

CPU

COMPUTER POWER USER



MODDER Q&A:
DEWAYNE CAREL TALKS SHOP



CIRCUITS

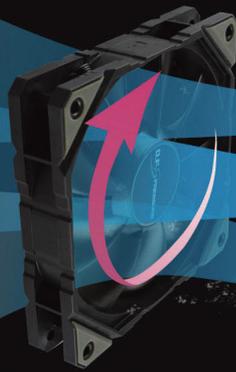
THE "THOSE LIGHT SIGNS" MOD



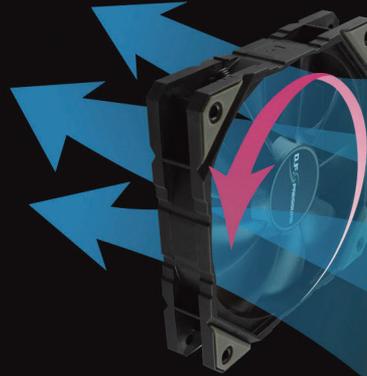


2016 Innovation

Patented Dust Free Rotation (DFR) Technology



Within 10 sec.



After 10 sec.

Automatic Dust Cleaning Solution Keep your gaming rig ready for battle



D.F. PRESSURE

Super High
Air Pressure
(4.812mm-H₂O)



ETS-T50 AXE

TDP 250W.
Patented PDF & Air Guide
to optimize the airflow



Platimax D.F.

Full modular design
100% IO5C JPN Cap
Twister Bearing Fan



ADV OSTROG

MaxBrite™ technology brings
the world first case with
LED lighting in the front
and top panel!





msi



**VR
READY**



GAMING Z

GAMING X

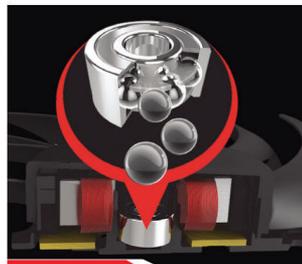
PLAY HARD, STAY SILENT

GEFORCE® GTX 10 SERIES

TWIN FROZR VI



Supreme Cooling



Ball Bearing Fans



Custom RGB LED



Unlocked Gaming Power

GAMING Z



GAMING X





33
Mad Reader Mod: Circuits



26
CPU At Computex Taipei 2016

FRONTSIDE — P. 5

News, product release information, and stats from the tech industry.

HEAVY GEAR — P. 12

The latest PC hardware is here: reviews, product profiles, and category roundups.

HARD HAT AREA — P. 33

CPU's Mad Reader Mod winner, LAN party coverage, and in-depth looks at the latest technology.

BUYER'S GUIDE — P. 50

Looking for a motherboard for your next build or upgrade? Your quest starts here.

LOADING ZONE — P. 58

Software projects, betas, updates, and more.

DIGITAL LIVING — P. 65

Trends and leisure, news from around the web, tech company interviews, and more.

BACK DOOR — P. 86

Monthly last-page interview with people who help to shape the PC industry.

DID YOU FIND THE HIDDEN CPU LOGO ON OUR COVER?



Gotcha. Here it is.

Contact Us
P.O.Box 82545
Lincoln, NE 68501
or
120 W. Harvest Drive
Lincoln, NE 68521

Advertising: (800) 247-4880
Fax: (402) 479-2104

Circulation: (800) 334-7458
Fax: (402) 479-2123
www.cpumag.com
email: feedback@cpumag.com





ASUS ROG Announces Rampage V Edition 10 For 10th Anniversary

The Republic Of Gamers is having its 10th anniversary this year, and to celebrate, ASUS is releasing a special edition of the Rampage V motherboard. The Rampage V Edition 10 includes support for Intel's new Broadwell EX series of CPUs for socket LGA-2011v3 and can handle up to 128GB (eight DIMMs) of DDR4. The board sports new Aura RGB lighting and adds another 4-pin RGB-strip header so you can connect lighting from elsewhere in your case. The PCIe slots also now sport LEDs, plus they're reinforced to add extra support for heavy graphics cards. This motherboard offers slots and ports galore, with four PCIe x 16 slots, one PCIe XR slot, one PCIe X1 slot, an M.2 slot and an NVMe U.2 port, 10 SATA ports, eight USB 3.0 ports, four USB 3.1 ports (two Type A and two Type C), and six USB 2.0 ports. ASUS pre-mounts the I/O shield to give the board a polished look. The motherboard is available at retail now for about \$599.

Corsair Releases New Dominator Platinum ROG Edition DDR4 Kit

Enthusiasts planning to build new systems with ASUS Republic Of Gamers motherboards have another reason to celebrate, as Corsair has released a special ROG Edition Dominator Platinum DDR4 kit for the Intel 100 series platform. The modules in the new kit are adorned with the ROG logo and original color scheme. Aside from getting DDR4 that looks great with your ROG board, the memory is fast, too. The new 16GB kits consist of four 4GB sticks that are rated at 3,200MHz with CAS latency of 16-18-18-36. With the ROG profile and built-in XMP 2.0 support, the kit runs at 3,333MHz. The memory comes with Corsair's aluminum heat spreader with DHX (dual-path heat Xchange) cooling technology, and it has a limited lifetime warranty. MSRP for the new Dominator Platinum ROG Edition 16GB kit is \$189.99.



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 FX-9590 Eight-Core (Vishera)	6/11/2013	n/a	\$224.99	\$199.99
AMD FX-9370 Eight-Core (Vishera)	6/11/2013	\$375	\$189.99	\$189.99
AMD FX-8370 (Vishera)	9/2/2014	\$199.99	\$199.99	\$199.99
AMD FX-6350 (Vishera)	10/1/2012	\$132	\$129.99	\$129.99
AMD A10-7890K (Godavari)	3/1/2016	\$164.99	\$163.95	\$163.95
AMD A10-7870K (Godavari)	5/28/2015	\$137	\$139.99	\$139.99
AMD A10-7860K (Godavari)	2/2/2016	\$116.99	\$104.99	\$104.99
AMD Athlon X4 880K (Godavari)	3/1/2016	\$94.99	\$93.87	\$93.87
AMD Athlon X4 860K (Kaveri)	8/1/2014	\$94.99	\$79.99	\$79.99
AMD Athlon X4 845 (Carrizo)	2/2/2016	\$69.99	\$66.00	\$66.00
Intel Core i7- 6950X (Broadwell E)	5/31/2016	\$1723**	n/a	\$1,749.99
Intel Core i7- 5960X Eight-Core (Haswell)	8/29/2014	\$999**	\$1,015.99	\$1,015.99
Intel Core i7- 6900K (Broadwell E)	5/31/2016	\$1089**	n/a	\$1,099.99
Intel Core i7- 6850K (Broadwell E)	5/31/2016	\$617**	n/a	\$649.99
Intel Core i7- 5930K Six-Core (Haswell)	8/29/2014	\$583**	\$579.00	\$599.00
Intel Core i7-5820K Six-Core (Haswell)	8/29/2014	\$389**	\$389.99	\$389.99
Intel Core i7-6700K Quad-Core (Skylake)	8/5/2015	\$359**	\$339.99	\$329.99
Intel Core i7-4790K Quad-Core (D.Canyon)	6/25/2014	\$339**	\$339.99	\$339.99
Intel Core i7-4790 Quad-Core (Haswell)	5/11/2014	\$303**	\$309.99	\$304.99
Intel Core i5-6600K Quad-Core (Skylake)	8/5/2015	\$249**	\$244.99	\$229.99

* As of June 2016
** Manufacturer's estimated price per 1,000



Turtle Beach Elite Pro Tournament Gaming Headset Now Available

The Elite Pro Tournament Gaming Headset, Elite Pro Tactical Audio Controller (T.A.C.), and Elite Pro accessories from Turtle Beach are now available at retail. The company began developing its Elite Pro headset system in 2013 after consulting with leading eSports gamers about what they wanted in a headset. The research led to the Elite Pro, a headset that uses 50mm Nanoclear speakers and has several innovations in the core mechanics of design, weight, and fit, such as the ComforTec Fit System with multiple adjustment points, AeroFit Ear Cushions designed to stay cool, and a ProSpecs Glasses Relief System designed to make the headset more comfortable for gamers who wear glasses. Turtle Beach says the Elite Pro T.A.C. is the most powerful audio controller created for eSports. It's designed to work with the Elite Pro headset and combines DTS Headphone:X 7.1 Surround Sound with chat and microphone-tuning tools.

MSI Announces GeForce GTX 1070 GAMING X 8G With Twin Frozr VI

MSI has announced a full series of graphics cards based on the GeForce GTX 1070, including the GTX 1070 GAMING X 8G. This card features MSI's Twin Frozr VI air cooler with a huge nickel-pated copper baseplate and 8mm copper heatpipes that are flattened at the bottom for better heat transfer. The two new TORX Fan 2.0 fans have double ball bearings and feature the patented TORX design that MSI says provides 22% more air pressure and reduces noise levels. The cover of the GAMING X 8G glows red, and the card comes with RGB LED lighting so you can match the color of the MSI GAMING dragon to your build. This will be one of just two cards in MSI's 1070 series that comes with a backplate; it has a black matte color for a clean, finished look. As with all other cards in the 1070 series, the GTX 1070 GAMING X 8G has 8GB of GDDR5 memory.



GIGABYTE Unveils GA-X99-Designare EX Motherboard At Computex 2016

Leading computer component maker GIGABYTE announced two new motherboard models, the Z170X-Designare and the X99-Designare EX, at the Computex trade show in June. Shown at left, the GA-X99-Designare EX has an X99 chipset and supports the latest Intel Core i7 Extreme Edition processors in the LGA2011-3 package, including the i7 6950X. It also supports up to 128GB of DDR4 (eight DIMMs) to 3,600MHz and beyond, as long as the memory is XMP-capable. The board can handle 3-way PCIe X16 SLI and CrossFire and it even supports the latest NVIDIA QUADRO graphics cards for professionals. There's an onboard header for LED lighting strips and full RGB support. GIGABYTE's ambient lighting application lets users select lighting modes. Other extras include dual Intel GbE LAN chips; one M.2 (Socket 3, M key), two U.2, and 10 SATA 6Gbps connectors; and two USB 3.1 ports (one Type A, one Type C).



EVGA DG-8 Gaming Cases Now Available With Pre-order Savings

EVGA announced a new line of full-tower cases aimed at enthusiasts. The DG-8 series is “Designed for Gaming” and has a built-in optimal airflow path. There are four models in the series: DG-84, DG-85, DG-86, and DG-87 (pictured). All of the cases support motherboards up to E-ATX and can hold dual 420mm radiators. The lower-end 84/85 models support fewer drives and come with no fans, fan controller, or water-cooling bracket, plus the 84 model lacks a window. The 86/87 models support up to 12 drives and include either four (for the DG-86) or six (for the DG-87) fans. The 86/87 models also include the fan controller and temperature sensor, plus they have a USB 3.1 Type-C port and liquid-cooling bracket. The four models in the series have MSRPs ranging from \$149.99 for the DG-84 up to \$229.99 for the DG-87, but EVGA has all the cases on sale now (you get \$50 off list) for initial pre-orders. Shipping starts in August.

HARDWARE MOLE



Watercool Preparing To Release New HEATKILLER Reservoirs

Germany-based Watercool is getting set to release the HEATKILLER TUBE series, a versatile and modular reservoir. The reservoir itself is made of borosilicate glass, which Watercool says has excellent chemical and thermal stability, making it an ideal reservoir material. There will be three versions of the HEATKILLER TUBE: a standalone version, a DDC pump version, and a D5 pump version. There will also be three lengths (100mm, 150mm, and 200mm) and various mounting systems, including a multifunctional clamp mount and two pedestals in different heights. You can customize the HEATKILLER tubes with interchangeable struts in red, blue, silver, or one with LED stripes for illumination.

G.SKILL Reveals Ripjaws KM570 MX & KM770 RGB Keyboards

G.SKILL is adding two new models to its portfolio of mechanical keyboards. The KM570 MX (top plank in photo below) uses Cherry MX keyswitches (red, brown, or blue) and has N-key rollover, macro recording, and a 1,000Hz polling rate. The single-color LEDs have seven lighting effect patterns that are baked into the hardware, so no software install is needed. It's a no-fuss, easy-to-use plank. The KM770 RGB is a revised version of the previous KM780 and has a smaller footprint. It has the same Cherry MX switch options as the KM570. The RGB lighting has been improved in this keyboard and offers special lighting options for top-row keys. G.SKILL says both keyboards will be available by the end of September.



Study: About One In Four Consumers Only Use A Mobile App Once

Businesses are facing a mobile engagement crisis, according to a new study by Localytics, and haven't innovated enough to keep pace with consumer expectations for mobile.



The study looked at loyalty and abandonment across the Localytics user base of 37,000 apps and found that 23% of users abandon an app after one use. On the flipside, user retention, which Localytics defines as the percentage of users who return to an app 11 or more times, reached 38%. Both

numbers have improved from the previous year's study, Localytics notes, but still show that not enough is being done to match what consumers want. "Even though 38% will return to an app 11 or more times, that means a whopping 62% will use an app less than 11 times. This is not a sustainable business model," said Localytics Marketing Research Analyst Caitlin O'Connell.

New or improved iOS features such as multitasking and split screen, she said, contributed to the improvement in retention rates. In the past year, the percentage of iOS users who only opened an app once went from 26% to 24%, and the number of users who opened an app 11 or more times improved from 32% to 36%.



AI App Promises To Organize The Information On Your Phone

Like most people, you probably rely on your smartphone for much of the information you need to function each day—email, appointments, contacts, the list goes on and on. Instead of having to dig for that information, a new free app called Snips offers to organize that information and make it easy to find.

Snips is an AI app that its makers say gets smarter with time. It'll take things on your phone (email, calendar appointments, contacts, and similar data) and create a personal knowledge graph. It can even find things such as hotel reservations or recently visited addresses that are hidden in your phone, according to its developers. The Snips Timeline can show a history of where you've been and what you've done, but Snips keeps that and all your information private by running and storing info locally on your smartphone.

SOFTWARE SHORTS

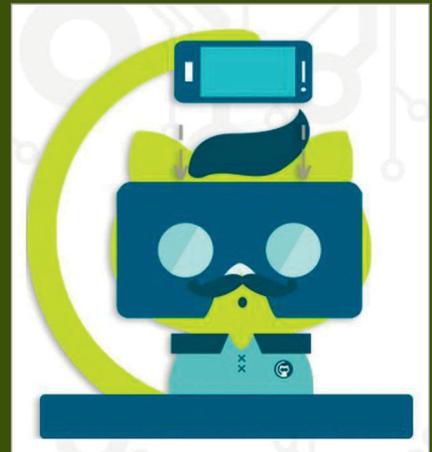
App Lets You Play PC VR Games On A Google Cardboard Set

Most of us don't have the cash to spend on a VR headset and all of the other gear (a new VR-ready PC, anyone?) needed to play virtual reality games. RiftCat is working to change that with VRidge, an app that lets you play PC virtual reality games wirelessly on Google Cardboard or another mobile VR headset.

To start, you'll need to download the RiftCat client from www.riftcat.com on your desktop PC (at least 4GB RAM, Windows 8.1 [AMD] or Windows 10 [NVIDIA], and a GeForce GTX 650 or greater or Radeon 7750 or greater graphics card). Then log in to create an account and gain beta access. RiftCat will connect with your phone, and you'll need to then download the application for your phone. Once that's done and you've paired your phone and

PC, you can play any PC VR game on your phone setup, or you can play games on RiftCat's database of VR games, which are all tested to work with VRidge.

RiftCat warns that, as a beta program, VRidge has some issues. The company also notes that some VR games might not work correctly because it can't test all games.





Microsoft, Facebook Collaborate On Undersea Cable

Microsoft and Facebook are working to build the highest-capacity subsea cable to ever cross the Atlantic. MAREA will have eight fiber pairs and an initial design capacity of 160Tbps. The 6,600km cable system will be the first to connect the United States to southern Europe, according to Microsoft. It will connect Virginia Beach, Virginia, to Bilbao, Spain (another first, Microsoft notes, as current transatlantic cable systems primarily land in the New York/New Jersey region). From Spain, the cable will connect to network hubs in Europe, Africa, the Middle East, and Asia.

Work on the new subsea cable is scheduled to start in August and be completed by October 2017. It will use an open design that's interoperable with a variety of networking equipment, providing benefits such as lower costs and easier equipment upgrades. Plus, the system can evolve at the pace of optical technology innovation. The cable will be operated and managed by Telxius.

Researchers Set World Record For Wireless Data Transmission

Imagine being able to wirelessly transfer the entire contents of a DVD in less than 10 seconds. Researchers from the University of Stuttgart and the Fraunhofer Institute for Applied Solid State Physics have shown it's possible by achieving a world-record transmission for wireless data of 6Gbps over a distance of 37km, exceeding the state-of-the-art by a factor of 10, according to the researchers. The discovery could supply 250 Internet connections with 24Mbps ADSL or serve as a cost-effective replacement for deploying optical fiber in cases of crises and catastrophe. The system uses efficient transmitters and receivers at a radio frequency of 71 to 76 GHz in what's branded as the "E band" typically used for terrestrial and satellite broadcasting. The researchers note that is the only frequency range where the required high effective bandwidths are available, allowing for the incredibly fast data rates. Such a powerful transmission requires efficient transmitters and receivers, for which the researchers used fully monolithically integrated millimeter wave circuits, or MMICs.



SITE SEEING

Get Your .GAME Domain

URLs with the .GAME top-level domain have launched globally, and Uniregistry, one of the registration services offering the domain, says .GAME has already gained broad-based support.

Virtually all of the leading gaming brands, including Blizzard Entertainment, Activision, Take-Two Interactive, and Square Enix, acquired .GAME domains by the first day of the launch, Uniregistry reports. Apple, Microsoft, and Sony also registered names such as iPad.game, Xbox.game, and PlayStation.game.

The global launch of .GAME comes after an early access period that saw registrations for URLs such as VR.game, play.game, i.game, and board.game; first-day registrations included chess.game and tabletop.game. In a press release,



Uniregistry's Frank Schilling commented that each of these "high-value early registrations" could become a "category-defining business," adding that ".GAME domain names are where the art of marketing intersects with computer science and the technology of the Web. This is a land-rush moment in time."

Uniregistry has set up a special website (get.game) with information about the .GAME extension with links to check availability and places to register and buy a URL.

ANNOUNCING

CPU LAN 2016

CPU magazine is hosting its first LAN event!

Sept. 23-24, 2016 | Lincoln, Nebraska

- + Play games and have fun with 500 fellow gamers
- + See the latest products from leading manufacturers
- + Have a chance to win thousands of dollars in prizes

sponsored by



msi



XOTICPC

EVGA

Save the date now, and watch for more details and registration information soon at www.ComputerPowerUser.com and in the pages of **CPU magazine!**





Job Of The Month

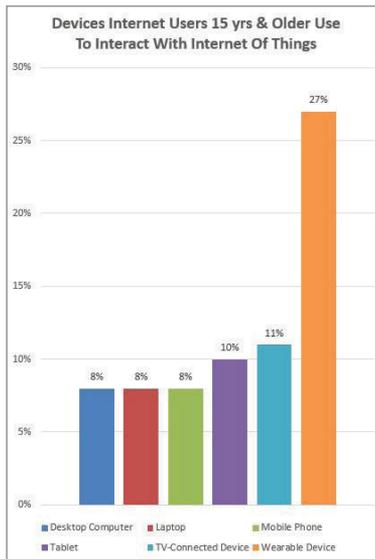
A lot of computing enthusiasts spend chunks of time on Steam, the gaming platform from Valve. If you're spending time there anyway, why not make it official and work for the company? Valve's Steam team is looking for a senior software engineer to help with ongoing architecture development and create new gaming features and experiences. You'll be part of a development team that takes feedback from the user community and helps build great new products for customers. You'll work with world-class engineers and designers, and you'll participate from the design inception to the completion of the project at hand. Candidates need at least five years of experience using C++ or a similar language in a commercial development environment. You need a BA in comp sci or the equivalent, and you need solid programming skills. The more you know about working with networks, the better. If working for one of the world's best-known gaming companies sounds acceptable to you, check the company's website for more details.

Source: www.valvesoftware.com

IoT Users Rely On Wearables

Despite all the hoopla about the Internet Of Things, it's still on the distant horizon for most of us. Ongoing research from the NTIA (National Telecommunications & Information Administration, part of the U.S. Dept. of Commerce) shows only 7% of internet users age 15 or older had used the internet to interact with any type of connected household device (light bulb, security camera, thermostat, and so on) by last year. Although that number is sure to grow as the IoT develops, it's interesting to note what devices people have been using to connect with IoT products at home. The NTIA says the most popular category of product by far is wearables, which have been used to interact with home IoT devices more than desktop PCs, notebooks, and mobile phones combined. Turn off the porch lights or crank up the air conditioning with your watch, perhaps?

Source: NTIA



It's The Software Economy, Stupid

If you've ever wondered just how much of an impact the software industry has on the overall U.S. economy, you might want to read "The Economic Impact Of Software." This 2016 report, sponsored by the BSA (Business Software Alliance) and conducted by the EIU (Economist Intelligence Unit), is the BSA's attempt to "capture the breadth of the software industry in the U.S. and the sweeping economic impact it is making at state and national levels." As The Donald would say, it's HUUUUUGE.

The Software Industry's Impact On The U.S. Economy**

Direct Value Added to U.S. GDP	\$.475.3 billion
Total Added Value to U.S. GDP	\$1.07 trillion
Direct Jobs	2.5 million
Total Direct & Indirect Jobs	9.8 million
Average Salary for Software Developer	\$108,760
Direct R&D Spending	\$52 billion
Portion of all domestic R&D in U.S.	17.2%

Source: BSA.org (**Figures in the table were drawn from 2014 data, except for R&D, which came from 2012)



RAW Numbers:

18 million

Forecasted annual sales of smart clothing items worldwide in 2021. The total includes existing and future fitness devices as well as personal, health, elder-care, interactive gaming, and business-related clothing items, most of which have not yet been introduced to the public.

ABI Research

21 million

Forecasted annual sales globally of autonomous vehicles in the year 2035. IHS, the research and consulting firm making the prediction, also forecasts that the cumulative global sales of self-driving vehicles between now and 2035 will be about 76 million.

IHS

52 million

The total number of virtual reality head-mounted displays that are forecasted to be in use in the U.S. by 2020. This total includes both the consumer and enterprise markets.

Forrester Data

9.6 trillion

Number of megabytes of mobile data used by wireless subscribers in the U.S. during 2015. This is three times the amount of data used in 2013 and double the amount used in 2014. The CTIA, the organization which compiles the stats as part of an annual survey of wireless usage, says using this much data is roughly equivalent to streaming 59,219 videos or 18 million megabytes of data every minute during the year.

CTIA.org

"We ran the SteamVR performance test . . . the system absolutely shredded the benchmark."



Avatar VR Ultimate Desktop
\$2,447 (as configured)
AVADirect
www.avadirect.com

Avatar VR Ultimate Desktop

Ready to jump aboard the VR train, but don't have the hardware horsepower necessary to punch your ticket? The Avatar VR Desktop is optimized to handle the demanding requirements of virtual reality. Every possible system configuration includes a VR-ready GPU, and AVADirect lets you design your rig with up to two NVIDIA GeForce GTX 1080 Founders Edition GPUs. The rest of the Avatar VR Desktop's hardware consists of relatively mainstream parts that deliver the requisite performance for gaming and VR without breaking the bank. For example, AVADirect sent us an Avatar VR Ultimate Desktop configuration that features one EVGA GeForce GTX 1080 Founder Edition, an Intel Core i7-6700K, 16GB of DDR4-2133, and a 500GB Samsung 850 EVO.

The VR experience is something that everyone will want to try out, so a VR PC needs to look at home in the living room or entertainment center. To this end, AVADirect employs a customized Aerocool DS Cube Black Edition case. The unassuming small form factor chassis blends in next to an entertainment center and is compact enough to fit inside an end table. The case features a small side-panel window that offers a good look at

the GPU—and let's face it, this is the part in the build you'll want to show off.

All Avatar VR Desktop configurations come with LED lighting. The basic package comes with a blue LED light strip, and you can upgrade to RGB lighting that's customizable via remote. Our test build included the RGB LED strip and it let us switch among one of 20 colors, as well as a variety of effects, including fade and color cycle. AVADirect runs the LED strips around the top panel, so the LED strips themselves aren't visible unless you remove the side-panel. The EVGA GeForce GTX 1080 Founders Edition card in our build looked great under the lights.

The miniature Avatar VR Desktop chassis supports motherboards no bigger than microATX, and AVADirect uses the powerful ASUS MAXIMUS VIII GENE in all configurations. We like that the MAXIMUS VIII GENE includes ASUS SupremeFX 2015 and Sonic Studio II for top notch audio fidelity—as sound quality is an important consideration for any VR build. The mainboard also comes with excellent onboard networking. There's an Intel i219-V NIC and ASUS GameFirst III software to prioritize game packets on your home network.

When it comes to VR duties, any potential system will need a lot of onboard USB 3.0 ports for connectivity with headsets and VR peripherals. The MAXIMUS VIII GENE provides six USB 3.0 ports on the rear panel and two more via the Avatar VR Desktop's front-panel. This motherboard also boasts two USB 3.1 ports, one Type-A and one Type-C, so you'll be ready for future VR hardware that might run over USB 3.1 ports.

The MAXIMUS VIII GENE sets the table for the Avatar VR Desktop's big gun—the GPU. The EVGA GeForce GTX 1080 Founders Edition in our build features a base clock of 1607MHz and a boost clock of 1733MHz. And when combined with the 8GB of system memory and the GeForce GTX 1080's 320GBps memory bandwidth, it's a killer piece of hardware for VR. AVADirect tells us that the GeForce GTX 1080 offers more performance per dollar than the GTX 980 Ti, so it only makes sense to select NVIDIA's newest flagship GPU.

AVADirect fills out the Avatar VR Ultimate Desktop with parts that optimally balance cost, performance, and reliability. The OS drive, for example, is a 500GB Samsung 850 EVO and there's also a 1TB Seagate Desktop HDD for



The side panel window in the Avatar VR Ultimate Desktop does a nice job of showing off the system's GPU. The LED lighting effects also help highlight various interior components.

pure storage duties. For memory, there's 16GB of DDR4-2133. The PSU is an 80 PLUS Gold certified EVGA SuperNOVA 850 G2. ASUS' MAXIMUS VIII GENE offers you some room to upgrade these parts in the future, should you need more speed down the road. The current hardware certainly won't negatively affect the quality of your VR or gaming sessions.

We ran the SteamVR Performance Test to give you an idea of the Avatar VR Ultimate VR Desktop's virtual reality rendering capability. The system absolutely shredded the benchmark. Out of 15,274 frames tested, there were no frames that rendered below 90fps, as well as zero frames that were CPU bound. This means the GPU did all of the heavy lifting, and it do so with aplomb. The Steam VR Performance Test rated the Avatar VR Ultimate Desktop with an average quality of 11. We also ran the VRMark preview tool found in 3DMark Professional. The VR experience was flawless.

We put the Avatar VR Ultimate Desktop through the paces of our conventional benchmark testing, as well.

As you might expect, the EVGA GeForce GTX 1080 Founders Edition helped the rig to deliver excellent results in GPU-intensive and gaming tests. In 3DMark's Fire Strike Extreme test, the rig produced an overall mark of 9241 and graphics score of 10189. In our games tests, which are run at 2,560 x 1,440 and the highest settings, the Avatar VR Ultimate Desktop delivered 95.3fps in Dying Light, 90.33fps in Metro: Last Light, and 75.2fps in Witcher 3.

When shopping for VR rigs, you're likely to find a number of big, powerful systems that provide all the bells-and-whistles—many of which don't improve the actual VR experience. The Avatar VR Desktop is a ready-to-go VR PC that keeps cost to a minimum. Even the Ultimate configuration we tested is comparatively cost-efficient to other VR systems on the market. AVADirect also doesn't include a VR headset, so you're free to pick the one you like the best. Whichever headset you choose, the Avatar VR Desktop will be up to the task. ■

BY NATHAN LAKE

Benchmark Results	AVADirect Avatar VR Ultimate Desktop
3DMark Fire Strike Ext.	9241
Graphics Score	10189
Physics Score	12186
PCMark 8	
Creative Score	5830
SiSoftware Sandra 2016	
Dhrystone AVX2 (GIPS)	193.56
Whetstone AVX (GFLOPS)	113.92
Multi-Media Integer AVX2 x32 (Mpixels/s)	411
Multi-Media Long-int AVX2 x16 (Mpixels/s)	193.9
Multi-Media Quad ALU x1 (Mpixels/s)	2.1
Floating B/F AVX/128 (GBps, mem bandwidth)	23
CrystalDiskMark 5.1.2 (MBps)	
Sequential Read (Q32T1)	550.5
Sequential Write (Q32T1)	529.2
Random 4K Read (Q32T1)	395.5
Random 4K Write (Q32T1)	360.5
POV-Ray 3.7 (Pixels/s)	1989.43
Cinebench 15 (Points)	930
Games	(2,560 x 1,440)
Metro: Last Light (Very High, 16xAF; SSAA off)	90.33fps
Dying Light (High, AO On, AA On, Vsync Off)	95.4fps
Witcher 3: Wild Hunt (Vsync Off, Unl. FPS, Ultra)	75.2fps

Specs: Processor: Intel Core i7-6700K; Motherboard: ASUS MAXIMUS VIII GENE; GPUs: EVGA GeForce GTX 1080 Founders Edition; RAM: 16GB HyperX Fury DDR4-2133; Storage: 500GB Samsung 850 EVO, 1TB Seagate Desktop HDD; PSU: EVGA SuperNOVA 850 G2; OS: Windows 10 Professional 64-bit; Warranty: 3 years

MSI GTX 1080 GAMING X 8G

"You want to game at 4K and/or enjoy everything VR has to offer, today? This is the card to get."



GTX 1080 GAMING X 8G
\$719.99
MSI
us.msi.com

As we teased last month, it is the dawn of a new era for PC gaming and our first look at the graphics cards ushering in this monumental shift comes courtesy of MSI. While its red and black Twin Frozr cooler is immediately recognizable, the NVIDIA Pascal-based GPU inside the GTX 1080 GAMING X 8G is all new.

The GP104 that forms the heart of this beast is manufactured using TSMC's 16nm FinFET process, and it comprises 7.2 billion or so dual-gate transistors. We've come a long way since 28nm, and NVIDIA's new architecture was designed from the ground up to capitalize on the reduced leakage, improved efficiency, and

smaller transistors inherent in the new process. How much smaller are 16nm FinFET transistors than the old 28nm variety? The die in the 1080 is 84mm² smaller than the Maxwell die found in the GTX 980, yet the Pascal chip features 2 billion more transistors.

When talking about CUDA cores, it's important to keep in mind that the new architecture has reprioritized things. For instance, every Streaming Multiprocessor in this generation's GPUs will feature half as many CUDA cores, but twice as much register file capacity compared to the SMMs in Maxwell. On the GTX 1080, there are 20 SMs, 2,560 CUDA cores, 160 texture

units, 64 render output units, and a new memory controller designed to handle Micron's 10Gbps GDDR5X memory.

MSI's GTX 1080 GAMING X 8G features 8GB of that GDDR5X memory, and it's clocked at 10,108MHz (quad piped) and runs on a 256-bit bus. As with many of MSI's overclocked cards, you can download the Gaming App to unlock a trio of clocking modes, OC, Gaming, and Silent. These run the core/boost clocks at 1,708MHz/1,847MHz, 1,683MHz/1,822MHz, and 1,607MHz/1,733MHz, respectively. We ran our benchmarks with the Gaming App set to OC Mode. For the record,

NVIDIA's reference clocks for the GTX 1080 are identical to MSI's Silent Mode.

MSI's familiar-looking Twin Frozr heatsink features a pair of 95mm TORX 2.0 fans with alternating dispersion fan blades designed to accelerate airflow without increasing noise output. The fans also rely on a dual-ball bearing design for extended reliability. With ZeroFrozr technology, the fan remains idle when the GPU is running at cooler than 60 degrees Celsius. There's an RGB LED-backlit MSI dragon logo on the top of the card that you can tweak, and the red accents on the right half of the heatsink are backlit as well. The heatsink relies on large 8mm nickel-plated copper heatpipes threaded through a large

bank of aluminum fins. Anodized black aluminum plates sandwich the PCB, adding rigidity to the card and helping improve cooling efficiency.

Outputs include three full-sized DisplayPort 1.4, one full-sized HDMI 2.0b, and one DL-DVI port. Although the Founders Edition (read: reference design) GTX 1080 relies on a single 8-pin PCIe power port, this card adds a 6-pin power port, no doubt to support the impressive clocks this card manages to hit.

The scores in our benchmarks speak for themselves. You want to game at 4K and/or enjoy everything VR has to offer, today? This is the card to get. ■

BY ANDREW LEIBMAN



Specs & Scores	MSI GTX 1080 GAMING X 8G
Core clock	1,708MHz (OC Mode)
Boost clock	1,847MHz (OcC Mode)
Memory clock	2,527MHz
Memory interface	256-bit
Memory	8GB GDDR5X
3DMark Professional (Fire Strike Extreme)	10043
Graphics Score	10783
Physics Score	16048
Games	(1,920 x 1,080)
Shadow Of Mordor (Vsync Off, Ultra, DoF, OIT, Tess)	128.59fps
Metro: Last Light (DX11, V High, 16XAF, V High Tess.)	136.33fps
Dying Light (High, AO On, AA On, Vsync Off)	149.84fps
Witcher 3: Wild Hunt (Vsync off, Unl. fps, Ultra)	109.22fps
	(2,560 x 1,440)
Shadow Of Mordor (Vsync Off, Ultra, DoF, OIT, Tess)	88.94fps
Metro: Last Light (DX11, V High, 16XAF, V High Tess.)	162.67fps
Dying Light (High, AO On, AA On, Vsync Off)	111.85fps
Witcher 3: Wild Hunt (Vsync off, Unl. fps, Ultra)	84.9fps
	(3,840 x 2,160)
Shadow Of Mordor (Vsync Off, Ultra, DoF, OIT, Tess)	43.74fps
Metro: Last Light (DX11, V High, 16XAF, V High Tess.)	174fps
Dying Light (High, AO On, AA On, Vsync Off)	55.5fps
Witcher 3: Wild Hunt (Vsync off, Unl. fps, Ultra)	49.05fps

Test System: CPU: Intel Core i7-5960X; Motherboard: GIGABYTE X99-Gaming G1; RAM: 16GB Ballistix Elite DDR4-2400; Storage: 240GB OCZ Vertex 3 MAX IOPS SSD; OS: Windows 10 Enterprise (64-bit)

GIGABYTE GA-Z170X-Ultra Gaming

"GIGABYTE gets solid marks all the way around with the GA-Z170X-Ultra Gaming."

The Z170 chipset was a big deal when it was released (a little less than a year ago) because it introduced DDR4 to mainstream Intel processors and significantly increased the number and speed of the PCIe lanes from the chipset. Specifically, Z170 more than doubles the chipset's PCIe lanes (from 8 in Z97 to 20 with Z170), which allows motherboard makers to expand support for M.2 SSDs and other I/O connectivity, such as Thunderbolt 3 and onboard WiFi. Unfortunately, mainboards age fast when you live on the bleeding edge. The majority of first generation Z170 motherboards lack U.2 and some don't have any USB 3.1 ports. DDR4 speeds have also pushed past what we saw on initial Z170 offerings. The GA-Z170X-Ultra Gaming is a brand new motherboard from GIGABYTE that modernizes Z170.

First and foremost, GIGABYTE takes the shackles off of NVMe-based, PCIe SSDs. The GA-Z170X-Ultra Gaming features an M.2 slot that supports type 2242/2260/2280/22110 form factors, as well as a U.2 connector for the 2.5-inch versions of Intel's SSD 750 Series. You can populate the M.2 slot, the U.2 port, and the board's bottom PCIe x16 slot (runs at x4 speed) with PCIe SSDs. It's even possible to create a RAID 0 configuration with three Intel SSD 750 Series devices for sequential reads of 3,525MBps, though such a setup would require the use of an optional M.2-to-U.2 adapter.

For conventional SATA SSDs, there are six 6Gbps ports—some of which become unavailable when you populate the M.2 slot, U.2 port, and bottom PCIe x16 slot. The user manual provides several detailed charts about which slots you can and can't use when the various PCIe SSD connections are filled. There are also two SATA Express ports, should anyone ever find a use for the fallow standard.

USB 3.1 support was fairly common on GIGABYTE's initial mid-range and high-end Z170 motherboards, and the

company continues to lead by including support for Power Delivery 2.0 on the GA-Z170X-Ultra Gaming. With Power Delivery 2.0, the board's USB 3.1 Type-C port can provide up to 100 watts of juice



to let you recharge or power Type-C enabled devices. The USB 3.1 connection is powered by an Intel controller that offers up to 32Gbps of bandwidth to the two USB 3.1 ports (one Type-C and one Type-A).

Blistering-fast DDR4 is no problem for the GA-Z170X-Ultra Gaming. GIGABYTE has tested the board with

kits boasting Intel XMP speeds as fast as 3866MHz. You can install up to 64GB of DDR4 into the four DIMM slots. GIGABYTE has also added its Ultra Durable metal shielding to the DIMM slots, which will help to prevent damage to the slot when pressing the modules into the slot. GIGABYTE also installed the metal shielding on the PCIe x16 slots to prevent slot damage from heavy GPUs.

Overall, the board's processor and graphics capabilities echo what you'll see on other GIGABYTE Z170 GAMING series motherboards. You'll enjoy basic support for overclocking and can install 2-way SLI or CrossFire setups. Multiple GPU configurations can also include two dual-GPU graphics cards for a Quad SLI or CrossFire configuration. The top two PCIe x16 slots will both run at x8 speed with 2-way SLI or CrossFire.

When it comes to looks, the GA-Z170X-Ultra Gaming has a few notable lighting improvements over previous generations. First off, GIGABYTE expands the LED lighting throughout the PCB, rather than just along the audio PCB and the rear I/O panel. The GA-Z170X-Ultra Gaming features a series of red LEDs along the right side of the board, as well as a few LEDs under the



GA-Z170X-Ultra Gaming
\$170
GIGABYTE
www.gigabyte.us



The motherboard is a basic black, but with the LEDs lit, key areas of the motherboard feature a red glow. GIGABYTE also includes a black I/O cover that is emblazoned with the company's G1 Gaming logo.

VRM and PCH heatsinks. GIGABYTE calls the illumination "Ambient Surround LED." It's an apt title, because the red LEDs also shine behind the motherboard to create a backlit, glowing effect that surrounds the edges of the board.

The slots and heatsinks on previous GIGABYTE GAMING series motherboards feature a red and black aesthetic, but on the GA-Z170X-Ultra Gaming's PCB, the onboard heatsinks are a subdued, basic black. Once the dazzling LED lighting comes on, of course, red and black are the dominant colors. We like this design, as there's virtually nothing on the PCB to detract from red illumination. GIGABYTE also adds a black rear I/O cover, emblazoned with the G1 Gaming logo, to conceal the I/O ports for a clean look.

In our benchmark tests, the GA-Z170X-Ultra Gaming played well with Intel's Core i7-6700K and PNY's GeForce GTX 980 Ti. The former helped our test rig to deliver 889 points in Cinebench 15,

while the latter was able to push Metro: Last Light at 81fps with settings maxed out and a resolution of 2,560 x 1,440. The test rig also featured 16GB of Patriot Viper Elite DDR4-3200, and it combined with the GA-Z170X-Ultra Gaming to produce 32GBps in SiSoftware Sandra's Memory Bandwidth tests.

GIGABYTE gets solid marks all the way around with the GA-Z170X-Ultra Gaming. Feature-wise, it stands out from the crowd of first generation Z170 motherboards. And yes, this mainboard is priced \$20 to \$30 more than most of GIGABYTE's mid-range motherboards, but we think that's a small price to pay for the extra connectivity. Builders looking for a board with an outstanding visual aesthetic should also consider the GA-Z170X-Ultra Gaming. The backlighting, in particular, draws the eye without being overly flashy. We think it'll please gamers and modders alike. ■

BY NATHAN LAKE

Benchmark Results	GIGABYTE GA-Z170X-Ultra Gaming
3DMark Fire Strike Ext.	7281
Graphics Score	7662
Physics Score	13058
PCMark 8	
Creative Score	5589
SiSoftware Sandra 2016	
Dhrystone AVX2 (GIPS)	185.22
Whetstone AVX (GFLOPS)	108.23
Multi-Media Integer AVX2 x32 (Mpixels/s)	393.69
Multi-Media Long-int AVX2 x16 (Mpixels/s)	183.52
Multi-Media Quad ALU x1 (Mpixels/s)	2.12
Floating B/F AVX/128 (GBps, mem bandwidth)	32
CrystalDiskMark 5.1.2 (MBps)	
Sequential Read (Q32T1)	556.4
Sequential Write (Q32T1)	298.1
Random 4K Read (Q32T1)	365.7
Random 4K Write (Q32T1)	253.8
POV-Ray 3.7 (Pixels/s)	1894.89
Cinebench 15 (Points)	889
Games	(2,560 x 1,440)
Metro: Last Light (Very High, 16xAF; SSAA off)	81fps
Dying Light (High, AO On, AA On, Vsync Off)	72.2fps
Witcher 3: Wild Hunt (Vsync Off, Unl. FPS, Ultra)	44.3fps

Specs: Max memory: 64GB DDR4 (DDR4-2133; Max OC: DDR4-3866); Slots: 3 PCIe 3.0 x16, 3 PCIe x1; Storage: 1 M.2 (type 2242, 2260, 2280, 22110), 1 U.2, 6 Gbps SATA, 2 SATA Express; Rear I/O: 1 HDMI, 1 mini DisplayPort (out), 1 mini DisplayPort (in), 2 USB 3.1 (1 Type-C, one Type-A), 4 USB 3.0, 2 USB 2.0, 1 PS/2, 1 Ethernet, audio I/O, 1 S/PDIF; Form factor: ATX; Warranty: 3 years

Test System Specs: Processor: Intel Core i7-6700K; GPU: PNY GeForce GTX 980 Ti; Memory: 16GB Patriot Viper Elite DDR4-3200; Storage: 240GB Intel SSD 730 Series; OS: Windows 10 Enterprise

Win This DXRacer Chair

We're Giving It Away At QuakeCon

When it comes to comfort, cushion can make all the difference in the world. Whether it's thicker foam in the sole of your shoe, a high-quality shock absorber in your car, or additional filling in your mattress, extra cushion is a desirable trait. DXRacer's Drifting Series chairs are designed with even more foam padding than the company's other premium seating offerings, and the cushy padding is applied to both the backrest and seat. The Drifting Series also features a higher backrest than what's available on conventional office chairs, so your spine is supported by firm padding all the way up to your neck.

Because no two people are alike, DXRacer designs its chairs to be completely adjustable. We got a chance to try out DXRacer's Drifting Series OH/DM132/N, and it put our normal office chairs to shame. The 3D adjustable armrest, for example, lets you change its height, angle, and direction (armrest can move forward or back) to let your arms and wrist rest in their most comfortable positions. You can also adjust the seat's tilt (from three to 17 degrees) and back angle (up to 135 degrees). The five-point metal base features a gas spring for quick height adjustment.

With the Drifting Series OH/DM132/N, DXRacer also includes a removable headset and lumbar cushion. These are firm cushions, not some wimpy pillow that will squish down as soon as you put pressure on it. The added support can help to alleviate back or neck pain—something we imagine that many gamers have experienced in the past.

The OH/DM132/N forgoes DXRacer's usual polyurethane seating surfaces in favor of a black mesh cover that's even more breathable, which is nice when temperatures rise, and its all-black cover should blend in with most décor. That means it will look every bit as good in an office as it will in your den.

If you're curious about the comfort of DXRacer's OH/DM132/N and will be attending this year's QuakeCon, stop by our booth and take a load off. We'll also be giving the chair away and the end of the show, so when you finally make yourself stand up again, be sure and sign up for the giveaway! ■



Specs: Cover: Strong mesh; Armrest: 3D adjustable; Tilt angle: 3 to 17 degrees; Back angle: Up to 135 degrees; Base: Inlaid color bar, 2-inch caster wheels; Accessories: Headrest cushion and lumbar cushion



“... lots of updates that reflect advances in case design over the last couple years.”

Ostrog ADV
 \$119.99
 ENERMAX
www.enermax.com

ENERMAX Ostrog ADV

ENERMAX's Ostrog and Ostrog GT mid-tower PC cases hit the scene in early 2013, offering affordability, a solid feature set, and a couple of exterior color options, all of which made them strong candidates for a budget gaming build. Now the company has continued its Ostrog line with the new Ostrog ADV, a similar value proposition, but with lots of updates that reflect advances in case design over the last couple years.

Like the Ostrog and the Ostrog GT, the Ostrog ADV is primarily black but comes in multiple variants differentiated by the color of their accent trim; the difference is that the ADV's external trim accents aren't just paint. ENERMAX built LED strips into the front and top panels that go all the way around the bulk of each surface and light up in red, blue, or green. ENERMAX says these strips use its MaxBrite LED Technology; each case has two pre-installed matching

Vegas LED fans behind the front panel that match the color of its MaxBrite strips, as well as matching paint on its motherboard tray and matching mesh expansion slot covers.

The effect is very cool, especially in a darkened room, and we think system builders who take the time to choose their components to fit with an overall color scheme will really love the way the Ostrog ADV pulls the whole PC together visually. The MaxBrite strips also sync with the Vegas fans to run in six modes, including On, Dimmed, Flash, Sparkle, Vegas, and Off, which you can control using a button on the case's top-facing I/O panel. (The panel also includes a fan speed control selector switch.)

The Ostrog ADV accommodates Mini-ITX, MicroATX, and ATX motherboards, has three 5.25-inch bays and six 3.5-inch/2.5-inch bays, and will hold graphics cards up to more than 16 inches long. You can mount a 240mm or 280mm radiator beneath the top

panel, and the bottom panel will hold a 120 rad, so you have some liquid-cooling options.

ENERMAX gives the case a few other nice little touches, like an oversized acrylic side-panel window on the left side, preinstalled motherboard standoffs (ATX), and quick-release panels in front and up top for access to fans and radiators without having to go in through the side panels.

You get all of this for a pretty reasonable price; ENERMAX's MSRP is \$119.99, and that likely means that you'll be able to find it for a little less online, although it's so new that it wasn't yet for sale at press time. If having a light show on the inside of your case is a little too restrained for you, or if you are just looking for a case that will stand out at your favorite LAN event but don't want to break the bank, the Ostrog ADV can get the job done for you. ■

BY CHRIS TRUMBLE

Specs: Dimensions: 20.3 x 8.5 x 19.4 inches (HxWxD); Materials: steel, plastic; Motherboard support: Mini-ITX, mATX, ATX; Drive bays: 3 x 5.25-inch external, 6 x 3.5-inch/2.5-inch internal; Fans (included): 2 x 120mm front, 1 x 120mm rear; Fans (optional): 2 x 120mm/140mm top, 1 x 120mm bottom; Ports: 2 x USB 3.0, 2 x USB 2.0, audio I/O

**MasterCase Maker 5**

\$199.99

(\$49.99 for tempered glass side panel)

Cooler Master

www.coolermaster.com

"We liked the MasterCase 5 and MasterCase Pro 5; we like the MasterCase Maker 5 even more."

Cooler Master MasterCase Maker 5

Last fall, Cooler Master unveiled the MasterCase 5 and the MasterCase Pro 5, a pair of enclosures designed to give users unprecedented flexibility in configuring their builds inside and out. The company told us at the time that these were just the first steps in an entire series of enclosures and accessories that would work together, and now the next entry in the series has arrived: The MasterCase Maker 5.

Like its predecessors, the Maker 5 utilizes Cooler Master's FreeForm Modular System design, which allows you to install, replace, and uninstall all sorts of panels, bays, side panels, fan brackets, GPU support brackets, reservoir mounts, and other accessories that let you change how the case looks and functions. These accessories are divided into two main groups, Master and Maker parts, where the former are built by Cooler Master and the latter are built by third-party vendors.

Cooler Master shipped its Master-Accessory Tempered Glass Side Panel along with our review unit, and swapping it onto the case in place of the standard steel side

panel with an acrylic window couldn't be easier. Just unscrew the original panel and lift it away, then slot the tempered glass panel's bottom hinge into the corresponding groove in the Maker 5, push the top shut, and lock it with the included key. Tempered glass panels were all the rage at Computex in Taipei this year, and this one looks great and has just the right amount of translucence to give your rig a classy, somewhat mysterious look while still showing your lighted components off in a darkened room.

Speaking of lights, the Maker 5 comes with a raft of cool extras that distinguish it from the MasterCase 5 and the MasterCase Pro 5, starting with a magnetic LED light bar that you can put anywhere in the case that strikes your fancy. A button on the top of the front panel lets you turn it on and off, and there's an LED and fan control board mounted on the back side of the motherboard tray that lets you connect even more lights. It also gives you manual speed control of any connected fans via another front panel button. The Maker 5's top

panel comes with a solid plate over its mesh portion that is held in place by magnets; if you want more ventilation, pop it out. The front panel is covered by a door that swings out and downward on hinges at its bottom to give you access to the external 5.25-inch bays; it is also held shut by magnets.

The case's accessory box is another cool little added touch. Rather than just packing in the plain cardboard box that most of us have come to expect, Cooler Master gives the Maker 5 a steel accessory box whose finish matches the case, and which has a magnetic bottom surface so you can stick it anywhere it's convenient during a build or upgrade. Inside you'll find a plastic lift-out tray with several little compartments that you can use to separate the various screws and fasteners that come in the box.

We liked the MasterCase 5 and MasterCase Pro 5; we like the MasterCase Maker 5 even more. The addition of the front-panel door and the solid top panel give it a stealth-fighter look, and we love the addition of a USB 3.0 Type C port on the front panel. Throw in the pre-installed light and fan controls—and the included LED light bar—and this case is well worth its \$199 MSRP. Even better, at press time you could get one on Amazon for \$177 and change, which sweetens the deal considerably. ■

BY CHRIS TRUMBLE

Specs: Dimensions: 21.6 x 9.25 x 20.8 inches (HxWxD); Materials: steel, plastic; Motherboard support: Mini-ITX, mATX, ATX; Drive bays: 2 x 5.25-inch external, 5 x 3.5-inch/2.5-inch internal, 2 x 2.5-inch internal; Fans (included): 2 x 140mm front, 1 x 140mm rear; Fans (optional): 3 x 120mm/140mm front, 2 x 120mm/140mm top, 1 x 120mm rear; Ports: 2 x USB 3.0, 2 x USB 2.0, audio I/O



\$199/\$249 (Pro)
www.bequiet.com

be quiet! Dark Base 900 & Dark Base Pro 900

This month we got a chance to take a look at the be quiet! Dark Base Pro 900 and came away very impressed.

The Dark Base Pro 900 is a fancier variant of the Dark Base 900; both are full-tower cases that come in black with black, silver, or orange trim accents, and for the most part they are very similar. But whereas the Dark Base 900 comes with two steel side panels, the Pro has a steel panel on the right and a tempered glass panel on the left side. The Pro also comes with a Qi wireless charger built into the front of its top panel, giving you a convenient spot for charging your Qi-enabled phone, and two LED strips you can use to dress things up a bit.

The Dark Base 900 is possibly the most user-configurable case we've seen to date. Each of its seven internal 3.5-inch drive bays can alternatively house two 2.5-inch drives, and the rack that houses all these bays isn't just removable—you can rotate it so that the trays slide out to the right instead of the left.

There are also no fewer than six positions for the case's internal PSU mounting bracket, including three positions from front to back and two lateral positions (toward the left side or the right). If you're wondering why you'd want those things, here's the best part: The Dark Base 900's mobo tray is also removable, so you can install your motherboard and various other components outside the case if you like, and you can also move it to one of three heights inside the case. This is great news for builders who favor thicker radiators, and for those who just like having some breathing room in their cases' interior. You can also (drum roll please) flip the tray and install it to the left side of the case.

That's right, you can invert the tray and drive rack and convert the Dark Base 900 to be a right-facing case, or you can leave it as a left-facing one! This is the first case we've seen that can do this neat trick, and we imagine that lots of builders will really appreciate the flexibility. (By the way, this extends to the

Pro version's tempered glass panel, which can easily be moved to the right side, and you can also adjust the front panel door so that it opens right to left instead of left to right.)

Like all be quiet! products, the Dark Base 900 is designed to keep your PC quiet and cool. The front, top, and steel side panels have sound-dampening mats affixed to them on the inside, and the case's vents are baffled to break the straight-line flow of air, and help keep things quiet. The steel side panels on the 900 and Pro 900 also come equipped with be quiet!'s 2-in-1 ventilation system, which means you can take the inset panels off altogether or move them out a few millimeters from the panel, as your airflow needs dictate.

The 900 also comes with three 140mm SilentWings 3 PWM fans pre-installed (two up front and one in the rear), and you can add several more if you like, including two behind the 2-in-1 side panel vents. The case is also very watercooling-friendly, with support for radiators up to 420mm long beneath the top panel and behind the front panel. Additionally, the rear panel will accommodate a single (120mm or 140mm) rad, and the bottom panel will hold a double (up to 280mm).

There are a lot of cases on the market today that provide some degree of modularity, but the be quiet! Dark Base Pro 900 takes the concept of modular design to a whole new level, and that's why we've awarded it the CPU Cutting Edge Award. ■

CHRIS TRUMBLE

Specs: Dimensions: 23 x 9.6 x 22.7 inches (HxWxD); Materials: Aluminum, ABS plastic, steel, tempered glass; Motherboard support: Mini-ITX, mATX, ATX, XL-ATX, EATX; Drive bays: 2 x 5.25-inch external, 7 x 3.5-inch internal, 15 x 2.5-inch internal; Fans (included): 2 x 140mm front, 1 x 140mm rear; Fans (optional): 1 x 140mm front, 4 x 120mm/3 x 140mm/1 x 180mm top, 2 x 140mm/1 x 120mm bottom; Ports: 2 x USB 3.0, 2 x USB 2.0, audio I/O

"You can build a capable gaming system around the GA-F2A88X-D3HP without much scratch."



GA-F2A88X-D3HP
\$76
GIGABYTE
www.gigabyte.us

GIGABYTE GA-F2A88X-D3HP

Here at *CPU*, we tend to focus on high-end parts that blow the doors off the average PC. Performance parts, though, don't always fit into the budget. Enter AMD's new lineup of Athlon X4 processors and A-series APUs (accelerated processing units), many of which are available for less than \$100. The Athlon X4 processors might be particularly attractive to gamers, as the CPUs offer speedy quad-core performance. GIGABYTE's GA-F2A88X-D3HP supports AMD's latest FM2+ Athlon X4 processors and other A-series chips. It also includes a host of modern conveniences. For example, the motherboard features two USB 3.1 ports with one reversible Type-C port and one standard Type-A port. Cash-strapped enthusiasts will also like that the GA-F2A88X-D3HP retails for only \$76.

AMD's Athlon X4 processors need to be paired with a discrete GPU, as the chips don't have the onboard graphics you'll find on an AMD APU. The GA-F2A88X-D3HP supports CrossFire GPU configurations via the board's two PCIe x16 slots. The top PCIe x16 slot operates at the full x16 speed,

while the bottom slot is designed to run at x4 speed. GIGABYTE also provides three PCIe x1 slots and two PCI slots.

When installing add-on cards, there are a couple important caveats to remember. First off, some AMD Athlon X4 processors (such as the Athlon X4 845 in our test rig) only provide eight PCIe graphics lanes, so PEG bandwidth could depend on what chip you select. Secondly, the bottom PCIe x16 slot shares bandwidth with the two PCIe x1 slots located between the top and bottom x16 slots. If you populate these PCIe x1 slots, the PCIe x16 slot will only operate at x2 speed.

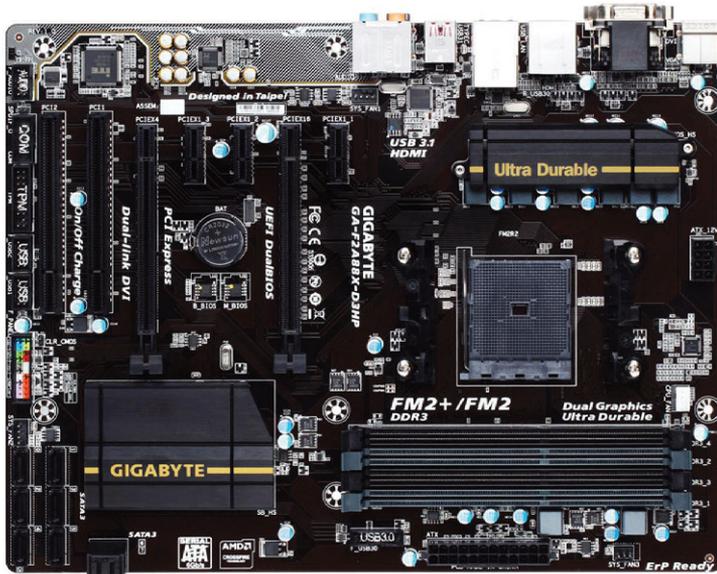
At first blush, the board's PEG lane-sharing might seem discouraging, but in reality, the PEG limitations shouldn't affect many users. GIGABYTE provides a PCIe x1 slot above the top PCIe x16 slot, and this slot doesn't share bandwidth with the x16 slots. As such, you'll have one slot for a PCIe x1 add-in card that won't affect your GPU setup in any way. And because GIGABYTE provides excellent onboard audio, networking, and connectivity additions, the GA-F2A88X-D3HP precludes the need for

the most common PCIe x1 add-in cards. The most notable exception for most users would likely be a wireless card.

System memory support is solid for an AMD chipset. You can install up to 64GB of DDR3-2133 memory, and GIGABYTE allows you to load up AMP (AMD Memory Profile) and Intel XMP settings for quick optimization. GIGABYTE's website also lists support for DDR3-2400 memory when overclocking.

The GA-F2A88X-D3HP is part of GIGABYTE's Ultra Durable motherboard series, meaning that it's constructed with components designed for stability and longevity. Ultra Durable protections vary from mainboard to mainboard, and there are a few key additions at play on the GA-F2A88X-D3HP. Notable features include a glass fabric PCB (to protect against short-circuit damage caused by humidity), low RDS(on) MOSFETs (to reduce transistor heat), and electrostatic discharge protection on the USB and Ethernet ports.

We also like that GIGABYTE includes its UEFI DualBIOS that provides you with a pair



of BIOS ROMs, with one serving as a backup BIOS for easy recovery. The intuitive UEFI setup also makes it easy to adjust settings.

For reliable, high-fidelity audio, GIGABYTE installs high-quality audio capacitors and uses its Audio Noise Guard to separate the audio PCB from the main PCB. This layout helps to reduce the chance of electromagnetic interference reducing your audio quality. Onboard audio is powered by a Realtek ALC892 codec that supports 7.1-channel surround sound. GIGABYTE provides an S/PDIF output on the rear panel to deliver digital audio, and there's also a set of analog ports that support 7.1 audio configurations.

USB ports are plentiful on this mainboard. We've already mentioned the two USB 3.1 ports; these are powered by an ASMedia USB 3.1 controller that supports USB 3.1's maximum 10Gbps transfer speed. GIGABYTE uses AMD's A88X chipset to provide you with four USB 3.0 ports (two rear, two internal) and eight USB 2.0 ports (four rear, four internal). Internal storage is also provided via the A88X chipset. There are eight 6Gbps SATA ports that can be configured in RAID 0, 1, 5, or 10, as well as JBOD.

The key components in our test system included an AMD Athlon X4 845, a PNY GeForce GTX 980 Ti, and 16GB of Patriot Viper DDR3-1600 memory. The GA-F2A88X-D3HP proved a good choice for gaming with our test rig, surpassing 60fps in Metro: Last Light (63.4fps) and Dying Light (68fps) and hitting 58.3fps in Witcher 3. In 3DMark's Fire Strike Extreme test, the GA-F2A88X-D3HP helped to deliver an overall score of 5741 and a Graphics Score of 7841. The rest of the benchmark numbers show that the system would be more than sufficient for everyday workloads.

You can build a capable gaming system around the GA-F2A88X-D3HP without much scratch. Start with a value-priced AMD processor or APU and price out the remaining parts accordingly. Costs for DDR3 memory and SATA SSDs are as low as we've ever seen, so you might even gain some extra flexibility on your GPU budget. And if you can cannibalize the PSU and case from an old build, total cost could come in under \$500. That kind of value is hard to ignore. ■

BY NATHAN LAKE

Benchmark Results	GIGABYTE GA-F2A88X-D3HP
3DMark Fire Strike Ext.	5741
Graphics Score	7841
Physics Score	4692
PCMark 8	
Creative Score	3014
SiSoftware Sandra 2016	
Dhrystone AVX2 (GIPS)	65.21
Whetstone AVX (GFLOPS)	49.31
Multi-Media Integer AVX2 x32 (Mpixels/s)	126.09
Multi-Media Long-int AVX2 x16 (Mpixels/s)	41
Multi-Media Quad ALU x1 (Mpixels/s)	0.71
Integer B/F AVX/128 (GBps, mem bandwidth)	14.24
CrystalDiskMark 5.1.1 (MBps)	
Sequential Read (Q32T1)	540.6
Sequential Write (Q32T1)	250.4
Random 4K Read (Q32T1)	215.1
Random 4K Write (Q32T1)	107.5
POV-Ray 3.7 (Pixels/s)	917.62
Cinebench 15 (Points)	308
Games	(2,560 x 1,440)
Metro: Last Light (Very High, 16xAF; SSAA off)	63.4fps
Dying Light (High, AO On, AA On, Vsync Off)	68fps
Witcher 3: Wild Hunt (Vsync Off, Unl. FPS, Ultra)	58.3fps

Specs: Max Memory: 64GB DDR3-2133 (DDR3-2400 Max OC); Slots: 2 PCIe x16, 3 PCIe x1, 2 PCI; Storage: 8 6Gbps SATA; Rear I/O: 1 HDMI, 1 DVI-D, 1 VGA, 2 USB 3.1 (one Type-C, one Type-A), 2 USB 3.0, 4 USB 2.0, 1 PS/2, 1 Ethernet, 1 optical S/PDIF, analog audio I/O: Form Factor: ATX; Warranty: 3 years

Test System Specs: Processor: AMD Athlon X4 845; Graphics Card: PNY GeForce GTX 980 Ti; RAM: 16GB Patriot Viper DDR3-1600; Storage: 240GB Kingston HyperX SSD; OS: Windows 10



XPREDATOR GOLD



Silent . Efficient . Protection
- for serious gamers



Be cool! Be Aerocool!

Modular cables

750GM

100-240VAc 11-5.5A 47-63Hz

DC OUTPUT VOLTAGE	+3.3V	+5V	+12V	-12V	+5Vsb
MAX. OUTPUT CURRENT	20A	20A	62A	0.3A	2.5A
MAX. COMBINED POWER	100W		744W	3.6W	12.5W
	750W				

1000GM

100-240VAc 15A 47-63Hz

DC OUTPUT VOLTAGE	+3.3V	+5V	+12V	-12V	+5Vsb
MAX. OUTPUT CURRENT	24A	24A	83A	0.3A	3A
MAX. COMBINED POWER	130W		996W	3.6W	15W
	1000W				

Authorized
Dealers

amazon.com

CYBERTRON
www.cybertronpc.com

electronics
Fry's

MA★LABS

performance
pcs.com

For more details, please visit www.aerocool.us



VIPER ELITE

UP TO:
3200MHz

AVAILABLE CAPACITIES:
8GB KIT - 64GB KIT

Designed for Intel® X99 and Z170 Platforms, XMP Ready



VIPER 4

UP TO:
3600MHz

AVAILABLE CAPACITIES:
8GB KIT - 32GB KIT

Designed for Intel® X99 and Z170 Platforms, XMP Ready

ALWAYS ON THE MARK

VIPER GAMING MEMORY

VIPER™ GAMING
GAMER CERTIFIED



[/PATRIOTMEM](#) [@PATRIOTMEMORY](#) [/PATRIOTMEMORYTV](#) [@PATRIOTMOBILE](#)

AVAILABLE AT [Fry's](#) [amazon.com](#)



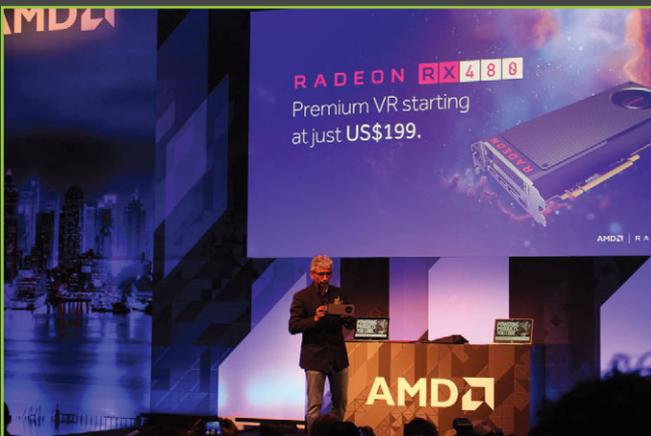
[Canada Computers & Electronics](#)
[NCIXUS.com](#) [NCIX.com](#)

SCAN TO LEARN MORE

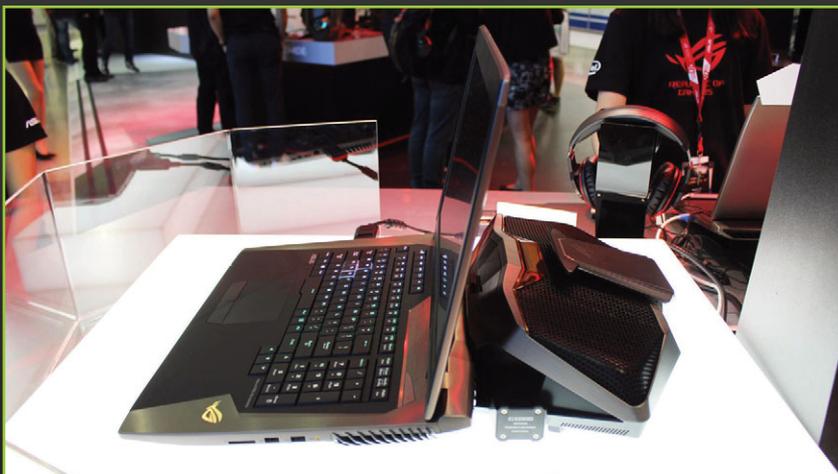


An Abridged Computex The Coolest Stuff We Saw In Taiwan

Computex is always a unique event, as much for its locale in Taipei, Taiwan as for its laser focus on PC computing in all its various forms. This year, we found a number of things we think you'll want to get excited about over the coming weeks and months. Here's our list of favorites from this year's amazing show.



AMD made a big splash at Computex, officially taking the wraps off the Radeon RX 480, a \$199 graphics card designed to bring VR to tens of millions of users. It features more than 5 TeraFLOPS of compute, 36 CUs, 256GBps of memory bandwidth, a 4GB or 8GB GDDR5 frame buffer, and a 256-bit memory bus. It's all built on 14nm FinFET manufacturing process and optimized by AMD. At the end of AMD's presentation, Dr. Lisa Su came back on stage to introduce the new Zen processor, which delivers 40% more instructions per clock, features eight cores, 16 threads, and a new AM4 desktop platform.



At Computex, ASUS demoed a dizzying array of products to tempt enthusiasts, including new motherboards, laptops, monitors, PCs, graphics cards, peripherals, and more. Of course, there were mods and even some 3D-printed ROG motherboard accessories. We first saw the GX800 Hydro Overclocking System—effectively a liquid-cooled notebook—at CES, but our excitement has not waned.

HEAVY GEAR



AeroCool started off our booth tour by showing us a few of the unique designs its team had come up with using the DreamBox, which won a Best of Computex award. We also tried out the company's range of stylish and comfortable gaming chairs and looked at a slew of soon-to-be-released accessories, such as charging cables, power banks, and speakers. We also saw AeroCool's latest mice, keyboards, AIO coolers, PSUs, and some new cases that we're excited to learn more about.

Corsair showed off its new LED-lit Dominator Platinum and Vengeance DDR4 DRAM modules. An enormous amount of engineering man hours are needed to make LEDs on DRAM modules do interesting things, but Corsair is one of the few companies equipped to make it happen.



At Cooler Master's booth we were bowled over by the sheer number of new products coming soon or in development. There's a lot on the horizon in product categories such as cases, mice, keyboards, notebook coolers, PSUs, modding supplies, headsets, and more. We saw some prototypes, including a behemoth COSMOS "concept" case that'll likely never be more than a one-off. Cooler Master is really fleshing out its modular Maker line of products, and the "Make It Yours" catchphrase is beginning to feel like a winning formula.



It's not easy to make mice and keyboards that stand out at a show like Computex, but Azio managed to do it. Here's a shot of the new MGK L80 RGB backlit mechanical gaming keyboard (due in June) and the EXO ALPHA metal frame backlit gaming mouse (available in September), in a variety of anodized colors.

HEAVY GEAR



At the Crucial booth, we talked about new SSDs, DRAM, M.2, and NVMe products. We have to say, we're really looking forward to some of the new Ballistix products coming out. We asked Jeremy Mortenson, senior product manager for DRAM, when we'd get to see some Ballistix Tracer memory; he said he's working on it, but we have a feeling it'll be impressive when it arrives.



While at Computex, we met with the folks at be quiet! and got our eyes on the modularity-obsessed Dark Base 900 (\$199) and Dark Base 900 PRO (\$249) cases, set to launch June 28. The PRO version features a 4mm-thick tempered glass side panel, five-color LED strips, and a Qi charger for mobile devices. The company also showed off new AIO liquid coolers, fans, and power supplies.



DEEPCOOL's booth had some really innovative products, as expected. Highlights include an RGB LED-equipped Neptwin CPU cooler, the ROG-certified GENOME case, a brushed aluminum case called the New Ark, Captain EX White series AIO liquid cooler, and the MF360 Magic Fan controller for syncing RGB LED colors and fan speeds. We also got an up-close look at the jaw-dropping Mnpctech Genome mod from Bill Owen.



Like most of NVIDIA's AIB partners, EVGA had a selection of its new GeForce GTX 1080 models to show off. We learned a little about the ACX 3.0 fans many of these cards come equipped with and what makes them so quiet, durable, and powerful. We also saw a production-ready version of EVGA's gigantic BG ("Built for Gamers") case. It effectively turns the left side panel into the front of the case, and it has some other unique features we'd love to cover in more detail later. As we were wrapping up our discussions about new power supplies, Taipei was hit with a mild earthquake. When the smoke cleared, everything was still humming right along. What more could you ask from your components?



Most DDR4 makers at Computex were showing off RGB LED-infused DRAM modules, and ADATA was no exception. The XPG Dazzle memory will come at speeds up to 3,200MHz, be available in densities of 8GB or 16GB, and feature red or black heatsinks. We also got a look at the firm's latest SSDs, including some ultra-fast NVMe devices and high-capacity M.2 devices.

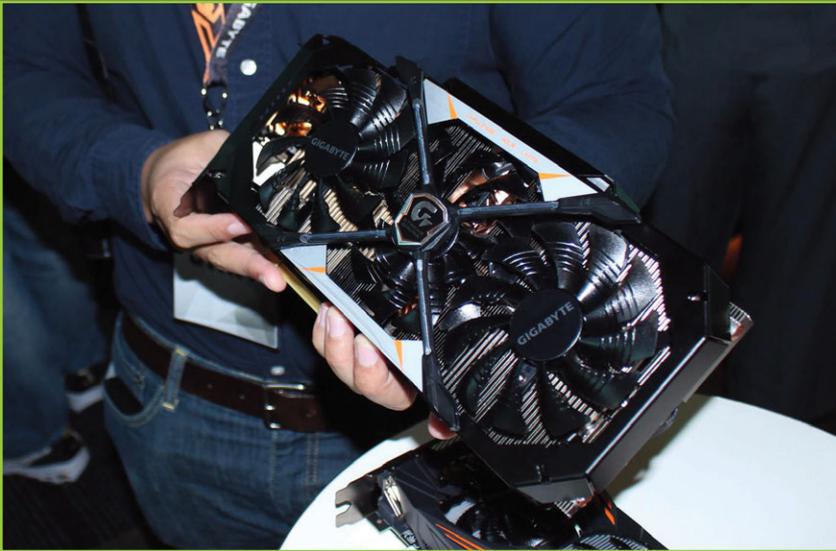


ENERMAX and LEPA shared a booth at the show. ENERMAX showed off its Giant LIQMAX RGB DIY Liquid Cooler, which is essentially a custom liquid cooling kit with an RGB LED in a massive reservoir, a pump with a digital speed readout, a set of LED fans with five Vegas lighting modes, and a DIY coolant color kit. We also loved the Steelwing Mini-ITX case. The LEPA-branded LED fans, AIO liquid coolers, and PSUs were attractive and powerful, especially the Titanium Series MAXTYTAN. The main attraction was a themed mod based on Tom Clancy's The Division, created by an in-house team of builders.

The morning before Computex officially kicked off, we attended a roundtable discussion hosted by NVIDIA's CEO, Jen-Hsun Huang. The talk focused on VR/AR/AI and self-driving cars. There was a mention of the new GeForce GTX 1080 and the just-launched GeForce GTX 1070; the word from NVIDIA is that both are selling extremely well. At the event we discussed the new HBM2-equipped Tesla P100 for HPC and datacenter applications, the NVIDIA DGX1 server built for AI, and the NVIDIA Drive PX2, which is a custom computing board that features two Tegra processors, LIDARS, radars, and ultrasonic tech; does over 20 TeraFLOPS of compute; and supports 12 HD cameras. According to Huang, it will be the brain behind the world's first AI-powered self-driving car.



HEAVY GEAR



GIGABYTE had two meeting spaces at Computex—a large booth on the floor of the Computex convention center in downtown Taipei and a massive suite of rooms in Taipei 101. Even as one of the longest meetings we attended at the show, we're still sure we missed a thing or two. We saw all the latest motherboards (and a few that are coming sooner than you think), new GeForce GTX 1080 graphics cards, innovative peripherals, gaming notebooks, and a ton of really creative mods. During the tour, we struck up a conversation with Hans Peder Sahl, a modder who is starting to sell his own case designs under the name HexGear (www.hex-gear.com). We'll be keeping an eye out for his work. As for GIGABYTE, there's going to be a lot to talk about for the rest of 2016.



As you'd expect, there were a ton of aluminum cases at Lian Li's booth featuring the company's signature dual-chamber design that keeps the PSU hidden away but shows off the graphics card behind a slab of tempered glass. We also saw a desk that transforms from a traditional height to a standing desk with the push of a button.



Intel, together with HWBOT Asia, hosted an overclocking World Series event and workshop at the Computex hall in Nangang. Attendees were free to scope out sponsored mods and chat with the expert overclockers on site. If you registered, you could even try your hand at LN2 overclocking on one of the shiny new Broadwell-E processors.



Thermaltake showed off a host of builder-friendly accessories and components at Computex, including new LED backlit watercooling fittings, mice, keyboards, cases, fans, and more. The company also exhibited dozens of mods, including this new concept "Tower" design that Thermaltake created in collaboration with French modder Mathieu Heredia.

Sponsored By



Cooling Corner

Pro Tips From Travis

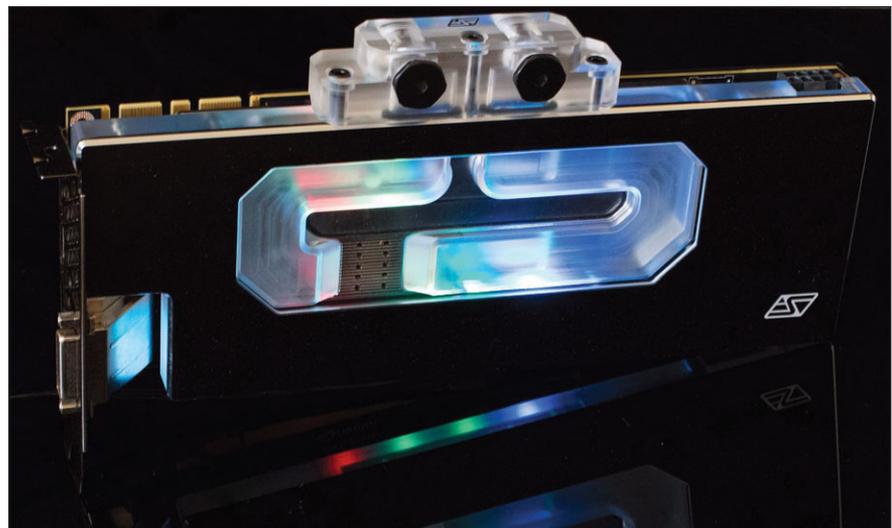
Travis Jank is the owner of NEXGEN Computers, a boutique high-performance custom computer company. Travis has always been into extreme things, from snowmobiling and dirt biking to gaming and modding, he has continually pushed the limits. So when it came to computers, he was not content with an off-the-shelf PC. His pursuit of the ultimate gaming experience eventually became paired with a love for sleek aesthetics and eye-catching flair, driving him to get involved in modding. Thanks in large part to his longtime friend Richard "DarthBeavis" Surroz, he has traveled to trade shows with many computer manufacturers and has been a guest speaker for TEDx. His modding work has appeared on "The Vanilla Ice Project," Intel #ExpertMode, and "Rig Wars." In order to feed his PC building addiction, Jank founded NEXGEN Computers, where he could express his dedication to and passion for pushing the known boundaries in the form of unique custom computers.

Q: OK, so most of our readers are up to speed on the whys of cooling, but from your perspective, what are the primary benefits of using liquid cooling in a PC, and in particular, what are the benefits of including a system's GPU(s) in the loop?

TJ: One of the primary benefits of liquid-cooling PCs is reducing total system noise output for a more acoustically pleasant experience. There are some air coolers that are exceptionally quiet, however they come at a price and are often incompatible with smaller chassis. More importantly, they tend to pose a significant hazard when shipping, as they can stress the motherboard and CPU, even bending or breaking free in rough transit. When coupled with a full-coverage block, the PCB is protected from flexing and thermal issues are mitigated, allowing maximum overlocks. An additional benefit of liquid cooling is the ability to unlock the full potential within your CPU and GPU; the increase in thermal dissipation helps us to edge out every last megahertz and achieve much more stability with today's components.

When talking about the benefits of liquid cooling, I can't stress enough the aesthetic value it will add to a rig—premium liquid cooling is a game changer for any system.

Q: So, generally speaking, a full-cover waterblock is preferable, correct? So



Swiftech's new Komodo NV-LE GPU waterblock for NVIDIA GeForce GTX 1080 and 1070 cards. For more information, visit www.swiftech.com.

that your card's memory and VRMs get cooled along with the GPU?

TJ: Full-coverage blocks are preferred for their superior ability in cooling the GPU, VRMs, and memory. Keeping them cool will ensure the long-term health and stability of your GPU and provide greater clock speed headroom.

Q: What kinds of things should someone who's never taken off a graphics

card's stock cooling solution know before attempting to give it a shot?

TJ: It is important to take your time and be gentle. Avoid pulling on anything too hard, as this could permanently damage the card, and be on the lookout for overlooked or hidden screws, both on the back of the card and the bracket. Pay attention to the delicate cables under the cooler, as well. Often the fan and LED cables will have a locking connector, so do not pull on the wires themselves, as

this can pull out the crimps. Instead, take the extra time to identify how to release the connector from the socket.

Q: Are there any special tricks or techniques that you've learned over the years to help ensure proper installation of GPU waterblocks?

TJ: One of the things I have picked up over the years is to always look at the original heatsink and identify the size of and where the manufacturer cooling pads are, as you don't want to omit the installation of a thermal pad. Be sure to double-check the user guide for your block, as the thickness of the thermal pad is crucial for successful installation of your block. When it comes to screws, size *does* matter! Use the provided mounting hardware, as the instruction manual will clarify the appropriate position, type, and length of each screw for optimal pressure and contact. Install it twice! When finished with the block installation, the first time you assemble the card, tear it back down and inspect the thermal grease coverage on the core. It should be evenly covered with no exposed areas of the die. I also recommend keeping the stock cooler, as it can be helpful for troubleshooting, and it will be necessary if you need to RMA the card or decide to sell it next time you want to upgrade.

Q: Do SLI and/or CrossFire configurations create any additional installation problems, and if so, what's the best way to overcome them?

TJ: Multi-card configurations can be tricky to plumb. Whether it's limited working space or you're going for that sexy look, take your time and plan out the flow. Identify the inlets and outlets of each block, as plumbing the system for pure aesthetics can result in cooling failure. The wrong flow patch can potentially bypass the internals of the block, causing high temperatures and rendering the cooling solution ineffective. One way to simplify installation is to use a manifold or liquid-cooling bridge that interconnects the blocks for easy SLI or CF plumbing.

Q: Can you provide some tips for leak-testing once a loop is complete and operational? Are there things that builders should watch for in particular with the connections over their GPUs?

TJ: Loop testing is one place where you don't want to take a shortcut. I prefer wrapping blue shop towels around and under any fitting or block, with a thick layer on the back of the GPU to absorb coolant that may drip from above fittings. The blue shop towels are handy in the event of a leak as they turn dark, making it easier to spot escaping fluid. It's crucial to watch your system closely, inspecting each fitting and block, and monitoring for 15 to 30 minutes prior to leaving the system unattended, as slow-forming leaks can take a while to appear. If the system passes a 24-hour leak test, chances are the system is good to go. Do yourself a favor and pick up an AC wall jack to 12V DC 4-pin Molex adapter to power the system pump(s), as this will alleviate the need to unplug power from your components or jumper the PSU.

Q: When you take a rig to a show or LAN party, do you prefer to disconnect your GPUs from the loop and pull them out, or would you rather use insulation or foam or something like that to support them in transit?

TJ: When shipping or traveling with systems, I prefer installing extended support brackets on each GPU that ties the back end of the GPU to the chassis. Where the bracket solution is not available, I will use foam padding between the cards and the case.

Q: What can you tell us about Swiftech GPU blocks based on your experiences in using them to cool your builds?

TJ: Based on my experience, Swiftech has a solid product. The blocks are virtually bulletproof in reliability, are excellent at cooling the core, memory, and VRMs, and I enjoy their elegant flow design and overall appearance. When it comes to modding, the luxury edition blocks make a great canvas for matching the theme of a build.

Q: Swiftech has announced a new line of its Komodo waterblocks that will be available shortly after this issue goes to press. What can you tell us about them?

TJ: The new Komodo blocks continue with the tradition of strong performance coupled with sleek luxury design, and the addition of RGB ALED (addressable LED) lighting to the Komodo is a great complement to their new X2 AIO line. ■



The new Komodo blocks use the same ALED (addressable LED) tech as Swiftech's all-in-one CPU liquid coolers, so you can add a GPU to your loop and maintain a consistent color scheme.

HARD HAT AREA
PC MODDER
MAD READER MOD



MRRMTM
MAD READER MOD

Circuits

If you've ever been to PDXLAN in Portland (or, for that matter, to any LAN party in the Pacific Northwest), you are probably aware of Those Light Signs (www.thoselightsigns.com). If you're not specifically aware of them but have ever wondered where everyone is getting the LED-lit wood and acrylic signs with their gaming handles on them, they come from Those Light Signs. One of the guys behind Those Light Signs, Kurt Schuff, built this month's Mad Reader Mod along with Matt Baker after getting an invitation to participate in the Modding For Charity fundraiser for the Philip Scholz Memorial Foundation at PDXLAN 27 in February.

"Getting to do a build for a system that you don't get to keep was a new experience for me, and when everything was said and done, really difficult," Schuff says. "Letting that system go was one of the harder things I've had to do at a LAN."

We can see why.

There's No I In "Team"

"By day I'm a software QA guy," Schuff says, "so I can get a bit nuts about getting details right. I went to school as a graphic designer, so I've found that modding really lets me exercise those neglected skills. Also, I do all the circuit and design work on all the light signs you see all over the LAN, so bringing that particular technique to the mod was a no-brainer."

Schuff does his work both in his dad's wood shop and on a table in the living room ("to my wife's great dismay"). "Don't let the phrase 'wood shop' fool you, though," he says. "We have a CNC that we built in there, as well as a laser."

Baker, who has his own CNC machines in his garage—to his wife's dismay—has a different skillset, and it works out perfectly.

"I am an aerospace manufacturing engineer, so to build things is second nature to me," Baker says. "My hobbies are to build things like robotics and CNC machines. In general, I have a lot of the tools and know how to do a lot of things, just no inspiration. Working with Kurt allows me to build something or figure out how to make something that is visually pleasing but not efficient, which is generally what I do."

Given their backgrounds and the audience, Circuits checks off all kinds of boxes.

"I generally find inspiration in the littlest thing," Schuff says. "It starts with, 'Hey, it'd be cool if . . .'" and snowballs into an entire case theme. With Circuits, the goal was to create something that would appeal to a wide variety of tastes. Given the target audience was LAN attendees, a tech-based theme was easy to choose, and circuit traces offer a huge amount of flexibility in what you can do with them. They are easy to manipulate and fit in different spaces, and are definitely a core component to technology."

There Ain't No "We," Either

"The core elements of the mod came out nearly exactly as planned," Schuff says. "The rest of the case evolved around those elements, and while some of them were spur-of-the-moment decisions, everything came together the way we wanted."

The guys say they spent about 100 hours on Circuits, not counting the initial planning work. "I tend to go a bit overboard with that," Schuff says.



HARD HAT AREA
PC MODDER
MAD READER MOD

They built the gorgeous wood panels you see at the top and bottom of the mod using wenge, the wood of a highly sought-after legume tree from Africa. The rest of their work was largely done in acrylic and resin, and of course they did plenty of laser etching and cutting. Also, you may notice that almost no cabling is visible despite the Thermaltake Core P5's clear front panel. "Being OCD but also being a slight bit lazy, I hate cable management," says Baker. "So early on in this build, I came up with the idea to remove all of the power connectors, USB connectors, and other headers from the motherboard so that only SATA and a few minor other ones would be on the top. I removed the connectors with a wave solder machine and then attached new wire harnesses and ran them from the underside, after masking off the board with pink bubble-gum-looking material."

The guys removed all of the stock LEDs from the fans and in the waterblock and replaced them with NeoPixel LEDs, which they also used to illuminate the front panel from above and below. They also embedded an LED in the reservoir cap that they custom-milled, and added some more to their custom PSU cover and the build's graphics card.

"All told, there are over 100 individual LEDs in the system, controlled by either a PCI slot-mounted switch or via Bluetooth from a smartphone app," Schuff says. "All the LEDs are individually addressable, thus the case can have

any color pattern you want to program and is not limited to a single color throughout."

The components that make up Circuits start with the aforementioned Thermaltake Core P5 and include an Intel Core i7-5960X mounted on an ASUS SABERTOOTH X99 board, 16GB of Crucial Ballistix Elite DDR4, an EVGA GeForce GTX 980 Ti, a Thermaltake Smart DPS G 700W power supply, a Crucial 512GB SSD and a WD Black 6TB hard drive, and of course "tons of" Adafruit NeoPixel LEDs. The cooling subsystem consists of a Thermaltake Pacific Water Cooling Kit.

So Happy Together

Schuff has modded a system or two for himself in the past, but as mentioned earlier, he'd never done one for someone else before. ("It was also my first mod with a deadline," he points out.) For Baker, Circuits was officially his first mod, which gives us an even greater appreciation for his skills.

Schuff says that in addition to other firsts, this was the first mod project he did with a partner.

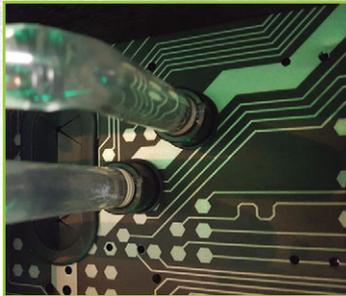
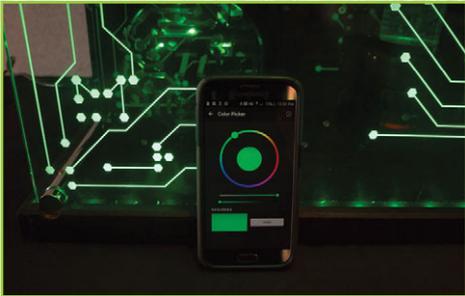
"Matt was great at keeping me from over-planning, and making me 'just do it,'" he says. Baker agrees that their team effort worked well.

"I am hoping to talk Kurt into doing something again next year!" he says.

We are hoping the same thing. ■



HARD HAT AREA
PC MODDER
MAD READER MOD

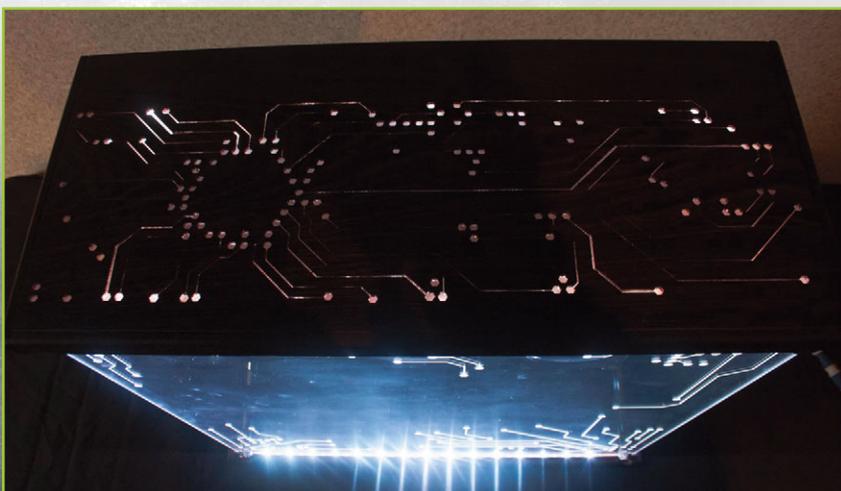


We Want Your Mod

Have a computer mod that will bring tears to our eyes? Email photos and a description to madreadermod@cpumag.com we choose your system as our "Mad Reader Mod," you'll win \$1,500! (U.S. residents only, please.)



Drop Us A Line Today!





EXTREME RIG CHALLENGE

SHARE. WIN. ALL SYSTEMS GO.

Enter for chance to win a \$10,000 AVADirect Custom Gaming Computer



HOW TO ENTER

1. Tweet **"I vote @AVADirect for the #IntelRigChallenge"**
2. Tweet daily to increase odds of winning



866-766-4629 | www.avadirect.com | sales@avadirect.com
[@avadirect](https://twitter.com/avadirect) | [f/avadirect](https://facebook.com/avadirect) | [@avadirect](https://instagram.com/avadirect)

Proudly Built and Supported in the United States

Intel, the Intel Logo, Intel Inside, Intel Core, and Core Inside are trademarks of Intel Corporation in the U.S. and/or other countries.

A Perfect 10

Broadwell-E Debuts Intel's First Decacore Desktop CPU

Forget about code names. Forget about release cycles and forget about ticking and tocking. We might be living in a world where Moore's Law has been retired, but power users can still expect big things from the future. This year, as spring wound down and summer started heating up, a little piece of the future became the present.

To all the enthusiasts who have been begging for a new flagship processor: Intel has heard your supplications and bestowed you with the Core i7-6950X Extreme Edition, a titanic chip that brandishes more physical cores than any other desktop CPU to date. And this processor brought friends. Intel introduced the following three processors alongside the 6950X: the Core i7-6900K, Core i7-6850K, and Core i7-6800K.

In terms of raw power, the 6950X and its band of multicore monsters set a new standard. However, we're not about to forget about the former king of the Intel dynasty, Haswell-E; in some respects, Intel is competing against itself. Considering the Core i7-5960X Extreme Edition and its siblings remain remarkably potent, getting on board with Broadwell-E will make more sense for some power users than for others.

The Road To Broadwell-E

For years, Intel has followed a pattern of releasing its HEDT (high-end desktop) processors with a similar cadence as the company's now-retired Tick-Tock model, a rinse-repeat routine of a manufacturing process shrink (Tick) followed by a new microarchitecture (Tock). To wit, for the last several processor generations, when Intel introduces a microarchitecture, it releases a wide range of chips across its Core i3, Core i5, and Core i7 lines. A little over a year later, the company rolls



The wait is over. At this year's Computex, Intel pulled back the curtain on its highly anticipated new family of HEDT (high-end desktop) processors, code-named "Broadwell-E." At the top of the stack is the Core i7-6950X Extreme Edition, a processor with 10 physical cores and, of course, an unlocked multiplier.

out a collection of HEDT processors based on the same architecture. For example, Intel's previous Extreme Edition CPU, the Core i7-5960X, which was code-named Haswell-E, arrived 15 months after Intel launched its Haswell-based chips.

A curious thing happened last year. Intel released a handful of Broadwell-based processors in June 2015 and almost immediately followed up with its Skylake-

based family. Given Broadwell's short reign as the freshest microarchitecture, power users and industry insiders alike pondered the nature of the next HEDT. Would Intel stick with tradition and produce HEDTs based on Broadwell-E, or would it skip Broadwell altogether and produce Skylake-E CPUs? Now, if all this seems like inside baseball, mothballing Broadwell-E in favor of Skylake-E could've had very real consequences.

The 5960X debuted in August 2014, so choosing Skylake-E as the successor to Haswell-E could have delayed a new HEDT launch for another year or more.

Obviously, Intel put those fears to rest with the 6950X. Announced at the end of May at Computex 2016, Broadwell-E continues the Extreme Edition CPUs' steady march of progress, and it has a few new tricks up its sleeve.

Turbo Boost Max 3.0: Now With More Boost

When it comes to overclocking, power users relish the opportunity to do it themselves; it's in the job description. On the other hand, we're not going to turn away hardware that delivers free and easy extra performance. Intel's Turbo Boost Technology is unlikely to set any HWBOT records on its own, but that doesn't stop it from lending a hand with certain workloads.

In simple terms, a processor with Turbo Boost is able to dynamically increase its base clock speed so long as the overclock doesn't push the processor beyond specified thermal limits. Single-threaded software and other light apps are good "targets" for Turbo Boost. The arrangement works especially well with massively multicore processors (like the 6950X) that have lower base frequencies to accommodate their large number of physical cores. When only a few cores are needed, Turbo Boost kicks in.

Intel whipped up a new and improved version of Turbo Boost for Broadwell-E. Turbo Boost Max 3.0 is, in essence, a smarter version of Turbo Boost 2.0, but interestingly enough it doesn't replace Turbo Boost 2.0 outright. Instead, Turbo Boost Max 3.0 identifies which single physical core in a Broadwell-E processor is best-suited for overclocking and then funnels single-threaded workloads to that core. In theory, Turbo Boost 3.0 Max helps the 6950X and its fellow Broadwell-E CPUs achieve peak performance with single-threaded software (excluding any manual overclocking).

Turbo Boost Max 3.0 relies on a combination of baked-in engineering

Intel is keenly aware that Broadwell-E buyers demand silicon that invites extensive tinkering, and the company has responded with a new bag of tricks.

and little bit of software. At the time of this writing, in order to flip the switch that activates Turbo Boost Max 3.0, users will need to download a driver, which should be included with new drivers Intel's motherboard partners have rolled out for their X99 boards. (As a related aside, in a similar fashion to previous HEDT processors, Broadwell-E CPUs should be compatible with existing X99 motherboards that use an LGA 2011-v3 socket once users update their motherboard BIOS.) Once the drivers are installed, users can launch the Turbo Boost Max 3.0 utility in Windows.

The software presents users with a pair of options. One is to configure Turbo Boost Max 3.0 to automatically identify when a single-threaded application is active and assign the fastest Broadwell-E core to work on that app; the overclocked core then powers through the app's workloads as quickly as it can. The second option is a priority queue of sorts, where users manually select programs for the Turbo Boost Max 3.0 treatment, and the program with the highest user-determined priority will be assigned to the Turbo Boost Max 3.0 core.

As we mentioned earlier, Turbo Boost 2.0 isn't going away, since Turbo Boost 2.0 and Turbo Boost Max 3.0 each perform different overclocking duties. For example, Turbo Boost Max 3.0 won't touch a multicore workload—even if it's not particularly demanding—but Turbo

Boost 2.0 can tackle it. The combination helps Broadwell-E more effectively maximize performance with a wide variety of tasks.

More Tools For Overclockers

Turbo Boost is, of course, only part of Broadwell-E's overclocking repertoire. (These CPUs wouldn't be classified as HEDTs if Turbo Boost was the only overclocking trick they knew.) The "X" and "K" designations indicate the presence of an unlocked CPU core multiplier, which is what overclockers turn to for the biggest core frequency gains. This is remedial info for most power users.

Intel is keenly aware that Broadwell-E buyers demand silicon that invites extensive tinkering, and the company has responded with a new bag of tricks. The first of these is per-core overclocking, which makes sense in the context of Turbo Boost Max 3.0. Relatively simple in concept, per-core overclocking is slightly more profound in execution. With such granular control over individual cores and their voltages, overclockers can zero in on the most capable two (or four, or six, or eight) cores and overclock those to best handle a corresponding workload.

Broadwell-E CPUs also approach AVX instructions differently than previous processor generations. Before Broadwell-E debuted, users had little

to no control over what their CPU did when it encountered an AVX workload. Now, Broadwell-E borrows a technology that first popped up in Intel's server/workstation processors and then made its way to the consumer market, which makes a fair amount of sense when you recognize that Broadwell-E shares a significant portion of its DNA with Broadwell-EP Xeon CPUs. AVX instructions put more strain on a CPU, resulting in higher thermal output and lower clock speeds to compensate. Power users can configure Broadwell-E to only reduce its clock speed when it detects AVX instructions while maintaining higher frequencies for SSE instructions.

Finally, Intel introduces yet another voltage setting for the most extreme among us to play with. With Broadwell-E CPUs, we can make changes to the VccU voltage, which is tied to the CPUs' ring architecture. Certainly Just Another Voltage Setting is not as significant as Turbo Boost Max 3.0, per-core overclocking, or even AVX offsets, but we wager that more than a few enthusiasts will be able to find the perfect VccU voltage for even more speed.

Bring The Thunder

With Broadwell-E's release, Intel has touted the concept of "mega-tasking," which really isn't any more complicated than incredibly resource-intensive multitasking. Things like VR gaming and 4K video editing fall under Intel's megatasking umbrella. And, in the case of the latter especially, the company seems to be positioning Broadwell-E as an attractive option for prosumers, in addition to the typical HEDT market of gamers and computing enthusiasts.

In its appeal to content creators and other prosumers, Intel has emphasized Thunderbolt 3 as an important (though technically optional) part of its Broadwell-E/X99 platform. Thunderbolt 3 is well on its way to becoming an industry-standard interface, and Broadwell-E's abundance of PCIe lanes (the 6950X, 6900K, and 6850K have 40, while the 6800K has 28) are ideal for Thunderbolt 3's maximum theoretical bandwidth of 40Gbps.

We've reviewed a handful of Thunderbolt 3 motherboards, but they were equipped with Intel's Z170 chipset rather than the X99. Broadwell-E's release has naturally prompted an X99 refresh from Intel's major

board partners, and Thunderbolt 3 (courtesy of Intel's Alpine Ridge controller) features prominently on many of those motherboards. Because Thunderbolt 3 uses a USB 3.1 Type-C physical connection, we expect that a number of Broadwell-E adopters will also jump on the Thunderbolt train and take advantage of its incredible throughput.

Anatomy Of A Monster

Just as the 5960X set a record for the most physical cores in an Intel desktop CPU, the 6950X takes its place as the undisputed multicore champ. Broadwell-E's flagship is more than a couple of extra cores. A lot of R&D went into the 6950X, so let's dig it out and put it under the microscope.

Broadwell-E processors are the first HEDTs manufactured on a 14nm process; specifically, these are Tri-Gate (second-gen FinFET) transistors. The process shrink is the first for HEDT processors in nearly three years. (Both the Core i7-5960X and Core i7-4960X used 22nm transistors, which made their Extreme Edition debut in September 2013.) With the smaller transistors, Intel was able to cram approximately 3.2 billion of them onto the

BROADWELL-E & FRIENDS

Intel's HEDT CPUs Through The Years	Core i7-6950X	Core i7-6900K	Core i7-6850K	Core i7-6800K	Core i7-5960X	Core i7-4960X	Core i7-3960X
CPU Cores (Threads)	10 (20)	8 (16)	6 (12)	6 (12)	8 (16)	6 (12)	6 (12)
Base Frequency	3GHz	3.2GHz	3.6GHz	3.4GHz	3GHz	3.6GHz	3.3GHz
Max Turbo 2.0 Frequency	3.5GHz	3.7GHz	3.8GHz	3.6GHz	3.5GHz	4GHz	3.9GHz
Cache	25MB	20MB	15MB	15MB	20MB	15MB	15MB
TDP	140W	140W	140W	140W	140W	130W	130W
Max Memory	128GB	128GB	128GB	128GB	64GB	64GB	64GB
Supported Memory	DDR4-2400 (4 channels)	DDR4-2400 (4 channels)	DDR4-2400 (4 channels)	DDR4-2400 (4 channels)	DDR4-2133 (4 channels)	DDR3-1866 (4 channels)	DDR3-1600 (4 channels)
PCIe Lanes	40	40	40	28	40	40	40
Lithography	14nm	14nm	14nm	14nm	22nm	22nm	32nm
Release Date	May 2016	May 2016	May 2016	May 2016	August 2014	September 2013	November 2011
Price	\$1,743	\$1,109	\$628	\$441	\$1,059	\$990	\$999



No one really questions the might of Intel's new Core i7-6950X Extreme Edition CPU, especially with workloads capable of harnessing the chip's 10 physical cores (plus Hyper-Threading, which lets the 6950X handle 20 simultaneous instructions). The kicker is that \$1,743 sticker price. If you aren't putting all those cores to work on a regular basis, the 6950X's cohorts are plenty powerful, too, and carry price tags more in line with Intel's previous HEDT processors.

6950X's die, which measures a shade over 246mm². Because of the new lithography, the 6950X winds up with a smaller die than the 5960X, which had a die size of approximately 355.5mm².

Even with two additional physical cores and a sizable increase in transistors (roughly 600 million, or 23% more) over the 5960X, the 6950X manages to maintain a 140W TDP. We'll undoubtedly see a wave of CPU coolers "optimized for Broadwell-E," but existing Haswell-E coolers should keep the 6950X's thermals in check.

As expected, the sheer number of physical cores in the 6950X keeps Intel from running wild with its base frequency. Also like the 5960X, the 6950X's base frequency is an even 3GHz. A jolt from

Turbo Boost 2.0 elevates that to 3.5GHz, and Turbo Boost Max 3.0 can coax a single core to hum along at 4GHz. The 6950X boasts 25MB of shared L3 cache. Each core also has 256KB of L2 cache, for a total of 2.5MB.

Memory support has changed with the arrival of Broadwell-E, as well. This crop of HEDTs supports DDR4-2400 right out of the box (although we all know that our favorite motherboard manufacturers will include XMP support for much faster modules, and memory makers will be all too happy to produce those modules). With the familiar quad-channel memory architecture, Broadwell-E remains a terrific choice for any enthusiast who

needs ridiculous memory bandwidth. More significant is the fact that Broadwell-E CPUs' integrated memory controllers can handle up to 128GB of DDR4, twice what previous HEDT generations were able to muster. With memory support that looks more like a Xeon processor than a typical desktop Core i7 CPU, it's easy to see why Intel concocted the idea of megatasking.

The Broadwell-E Bunch

A trio of processors joins the 6950X for Intel's HEDT refresh, which is a slight departure from tradition. Usually, two processors join the Extreme Edition CPU for what amounts to a "good-better-best" offering. Now, the 6800K, 6850K, 6900K, and 6950X form a "good-better-best-bestest" quartet.

The eight-core 6900K closely resembles the previous king of HEDT, the 5960X. Both have eight cores and can deal with up to 16 threads simultaneously with Hyper-Threading. Intel manages to wring a little extra speed out of the 6900K, though, adding 200MHz to both the base and Turbo Boost 2.0 frequencies.

When you step down to the 6850K, you get a CPU that compares favorably to Intel's Core i7-4960X, which is based on the company's Ivy Bridge architecture. Although the 4960X is able to reach a slightly higher Turbo Boost 2.0 frequency on a slightly lower thermal budget, the 6850K offers DDR4 support.

The 6800K is a particularly intriguing chip. It's a 6-core processor, which is more than the Skylake-based Core i7-6700K, but at \$441, its price is at least in the same ZIP code as the 6700K. For an additional \$100, the 6800K gives enthusiasts two extra physical cores, nearly twice as much L3 cache, more PCIe 3.0 lanes, and support for twice as much DDR4.

The Elephant In The Room

In multithreaded workloads, the Core i7-6950X is a force of nature, easily eclipsing the 5960X. With this unprecedented performance comes an unprecedented price: Intel anticipates a retail price of \$1,743 for its new flagship, which is well above its historical pricing model. The 6900K, our second-in-command, also received a fairly significant price increase.

There will always be enthusiasts willing to acquire the best of the best by any means necessary, but with a price closer to \$2,000 than \$1,000, power users who already own a Haswell-E or Ivy Bridge-E CPU may opt to hold on to the silicon a little longer.

Nevertheless, now that we've entered the PAO (process-architecture-optimization) era, Broadwell-E could enjoy a long reign. If you know you'll regularly slam your system with demanding multithreaded workloads, these HEDTs are a long-term investment that should pay dividends. ■

Down To The Wire

Custom Cabling Done Right

Once upon a time, PC cases were ugly, hideous things, beige boxes with zero personality. The only thing more revolting than the outside of these old-school systems were their insides. Back in the day, cable management meant finding a way to stuff your excess PSU cables into empty bays and maybe bundling them together with zip ties.

Thankfully, we now live in a more civilized age. Case manufacturers understand that enthusiasts will not abide a disheveled PC interior. It's almost impossible to find a case that doesn't have

pre-drilled holes to route cables out of sight and keep your PC neat and tidy. Modular PSUs help a great deal, too. Power users haven't had to be ashamed of removing their rigs' left-side panels for many years.

A lack of shame isn't necessarily the same thing as pride, though. Everyone has a case with terrific cable management, and nearly everyone uses a modular power supply. So, your build's clean interior might get a nod of approval occasionally but don't expect the double takes that say, "Now that's a good-looking PC!" If that's

the type of reaction you're hoping your system can provoke, you'll have to step up your mod game considerably.

If you want to give your PC more personality, consider a project that adds an awesome aesthetic without pillaging your bank account. Individually sleeving your cables' wires lets you pick any color(s) you want, and the finished product looks incredible. Builds/mods with custom-sleeved cables are a rare sight and usually the sign of a dedicated modder.

Now, there's a good reason why only the dedicated few choose to make custom



Unlike most mod projects, resleeving your system's cables doesn't require a lot of expensive power tools and materials. To do the job, a few relatively inexpensive hand tools are all you need. On the other hand, there's crucial element for custom sleeving that isn't pictured: time. The process of resleeving each PSU wire requires patience, practice, and determination.



Prepare to become good friends with your trusty pin removal tool. The two of you will be spending a lot of time together. Both of our modders strongly recommend forking over extra cash to get a quality pin removal tool; they favor Molex's offering.

cables. The process, although reasonably affordable, is time-consuming, often frustrating, and sometimes both. Before you embark on such a quest, be aware that your journey will last for several hours.

But don't fret. We found a couple of friends to offer you advice. Think of it as private lesson in custom cable sleeving. Accomplished modders and Josh Sniffen and Dave Alcock will guide you through choosing the best tools and sleeving, breaking down your cables, hand-sleeving wires, and putting everything back together.

Start pulling out your cables now. Class is about to begin.

Essential Tools

For this job, you won't need much more than a few relatively inexpensive tools and sleeving for your cables' wires.

First, your project will be derailed before it even begins if you don't have a way to remove each wire's pin from the connector. You'll need a pin removal tool, and for this Sniffen and Alcock agree that it's worth splurging on Molex's version.

"The Molex-branded pin removal tool is far superior than any other removal tool I have used, and I have used a lot," Alcock says. "They are strong enough to remove the pins easily, small enough to handle, but still large enough to be able to be gripped properly. They are an expensive option though, usually costing twice the amount of the cheap versions."

To continue breaking down your cables, a reliable pair of wire strippers is also essential. Sniffen calls out IRWIN TOOLS' 8-inch Self-Adjusting Wire Stripper (model 2078300) as one of his secret weapons. "It deserves more praise than I can offer," he says. "This wire stripper cost less than half of what my old one did, and it automatically adjusts for wire gauge. You can set the depth and get perfect, uniform, strips every time. I can strip an entire wire set for a PSU in less than three minutes with this tool and have the ends 100% even."

As it turns out, the IRWIN TOOLS' wire stripper doubles as a terminal crimper, but if you decide to buy a basic wire stripper you'll have to add a separate

wire crimper to your arsenal, as well. Alcock recommends buying a pair that's able to crimp ATX pins and 16AWG and 22AWG wire.

Sleeving also involves cutting, so a few types of bladed instruments will be joining the team. A pair of side-cutting pliers work well for wire snipping, but make sure they're sharp enough to make clean cuts instead of crushing your wires. To slice up your sleeving, use scissors. Alcock says he fancies a pair of all-metal Singer fabric scissors for cutting sleeving. If you plan to use heatshrink tubing, we recommend small hobby knife, as well.

Speaking of heatshrink, you'll also need a heat source if you decide to use it. A heat gun is arguably the easiest, most consistent way to work with heatshrink, but a cheap cigarette lighter can work in a pinch. If you decide to sleeve your wires with paracord, a lighter is actually better.

Sleeving with paracord requires one additional consideration. A threading tool is a must-have to prevent a wire terminal's hooks from snagging on the paracord as you pass it over the wire. The hooks will rip and snarl the paracord and your sanity in equal measure. Combat this by first slipping the threading over the terminal. Then, you can easily pass the paracord over the sheathed terminal.

Specialized threading tools are available for purchase, but this is one instance where Alcock has decided to take the cheap route, using plastic straws to slide over the terminals. "I bought a pack of 50, and they have lasted me for years. I cut them down to around an inch long, melt the end a little so that the terminal can't poke through the other end and then just pop it over the terminal. This makes sure that none of the terminal can snag on the paracord and enables you to thread the wire through the sleeve easily."

Sleeving Selection

So often, power users are forced to choose between this or that—Intel or AMD, AMD or NVIDIA, tacos or pizza (hint: taco pizza). When the time comes to decide on wire sleeving, you also have a choice. The most popular two options

are paracord and PET. One isn't strictly better than the other, so let's examine your options.

PET, which is a lot easier to say than "polyethylene terephthalate," is your premium option. It's more durable than paracord and, as mentioned earlier, won't snag during the sleeving process. PET has a glossy finish that leads to vibrant colors, especially when you wipe it down with a damp cloth, as Alcock points out. Alcock adds that PET sleeving is slightly stiffer than a paracord, which lets you "train" your cables into shape. On the other hand, PET is generally more expensive, and being a cheapskate could lead to suboptimal results. For example, Sniffen recommends getting MDPC PET and nothing else.

But listen: Paracord isn't for chumps. For starters, it's less expensive than PET, so if you have a lot of cables and a limited budget paracord could be a better option. Alcock points out that modders can use paracord without heatshrink, if desired. Sniffen says that paracord has a lower learning curve than PET, another reason to consider the former if this is your first sleeving job and you can't afford a bunch of do-overs.

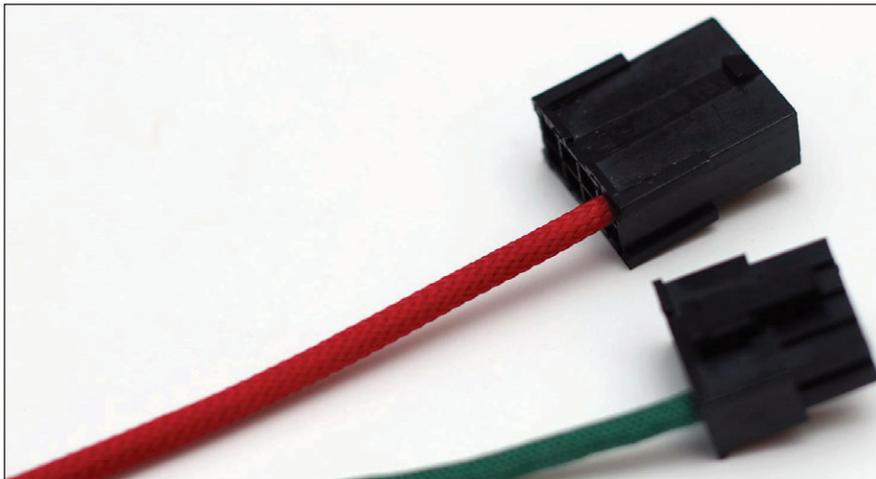
Paracord also presents you with colors aplenty. You can buy several dozen colors of PET, but paracord colors and patterns number in the hundreds. Some modders may prefer paracord's subdued matte finish, too.

Cables By You

Once you learn the tricks of the trade, you may decide it's easier to create your own cables from scratch. For now, we'll work with an existing PSU cable.

Start by breaking down the cable. (Keep track of your cable's pinout or work one wire at a time.) Remove any existing heatshrink with your hobby knife and cut away the stock sleeving with scissors. Disengage the wire terminal's hooks by inserting the pin removal tool into the power connector and pushing it toward the wire. Then, you should be able to pull the wire from the connector housing.

Next, prepare the sleeve. Alcock recommends measuring the sleeve so the ends extend to the first portion of the wire



We won't tell you to pick paracord (in focus above) over PET (in focus below), but each has advantages and drawbacks. PET, although more expensive, is more vibrant and not prone to snag on wire terminals. Paracord costs less and is available in more colors, but it lacks PET's durability.

terminal. If you're working with PET, you might want to prime the ends by quickly and carefully exposing them to your lighter's flame and then tapering the edges slightly. Insert one end of the wire into the sleeve and thread the wire through the sleeve.

When you're satisfied that the sleeve is the right length and positioned over its wire, cut a small piece of heatshrink for each end of the wire—Alcock likes to keep it under half an inch—and work it over the terminal and sleeve. If you're having trouble sliding the heatshrink over the terminal, you can use needle-nose pliers to slightly expand the heatshrink. With the heatshrink in place, break out

your heat gun and fire a blast of hot air at the heatshrink. Don't be reckless at this point; it's often a good idea to pause halfway through this step and re-position the heatshrink in case it slips as it shrinks. Use a light touch, pinching instead of squeezing, and continue applying heat until the heatshrink tightly binds everything together.

Once you've applied heatshrink to both ends of the wire, it should be ready to reinsert into the connector housing. As you push the terminals into the housing, you might hear an audible "click" as the terminal hooks re-engage with the housing. If the added thickness of the heatshrink

makes the wires stubborn when you try to reinsert the terminal, you can briefly reheat the heatshrink, which will soften it enough to let you reinsert the wire with ease.

Sleeving with paracord lets you ditch the heatshrink and instead bind the paracord directly to the wire. Measure and cut your sleeving; aim for about a quarter inch between the ends of the sleeve and the terminal's hooks. Before you slip the paracord over your wire remember to cover the terminals with a threading tool, a plastic straw, or a cylinder of similar diameter that will prevent the paracord from snagging on the wire terminals.

After you're satisfied with the paracord's positioning over your wire, it's time light a fire. Using your lighter, hold the flame over the ends of the paracord until they begin to melt. Similar to working with heatshrink tubing, you can pinch the paracord to create a tight seal between it and your wire. Again, a careful, light touch is the best approach, both with your fingers and the lighter.

To see the process in action, Sniffen created a helpful YouTube video that walks you through sleeving a couple of wires. Although he's preparing a custom-sleeved Bulgin switch, the basic principles are

largely the same. Check it out at <https://youtu.be/MDIGPCZb-9s>. You'll even learn a few soldering tips at no extra charge.

Super Sleeving

Hopefully that first wire didn't take too much time. There are many, many more waiting for you. With enough practice and the right tools, though, you'll be cabling like a pro in no time.

When you've mastered replacing the sleeving of modular PSU cables, more projects await, such as creating fully custom cables, re-sleeving a semi-modular PSU's hardwired cables, and more. ■

Do It Yourself . . . Or Not

Modding should be exciting. Modding should be fun. Modding should not be hours upon hours of tedium, only to discover that you've made a mistake that will lead to more hours of tedium. You know you can create custom-sleeved cables. We know you can create custom-sleeved cables. But we also know that if you have to break down, sleeve, and reassemble another 24-pin ATX power cable you're going to lose your mind. (And if you *don't* know how make custom cables and have no desire to learn, we promise to keep your dark, embarrassing secret.)

If you want a custom look without doing all the work, we recommend you fall back on a very popular course of action: Pay someone else to do it for you. Plenty of companies dedicated to serving the modding market produce PSU cables with individually sleeved wires that are highly customizable. Retailers such as PrimoChill (whose mod/smart Maxcord cable kit is pictured to the right) and Icemodz sell custom cables for a variety of popular power supplies. Choose your colors, indicate cable length, and add the cable(s) to your cart.

Buying custom cables easy but it's also expensive. A single 24-pin ATX cable costs roughly \$40, and other cables (PCIe, SATA, etc.) routinely exceed \$20 per cable. You can buy a kit that includes several cables, but expect to pay over \$100 for most PSU models.

Several PSU makers have caught on to the fact that individually sleeved cables are incredibly popular (and that enthusiasts are willing to pay up to get them) and have started selling kits for their power supplies. Although color combinations are more limited, if you're willing to settle for a "semi-custom" look, buying a PSU manufacturers' own kit is a little easier on your wallet. This is a particularly appealing option if you have a semi-modular PSU; a small bundle of PCIe and peripheral cables might only set you back 30 bucks.

Finally, another option exists for the semi-lazy. If individually sleeving wires is a deal breaker but you're up for removing the PSU wires from their connectors (and then reinserting them), you can buy individually sleeved wires and use those to create your own custom cables. BitFenix's Alchemy 2.0 family of modding accessories includes bundles of individually sleeved wires, which you insert in your PSUs' modular cable connectors. Although you might not save a fortune on these wire kits (we found a 5-pack for \$10 online), you can create a color scheme that matches the rest of your components.



Modder Q&A: Dewayne Carel

A Modding Pioneer Talks Shop

Dewayne Carel has won *CPU*'s Mad Reader Mod contest, and many of his mods have been featured in the magazine over the years. Carel is CEO and Editor-in-Chief of Modders-Inc.com, presides over the annual mod contest at QuakeCon, and has competed in a number of major modding events.

Q: Do you remember the moment you decided to start modding PCs? When was it, and how did it go down?

DC: OK, this will date me: I can remember rebuilding my first PC from a 386 processor to the newer 486. Back then everything ran hot, so I needed to add a fan to the case, and I remember cutting a hole in the top of the case to install an 80mm fan to help bring the hot air out of the case. Boy, did it look like crap. I had to make it look better, so from there I progressed to painting the case, wire management, and all the first-time stuff that is common today.

Q: How many projects would you say you did before things started turning out exactly the way you wanted them to?

DC: I have not reached that point yet and I hope I don't. Call me weird, but if they turned out 100% the way I wanted them too, then I feel that I would have no room to grow and learn from what I did. Do I achieve the look, the feel, the style I want? I will say 100% yes. Now, if you are asking how many projects it took before I felt comfortable with my skills and they looked the way I wanted them to I would say at least two.

Q: Are you a hardcore planner, or do you just get an idea and start cutting?

DC: I would say a little of both. For a theme-based mod I like to research as much as possible and find the things that will most impact and grab the attention of the viewer. I will draw or make up a few images and then begin modding. During the process, I am always running new ideas



and ways in my head about how to do something, and by the time I get to that point I have it already completed in my head and know exactly how to do it. Of course, there are times when you change something on the fly because you have to make it work, or you see a better way to do it.

Q: How many mods have you done at this point, and what's your favorite?

DC: Oh, wow . . . maybe I should answer that with at least 15 to 20 successful mods. They say you never forget your first and my first successful mod, which I still have today, was a case I made completely out of Lexan called Lucid Dream and was featured in *CPU* mag many years ago. It was watercooled (back when that was just starting out) and had two mini LCD screens inside.

Q: What do you do with all of your old mods? Do you still have the Fallout 3 mod you did a few years back, for example?

DC: I guess you can say that I am one of the lucky case modders, as most of my mods were created for manufacturers. I only have four modded cases in my house. One is Lucid Dream. Two are from our Staff vs. Staff Mod-Off contests, and one I did to learn a new technique of working with foam. As for the Fallout 3 case, I don't have it any longer, and it was hard to give up as it had become the most recognizable case I have done—and it was only the second case that I have ever done for myself. It sat in a box most of the time, and that was a shame. NVIDIA asked if I would sell it, and it took me a day to finally say I would. They used it as a grand prize for a contest during the release of Fallout 4. Whoever has it now, please take care of it and send me a picture of you and the case.

Q: Let's talk about your site! When did you start Modders-Inc.com, and why?

DC: Modders-Inc was born in 2006 for the sole purpose of allowing



February 2006 Mad Reader Mod: Lucid Dream.

others to have a place where they could show off their work, talk about projects, and help others learn about modding. The site has never been about making money, getting free stuff, or the recognition—it has always been about having fun and spreading the word about computer case modding.

Q : How much time would you say you spend in an average week working on Modders-Inc-related stuff?

DC : Some would say too much time when they find out I also have a 50-plus hour-a-week day job. Normally, I spend my weeknights at the PC or in the workshop (three to four hours a night) and my days off (which can be as long as 10 to 12 hours) doing Modders-Inc-related work. There is never a shortage of things to do, whether it's making sure the site is up-to-date and secure and has fresh content, or working with manufacturers on upcoming projects, events, and product reviews. But I am not the only one that dedicates this crazy amount of time; Tom Brokaw and Ron Perillo have taken on roles that have both helped me gain time and made the website grow. The site would have shut down if not for the help of these two friends.

Q : What has been your favorite part of running the site?

DC : I would have to say that it has allowed me to meet a lot of interesting and talented people. Being able to travel to other parts of America and outside the country and meeting people that have a common interest, which is the willingness to help others who have an interest in our hobby.

Q : It's time for Five Quick Questions!

1) Mechanical keyboards: Clicky or quiet?

I Like my keyboards how like I my music. Loud and noisy! There is nothing like a mechanical keyboard. I was so happy when the world rediscovered mechanical keyboards. I think I still have one of the old IBMs that could wake the dead with all the noise.

2) Surf or turf?

Come on, a thick, juicy steak (any type) with a loaded baked potato is first on everyone's list. But I will say that crab and lobster run a very close second. For me, the perfect meal is a top sirloin center cut with lobster tail and a generous pour of aged brandy . . . and someone else is buying.

3) Mini-ITX or EATX?

What is this, a Sophie's Choice question? Each has a place and usage, but I would



DOOM'ed, from the 2015 Modders-Inc Mod-Off.



Dewayne's excellent Fallout 3 mod.

have to lean more towards the Mini-ITX. The future is now, and we are finally getting to the point where you do not need a huge case anymore, as everything is either getting smaller or is no longer needed. I think the days of two video cards are numbered, and who uses ROM drives anymore?

4) Cardinals or Sun Devils?

Uh oh, here comes the hate mail, but I really do not like any college sports. They just don't interest me. It has been a long, hard road being a Cardinals fan, as there have been many challenges that faced them when they moved to Arizona. But when the owner's son took over and a new stadium was built, the team was reborn and has made huge gains. 2016 will bring the Arizona Cardinals a Super Bowl win!

5) New DOOM or old DOOM?

Old DOOM for sure. It was groundbreaking gaming, and paved the way for everything else to follow. When you have been around the block as many times as I have and you see that what was old is new again, you appreciate the challenges that have been overcome before to give you what you have now. What I want to experience is DOOM-VR! ■

A million computers are waiting to be built.



DARK BASE 900

There may be countless ways to build a PC. But there's one series of PC cases that makes them all possible: Dark Base 900. It offers maximum flexibility to suit your individual space requirements. And of course, it's one of the quietest cases in the world, featuring:

- Repositionable motherboard tray and HDD tray with the option of inverse layout
- Three virtually inaudible be quiet! SilentWings® 3 PWM fans
- Full-circuit airflow system with noise-dampened vents
- Four areas for water cooling radiators up to 420mm
- Dark Base Pro 900 with LED illumination, window with tempered glass and wireless Qi charger

For more information visit bequiet.com

Available at: newegg.com · amazon.com · ncixus.com · performance-pcs.com



GERMANY'S NO. 1*
PSU MANUFACTURER

*GfK data 2016

be quiet!®



Make It Yours.



Jyunwei Huang
3D Animator



"I BELIEVE THAT PUTTING EVERYTHING TOGETHER YOURSELF, AND THEN WATCHING YOUR CREATION COME TO LIFE IS A VERY REWARDING EXPERIENCE."

Power Your Passion

Jyunwei's system needs to meet and exceed the intensive demands of 3D animation. That's why he built his workstation with Cooler Master's high-end eco-system products. The advanced components help power his passion and reduce the time needed for 3D rendering and special effects composition.

Power Your **3D Animation** #makeityours



MasterCase Maker 5
MasterLiquid Pro 240
MasterWatt Maker 1200

Available At: [amazon.com](https://www.amazon.com)



MICRO CENTER
computers & electronics



CM Store

maker.coolermaster.com

The Motherload

Of all the components in a build, the motherboard might be the one that power users spend the most time evaluating before purchase. From CPU, GPU, and memory compatibility to onboard storage, audio, and networking capabilities, you have a lot of factors to consider.

New options for internal and external connectivity in particular have been notable in recent motherboard offerings. Before jumping into our buyer's guide, here are a few of the trends you'll want to pay attention to.

Storage Moves To The PCIe Bus

The age of PCIe SSDs is here, and with it comes several new interfaces. M.2 is the most common PCIe SSD interface, and these small slots are typically located above or below a motherboard's expansion slots. When combined with a chewing gum-sized M.2 SSD, the storage takes up little to no space on your mainboard. Most motherboards released in the past two years feature one or two M.2 slots that support 32Gbps transfer speeds. U.2 is an interface that's gaining traction and can be found on many new motherboards. The U.2 interface allows you to attach an Intel 2.5-inch SSD 750 Series drive, and the U.2 connector is typically located next to the board's SATA ports. PCIe SSDs are also available via add-in cards, although enthusiasts need to weigh the benefits of this form factor vs. having a free slot for a graphics card.

USB 3.1 & Type-C

There aren't a lot of USB 3.1 devices right now, but it's expected that USB 3.1 will eventually take over the USB market—much like USB 3.0 has slowly replaced USB 2.0. Technically, USB 3.0 is now called USB 3.1 Gen 1, as the USB-IF group that makes these decisions says that USB 3.0 has been succeeded by USB 3.1. As such, there are actually two USB 3.1 speeds: Gen 1 (5Gbps) and Gen 2 (10Gbps). The Gen 1 rate is the same speed as USB 3.0, and some motherboard makers still call the 5Gbps ports USB 3.0, rather than USB 3.1 Gen 1. The end result is that you'll have to check which speed a USB 3.1 port truly supports. USB 3.1 also introduces a new reversible connector, called Type-C, so you won't have to orient the connector before plugging it in. You might run into confusion regarding the connectors, as well, because USB 3.1 ports can either be the standard Type-A port or the reversible Type-C port.

In the following pages, we highlight the most important additions found on each motherboard to help you determine what motherboards have the right combination of features, design, and price for your next build.

Supermicro SuperO C7H170-M

\$144.99

www.supermicro.com

Why You'll Dig It: The H170 chipset is a solid core for small form factor rigs where you don't plan on overclocking the CPU, and Supermicro does much to enhance reliability on the C7H170-M. The PCB, for instance, features extra layers of material, which helps to ensure signal integrity. The material in these extra layers is qualified for Supermicro's server standards. For best connectivity, Supermicro uses 15-micron-thick gold plating on the PCIe sockets, connectors, and CPU socket. Besides helping to create a perfect connection with your hardware, the gold plating also helps ports to resist corrosion over time. For storage, there are six 6Gbps SATA ports and an M.2 slot. The latter can utilize four PCIe 3.0 lanes to expose the maximum potential bandwidth to PCIe SSDs. Supermicro also maximizes M.2 compatibility by including screw holes for 2260, 2280, and 22110 form factors.

Who Should Apply: Budget-minded buyers wanting a motherboard that supports Intel's Skylake processors and modern hardware.

Socket: LGA 1151

Expansion slots: 1 PCIe 3.0 x16, 1 PCIe x4, 1 PCIe x1

Memory support: 64GB DDR4-2133+



GIGABYTE GA-Z170X-Gaming G1

\$488

www.gigabyte.us

Why You'll Dig It: This is one of the most feature-filled Z170 boards you'll ever find. It supports 4-way SLI and CrossFire (at x8/x8/x8/x8), and both cards in a two-way GPU configuration will operate at the full x16 speed. For storage, the mainboard provides a plethora of options, including two M.2 slots that work at up to 32Gbps, as well as support for U.2 storage devices via the included M.2 to U.2 adapter. You'll find a host of onboard overclocking capabilities on the G1. There are voltage read points, a POST code display, main and backup BIOS chips, and power, reset, and clear CMOS buttons. GIGABYTE also adds a Turbo B-Clock IC, which lets you fine-tune the BCLK (base clock) frequency beyond the 5% ranges of traditional straps. For audio, GIGABYTE implements Creative's Sound Core3D quad-core audio processor that can deliver a 192KHz/24-bit audio signal.

Who Should Apply: Performance enthusiasts who want to push their system to the limit and need plenty of onboard connectivity options.

Socket: LGA 1151

Expansion slots: 4 PCIe 3.0 x16, 3 PCIe 2.0 x1

Memory support: Up to 64GB of DDR4-3866



GIGABYTE GA-X99-Designare EX

\$419

www.gigabyte.us

Why You'll Dig It: Although all of GIGABYTE's X99 chipset motherboards support Intel's new Broadwell-E lineup, the GA-X99-Designare EX was built with the Broadwell-E in mind. For example, this board supports Intel Turbo Boost Max Technology 3.0 that can produce up to 15% better performance in single-threaded applications. It'll also work with PCIe SSDs via the M.2 slot and two U.2 connectors. For memory, there are eight DDR4 slots that support up to 128GB of DDR4-3600. The DIMM slots, along with the PCIe slots, feature GIGABYTE's Ultra Durable Metal Shielding to prevent slot damage. For ideal performance when using a 28 lane Intel Extreme processor and a 3-way SLI or CrossFire setup, GIGABYTE optimizes the PEG to provide you with three, full-speed x16 slots. Builders who want to match the board to a color scheme will like the Ambient Surround LED that features RGB lighting.

Who Should Apply: Builders who want a feature-rich X99 motherboard to support their enthusiast tasks.

Socket: LGA 2011-3

Expansion slots: 5 PCIe 3.0 x16, 1 PCIe 2.0 x1

Memory support: 128GB DDR4-3600



GIGABYTE GA-Z170X-Ultra Gaming

\$170

www.gigabyte.us

Why You'll Dig It: The newly released GA-Z170X-Ultra Gaming is built with the latest amenities, including GIGABYTE's Ambient Surround LED, three ports that support NVMe, PCIe SSDs (two M.2 and one U.2), and a USB 3.1 Type-C port with power delivery. You can install two dual GPU graphics cards onto the GIGABYTE GA-Z170X-ULTRA GAMING, as the board supports both NVIDIA and AMD Quad-GPU configurations. Enthusiasts will also like that they can create RAID 0 configurations with PCIe SSDs among the two M.2 SSDs slots and U.2 port. For up-and-coming external connectivity, there are two USB 3.1 ports on the rear panel—one standard Type-A USB connector and a reversible Type-C connector. The USB 3.1 ports are powered by Intel's USB 3.1 controller that offers up to 32Gbps of total bandwidth for uncompromised transfer speeds.

Who Should Apply: Gamers and power users who want a board that offers a variety of high-end features for a competitive price. It's especially ideal for those looking to wring the highest levels of storage performance.

Socket: LGA 1151

Expansion slots: 3 PCIe 3.0 x16, 3 PCIe 3.0 x1

Memory support: Up to 64GB of DDR4-3866



Supermicro SuperO C7Z170-SQ

\$199.99

www.supermicro.com

Why You'll Dig It: The C7Z170-SQ allows for fine-tuning of the BCLK, which can be adjusted from 100MHz on up to 210MHz in 1MHz increments. Onboard power, clear CMOS, and BIOS Restore buttons allow you to easily recover from any overclocking missteps. We also like that the C7Z170-SQ comes with a new, modern UEFI BIOS interface. When overclocking, it's extremely easy to make quick adjustments to the clock speed, BCLK ratio, and voltages, for instance. It can run DDR4 clocked at up to 3,600MHz, and the board's four DIMM slots can handle up to 64GB of memory. There are some excellent connectivity additions for performance enthusiasts, including the 32Gbps M.2 and USB 3.1 Type-C ports, to quickly transfer files and data. Compared with previous Supermicro offerings, the C7Z170-SQ looks the part of a gamer's motherboard with a red and black color scheme.

Who Should Apply: Power users who want to overclock their Skylake processor and DDR4 memory.

Socket: LGA 1151

Expansion slots: 3 PCIe 3.0 x16, 2 PCI 3.0 x1

Memory support: 64GB DDR4-3600+



MSI Z170I GAMING PRO AC

\$189.99

us.msi.com

Why You'll Dig It: Do you require speedy DDR4 in a small form factor build? MSI rates the Z170I GAMING PRO AC to support 32GB of DDR4 running at 4200MHz. This Mini-ITX motherboard also includes an Intel 802.11ac/Bluetooth 4.2 wireless combo module that supports WiFi transfer speeds of 867Mbps and Bluetooth transfer rates of 25Mbps. MSI also includes its Audio Boost 3 technology, which is a collection of hardware and software designed to provide you with the cleanest sound fidelity. For instance, there's a built-in headphone amplifier that can deliver audio to studio quality headsets at 600 ohms. If you use a USB headset, you'll like that MSI includes its Audio Power PRO technology that delivers a stable 5V output for sound as clear as what's piped over a premium DAC. There's a lot of power inside this Mini-ITX PCB.

Who Should Apply: Builders looking to create a portable gaming PC or a powerful small form factor system.

Socket: LGA 1151

Expansion slots: 1 PCIe 3.0 x16

Memory support: 32GB DDR4-4200



MSI Z170A GAMING M9 ACK

\$399.99

us.msi.com

Why You'll Dig It: MSI's GAMING motherboards are typically loaded with improvements for onboard audio, networking, and connectivity. The Z170A GAMING M9 ACK is one of the best models in MSI's GAMING lineup and boasts the top onboard additions MSI has to offer. You'll get studio-grade sound, thanks to the combination of an Xtreme Audio DAC (powered by a C-Media 384kHz/32-bit audio processor), an ESS SABRE HiFi DAC, and Nahimic Sound Technology. The latter is an audio processing software that provides virtual 7.1 surround sound, mic noise reduction, intensified bass, and more. Your network connection is automatically managed by MSI's GAMING LAN Manager, which takes full advantage of the wired Killer E2400 NIC and Killer Wireless-AC 1535 to reduce lag and latency. For fast storage, MSI provides two of its Turbo M.2 slots that each provide 32Gbps of bandwidth—ideal for PCIe SSDs.

Who Should Apply: Builders who want a motherboard with powerful onboard tools to maximize the gaming experience.

Socket: LGA 1151

Expansion slots: 3 PCIe 3.0 x16, 3 PCIe 3.0 x1

Memory support: 64GB DDR4-3600



MSI X99A GODLIKE GAMING CARBON

\$599.99

us.msi.com

Why You'll Dig It: The X99A GODLIKE GAMING CARBON is a motherboard that combines the key features of MSI's GAMING and XPOWER (overclocker-centric) series to provide enthusiasts with a board that's equally at home with CAD work as it is with 4K gaming. It's extreme in most every way possible. When overclocking, for instance, you'll benefit from a socket with 2036 total pins, double the amount of pins on a traditional 2011-3 socket. The extra pins allow for additional tuning of DDR4 memory and Ring voltages. MSI also includes overcurrent protection, so the motherboard will protect itself from possible damage. The X99A GODLIKE GAMING CARBON also looks stunning, thanks to its black color scheme and Mystic Light RGB LEDs that you can control via your smartphone. Carbon fiber accents deliver a nice fit and finish, too.

Who Should Apply: Enthusiasts building a rig that doubles as a high performance workstation and gaming system.

Socket: LGA 2011-3

Expansion slots: 5 PCIe 3.0 x16

Memory support: 128GB DDR4-3400



MSI Z170A KRAIT GAMING 3X

\$149.99

us.msi.com

Why You'll Dig It: This special edition motherboard celebrates the 30th anniversary of MSI, and it boasts a number of features you'll find in higher end mainboards. Enthusiasts should appreciate the debug LED, DDR4-3600 support, and the 32Gbps M.2 port. The M.2 port also works with an optional U.2 host card to let you connect 2.5-inch Intel 750 SSD Series drives. The rear I/O panel features two USB 3.1 Gen 2 ports: one Type C (the reversible connector) and one Type A (standard USB port). MSI also includes its GAMING LAN port, which features an Intel i219 NIC that reduces CPU overhead and optimizes throughput. GAMING LAN Manager software is provided to let you prioritize network traffic. For GPU support, the Z170A KRAIT GAMING 3X can handle 2-way SLI and 3-way CrossFire. We also like the contrasting black and white color scheme of this mainboard.

Who Should Apply: Builders looking for a high-quality Z170 motherboard that won't break the bank.

Socket: LGA 1151

Expansion slots: 3 PCIe 3.0 x16, 4 PCIe x1

Memory support: 64GB DDR4-3600



GIGABYTE GA-Z170N-Gaming 5

\$155

www.gigabyte.us

Why You'll Dig It: Supporting modern hardware and connectivity on the Mini-ITX form factor is a challenge, one that GIGABYTE is up for. The GA-Z170N-Gaming 5 works with up to 32GB of DDR4-3333, PCIe and SATA M.2 SSDs, and USB 3.1. GIGABYTE also includes an Intel WiFi/Bluetooth combo module that supports 802.11ac (up to 867Mbps) and Bluetooth 4.2 wireless. Your wired connection is stellar, too, thanks to Killer's E2200 NIC. Looking to do some overclocking with your Skylake CPU? The GA-Z170N-Gaming 5 is built with solid state capacitors rated to perform at maximum capacity for more than 10,000 hours, so you can push the system hard and still enjoy long term stability. The GA-Z170N-Gaming 5 is a good looking board with an ambient LED, which adds a custom look and can be programmed to beat to the rhythm of music or pulse.

Who Should Apply: Gamers who want big performance in a small package.

Socket: LGA 1151

Expansion slots: 1 PCIe 3.0 x16

Memory support: Up to 32GB of DDR4-3333



Supermicro SuperO C7Z170-M

\$169.99

www.supermicro.com

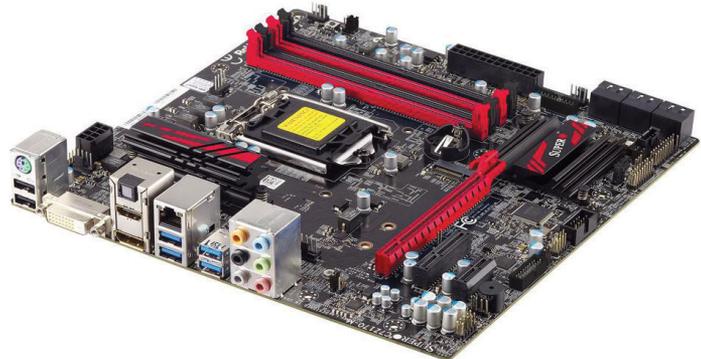
Why You'll Dig It: Supermicro ports much of its server expertise over to the gaming arena with the SuperO family. For example, the PCB is designed with extra layers and using material qualified by Supermicro's server standards. Top-grade X5R or X7R ceramic chip capacitors populate the motherboard to help withstand heat, while Japanese NPCAP solid-state capacitors deliver low equivalent series resistance and outstanding ripple reduction. The end result is improved stability when overclocking and greater reliability in general. Lastly, the SuperO motherboards are validated using Supermicro's full-load server testing, which includes 100% loads for at least 150 hours. This microATX motherboard is loaded with all the goodies you expect from the Z170 chipset, including an M.2 slot that supports PCIe SSDs, DDR4 memory at 3300MHz, and Intel's i219V NIC.

Who Should Apply: Power users who want a motherboard that's built with stability and reliability in mind for their desktop workhorse.

Socket: LGA 1151

Expansion slots: 1 PCIe 3.0 x16, 1 PCIe x4,
1 PCIe x1

Memory support: 64GB DDR4-3300+



Supermicro C7X99-OCE

\$299.99

www.supermicro.com

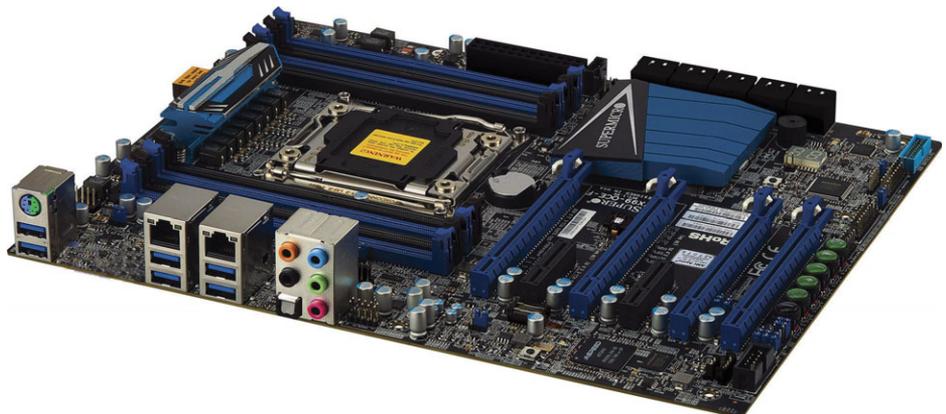
Why You'll Dig It: The C7X99-OCE is a cross-platform motherboard that supports Intel's Haswell-E and Broadwell-E processors (such as the Core i7-5960X, 5930K, 6950X, and 6900K), as well as Intel's Xeon E5-1600/2600 v3/v4 processors. You can overclock your processor at the touch of a button, thanks to the OC1, OC2, and OC3 buttons on the motherboard. The OC1 button will bump the CPU speed by 15%, while the OC2 button goes even further, with a speed increase up to 25%. The third OC button will load a custom overclocking configuration stored in the BIOS. If any of the overlocks cause instability, you can quickly return to default BIOS settings by pressing the onboard Home button. You can install up to 128GB of DDR4-3300 memory, and Supermicro allows for M.2 storage on this board via an optional add-on card, the AOC-SLG3-2M2.

Who Should Apply: Professionals and enthusiasts looking to build a high performance workstation.

Socket: LGA 2011-3

Expansion slots: 4 PCIe 3.0 x16,
2 PCIe x4

Memory support: 128GB DDR4-3300+



High-End LGA 1151	MSRP	Form Factor	Max Memory	Expansion Slots	Storage	Rear-Panel USB Ports	Warranty
GIGABYTE GA-Z170X-Gaming G1	\$488.00	E-ATX	64GB DDR4-3866	4 PCIe x16, 3 PCIe x1	2 M.2, 6 6Gbps SATA, 3 SATA Express	2 USB 3.1, 4 USB 3.0, 2 USB 2.0	3 years
MSI Z170A GAMING M9 ACK	\$399.99	ATX	64GB DDR4-3600	3 PCIe x16, 3 PCIe x1	2 M.2, 6 6Gbps SATA, 2 SATA Express	2 USB 3.1, 2 USB 3.0, 3 USB 2.0	3 years
Supermicro SuperO C7Z170-SQ	\$199.99	ATX	64GB DDR4-3600+	3 PCIe x16, 2 PCIe x1	1 M.2, 6 6Gbps SATA	1 USB 3.1, 2 USB 3.0, 2 USB 2.0	3 years
Value-Priced LGA 1151	MSRP	Form Factor	Max Memory	Expansion Slots	Storage	Rear-Panel USB Ports	Warranty
GIGABYTE GA-Z170X-Ultra Gaming	\$170	ATX	64GB DDR4-3866	3 PCIe x16, 3 PCIe x1	1 M.2, 1 U.2, 6 6Gbps SATA, 2 SATA Express	2 USB 3.1, 4 USB 3.0, 2 USB 2.0	3 years
Supermicro SuperO C7Z170-M	\$169.99	microATX	64GB DDR4-3200+	1 PCIe x16, 1 PCIe x4, 1 PCIe x1	1 M.2, 6 6Gbps SATA	4 USB 3.0, 2 USB 2.0	3 years
MSI Z170A KRAIT GAMING 3X	\$149.99	ATX	64GB DDR4-3600	3 PCIe x16, 4 PCIe x1	1 M.2, 6 6Gbps SATA, 1 SATA Express	2 USB 3.1, 2 USB 3.0, 4 USB 2.0	3 years
Small Form Factor	MSRP	Form Factor	Max Memory	Expansion Slots	Storage	Rear-Panel USB Ports	Warranty
MSI Z170I GAMING PRO AC	\$189.99	Mini-ITX	32GB DDR4-4200	1 PCIe x16	1 M.2, 4 6Gbps SATA, 1 SATA Express	4 USB 3.0, 3 USB 2.0	3 years
GIGABYTE GA-Z170N-Gaming 5	\$155	Mini-ITX	32GB DDR4-3333	1 PCIe x16	1 M.2, 6 6Gbps SATA, 2 SATA Express	2 USB 3.1, 5 USB 3.0, 2 USB 2.0	3 years
Supermicro SuperO C7H170-M	\$144.99	microATX	64GB DDR4-2133+	1 PCIe x16, 1 PCIe x4, 1 PCIe x1	1 M.2, 6 6Gbps SATA	4 USB 3.0, 2 USB 2.0	3 years
Enthusiast LGA 2011-3	MSRP	Form Factor	Max Memory	Expansion Slots	Storage	Rear-Ppanel USB Ports	Warranty
MSI X99A GODLIKE GAMING CARBON	\$599.99	E-ATX	128GB DDR4-3400	5 PCIe x16	1 M.2, 10 6Gbps SATA, 1 SATA Express	2 USB 3.1, 4 USB 3.0, 2 USB 2.0	3 years
GIGABYTE GA-X99-Designare EX	\$419	ATX	128GB DDR4-3600	5 PCIe x16, 1 PCIe x1	1 M.2, 2 U.2, 10 6Gbps SATA, 1 SATA Express	2 USB 3.1, 5 USB 3.0	3 years
Supermicro C7X99-OCE	\$299.99	ATX	128GB DDR4-3300+	4 PCIe x16, 2 PCIe x4	10 6Gbps SATA	6 USB 3.0	3 years

Revisiting AHCI: Is Your SSD Living Up To Its Potential?

More than three years ago, we ran a tutorial on how to retroactively enable AHCI (Advanced Host Controller Interface) mode on your Windows 7-based PCs. Now that we're hip-deep in the era of Windows 10, we wondered if the procedure is still necessary, and if so, do we need to update it for the new OS? Based on our preliminary findings, the answer to the first question is a "Yes, sometimes." Let's take the fact that you're reading this as a hint that the answer to the second question is also a "Yes."

Before we get to how to fix this problem on your system, let's talk about why you may find yourself here to begin with. For the most part, modern systems with a chipset from the past three or so years have obviated the need to choose AHCI mode from the BIOS prior to installing Windows 10 (or any new OS for that matter). When researching this article, none of the dozen or so systems we run Win10 on was operating with the boot drive in IDE mode, and in almost all cases, we didn't manually enable AHCI from the BIOS before launching each respective installation. AHCI mode appears to have become the default choice for storage devices interfacing with the SATA controller.

The only Win10 PC we found that was running an SSD in IDE mode had some rather old hardware. How old? This old man features an AMD Athlon 64 X2 5200+ processor installed in a GIGABYTE AMD 690G chipset-based motherboard from 2007. Although enthusiasts aren't likely to be running such old hardware for a main system, we can see a handful of use cases where Win10 makes its way onto some dated systems. These legacy systems are the ones that are most likely to be suffering under the yoke of IDE mode.

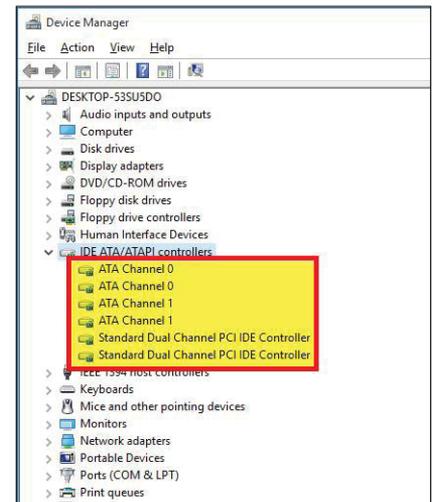


The first step in figuring out if your storage device is operating in IDE or AHCI mode is to dig into the Device Manager. Access it using the Windows key + X.

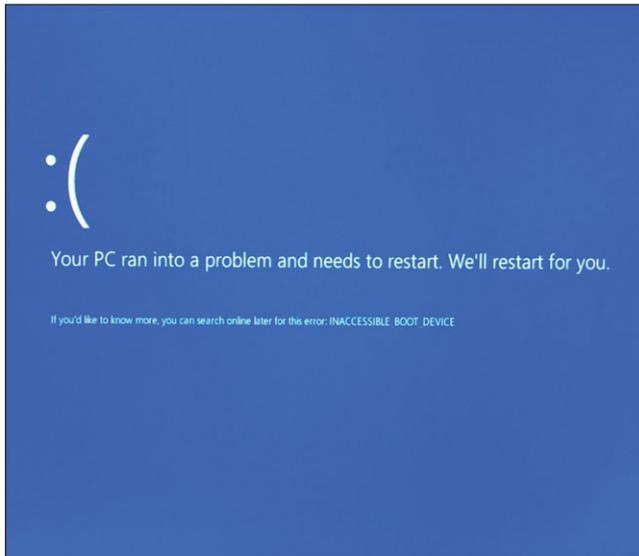
You can determine the setting for your SATA devices via the BIOS menu, but after the install is complete, it's no longer as easy as changing a BIOS setting. In this article, we'll show you how to revert to AHCI mode post-install. But first we'll explain what makes AHCI so effective in modern computers.

Why AHCI?

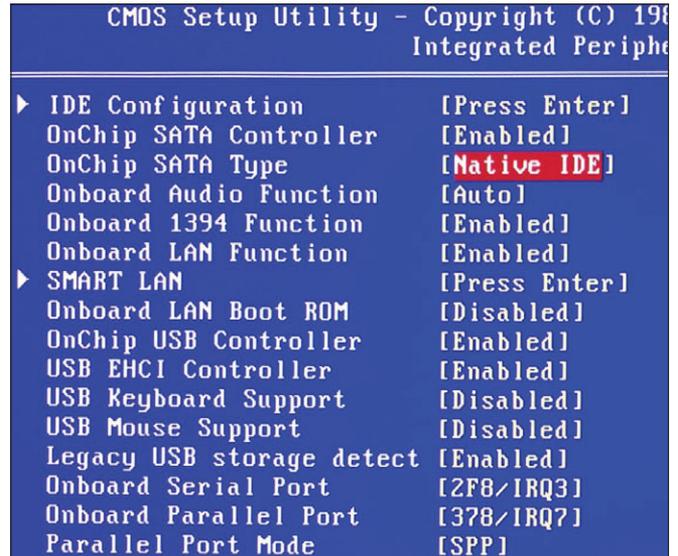
When you connect an SSD or HDD to a SATA port on your motherboard, your BIOS determines how the SATA controller interfaces with the drive, either in IDE or AHCI mode. IDE mode is designed for use with legacy operating systems. If you've installed a newer operating system such as Win7/8.1/10, newer mainstream Linux kernels, or FreeBSD 8.0 and newer, then AHCI is your only real choice. That's because



Click to expand the IDE ATA/ATAPI controllers item in Device Manager and scan the handful of devices there. No AHCI? We'll fix that.



If you change the SATA controller over to AHCI mode too soon, this will greet you.



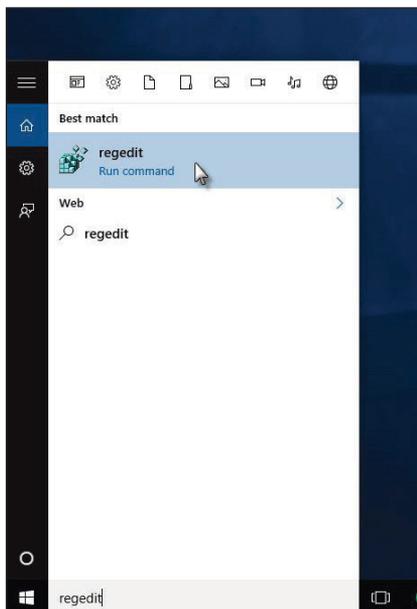
Make sure to select IDE mode before you edit the Registry.

AHCI lets your SATA device support NCQ (Native Command Queuing) and a feature called hot swap that lets you remove auxiliary SATA-based devices without first shutting down the system.

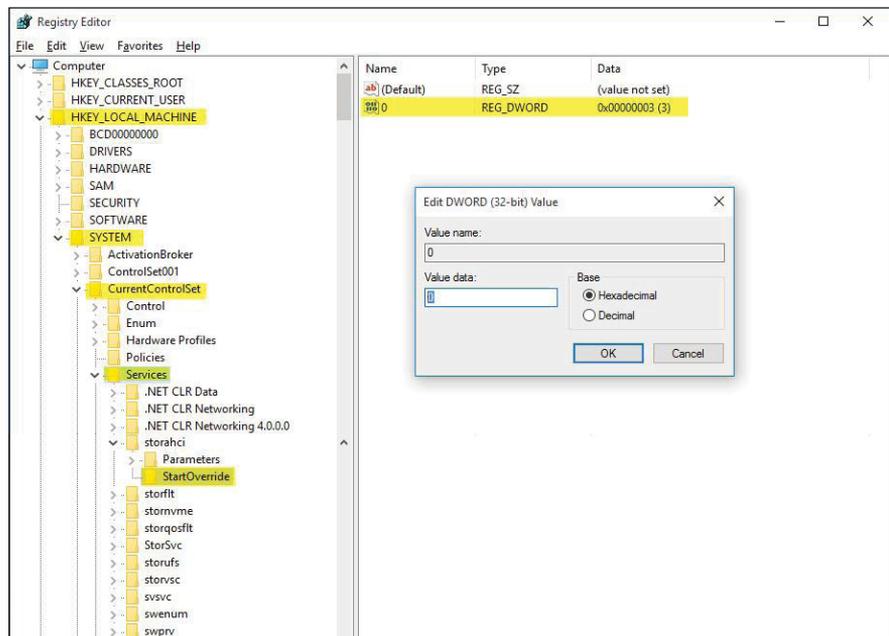
The NCQ feature is what makes AHCI the obvious choice for modern systems, though NCQ means different things

for HDDs and SSDs. In mechanical hard drives, NCQ refers to the scheme whereby the drive can reorder the pending read/write commands to better suit how the requested data is arranged on the platters. Because it takes longer for the platter to make a single revolution than it does for the actuator arm to skip

across the surface of the platter, NCQ lets the hard drive execute multiple read and write commands based on a more latency-aware sequence as opposed to just performing them in the order in which they are received. This effectively decreases the number of revolutions necessary to perform the commands. NCQ in



When using the Registry Editor, always make backups and tread carefully.



In Windows 10, this is where you'll need to go in the Registry Editor to make the edit.

WINDOWS TIP OF THE MONTH:

Manipulate Partitions With GParted

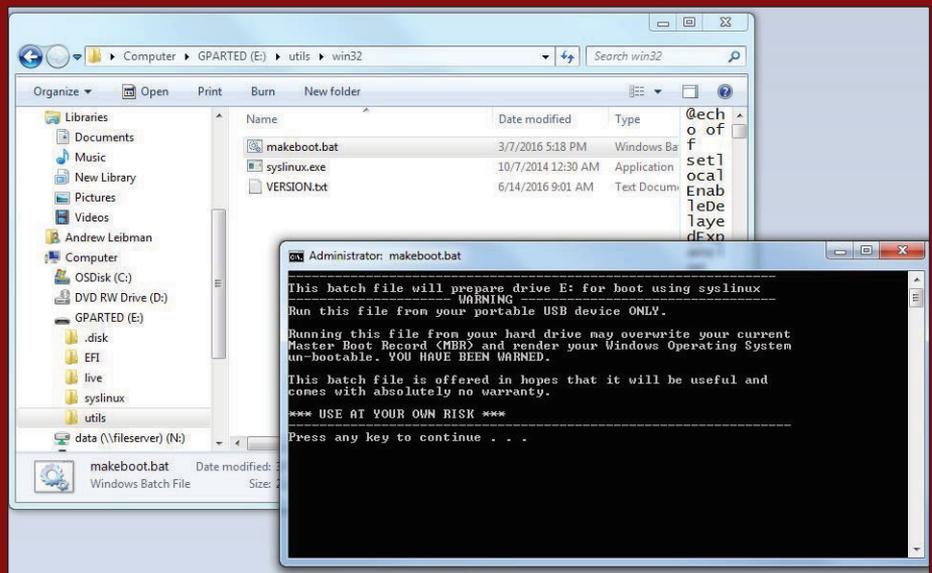
Since we're on the topic of tweaking how your system works with your storage devices, we thought we'd go the extra mile and help you with any and all partitioning tasks, including resizing, copying, and moving partitions. For this tip, we're going to install GParted (short for GNOME Partition Editor) Live onto a bootable USB flash drive.

To get started, visit gparted.org/download.php and download the GParted Live ISO. As we went to press, the latest release version was Gparted-live-0.26.1-1-i686.iso, so we clicked the link and saved the 271MB file to our system. The next step is to plug in a USB flash drive with a capacity greater than or equal to 512MB, locate the drive in Windows Explorer, right-click it, and then click Format. For the file system, FAT32 is the default option; leave it alone. Click Start, click OK to dismiss the warning, and click OK again to dismiss the Finished dialog. Optionally, you can right-click the flash drive from Windows Explorer, click Rename, and then type GParted. We're going to be using this drive frequently, so naming the drive will pay off later.

Next, open the GParted Live ISO ZIP file and extract it as-is onto the USB flash drive. Resist the urge to put it all into a folder; the files GPL and GParted-Live-Version should be in the flash drive's root directory. Next, open the USB flash drive as an Administrator, double-click the UTILS folder, open the WIN32 folder, and then double-click Makeboot.bat and follow the instructions to make the flash drive a bootable device.

To start creating and managing partitions on your computers with your new GParted Live USB flash drive, just plug it into a USB port on the system, restart it, and enter the BIOS by pressing the DELETE or F1 key (consult your PC or motherboard's manual for the specific key that lets you access the BIOS). Once in the BIOS, change the boot priority so that the USB flash drive is the first boot device. Save the settings and reboot. When the USB flash begins to boot into GParted Live, select the GParted Live option and press ENTER. Choose the Don't Touch Keymap option and press ENTER. Press ENTER again to go with option 33, which installs the US English keymap, and then press ENTER again to choose option 0, which boots into GParted.

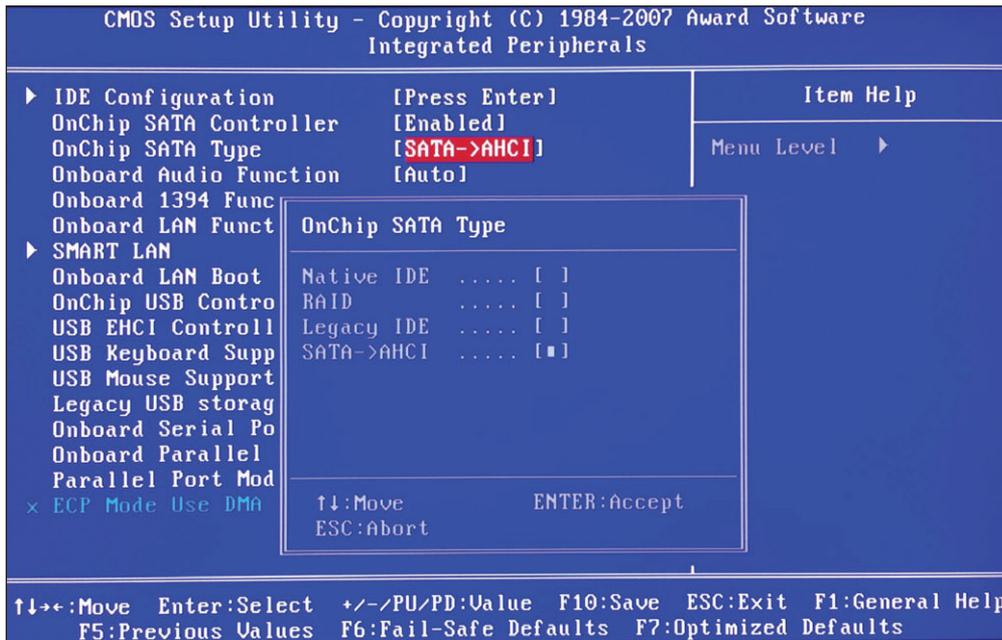
You can select the storage device you want to modify by clicking the button in the top right of the GParted interface. We used the application to shrink an unused partition so we could enlarge another partition that was getting close to full. To do this, we clicked the partition we wanted to shrink to make it the active partition, clicked the Resize/Move button, and then dragged the edge of the green rectangle to the left. We shrank the existing partition from 70GB to 30GB, which gave us 40GB of unallocated space.



Use the utility's built-in bootable drive executable, and your new GParted drive is ready for prime time.

When the partition is the size you want, click the Resize/Move button and then click Apply to make the change. This effectively leaves a block of unallocated space to the right of the newly svelte partition, so click that partition again, click Resize/Move, and then drag the whole partition so that the unallocated space is now to the left of the non-boot partition, then click Apply to make the move.

GParted warns you to not attempt to move the boot partition for your system as doing so may render your system unbootable. The operation (on an SSD) took about seven minutes to complete. Finally, we selected the boot partition, clicked Resize/Move, dragged its boundaries to take up the unallocated space, clicked Resize/Move again, then clicked Apply to make the change. Next, just exit and reboot to enjoy your newly partitioned or repartitioned storage device.



Now it's time to jump back into the BIOS to change the setting from Native IDE to SATA AHCI.

SSDs lets them offset host latency by queuing commands and using pipelines to concurrently process commands. NCQ on SSDs requires device-level support, and older drives can't take advantage of it regardless of the BIOS and Registry settings.

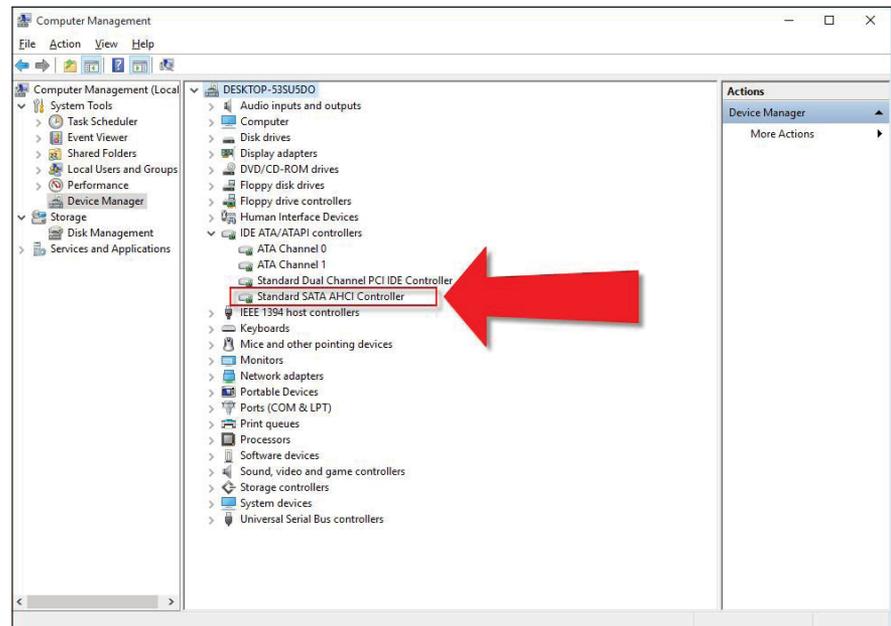
Solving The IDE/AHCI Conundrum

Now that you understand why you need your storage devices to run in AHCI mode, you may be wondering why anyone would use IDE mode given the option. Sadly, some motherboards don't enable AHCI by default and as a result, some users might find their AHCI-supporting storage devices running in IDE mode. In rare instances, users encounter errors in which a storage device won't appear as a valid option with AHCI enabled in the BIOS, forcing them to install using IDE mode. Some systems, typically older, required drivers to install AHCI-based storage devices, and locating the right drivers can be a pain.

If you suspect that an older PC running Win10 might be suffering from this affliction, diagnosing it is simple. Press Windows key + X and then click Device Manager. Next, click to expand

the IDE ATA/ATAPI Controllers file tree. If AHCI is enabled properly, you should see Standard SATA AHCI Controller or something else that mentions AHCI in the name. If not, then either your system doesn't support the feature or it does and it is just not currently enabled. If your

[Unified Extensible Firmware Interface] BIOS, chances are slim that your storage device will run in IDE mode by default in Win10.) As the PC restarts, press the key that'll open the BIOS, usually the DELETE, F1, or F2 key. You may need to consult your motherboard or



Back in the Device Manager, if you see SATA AHCI on one of the device entries, you succeeded.

system is in the latter category, this tutorial is for you.

The AHCI Mode Shortcut

There are two ways to make sure AHCI is running on your machine: You can reinstall Win10 again after enabling AHCI from the BIOS (which is what most OEMs will tell their customers to do if they ask about this), or you can follow this fairly straightforward procedure.

The first step is to make sure your SATA controller is using plain old IDE mode. To verify that this is the case, you'll need to reboot your system and access the BIOS setup menu, sometimes called CMOS Setup Utility. (NOTE: If your motherboard features a UEFI

system documentation to determine the appropriate key to press.

Once in the menu, you'll need to locate the SATA controller settings. For our test system, we selected the Integrated Peripherals menu item from the main page and found a setting called OnChip SATA Type, which was set to Native IDE. As tempting as it may be to try to change the setting to SATA AHCI mode right here and now, resist the urge. If you make the switch now, chances are good that you'll get an inaccessible boot device BSOD, and you won't be able to boot back into Windows until you change it back to IDE mode. Now that your BIOS is primed, save the changes and restart (usually by pressing the F10 and ENTER keys in succession).

The next stage of the procedure involves editing the Windows Registry, but first you'll want to make a backup of it in case something goes wrong. Start by going to the Win10 search box and typing **regedit** and pressing ENTER. If a User Account Control pop-up appears, click Yes to proceed. In the Windows Registry Editor, click File, Export. Choose a location for the backup, name the file, and then click Save. Even though you have a backup, make sure to follow any Registry editing instructions closely as failure to do so could result in an unbootable system.

In the Windows Registry Editor, use the file tree in the left pane to navigate to the HKEY_LOCAL_MACHINE\SYSTEM\CURRENTCONTROLSET\SERVICES\STORAHCI folder, which contains at least two subfolders, PARAMETERS and STARTOVERRIDE. Click STARTOVERRIDE from the file tree in the Registry Editor to view the pair of items in the right pane of the utility. Double-click the REG_DWORD item to edit its value. Change the Value Data field from 3 to 0, then click OK. Close the Registry Editor, reboot your system, and re-enter the BIOS setup menu before Windows has a chance to reboot. For our system, we again accessed the Integrated Peripherals menu item from the main

page and used the arrow keys to highlight OnChip SATA Type, pressed the ENTER key to bring up the list of available options, switched the setting from Native IDE to SATA AHCI, then pressed ENTER. Use F10 again (or the appropriate key that lets you save changes and exit) and press ENTER if necessary to reboot.

If your system has the necessary AHCI drivers on it, like ours did, it should load Windows without missing a beat. If not, your system may restart in

Safe Mode to install the AHCI drivers for your storage device.

Now That Was Easy

The final step is to verify that your storage device is using AHCI mode. Press Windows key + X, click Device Manager, click to expand the IDE ATA/ATAPI Controllers file tree, and look for Standard SATA AHCI Controller or something similar mentioning AHCI. If it's there, you successfully pulled off the trick. ■

Enable AHCI In Windows 7 & Windows 8.1, Too

If you're still running Win7 or Win8.1, your AHCI-supporting storage devices shouldn't have to make do with operating in IDE mode. In fact, because of the older hardware you are more likely running, chances are even better that your system is thusly hamstrung. The procedure for making this change in Microsoft's older operating systems is nearly identical to the one we outline in this article, just with slightly different folder paths to navigate in the Windows Registry. Follow the steps outlined in this article until you get to the part that requires Registry edits.

For Win7 users, navigate to HKEY_LOCAL_MACHINE\SYSTEM\CURRENTCONTROLSET\SERVICES, then click the MSAHCI folder from the left pane. Next, double-click the Start binary value in the MSAHCI folder and change the number in the Value Data field to 0.

To make the change in Win8, go to HKEY_LOCAL_MACHINE\SYSTEM\CURRENTCONTROLSET\SERVICES, then click the STORAHCI folder from the left pane. To proceed, double-click the Start binary value and change the number in the Value Data field to 0. It's possible that you'll find a StartOverride entry in the STORAHCI folder. If you do, change the Value Data field here to 0 as well.

Users of these older OSes may also need to make sure the AHCI drivers for the SATA controller in question are currently installed. Consult your motherboard manufacturer's website to download the appropriate drivers. When we originally wrote this article three years ago, our test system had three different SATA drivers. If this is the case for you, download the files from the motherboard manufacturer's website or system builder's website as the case may be and cross-reference the names of the drivers against the list of Services in the Registry, installing any that don't appear.

Once the drivers are installed, go to HKEY_LOCAL_MACHINE\SYSTEM\CURRENTCONTROLSET\SERVICES\DriverName, where *DriverName* refers to the name of the specific driver. Double-click the StartOverride entry and change the Value Data to 0. Repeat this for all SATA AHCI driver entries to make sure your bases are covered. (NOTE: If your PC reboots during the driver installation process, you'll need to repeat these Registry edits.)

Once complete, restart the system and enter the BIOS during the boot sequence. Enable AHCI in the BIOS as described above, then save the changes and reboot. When you're back in Windows, double-check with the Device Manager's IDE ATA/ATAPI Controllers item to ensure the words SATA AHCI appear there. If you see them, then you're good to go.

Upgrades That'll Keep You Humming Along

Is it possible for your PC to be *too* secure? A question for the philosophers, to be sure, but we're not taking any chances. The majority of apps featured this month are built to keep your system safe one way or another. Android users should check out AirDroid, a very handy screen-mirroring program.

SOFTWARE UPDATES

BleachBit 1.11.2 Beta

Sure, BleachBit can scrub your drives of all the digital gunk that builds up over time, but by shredding files and overwriting free disk space the software aids in maintaining your privacy, too. The recently released beta fixes an error that could pop up when BleachBit cleans Google Chrome's history. Beyond that, you'll find a handful of changes specific to either the Linux or Windows version of the beta. The update for Linux bolsters BleachBit's cleaning capabilities with a bunch of apps, including X11, GNOME, Rhythmbox, and Transmission, while the Windows version fixes an execution error on systems that also run Avast.

<https://www.bleachbit.org>

CyberDuck 5.0.3

We tend to associate browsers with the Internet, but Cyberduck's forte is browsing things like WebDAV, S3, Backblaze B2, and so forth. A series of updates have added minor features and fixed bugs, but the 5.0 launch at the end of May was a big one. Mac users got a brand-new UI, complete with monochrome toolbar icons. The browser now supports Google Drive and Spectra BlackPearl Deep Storage Gateway. Cyberduck users also now have the ability to use AWS KMS-managed keys for server-side encryption.

<https://cyberduck.io>

Eyeo Adblock Plus 1.12

One of the best browser extensions for thwarting advertisements gets even better, with the release of Adblock Plus 1.12 for

Chrome, Opera, and Safari. Although it's experimental, the headlining feature of this release is content blocking support for the Safari version. (Safari users can enable content blockers in the Options menu.) Regardless of the platform you're using, Adblock Plus 1.12 boasts reduced page load times thanks to better element hiding. On that note, websites can no longer bypass Adblock Plus' element hiding by removing or disabling the stylesheet.

<https://adblockplus.org>

LastAudit 1.5

We try to keep our systems as secure as possible, but vulnerabilities have a habit of creeping in. LastAudit tries to sniff 'em out. The portable app scans for common weaknesses (browser history, Clipboard data, torrent software, etc.) but also digs through the filesystem, Active Directory, and LAN. A trio of updates over the last two months has greatly improved lastAudit's capabilities, but the latest gives power users a treat: Now, lastAudit presents the option of a command line interface.

<https://lastaudit.wordpress.com>

Sand Studio AirDroid 3.2.2

Take AirDroid for a spin, and you might never send another text from your Android smartphone again. AirDroid mirrors your Droid's screen to a PC or Mac, so go ahead and use a keyboard and mouse with your phone like you've always wanted. An early June update introduces some sweet new additions. Record Screen, which may be the most self-explanatory feature of all-time, is a terrific way to capture gameplay action, for example. According to developer Sand

Studio, AirDroid 3.2.2 should be much friendlier on phones' batteries, claiming as much as a 65% increase in battery efficiency during a six-hour test.

<https://www.airdroid.com>

SecureState King Phisher 1.3.0

Think your staff has the smarts to steer clear of phishing attacks? SecureState's King Phisher puts them to the test by launching simulated phishing offensives. The software creates and sends mock phishing emails that reveal who wasn't paying attention to your security seminars. Version 1.3.0 makes PostgreSQL database setup automatic, and the client-side application now supports plug-ins. The update also includes several fixes; it corrects a bunch of Python 3.x compatibility issues and squashes some server-side bugs when King Phisher runs on non-standard HTTP ports.

<https://www.securestate.com>

Wireshark 2.1.0

Wireshark picks apart your network's packets so you can troubleshoot, analyze, and educate. Although the Wireshark Foundation is calling version 2.1.0 a "semi-experimental release" to pave the way for Wireshark 2.2, the latest update nonetheless has several new and updated features. The software now allows regular expressions in Find Packet and in advanced preferences. The Windows and OS X installers now have "sshdump" and "ciscodump" extcap interfaces, and the Follow Stream dialog includes support for UTF-16. Version 2.1.0 adds a small mountain of supported protocols.

<https://www.wireshark.org>



www.uat.edu/majors



Tech Respect

LEARN

Advancing Computer Science
Artificial Life Programming
Business Technology
Digital Maker and Fabrication
Digital Media
Digital Video
Enterprise Software Development

Game Art and Animation
Game Design
Game Programming
Human-Computer Interaction
Information Assurance
Network Engineering
Network Security

Robotics and Embedded Systems
Serious Game and Simulation
Technology Forensics
Technology Leadership
Technology Studies
Web Design

Bachelors | Masters | Online | On-Campus | www.uat.edu

Please see www.uat.edu/fastfacts for the latest information about degree program performance and costs.

Turning Heads

How Online Video Stars Are Gaining Fame & Fortune

Late last month, about 30,000 tweens and teenagers, marketers, ad-agency reps, online video experts, social media whizzes, and entertainment industry bigwigs converged on Anaheim, California, for VidCon 2016.

Businesspeople attend this annual convention, which targets the increasingly key world of online video, to learn the prevailing strategies for growing their brands and products by way of the online video universe. The younger attendees come for entirely different reasons. Most want to meet in the flesh the online stars of the videos that they're devouring via their mobile devices on YouTube, Vine, Snapchat, and other platforms. Some of these younger attendees are looking to better their own chances of becoming one of these stars. Reaching that level of success, however, generally means amassing millions of subscribers and followers, consistently posting videos that collectively generate millions of views, and pulling in meaningful revenue while doing it.

Those businesspeople representing the corporations, tech companies, movie and television studios, marketing and ad agencies, and others at VidCon really want to meet these stars to explore such possibilities as brand promotions, collaborations, movie and book deals, product launches, and scads of other partnerships.

A key bargaining chip that today's online video stars, often called "YouTubers," bring to the table is the amount of influence they have on the behaviors, including spending habits, of their massive audiences. The influence that such stars as PewDiePie (45.8 million YouTube subscribers) and Lele Pons (11.1 million Vine followers) are collectively gaining over younger users in particular is altering how many in that age group



The 2016 version of VidCon, an annual convention where online video stars, their fans, and businesspeople from numerous industries come together, was expected to draw 30,000 attendees in June. This year, YouTube live-streamed the three-day conference.

now consume media, impacting individual social network usage, and broadly changing what being a "celebrity" and "influencer" means to them.

Meet The New Age

Jenna Marbles, Hannah Hart, Grace Helbig, Zoe and Joe Sugg, Michelle Phan, VanossGaming, Ray William Johnson, Rachel Levin, Lilly Singh, Smosh, the Fine Brothers, Rhett and Link, KSI, and the VlogBrothers. These

names and many others are what's causing the online video universe to spin so fast today. The less hip and older among us may not have a clue who they are, but millions and millions of young people do. Moreover, they religiously follow their YouTube channels and Snapchat, Vine, Instagram, and Facebook accounts where they post and promote their videos.

Together, the videos from these online video stars attract billions of views. The

content features comedic sketches; singing; personal vlog entries; beauty, makeup, and fashion advice; education; politics; current events; videogames; reviews; talk-show elements; elaborate pranks; and about every type of entertainment imaginable. Impressively, many creators write, produce, film, edit, promote, and distribute much of the content themselves.

The data and statistics concerning the online video world are just as impressive and sometimes mind-blowing. One stat from the website of *The Washington Post*, for example, states that the top five YouTubers have more subscribers than there are people in Mexico. Another stat declares that the subscribers/followers of online video channels are double the number of U.S. cable TV watchers.

Combine the legions of subscribers with the millions of views that videos attract, and it's not difficult to understand how top online video stars can earn millions annually in ad-generated revenue. (YouTube reportedly now hosts more than 300,000 ad-supported channels compared to just 10,000 a few years ago.) It's also easy to understand why many YouTubers are expanding beyond their online presences via external projects, including launching personal product lines, writing books, signing film (internet-based and feature film) and TV deals, and more.

Michelle Phan is an often-cited example of this. She began posting beauty-related YouTube videos in the mid-2000s. Beyond earning ad-generated revenue, Phan's videos also led to her landing a cosmetics line with L'Oréal and co-founding a mail-order subscription business called Ipsy that reportedly generates millions in annual sales. Bing Chen, former creator development lead at YouTube, told *Fast Company* that he believes Phan is what the next generation of media businesses will look like. "Michelle Phan is unequivocally this generation's Oprah Winfrey. FreddieW has with RocketJump become this generation's Steven Spielberg. Phil DeFranco and SourceFed has become this generation's Jon Stewart, if not Rupert Murdoch and News Corp.," Chen stated.

While some YouTubers have authored books targeting their fan bases, still others such as Colleen Evans, known for her Miranda Sing character and videos, and Lilly Singh, known as Superwoman to her 9 million YouTube subscribers, have done national tour dates to reach their fans. For sponsors, promoters, financial backers, and others with a stake, what's so appealing about working with online video stars is their built-in audiences of millions craving content, the need for less promotion to reach them, and the good odds of returning a profit on their investment.

Increasingly, the top online video stars are also gaining attention from

MCNs (multi-channel networks), which specialize in delivering services to content creators that can cover content creation, advertising, marketing, publicity, and distribution. Traditional media-oriented companies are also getting more heavily involved. Disney, for example, spent \$500 million to acquire Maker Studios, which bills itself as the largest content network on YouTube, attracting 10 billion-plus views monthly and more than 650 million subscribers. Verizon, DreamWorks, and Hearst all own pieces of AwesomenessTV, which an employee of the company described in an interview as essentially bringing "Hollywood and YouTube together."

The Need-To-Know Lingo

Like many communities living on the internet, the world of online video celebrities has its own language that the fans, media networks, ad agencies, marketers, and others in this world know and understand. The following are a few examples:

Famechanger. This term stems from research that *Variety* has presented in recent years to designate online video creators "whose influence stands head and shoulders above the rest." Although famechangers come to their celebrity status and success in different ways, *Variety* states that as individual personalities "who amass audiences that exceed those of some of the biggest media brands, they all redefine conventional notions of celebrity."

Influencer. Influencers in the online video world are considered especially valuable to brands because they've amassed huge fan bases that are extremely loyal and active. In a 2015 article, *Forbes.com* cited YouTube as the best social platform dollar for dollar for returning the best ROI, noting "people are constantly turning to YouTube influencers to discover helpful tips, find reputable products, and honest reviews."

MCN (multi-channel network). According to YouTube, MCNs are entities that "affiliate with multiple YouTube channels," often to provide video creators assistance in such areas as production, promotion, DRM, sales, and audience-building. *Forbes* describes MCNs as independent outfits "built on top of the YouTube platform, using its video capabilities." eMarketer.com, meanwhile, points out that MCNs provide these services for a "fairly large" cut of the ad-generated revenues created by the online video star's content.

Spon. Short for "sponsored content," "spon" is content a company compensates an online video star to promote. If the star handles this poorly and seems phony and disingenuous, it can damage the star in terms of subscribers leaving and fewer video views.

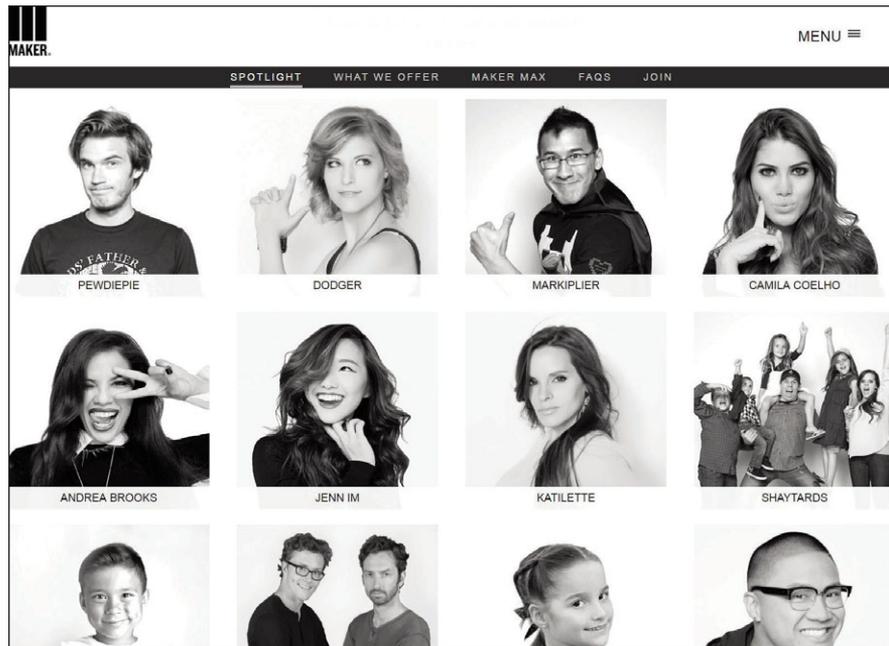
YouTuber. At the simplest level, a "YouTuber" is someone who uses YouTube. A more strict definition reserves the term for only those who actively produce and post content. An even stricter definition defines a "YouTuber" as a content creator who has reached a position of celebrity within the YouTube universe.

Hollywood has seen the release of a few recent full-length films born from the online video world, most notably “Smosh: The Movie” in 2015 and “Natural Born Pranksters” in 2016. iTunes and YouTube’s paid subscription service have also released various full-length internet-only movies featuring online stars.

Phillip Ross, a social media analyst with Socialbakers, says other examples of social media stars segueing into more traditional forms of media include movies for mobile distribution (“Sickhouse” starring Andrea Russett) and Netflix distribution (“Mono” featuring Vine stars Christian DelGrosso, Brandon Bowen, and Jake Paul). Additionally, online stars are being cast in traditional TV shows and movies, and some online stars are also forming their own studios, he says.

Those oblivious to how big the online video world has become often ask how people can get so many fans and so much money “just from posting videos.” In a word: authenticity, a vital ingredient to the success of YouTubers to date. Whereas most people often associate traditional celebrities with being untouchable, distant, and generally “not like the rest of us,” YouTubers are truly of the people, looking and acting like their viewers and offering a delivery that is genuine, believable, and anything but phony.

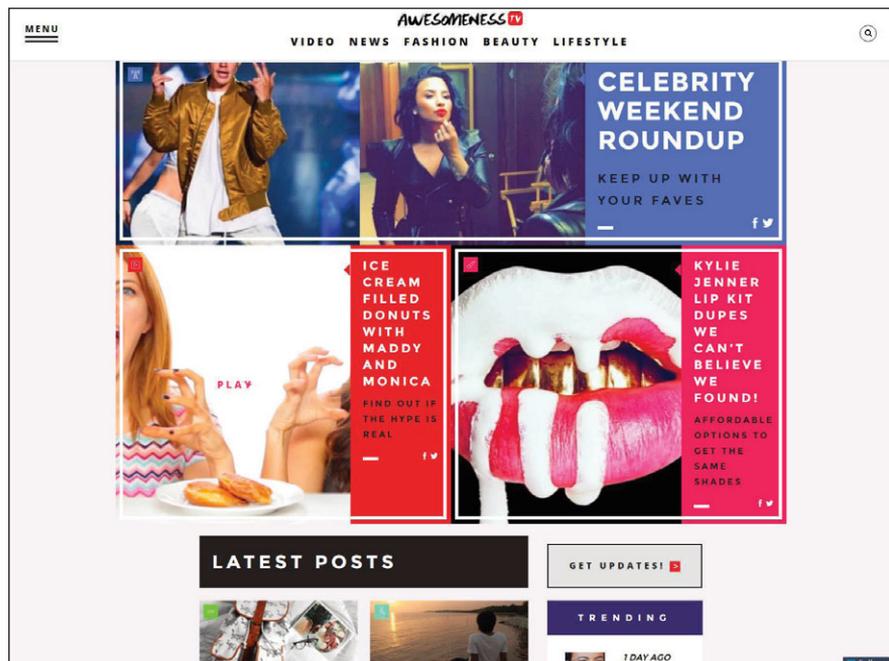
“The relationship between YouTube creators and their audience is unique because they’re more relatable and engaging with their fans than traditional celebrities,” says Kim Bond, co-founder and community director at Grapevine, a company that brings together brands and content creators. “This is especially true considering that creators’ audiences often comprise people very similar to themselves.” This similarity helps form an extremely loyal community of subscribers who interact with each other. “There are even traditional celebrities, such as Shay Mitchell and Karlie Kloss, who are moving their brand to social platforms like YouTube to capture the value of video sharing that creators have already proven is effective to attract and retain fans,” Bond says.



Maker Studios is an example of one of the MCNs, or multi-channel networks, that are becoming more prevalent in the world of online video. MCNs essentially partner with various YouTube channels, offering tools and resources to help with content creation, advertising, promotion, management, and more.

Alex Taub, co-founder of SocialRank, which helps users find and analyze their Twitter and Instagram followers, echoes

Bond’s thoughts. “Tools like Twitter make it so that you’re seconds away from someone you’re a fan of, but it seems like



Verizon, DreamWorks, and Hearst all own chunks of AwesomenessTV, a company described as uniting the worlds of YouTube and Hollywood by specializing in creating video content and so much more.

It's A Good Life If You Can Get It

The earnings of top online video stars is a touchy subject for many in the online video universe, in part because stars are tired of having to justify their earnings. It's nearly impossible, though, to not mention the vast sums some stars are making from ad revenues, personal product lines, book and movie deals, and other sources. The following is *Forbes'* list of top-earning YouTube stars for the year ending June 1, 2015:

- **PewDiePie.** Otherwise known as Felix Kjellberg, PewDiePie tops the list at \$12 million, in part for what *Forbes* calls “providing expletive-heavy commentary as he plays videogames.”
- **Smosh.** This comedy team of longtime friends Ian Hecox and Anthony Padilla pulled in \$8.5 million via multiple YouTube channels. The duo was part of the 2015 major movie release “Smosh: The Movie.”
- **Fine Brothers.** The duo of Benny and Rafi Fine have earned \$8.5 million and amassed 13 million subscribers with channels of videos showing people reacting to various things.
- **Lindsey Stirling.** Arguably one of the most oddly addictive YouTubers on this list, Stirling has made a name and fortune (\$6 million) via videos in which she simultaneously plays the violin and dances.
- **Rhett & Link.** This comedy team, which consists of nearly 40-year-olds Rhett McLaughlin and Charles Lincoln Neal III, hauled in \$4.5 million. They host the popular “Good Mythical Morning” weekday web news/talk show.
- **KSI.** Hailing from Britain, Olajide Olatunji, otherwise known as KSI, made \$4.5 million in 2015 through comedy and hip-hop-flavored videos. KSI has gained more than 13 million subscribers.
- **Michelle Phan.** Phan, who *Forbes* listed as earning \$3 million, gained fame through videos that helped her land a cosmetics line and co-found and launch a monthly subscription service for makeup called Ipsy that generates millions in revenue.
- **Lilly Singh.** Known for her online Superwoman personae, Singh was on her way to a professional career before she detoured into making YouTube comedy videos. The decision paid off, as *Forbes* put her 2015 earnings at \$2.5 million.
- **Roman Atwood.** A member of the team behind the full-length major movie release “National Born Pranksters,” Atwood also heads up the prank-gearred RomanAtwood YouTube channel that helped him earn \$2.5 million.
- **Rosanna Pansino.** Also earning \$2.5 million, Pansino regularly posts baking tutorials, cooking-series entries, and other videos to 5 million subscribers. She also has a book publishing credit to her name.



Michelle Phan is as an example of a YouTube celebrity who has built on the success of her YouTube videos to launch outside projects.



Lilly Singh has acquired more than 9 million YouTube subscribers through her comedy-filled videos.

online video creators, having been ‘built’ on the internet as opposed to in the movie theater or on TV, seem just like you and me,” he says. “It feels more real, so they connect better with their audience.”

A Shift In Behavior

Every industry has “influencers,” and the online video universe most especially does. Although Ross says it’s unclear exactly when someone becomes a celebrity or influencer, it generally requires leading a group and starts within specific circles of interest. “[Online video stars] could be unboxers, live-streamers, comedians, etc. and gain their influence by being looked up to within that circle,” he says. Another key to becoming an influencer is meeting and talking with people in genuinely enthusiastic exchanges, he says.

Similarly, Bond says online video influencers are essentially everyday social media users with large followings and expertise in certain topics, but they also have power to impact others, including in terms of buying power. “Influencers are impacting our culture in everything from fashion and entertainment to travel and food,” she says. She points to Kylie Jenner as having built a brand and becoming an influencer via Snapchat and Instagram rather than through reality TV as her Kardashian sisters did.

One contributor to online video stars gaining such influence is their savviness and skill at using numerous social media tools and platforms. Chase Buckle, trends analyst with GlobalWebIndex, says in addition to younger groups typically being more engaged with social media, those 16 to 24 years old are the most prevalent consumers of online video on social media. This same age group is largely driving the rise of multi-networking, or conducting online activities across a range of different platforms, he says. Those ages 16 to 24, he says, are members of about eight different networks while those 55 to 64 years old have accounts on an average of 2.5 networks.

“We track motivations behind using social media, and whereas older age

groups typically see their biggest over-indexes for work-based motivations, the 16 to 24 age group is much more likely to use social media to follow celebrities (a fifth do) and for fear of missing out,” Buckle says. “They also over-index for using social media to find funny or entertaining content such as videos, which four in 10 do.”

Bond says younger generations are more visual, which is another reason they use social media differently. “We love photo and video content because our attention spans are short and we have a higher standard for engaging content,” she says. “Other generations may prefer micro-blogging or written statuses, but younger generations like to deviate to platforms their parents typically aren’t using. So, while mom might be updating her status on Facebook, her kids will be sending Snapchats.”

Ross also points out a “shared space experience” factor. For example, watching TV in a shared space is become increasingly foreign to younger generations, he says. Thus, it makes sense they use social media more and that the influencers they follow will point the way to the new platforms that those who don’t follow those influencers (such as parents) will likely be slow to find.

Overall, Taub says in terms of pushing products, sign-ups, video views, and

general interest, online video celebrities can be just as powerful as traditional celebrities. “Young people growing up are more familiar with PewDiePie than George Clooney,” he says. “There’s a whole generation being brought up caring more about YouTube stars than movie or TV stars.”

A survey conducted for *Variety* in 2014 and 2015 by Jeetendr Sehdev, a celebrity branding authority, bears this out. Comparing the 10 YouTube celebrities with the most subscribers to 10 traditional stars with the highest Q score (a measurement that advertisers and marketers use to gauge influence), Sehdev found that specifically in the eyes of teens ages 13 to 17, YouTube video stars held eight of the top 10 slots in terms of approachability, authenticity, and other criteria making up overall influence.

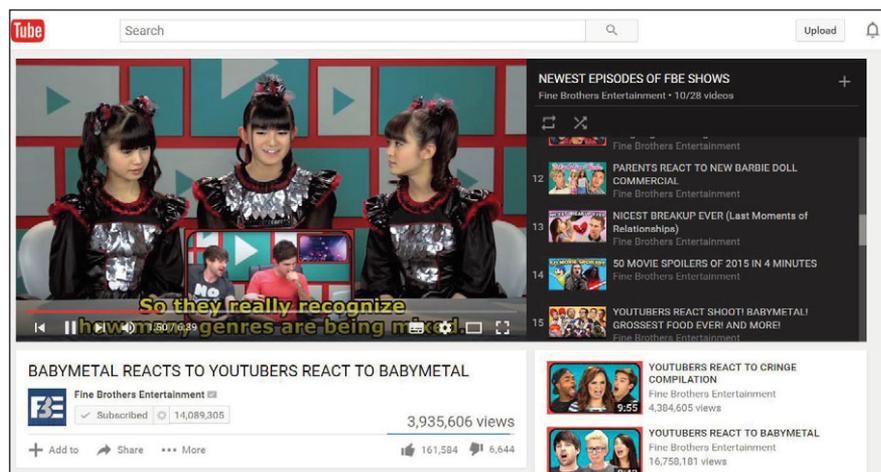
Sehdev stated that “YouTube has an inherent ability to create contagious content,” and that the “level of advocacy teens have about YouTube stars is out of control.” Sehdev also found that teens’ emotional ties to YouTube stars is up to seven times greater than that for traditional celebrities. This same group also perceives YouTube stars to be 17 times more engaging and 11 times more extraordinary than mainstream stars.



Increasingly, companies dealing in more traditional forms of media are paying attention to online video stars. “Smosh: The Movie,” a major studio film released in 2015 starring online video comedy team Ian Hecox and Anthony Padilla, is one example.

In recent years, Bond says the power content creators have acquired has helped build and shape brands and marketing campaigns in ways unheard of with traditional media. That’s helped creators and brands get in front of targeted audiences in new and unique ways, she says. NYX Cosmetics, an early Grapevine client, is an example. “We ran a contest for them that generated more than 400-plus videos, 10 million-plus video views, and 20 million-plus impressions to their site in a matter of weeks,” she says. That built momentum much faster than using traditional marketing approaches, she says. Ultimately, the campaign’s success contributed to L’Oréal acquiring NYX and NYX becoming a staple in major national retail outlets, says Bond, who adds it also helped newer YouTube creator Chelsea Crockett, whom Grapevine worked with on the campaign, expand her channel’s growth to about 1 million subscribers.

Taub notes that while influencer marketing can be great if done well,



Benny and Rafi Fine, the duo behind the Fine Brothers Entertainment network of YouTube channels, have amassed more than 14 million subscribers with popular videos in which kids react to various things.

Build Them Up, Tear Them Down

If you're unfamiliar with the names of today's YouTube and online video stars, you're not alone. In fact, scads of people (especially from older generations) aren't aware that being a YouTube star or celebrity is even a thing. Among those who are aware, many find the reality baffling and without merit.

Read even a few comments from articles on the subject of today's online video stars and it's apparent many people believe online video stars are overpaid, talentless, and far nastier things. It's not uncommon to see declarations such as "corporate sponsors are throwing money down the drain" when hiring online video stars to promote their brands. Another theme equates YouTube stars to "sad-looking millennials who couldn't get a day job with their useless psychology or Middle Ages philosophy degrees."

Negativity (and probably some jealousy, too) noted, many accounts of online video creators who become stars portray them as putting in a tremendous number of hours to constantly produce original content several times a week. On top of that, YouTubers must master numerous social network and communication platforms and tools, learn how to grow an online audience, promote themselves, and then maintain it all.

In a blog post, WeTheUnicorns.com, which tracks the online video world and its stars, points out that a YouTuber often juggles writing, acting, directing, audio, lighting, editing, publishing, and promotion duties—something few, if any, traditional TV and movie stars do daily. As WeTheUnicorns.com suggests, becoming a "YouTuber" isn't something that happens quickly. Instead, content creators literally grow their subscriber base and video views one at a time and without a team of publicists, agents, managers, and others.

Another "weird phenomenon" that WeTheUnicorns.com points out is the lack of respect YouTubers get from traditional media. "Newspapers may make fun of TV stars, but they still seem to find it fundamentally impressive that they're a TV star." Conversely, the blog post notes, the media seemingly gets mad when YouTubers find fame and fortune, dubbing the "job fake" and questioning why they make the money they do.

Ultimately, there's no denying the current success of YouTubers. As the HollywoodReporter.com notes, even if Hollywood bigwigs born before 1980 don't recognize today's online video stars, they're still "enormously famous" with global fan bases and incomes "that make some traditional TV and film stars look like dinner theater stand-ins."

it can also be horrendous if done poorly. "I think the word 'influencer' is all-encompassing because everyone is influential about something—to their friends, family, coworkers," he says. Taub, however, sees online video stars as being another spending outlet for brands/agencies. "A few years ago, you could get influencers on the cheap," he says. "Now, I think times are catching up and influencers are getting repped by agencies and looking for more than just an invite to a special

event or free product. It is becoming their lifestyle."

The YouTube Influence

Understandably, YouTube isn't shy about the opportunities its platform opens, including working with top YouTubers in an advertising and promotional sense. Among the possibilities is the Google Preferred program, which offers access to paid content and taps into the influence that YouTubers possess. Google Preferred

includes 13 categories of "the most-loved and most-watched content" where advertisers can get involved.

In a recent blog post following the annual advertising-related Brandcast event, YouTube stated it now reaches more 18- to 49-year-olds in the United States than any broadcast or cable TV network. It also claims about 60% of YouTube subscribers would take a YouTube creator's buying advice over a favorite TV or movie star's. A Google-commissioned study found that, by 2025, half of viewers under age 32 won't subscribe to a pay TV service. Among millennials, it claims YouTube currently accounts for about 66% of the premium online video watched across devices. Last year, viewers ages 18 to 49 spent 4% less time watching TV while time on YouTube went up 74%, Google states.

Indisputably, YouTube is and has been the dominant platform for online video, but others are trying to close the gap. Snapchat in particular has made considerable news lately, particularly as scads of younger users have joined after leaving Vine. Taub cites Snapchat as being "on a tear in 2016," noting that Snapchat Stories in particular are clicking with older generations. "The ability to put together a string of snaps and create a narrative is the most popular form of upcoming video content," he says.

Buckle cites Facebook as also making moves with Facebook Live and a recent announcement concerning live game streaming to compete with Twitch and YouTube Gaming. Buckle adds it's not just social networks heavily moving into video, as data shows one in two WhatsApp and Facebook Messenger users 16 to 24 years old sent at least one video in May via those platforms.

Currently, Bond views YouTube, Vine, and Snapchat as the main video platforms being used by online video influencers, partly because they're geared more toward a millennial audience. "I anticipate curated video content to be a big factor in the future of social media," she says.

Overall, Ross agrees that while YouTube and Vine aren't going

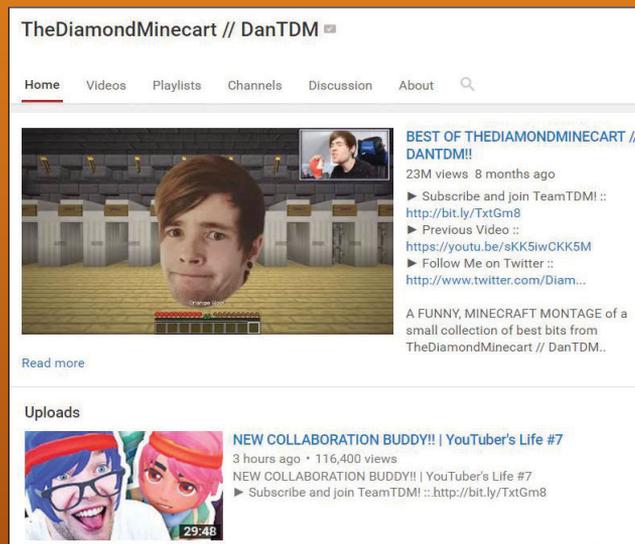
A Channel For Every Taste

Name a subject, and there's probably a channel for it on YouTube, whether tastes lean toward vlogs, beauty and fashion, music, comedy skits, cooking, sports, science, technology, gadgets, news, cars, gossip, advice, or reviews. Among the most popular channels, however, are family-friendly, kid-hosted ones, such as EvanTubeHD, a network of channels featuring grade schoolers that has nearly 3 million subscribers and generates hundreds of millions of views.

According to a Tubefilter.com list of the 50 most-viewed YouTube channels over a recent one-week period in June, the Ryan ToysReview channel featuring a four-year-old giving rundowns of toys topped all other channels with more than 140.2 million views. The channel has nearly 3.1 million subscribers and generated about 4.9 billion views, according to Tubefilter.com, which uses data from the OpenSlate video content analytics platform.

Gaming and prank videos are two other extremely popular channel categories. Within gaming, "let's play" videos in

which a host records himself playing a particular title are especially popular. Inverse.com writes that in addition to "let's play" videos being an entertainment form native to the 21st Century, they sit "at an intersection of pop culture, uniting videogames, the Internet, TV, and celebrity culture in one video."



One of the most popular channels on YouTube is the gaming-oriented TheDiamondMinecart//DanTDM channel. Overall, gaming channels are among the most popular categories on YouTube.

Historically, the king of the gaming category and arguably all of YouTube is PewDiePie. Born Felix Arvid Ulf Kjellberg, PewDiePie has about 45 million subscribers and close to 12 billion all-time views. Also extremely popular, however, is TheDiamondMinecart//DanTDM channel, which has 10.5 million subscribers and 6.7 billion views and topped a recent Tubefilter.com list of the Top 100 most-viewed YouTube gaming channels. During April 2016, the channel drew more than 317 million views and gained nearly 383,000 subscribers. Collectively, Tubefilter.com reports that the Top 100 most-subscribed YouTube channels for April 2016 collected a whopping 37,300,893 new subscribers.

anywhere, other platforms are definitely emerging. Live-streaming sites such as Periscope and YouNow are playing a big role, he says, because of such activities as fan-oriented Q&As that provide an immediate experience on the screen. "There is no separate comments bar. Engagement crosses over onto the video itself. It is participatory, and thus, authentic," he says.

Mobile devices are the major connector between younger generations and all video platforms and social networks. Buckle says they're partially why 16- to 24-year-olds globally now average 1.06 hours of online TV per day vs. 0.82 hours in 2012 and why that average tops the 0.33 hours per day for those 55 to 64 years old. "Younger groups are at the

forefront of the rise of mobile and are spending longer amounts of time online via mobile with each passing year," he says. Combined with 4G access, viewers have more opportunities to watch online video, even if in short spurts.

Bond also believes mobile devices are the biggest reason traditional TV viewing is dropping among younger ages. "This generation is always on the go, and online video is extremely accessible to essentially anyone with a smartphone," she says. "You can watch online videos when it's convenient for you rather than appointment viewing—waiting for a network to release a new episode at 7 p.m. on a Tuesday night, for example." Taub points out that online video is virtually free and easily accessible. "They pay for

Netflix and maybe HBO, but they've basically unbundled. They will go to the movies for the new superhero or action movie, but YouTube is where they live," he says.

Also key to the growth of online video is that younger generations especially no longer view mobile devices as having a "second-screen status," Ross says. "Consider two things: time and privacy," he says. Younger generations have "multifunctional private TVs" connecting them directly to their favorite stars, he says. "Why would they spend time on a TV they share with their family or friends or public, which will be an increasingly foreign experience for kids to grow up with as time goes on, when they have this magic in their pockets?" ■

Buying Action Cams

It Shouldn't Feel Like Jumping Out Of A Plane



The first time I saw an action cam—in action—was a few years ago. I was at a local park enjoying the warm weather and letting the kids burn off some energy. The bearer, or perhaps, wearer, of the action cam was a squirrely preteen, with a helmet-mounted GoPro, and pink knee and elbow pads. She was giving it her all, running up to and kicking off of trees, hopping on and off picnic tables, climbing the park equipment she'd aged out of years ago and hurling herself down into an awkward roll. She never stopped moving, shimmying, and spinning around. It was a spectacle, indeed, but it also looked like fun.

Fun is the action cam's hook, and once you have the bug, it doesn't let go easily. A couple years ago, there were only a handful of the cams available, and they all

topped out at 720p, took some seriously shaky video, and wouldn't take too much punishment before they started to suffer the effects. These precursor action cams were merely cut-down camcorders, designed to maximize battery life and compactness at the expense of just about everything else.

Fun is the action cam's hook, and once you have the bug, it doesn't let go easily.

But it's a completely different story today. There are dozens of models available that cater to everyone from curious beginners to seasoned professional thrill-seekers, and everyone in between. If you've been eyeing an action cam lately,

read on for a few tips to keep in mind when buying and some more that'll help you get the most out of your purchase.

Buying Tips

The best and worst thing about buying an action camera today is the ridiculous number of options currently available. Narrowing down your choices is important. Here are some things to bear in mind:

Know what you plan to use it for. If you own a small business that specializes in Jet Ski rentals and you do your own marketing, you might want to invest a little money in an actioncam that is durable, waterproof, and buoyant. It also wouldn't hurt to get one that makes uploading, editing, and sharing video as painless as possible. If you'll mostly be mounting the camera to a vehicle, then optical image stabilization is less important than if you plan to wear it around as you jog through the woods.

Research the available accessories. If you spend all your time getting the action camera that offers the best possible video scores, you may be disappointed when you find that the mounting hardware is expensive, or worse, nonexistent. In that case, you'll be digging up your receipt in no time.

Do you really need 4K? 4k is a bit of a buzzword these days, especially in gaming. Yes, content in 4K looks amazing, but only if you have the means to view it at that native resolution, such as with a 4K TV or a 4K monitor. Similarly, don't dismiss



Never Suffer Insufficient Storage

It's true, your action cam is only ever as good as the flash memory you put in it, and to get the best performance, you need something that's fast. A massive amount of capacity will also come in handy when you're on one of those short jaunts that frequently turns into an all-day excursion.

Reliability is also key. There are plenty of no-name brands out there that sell lower quality storage cards. We suggest you stick with an established memory brand from a company that has a proven history of producing high quality products at affordable prices.

Patriot Memory is a well-known company that has been around for 30 years. With prices starting at \$7.99 for 16GB of capacity, Patriot Memory's LX Series microSDHC/microSDXC cards pack a lot of performance into a fingernail-sized package. Available in capacities up to 200GB, these Class 10, UHS-1 (Ultra High Speed 1) cards support up to 90MBps read and 40MBps write datarates, which is optimal for swapping HD recordings between your PC, laptop, smartphone, and action cam.

If you'd rate your action cam usage at enthusiast or professional level, or if you're working a lot with 4K video, even casually, then consider upgrading to Patriot Memory's EP Pro microSDHC/microSDXC card. This Class 10 series supports capacities up to 64GB, read/write speeds of 90MBps and 80MBps, and UHS-I U3 rated devices, which is ideal for ferrying loads of 4K video wherever you want, quickly.

Both of these memory cards are backed by Patriot's 5-year warranty, which is great, but that's probably longer than your action cam will last.

later. Bluetooth and Wi-Fi are common ways action cameras connect to wireless remotes or smartphones. Support for framerates above 30fps can produce smoother video, and frame rates of 120 and up can even enable the camera to do vivid slow-mo tricks. Other goodies to keep an eye out for include optic stabilization, HDR support, easy-to-use software, and a rugged design that's in tune with what you plan to use the camera for.

Usage Tips

Once you've settled upon an action cam and pulled the trigger, there are a few useful habits you'll want to practice to help you make the most of the device in your life.

Tie string to it. Mounts are great for planting your action camera on any and all surfaces imaginable, but it pays to tie a relatively short length of durable cord to the action cam and something other than the mount. This ensures that if the mount (or the adhesive used to affix the mounting plate) fails, you won't lose your potentially expensive action cam.

Know your battery situation. If you're planning on taking a three-hour boat tour, make sure you have enough battery life (or spare batteries) to last four or five. Remember what happened to Gilligan?

Pack thoroughly. For avid adventurers, action cams can be a frequent travel accessory, but make sure when packing that you don't forget this accessory's accessories. Things like batteries, waterproof cases, spare mounts, and lens care items can be expensive or impossible to acquire where you're going.

3, 2, 1, Action!

If you're buying a new action cam today, it's possible to get one that seems like it was designed to meet all of your particular needs. And now that we've touched on some basic buying and usage tips, the only thing left to do is get one of your own and start having fun, with or without pink knee and elbow pads. ■

4K out of hand because you don't have a 4K-capable screen. Chances are good that you'll want to watch that action cam footage down the road, and you may regret picking a 720p or 1080p cam when you made your initial purchase.

Get to know the extras. Currently available action cams can do a lot of

neat things beyond simply sticking to things and recording video. Many feature built-in GPS that helps you find them when they fall off or tag footage to locations. Some can even use this sensor to detect changes in speed and G-force, triggering the camera to wake up and record, or flag the event for easy review

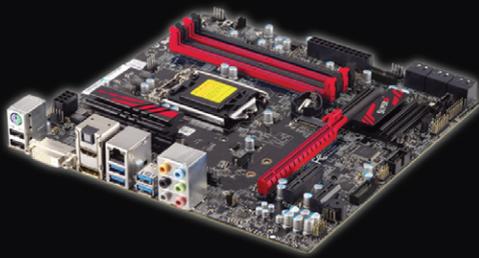
BY ANDREW LEIBMAN

SUPERTM | Gaming Solutions

Server Quality, Built For Gaming



Leveraging server-grade designs and components to deliver industry leading durability, stability and performance



Core Gaming

C7Z170-M

Designed for extreme gamers who crave the highest performance
Supports 6th Gen Intel® Core™ processors



WHERE TO BUY :



amazon.com



Learn more at www.supermicro.com/Gaming

© Super Micro Computer, Inc. Specifications subject to change without notice.
Intel, the Intel Logo, Intel Inside, Intel Core, and Core Inside are trademarks of Intel Corporation in the U.S. and/or other countries.

CPU

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.



Blizzard games have been gold-standard experiences since Blackthorne hit the Super NES in 1994 and before, and the company went on to utterly dominate RTSes (WarCraft and StarCraft), action-RPGs (Diablo), and MMORPGS (World of Warcraft) in the years since then. Toss in a massively popular CCG (Hearthstone) and a MOBA (Heroes of the Storm), and you have what can be reasonably called an entertainment juggernaut.

In its early days as Silicon & Synapse, the company even had a hand in racing and sports games, so you might say that the only major genre left was FPSes. And then, near the end of May, Blizzard dropped Overwatch to considerable fanfare, and the last bulwark toppled.

For the few of you who are still not aware, Overwatch is a team-based shooter that is strictly a multiplayer exercise in teamwork. The game shares a couple attributes with Team Fortress 2: it uses colorful animated characters rather than photo-realistic warriors, and it puts players in specialized roles that are each critical to the success of a team. Overwatch, however, gives players many more character options, ensuring that players of all skill levels can contribute in all four classes (Offense, Defense, Tank, and Support).

Games in Overwatch are separated into Assault, Escort, Assault/Escort, and Control game types, and they play out across 12 maps. When you enter the game lobby and toss your hat in the ring to enter a game, you'll be prompted to choose a hero from among the 21 available, and the game lets everyone joining your team know if nobody has chosen to play (for example) a Tank or a Support character yet, so that you can choose a character that will best help your team.



Blizzard Dominates Yet Another Genre

BY CHRIS TRUMBLE

\$59.99 (PC, XOne, PS4) • ESRB: (T)een
Blizzard Entertainment • playoverwatch.com

Additionally, you can change players during the game while waiting to respawn if you have died, which is a pretty cool way to ensure that teams can adapt if they start off with a glaring weakness or if they are playing a team that is particularly strong in one area or another and need to counter.

As such, the ideal Overwatch player is one who has solid familiarity with at least one character from each class and can switch as needed and not create a skill deficit. This makes Overwatch more difficult to learn than some shooters, but it also gives the game a great deal more depth, as your role (and, therefore your gameplay experience) can vary wildly in the course of a single evening of play.

Because Overwatch is more about tactical team play and cooperation than fast-twitch reflexes, movement in the game feels a little slow at first compared to many shooters, but once you become acclimated you'll forget all about it. As you progress as a player, your overall level increases, and you earn loot boxes that contain random prizes that let you customize your characters and your nameplate.

The most important thing to know about this game is that it is ridiculously fun and (as you'd expect from Blizzard) incredibly well-made. Characters and environments look amazing, everything works the way it should, and although the learning curve seems a little daunting when you first jump in, you'll find that learning the ins and outs of each class (and each character) is a labor of love. The result: Overwatch has been out for a month exactly at press time, and it is already a solid candidate for Game of the Year. ■





Heroism Has A Price (But Today It's 10% Off!)

BY VINCE COGLEY

\$9.99 (PC) • ESRB: N/A • Excalibur Games
www.excalibur-publishing.com

Fantasy RPGs tend to attract a variety of adventurers. There are single-minded heroes who never swerve from the main questline until they've slain Dark Wizard Vilecurse. Others are tireless explorers who put off saving humanity until they've charted every last rock and shrub in the land. The collectors are not only after the Sword of Kingly Kings but also the Hauberk of Dubious Durability.

MMORPGs in particular have another species of player: the medieval huckster. These people make a game of making money. They're not as interested in slaying dragons as they are in selling weapons, armor, and potions to the players who do. The only item stat they care about is profit margin. The only "dungeon" they care to visit is the auction house.

In Shoppe Keep, the hero of legend is the merchant who peddles his wares to other heroes. If you've ever played an RPG and wondered aloud, "Why isn't this apothecary adjusting the price of Manticore Saliva according to market demand?" Shoppe Keep is the game for you. The product of Lithuanian developer Strange Fire, Shoppe Keep puts you in the shoes of a humble retailer and tasks you with raking in as much gold as possible from would-be adventurers.

The role reversal is simple: In a typical RPG, vendors are the NPCs. Usually, we try to spend as little time in their stores as possible, selling the junk we've pillaged from one dungeon and buying what we need to raid the next. In Shoppe Keep, the NPCs are the warriors, mages, rogues, and druids who step into your five and dime.

Let's address a couple of *caveat emptors*. Most importantly, the main objective in Shoppe Keep is making gold—mountains and mountains of gold. There are a few "side quests," if you will, to embark upon, but if reckless profiteering ain't your thang, then Shoppe Keep ain't your game. Also, Shoppe Keep isn't exactly a visual tour de force. This isn't a criticism *per se*, but if you come into the game expecting the lush graphics of *Witcher 3* or *Skyrim*, you're going to leave disappointed.

If you can live with those limitations, Shoppe Keep is a lot of fun. The game's strongest . . . *ahem* . . . selling point is how well it understands and executes the fundamentals of the traditional RPG experience. You essentially start as a level 1 merchant with only a handful of gold and an empty retail space to your name, and Shoppe Keep doesn't let you immediately create a massive emporium stocked full of epic and legendary weapons and armor. In the beginning, you're limited to selling cheap potions and basic armor; we dare say that you have to grind your way to bigger and better merchandise, not unlike a typical RPG.



Other RPG hallmarks give Shoppe Keep a comfortable feel. As you gain XP (in the form of kPoints), you can invest in a series of talent trees that let you increase profits, attract new customers, deter thieves, etc. One way to accumulate kPoints is—you guessed it—completing quests. As your operation expands, you'll be able to craft items and hire your own adventurer who will undertake quests and venture into dungeons, bringing back loot for your shop.

Shoppe Keep isn't complicated, but it's strangely addictive. We like that the game doesn't take itself too seriously. (If you don't believe us, try jumping.) The pacing might be a tad sluggish in the beginning (for the first few hours, you'll spend a lot of time staring at that fire resist potion and waiting for it to sell), but once business picks up, Shoppe Keep is hard to put down. ■

MULTIPLE COLORS AND DESIGNS

COMPLETE YOUR SETUP WITH THE COLOR AND DESIGN THAT FITS YOUR STYLE

DXRACER

STEEL FRAMEWORK

PROVIDES UNPARALLELED SUPPORT AND DURABILITY

3D ARMRESTS

THREE DIFFERENT ADJUSTMENTS FOR THE PERFECT FIT

MULTI-FUNCTIONAL MECHANISM

TILT BACK 135°, LOCK THE ANGLE, AND ENJOY THE COMFORT

SENTINEL SERIES
OH/SK00/NB

HEAVY DUTY BASE

SUPPORTS UP TO 500 LBS

DXRACER

WWW.DXRACER.COM

USE CODE
CPUJULY2016
FOR 10% OFF

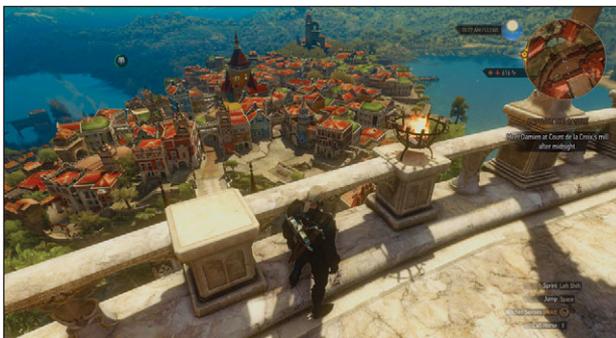
ATTENDING **QUAKECON?**
COME VISIT US
AT OUR BOOTH!



The latest, and last, DLC expansion for the stellar fantasy epic *The Witcher 3: Wild Hunt* just dropped, and after spending more than a hundred hours with this game, we feel we owe it to CD Projekt RED to not bury the lead—*Blood And Wine* is every bit as good as the core game (\$59.99) and last year's *Hearts Of Stone* expansion (\$9.99). Although *Blood And Wine* is double the standalone price of *Hearts Of Stone*, there's more than twice as much content, and it's worth every penny.

According to the developer, this expansion's story will take you 30 hours or more to complete. We're 33 hours in and still not done with the main story. The more than 90 quests, with 40-plus points of interest, all take place in the new region of Toussaint. Compared to the battle-scarred region of northern Temeria, where the events of *The Wild Hunt* primarily occur, Toussaint looks like a pristine fantasy utopia. It abounds with verdant rolling hills accented by patches of colorful wildflowers against a backdrop of craggy snow-peaked mountains. The centerpiece of the southern France-inspired landscape is a stunning white stone palace with red-roofed turrets that overlook the terraced duchy of Beauclair. It makes Disney's logo look like a shabby fixer-upper.

Of course there's the dark wilderness, populated with monsters of the slimy and scaled variety, as well as the more familiar depraved human variety. Vampires play a central role in the expansion, but like most fantasy tropes *The Witcher 3* adopts, there's a lot more to them. Apparently, they're just as apt to enjoy a sunny day as much as any human, and they fall in love and harbor grudges (usually for centuries at a time). The human-against-human conflict is here too, always



Geralt's Last Contract In The Land Of Love & Wine

BY ANDREW LEIBMAN

\$19.99 (PC, XOne, PS4) • ESRB: (M)ature
 CD Projekt RED • www.cdprojektred.com

bubbling under the surface: the gulf between the Haves and Have Nots is wider in Toussaint. And of course, it's on Geralt to right as many wrongs as he can, kill both manner of monsters, and maybe save a few of the people and creatures caught in the middle.

The main story centers on a series of savage unexplained murders that Geralt must solve, but there are dozens of side quests. One particularly good diversion was Geralt's task to obtain the saliva of a thought-to-be-extinct spotted wight with an affinity for spoons. As you play, you'll encounter a number of interesting characters, fill out more pages in your bestiary, acquire more powerful armor and weapons, and duel your way to an even more OP Gwent deck. There's even a new Gwent faction to try out. Early on, you get access to your own personal estate and vineyard, which you can upgrade to bestow Geralt with special bonuses that'll take the edge off some of the tougher battles.

Like with the previous expansion, you can dive into *Blood And Wine*'s first quest from your current quest log as long as you're at or above level 34. If not, you can start a new game with Geralt leveled appropriately with the corresponding number of skill points to spend on upgrades. Other new things include the ability to dye armor different colors, a level cap that has been raised to 100, and Geralt's ability to further enhance his skills with 12 new mutations.

There are bugs, like invisible horses and villagers, and glitched switches. They're annoying, but not game-breaking. If you're like us and don't want *The Witcher 3* to end, this expansion will more than sate you. For a little while at least. ■





"What is Duskers?" developer and publisher Misfits Attic asks of its game. Indeed, what is Duskers? Superficial answers are easy enough to come by. Duskers is a post-apocalyptic sci-fi game set in outer space. It's a rogue-like. It's a dungeon crawler. It's a strategy game. It's psychological horror. What sounds like an odd potpourri of genres turns out to be a singular experience that is in some ways indescribable.

Of course, it's our job to describe it, so here goes. In the future, an unknown catastrophe has apparently wiped out all human life, leaving behind a galactic graveyard of ruined spacecraft. You're the lonely soul who has to figure out how everything went pear-shaped. To do this, you must recover communications logs from the broken-down ships and try to make heads or tails of them. (Logs are frequently corrupted, and those that aren't may contain little or no useful information.) Instead of suiting up and scouring the ships yourself, Duskers gives you a small fleet of plucky drones that do the dirty work for you.

The drones respond to your commands, and you command them with—wait for it—a command-line interface. Perhaps as an homage to the computers of yestercenity, a keyboard is all you need to play Duskers. Issue your commands by typing, not clicking, them. Gaming without a mouse sounds like heresy, but it doesn't take long for the keyboard-only approach to set the mood. You really feel like a drone operator when you tell your little robotic workers to open this door and collect that scrap.

Your drones' chief tasks are exploration and scavenging, and this constitutes the bulk of Duskers' gameplay. As you pilot the drones through vessel after broken-down vessel, they'll come across upgrades



Boldly Go Where No Drone Has Gone Before

BY VINCE COGLEY

\$19.99 (PC) • ESRB: N/A • Misfits Attic
 duskiers.misfits-attic.com

for your ship as well as the drones themselves, other drones, and malevolent aliens. The latter want nothing more than to dine on your drones and are the biggest challenge you'll face.

The ships you encounter are procedurally generated, which is what gives Duskers its rogue-like feel. As you might expect, the benefits and drawbacks of using procedurally generated levels present themselves in Duskers like they do in any other rogue-like. No two ships are the same (although it's fair to say they can be very, very similar), and the threat of permadeath keeps you on your toes as you navigate through each ship.

Duskers' drones are the stars of the show. Each one has a name, which humanizes them more than it rightly should. This is a good thing. As you progress through the game, it's impossible not to form attachments to your little space-age Roombas. So when Kenneth gets his gears ripped out through his chassis, it's surprisingly affecting. I haven't been this moved by a bucket of bolts since "Wall-E."

The terror of having a hungry alien bearing down on my drones was as intense as any horror game I've recently played. All of this ratchets up the tension and horror *and* forces players to strategize the best ways to get their drones in and out of a particular ship unscathed. Each drone fulfills a different role based on the way you customize it, so you must coordinate drones based on their individual skills, as well as their limitations.

Duskers doesn't look like much, and that's OK. What it lacks in style it makes up in substance. Keep it on your deep-space scanner. ■



Q&A With Craig Smith

The Mechanics Of Car Hacking

Within the universe of automotive security research, Craig Smith is respected and well-known. Beyond being a frequent speaker at conferences and teaching classes on the subject, Smith authored “The Car Hacker’s Handbook: A Guide for the Penetration Tester.” Published in March, the book aims to propel more people to investigate the inner workings of their increasingly software-fueled automobiles. This includes communications-related components that can open up various threats and vulnerabilities. *The Wall Street Journal* notes Smith’s book “describes, in meticulous detail, how your car’s components talk both to one another and to diagnosticians—outlining all the ways good and bad guys can modify or attack the systems.”

Smith’s background in security includes years as a reverse engineer and running the security research company Theia Labs. He founded Open Garages, a community of individuals sharing and collaborating on automotive research, plus Smith cofounded the Hive13 Hackerspace and the automotive arm of the organization I Am The Cavalry. We spoke with Smith about his book, automotive industry security concerns, how to get started with car hacking, and why all owners should learn what’s going on under the hoods of their autos. (You can read our entire conversation at www.computerpoweruser.com/23113)

Q: You have a lot of titles: security researcher, hacker, reverse engineer, software developer, and others. How did hacking, technology, and automobiles specifically converge for you?

CS: That’s a great question. I definitely have a history of security research. I’ve done that for decades now, I guess. The transition to cars didn’t just happen. It wasn’t one of those overnight things. It was totally accidental. What happened was at the time, I was living in Cincinnati and driving to Dayton for my job, which was a two-hour commute. I bought a newer vehicle that could handle that commute, and this newer vehicle had a large touchscreen display. I used to have a radio that didn’t work half the time prior to that, so I was excited. I recognized the display as being a computer in my car, and I really thought of it that way. The first thing I did wasn’t really with the intention of a security assessment of my car. It was more like, “The maps are nice, but I know where I’m going and I don’t really need them. What I’d really rather have with that large-screen display is music videos.”

So I went to modify the radio to have music videos on my commute—not the most mature thing to do, but it’s what I do, and it passes the time. I had some



exposure to mechanics, but I’m not a mechanic. I came from the electronics area and software area. I really didn’t know how to go about it. I just started digging at it. I have a reverse-engineering background in general, so it wasn’t too intimidating for me, but eventually I figured out how to get code running, how to change things, and all that good stuff. I posted them online.

By the way, I never got the music videos to work because once I dug into it, I realized the processor just couldn’t

handle it. But I took the whole reverse-engineering journey into the entertainment center, and what happened was I got the attention of some researchers who had just started looking at car hacking. They approached me and said, “You’re one of the few people who is posting this stuff online.” They were looking to do security assessments on vehicles. That company was Battelle. They no longer have an automotive practice as of last year, but this was back in, I guess, 2010.

They asked if I’d be interested in helping out. They were doing this one-week experiment where they were bringing in high-school kids into this bunker. In this bunker they would have no cellphone access, no Internet access. These kids were selected by their teachers as kids doing well in school, interested in technology, and that sort of stuff. What we were going to do was bombard them with information on security, on how vehicles work, on electronics components, you name it. Then we were going to give them cars and let them hack and see what happened. When I heard that, I was like, “Absolutely. I’m in. 100%. Where do I have to be?” I did that and actually working with the kids and seeing what occurred in just a week’s time really opened my eyes to what I thought was a

really great experiment. Unfortunately, it was all under NDA, so nothing could be discussed as to what came about from it. I thought that was really unfortunate. I'm a very open person. I like open technology and open communications and inventions and all that good stuff. So I left that group to start my own that would be called Open Garages, initially thinking we'll do the same things as with Battelle and the kids, except we'll do it in public with no NDAs.

What happened was in the very first meeting, we had a bunch of mechanics and performance tuners who weren't security people at all. But they were like, "Hey, we have very similar issues. We're trying to understand how the electronics work and how these pieces get the jobs done." I kind of realized the problem was much, much bigger than just basic security. This involved the entire modification community and fully owning your vehicle. That changed the description of Open Garages to be all-encompassing. One of the biggest problems with some of the mechanics and performance tuners was they didn't grow up in as open a community as security people. They were very afraid of being sued for being open about what they figured out, whereas security people kind of talk about whatever they think of talking about. We don't have the same kinds of fears.

Being able to openly share how cars work and how we're really seeing things in the field and how we see the computers are working really helps out. There was a great deal of advancement. They'll lean on each other and be more public about things. From there, I got excited about it and collecting that information and making it easier for people to get into because I didn't consider getting started with car hacking really that hard. There's a lot to it, but there's not necessarily a difficult problem. I really wrote the book to get people over that initial learning curve of, "Well, I don't really know about cars. I don't know about computers or reverse-engineering." Hopefully this makes it that much easier to take that first step.

Q: How does a hacker's view of an automobile differ from that of the average driver or even a mechanic?

CS: The manufacturing groups have been around a long time, and they originally started as a bunch of mechanical engineers building vehicles. They kind of morphed into electrical engineers building vehicles. As a hacker, I don't see automobiles as either of those two. I see them as a software computer. All of these embedded systems are just running software now. These are discrete logic chips. They have firmware on them, and firmware runs code. That's just like anything else. We have thousands of chips all running code. Basically software in a box on wheels is how I see it. That's a little different than how the industry in general currently sees its vehicles. I think it's actually why we have a communications gap because manufacturers are still thinking that this is a physical vehicle, and I don't see it that way at all.

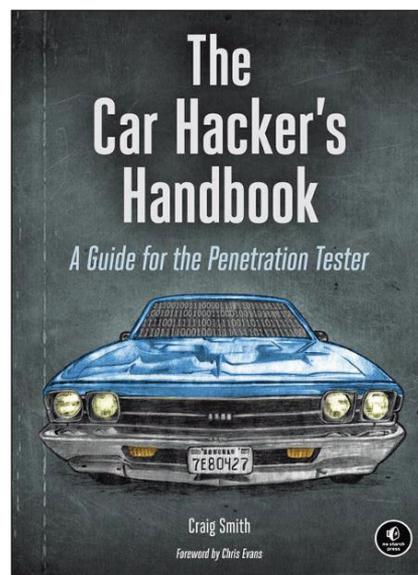
Q: Who is the "Car Hacker's Handbook" aimed at?

CS: This is the second iteration. The first one I wrote was in 2014. It's a much smaller version of the book I released for free. You can buy a physical copy, but for the most part it

was released for free. I was giving classes on car security at Virginia Tech at the time—not full-blown classes but more like one-day classes that happened to be on campus. I really wanted the students to have a little textbook to go with it, so I wrote one and released it for free. Within the first four days, my ISP where I put the book up on got shut down because I had over 300,000 downloads. I had a high-resolution version of the book and 300,000 downloads. They shut me down. I had no idea there was that kind of interest. It just seemed to me like, "Oh, some people might have an interest in seeing how cars really work and reverse-engineering them." Turns out I was way off. There were tons of people interested.

After realizing that, I went back to take a more serious stab at making a collection of a book. I started talking to a bunch of people. So it was a lot of lessons learned. Those people from the auto industry saw the first book and said, "This raises awareness but it doesn't really tell us ways of fixing things." That's a good point, so I added that to the new book. Then there was those people who said, "Hey, this is great from a security perspective, but performance tuners need that information, too," which they do. When I started Open Garages, I just didn't think about that because it was targeted at a small classroom environment that I was personally teaching. So the new version has performance-tuning information in it, as well. It was an accumulation of a lot of things to make this book.

With the original book, the reason it has the name "Owner's Manual" is because old-school cars used to have all the information you needed to modify them. They had full wiring diagrams. They had all the details on the parts. It really told you, "Here's your car. Here's everything you need to know if you want to mess with it." And they got away from that. I wanted to bring that back. That's why there's a picture of an old car on the cover of the "Hacker's Handbook"—to reopen that box and tell you how this is really working. That's really kind of the



big goal behind it. The new version of the book goes into even more detail with some extra stuff. It's primarily guided toward security-related things, but it does cover some other stuff, as well.

Q: A lot of our readers will read this and say, "This looks interesting. How do I get started?" You're very encouraging of this and even offer some tools to help. How do you suggest someone begin in car hacking?

too. Linux comes with all the capabilities to sniff and inject onto the CAN bus, which is built-in. And then if you have a sniffer that integrates between your car and your computer, you're good to go. You'll be able to get started with that.

If you're a little bit timid about working on your car, it's relatively safe assuming you're not driving the car. You can test on the OBD port and see things running but not moving without much risk of doing any damage. But if you're

If you're a little bit timid about working on your car, it's relatively safe assuming you're not driving the car. You can test on the OBD port and see things running but not moving without much risk of doing any damage.

CS: That's fantastic, and I would totally encourage that. I like to make it as cheap as possible. I think that's a large part of learning. If there's a financial hurdle, you're really limiting the intelligence and innovations by doing that. Whenever I try to teach someone, I try and go with open-source software and open-source tools. I try to keep everything under \$100 if possible. What I'd recommend is getting a device such as the CANtact. Or I also use a USB2CAN. Those are both around \$50 to \$60. One is open-source and one is not but also affordable. And then a Linux machine. This could be a live CD or if you just have a Linux box that would work,

timid about doing this or maybe you don't have a car, one of the tools I created is called ICSim, or Instrument Cluster Simulator. That will let you do the same kind of reverse-engineering and learning you'd do on your car but do it on your computer. It does require Linux because Linux has a virtual CAN environment built-in. It will let you just get started. It uses a joystick or Xbox controller or PS3 controller to simulate driving using the same controls that Grand Theft Auto would use. And then you can monitor a virtual box and reverse-engineer it and see the differences. That's usually what I teach my classes on.

Q: We've read things you've said about risks that third-party suppliers can open up in terms of car security. Can you talk about that?

CS: The FBI even touched on this, too. The FBI recently had a warning or sort of public service announcement saying, "By the way, your car could be hacked. You need to be diligent about who has access to your car" and these sorts of things. One of the things they pointed out multiple times was the OBD port. That's the dongle access that you'd use for emissions checks under the steering column. You still have to be in the car to have access to it, but it has pretty much raw access to a vehicle's bus networks. So if you leave a device in there, say some third-party device that maybe was supposed to track your teen's driving habits or something of that nature, if that's reported over the cellular line, which it usually is, you've now taken a vehicle and added a new entry point. So you now have a cellular connection to a small dongle that goes right into your vehicle bus. If you're driving around with that, what's to tell you that little device is secure when right now there's no certification for that? So you're really taking on a lot of risk.

Insurance companies are telling us that, "Hey, you can save \$25 if you drive around with a dongle in." But if that has cellular service, which a lot of them do, they're adding another attack surface, and you need to be very careful with that. They've been known to be hacked before. In the FBI document, they wrote about it at least twice. The FBI warned about insurance dongles. They may eventually get better about doing security there, but again, there's no certification or checks. So you're really putting your life at risk leaving a dongle in while you drive around. Even with older cars, people are like, "Oh, my car isn't new enough to have these attacks." But they're driving around with some kind of performance dongle. It's like, you just added that attack surface. It didn't have it, but it does now. ■



LANparty

LISTINGS

07.08-10.16

LANFest MLP'016*
Hamburg, NY

lanfest.intel.com/events/mlp016-summer

07.15-17.16

Ancient City Con
Jacksonville, FL
www.wardogz.org

07.15.16

CRITGAMER BYOC LAN Party
Tyler, TX
www.critgamer.com

07.15-18.16

PDXLAN 28*
Portland, OR
pdxlan.net

07.16.16

Oklahoma Gamers Group
Oklahoma City, OK
www.okgg.org

07.23.16

Willamette Valley Gamers LAN
Eugene, OR
www.wvgamers.com

07.28-31.16

MillionManLan
Louisville, KY

www.lanwar.com/LWEventHome.asp?EventID=133

07.30.16

KCGame On 70
Kansas City, MO
kcgameon.com

08.04-07.16

QuakeCon*
Dallas, TX

www.quakecon.org

08.05-07.16

MidWestLAN2016.reboot
Middleton, WI
midwestlan.com

08.12-14.16

DreamHack Montreal
Montreal, QB
montreal.dreamhack.com

08.20.16

Oklahoma Gamers Group
Oklahoma City, OK
www.okgg.org

08.20.16

Willamette Valley Gamers LAN
Eugene, OR
www.wvgamers.com

08.27-28.16

Wichita LAN 32
Wichita, KS
wichitalan.com

09.02-05.16

PAX Prime*
Seattle, WA
west.paxsite.com

09.16-18.16

Ready Set FightCon
Tigard, OR
readyssetfightcon.com



Introducing NEW BAWLS Guarana ZERO.

NOW available at

MICRO CENTER and WWW.BAWLS.COM

Zero sugar. Zero calories. Same delicious
BAWLS Guarana flavor and caffeinated kick!



BAWLS[®]

GUARANA

09.17.16

Oklahoma Gamers Group
Oklahoma City, OK
www.okgg.org

09.23-24.16

CPU LAN
Lincoln, NE
www.computerpoweruser.com

09.23-25.16

PONG Expo LAN 2016
Menomonie, WI
pong.uwstout.edu

09.23-25.16

Wardogz LAN Group
Orange Park, FL
www.wardogz.org

09.24.16

Willamette Valley Gamers LAN
Eugene, OR
www.wvgamers.com

10.08.16

KCGame On 71
Kansas City, MO
kgameon.com

10.15.16

Oklahoma Gamers Group
Oklahoma City, OK
www.okgg.org

10.22.16

Willamette Valley Gamers LAN
Eugene, OR
www.wvgamers.com

10.28-30.16

BaseLAN 30
Winnipeg, MB
www.aybonline.com

11.04-06.16

LAN In The Highlands
Latrobe, PA
www.clubconflict.com

11.04-06.16

Maryland LAN Gamers
Greenbelt, MD
www.marylandlangamers.net

11.18-20.16

PONG November LAN
Menomonie, WI
pong.uwstout.edu

11.19.16

Oklahoma Gamers Group
Oklahoma City, OK
www.okgg.org

12.03.16

KCGame On 72
Kansas City, MO
kgameon.com

12.17.16

Oklahoma Gamers Group
Oklahoma City, OK
www.okgg.org

* Event scheduled to include a **CPU** case mod contest

Looking to get your LAN sponsored? Hit us up at
www.CPUMag.com
www.Bawls.com/sponsorship-requests



20TH ANNIVERSARY

UPGRADE YOUR RIG WITH
UP TO 30% OFF



Q&A With Travis Bortz

AVADirect Exec, VP Talks VR

Q: With the advent of the Oculus Rift and the HTC Vive, VR is obviously becoming a pretty big deal. What is AVADirect's outlook on VR as a whole, and what is the company doing to prepare customers for the VR experience?

TB: In December 2014, the term "virtual reality" became a buzzword around the office, and we began positioning ourselves in the industry with strategic partnerships. Those partnerships include Virtuix Omni, Sixense Entertainment, and Road to VR. Over the course of the past 18 months, we have conducted extensive R&D to ensure we are powering the most immersive and powerful VR experience in the marketplace. Additionally, we have updated our website with VR-Ready emblems to provide our customers with a user-friendly experience when shopping for their VR PC.

Q: What things must a PC have to be considered VR-ready, and how much difference is there at this point between the minimum specs and the recommended system specs?

TB: For a PC to be considered VR-ready for the HTC Vive and the Oculus Rift, the requirements are different. The HTC Vive requires the following specifications: NVIDIA GTX 970 or greater, an Intel Core i5-4590 or greater, and 4GB of RAM or greater. For the Oculus Rift, the minimum specifications are: NVIDIA GTX 970 or greater, an Intel Core i5-4590 or greater, and 8GB RAM or greater. Our universal recommended specs at AVADirect are an NVIDIA GTX 1070 or greater, an Intel Core i5-6400 or greater, and 8GB RAM or greater. We also recommend having the system built with an SSD.



With that being said, HTC's and Oculus' specifications are the minimum requirements, and while they will provide a good experience, it won't be a phenomenal experience. This is because VR is extremely GPU-intensive. By compromising your choice of graphics card, you also compromise the frame rate (FPS). This affects the rate at which a GPU displays consecutive images. The higher the FPS capability, the smoother the experience will be. Additionally, running your OS and games on an SSD is going to improve your experience from that of an HDD.

Q: It looks from your site like AVADirect has a variety of VR-ready options available. What can you tell us about the Avatar, for example?

TB: The Avatar is our flagship VR computer. The name "Avatar" reflects the system's ability to create an extension of the user through the use of another vessel—often how a VR experience is. It is built using the industry's top hardware components, coupled with optimized testing

to meet the most rigorous VR hardware demands. We selected the hardware and configuration we did because it allows for SLI, enabling more fluid performance, and ultimately creating a better VR experience. Again, the importance of attaining the highest frame rates possible is imperative when wanting to achieve the utmost immersive VR experience.

Q: Your AVA Omni VR Desktop is designed for use with the Virtuix Omni, correct? For readers who aren't familiar, what is the Virtuix Omni, and how does it work?

TB: AVADirect and Virtuix Omni began their partnership in 2014 to enhance the virtual-reality experience by combining their core competencies. The Virtuix Omni is an immersive, first-of-its-kind gaming system that supports a full virtual reality experience. The Omni allows anyone to walk, run, strafe, and jump within a 360-degree virtual world by leveraging natural movement creating an unprecedented sense of reality. The AVA Omni VR Desktop Series was engineered and designed for the Virtuix Omni gaming platform by AVADirect. Endorsed by Virtuix Omni, this desktop was configured with VR users at the forefront, providing a seamless gaming experience and offering optimal capabilities, while achieving top-tier 3D virtual reality gaming functionality.

Q: OK, and you also have a system that your team has designed to work hand in hand with the Sixense STEM System. What kinds of experiences does this provide?

TB: In 2015, AVADirect and Sixense initiated their partnership to

enhance the virtual-reality landscape by merging their companies' visions within the industry. The Sixense STEM System is a wireless motion-tracking platform that enables gamers to interact naturally and intuitively by tracking full positions and orientation at all times. The STEM System enables the freedom of movement for any activity, spanning the spectrum from desktop competitive gaming to VR with full-body tracking and locomotion. The AVA Sixense VR Desktop Series was specifically engineered and designed for the Sixense STEM System gaming platform. Certified by Sixense Entertainment, this PC is designed to provide a seamless gaming experience through the AVA Sixense custom computer, the STEM System, and a VR headset.

Q: What can you tell us about the AVA Exemplar and what kind of collaboration did you have with Road to VR in designing the system?

TB: AVADirect and Road to VR teamed up to create the Exemplar, designed to push virtual reality experiences above and beyond what's possible with systems built to lesser recommended VR specifications. Road to VR is a leading publication dedicated to the consumer virtual reality industry; it worked directly with AVADirect to create a system capable of handling the most demanding virtual-reality experiences.

Q: Given your work with VR systems, you've probably spent a little time under the headset yourself, right? What's your favorite VR experience so far?

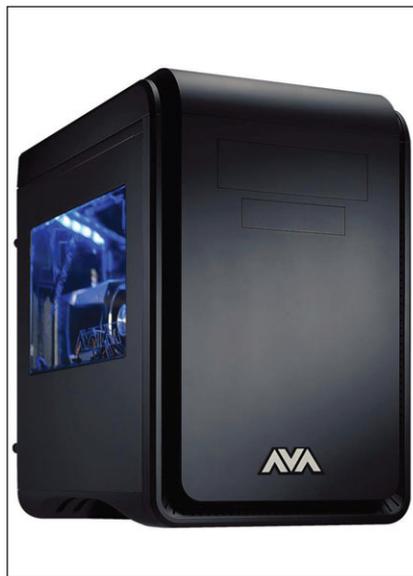
TB: I have, and of course my best experiences have been those with our partners. The games developed with Virtuix and Sixense Entertainment in conjunction with their respective peripherals, the Virtuix Omni and the Sixense STEM System, take virtual reality to unparalleled levels. For the experience to not only be immersive but also physically interactive provides unmatched experiences.



AVADirect's Sixense VR Desktop, built for use with the Sixense STEM System.

Q: How have VR games and other kinds of applications surprised you the most at this point?

TB: I think what is most fascinating is how virtual reality is transforming the medical space. Gaming is great and much of our business model, however when you can positively impact people's lives who are suffering from extreme pain or other medical challenges—well, that's especially



AVADirect's Avatar (above left) and AVA Exemplar (above right), just two of the many VR-ready configurations available on www.avadirect.com.

gratifying. Additionally, how virtual reality is going to transcend much of the entertainment world as well as business as a whole is pretty intriguing. The advancements in virtual reality in the past three years have been tremendous, and I can only imagine how VR will continue to evolve over the course of the next couple years. It is exciting to be a part of it.

Q: Thanks for your time today, Travis. Before we go, what would you say to someone who's curious about VR but has never experienced it?

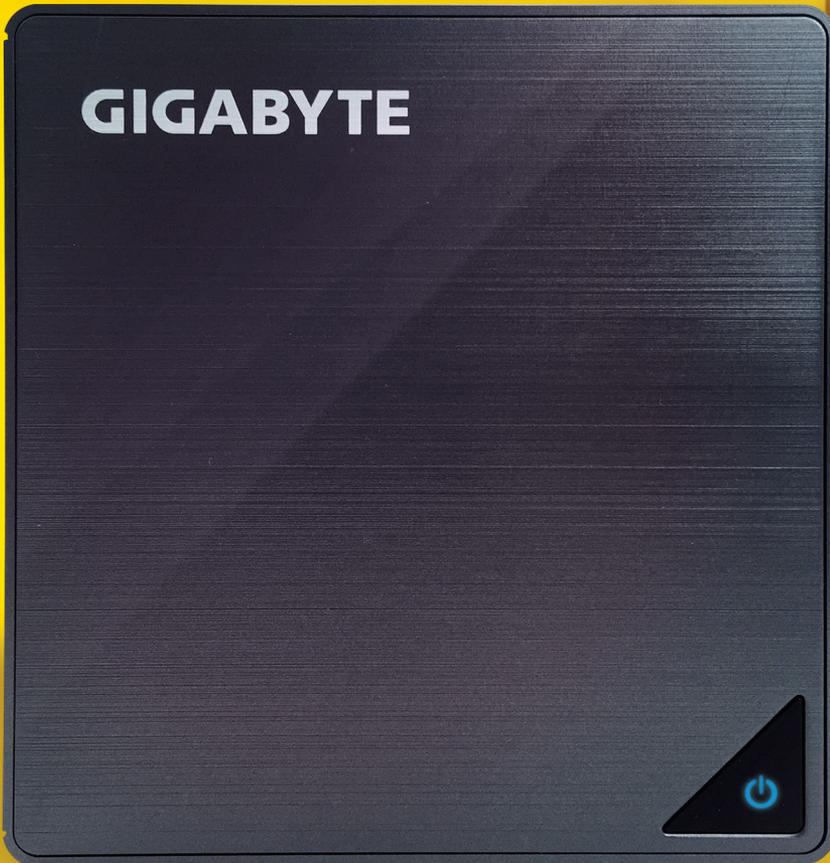
TB: Go out and try it. Virtual reality is something special. It is mind-blowing. It's not comparable to other gaming experiences. While it is more expensive than traditional gaming experiences, the return on investment is there. Immersing yourself in the world of virtual reality will change your perspective on the way you view technology and gaming today as well as the future of technology as a whole. I can promise you, experiencing VR powered by an AVADirect VR-ready PC will set the bar for you. ■



GIGABYTE™

BRIX™ PC

FULL COMPACT SYSTEM



GIGABYTE

BUILD APPEALING



BRIX FULL SYSTEM

GB-BSI7H-6500-LA-IWUS | MSRP \$699.99

* BANANA FOR SCALE

EXCLUSIVE DEALS AT

amazon.com

PRICING AND MODELS MAY VARY



GA-Z170X-GAMING 6
MSRP \$169.99



GA-X99P-SLI
MSRP \$249.99



BRIX FULL SYSTEM
GB-BSI7H-6500-LA-IWUS
MSRP \$699.99

UP TO \$20 OFF

WWW.GIGABYTE.US | CA.GIGABYTE.COM

WHERE TO BUY



amazon.com



MICRO CENTER

