typically well designed and great fun to traverse. As with all previous Dishonored content, Death of the Outsider lets you choose how to play. You can accomplish your missions through a variety of means, employing either stealth or brute force, and while either sparing the lives of your targets or taking a decidedly more antisocial approach.

Dishonored: Death of the Outsider is a well-made return to one of the coolest, most fully realized game worlds of all time, and it's a blast to play. ■



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LANFest NETWAR 33.0  
Omaha, NE

[lanfest.intel.com/events/netwar33](http://lanfest.intel.com/events/netwar33)

**10.27-29.17**

FortCON 2017  
Fort Wayne, IN

[www.fortlan.org](http://www.fortlan.org)

**10.07.17**

KCGames On 77  
Kansas City, MO

[kcgameon.com](http://kcgameon.com)

**10.27-29.17**

BaseLAN 32  
Winnipeg, MB

[www.aybonline.com/baselan-32](http://www.aybonline.com/baselan-32)

**10.07-08.17**

River Valley LAN  
Russellville, AR

[www.outofeleven.com/rivervalleylan](http://www.outofeleven.com/rivervalleylan)

**11.03-04.17**

Legendary LAN 2017  
Harrisburgh, PA

[legendarylan.com/tournament/event-legendary-lan-2017](http://legendarylan.com/tournament/event-legendary-lan-2017)

**10.13-15.17**

WINLAN Party 8  
Eau Claire, WI

[www.lanreg.org/winlan/winlan8](http://www.lanreg.org/winlan/winlan8)

**11.03-06.17**

PDXLAN NOV 2017  
Portland, OR

[www.lanreg.org/pdxlan/pdxnov2017](http://www.lanreg.org/pdxlan/pdxnov2017)

**10.21.17**

Oklahoma Gamers Group  
Oklahoma City, OK

[www.OKGG.org](http://www.OKGG.org)

**11.04-05.17**

BoilerFrag  
West Lafayette, IN

[pugg.org](http://pugg.org)

**10.21.17**

Source Gaming Lounge  
Denton, TX

[sourcegaming.org](http://sourcegaming.org)

**11.08.17**

Critgamer LAN  
Tyler, TX

[www.critgamer.com](http://www.critgamer.com)

**10.21-22.17**

Laclede's LAN 17  
St. Louis, MO

[www.lacledeslan.com](http://www.lacledeslan.com)

**11.10-11.17**

True Gamerz Expo  
Jacksonville, FL

[www.beaucoreenterprises.com](http://www.beaucoreenterprises.com)

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Puyallup, WA  
[lanfest.intel.com/events/infernalan2017](http://lanfest.intel.com/events/infernalan2017)

**11.17.17**

Afterlife LAN Thanksgiving Event  
Springdale, AR  
[fslan.com](http://fslan.com)

**11.17-19.17**

Battle Of The LAN  
London, Ontario  
[techalley.ca](http://techalley.ca)

**11.17-19.17**

November LAN  
Menomonie, WI  
[pong.uwstout.edu](http://pong.uwstout.edu)

**11.17-19.17**

San Diego Winer LAN-A-THON  
San Diego, CA  
[www.SanDiegoLAN.net/LANaThon.html](http://www.SanDiegoLAN.net/LANaThon.html)

**11.18.17**

Oklahoma Gamers Group  
Oklahoma City, OK  
[www.OKGG.org](http://www.OKGG.org)

**11.18.17**

Source Gaming Lounge  
Denton, TX  
[sourcegaming.org](http://sourcegaming.org)

**11.18-19.17**

Windy City LAN 3.0  
Chicago, IL  
[www.windycitylan.com](http://www.windycitylan.com)

**11.18-19.17**

Winter LAN  
Rochester, NY  
[www.facebook.com/EGSRIT](http://www.facebook.com/EGSRIT)

**11.24-26.17**

LANtastic VIII  
Waterloo, Ontario  
[lantastic.ca](http://lantastic.ca)

**11.25-26.17**

Wichita LAN 34  
Lyons, KS  
[www.facebook.com/events/327652644327719](http://www.facebook.com/events/327652644327719)

**12.01-03.17**

KCGames On 78  
Kansas City, MO  
[kcgameon.com](http://kcgameon.com)

**12.16.17**

Dirty Santa Comes To The LAN  
Oklahoma City, OK  
[www.OKGG.org](http://www.OKGG.org)

**12.16.17**

Source Gaming Lounge  
Denton, TX  
[sourcegaming.org](http://sourcegaming.org)

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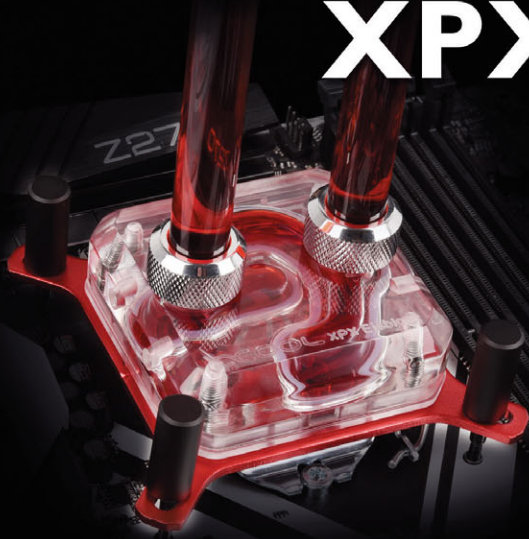
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## Q&amp;A With Tony Vera

Intel X-Series Platform Manager  
Talks Core i9-7980XE

**Q:** What were Intel's goals in developing the Core i9-7980XE processor?

**TV:** We've been clear that we're committed to an annual cadence of leadership products. Our X-series processor family is no different. We know people have vastly different needs depending on what they are passionate about. And no one wants to settle, particularly when it comes to performance. So, we set about to introduce our most powerful, scalable, and accessible desktop processor platform ever to drive our new Core i9 brand. The Intel Core i9-7980XE Extreme Edition Processor represents the highest performance at the top of our X-series processor lineup. This processor is the first 18-core consumer desktop processor delivering extreme megatasking power for today's demanding enthusiasts.

**Q:** What do you mean by "extreme megatasking"?

**TV:** While the entire X-series processor family delivers on the promise of rich, immersive experiences that require significant compute power, the 18 cores and 36 threads on the Extreme Edition brings a new level of power to content creators so they can spend more time creating and less time waiting. They're editing video footage, doing image retouching, creating and rendering high-resolution graphics in 4K and for VR, downloading footage from cameras, and working on soundtracks. A system powered by the new Extreme Edition can simultaneously handle these applications and workloads, and we refer to this as "extreme megatasking."

**Q:** Where does gaming fit in?

**TV:** Gamers have increasingly demanding workloads, too. They're gaming in



4K, live-streaming, encoding their gameplay for editing and uploading later to YouTube, and communicating with their eSports teams all at the same time. Again, the term "extreme megatasking" comes to mind.

**Q:** How much L3 cache memory does this chip have onboard, and how many PCIe lanes does it provide?

**TV:** The Intel Core i9-7980XE has 24.75MB of L3 cache. And with up to 68 PCIe 3.0 lanes on the top-end X299 platforms (the 7980XE providing 44 lanes and the X299 chipset providing up to 24 lanes), people have the ability to expand their systems with native support of fast NVMe-based SSDs, up to four discrete graphics cards, and ultrafast Thunderbolt 3 solutions. The platform offers plenty of high-speed ports and I/O to maximize your gaming and content creation usage experience.

**Q:** Previous Extreme Edition chips have seemed to increase core counts at a fairly incremental pace, but this new

Extreme Edition chip nearly doubles the numbers of cores and threads over its predecessor. Why such a big jump this time?

**TV:** Last year, when we introduced our first 10-core part for the X-series platform, it became immediately clear to us that people want as much technology as we can give them. The needs of enthusiasts differ greatly and the specific experience desired can span the spectrum of needs. The new X-series family delivers scale in product options and accessibility in pricing, while delivering the best performance—the common need across enthusiasts, content creators, and overclockers.

**Q:** How does Turbo Boost 3.0 work with the Core i9-7980XE?

**TV:** We first introduced Intel Turbo Boost Max Technology 3.0 with our last generation of X-series processors to improve single-threaded performance by identifying the fastest core on the processor die and directing critical workloads to that core first. With our newest X-series processors, we made updates to this technology so that it identifies the two fastest performing cores to provide increased single- and dual-core performance. It's also now natively supported with Windows 10 anniversary edition, Linux distributions based on kernels from 2017, or with a driver for legacy Windows products.

**Q:** Is the Core i9-7980XE the world's most powerful desktop processor?

**TV:** With up to 18 cores and 36 threads of performance, the Intel Core i9-7980XE Extreme Edition Processor is the most powerful consumer desktop processor we've ever delivered and by far the most extreme desktop processor ever introduced. ■

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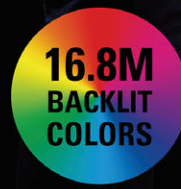
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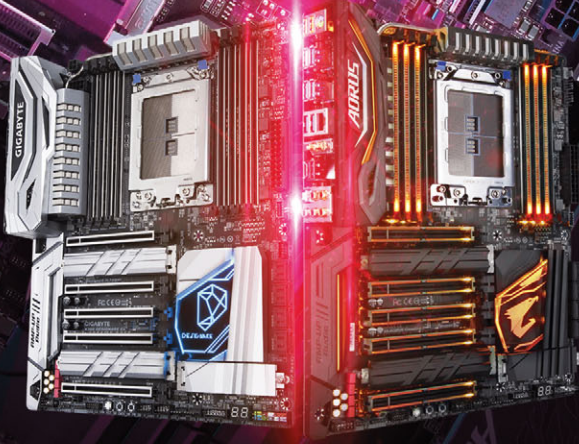
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