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MODDER Q&A  
RON LEE CHRISTIANSON

## PROJECT RED GOTHAM

CLEANING UP THE STREETS ONE MOD AT A TIME





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**GT72s Dominator Tobii**

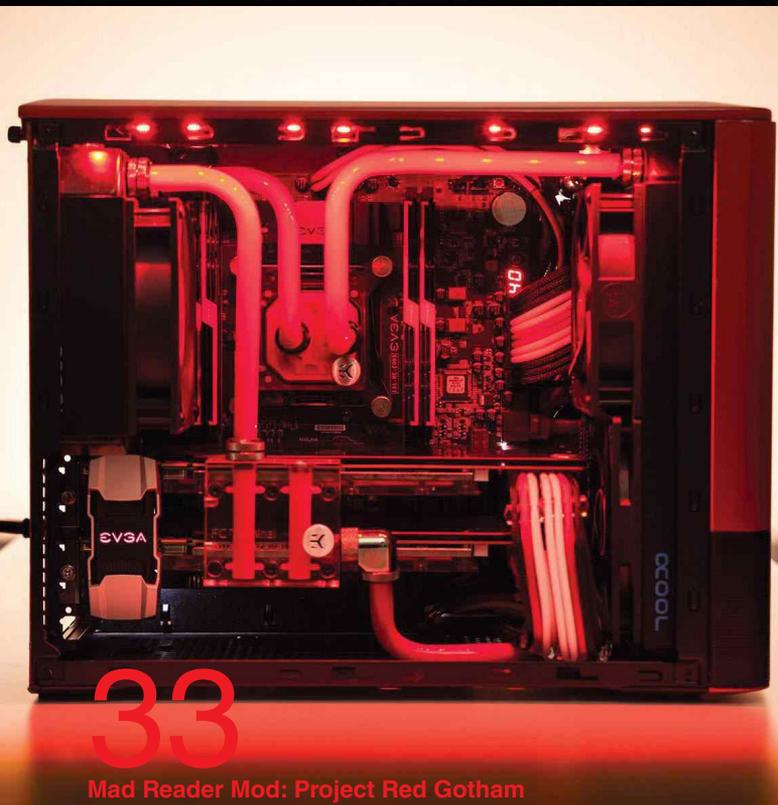
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33

Mad Reader Mod: Project Red Gotham

43

CPU At Dreamhack Austin 2016

**FRONTSIDE — P. 4**

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. 57**

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

**LOADING ZONE — P. 64**

Software projects, betas, updates, and more.

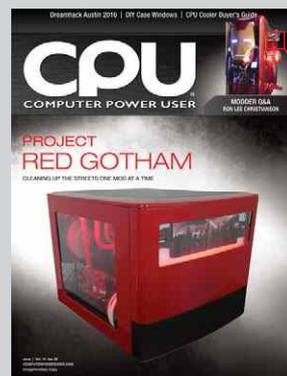
**DIGITAL LIVING — P. 70**

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

**BACK DOOR — P. 87**

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

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## ASUS ROG Strix X99 Gaming Lets Builders Swap Logo Patches

ASUS recently announced four new motherboards with the X99 chipset. Three of the boards fall under its Signature Series brand: the X99-Deluxe II, X99-A II, and X99-E. These boards are all ATX motherboards that are designed for Intel Core i7 processors that use socket LGA 2011-v3. The fourth X99 board ASUS announced is the ROG Strix X99 Gaming. The Strix board targets users who like to show off their systems, and it includes ROG logo stickers in various colors so users can match the color scheme of their particular builds. Specs for the board match its good looks: It supports up to 128GB of DDR4 at 3,333MHz and has one U.2 connector and one M.2 Socket 3 with M Key; eight SATA 6Gbps; two USB 3.1 (one Type-A and one Type-C) and eight USB 3.0; SafeSlot, a reinforced PCIe slot that provides extra support for heavy graphics cards to prevent them from shearing off from the motherboard; and Aura, the ASUS technology for controlling LED lighting on your system.

## ADATA Launches Xtreme Performance Gear Dazzle DDR4

ADATA is launching a new line of memory modules under its XPG (Xtreme Performance Gear) brand. The XPG Dazzle modules are DDR4 memory with heatsinks that include special LED memory technology patented by AVEXIR. LED strips on the heatsinks light up with a soft red glow that really shows off the interior of your build. ADATA's XPG Dazzle memory will be available in these kit capacities: 8GB x 2; 8GB x 4; 16GB x 2; and 16GB x 4. The 1.2v memory supports Intel's XMP 2.0 standard that allows users to easily overclock their systems. ADATA says the modules use high-quality 10-layer PCBs and take advantage of special Thermal Conductive Technology to provide better heat dissipation and improve reliability. Modders and enthusiasts who want something different to show off in their next build should take a look.



### 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	\$229.99	\$224.99
AMD FX-9370 Eight-Core (Vishera)	6/11/2013	\$375	\$199.99	\$189.99
AMD FX-8350 Eight-Core (Vishera)	10/23/2012	\$195	\$149.99	\$149.99
AMD FX-8320 Eight-Core (Vishera)	10/23/2012	\$169	\$139.99	\$124.99
AMD FX-6350 Six-Core (Vishera)	4/30/2013	\$132	\$129.99	\$129.99
AMD A10-7850K Quad-Core (Kaveri)	1/14/2014	\$173	\$114.58	\$114.95
AMD A10-7800 Quad-Core (Kaveri)	7/2/2014	\$153	\$122.73	\$121.95
AMD A10-7700K Quad-Core (Kaveri)	1/14/2014	\$152	\$114.99	\$104.99
AMD A10-6800K Quad-Core (Richland)	6/4/2013	\$142**	\$127.10	\$131.55
AMD A10-5800K Quad-Core (Trinity)	10/2/2012	\$122**	\$176.16	\$109.95
Intel Core i7- 5960X Eight-Core (Haswell)	8/29/2014	\$999**	\$1,049.99	\$1,015.99
Intel Core i7- 4960X Six-Core (Ivy Bridge)	9/3/2013	\$990**	\$1,500.00	\$1,268.18
Intel Core i7- 5930K Six-Core (Haswell)	8/29/2014	\$583**	\$598.00	\$579.00
Intel Core i7- 4930K Six-Core (Ivy Bridge)	9/3/2013	\$583**	\$599.99	\$549.99
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**	\$349.99	\$339.99
Intel Core i7-4790K Quad-Core (D.Canyon)	6/25/2014	\$339**	\$339.99	\$339.99
Intel Core i7-4820K Quad-Core (Ivy Bridge)	9/3/2013	\$323**	\$497.99	\$455.74
Intel Core i7-4790 Quad-Core (Haswell)	5/11/2014	\$303**	\$309.99	\$309.99
Intel Core i5-6600K Quad-Core (Skylake)	8/5/2015	\$249**	\$244.99	\$244.99

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



## MSI X99A GAMING PRO CARBON Debuts With Mystic Light RGB LED

With a complete redesign for its heavy plated heatsinks and covers, onboard Turbo U.2, a USB 3.1 Type C slot on the front, and more, MSI says its X99A GAMING PRO CARBON motherboard was built from the ground up. Onboard Turbo M.2 and Turbo U.2 mean you can transfer data through a PCI Express 3.0 x4 interface at up to 32Gbps, plus it offers both a USB 3.1 Gen 2 Type A and Type C interface. The X99A GAMING PRO CARBON supports the Intel Core i7 Processor Extreme Edition and is the first X99 model from MSI that features Game Boost, which offers eight gears of up to 5GHz of one-second overclocking. In addition to those features, the X99A GAMING PRO CARBON has other items MSI has become known for. Mystic Light RGB LED supports up to 16.8 million colors and 17 LED effects to personalize your rig. Plus, you can now control Mystic Light features through Wi-Fi using your smartphone.



## Newest MasterCase Arrives

Cooler Master has officially released its MasterCase Maker 5, one of three MasterCase models it unveiled earlier this year. The MasterCase concept involves a totally modular case, with base models that can be reconfigured in multiple ways. Cooler Master says its MasterCase Maker 5 model is aimed at “enthusiasts that look for state-of-the-art technologies.” The new case model includes a tempered glass side panel, and the front and top panels have extra padding to reduce noise. The I/O in the MasterCase Maker 5 includes four USB ports (including one Type C). The case comes with four preinstalled fans (two 140mm at the front, and one 140mm in the rear), but it can support up to six more. There are seven expansion slots. There are two 5.25-inch optical drive bays, five 3.5-inch HDD bays, and 2+5 2.5-inch SSD bays. Other features include a preinstalled red LED strip (with four LED connections available). This version of the MasterCase series comes with a top cover, solid plate, front-panel door, and fan controller for an MSRP of \$189.99.

## Razer's ManO-War Tournament Edition Headset For Overwatch

If you're enjoying the release of the team-based shooter Overwatch, you'll want to check out a new line of PC peripherals from Razer that are based on the game. First up in the Overwatch-themed lineup is the Razer ManO-War Tournament Edition gaming headset. The \$109.99 Overwatch headset has a fully retractable MEMS mic with inline volume and mic controls for crystal-clear communications. Extra-large 50mm drivers are custom-tuned to ensure you hear chat and audio cues, and the headset's rotatable, closed ear-cup design with plush circumaural padding blocks out ambient noise. Other products Razer is rolling out with the Overwatch theme include a BlackWidow Chroma keyboard (\$179.99), DeathAdder Chroma mouse (\$79.99), and Goliathus Extended Overwatch mouse mat (\$34.99).





## Lian Li PC-O9 For Liquid-Cooling Fans

Lian Li has a new case coming in mid-June that's sure to appeal to liquid-cooling fans and builders who like to show off the interiors of their systems. The PC-O9 is a midtower chassis that's basically cleaved in two, with brushed aluminum on one side and smoky tempered glass on the other. The glass side of the case is the primary compartment and the thicker of the two parts, and it's meant to house the motherboard and graphics card(s). The windowless aluminum side holds the power supply and drives. There's a band etched with the Lian Li logo that connects the two sides. The band comes in either black or red, and it contains the power button and inputs. Lian Li says this case has the most flexible layout for cooling in the "O" (for open) series of cases and is the company's "best chassis for water cooling." The PC-O9 can hold two 120mm x 360mm radiators on the glass side, plus there's an option to hide a radiator in the aluminum side and pass the tubing through rubber grommets to the glass side. The case comes with a removable universal mounting plate that should fit most water pumps.

### HARDWARE MOLE



## G.SKILL Expands Trident Z Lineup

G.SKILL announced it is adding new memory kits to its burgeoning Trident Z brand line. The new kits all use either 8GB or 16GB modules and offer lower latency settings than existing models. At the high end, the new kits top out at 4,266MHz. The new DDR4 kits are all 1.35V units that come in 3,200MHz, 3,466MHz, and 4,266MHz frequencies. The fastest memory is only available in a 16GB kit (8GB x 2) with a CL timing of 19-23-23-43. The 3,466MHz kits all have CL timings of 14-14-14-34 and come in four capacities: 8GB x 2; 8GB x 4, 16GB x 2, and 16GB x 4. The 3,200MHz kits all have CL timings of 13-13-13-33 and come in the same capacities as the 3,466MHz models. Pricing was not available as we went to press, but G.SKILL says we can expect to see the kits at retailers this month.

## EK Rolls Out Slim Series Kits

EKWB's new Slim Series kits contain all the components a user needs to construct a cooling loop. The kits are called "Slim" because they contain slim radiators and are meant to be used in smaller builds. The three kits in the series take their names from the size of the radiators: EK-KIT S120, EK-KIT S240, and EK-KIT S360. Each kit comes with a slim radiator, pump with reservoir, waterblock, 120mm cooling fans (one for the 120, two for the 240, and three for the 360), tubing, coolant, and various fittings. EK says most of the items in the kits are already preassembled as the kits target liquid-cooling novices and people who are building space-constrained systems. The kits allow a builder to form a custom loop, but they include everything the user needs in one package. Pricing varies by size; the EK-KIT S360 is \$219.99.





## Panda Offers Pay-As-You-Go Antivirus

The new Panda Protection Service is the only antivirus service that lets you pay for what you use and have the flexibility to cancel the service any time you want.

The service has features to safeguard your data, stay secure with real-time antivirus protection, block access to inappropriate and harmful content, manage passwords, know the real-time location of all your devices and lock and wipe them when needed, and access important information regardless of the time or place.

Panda Protection Service is offered as a pay-as-you-go plan. Coverage starts at \$5.99 a month, with the first month free and the ability to cancel the subscription at any time. It comes with an unlimited license to protect all your devices, including PCs, smartphones, and tablets, and the Panda 100% virus detection guarantee.

## Report Shows Progress When It Comes To Harmful Applications

The installation of potentially harmful applications is the biggest threat to the Android ecosystem. But last year, Google made significant headway in limiting those threats, decreasing by more than 40% the likelihood of installing such an app from Google Play. The company made the announcement as part of its most recent annual report on Android security.

The report shows that 17.8 million people used Android Device Manager to locate their device last year; most users find their device with locate and ring functionality and don't have to resort to the lock and wipe functions. Google's



application security analysis systems were performing ongoing automated analysis on more than 35 million APKs (Android Application Packages), which the company says includes every version of every application that has been published in Google Play and millions that were never published. In fact, at the end of last year, 75% of those APKs were not in active circulation and another 10% had fewer than five installations. In all, Google reports that it checked more than 6 billion installed applications each day last year, scanned 400 million devices per day, and protected hundreds of millions of Chrome users on Android.

### SOFTWARE SHORTS

## FileMaker Updates Its Program For Creating Custom Apps



The FileMaker platform, which makes it easy for non-programmers to build custom apps, gained a number of new features in its latest update, version 15. FileMaker, which is an Apple subsidiary, added functionality aimed at iOS, including being able to use the

capabilities of other apps on an iOS device to share and modify FileMaker content. For example, you can use a photo-editing app to enhance pictures or use iCloud or another cloud storage service to easily send and receive files. FileMaker 15 also supports 3D Touch and Touch ID for securely accessing your custom apps;

iBeacon support provides location-based data to your custom apps. With FileMaker WebDirect, you can use your mobile phone, in addition to a desktop or tablet, to access FileMaker apps via a web browser. A responsive user interface optimizes buttons, fonts, and menus for a streamlined experience, according to FileMaker. Updated security features include support for more SSL certificate types and those from more vendors.

Other enhancements in FileMaker 15 are aimed at streamlining the app-building process. For example, script errors are now highlighted in red so you can quickly find problem areas, and you can undo scripting to instantly recover scripting work (there are unlimited undos and redos, as changes aren't finalized until you save and exit the Script Workspace). Plus, more options such as basic Starter Solution templates; web-based help; and an updated user interface and newly designed status toolbar icons improve FileMaker's ease of use.

## Survey: We're Increasingly Worried About Online Privacy & Security

How do you feel about the way private corporations and the government are handling your personal data? If you're like most, you're getting increasingly worried, according to a survey of Internet users worldwide. About 57% of respondents are more concerned about their online privacy than they were a year ago, according to the survey conducted by Ipsos and the Centre



for International Governance Innovation. Just 30% think their government is doing enough to keep personal information secure, and 80% are concerned their information may be bought, sold, or monitored.

Users are taking action, with 83% of respondents changing their online behaviors to control the amount of personal information being shared online. About 55% avoid opening emails from unknown addresses and 39% limit the biographically accurate information they give online. When it comes to addressing cybersecurity threats, 85% of respondents agree that governments should work together to combat such threats. In cases of national security, most Internet users are in favor of law enforcement accessing private online conversations, with 85% saying governments should be able to find out who a crime suspect has communicated with online and 63% agreeing that companies should not be able to develop technologies that prevent law enforcement from accessing online conversations.

## New Company Looking To Transform Internet Service

We've heard companies before promise to "transform" Internet service, but Starry, which launched in January, is focused on fixing a few key issues: spotty service, complicated setup, and difficult-to-understand pricing plans. The service, scheduled to launch in beta form in the Boston area this summer, promotes itself as the "wireless broadband network of the future."



Starry Internet is based on millimeter-wave active phased array technology, which takes underutilized high-frequency spectrum and uses it to form a wireless broadband network capable of speeds up to 1Gbps. Starry explains that the service depends on a Starry Beam that sends an Internet connection to a Starry Point subnode that's inside your home. Starry Point connects wirelessly to your Starry Station, which provides the Internet access. The lack of wiring and simple hardware mean you can be online in minutes, the company notes. Starry advertises "simple pricing" and "open, transparent, cap-free data." You can head over to [starry.com](http://starry.com) to learn more about the Starry Internet service and how it works and get signed up for notifications when Starry Internet will be available in your area.

### SITE SEEING

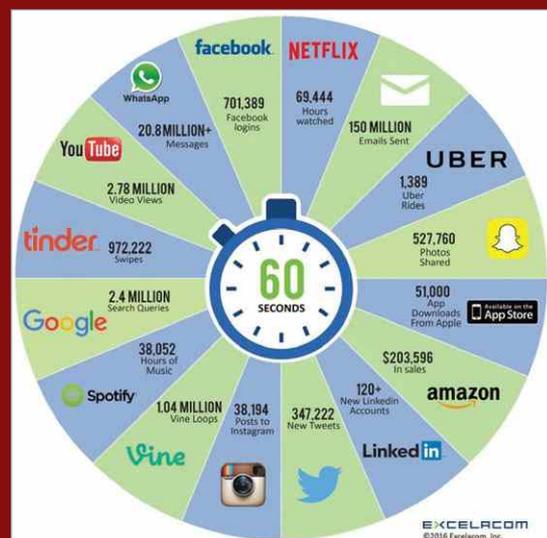
## What Happens In An Internet Minute?

How many search queries do you think Google answers each minute? What about the number of apps downloaded from Apple's App Store? A study by Excelacom offers the answers.

Every 60 seconds, on average, there are:

- 2.4 million search queries on Google
- 69,444 hours watched on Netflix
- 51,000 app downloads from Apple's App Store
- 1,389 Uber rides booked
- 2.78 million video views on YouTube
- More than 120 new accounts set up on LinkedIn

Excelacom reports the vast majority of those numbers have increased significantly from a year ago, with Uber rides almost doubling and Amazon selling \$83,836 more in goods each minute.



# 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

Save the date now, and watch for more details and registration information soon at [www.ComputerPowerUser.com](http://www.ComputerPowerUser.com) and in the pages of ***CPU* magazine!**





## Job Of The Month

Dell has been around almost as long as personal computers and is now one of the largest computing technology companies in the world (it's getting even bigger thanks to acquiring EMC for about \$65 billion). The company is looking for a cloud services engineer in the Atlanta, Georgia, offices of another one of its subsidiaries called SecureWorks (see, we told you Dell was big). This person will join a cloud ops team that builds full application stacks in AWS. You'll need excellent scripting skills, as you'll be "writing infrastructure as code in Python and Ruby." You also need solid Linux credentials and familiarity with AWS and network services such as LDAP and DNS. If you're acquainted with Chef and Puppet and know a little about Vagrant and Packer, those are big pluses. A BS or MS in CS is good, but experience can count, too. It's what you know, you know? Atlanta has a big and growing tech scene, so if working in the cloud in the land of peaches sounds like your thing, check out the details at the link below.

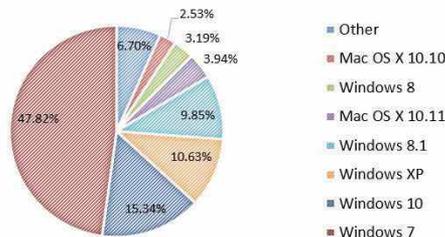
Source: [jobs.dell.com](http://jobs.dell.com)

## And It's Windows To Win, Place & Show

The good news for Microsoft is its flagship product family, the Windows operating system, continues to dominate the worldwide OS market. The five most popular iterations of Windows account for 86.83% of the installed market, while the top two Apple OSes account for just 6.47%. The bad news for The Gang From Redmond? Microsoft's most recent Windows version, Windows 10, has only a third as many installations as the aging king of OSes, Windows 7 (15.34% compared to 47.82%). That's even though upgrades to Win10 are still free, at least until July 29. In the "Other" category, less popular versions of Windows and Mac OS are lumped in with Linux to reach a total of 6.7%.

Source: [NetMarketShare.com](http://NetMarketShare.com)

OPERATING SYSTEM MARKET SHARE BY VERSION



## As Internet Of Things Grows, So Do Security Risks

The transition to IoT, or the Internet Of Things, is already taking place, with all kinds of products (cars, light bulbs, drones, doorbells, and so on) being connected to the Internet. But with every new device that goes online, there's another connection that could possibly be exploited. According to research firm Gartner, 6.4 billion devices will be connected globally this year, and that number is expected to nearly double by 2018. Gartner predicts that by 2020, more than 25% of digital attacks at the enterprise level will involve IoT breaches. Forecasts like this are helping drive growth in the nascent IoT security industry, which Gartner forecasts will pass \$547.2 million in 2018. Gartner says spending on IoT security will keep growing, and that by 2020, more than half of all IoT implementations will use some form of cloud-based security service.



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

## RAW Numbers:

27

The percentage of American car owners who say they would like it if their auto could communicate with other connected smart home devices such as garage doors.

[Parks Associates](http://Parks Associates)

2.3 million

The number of United States households that already own some type of virtual reality headgear.

[Parks Associates](http://Parks Associates)

101 million

The total number of PCs (desktop computers, notebooks, 2-in-1 portables, and tablets) that shipped globally during the first quarter of this year. This was a 13% year-over-year decrease from Q1 2015. Apple shipped 14 million units during the quarter, the most of any manufacturer.

[Canalys](http://Canalys)

427 million

The projected number of people worldwide who will watch at least some eSports events on television or online by the year 2019.

This number includes an estimated 215 million enthusiasts or frequent viewers and 212 million occasional viewers.

[Newzoo](http://Newzoo)

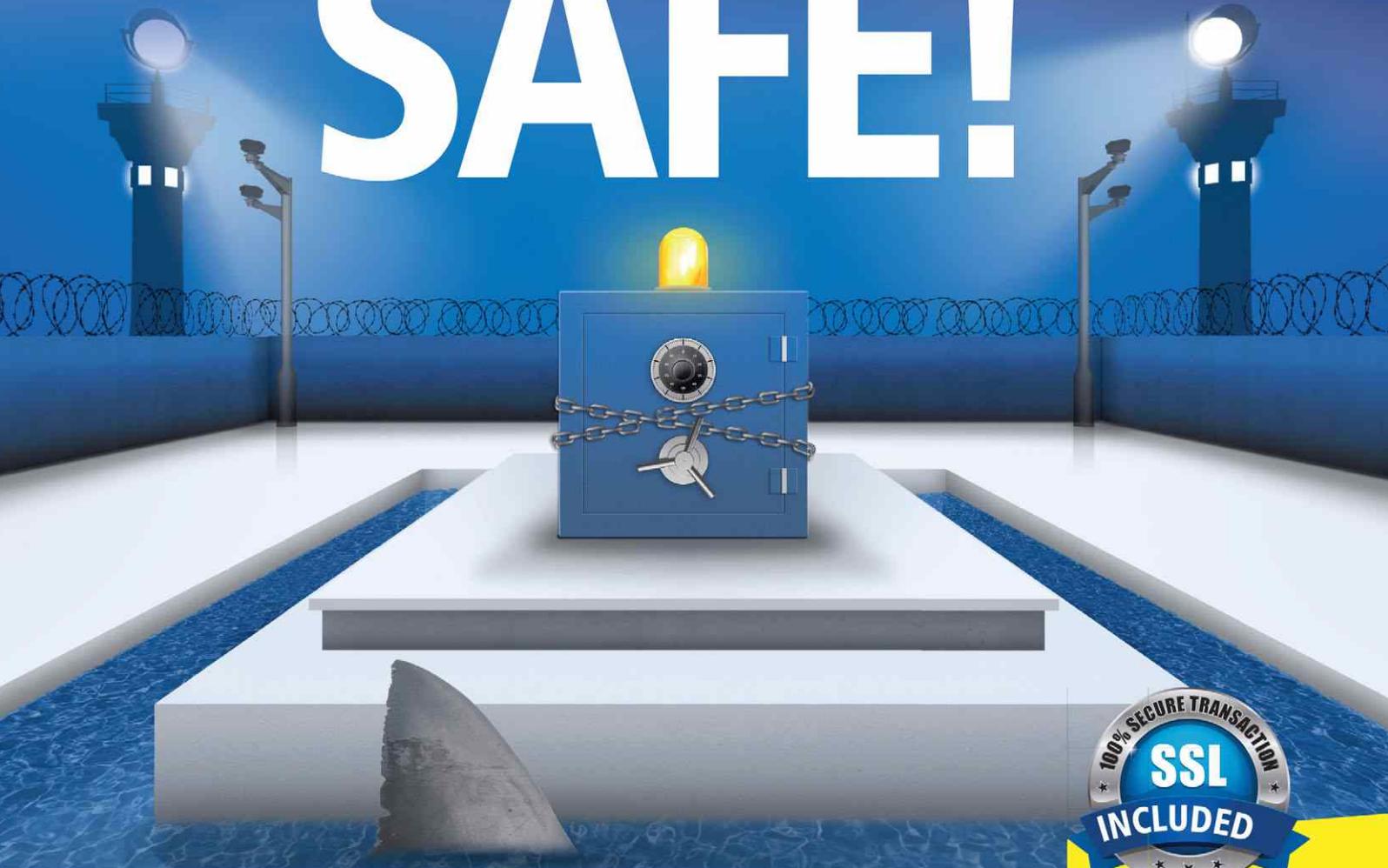
9 billion

The total number of hours that Microsoft says people have spent playing games on Windows 10 computers since the OS launched in July 2015. That's more than 1 million years of gametime.

[Microsoft](http://Microsoft)

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# Force 10 From Santa Clara

## NVIDIA Unveils The GeForce GTX 1080



As paper launches go, the new GeForce GTX 1080 from NVIDIA is a very pretty bit of origami. While in Austin for DreamHack, we took a brief break to attend a special launch presentation for gamers and the press. At the event, NVIDIA President and CEO Jen-Hsun Huang took the stage to pull the wraps off the GeForce GTX 1080 and 1070. It's safe to say, PC gaming just got the shot in the arm it sorely needed.

The GPU inside this flagship enthusiast graphics card is code-named "GP104," and it's manufactured using a new 16nm process, with 7.2 billion FinFET transistors. These are dual-gate transistors, not like

Intel's tri-gate variants, but the benefits of both designs are the same; the ability to dynamically power down the channel to reduce current leakage and dramatically

improve efficiency. The 16nm manufacturing process saves a lot of space compared to the Maxwell GPU in the GeForce GTX 980, which is manufactured at 28nm; NVIDIA

NVIDIA was able to cram 2 billion more transistors onto a die that's actually 84mm<sup>2</sup> smaller . . . . .

was able to cram 2 billion more transistors onto a die that's actually 84mm<sup>2</sup> smaller.

If you follow GPU launches as closely as we do, you'll note that new architectures and die shrinks rarely come all at once, but Pascal is the exception. Some of the highlights of the new architecture include support for DirectX 12, OpenCL 1.2, OpenGL 4.5, HDMI 2.0b, HDCP 2.2 support for 4K content, fourth-generation delta color compression, a new PureVideo feature set, an in-game photography utility called Ansel, GPU Boost 3.0, Simultaneous Multi-Projection, and a new memory controller.

On the topic of memory, NVIDIA is using a new memory type in the form of Micron's GDDR5X, which is capable of delivering an impressive raw data rate of 10Gbps. While we wait for these cards to launch, check out the specs below to see for yourself just how much graphics horsepower you'll be able to harness very soon. ■



	GeForce GTX 1080	GeForce GTX 1070	GeForce GTX 980	GeForce GTX 980 Ti	GeForce GTX Titan X
Price	\$599	\$379	\$549	\$649	\$999
Architecture	Pascal	Pascal	Maxwell	Maxwell	Maxwell
Manufacturing Process	16nm FinFET	16nm FinFET	28nm	28nm	28nm
Die Size	314mm <sup>2</sup>	314mm <sup>2</sup>	398mm <sup>2</sup>	601mm <sup>2</sup>	601mm <sup>2</sup>
Transistor Count	7.2 Billion	7.2 Billion	5.2 Billion	8 Billion	8 Billion
Core Clock	1,607MHz (1,733MHz Boost)	1,506MHz (1,683MHz Boost)	1,126MHz (1,216MHz Boost)	1,000MHz (1,076MHz Boost)	1,000MHz (1,089MHz Boost)
Memory Clock	10,000MHz	8,000MHz	7,000MHz	7,000MHz	7,000MHz
Memory Interface	256-bit	256-bit	256-bit	384-bit	384-bit
Memory	8GB GDDR5X	8GB GDDR5	4GB GDDR5	6GB GDDR5	12GB GDDR5
Memory Bandwidth	320GBps	256GBps	224GBps	336GBps	336GBps
Graphics Processing Clusters	4	3	4	6	6
Streaming Multiprocessors	20	15	16	22	24
CUDA Cores	2,560	1,920	2,048	2,816	3,072
Texture Units	160	120	128	176	192
ROPs	64	64	64	96	96
Power Connectors	8-Pin	8-pin	6-pin, 6-pin	6-pin, 8-pin	6-pin, 8-pin
Recommended PSU	500 Watts	500 Watts	500 Watts	600 Watts	600 Watts
Thermal Design Power	180 Watts	150 Watts	165 Watts	250 Watts	250 Watts

"... the 970-Gaming SLI makes a compelling choice for any gamer looking to upgrade."



**970-Gaming SLI**  
\$98.99  
GIGABYTE  
[www.gigabyte.us](http://www.gigabyte.us)

## GIGABYTE 970-Gaming SLI

AMD's 970 chipset lies at the bottom of the firm's 9 Series stack, but for gamers on a shoe-string budget, it makes an excellent foundation for your new rig. It's these folks GIGABYTE was thinking about when it built the 970-Gaming SLI motherboard, and you may be surprised at all the extras they threw in.

One of the best aspects of the 970 chipset is that it offers full support for the AM3 and AM3+ processors with Hypertransport 3.0. For testing, we used our handy eight-core 4GHz FX-8370 processor. In addition to the FX processors, the socket in this board also supports AMD Athlon II and Phenom II processors. The 970 chipset allows for discrete graphics cards to run on a x16 PCI Express 2.0 bus, which offers plenty of bandwidth for modern games and applications. You can even unlock the full power of your system using AMD OverDrive software in conjunction with a Black Edition processor and Radeon-

based graphics card. The chipset also includes a 6GBps SATA controller for fast solid-state storage devices. You can multiply your performance, increase the reliability of your storage, or enjoy the best of both worlds with the SATA controller's built-in RAID support. The



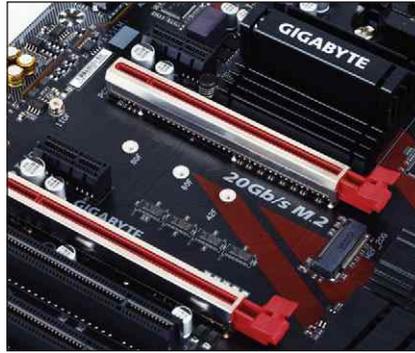
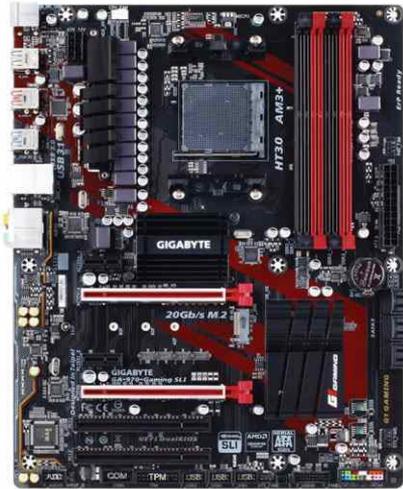
memory controller on these processors is still limited to DDR3, and AMD provides for up to 14 USB 2.0 ports via the chipset.

But GIGABYTE doesn't slap its G1 Gaming moniker on just any board. The

970-Gaming SLI is built upon a matte black PCB and features maroon racing stripes running from the I/O panel through the north bridge and south bridge chipset heatsinks, with another above the AM3+ socket. The memory and PCIe slots are either red or black, and the heatsinks are black anodized aluminum. When the board's installed and powered on, GIGABYTE's signature Ambient LEDs for the audio guard and the G1 Gaming logo on the opposite side lend the interior of your case an attractive red glow.

You can install up to 64GB of DDR3-2000 memory into the board's four slots (max memory speeds depend on the processor you install). We like that the memory slots are all on the right side of the processor, so tower-style CPU coolers with a full-size 120mm or 140mm fan can still fit, even if your DRAM heatsinks are mini skyscrapers.

There are two x16 PCIe slots, two PCIe x1 slots, and a pair of PCI slots for



By moving all the memory slots to the right side of the CPU socket, GIGABYTE ensured CPU coolers wouldn't interfere with tall memory heatsinks. The 970-Gaming SLI squeezes in a lot of nice features, including an M.2 slot and an ASMedia controller for the two red USB 3.1 Type-A ports on the rear I/O.

those legacy components you just can't quit. Given this board's gaming focus and the "SLI" in the model name, you shouldn't be surprised to learn that you can install a pair of graphics cards in it. With both slots sharing bandwidth, they will become x8 slots when running 2-way SLI or CrossFire. These slots also feature Ultra Durable Metal Shielding, which reinforces the slots to ensure they remain in-place and reliable no matter how many trips your rig makes to various LAN parties.

There's a x4 PCIe lane set aside for the type 2242/2260/2280/22110 M.2 slot that resides between the two PEG slots. This port supports PCIe NVMe and SATA SSD devices with blisteringly fast data rates, up to 20Gbps.

GIGABYTE knows USB 2.0 is so Y2K. In addition to the 12 enabled by the chipset, they've included a VIA VL805 controller for up to 4 USB 3.0 ports and

an ASMedia controller for two USB 3.1 ports on the rear I/O panel. These Type-A ports are red so you can tell them apart.

Another extra that'll enhance your gaming and computing experience includes a Realtek ALC1150 codec that supports 115dB SNR HD audio. GIGABYTE installed a rear audio amplifier and the audio subsystem uses high-quality capacitors to ensure everything you hear is crisp and clear. The board also features an Intel GbE LAN controller, GIGABYTE USB DAC-UP ports, a redesigned GIGABYTE APP Center and UEFI DualBIOS Technology.

With all of the above, the 970-Gaming SLI makes a compelling choice for any gamer looking to upgrade. Better yet, the sub \$100 price tag makes this one package that's hard to beat. ■

BY ANDREW LEIBMAN

Benchmark Results	GIGABYTE 970-Gaming SLI
3DMark Fire Strike Ext.	6095
Graphics Score	6843
Physics Score	7725
PCMark 8	
Creative Score	3563
Sandra 2015.SP2	
Dhrystone SSE4.2 (GIPS)	111
Whetstone AVX (GFLOPS)	74.78
Multi-Media Integer x16 AVX (Mpixels/s)	242.83
Multi-Media Single-Float x16 FMA (Mpixels/s)	162
Multi-Media Quad-Float x2 FMA (Mpixels/s)	5.93
Integer B/F AVX/128 (GBps, mem bandwidth)	18.18
Floating B/F FMA/128 (GBps, mem bandwidth)	18.39
CrystalDiskMark 5.1.1 (MBps)	
Sequential Read (Q32T1)	547
Sequential Write (Q32T1)	322
Random 4K Read (Q32T1)	240.9
Random 4K Write (Q32T1)	129.6
POV-Ray 3.7 Beta*	1508.99
Cinebench 15**	641
Games	(2,560 x 1,440)
Metro: Last Light (Very High, 16xAF, SSAA off)	64.65
Dying Light (High, AO On, AA On, Vsync Off)	63.53
Witcher 3: Wild Hunt (Vsync Off, Unl. FPS, Ultra)	49.81

**Specs:** Max Memory: up to 64GB DDR3-1866 (DDR3-2000 Max OC); Slots: 2 PCIe x16, 2 PCIe x1, 2 PCI; Storage: 1 M.2 Connector (type 2242/2260/2280/22110); 6 6Gbps SATA; Rear I/O: PS/2, 6 USB 2.0, 2 USB 3.0, 2 USB 3.1; Audio I/O: 1 optical S/PDIF out, analog audio ports; GbE RJ45 port; Form Factor: ATX; Warranty: 3 years

**Test System Specs:** Processor: AMD FX-8370; Motherboard: GIGABYTE 970-Gaming SLI; Graphic Card: XFX R9 Fury; RAM: 16GB Patriot DDR3-1600; Storage: 240GB Kingston HyperX SSD

“... includes a bevy of powerful onboard additions to deliver the gaming experience we’ve come to expect on Z170 motherboards.”

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## MSI B150M GAMING PRO

Historically, motherboards running the “B” variant of Intel’s mainstream chipsets have been geared toward business use and sported few, if any, power user features. Recently though, motherboard makers are putting a new spin on the B150 chipset (the “B” version of the Z170 chipset) with gaming additions to provide a new low cost option for gamers on a budget. MSI’s B150M GAMING PRO is such model, and it includes MSI’s GAMING LAN, Audio Boost, and Gaming Hotkey features. Most importantly, the \$79.99 price tag is noticeably more affordable than entry-level Z170 motherboards, which generally retail for around \$120.

Before you consider the B150M GAMING PRO, you should know which amenities are off the table. The two big ticket items power users might miss are support for CPU overclocking via multiplier and extremely limited support for multiple graphics cards. We’ve seen some H170 and B150 chipset

motherboards with modified BIOSes that let you overclock by adjusting the BCLK, but the B150M GAMING PRO (with the current BIOS version) does not. When it comes to system memory, you’ll also be limited to DDR4 modules running at 2133MHz.

The B150M GAMING PRO provides you with one PCIe 3.0 x16 slot and two PCIe 3.0 x1 slots. We like the layout of the expansion slots, as you can install a dual-slot graphics card into the PCIe 3.0 x16 and still have access to the two x1 slots. The expansion slots fit nicely into the B150M GAMING PRO’s microATX form factor—a size that’s suitable for use with miniature rigs. For those gamers who are looking for a B150 chipset board with a little extra pixel pushing power, MSI’s B150 MORTAR does allow for CrossFire, though the second CrossFire card only runs at x4 speed.

Storage on the B150 chipset is another area that could potentially hamstring power users, as there are only 8 PCIe 3.0

lanes on the chipset itself, while the Z170 chipset supports 20. On both chipsets, the processor can still provide up to 16 PCIe 3.0 graphics lanes, but these aren’t typically available for storage duties. The B150M GAMING PRO’s storage connectivity is limited to six 6Gbps SATA ports, which can’t setup in RAID. And with no M.2 or RAID 0 options, 6Gbps is the fastest storage speed you’ll see.

When added together, the caveats of the B150 chipset may seem daunting, but take a moment to consider the bare necessities for a new DIY gaming rig. Performance-wise, you only really need support for one GPU, and for build convenience, you’ll want compatibility with the latest processors and memory. The B150M GAMING PRO lets you accomplish this setup easily, and MSI enhances the gaming experience with the onboard goodies you’ll find on its higher-end motherboards.

For a stable, high-performance network connection, the B150M GAMING

PRO comes with Intel's i219 NIC with MSI's GAMING LAN utility. The latter optimizes bandwidth for latency-sensitive applications and will prioritize games above all other traffic. You can also manually adjust the traffic priority. The LAN port itself features 15KV anti-surge protection, which helps to protect the board from lightning strikes and static electricity. Premium audio components are present, as well. Highlights include Chemi-Con audio capacitors, an isolated audio PCB, and support for up to 7.1-channel surround sound from the front-panel header. It all adds up to crystal clear sound.

To get more gaming performance out of your keyboard, MSI provides its Gaming Hotkey utility. You can setup macros, assign functions, and create profiles to customize the keyboard to the games you play. Gaming Hotkey also feature a Login Key feature, where you can program passwords to enter credentials at the press of a key. MSI also includes its Gaming Device Port technology, so you can bind macros to mouse buttons. Don't have a gaming mouse? MSI packages its Interceptor DS B1 Gaming mouse with the motherboard.

Although budget buyers probably won't go with a Core i7-6700K and GeForce GTX 980 Ti, we benchmarked with these components to show off just how powerful a system you can create with the B150M GAMING PRO. Results in our processor-intensive tests are comparable to what we've seen on motherboards running the Z170 chipset. The rig produced



877 Cinebench 15 test, for instance, and 1888.77 pixels per second in POV-Ray 3.7. Frames per second rates were also right in line with other motherboards where we used PNY's GeForce GTX 980 Ti. Our test bench hit 61.3fps in Witcher

3 when tested at a resolution of 2,560 x 1,440.

As the market for gaming continues to grow, it's tougher and tougher for hardware manufacturers to establish new market niches. By building off of the B150 chipset, MSI is able to deliver a motherboard for under \$80 that still provides the absolute basic support for a modern gaming PC (plus a gaming mouse). The B150M GAMING PRO also includes a bevy of powerful onboard additions to deliver the gaming experience we've come to expect on Z170 motherboards. If you need to make every dollar in your build count, the B150M GAMING PRO is here to help. ■

BY NATHAN LAKE

MSI B150M GAMING PRO			
<b>3DMark Fire Strike Score</b>	<b>7431</b>	<b>POV-Ray 3.7 (Pixels per second)</b>	<b>1888.77</b>
Graphics Score	7902	<b>Cinebench 15 (Points)</b>	<b>877</b>
Physics Score	12810	<b>CrystalDiskMark 5.0.3 (MBps)</b>	
<b>PCMark 8 Creative Score</b>	<b>5532</b>	Sequential Read (Q32T1)	557.3
<b>SiSoftware Sandra 2016</b>		Sequential Write (Q32T1)	281.6
Dhrystone AVX2 (GIPS)	184.84	Random 4K Read (Q32T1)	360.6
Whetstone AVX (GFLOPS)	107.08	Random 4K Write (Q32T1)	240.2
Multi-Media Integer AVX2 x32 (Mpixels/s)	407	<b>Games</b>	<b>2,560 x 1,440</b>
Multi-Media Long-int AVX2 x16 (Mpixels/s)	183.79	Metro: Last Light (DX11, V High, 16XAF, V High Tess.)	79.33
Multi-Media Quad ALU x1 (Mpixels/s)	2.11	Dying Light (High, AO On, AA On, Vsync Off)	85.4
Integer B/F AVX/128 (GBps, mem bandwidth)	21.5	Witcher 3: Wild Hunt (Vsync off, Unl. fps, Ultra)	61.3
Floating B/F AVX/128 (GBps, mem bandwidth)	21.92		

**Specs:** Max memory: 32GB DDR4 (DDR4-2133); Slots: 1 PCIe 3.0 x16, 2 PCIe 3.0 x1; Storage: 6 GBps; Rear I/O: 1 VGA, 1 HDMI, 1 DVI-D, 6 USB 3.0, 2 PS/2, audio I/O, 1 Ethernet; Form factor: micro-ATX; Warranty: 3 years

**Test system specs:** Processor: Intel Core i7-6700K; GPU: PNY GeForce GTX 980 Ti; Memory: 16GB Crucial DDR4-2133; Storage: 240GB Intel SSD 730 Series; OS: Windows 10 Enterprise



CPU's Cutting Edge Award recognizes products that redefine the function and/or capabilities of products in their category by virtue of forward-thinking, innovative design

"Whether you're a first-time builder or a power user, the Aegis has plenty to offer for your next build."



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## MSI Aegis

Remember your first DIY PC build? If you're like us, the process was simultaneously exciting and terrifying, because we weren't 100% confident everything was installed correctly. The dread of something going wrong often leads some people to go with a custom OEM that lets you select most of the individual components, while the OEM assembles everything for you. MSI's Aegis is a sort of halfway point between the DIY and OEM routes.

The Aegis is a barebones kit that serves as the foundation of a great gaming rig. MSI preinstalls the motherboard, a 600 watt PSU, and a high-end CPU cooler into a slick chassis. You still get to select the critical system components, including the processor (Intel's 6th Generation Core CPUs), GPU, memory, and storage. MSI designs the Aegis case for easy access, so component installation is primarily plug-and-play.

Besides being an ideal starting point for first-time builders, MSI's Aegis provides a number of refinements sought after by power users. First off, the Aegis is incredibly small for a gaming rig. It's about half the size of your typical mid-tower at 15 x 6.7 x 17 inches (HxWxD). If you're limited on desk space, such as people with multiple monitors, the minimal footprint helps to keep you from having to stow the desktop PC on the floor. There's even a handle on the back that makes the system easy to tote.

The Aegis chassis is also a showcase piece. It features an angular front panel with armor plates. The exterior reminds us a bit of Batman's Tumbler in the Dark Knight trilogy—without wheels, of course. The front panel shows off MSI's Mystic Light feature that lets you control the color and effects of the LEDs inside the front panel. We're partial to the Gradient mode where the openings in

the body armor each display a rainbow of LED colors. There are also modes to pulse in sync with games or music.

Compact dimensions and hot hardware generally mean roaring fans, as anyone with a noisy laptop can attest. MSI engineers solve this problem on the Aegis with Silent Storm Cooling 2 technology that keeps system noise under 36dB(A) under full load. Silent Storm Cooling 2 is based around a compartmentalized airflow design with separate flows for the CPU, GPU, and PSU. With CPU cooling, for example, MSI installs a CPU cooler with two big copper heatpipes running to an array of aluminum fins along the rear panel. A blower-style fan, similar to what you see on many GPUs, exhausts the heat from the fin array out the rear panel.

For the GPU, MSI installs a riser card onto the mainboard, which allows you to easily install or change your GPU by



opening the chassis' right panel. And by flipping the GPU from horizontal to vertical, MSI is able to avoid the Aegis' internal drive cages and provide the space to install today's high-end, dual-slot GPUs (up to a GeForce GTX 1080). A vent on the right side of the case allows the GPU to pull in fresh air and vent it out the case's rear exhaust. Airflow to the PSU is completely separated from the main components, because the PSU resides in the chassis pedestal.

Now that you're familiar with how the Aegis is designed, we'll take a look at what parts are preinstalled and which components you'll need to install. The motherboard runs the B150 chipset, which we found to be quite a capable partner for small form factor gaming (see our review of MSI's B150M GAMING PRO elsewhere in this issue). MSI equips the custom-designed motherboard to handle the components in a high performance rig. System storage, for instance, could include an M.2 PCIe/SATA SSD, a 2.5-inch SSD/HDD, and two 3.5-inch

HDDs. For ease of installation, MSI includes hot-swap bays for the 2.5-inch and 3.5-inch drives. You can install up to 32GB of DDR4-2133 memory into the motherboard's two SO-DIMM slots.

We filled out this system with an Intel Core i7-6700, an NVIDIA GeForce GTX 970, 8GB of SK Hynix DDR4-2133 memory, a 128GB Transcend MTS800 M.2 SSD, and a 1TB WD Blue HDD. The completed Aegis cruised through our benchmark tests. Notable results include an overall score 5113 in 3DMark's Fire Strike Extreme test and a Cinebench 15 mark of 808 points. Both scores show how effective the Aegis can be when filled out with decent hardware.

The design of the Aegis is ingenious and judged worthy of CPU's Cutting Edge Award. Most all of the parts you'll need to install can be reached by simply removing the side or top panels. Installing the CPU takes the most effort, but that's only because you'll need to



temporarily unscrew the CPU cooler. The ease of installation is complemented by the fact that MSI also optimizes airflow with the internal layout and manages to fit everything into an incredible small footprint. Whether you're a first-time builder or a power user, the Aegis has plenty to offer for your next build. ■

BY NATHAN LAKE

#### MSI Aegis

<b>3DMark Fire Strike Extreme</b>	<b>5113</b>	<b>POV-Ray 3.7 (Pixels per second)</b>	<b>1662.3</b>
Graphics Score	5330	<b>Cinebench 15 (Points)</b>	<b>808</b>
Physics Score	11936	<b>CrystalDiskMark 5.1.2 (MBps)</b>	
<b>PCMark 8 Creative Score</b>	<b>4783</b>	Sequential Read (Q32T1)	556.8
<b>SiSoftware Sandra 2016</b>		Sequential Write (Q32T1)	158.1
Dhrystone AVX2 (GIPS)	162.1	Random 4K Read (Q32T1)	277.2
Whetstone AVX (GFLOPS)	99.36	Random 4K Write (Q32T1)	157.9
Multi-Media Integer AVX2 x32 (Mpixels/s)	366	<b>Games</b>	<b>2,560 x 1,440</b>
Multi-Media Long-int AVX2 x16 (Mpixels/s)	159.19	Metro: Last Light (16xAF; SSAO off)	62.33fps
Multi-Media Quad ALU x1 (Mpixels/s)	1.86	Dying Light (High, AO On, AA On, Vsync off)	55.8fps
Integer B/F AVX/128 (GBps, mem bandwidth)	22.38	The Witcher 3 (Vsync off, unlimited fps, Ultra)	41.4fps
Floating B/F AVX/128 (GBps, mem bandwidth)	22.59		

**Barebones Specs:** Motherboard: B150 proprietary motherboard included; Processor: Supports Intel 6th Generation processors; GPU: Supports dual-slot GPUs up to the NVIDIA GeForce GTX 1080; Memory: Supports up to 32GB DDR4-2133, 2 SO-DIMM slots; Storage: Supports up to 2 3.5-inch HDD, 1 2.5-inch SSD/HDD, and 1 M.2 PCIe/SATA SSD; PSU: 600W, 80 PLUS Silver efficiency (included); Front panel: 1 USB 3.1 Gen 1 Type-C, 2 USB 2.0; Rear panel: 4 USB 3.1 Gen 1; 2 USB 2.0, 1 PS/2, Audio I/O, 1 Ethernet, 1 DisplayPort, 1 HDMI

**Test System Specs:** Processor: Intel Core i7-6700; GPU: NVIDIA GeForce GTX 970; Memory: 8GB SK Hynix DDR4-2133; Storage: 128GB Transcend MTS800, 1TB WD Blue; OS: Windows 10 Home (64-bit)

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## ENERMAX ETS-N30R-HE

Component selection on a tight budget is often just as, if not more, challenging than picking the parts for a first-class, benchmark busting rig. One of the toughest choices, of course, is weighing a component's performance against cost. A custom liquid-cooling loop, for example, will generally run you well above \$100, while closed-loop coolers and high-end air coolers cost anywhere between \$50 and \$100. There are also a bevy of entry-level, aftermarket CPU coolers that serve as a cost-effective upgrade, in terms of both noise and cooling performance, over the stock cooler that came with your processor. Priced at \$29.99, ENERMAX's ETS-N30R-HE is an affordable air cooler that's also designed to help you avoid clearance issues with memory.

Regular readers of CPU might remember that we reviewed the ETS-N30R-TAA in the April issue, and the ETS-N30R-HE is quite similar. It features the exact same dimensions of 5.4 x 3.05 x 3.74-inches (HxWxD) and also has three 6mm heatpipes. The cooler's small size—most notably the 3.05-inch width—ensures the heatsink and fan won't extend over the DIMM slots (or installed modules) on your motherboard. The only real difference between the two models is the included 90mm fan. On the ETS-N30R-HE, ENERMAX opts for a solid black fan that produces up to 55.4cfm at the fan's

2,800rpm maximum speed. By comparison, the 90mm fan on the ETS-N30R-TAA is rated for a maximum airflow of 50.8cfm.

The fan ETS-N30R-HE offers a wide PWM speed range of 800 to 2,800rpm, and at the fan's maximum speed, ENERMAX rates it for a noise level of 28dB(A). If you find that the 90mm fan is too noisy, you can use the included fan RPM reduction adapter to lower the fan's PWM range to 600 to 1,800rpm, which brings the maximum noise level down to 20dB(A). During our testing, we found that the ETS-N30R-HE was near silent at idle, no matter if we used the adapter or not. Under full load, fan noise without the adapter cable was barely audible above the GPU and system fans in our test rig. Installing the adapter cable did indeed knock noise levels down. Slower fan speeds, of course, do reduce airflow, and at 1,800rpm, ENERMAX rates the 90mm fan for 30.8cfm.

The heatsink on the ETS-N30R-HE is a product of extensive ENERMAX engineering. The main technologies at play are ENERMAX's VGF (Vortex Generator Flow) and VEF (Vacuum Effect Flow). VGF helps to increase air convection around the heatpipes, while VEF creates an airflow path that prevents cool air from leaking out the side of the heatsink. And by directing all the cool air through the heatsink, ENERMAX optimizes heat dissipation. When installing

the CPU cooler, you'll also notice ENERMAX's HDT (Heat-pipe Direct Touch), as the flattened and machined copper heatpipes are visible on the baseplate.

We tested the ETS-N30R-HE on the same rig as ENERMAX's ETS-N30R-TAA; a system featuring Intel's Core i7-6700K and a GIGABYTE GA-Z170X-SOC FORCE. Idle temperatures in this system averaged 23.8 degrees Celsius. To see how the CPU cooler responded under demanding loads, we ran POV-Ray 3.7 for 10 minutes, and the average temperature climbed to 72 C with a maximum temperature of 77 C. Next, we loaded up Prime95's Small FFT torture test. The ETS-N30R-HE responded well by holding our Intel Core i7-6700K to an average temperature of 90.3 C and a maximum of 98 C. Overall, temps were nearly identical to the ETS-N30R-TAA. We also ran our tests with the fan rpm reduction adapter attached, and average temps under load increased by around five degrees.

The ETS-N30R-HE is priced right for a budget-friendly CPU cooler. We also like that it's quiet and our testing shows the cooler keeps Intel's flagship Skylake chip from throttling any of the cores under heavy loads. In short, it is \$30 well spent for builds where cost is your most important consideration. ■

BY NATHAN LAKE

**Specs:** Materials: Copper (heatpipes), aluminum (fins); Fan: 90mm PWM (800-2800rpm or 600-1800rpm with adaptor); Cooler Dimensions: 5.4 x 3.05 x 3.74-inches (HxWxD); Socket compatibility: Intel LGA775/115X/1366/2011(3), AMD AM2+/AM3+/FM1/FM2+; Warranty: 1 year

**Test System Specs:** Processor: Intel Core i7-6700K; Motherboard: GIGABYTE GA-Z170X-SOC FORCE; GPU: PNY GeForce GTX 980 Ti; RAM: Viper Elite Series DDR4 16GB (2 x 8GB) 3200MHz; Storage: 240GB Intel SSD 730 Series; OS: Windows 10 Enterprise



"The numeric keypad is a highlight for fans of macros and a multitude of programmable buttons."

#### ML160 Laser Gaming Mouse

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## Bloody ML160 Laser Gaming Mouse

PC gamers are particular when it comes to their peripherals, especially mice. And for good reason. The mouse is the key to movement, combat, exploration, and virtually every activity you partake in when gaming. Comfort, sensitivity, speed, and style are all important factors to consider, and if the ML160 Laser Gaming Mouse is any indication, Bloody understands each one well.

I was immediately intrigued by the ML160 because of its shape, which is reminiscent of one of my favorite mice, the Corsair M65 (I currently own two of 'em). The mouse body is on the larger side and there's a smooth matte black plastic top panel with a textured black plastic on the sides of the unit. A backlit Bloody logo glows in seven different colors under your palm. The mouse wheel and numeric keypad are both backlit as well. While the M65 has an aluminum panel and Teflon-coated pads underneath, Bloody flips the script and uses a silver plastic for the bottom of the mouse and metal pads, called X'Glide Pro Metal, for the

mouse feet. They look like anodized pink aluminum pads (we've heard that red anodizing is a very hit or miss process), but when using the mouse on a variety of mousing surfaces, we felt little friction.

The laser the ML160 is packing is the AVAGO A9800, and the DPI scales from 100 to 8,200. The left mouse button uses Bloody's LK (Light Strike) infrared micro switch, which the company claims is 30ms faster than traditional metal switches. The numeric keypad is a highlight for fans of macros and a multitude of programmable buttons.



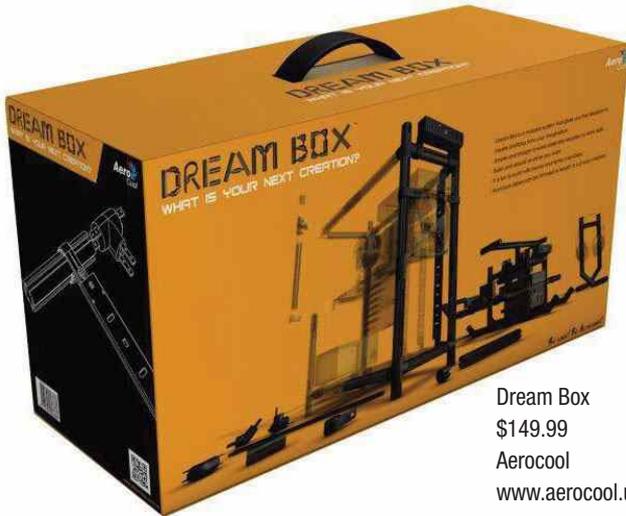
There's 160KB of onboard memory and every one of the 17 buttons on this mouse can be reprogrammed. But all that customizability is for naught if the software you need to tap into to make the changes is no good. On that point, we're happy to report that the utility is accessible and changing button assignments is easy with scrollable lists of common options and built-in shortcuts. There are even shortcuts for apps outside of games.

The ML160 features a 1 year warranty, but the left click switch is rated for 50 million clicks and the infrared scroll wheel is rated for 10 million scrolls. Other features we like include the red and black braided nylon cord, the inconspicuous DPI indicator that you can dock to the desktop, and the textured rubber pad over the left mouse button. If you're in the market for a tweakable laser gaming mouse, few others offer as many options as the Bloody ML160. ■

BY ANDREW LEIBMAN

**Specs:** Sensor: AVAGO A9800 laser, 100 to 8,200 DPI; Body Type: right-handed; LEDs: 7 color LEDs in two zones, red backlit numeric keypad; 17 programmable buttons; Macros: Yes; 160KB onboard memory; Switch response time: 0.2ms; 125 to 1,000Hz polling rate; Interface: USB 2.0; Cable: braided black nylon

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## Aerocool Dream Box

When is a door not a door? When it's ajar.

When is a case not a case? When it's an Aerocool Dream Box. (Except sometimes it's still a case.)

We've seen a number of . . . non-traditional cases over the years. Open-air test benches, hanging wall units that turn your PC into art, and much more. We've also seen some cases in the last year or two that are designed for you to use in building custom, modular enclosures from their parts, but Aerocool's Dream Box is probably the most unique "enclosure" that we've seen to date.

For starters, when you open the box the Dream Box comes in and begin to unpack it, you expect some kind of basic structure to emerge from the Styrofoam packing, maybe with lots of additional rails, panels, and the like—that's what we've been conditioned to expect. But that's not what happens when you unbox this bad boy.

Instead, you lift out tray after Styrofoam tray packed with pipes, rails, joints, and brackets. And that's it. The only stuff in the box that you'll recognize as case parts are the Dream Box's motherboard standoffs, its

PSU bracket, and its plastic I/O unit with power and reset buttons. You really do start with nothing but a couple pictures and your imagination with the Dream Box, and while some might find that a little terrifying, we suspect there are more than a few CPU readers who would find it to be a singularly intriguing challenge.

It's like a puzzle, but instead of figuring out how to get the puzzle to look like the thing on the box, you are trying to figure out how to get it to look like the thing in your head.

Aerocool's marketing materials and its box show pictures of the Dream Box configured into things like a coat rack, a coffee cup holder, and a lamp to show that you don't even have to build this thing into a PC case. And that's fine, but what we like more than that idea is that you can make it into any kind of PC frame you want. If you currently have parts for an ATX build but you think you might want to pivot to a Mini-ITX rig later, no problem. Or maybe you need to put your PC in a space that is narrow but long, or wide but shallow. Maybe you need a coffee table base that also houses your PC . . . the Dream Box

can do all those things for you, and much, much more.

The aluminum pipe pieces, steel beams, and plastic joint and joint cap pieces are uniformly finished in black, and Aerocool provides 400 of the screws you'll need to connect them with the kit. You also get drive-mount screws, multi-purpose brackets, C-ring connectors, and 15 cable ties in the box, and a very basic manual that provides a full parts list and some basic configuration tips. Aerocool provides a quick tutorial video on its website that gives quick, step-by-step instructions on building Dream Box into an ATX mid-tower frame, and once you've absorbed that, you can use those concepts to make pretty much anything you want.

If you like the idea of building something truly unique and like creating with your hands, take a look at the Aerocool Dream Box. We'll be designing and building our own custom project using the Dream Box in the coming weeks; head to [www.computerpoweruser.com](http://www.computerpoweruser.com) for pictures and video of what we come up with. ■

BY CHRIS TRUMBLE

**Specs:** Materials: Aluminum, steel, plastic; Ports: 2 x USB 3.0, 2 x USB 2.0, audio I/O

"Connectivity is impressive for such a small device."

## GIGABYTE BRIX PC

Ultra-compact PCs, including the majority of models in GIGABYTE's BRIX series, are traditionally sold as barebones kits where you'll provide the memory, storage, and OS. The barebones design is fine for power users and tech-friendly peers, but what about a technologically challenged Uncle, for instance? If provided, could he install Windows from a USB drive and would he feel comfortable installing the memory or storage? Let's say he lives out of state and you could only help him over the phone. Sounds discouraging, right? The BRIX PC (product name GB-BSI5H-6200-B2-IWUS) is a ready-to-go BRIX system with all the necessary hardware and Windows 10 Home preinstalled.

This BRIX PC is built around Intel's Core i5-6200U, which is an Intel 6th Generation Core processor designed for use with laptops and mini PCs. The Core i5-6200U is a dual-core processor with Hyper-Threading, and its ability to handle four simultaneous threads makes it a good multitasker. It features a base clock of 2.3GHz and can ramp up to 2.8GHz in Turbo mode. The CPU's speed is enough to effectively handle productivity and multimedia duties.

Graphics-wise, the Core i5-6200U provides you with Intel HD Graphics 520, which supports 4K resolutions over both the BRIX's HDMI (4,06 x 21,60 at 24Hz) and Mini DisplayPort (3,840 x 2,160 at 60Hz) outputs. You can connect a monitor to each video output for dual display setups. Intel's HD Graphics 520 can handle some light gaming. When running Dota 2 at all settings on low and a resolution of 1,920 x 1,080, for example, the BRIX delivered 38.2fps.

To fill in the system's memory and storage, GIGABYTE installs a 1TB

hard drive (our test unit featured a 1TB WD Blue drive) and 4GB of memory (a Kingston DDR3L-1600 module). Further upgrades are possible, as well. The BRIX PC supports blazing-fast PCIe SSDs via an M.2 slot that supports 2280 form factor drives. For memory, there are two DIMM slots that support up to 16GB of DDR3L memory running at 1,600MHz, 1866MHz, or 2133MHz.

Connectivity is impressive for such a small device. The BRIX PC comes with an 802.11ac wireless/Bluetooth 4.2 module, and there's also an Ethernet port on the rear panel. For USB peripherals, there are four USB 3.0 ports with two on the front panel and two on the rear. Audio I/O are also conveniently located on the BRIX's front panel.

The BRIX PC benchmark numbers won't blow you away, but it's saying something that it was able to power through our processor, memory, and storage-intensive tests without issue. Notably, it also was able to run 3DMark's Sky Diver test aimed at gaming laptops

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and mid-range PCs. The biggest takeaway, here, is that it's got enough power to handle the everyday productivity and multimedia tasks it's designed for.

GIGABYTE is currently selling this version of the BRIX PC at Amazon for \$579.99, which is a fair price considering that it's a complete preassembled system that includes Windows 10 Home. If you or a friend requires a discrete PC in the living room or in the entertainment center—and don't want to go the barebones route—the BRIX PC is an appealing option. ■

BY NATHAN LAKE

### GIGABYTE BRIX PC

<b>3DMark Sky Diver Score</b>	<b>2541</b>	Floating B/F AVX 128 (GBps, mem bandwidth)	8.5
Graphics Score	2512	<b>POV-Ray 3.7 (Pixels per second)</b>	<b>636.78</b>
Physics Score	2836	<b>Cinebench 15 (Points)</b>	<b>283</b>
<b>PCMark 8 Creative Score</b>	<b>2296</b>	<b>CrystalDiskMark 5.1.2 (MBps)</b>	
<b>SiSoftware Sandra 2016</b>		Sequential Read (Q32T1)	113.7
Dhrystone AVX2 (GIPS)	63.73	Sequential Write (Q32T1)	111.3
Whetstone AVX (GFLOPS)	61.91	Random 4K Read (Q32T1)	1.18
Multi-Media Integer AVX2 x32 (Mpixels/s)	152.21	Random 4K Write (Q32T1)	1.32
Multi-Media Long-int AVX2 x16 (Mpixels/s)	63	<b>Games</b>	
Multi-Media Quad ALU x1 (Mpixels/s)	0.7	Metro: Last Light (1,024 x 768; all settings on Low)	15fps
Integer B/F AVX/128 (GBps, mem bandwidth)	8.2	Dota 2 (1,920 x 1,080; all settings on Low)	38.2fps

**System Specs:** Processor: Intel Core i5-6200U; Motherboard: GIGABYTE MKLP5AP; GPU: Intel HD Graphics 520; Memory: 4GB Kingston DDR3L-1600 (upgradable to 16GB); Storage: 1TB WD Blue (optional M.2); OS: Windows 10 Home (64-bit)



V360 HEADSET



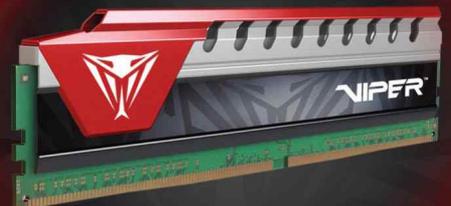
V560 MOUSE



V760 KEYBOARD



VIPER USB



VIPER DRAM

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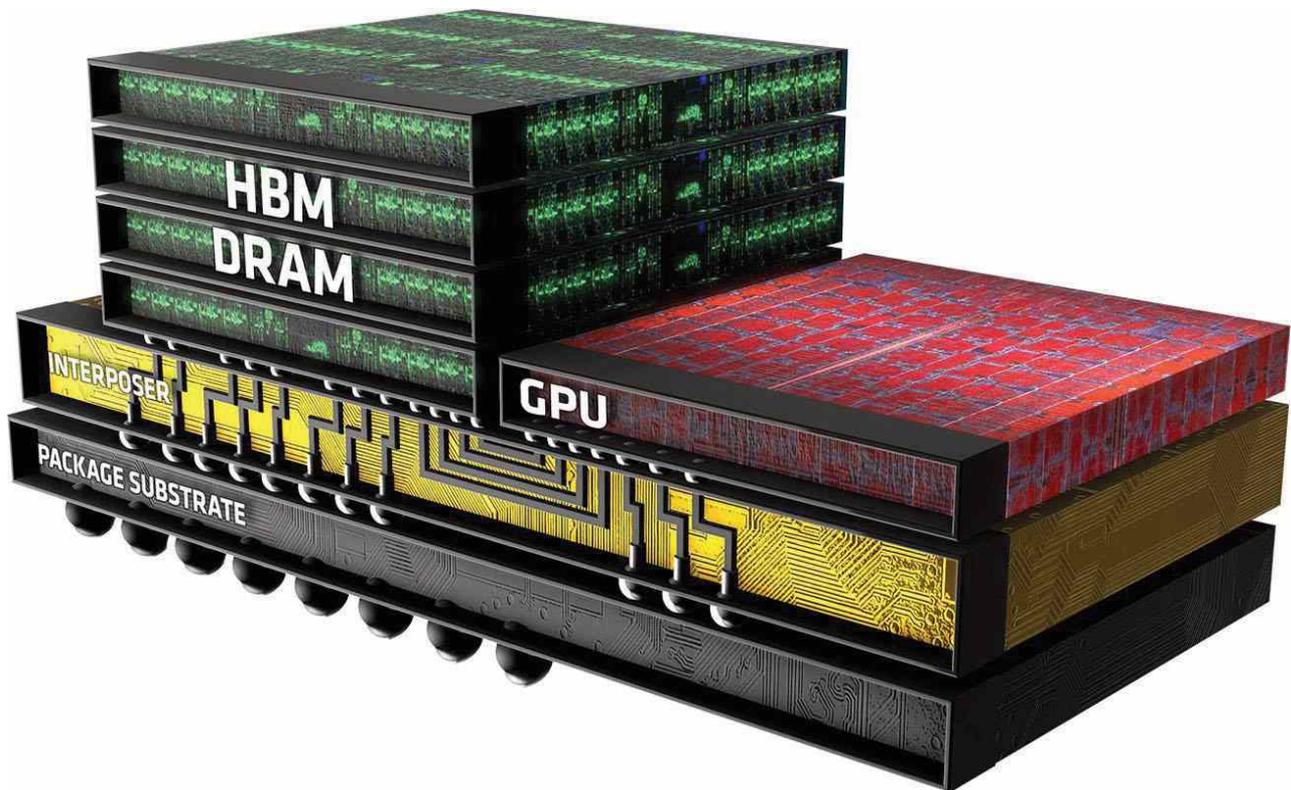
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# State-Of-The-Art Standards

## High Bandwidth Memory



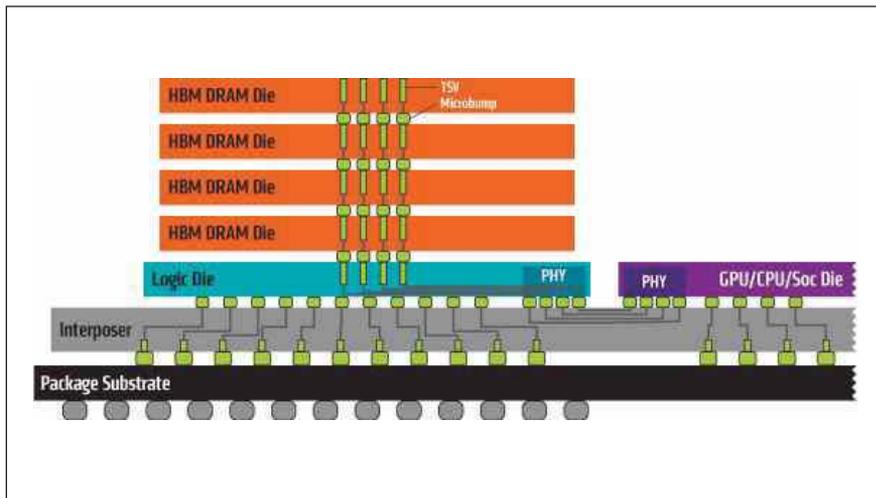
Stacks of High Bandwidth Memory sit atop an interposer, which also connects the DRAM to the GPU.

Our appetites for bigger and better graphics are well-nigh insatiable. The once-revolutionary 1080p is now the baseline visual quality for gamers and enthusiasts. The next frontiers in PC graphics appear to be 4K and VR, and both technologies have evolved beyond the marketing hype to the point where consumers can get hands-on experience and judge the products for themselves. The bigger question might be, is your PC's

graphics card ready for 4K and VR? It's no easy task for a GPU to deliver playable frame rates when you increase the pixel count, and in VR's case, also increase the refresh rate.

One of the biggest factors when it comes to determining the highest resolution you can play at without killing your frame rate is a graphics card's memory size and speed. Several other factors impact performance, but in general, the larger and faster the

frame buffer, the better your overall gaming experience is likely to be. For the last few years, GDDR5 has been the dominant video memory standard, but we're beginning to reach its performance limitations. Bottlenecks in performance are like squeaky wheels, and AMD—one of the companies that pioneered GDDR5—has some fancy new grease called HBM (High Bandwidth Memory) to fix the problem. AMD's Fiji GPUs were the first to feature HBM, and the



In this illustration, you can see how TSVs (through-silicon vias) and micro-bumps are used to interconnect the DRAM dies.

memory technology could ultimately replace GDDR5.

### Build Up, Not Out

HBM is a completely different architecture than GDDR5, and Robert Hallock, AMD's head of global technical marketing, lays out why it was necessary to move away from the existing GDDR template: "Traditional GPUs would lay out multiple memory chips on a circuit board and connect them back to the GPU, which is also on the circuit board, with long wires called traces. As you add more memory chips, you need more and longer traces connecting back to the GPU. You eventually reach a point where the complexity of routing and sending information over these traces is too costly—costly as in money, power usage, and the size of your product."

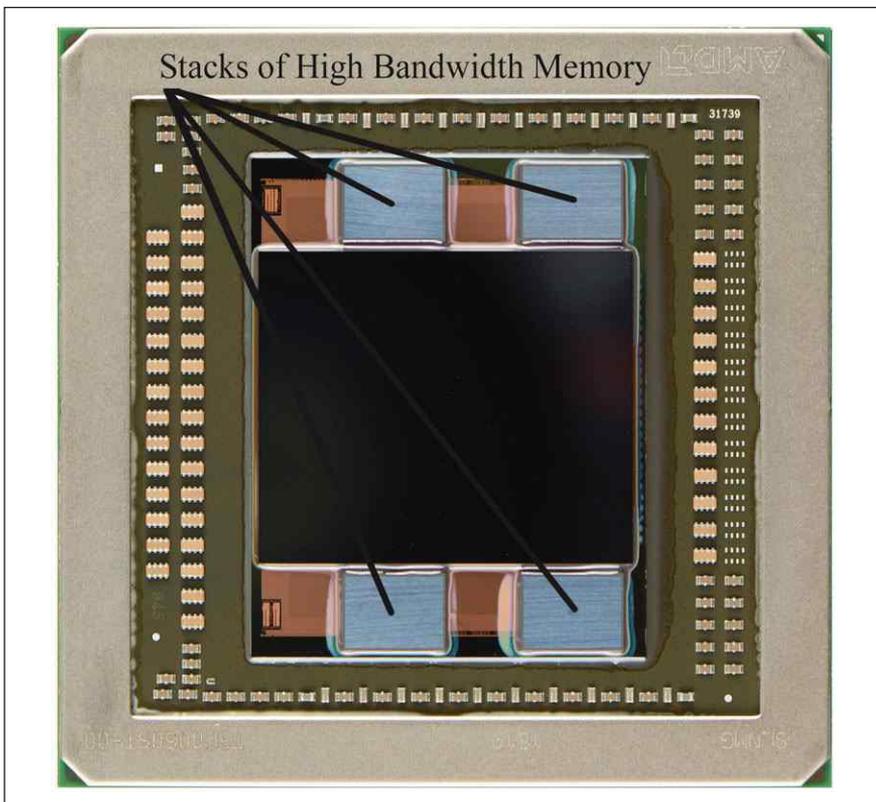
With HBM, DRAM dies are stacked on top of each other, which reduces complexity, power, and size. "HBM is organized a lot like floors in a skyscraper: multiple memory chips stacked vertically, all connected to a memory controller at the base," says Hallock. "Several of these stacks are attached to a square slab of silicon called the 'interposer,' which also hosts the GPU."

Stacking the memory provides HBM with ultra-wide communication lanes and a streamlined memory interface. "In terms of designing a GPU, there is

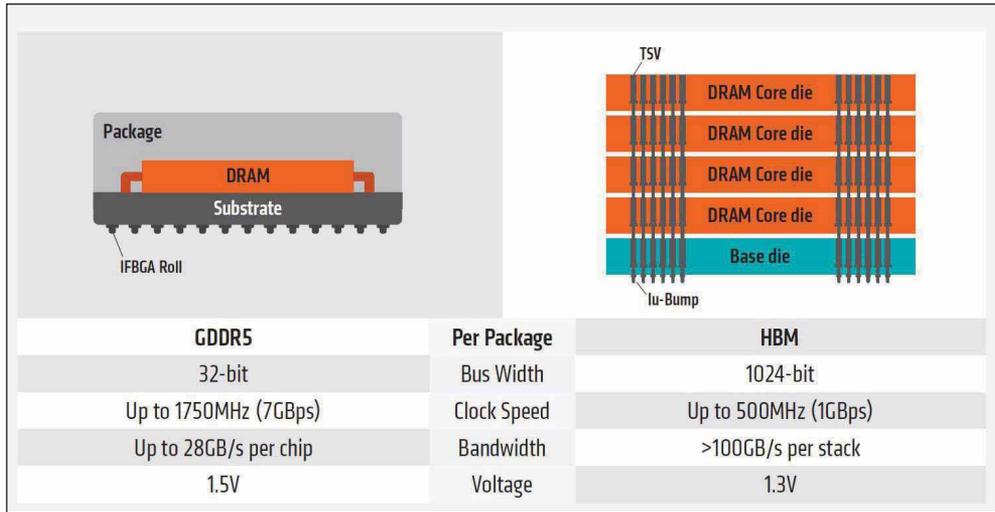
generally more bandwidth and power efficiency in being wide and slow than narrow and fast," says Hallock. On AMD's R9 Fury GPUs, for instance, the cards feature a 4,096-bit memory bus operating at 500MHz for 512GBps of total memory bandwidth. By comparison, the stock NVIDIA GeForce GTX 980 features a 256-bit memory bus with quad-piped memory running at 1,752MHz for a 224GBps memory bandwidth.

The interposer is a big part of what makes HBM so effective, because it allows AMD to use microscopically small traces between the memory stacks and the GPU. "We can pack tons of these microscopic traces into a small area, and they can be very short," says Hallock. "Shorter traces allow us to simplify some of the circuits in the GPU that communicate with memory."

There's another benefit to using a lot of small traces, according to



On AMD's Fiji chip, there are four stacks of HBM.



Per single stack, the first generation of HBM provides a much higher bandwidth than GDDR5.

Hallock. “Increasing the number of traces between the GPU and the memory also allows the GPU to send and retrieve much more information in fewer total requests than GDDR5; that drives down power consumption quite a lot by allowing for more even more circuit simplification inside the GPU.” On AMD’s Fiji-based

GPUs, you see evidence of the power efficiency, as there are fewer voltage regulators strung along the PCB than in a GDDR5-based card.

The lower relative power consumption of HBM allows GPU developers to devote more power draw to performance. “To put a point on it, we get about 42GBps of bandwidth

“AMD understood many years ago that GDDR5 would ultimately hit a ‘wall’ where power consumption would rise disproportionately against the performance gained for frequency increases . . . .” Robert Hallock

per watt of power used in an HBM subsystem,” says Hallock. “By comparison, the Radeon 290X with GDDR5 turned up about 10.6GBps of bandwidth per watt.” And by switching to HBM on the Radeon Fury, AMD was able to invest the power draw into performance and deliver roughly the same power envelope.

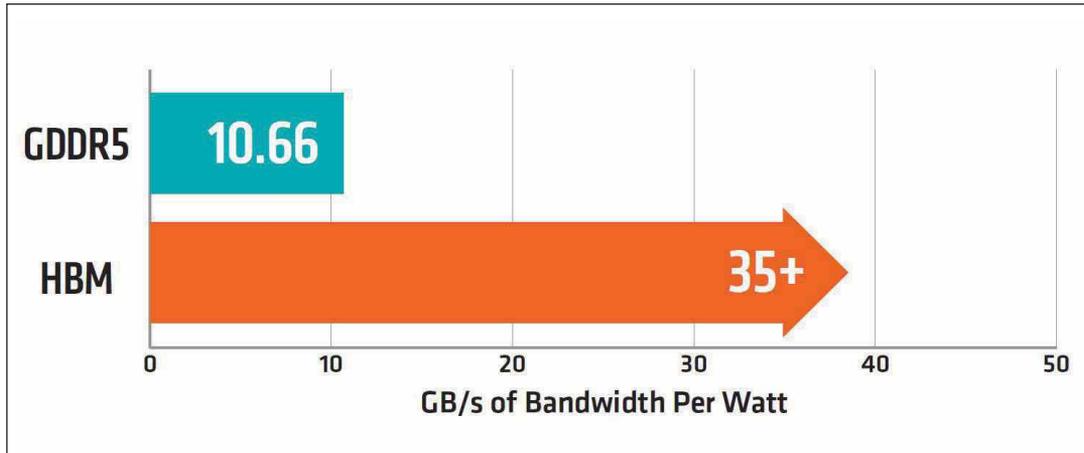
Compared to GDDR5 technology, the HBM and interposer package is quite small. “The interposer, with all the RAM and the GPU, is attached to the graphics card’s circuit board as one compact and pre-assembled module,” says Hallock. “This module

uses about three times less surface area on the GPU’s circuit board, which allows us to make a smaller product.” A perfect example is AMD’s Radeon R9 Nano. This 6.25-inch GPU can deliver 4K gaming performance, in large part thanks to the use of HBM.

### The Road To Here

“AMD understood many years ago that GDDR5 would ultimately hit a ‘wall’ where power consumption would rise disproportionately against the performance gained for frequency increases,” says Hallock. “This was the same motivation that inspired us to start developing GDDR5 to replace GDDR3.” Interestingly, AMD tells us they started development of HBM around eight years ago, which is right around the time GDDR5 showed up inside AMD’s Radeon HD 4870 graphics card.

In 2007, AMD built the first mechanical sample of the interposer. Hallock says, “We combined an AMD Turion Ultra CPU and a DDR3 memory chip on an interposer as a design exercise on our test infrastructure, shaping our requirements, and obtaining reliability data.” A few years later, the prototype



HBM also outclasses GDDR5 when it comes to GBps of bandwidth per watt.

for the interposer was scaled up with two stacks of GDDR3 on an ATI Radeon HD 3650. “This was a big step forward for us in developing and shrinking the interconnects through the interposer,” says Hallock.

When evaluating a GPU’s design, we don’t usually spend much time discussing interconnects, but the development of TSVs (through-silicon vias) was a huge for HBM. “There was a lot of engineering and effort that went into perfecting ‘microbumps’ and through-silicon vias, which are the actual nanoscale technologies behind the ‘traces’ that connect the GPU and HBM together within the interposer,” Hallock says. On modern HBM designs, there are four DRAM stacks, and inside each of the stacks, TSVs are placed on the bottom three DRAM chips and linked to the interposer,

## HBM vs. HBM2

Metric	HBM	HBM2
Maximum memory	4GB	32GB
Max memory per HBM stack	1GB/stack (4 2Gb chips, 4 stacks)	8GB/stack (8 chips, 4 stacks)
Clock Speed	500MHz	1GHz
Peak bandwidth	512GBps	1TBps

where the GPU can perform the necessary read/write functions.

“Between 2011 and 2014, we built two more interposer-based prototypes with the Radeon HD 5870 and the Radeon HD 7770,” says Hallock. “The former being a good vehicle for improving our die-stacking technique, and the latter being a good vehicle for designing a prototype that was produced within the same toolsets as our ultimate goal.” At each step, AMD increased the complexity of interconnects, further tested manufacturability, and tested HBM for a production run. The final product was the Fiji chip that powers the Radeon R9 Fury and Nano GPUs.

### HBM Gen 1

Thus far, we’ve established that the HBM concept revolves around sets of

vertically stacked DRAM dies that sit on an interposer next to the GPU, but it’s helpful to know what exactly makes up a stack. With the first generation of HBM on AMD’s Fiji chip, there are four “4-Hi” HBM stacks. The 4-Hi designation means that there are four vertical dies in each stack. On AMD’s Fiji, each die layer provides a 2Gb memory chip for a

total of 1GB of memory per stack. The memory in each stack runs at 500MHz, and the stack is attached to a 1,024-bit wide bus.

When taken all together, Fiji’s four stacks provide you with 4GB of total memory and the 4,096-bit wide memory bus mentioned earlier. These specs are the maximum the first HBM generation can support. HBM’s 4GB capacity is fairly average, considering the vast number of graphics cards with 4GB of GDDR5 memory, yet HBM’s ample memory bandwidth tends to mask problems that a GPU with 4GB of GDDR5 might incur at high pixel densities. GDDR5, of course, isn’t limited to 4GB. AMD’s R9 390 series packs 8GB of GDDR5 video memory, as does NVIDIA’s soon-to-be-released GeForce GTX 1070. NVIDIA’s flagship GeForce GTX 1080 also features 8GB of video memory, but it utilizes GDDR5X, which we’ll discuss a little later.

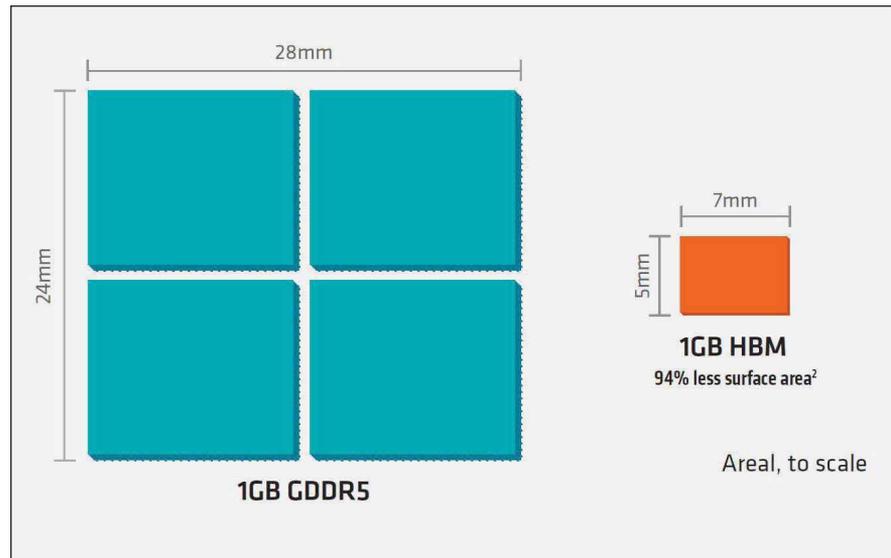
### HBM Gen 2

Like any new standard, the first generation of HBM represents the ground floor of what is possible, and HBM2 blows the lid off of HBM’s first iteration with a maximum capacity of 32GB and a peak memory bandwidth of 1TBps. The JEDEC (Joint Electron

Device Engineering Council) recently published the ratified specifications for HBM2, so it might not be ready for GPUs right away. But with double the memory bandwidth and eight times the capacity, you get an idea of just how well the HBM might scale in the future.

HBM2 features the same 4 x 4-Hi design as HBM1, but each stack can support up to 8GB of memory operating at a 1GHz clock speed. Similar to the first generation, bandwidth is also delivered across a 1024-bit wide memory bus on each stack. A big upgrade, according to the JEDEC, is HBM2's "pseudo-channel" architecture, which is a technology that helps to maximize memory bandwidth. "Pseudo-channel architecture is an optional component of the HBM2 specification that subdivides certain aspects of the communication channels within the memory," says Hallock. "This can reduce latency and increase higher effective bandwidth in some configurations." The pseudo-channel is similar in function to Intel's Hyper-Threading technology for processors,

Like any new standard, the first generation of HBM represents the ground floor of what is possible, and HBM2 blows the lid off of HBM's first iteration with a maximum capacity of 32GB and a peak memory bandwidth of 1TBps.



HBM chips are much smaller than GDDR5 video memory.

as it splits a memory channel into two sub-channels that can individually decode and execute commands.

To the best of our knowledge, SK Hynix has been the only memory manufacturer to develop HBM1, but Samsung has jumped onboard with

the HBM2 interface and begun mass production of 4GB HBM2 DRAM packages. Each package contains four 8Gb cores and can produce 256GBps of memory bandwidth. When utilized in GPUs, it's expected that GPU designers would combine four of Samsung's 4GB HBM2 DRAM packages to deliver 16GB of total video memory and 1TBps of memory bandwidth. Samsung also announced that it is working on 8GB HBM2 DRAM packages, which Samsung points out will be ideally suited for graphics cards. As such, GPUs with 32GB of video memory might be achievable in the near future.

SK Hynix, for its part, also looks to be working on HBM2 memory, though there's no official word on whether production has started or when it plans to have HBM2 packages ready for GPU makers. At this year's GTC (GPU Technology Conference), SK Hynix was showing off side-by-side images of GDDR5, HBM, and HBM2 chips to display the compact size of HBM chips.

Despite the strong interest in HBM2, most experts don't expect the technology to reach GPUs until sometime next year. Whenever HBM2 does reach mass production, the process to

## HBM Overall specification

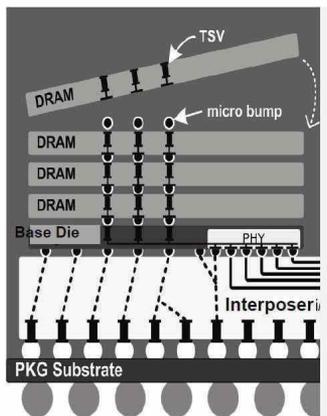
### ➤ HBM1

- 2Gb Density per DRAM die
- 1Gbps speed /pin
- 128GB/s Bandwidth
- 4 Hi Stack (1GB)

- x1024 IO
- 1.2V VDD
- KGSD w/  $\mu$ Bump

### ➤ HBM2

- 8Gb per DRAM die
- 2Gbps speed/pin
- 256GBps Bandwidth/Stack
- 4/8 Hi Stack (4GB/8GB)



SK hynix

SK Hynix, a manufacturer of HBM and HBM2, shows how much better HBM2 can perform than the first generation of HBM.

incorporate into GPUs should be quicker than it was with the first generation of HBM. “Now that the infrastructure has been laid with our work on HBM1 and the interposer, products utilizing HBM2 are certainly easier to realize,” says Hallock. “For example, AMD’s future ‘Vega’ graphics chip will incorporate HBM2.” Hallock declined to provide any date or time frame when we should expect the Vega graphics chip.

### HBM2 & GDDR5X

Soon after the JEDEC announced the HBM2 specification, the standards board also released development standards for GDDR5X memory. Much like HBM, the GDDR5X standard is focused on increasing the memory bandwidth. “GDDR5X represents a significant leap forward for high-end GPU design,” says Mian Quddus, JEDEC board of directors’ chairman. “Its performance improvements over the prior standard will help enable the next generation of graphics and other

high-performance applications.” On NVIDIA’s GeForce GTX 1080, for instance, the 8GB of GDDR5X features a 256-bit memory bus and a quad-piped, 2,500MHz memory clock for a memory bandwidth of 320GBps.

The memory speed increase of GDDR5X allows the GeForce GTX 1080 to deliver a memory bandwidth similar to GPUs with wider memory buses, which can be costly to use and drive up the price point of the GPU. Micron, the developer of the GDDR5X on NVIDIA’s new flagship GPU, has stated that GDDR5X can reach data rates of 13Gbps (3,250MHz quad-piped memory clock), so we might see even faster GDDR5X memory in the future. Micron also packages the GDDR5X in a smaller, more power-efficient (at a per-bit level) package to reduce the size and power requirements for the new memory. And because GDDR5X uses a similar manufacturing technique, its cost is similar to GDDR5’s.

### What Happens With GDDR5?

“People should be very clear on the fact that GDDR5 is still an excellent technology that’s improving all the time with higher-density chips (1GB GDDR5 chips, for instance), and higher data rates (e.g. 8Gbps),” says Hallock. “Technologies like AMD’s lossless delta color compression can also make a GDDR5 memory interface a lot more efficient in important user metrics such as performance per watt and performance per dollar.” Similar to how GDDR3 was still employed on GPUs after the release of GDDR5, it’s likely that GDDR5 will still be around after HBM, HBM2, or GDDR5X becomes mainstream technology, until the advanced video memory technology becomes more affordable to manufacture. We asked Hallock how HBM manufacturing costs compare to those of GDDR5, and he tells us that costs are comparable for the world’s fastest GPUs, but that GDDR5 is still a far better option cost-wise for most GPUs.

### The Fattest Pipe

When it comes to frame buffers, it’ll be tough for any technology to come close to the maximum capabilities of HBM and HBM2. “HBM makes a lot of sense when a desired product has memory bandwidth or form factor demands that would outstrip GDDR5’s technical ability to deliver,” says Hallock. And once we start to see HBM implemented more frequently on GPUs, the cost of the chips should go down. As one of the key developers of HBM, AMD looks committed to using HBM and HBM2 with its high-end GPUs. At press time there was no word yet as to what type of video memory the upcoming Polaris chips will use, but we should know very soon, possibly by the time you read this. Whatever the case, the competing offerings from AMD and NVIDIA should definitely spice up the video card market over the next few years. ■

HARD HAT AREA  
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# Project Red Gotham

As superhero-themed mods go, Travis “The Raw View” Jacques’ Project Red Gotham is fairly distinctive. For starters, the name of the superhero in question isn’t even part of the name of the mod. In addition, the mod is a cube-shaped small form factor build, and therefore has five visible surfaces and all kinds of interior nooks and crannies, yet our hero only shows up on one side panel. Not even a batarang or so much as a logo anywhere else on the build.

“I have always been a Batman fan, ever since I was a boy,” Jacques says. “I wanted to make a computer that incorporated Batman into the build but was not the main focus. So I made the main focus Gotham City. I chose to put red in the name and in the build because I think of Gotham as being a bloody city.”

## Tiny Canvas

OK, so Batman and Gotham and red make sense. But how did Jacques choose Fractal Design’s Node 804 as his case?

“Sometimes, I draw inspiration from what I don’t see,” he says. “I see very few people doing water-cooled builds in the Node 804, and the ones that I did see, I knew I could do it better. So it was the lack of seeing people water-cooling in this case that inspired me to build in it. Of course, I also draw inspiration from things that I like and stuff from my childhood, like the Batman cartoons I watched every Sunday morning.”

Jacques also wanted to build a small form factor build without compromising on storage. “I would say that I accomplished that, with 1.5TB of SSD storage and 12TB of hard drive space,” he says. “And when I first set out to do this build, I planned to do it with GTX 970s

in SLI, but then I won a 980 Ti in the NVIDIA scavenger hunt in Atlanta, so then I picked up another one.”

## Hand Me The Bat-Dremel

Jacques has an office with a custom-built desk where he does all of his building and modding; the whole room is dedicated to computers.

“One thing about my office is that I have designed it to be very clean and aesthetically pleasing because it is where I spend a large amount of my time,” he says. Jacques tells us he spent about 48 hours altogether on Project Red Gotham. “I really enjoy challenging myself and doing new things; building computers is a passion of mine that I really didn’t start doing until about 2013. In 2013, I had a near-death experience (I was the victim of a robbery and was shot—one centimeter higher, and the bullet would have killed me—and from that point on, I have made it a point to do things that I enjoy. Building computers is definitely something that I enjoy.”

“When I got my 804, I cut a window in the front to show off the SSD’s,” Jacques says. (The Gotham City skyline on them is a vinyl wrap, he says.) “I cut one more window on the right-side panel to show the pump, then I cut the grilles on the top of the case and painted everything red. Painting Batman on it was an afterthought because that side seemed too plain.”

Jacques says he also did some work inside the case to adjust for the cooling loop, and he added custom IceModz cables and IceModz LEDs into the mix.

Project Red Gotham has plenty of crime-fighting power, thanks to its Core i7-5930K Haswell-E CPU, EVGA X99



Micro2 motherboard, 32GB of G.Skill Trident Z memory, two GeForce GTX 980 Ti graphics cards in SLI, 1,300-watt EVGA SuperNOVA G2 power supply, two Samsung EVO SSDs (one 840 EVO 1TB drive and one 850 EVO 500GB drive), and three 4TB WD hard drives.

Does anything in that list sound like something you'd expect to find in a small form factor build, by the way? Nope, we didn't think so either, but Jacques made it all work, and made it look great. Plus he cools the CPU and GPUs with EK blocks, an EK pump and EK reservoir, Alphacool radiators, EK fans, and Bitspower fittings.

### Onward & Upward

Jacques would like to thank IceModz.com, ModMyMods.com, and MemoryC.com, all of which sponsored the construction of Project Red Gotham. You can keep up with Jacques at <https://youtube.com/theravview>.

He has already completed another mod called "Project ATS," a black-and-gold-themed build in a Corsair Carbide Series Air 240, and has additionally begun "Project Wifey," a silver, black, and white Corsair Carbide 600C build. "I'm really excited about this build and I cannot wait to share it," he says. Jacques tells us that he has been modding PCs for a while, but wasn't really aware of the modding community until about three years ago.

The modding community may not have been aware of you either, Travis, but we bet it is now. ■

## We Want Your Mod

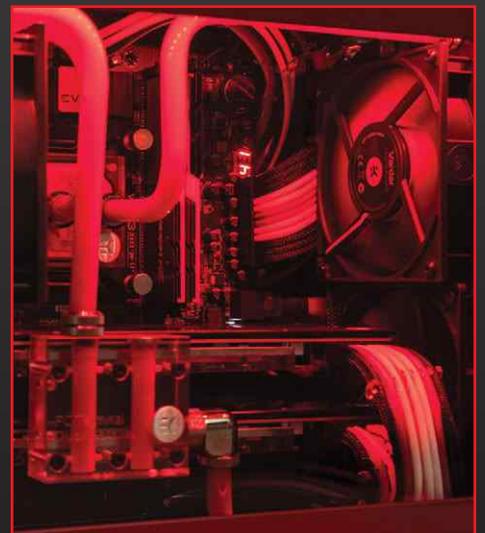
Have a computer mod that will bring tears to our eyes? Email photos and a description to [madreadermod@cpumag.com](mailto:madreadermod@cpumag.com). If we choose your system as our "Mad Reader Mod," you'll win \$1,500! (U.S. residents only, please.)



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HARD HAT AREA  
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MAD READER MOD



# LANFest Sacramento Spring 2016

## It's ~~Not~~ All Fun & Games

One of LANFest's premier events, LANFest Sacramento, took place once again at Intel's Folsom campus starting on Friday, May 13 at 6 p.m. and going until 6 p.m. on Sunday, May 15. And let us tell you, the LANFest Sacramento team knows how to pack a lot into 48 hours. In two days' time, attendees had access to tournaments for League of Legends, Rocket League, and Counter-Strike: GO; contests in Minecraft, World of Tanks, CS:GO, and others; workshops in building computers and more; a mammoth prize giveaway; a CPU mod contest, and much more.



Faithful staffers prepare in the calm before the storm.



Almost there.



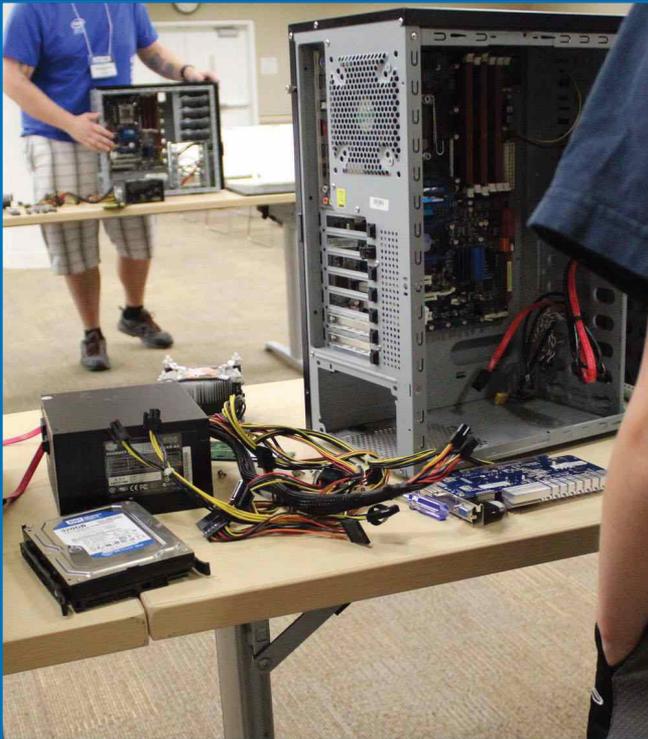
Stay on target!



Bingo.

## A Plethora Of Activities

LAN parties are pretty interactive affairs by definition, but LANFest Sacramento is one of the most interesting events in the LANFest schedule because of the diverse range of non-gaming activities the staff provides. This event was no different, with product demos and workshops a-plenty.



This is one of our favorites; the LANFest staff puts on a very cool workshop on building a PC.



Also, there was lots of . . . whatever this is.

## HARD HAT AREA PC MODDER

### And Vive For All

VR is kind of a big deal right now, and HTC stopped by with its Vive and gave demos to attendees. As you can see, a good time was had by all.



It's always hard to tell who enjoys VR more—the player or the people watching the player.

## Mods On Parade

Another thing we love about LANFest Sacramento is that our mod contests here are always great. Every event we get lots of entries, and the level of competition is very impressive. The same was true at the Spring 2016 LAN, and in the end, our winner was Trevor Lagomarsino's Mortal Kombat Arcade Kabinet. Lagomarsino built the impressive unit from an old ATM shell. As cool as the Kabinet is, it wasn't an easy decision, as you'll no doubt agree.



The Mortal Kombat Arcade Kabinet, by Trevor "Vojox Boggymann" Lagomarsino. Finish him!



Gaming PC built into a Corvette wheel?  
Gaming PC built into a Corvette wheel!



This super-clean rig generated more than a little envy.



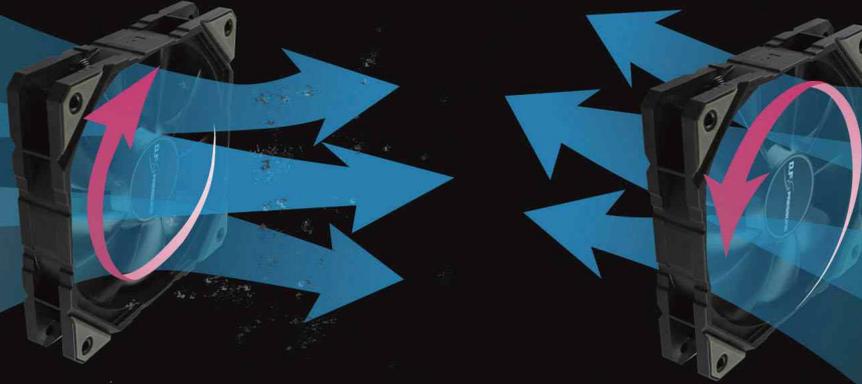
Raw gaming horsepower to the left of us, a companion (cube) to the right.





# 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**

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Air Pressure  
(4.812mm-H<sub>2</sub>O)



**ETS-T50** AXE

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Patented PDF & Air Guide  
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**Platimax D.F.**

Full modular design  
100% IO5C JPN Cap  
Twister Bearing Fan



**ADV OSTROG**

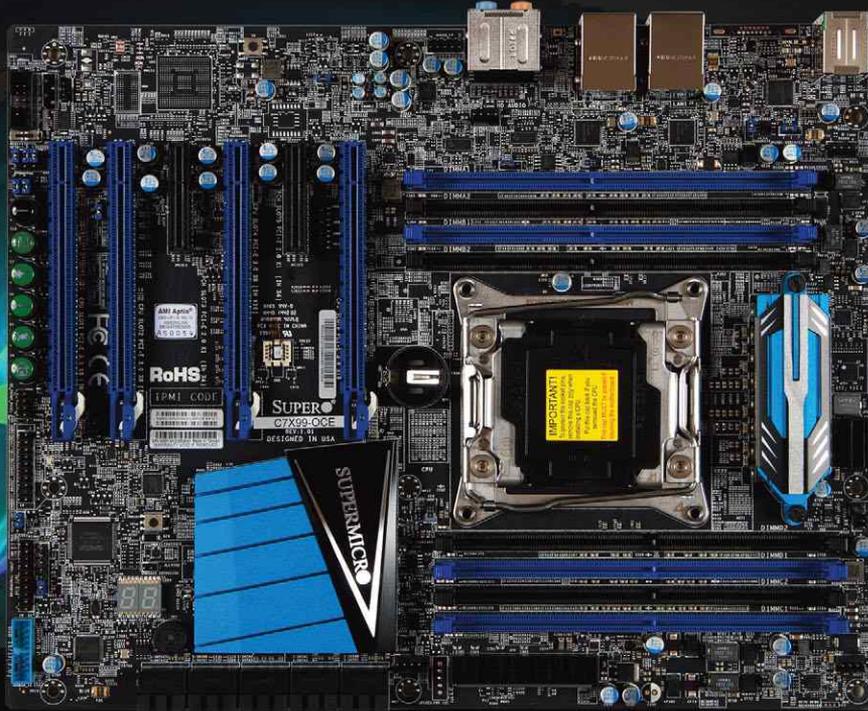
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# DreamHack Austin 2016

## Texas Comes Down With Stockholm Syndrome

If we could make our ideal gaming expo with a computer à la “Weird Science,” we’d start by splicing in QuakeCon’s massive BYOC LAN party, add PAX’s rabid games-loving audience, invite dozens of PG gaming and enthusiast computing vendors, and host several competitive eSports tournaments with prize pools massive enough to attract the world’s best teams. Oh, and we’d sell beer and wine, too. If all of this sounds like a unicorn riding an unobtainium hoverboard through a field of black tulips, then you may be surprised to learn that such an event already exists.

DreamHack, the granddaddy of all digital festivals once confined to Europe, made its first-ever North American stop in Austin, Texas, May 6th through the 8th. We were there, and we brought back souvenirs.



DreamHack Austin was the site of the ZOWIE Open, StarCraft II World Championship Circuit, and the Heroes Of The Storm North America Spring Regional.



Even if you didn't bring your own PC, there were still plenty of opportunities to play games.



The quiet before the storm. DreamHack's nearly 2,000-seat BYOC was split into three large sections that nearly filled a large portion of the Austin Convention Center.

HARD HAT AREA  
PC MODDER



FrozenPCMods was exhibiting a cool-looking DIY LF Reaction reservoir kit that would be a great centerpiece for any modded system.



Altex Computers & Electronics was on hand showing off almost as many mods as we were. Almost.

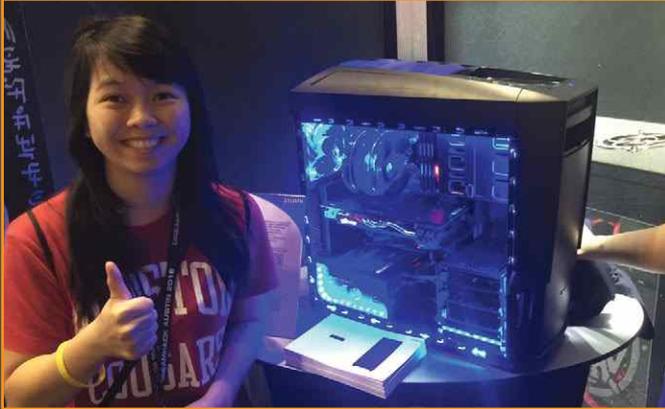


At Razer's booth, attendees could try out some of the firm's slick-looking gaming laptops, mice, keyboards, mousepads, and headsets.

The tricked-out Alienware truck was a favorite spot for gamers to stop and play a handful of the hottest games on half-a-dozen Alienware systems.



HARD HAT AREA  
PC MODDER



Zalman's demo system got a hearty thumbs-up from this enthusiastic DreamHacker.



This little guy was enjoying himself while making one of AVADirect's gaming PCs sweat.



CPU's DreamHack mod contest was a smashing success, especially thanks to the prize packages put together by MSI, PNY, HyperX, and ADATA.



These eager attendees are anxious to get their hands the loot we brought from the likes of Patriot, Zalman, G2A.com, MSI, Rantopad, ENERMAX, ROCCAT, Bloody, DXRacer, Raijintek, and Rosewill.

HARD HAT AREA  
PC MODDER

We found close to a dozen impressive mods at the inaugural North American DreamHack, but these were our favorites of the bunch.



The second- and third-place mod contest winners, Dave "InsolentGnome" Cathey and Sam P., showed some serious chops with their Scout and Resident Evil mods. I hope that's not Chris' blood.



The mod contest runners up, Jon C. and Jeff F., added a 3D-printed front panel to an old-school beige case and used a completely sealed Pelican case to make their respective versions of the perfect LAN box.



The winner of the DreamHack Austin 2016 mod contest was Gary "NavyChief" Murphy, with his impressive and creative BAWLS mod. Can your system run on super-caffeinated guarana? We didn't think so.

# Bring The Pane

## Cut Case Windows Like A Pro

Kids these days. They don't understand how good life is for them. Smartphones can do everything that used to require a cellular phone, camera, camcorder, laptop, and portable music player. Any music video is available on-demand, without having to sit through the rest of the top five. Movie rentals are spit out of a giant box, and when they're returned they don't need to be rewind!

The real outrage, though, is that today's entitled young punks often have their dream cases made for them. Today it's all too easy to go online and choose from dozens, if not hundreds of PC cases with awesome pre-cut side panel windows. What happened to the good old days, when people who wanted a windowed case had to break out a jigsaw, roll up their sleeves, and take a bite out of the side panel? A real case window was one you cut yourself.

Normally, at this point, we'd turn on the hose and bark at those brats and their fancy prefabbed cases to get off our lawn. This month, though, we're going to invite them into our garage, because everyone can and should learn to cut their own case windows.

Now, in all seriousness, if all you want is a simple, square or rectangular window that showcases the wicked hardware within your case, buying a case with a pre-cut window is not only easy but completely eliminates the margin of error; no enthusiast will judge you for letting the case's manufacturer do the hard work.

However, there are still plenty of reasons to start with a windowless case and cut the perfect window for your machine. Most obviously, when you do it yourself, you're creating a case window (or windows) on your own terms. We hesitate to say the sky's the limit when cutting a custom window, because the panel's structural integrity is a consideration.



This is why you don't settle for stock. A DIY case window lets you show off the inside of your build on your own terms. With enough time and the right tools, cutting a custom window is easier than you think.

(Sorry, the extremely intricate spider web window just might not be possible regardless of your skill with a saw.) Otherwise, any shape, design, or logo is within your grasp, provided you have the necessary tools and the patience.

Cutting a custom window gives you control over not only what size and shape of window you cut but also where on the panel you want to locate it. If you'd rather your system's internal drive bays stay out of sight, a custom case window will keep

them hidden. Conversely, if you've created an unbelievable custom bay for your drives and want to show it off, you can cut a custom window in the perfect spot to highlight it. Whereas "clear" is typically the go-to color of choice on case windows installed at the factory, you can pick a custom acrylic window that matches the rest of your rig.

To help us in our case-carving endeavors, we've assembled a posse of talented and experienced modders to



Tools make the modder, and the right tools can make the mod easier. Try to purchase a high-quality, variable-speed jigsaw, such as the RYOBI JS651L (above left) that Bob Stewart and Rod Rosenberg use. A set of metal files will clean up the jagged edges left behind and in some instances can correct minor mistakes.



guide you through the process of cutting a custom window. Our team consists of Bob Stewart and Rod Rosenberg (often known by their band name, “BS Mods”), Dewayne “Americanfreak” Carel of Modders-Inc.com, and Brian “Boddaker” Carter (dba “Bods Mods”). These guys know their way around a workbench and are here to help.

### Inside The Modder’s Toolbox

Compared to other mod projects, cutting a custom case window doesn’t require a bunch of tools. You need something that can slice through steel, plus a supporting cast to help you make and clean up the cuts. Plenty of power tools can wreak havoc on a PC case, but when it comes to cutting a case window, our modders agree that nothing beats a trusty jigsaw. “It does the job cleanly and quickly,” Carter says. A basic drill will help you create a starting point for your jigsaw.

Stewart and Rosenberg both favor RYOBI’s JS651L (“It has a light on it, so you can see the blade better, and it has a great feel to it,” Stewarts say, while Rosenberg adds, “It tracks very well, making it much easier to create a straight cut.”) Stewart also mentions that a variable-speed jigsaw has the advantage of offering increased control while cutting, especially turning corners. Carter says he prefers a Porter-Cable unit, while Carel offers general advice for finding the right jigsaw.

“Tools are like anything else you buy—you buy crap, and your end result

will be crap,” he says. “Quality tools do give you better control and finish. If the tool is from a discount tool supply store, then you know the quality will be below standard. But at the same time, the fact that one has a lot more [features] does not automatically mean it is the best.”

When you’re ready to move beyond simple shapes and attempt more intricate window work, both Carter and Carel suggest using a scroll saw. In fact, Carel considers a good scroll saw his secret weapon. “A scroll saw is a stationary saw that moves the blade while you move the material,” Carel says. “Normally a scroll saw is used for fine detail work for woodworking, but with a metal blade it is hard to beat. This same saw can be used to cut different-shaped acrylic for windows.” Carter also lists a Dremel rotary tool with “a wide assortment of cutting and grinding bits” among his arsenal.

A jigsaw is only as good as its blades, and simply choosing blades for cutting metal isn’t enough. Wider blades are better for cutting straight lines, while narrower blades are better for turning corners and making more detailed cuts. Once you reach the inevitable conclusion that all of your cases need custom



For starting your cut and turning tight corners, pilot holes are essential. Even basic shapes will require a handful of pilot holes, but for elaborate designs such as a flame-shaped window (bottom), you should drill a pilot hole everywhere your jigsaw blade needs room to maneuver.

windows, we'd recommend using a new set of blades for each project.

After your jigsaw has chowed down on the case panel, you'll want to refine the sharpened metal it leaves behind. For this, you'll want a set of metal files. In addition to smoothing the metal, files can occasionally help correct minor imperfections in your cuts, as long as you realize a file is not a magic wand. Carter adds that he uses 400-grit sandpaper for a finishing touch after filing his cuts.

Painter's tape is another essential, and it serves a couple of roles. First, it offers protection to your panel while you're cutting the window, and you can also lay out your window design directly on the tape itself. Buy yourself a roll or several.

Carel likes to use a set of clamps to ensure that his patient stays put on the operating table during surgery. "For making better cuts and eliminating any mistakes, you need to make sure that you work doesn't move," he says.

Our modding experts presented a pair of options if you need to cut your acrylic to fit the window. Carter simply changes the blade of his jigsaw. "I swap out the blades—higher TPI (teeth per inch) for metal, narrower scrolling blade for acrylic," he says. Carel likes to use a plexiglass cutting tool. "It's basically a handle with a blade on the other end that has a sharp, hook-like edge. This tool will scribe the plastic and will allow it to break precisely on the scribed line. You can buy one at any hardware store for under \$10."

Finally, our lawyers have compelled us to mention that before starting a case window mod (or any mod, for that matter) it's a very good idea to invest in a solid set of safety equipment—glasses, gloves, and ear plugs. You want to avoid modding yourself.

### No Mistakes

Although a DIY side panel window project tends to have a reasonably high margin for error, you'll still have plenty of chances to botch the job. The top rookie mistake, according to Stewart, is not holding down the panel enough to prevent it from bouncing around as you cut. When the panel starts to jump, it's

easy to bend the edges of the windows. When this happens, Stewart says that you can sometimes straighten the edges with a hammer, but the better approach is simply keeping the panel secure while cutting.

Carter calls out the all too common mistake of simply making measurement errors. "Measure twice, cut once' is more than a rule of thumb," he says. "It's a way of life."

Measuring properly is, of course, basic advice, but less obvious is a mistake closely related to sloppy measurement: failing to account for how the piece of acrylic affects the panel once you return it to the case. "Sometimes, the new window material causes a problem with how the case side panel attaches," Rosenberg says. "This is most common with cases that have a panel that must be pressed against the case and slide forward to lock. A tip to avoid this is to temporarily tape the window into the case side panel before you cut." Rosenberg adds that a piece of cardboard of equal thickness to your acrylic can be taped to the panel for a trial installation, if you're worried about scratching or damaging your acrylic.

When the worst happens and your case panel is beyond saving, your case's manufacturer may be able to come to the rescue. Today, case makers recognize the importance of the modding community. Certain companies may give you the option to purchase a replacement panel directly from their website. Those that don't might still be able to help a modder with a mangled case panel. Our group of modders agree that most will accommodate requests to buy a replacement panel, as opposed to purchasing a brand-new case.

"Ask if they have RMA cases in the warehouse that have a side panel you could purchase," Carel says.

### Addition By Subtraction

With your tools in hand and your workspace set up, you're ready to begin slicing and dicing your case panel. Start by covering the panel in painter's tape. You can draw your window pattern directly on the tape, and the tape will keep your panel safe as you saw. "If you don't apply tape over every piece of the side panel, you



Be sure to cut your acrylic so that it extends well beyond the window's edges, at least one inch on all sides.



Combined with a sweet paint job, a custom case window looks much cooler than anything an assembly line could put together.

will scratch some part of the panel, no matter how careful you are,” Carel says. Completely wrapping your panel in tape isn’t strictly necessary if you’re also planning a custom paint job.

After you’ve plotted the design of your window on the inside of the panel, identify all the corners and/or tight turns in your design. These are the spots you’ll want to use your drill to create pilot holes. All of our modders agree that pilot holes are your best friend.

“You want to think about drilling some holes on the inside area of the opening at the corners so the jigsaw blade has a place to start,” Stewart says, “and it helps when you turn the corner.”

“If there are tight turns or a straight 90-degree corner, you should drill a hole just a bit bigger than the blade you are using as close as possible at the point of the hard turn,” Carel adds. “When you are cutting and you come to the corner, your blade will go into the hole and you can maneuver the saw to make the continuing cut.”

For the majority of the cut, you should simply follow the best practices for operating a jigsaw. Work slowly and

don’t force the jigsaw to cut faster than necessary. “Let the tool do the work,” is a tired cliché, but it’s especially important for keeping your lines straight. Keep the panel firmly in place (this is where clamps help immensely) and always cut on the inside of your lines; you can file off excess, but you can’t replace the metal you’ve already sliced off.

With the window cut and filed, you’re ready to attach your acrylic. Cut the acrylic to fit, if necessary (and here, precision is not as important when the acrylic is affixed behind the panel), using your jigsaw or cutting tool. Carter recommends having the acrylic overlap the window at least one inch on all sides, a fact that could influence your window’s location.

Strong double-sided tape will secure the acrylic to the panel. Carter says he uses 3M tape, while Stewart and Rosenberg favor Bron Killer Red tape, citing the latter’s thinness.

### Pick A Pane

For the pane itself, acrylic is the most commonly used material. You have a lot of options, but of them all,

Stewart prefers to use cast acrylic, which he orders from Delvies Plastics ([www.delviesplastics.com](http://www.delviesplastics.com)). “We get cast acrylic because it has better clarity and is much better for windows. Things like Lexan are more impact-resistant but much softer and will scratch when cleaning.”

It’s possible to make a truly traditional window in your case by using a glass pane, but as Carter points out, be aware that its extra weight will more than likely require a stronger adhesive than the double-sided tape used to secure acrylic. For their Throne Industrial mod (flip back to the first page of this article), Stewart and Rosenberg used safety glass, which is laced with wire mesh and cannot be drilled through. For this heavy pane, they used Permatex’s The Right Stuff to secure the pane to their panel.

“Sure enough, it was the right stuff,” Stewart says.

You can customize your window even further etching a pattern into the pane itself. Again, you have a couple of options. Laser engraving will deliver great results, but if you don’t plan to create many custom case windows, hiring a professional engraving service to handle the work for you is the most cost-effective approach.

Carter, Rosenberg, and Stewart use a media blasting cabinet to customize their panes. “It uses sand or other small media like glass beads to etch the acrylic,” Carter says. “Whatever isn’t masked off will get a nice frosted texture to it.”

“We have a sandblaster with glass beads that we use to create images on the acrylic,” Stewart says. “We cut a stencil and then stick it to the window and blast it. It really works great. Harbor Freight has cheap units that you assemble yourself.”

### Window Work

A custom case window adds an undeniable personal touch to your system, and it’s great for beginners looking for a first serious mod project. Grab your jigsaw and get in touch with your artistic side. ■

# Feeling Is Believing

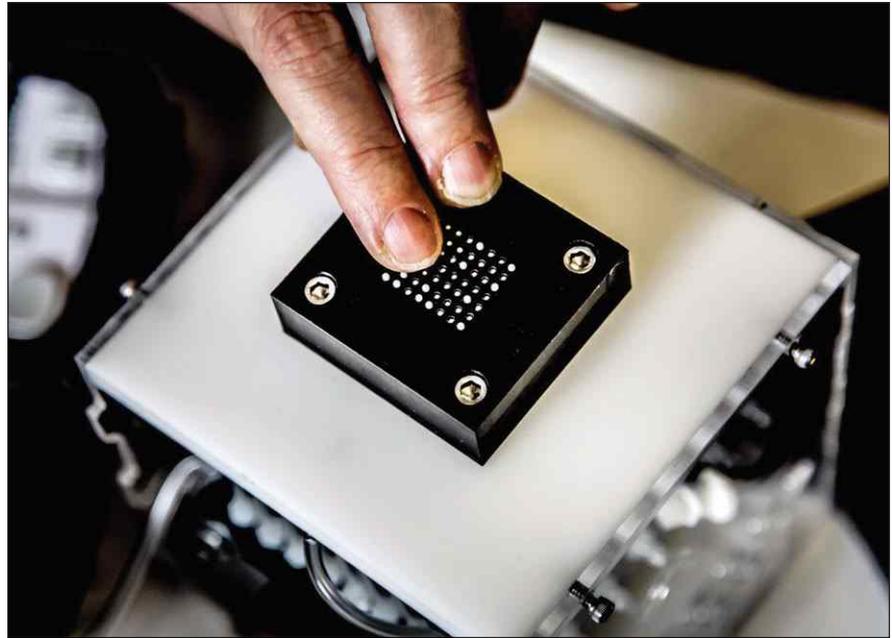
## UMich Research Could Lead To Better, Cheaper Braille Tablets

In the age of iEverything, touchscreens have become second nature. Pinch, zoom, swipe—we’ve committed these gestures to muscle memory. Toddlers learn how to swipe from digital page to page on an iPad before they can do the same with an actual paper page. It’s safe to say that most people know their way around a smartphone or tablet.

“Touchscreens” are also a part of everyday life for many visually impaired individuals. Although these aren’t tablets in the same sense as a Microsoft Surface or Google Nexus 9, the devices are very useful to blind users. They present information in braille and are able to dynamically change the words “displayed” by raising and lowering a series of small bumps that blind users read in a fashion similar to printed braille pages.

Like the touchscreen gadgets we use every day, braille tablets, also known as refreshable braille displays, are naturally able to condense volumes of printed information into a portable handheld. The devices are immensely helpful to their owners, but like most technologies, there’s room for improvement.

A small team of researchers from the University of Michigan recognizes the limitations of current RBDs and is working to build a better mousetrap. To do so, they’ve essentially scrapped the existing design and are building an RBD from the ground up to have a form factor closer to a standard tablet, which would present blind readers with more possibilities. If they succeed, the group’s innovations will result in a vastly superior device. The team consists of project lead Sile O’Modhrain, an associate professor in UMich’s School of Music, Theatre, and Dance and the School of Information, Brent Gillespie, associate



For years, visually impaired individuals have turned to refreshable Braille displays to read text from computers. A small group of researchers at the University of Michigan want to make them better, and they’re starting from scratch with a bold new approach to do so. *(photo courtesy University of Michigan)*

professor of mechanical engineering at UMich’s College of Engineering, Alex Russomanno, a mechanical engineering doctoral student, and chair of the school’s chemical engineering department professor Mark Burns, whose background in microfluidics has been instrumental in developing a working prototype. The project eventually became known as “The Holy Braille,” and it has the potential to revolutionize braille tablets for visually impaired readers.

### Out With The Old

Certainly, prevailing braille displays are a far better choice than lugging around printed braille books. Their underlying technology consists of using piezoelectrics to raise and lower a series

small dots, or bumps, which lets an RBD change the braille that’s displayed as it’s read. Each bump is connected to a pin, which in turn is connected to a piezoelectric electric bimorph. For each line of text a connected computer passes to the RBD, the display uses the piezoelectric bimorphs to raise or lower each bump and create the line of text in braille. The implementation works and lets visually impaired computer users read text that would otherwise require text-to-speech software. (Users with both typically have the option to toggle between using an RBD or TTS software.) That said, the UMich team initiated their project to address a couple of key disadvantages that restrict braille tablets’ potential.



Refreshable braille displays give visually impaired readers the ability to read text from a computer without relying on conventional text-to-speech methods, which is useful, but a University of Michigan research team thinks they can be better. The piezoelectric technology that RBDs use is expensive and limits the size of such devices. (Image modified; original image credit: [www.flickr.com/photos/ghwpx/](http://www.flickr.com/photos/ghwpx/))

First, most current displays consist of only a single line of braille text, which limits both the speed and content that blind users are able to read.

“Imagine trying to read a book on a Kindle one line of text at a time,” O’Modhrain said in a UMich-produced video on the project.

“You can’t do much with a single line [of text],” Russomanno added. “It’s hard to read. You can’t do things like graphs. You can’t do spreadsheets. You can’t do any kind of spatially displayed information.”

RBDs that display a line of braille text using piezoelectrics require a lot of moving parts. Consider an 8-dot braille character: Such a module on an RBD consists of eight bumps, eight pins, and eight piezoelectric bimorphs. Multiply that across the length of an RBD, and you have a device that’s densely packed with components. The end result is an expensive piece of equipment. Even at the low end, a basic RBD costs over \$1,000, and most range from \$3,000 to \$5,000, according to O’Modhrain.

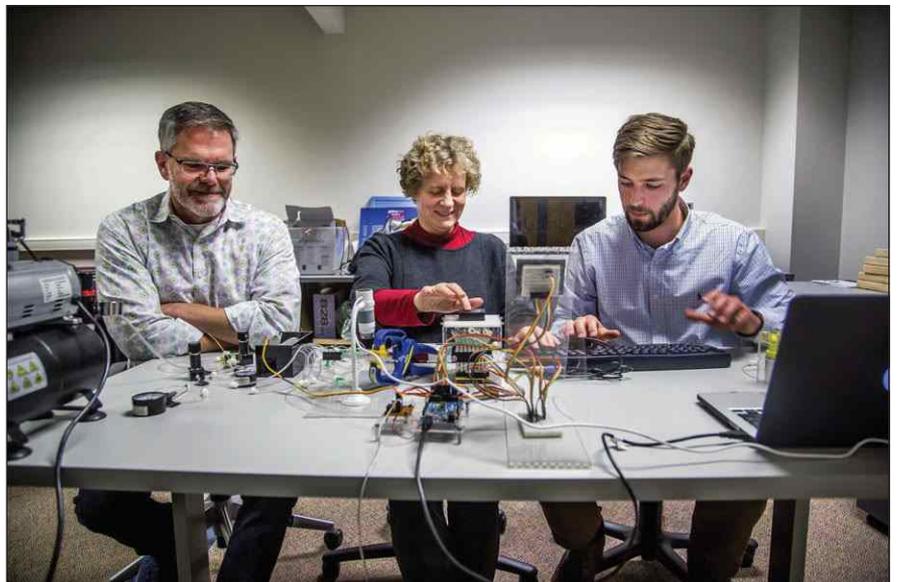
Cost is the chief reason most RBDs are limited to a single line of braille; scaling up an RBD to be comparable in size to a Kindle, iPad, or similar tablet would result in a sticker price north of \$50,000. If the Holy Braille project succeeds, the team believes they can produce larger RBDs at a drastically reduced cost. They

believe their microfluidic-powered RBD could cost around \$1,000.

### In With The New

As we’ve mentioned, the UMich researchers’ approach relies on microfluidic, rather than electronic, components. Microfluidics is a field that involves a wide range of disciplines, including engineering, chemistry, nanotechnology, etc. at a

microscopic scale. Microliters is usually the threshold for volume, but microfluids can be even smaller. At a scale of microliters or nanoliters, microfluids can be arranged and manipulated to form transistors, resistors, and circuits. These behave the same as their electrical counterparts, but instead of using voltage and current, the microfluidic equivalents rely on pressure and fluid flow, respectively.



University of Michigan professor Brent Gillespie (left) and Ph.D. student Alex Russomanno (right) join professor Sile O’Modhrain (center), who tests a prototype of the microfluidic-based refreshable Braille display the team is currently developing. (photo courtesy University of Michigan)

The Holy Braille project's prototype replaces the piezoelectric "guts" of an RBD module with pneumatic actuators. Essentially, rather than have a piezoelectric bimorph connected to a pin that raises and lowers a small bump, the prototype's pneumatic actuators use a minuscule amount of air to inflate or deflate tiny polymer bubbles. A large array of bubbles either inflated or deflated according to the microfluidic circuit, creates braille the same way a piezoelectric RBD would create it.

"In essence, we're stealing what has been done with electric circuits and adapting it to microfluidics," Russomanno tells us.

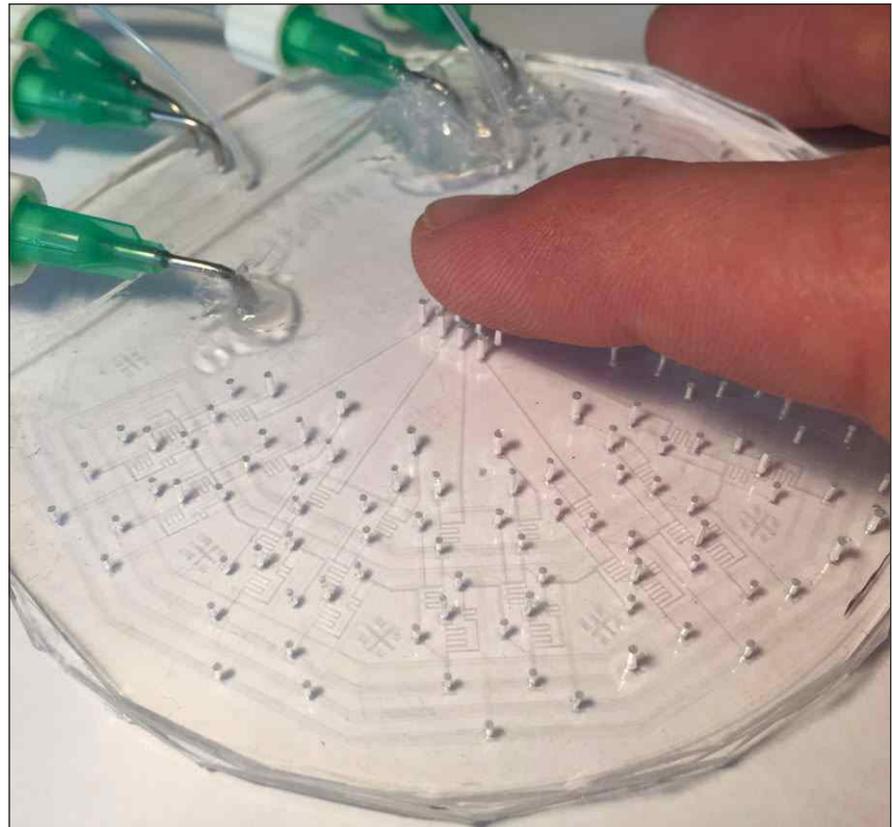
Russomanno says that their RBD's microfluidic components theoretically let them create tablets cheaper than piezoelectric displays. "It's easy to make the actuators in a lab using a polymer molding process." Part of the genius of microfluidics is that the team can use the same material to make their device's actuators and circuits. According to Russomanno it's as easy to make 10,000 actuators as it is to make 1,000. Despite this, don't expect Holy Brailles to start rolling off the assembly line anytime soon.

### Room To Shrink

Russomanno stresses that the team's prototype is still in the proof of concept stage and that they have a number of hurdles to clear before a microfluidic-based RBD is ready for prime time.

The most significant challenge is reducing the size of the components in order to make the device thin enough to remain portable. Otherwise, the type of tablet the team hopes to produce, one that boasts thousands or tens of thousands of braille dots, would be far too large and unwieldy.

"Microfluidic technology to control actuators previously existed for other applications. The challenge is manipulating it and changing it to suit our needs," Russomanno explains. "Recent journal papers we've put out describe the process of controlling the actuators. "Once you can



Microfluidics are the foundation of the Holy Braille project. At microscopic levels (get it?) fluidic substances, frequently liquid or gas, can be engineered to function the same way as common electronic components, such as transistors, resistors, and circuits. (photo courtesy University of Michigan)

do that, it becomes cheap to make such a display.

"But how do you have the pressure/energy to control the actuators? It's a technical hurdle we have to overcome." Russomanno adds that the team is exploring the possibility of using microcompressors utilized in the medical industry as a solution.

Proving that their actuator concept is viable is the team's first undertaking, but they're also focused on usability considerations. With O'Modhrain's guidance, the researchers will be able to tweak parameters such as dot size and spacing to ensure their RBD is comfortable, intuitive, and easy for blind readers to use.

"Essentially, I had no idea coming into the project about what devices are currently out there for blind people," Russomanno says, "what's lacking in terms

of the electronic medium and digital information. [Professor O'Modhrain] is connected to the blind community, braille press, blind advocacy programs. She's been a great resource for what's missing, what's out there, and what we need to work on."

### Beyond Braille

Ultimately, the UMich team wants larger braille devices simply so visually impaired readers can read braille more quickly, but if they succeed, a bigger display could open even more doors. Additional lines of dots could be programmed to display more than braille; Russomanno suggests images, mathematical notations, and music as other things the Holy Braille might be able to display.

"The fact that such a device doesn't exist is pretty crazy, when you think about it." ■



# XPREDATOR GOLD



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## Modular cables

### 750GM

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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				

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For more details, please visit [www.aerocool.us](http://www.aerocool.us)

## Modder Q&A: Ron Lee Christianson

### A License To Create

Ron Lee Christianson's work has appeared in *CPU*'s "Mad Reader Mod" feature on three occasions, including his Iron Man Mod in the January 2013 issue, his Half-Life Black Mesa project in the May 2014 issue, and of course the mod he created with Jon "PennyWise" Hansz based on *The Witcher*, which appeared in the April issue this year. Christianson's Blue Horse Studios ([bluehorse-studios.com](http://bluehorse-studios.com) or [www.facebook.com/bluehorsestudios](http://www.facebook.com/bluehorsestudios)) offers a full range of graphic design services as well as custom-built PCs; his broad expertise shines through in each of his mods.

**Q** : Did you start out in graphic design and then get interested in modding, or was it the other way around, and when did you mod your first PC?

**RLC** : I come from a family of artists and musicians and have been painting, sculpting, building models, and doing anything creative since I was young. When I was three, I drew the Lucky Charms leprechaun on my wall. It was great having an older brother who was an artist to mentor me, and I really progressed at such an early age from taking art classes and being surrounded by other creative people. PC modding came just within the last seven or eight years as another way to express myself and has been a huge part of my creative release.

**Q** : Your mods are so impressive because you clearly have a firm grasp of so many areas, from design and paint to custom metal fabrication and sculpting; what's your favorite part of the modding process, and why?

**RLC** : I really enjoy the R&D part of it and spending hours just lost in the creative process of building and sculpting the pieces that go into my projects. Sometimes eight to 12 hours will go by seemingly in the blink of an eye.

**Q** : If you had to build a custom PC and could only use one tool from your extensive workshop, what tool would you choose, and why?



**RLC** : Does the creative process count as a tool or can I choose two? I think creativity and/or inspiration are my tools of choice, without those I wouldn't have the builds I have today.

**Q** : Back in 2013 when we talked to you about the Iron Mad mod, you mentioned that you had plans to do several Avengers-based mods. Have you completed mods based on any of the other Avengers?

**RLC** : I built Iron Man for Thermaltake, and we were discussing doing a line of Avenger characters but they decided just to do an Avengers build instead. But I may come back to it.

**Q** : One more question about the Iron Man mod: You included a broken piece of Cap's shield on the inside of one of the side panels, and in retrospect that almost seems like a prophetic reference to Civil War. Were you aware of the Civil War storyline from the comics, or did you just get lucky?

**RLC** : Um, Stan Lee and I had drinks during happy hour—can't tell you any more than that.

**Q** : A lot of your mods are based on cool pop-culture references to movies and videogames. Do you have any ideas for mods that you haven't done yet that you can share with us?

**RLC** : I'm a huge "Star Wars" fan and just completed a build for NVIDIA that is still under NDA: Hopefully you'll see that soon. I want to do a "Blade Runner" mod, but still doing the R&D and can't decide if I want to scratch build it or case mod it, but yeah I get a lot of inspiration from comics, videogames, and sci-fi movies.

**Q** : Are you currently using one of your mods as your own personal gaming rig, and if so, which one and why?

**RLC** : Yes, my Alien mod! As a huge sci-fi fan, nothing gets any better than "Star Wars" and "Aliens," and I enjoy looking at the Xenomorph crawling out of the top of the airlock while I'm gaming.

**Q:** Tell us a little about Blue Horse Studios! When did you start it up, and do you mostly do mods and custom builds, or do you do a lot of other kinds of graphic art and design, as well?

**RLC:** Blue Horse Studios has been around long before I ever was involved in the modding scene as a graphics and portrait studio established in 2001. I do murals, portraits, illustrations, vinyl signs, lettering, web graphics, and much more. I became involved in modding around 2007 to 2008.

**Q:** What's your favorite project out of all the mods that you've done over the years, and why?

**RLC:** Steampunk Time Machine definitely; it's not based off any other design or pop-culture reference other than the steampunk genre. I was able to go crazy with different elements and allow my creativity to really control how the build would turn out. Plus I can travel back in time! Still trying to figure out the calculation for future travel, though.

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

1) NVIDIA Pascal or AMD Polaris?

NVIDIA FTW. Isn't a Polaris some sort of off-road vehicle?

2) Resident Evil 1 or Resident Evil 4?

RE1.

3) Pre-paint sanding or cable sleeving?

Paint please, I love the smell.

4) "Alien" or "Aliens"?

Tough one! Both great movies, but I'll go with "Alien."

5) McDonald's or Burger King?

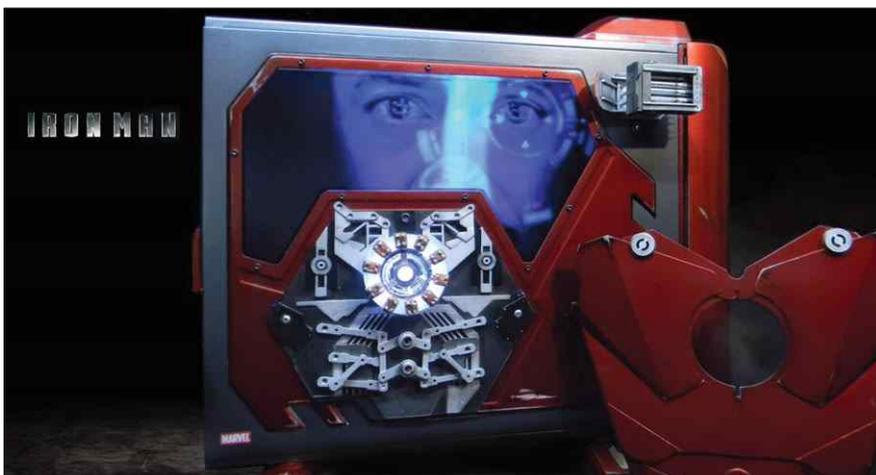
If I was starving and had to choose one, Burger King and then the toilet. ■



Ron's favorite project, the Steampunk Time Machine. He promises not to use its power for evil.



Do yourself a favor and check out our May 2014 issue online for more pics of this incredible mod.



We've seen quite a few Iron Man mods, but Christianson's take on the character is the best yet.

# Clocks Up, Heat Down

The story of Icarus, who in Greek mythology was given a pair of wax wings and flew too close to the sun, provides solid advice about the folly of overconfidence (and the importance of listening to your father). But there's another lesson here for PC users—heat kills. Maybe if Daedalus were around today, he'd give Icarus a pair of liquid-cooled wings.

Enthusiasts and overclockers are well aware that heat can prevent a CPU from reaching peak overlocks, and expert builders often create custom liquid-cooling loops to dissipate processor heat. The DIY route isn't for everyone, though, as custom loops can complicate your build plan and can be cost-prohibitive. Modern air and all-in-one liquid CPU coolers offer minimal fuss and generally do a great job of keeping the mercury down.

### **Clear Air**

The design of air coolers hasn't changed too much over the past few years, but recently, manufacturers appear to be more conscientious about clearance issues with system memory. Even on monster air coolers with fans and heatsinks that hang over the motherboard's DRAM, the aluminum fin structure is typically raised to let you use memory modules with tall heat spreaders. There are also several air coolers with slim aluminum fin arrays to completely avoid memory obstruction. Fan noise is another area where air coolers have made gains. Noise levels are typically less than 30dB(A).

### **Closed-loop Closer To Custom**

The first wave of closed-loop CPU coolers were all quite similar in both look and performance, because the vast majority were based on the same Asetek design. Over the years, CPU cooler manufacturers have put some serious R&D into pump, fan, waterblock, and radiator designs, resulting in preassembled kits that deliver performance approaching that of DIY liquid-cooling loops. In our buyer's guide, we detail the key modifications of each model. On the whole, radiators are much larger today than the 120mm rads that were common among the first models we reviewed; today there are plenty of closed-loop kits with 240mm, 280mm, and 360mm radiators. The longer the radiator, the easier it is for the closed-loop CPU cooler to battle heat.

In this guide, you'll find air and closed-loop CPU coolers of all shapes and sizes. Each entry lists either the CPU cooler dimensions (for air coolers) or radiator size (for closed-loop coolers), as well as the rated noise level to help you find the cooler that best fits your build's needs.

## Cooler Master MasterAir Maker 8

\$129.99

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

**Why You'll Dig It:** The 3D Vapor Chamber technology in the MasterAir Maker 8 combines horizontal vapor chambers, similar to the cooling on a GPU, with conventional heatpipe technology for exceptional heat transfer. Testing in our labs shows that the 3D Vapor Chamber technology is amazing effectively, as the average temp of our Core i7-5960X under Prime95's load was only 53.5 degrees Celsius. Modders will also like that Cooler Master supplies a 3D printing file for the cooler's top plate. The MasterAir Maker 8's default top cover is translucent and lets you see the cooler's LED lights, and Cooler Master also includes an aluminum top cover, should you want a cleaner appearance. High performance air cooling sometimes goes hand-in-hand with noisy fans, but Cooler Master's two 140mm Silencio FP fans keep the cooler to 24dB(A) or less.

**Who Should Apply:** Overclockers and modders wanting an air cooler that can keep up with (and beat some) closed-loop CPU coolers.

CPU Cooler dimensions (HxWxD): 6.77 x 5.71 x 5.31 inches

Fans: 2 x 140mm (600 to 1,800rpm)

Rated noise level: 8 to 24dB(A)



## be quiet! Pure Rock

\$34.90

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

**Why You'll Dig It:** be quiet! rates the Pure Rock with a 150 watt TDP cooling capacity, and at only \$34.90, you won't have to break the bank to see a significant upgrade over the stock CPU cooler. For near silent operation, the Pure Rock is equipped with a 120mm Pure Wings fan featuring nine airflow-optimized blades that are designed to reduce noise-generating turbulence. Even at top speed, the Pure Rock's noise levels reach only 26.8dB(A). Heat is quickly dissipated on the Pure Rock, thanks to four high-performance, 6mm heatpipes in the heatsink. The air cooler is also compatible with a wide-range of Intel and AMD sockets, including the latest options, so there's no need to worry about if it'll work with your build. System builders concerned about look will also like the aluminum top cover that delivers a high-end fit and finish to the CPU cooler.

**Who Should Apply:** Power users looking for cooling performance and quiet operation at an affordable price.

CPU Cooler dimensions (HxWxD): 6.10 x 4.76 x 3.44 inches

Fans: 1 x 120 Pure Wings fan (1,500rpm max)

Rated noise level: Up to 26.8dB(A)



## Deepcool GAMER STORM ASSASSIN II

\$89.99

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

**Why You'll Dig It:** Deepcool's GAMER STORM ASSASSIN II is a big air cooler that battles enthusiast-level overlocks at sneaky quiet noise levels. The PWM fans feature a minimal speed of 300rpm for exceptionally quiet operation during idle. When the heat ramps up, so does the fan speed to get the job done. The ASSASSIN II kills heat with two of Deepcool's Gamer Storm GF fans, one GF140 and one GF120. The 140mm fan is sandwiched between the twin-tower array to help move air inside the fin structure, while the 120mm front fan helps bring in cool air. There are eight high-performance heatpipes coupled to an aluminum, twin-tower fin structure. Deepcool applies a mirror finish to the polished copper base for optimal contact and cooling performance.

**Who Should Apply:** Uncompromising overclockers who want an air cooler that's quiet when it needs to be and has gale-force cooling potential under load.

CPU Cooler dimensions (HxWxD): 6.57 x 6.22 x 5.63 inches

Fans: 1 x Deepcool GF120 (300-1,400rpm), 1 x GF140 (300-1,200rpm)

Rated noise level: 17.8 to 27.3dB(A)



## be quiet! Dark Rock Pro 3

\$89.90

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

**Why You'll Dig It:** Many of today's tallest, bulkiest air coolers can handle overlocks, but some make a real commotion when doing the job. The Dark Rock Pro 3 dissipates up to 250 watts of heat at the almost unbelievably quiet noise level of 26.1dB(A). be quiet! is able to accomplish such an impressive performance to noise ratio by using two of its SilentWings fans, one 135mm and one 120mm, in a double-tower heatsink. The 135mm fan produces a maximum airflow of 67.8cfm at 1,400rpm. The 120mm generates 57.2cfm at only 1,700rpm. There's some secret sauce in the heatsink, too, which is built with wave-contour cooling fins with small dots on the surface to increase circulation. Dark nickel plating and a brushed aluminum top cover deliver an imposing look inside your case.

**Who Should Apply:** Users who want a CPU cooler that doesn't sacrifice noise for high performance. The Dark Rock Pro 3 shouldn't be heard over the other components in your system.

CPU Cooler dimensions (HxWxD): 6.42 x 5.24 x 4.84 inches

Fans: 1 x 135mm fan (max 1,400rpm), 1 x 120mm fan (max 1,700rpm)

Rated noise level: Up to 26.1dB(A)



**ENERMAX ETS-T40F-BK**

\$45.99

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

**Why You'll Dig It:** With the fan installed, this air cooler is only 2.7-inches wide—a slim design that virtually eliminates clearance issues with system memory. The black-clad cooler is a refreshing change from the seemingly endless sea of nickel-plated air coolers on the market. ENERMAX even coats the copper heatpipes for a uniform appearance. Within the aluminum fin array, ENERMAX applies its VEF (Vacuum Effect) design that deters cool air from leaking out of the fin structure before it passes all the way through the heatsink. Air movement is provided by ENERMAX's T.B. APOLLISH Fan that generates up to 75.98cfm at the fan's maximum 1,800rpm speed. The fan also boasts blue LEDs that illuminate light reflex strips on the blades, which generates an effect where you see the curved line on each blade.

**Who Should Apply:** The LED fan and black heatsink look cool, but what most people will really enjoy is the fact that you can use whatever memory you'd like next to this air cooler.

CPU Cooler dimensions (HxWxD): 6.4 x 5 x 2.7 inches

Fans: 1 x 120mm ENERMAX T.B. APOLLISH (800-1,800rpm)

Rated noise level: Up to 26db(A)

**Deepcool GAMER STORM CAPTAIN 240EX**

\$109.99

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

**Why You'll Dig It:** Deepcool goes steam punk with the water block/pump combo on this closed-loop CPU cooler. The reactor-style pump housing is a perfect complement to the short section of clear hard tubing that gives you a glimpse of the coolant flowing through the loop. There are two versions of the GAMER STORM CAPTAIN 240EX: a black and red version with red coolant and red LED in the pump, and a white and black version with black coolant and a white LED in the pump. Deepcool designs its own pump with a three-phase motor and closed impeller, which the company says improves power and reduces vibration. The CAPTAIN 240EX also boasts a high-density water microchannel with a self-governing circulation system for 10% more efficient heat dissipation than a traditional cold plate. We also like that Deepcool includes two of its TF120 fans that are dustproof, waterproof, and oil-leakage proof.

**Who Should Apply:** Builders who want to break away from the usual flat water block/pump combos with a design that's sure to draw the eye.

Radiator (actual width): 240mm (274mm/10.79-inches)

Fans: 2 x Deepcool TF120 (500-1,800rpm)

Rated noise level: 17.6 to 31.3dB(A)



## Swiftech H320 X2 Prestige

\$214.95

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

**Why You'll Dig It:** This AIO comes preassembled with a 360mm radiator and a boatload of premium Swiftech parts to deliver tremendous overclocking potential. Just a few of the high-end components built into the loop include a Swiftech Apogee XL2 water block, a Swiftech MCP30 pump, and clear PVC tubing that won't require any maintenance. The AIOs in the X2 Prestige lineup feature NoiseBlocker-eLoop fans that provide exceptional airflow (up to 132.4m<sup>3</sup>/H [around 78cfm]) at minimal noise levels—a maximum of 28.4dB(A). The H320 X2 Prestige, of course, comes with three of the 120mm NoiseBlocker-eLoop fans. You can modify the clear coolant inside the loop by using the included red, UV blue, and UV green dyes, and Swiftech makes it easy to drop the dye in. The coolant is highly visible, thanks to the AIO's clear water block housing, reservoir, and tubing.

**Who Should Apply:** Overclockers who want a top performing AIO that looks the part of a custom loop.

Radiator (actual width): 360 (375mm/14.76-inches)  
Fans: 3 x 120mm NoiseBlocker-eLoop (800-2,800rpm)  
Rated noise level: Up to 28.4dB(A)



## Swiftech H220 X2

\$139.99

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

**Why You'll Dig It:** Swiftech is a known brand in the world of custom liquid cooling components, and on the H220 X2, the company has put all of its engineering and liquid-cooling expertise into a pre-assembled AIO. The parts in this closed-loop cooler have a distinctly custom look and feel, probably because most of the hardware is what you'd buy for a DIY cooling loop. The built-in water block, for example, is Swiftech's Apogee XL2, which features an acrylic housing, so you can see the coolant flow. The pump, which is located in the unit's acrylic reservoir (yes, the AIO also has an actual, visible reservoir) is Swiftech's MCP30, which features a PWM range of 1,200 to 3,000 to keep noise to a minimum. The custom look is further cemented with the ultra clear tubing and acrylic water block. Swiftech provides three bottles of dye (a red, a UV blue, and a UV green).

**Who Should Apply:** Enthusiasts who want the look and performance of a custom loop and the convenience of an AIO cooler.

Radiator (actual width): 240 (254mm/10-inches)  
Fans: 2 x 120mm Swiftech Helix (800-1,800rpm)  
Rated noise level: Up to 33dB(A)



## Cooler Master MasterLiquid Pro 240

\$119.99

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

**Why You'll Dig It:** The wizards at Cooler Master designed their own pump/waterblock combo, and it boasts some ingenious tech, which Cooler Master calls Flow Op. The copper waterblock, for instance, features 657% more internal surface area than previous models, and the MasterLiquid Pro 240 also uses a structure that focuses coolant on the center of the block. The end result, according to Cooler Master, is a 40% performance boost. To keep noise to a minimum, the MasterLiquid Pro 240 employs a pump that rotates more smoothly than conventional pumps, which reduces clicks and vibration. This AIO's radiator also differs from the standard design, as Cooler Master uses square fins, rather than the traditional sine wave pattern. The square fin design is said to maximize contact for faster heat dissipation.

**Who Should Apply:** Power users looking for a powerful AIO that does things a little differently than the standard closed-loop CPU cooler to better drive your CPU and overlocks.

Radiator (actual width): 240mm (275mm/10.83-inches)

Fans (speed): 2 x 120mm MasterFan Pro Air Balance fans (500-2,000rpm)

Rated noise level: 6 to 30dB(A)



## ENERMAX Liqmax II 240

\$89.99

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

**Why You'll Dig It:** Dissipating heat from a radiator requires specially-designed fans that deliver high static-pressure. The LIQMAX II 240 features two 120mm fans with ENERMAX's Double Batwing blades that produce continuous bursts of air, resulting in a static pressure of 3.0mmH<sub>2</sub>O at the fan's maximum 2,000rpm fan speed. The two 120mm PWM fans also feature ENERMAX's smart APS (Adjustable Peak Speed) switch where you can choose among three maximum fan RPM settings (1,200rpm, 1,600rpm, and 2,000rpm). The APS switch makes it easy to control system noise when temperatures rise. No matter which speed you select, the 120mm fans spin as slow as 500rpm when the PC is idle. ENERMAX also makes some interesting additions to the waterblock. You'll find its SCT (Shunt Channel Technology) that distributes coolant flow over multiple channels helps to accelerate heat transfer.

**Who Should Apply:** Enthusiasts who want a closed-loop cooler that's a good performer with an innovative design that lets you control noise.

Radiator (actual width): 240 (274mm/10.79-inches)

Fans: 2 x 120mm (500-2,000rpm)

Rated noise level: Up to 35dB(A)



Closed-loop	MSRP	Radiator	Fans	Rated Noise Level	Intel Socket Compatibility	AMD Socket Compatibility	Warranty
Swiftech H320 X2 Prestige	\$214.95	360mm	3 120mm	7.8 to 28.4dB(A)	Intel LGA 2011-3 /2011/ 115X	FM1, FM2 (+), AM2 (+), AM3 (+), 939	3 years
Swiftech H220 X2	\$139.95	240mm	2 120mm	16 to 33dB(A)	Intel LGA 2011-3 /2011/ 115X	FM1, FM2 (+), AM2 (+), AM3 (+), 939	3 years
Cooler Master MasterLiquid Pro 240	\$119.99	240mm	2 120mm	6 to 30dB(A)	LGA 2011-3/ 2011/ 1366/ 115X/ 775	FM1, FM2(+), AM2(+), AM3(+)	5 years
Deepcool GAMER STORM CAPTAIN 240EX	\$109.99	240mm	2 120mm	17.6 to 31.3dB(A)	LGA 2011-3/ 2011/ 1366/ 115X	FM1, FM2(+), AM2(+), AM3(+)	3 years
ENERMAX LIQMAX II 240	\$89.99	240mm	2 120mm	Up to 35dB(A)	LGA 2011-3/ 2011/ 1366/ 115X	FM1, FM2(+), AM2(+), AM3(+)	2 years
Air Cooler	MSRP	Dimensions (inches; HxWxD)	Fans	Rated Noise Level	Intel Socket Compatibility	AMD Socket Compatibility	Warranty
Cooler Master MasterAir Maker 8	\$129.99	6.77 x 5.71 x 5.31	2 140mm	8 to 24dB(A)	Intel 2011-3/ 2011/ 1366/ 115X / 775	FM1, FM2 (+), AM2(+), AM3(+)	5 years
Deepcool GAMER STORM ASSASSIN II	\$89.99	6.6 x 6.2 x 5.6	1 120mm, 1 140mm	17.8 to 27.3dB(A)	LGA 2011-3/ 2011/ 1366/ 115X/ 775	FM1, FM2(+), AM2(+), AM3(+)	3 years
be quiet! Dark Rock Pro 3	\$89.90	6.4 x 5.2 x 4.8	1 120mm, 1 135mm	Up to 26.1dB(A)	LGA 2011-3/ 2011/ 1366/ 115X/ 775	FM1, FM2(+), AM2(+), AM3(+), 754/939/940	3 years
ENERMAX ETS-T40F-BK	\$45.99	6.4 x 5 x 2.7	1 120mm	Up to 26dB(A)	LGA 2011-3/ 2011/ 1366/ 115X/ 775	FM1, FM2(+), AM2(+), AM3(+)	1 year
be quiet! Pure Rock	\$34.90	6.1 x 4.8 x 3.4	1 120mm	Up to 26.8dB(A)	LGA 2011-3/ 2011/ 1366/ 115X/ 775	FM1, FM2(+), AM2(+), AM3(+)	3 years

## Alternative Browser Brawl, Round 2

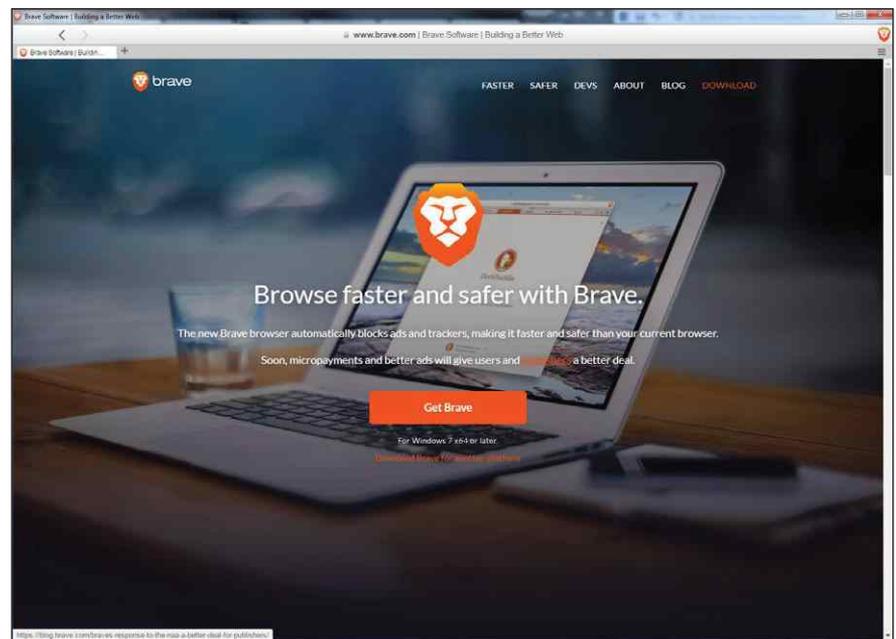
Last month, we gave you a closer look at a handful of Internet browsers that make compelling alternatives to Chrome, Internet Explorer, Microsoft Edge, Firefox, Safari, and Opera. Vivaldi ([vivaldi.com](http://vivaldi.com)), SRWare Iron ([www.srware.net/en](http://www.srware.net/en)), and Avant Browser ([avantbrowser.com](http://avantbrowser.com)) each offer a few unique features in areas such as security, privacy, performance, customizability, and ease of use. But the list of marginalized-but-competent browsers is long, so we're picking up where we left off last month with three more browsers you may or may not have heard of. Between these two articles, there's bound to be a browser that beats the pants off your current choice.

### Brave

Like Vivaldi, Brave ([www.brave.com](http://www.brave.com)) is a new browser that shares a connection with another browser that you're likely familiar with. Brave's developer, Brendan Eich, was also a co-founder of the Mozilla Project, which in turn is responsible for the Firefox web browser, Thunderbird e-mail client, and Firefox mobile OS.

With Brave, Eich's goal is to deliver a web browsing experience without website trackers and obtrusive Internet advertisements. We know what you're thinking, "Wow, no advertisements, where do I sign up?" Not so fast. Brave's approach to advertising isn't to throw it out altogether, just to fix the parts of it that are broken. This entails enforcing better overall user privacy by divulging less data to advertisers and anonymizing browser history to deliver targeted ads. The new browser is also shaking up how ad revenue gets paid out, with 55% going to the content publishers and the remaining 45% getting split evenly between ad partners, Brave users, and Brave itself. You won't exactly get cut a check every two weeks, but you can use your portion

The list of marginalized-but-competent browsers is long, so we're picking up where we left off last month with three more browsers you may or may not have heard of.

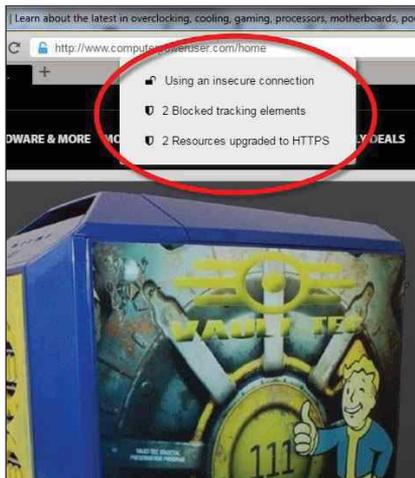


The goal behind Brave is a browsing experience without website trackers and obtrusive advertisements.

of the revenue to donate to bloggers and other content providers via micropayments. This ensures ad revenue actually goes to the people who deserve it.

Brave is built around the Blink and Gecko web browser engines, which are

based on a tweaked version of Chromium and the same engine used in Mozilla's Firefox browser, respectively. A vast majority of the browsers we're covering feature proprietary or closed-source software licenses, but this one uses the Mozilla Public

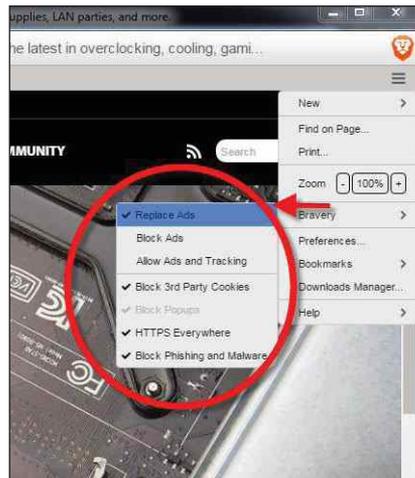


Brave puts a handful of security features right at your fingertips . . .

License, which is a free open-source license that combines aspects of the BSD license and GNU General Public License in an attempt to appease both proprietary and open-source developers.

When you visit the site, downloading the browser (which currently supports Windows, Mac, and Linux) is as easy as clicking the Get Brave button. As we went to press, Brave version 0.9.4 was a 100MB download, but there aren't any settings available to you as the utility installs; the browser just launches immediately after the install is complete.

The UI is as clean and modern as Vivaldi and other Chromium-based browsers. There are less than and greater than signs for the back and forward buttons, and the address bar features a Reload button and a traditional appearance when you hover the cursor nearby, but when you move the cursor to the web page itself, the address bar disappears and lists the main domain as well as the website's title and tagline. Click the page icon to the immediate left of the site address to determine if you're using a secure connection and see how many tracking elements were blocked and resources upgraded to HTTPS. The right side of the address bar also displays a figure (in seconds) that informs you how long it took to load the page. To the far right of the address bar is a Bookmark



. . . and it's also looking to revamp how advertising revenue is distributed.

button in the shape of a star and Brave's stylized lion logo, which is just for show.

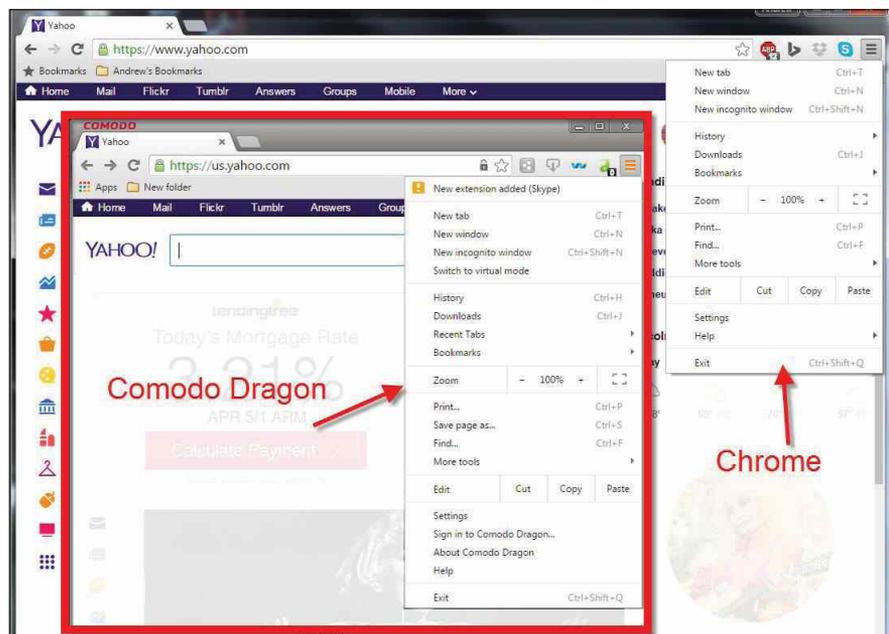
Each page you load can be viewed in a separate tab just like most every other modern browser, and clicking the plus symbol loads a new tab. The menu icon on the right side of the page features all the nuts and bolts you expect it to with one exception. Click the Bravery menu item to view checkable settings, including Replace Ads, Block Ads, Allow Ads And

Tracking, Block 3rd Party Cookies, Block Poppers, HTTPS Everywhere, and Block Phishing And Malware. The Replace Ads option (although selected by default) is the one that looks to turn web advertising on its head, but as we went to press, this feature wasn't live yet and it effectively just blocks ads.

In addition to liking the concept of Brave's ad scheme, we also appreciate the browser's built-in password manager and the handful of privacy settings you can enable from the associated Preferences menu. When it comes to general settings, Brave's menu offerings are rather spartan compared to Chrome and Firefox. Missing features include extension support, a Save Page As option, and a detailed browsing history you can sift through. Although these omissions are glaring, we're willing to cut Brave some slack for its radical ad strategy and given the fact that the browser was just announced in January of this year. Brave's impressive benchmark performance (see sidebar) doesn't hurt either.

### Comodo Dragon

The company behind Comodo Dragon ([www.comodo.com](http://www.comodo.com)) would best be



Chrome and Comodo Dragon look so similar at first glance, you might not be able to tell them apart.

## More Browser Benchmarks

As we mentioned last month, because a web browser is the one utility many of us use the most, a browser's look, feel, and features alone aren't the only things you'll want to consider when it comes to finding a replacement. Raw performance plays a major role in your decision.

To break down how these alternative browsers perform compared to the old standbys, we used a pair of web-based benchmarks from [www.browserbench.org](http://www.browserbench.org) designed to test the latency and throughput of various online workloads, applications, and tasks.

The first one, Speedometer, attempts to rate web application responsiveness using a to-do list web utility called TodoMVC to simulate a typical modern browser workload. Its score is displayed in runs per minute, and a higher score is better. JetStream version 1.1 utilizes 39 JavaScript workloads that are commonly used by advanced users and programmers. The score is a geometric mean of the individual test results, and again, a higher number is better.

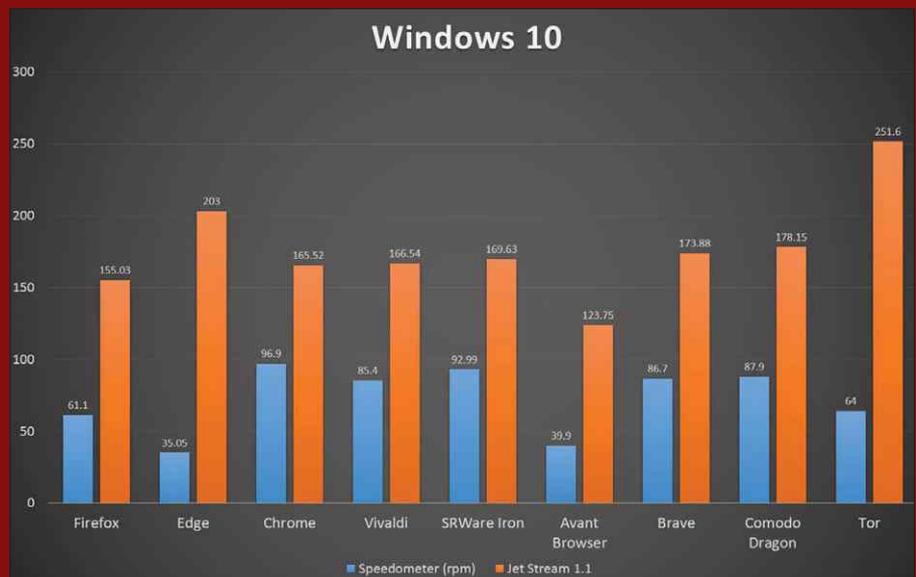
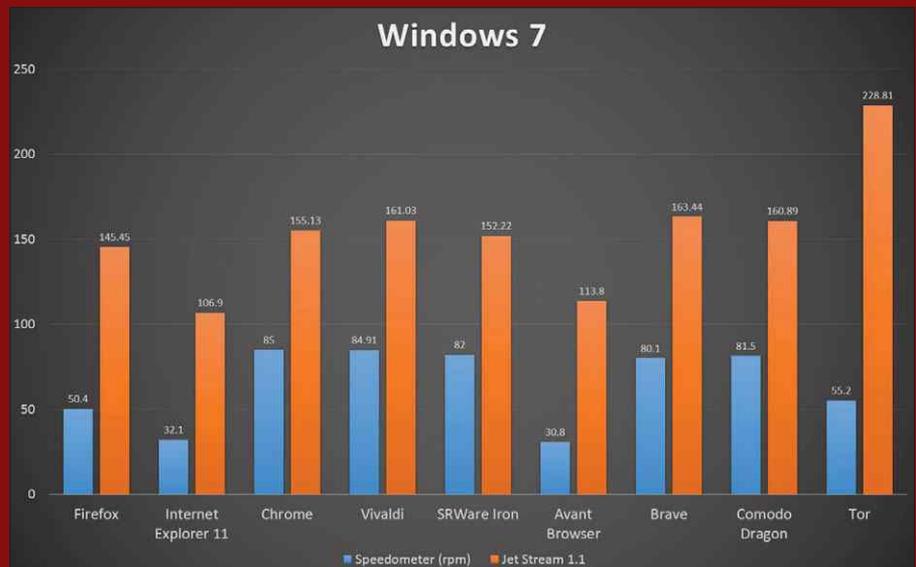
We ran the two tests on a midrange laptop running Windows 7 wired to our corporate network (typically ~580Mbps down and ~600Mbps up), and again on a high-end PC running Windows 10 and connected to a wireless network (typically ~200Mbps down and ~200Mbps up).

The tests running on the Windows 7-based notebook connected to a Gigabit network connection were similar to those of the Win10 system. Tor took home the trophy in JetStream with a 228.81 score, but Brave and Comodo Dragon both walloped Tor in the Speedometer test. Because they're both based on Chromium, we were not surprised to see Brave and Comodo Dragon achieving such similar scores.

In Windows 10, both Brave and Comodo Dragon scored nearly identical results in both Speedometer and JetStream 1.1. Last month, Microsoft's Edge browser took the top spot on JetStream, but Tor

demolished it this time around. Brave and Comodo Dragon both beat Tor in the Speedometer test, as did the rest of the Chromium-based browsers we tested.

As with last month, the performance difference among the browsers is a non-factor. Although Tor performed admirably in the benchmarks, its extra routing and encryption will take its toll on your browsing speed. But for those who need complete and total privacy, it could be a worthwhile tradeoff.



described as most concerned with Internet authentication and security. The Comodo Group's products, including Comodo Antivirus, Comodo Firewall, Comodo Internet Security Pro, GeekBuddy, and Comodo Cleaning Essentials, back up this assertion.

Releasing its own browser with security as the prime focus seems like a no-brainer, but Comodo took it a step further and released three different browsers: Comodo Dragon, Comodo Chromodo, and Comodo IceDragon. The first two browsers are based on a Chromium (Blink) engine and are essentially identical save for a few minor features and a slightly different look and feel. IceDragon is Comodo's Firefox look-alike, which attempts to appeal to those who prefer Firefox over Chrome. We'll be covering Comodo Dragon. It's the most feature-rich of the three, has been in development the longest, and continues to get regular updates.

From the Comodo home page, click the Personal tab, then click the Comodo Dragon icon from the Free And Secure Browsers section on the right side of the page. Version 43 is a 54MB executable. Running the file displays a user agreement, followed by a folder destination field and portable installation option page, a list of items you can choose to import from your current browser and Make Comodo Dragon My Default Browser checkbox screen, and a page that lets you enable or disable Comodo's secure DNS servers for the browser or all applications that connect to the web. Click Install, click the Run Comodo Dragon checkbox, then click Finish to launch the browser.

The UI is very similar to Chrome's, right down to the icon shapes and tab colors. Even the main drop-down menu is nearly identical. In that menu, one item you won't find in Chrome is the Switch To Virtual Mode option. To be

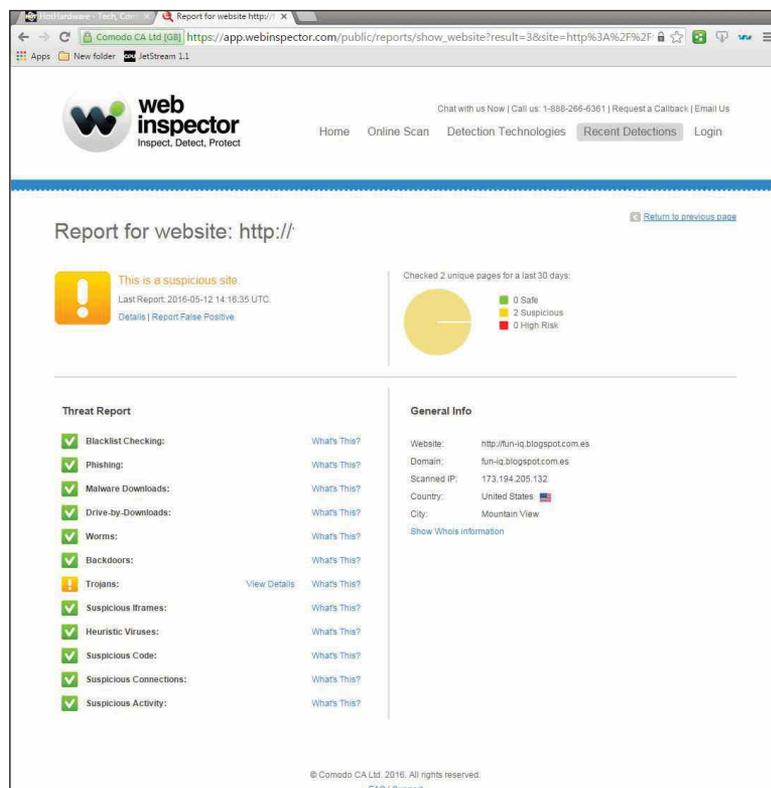
also has a Report False Positive hyperlink and a running tally of the number of safe, suspicious, and high-risk scans the URL has accrued.

The Comodo Media Grabber icon is to the left of the Web Inspector, and it can detect video and audio from streaming sites and download it to your PC. We tested it to work on a handful of YouTube videos, but when we signed in to our Netflix and HBO GO accounts, we got Video Player Unavailable and HDCP Issue Detected errors that prevented video playback. Even after disabling the Media Grabber extension, our video streaming services were still blocking the content.

The Comodo Share Page Service icon is to the left of the Media Grabber. It gives you a quick way to post the web page you're currently viewing to Facebook, LinkedIn, and Twitter.

If you've been following browser news, you may have noticed that Comodo

is frequently a subject of criticism for a few of its heavy-handed practices regarding sneaking extra software onto your system. We didn't encounter this, and Comodo Dragon lets you disable these additional software packages during the install process, so no harm there. When it comes to the security of the Chrome look-alike, Google Chrome's engineers have gone on record saying that Comodo's offerings are dangerous because of the slow response to fixing vulnerabilities. As we went to press, we found no outstanding security vulnerabilities, but you should be extra vigilant if you determine the positives of Comodo Dragon outweigh the negatives.



Comodo's Web Inspector utility can give you a good idea of a website's trustworthiness.

able to access the browser's virtualization technology, you'll need to install Comodo Internet Security. Once that's installed and the option enabled, you can browse the Internet in an environment that is isolated from the rest of your system. In theory, this would prevent malicious scripts and malware from being able to take root.

To the immediate left of the menu button, you'll find the Comodo Web Inspector icon, which scans the current URL and gives you a detailed threat report listing any detected blacklists; phishing; malware; drive-by downloads; worms; backdoors; Trojans; heuristic viruses; and suspicious code, iFrames, connections, and activity. The report page

## Tor Browser

Almost every one of the browsers we've looked at so far has one or more features designed to help protect your privacy. But the structure of the Internet, as a globe-spanning collection of servers that individuals call for data from via IP addresses tied to geographic locations, works against keeping what you search for separate from who you are and where you live. Tor ([www.torproject.org](http://www.torproject.org)), or The Onion Router, is a collection of free software and an open network that obscures your IP address and effectively anonymizes your browsing activity.

This browser is based on a modified Mozilla Firefox Extended Support Release, with a handful of extensions enabled by default, including the TorButton, TorLauncher, NoScript, HTTPS Everywhere, and Tor proxy. As you might expect, the engine powering the Tor Browser is the same as Firefox's—Gecko.

Tor manages to accomplish what none of the other browsers we've covered could by utilizing a network of relays from all over the Internet, built and maintained by thousands of volunteers focused on protecting the anonymity of the web. When you visit a web page in the Tor

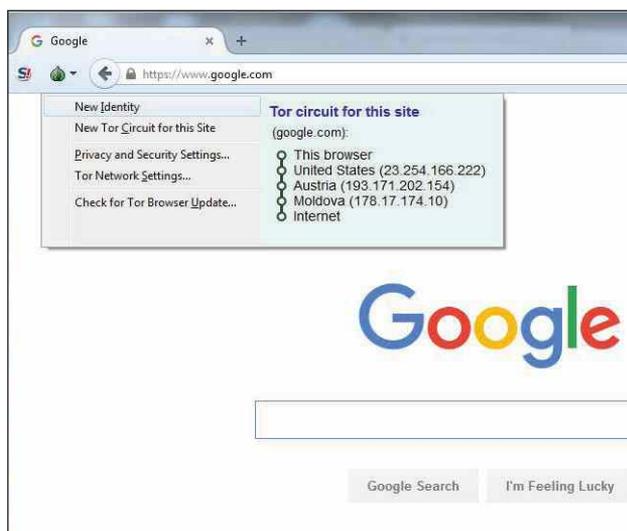
browser, your web traffic is funneled through a handful of IPs from every corner of the Net, adding encryption as it goes in order to effectively scrub any trace of your header info from the packets originating from your system.

Complete anonymity isn't as simple as flipping the magical Tor button; you'll also have to change many of your browsing habits. For instance, you shouldn't use Tor to torrent anything; don't enable or install browser plug-ins such as Flash, RealPlayer, and QuickTime; and avoid opening documents you downloaded while running the Tor Browser. If you don't want an entity that might be monitoring your web activity to know that you're using Tor, you can either use a Tor bridge relay or convince the people near you to also use Tor, thus obscuring your traffic even more. Another alternative is to just stop being so paranoid.

All this sounds great, but there's a cost, and it comes in the form of a significant hit in performance. In terms of how the browser feels to use, it will be noticeably slower. With that in mind, who would be willing to put up with such a slowdown in bandwidth? If you want to avoid having your web traffic tracked by governments or businesses, need to maintain anonymity for work purposes, or want to access the Deep Web (the significant portion of the web not accessible



Tor is the only browser we looked at that can completely anonymize your browsing activity.



To anyone looking to figure out our IP address, they will think we're located in Moldova.

with traditional search engines), then the Tor Browser is for you.

As we went to press, the version 5.5.5 installer, downloadable via a button on the main page, weighed in at 41.8MB. When you launch it, you'll be asked to choose your language and then set the installation directory. Once installed, you'll get a pop-up asking whether you want to connect directly to the Tor network or configure a bridge or local proxy settings.

Visually, the Tor Browser looks almost identical to Firefox, with a Back button molded into the address bar, a search box to the right, and a Menu button that looks mostly the same, but has a few differences. Tor's menu features icons for Downloads, Bookmarks, and HTTPS Everywhere, which Firefox replaces with New Private Window, Full Screen, and Synced Tabs icons. In another departure from Firefox, Tor disables many of that browser's default extensions. To the left of the address bar are two icons: the Tor button that shows you the current Tor circuit, and the No Scripts button, which lets you disable/enable scripts for the current site.

For those who regularly or occasionally need to go completely anonymous, the Tor Browser is your best option. For most everything else, it's not worth the sluggish performance. ■

# Upgrades That'll Keep You Humming Along

A pair of programs that give you more control over your multimedia are in the spotlight this month. Conceiva's Mezzmo DLNA server passes the 5.0 mark, while Xequete Software DVD PixPlay version 10.01 hits the streets. AdFender and Folder Size are also among our featured updates.

## SOFTWARE UPDATES

### AdFender 2.25

Unlike the handful of popular ad-blocking plug-ins and add-ons, AdFender is a standalone program, stomping malvertisements, pop-ups, and other such undesirables. As such, you can switch between browsers, and AdFender will keep plugging away. In version 2.25, AdFender learns a few new tricks, including a Spam404 filter list and support for using the \$popup filter option to block pop-ups. Several bugfixes and optimizations are also added, of course.

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

### Conceiva Mezzmo 5.0.1.0

One of Conceiva's signature programs, Mezzmo is a high-powered DLNA media server that works with nearly every device imaginable, including videogame consoles, smartphones, and Chromecast. The 5.0 release has been baking in the beta oven for several months, but now it's here, hot and fresh. With the latest version, Mezzmo users can add video, music, and photo URLs to their libraries and then stream them to their connected devices. (Site support is impressive, too, with over 700 sites including YouTube, Vimeo, SoundCloud, Dailymotion, etc.) A new web interface gives users the option to search and stream their libraries from any major web browser, and Mezzmo will even let you stream your collection remotely. New plug-ins, live streaming options, and Intel QuickSync support round out Mezzmo 5.0.1.0's impressive package of goodies.

[www.conceiva.com/products/mezzmo](http://www.conceiva.com/products/mezzmo)

### Crystal Office Systems WinLock 7.02

Try as we might, there will be times when filthy commoners have to use our high-end rigs. For those situations, Crystal Office Systems' WinLock, which lets you restrict what others can do with your PC when they use it, is the answer. The latest update, version 7.02, is a small one with support for Chrome 49 and 50, plus a bugfix associated with the app's Unlock prompt. As usual, WinLock 7.0 delivered a bunch of big changes. There's a new virtual keyboard, and users have even more options available for cordoning off certain parts of their machines. Now, WinLock can disable Ease of Access, block network drives, put the Clipboard on lockdown, and create USB exclusions. Instant Lock, a new feature, can set up a hotkey combination that hides programs and windows from prying eyes.

[www.crystaloffice.com/winlock](http://www.crystaloffice.com/winlock)

### MindGems Folder Size 3.4.0.0

Naturally, Folder Size will tell you, in exhaustive detail, the size of each folder on your system, but the program can also provide information about subfolders and individual files and present that information in chart form. With version 3.4.0.0, a big batch of reports (Oldest Files, Oldest Folders, Newest Files, etc.) are added. Folder Size can now detect Administrator privileges and has a button to restart itself with elevated privileges. MindGems also removed the "Scan With Folder Size" context menu option when a user right-clicks the Recycle Bin.

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

### The EasyUEFI Development Team WinToUSB 3.0

Over the last few months, The EasyUEFI Development Team has been hard at work pumping out updates for WinToUSB, which lets users quickly and easily create a Windows To Go USB drive. With version 3.0, it's now possible to use WinToUSB to set up Windows To Go from a VHD or VHDX. Encrypted ESD is also supported, and the latest version also includes the typical batch of minor bugfixes. The April 2016 update (v2.8) fixed more bugs and improved VHD(X) disk partitioning and formatting algorithms. Version 2.8, released early February 2016, introduced support for creating Windows To Go from .WIM, .ESD, and .SWM files.

[www.easyuefi.com/wintousb](http://www.easyuefi.com/wintousb)

### Xequete Software DVD PixPlay 10.01

A favorite of everyone who enjoys cobbling together those embarrassing wedding slideshow videos, DVD PixPlay makes creating and distributing (DVD, BD, YouTube, Facebook, etc.) HD slideshows a breeze. Although version 10.01 (a minor update that corrects a startup error when some older versions upgraded) is the most recent, version 10.0 is the big update. The software's UI receives a fresh coat of paint, including a new skin design. Creating YouTube videos with DVD PixPlay should be a much slicker process now, and you can now pull images directly off of smartphones and tablets. And thanks to a rebuilt rendering engine, the software's pan-zoom effects are smoother.

[www.xequete.com/pixplay](http://www.xequete.com/pixplay)

# Cinematic VR

## The Way We Experience Movies Will Never Be The Same

**H**ype and new movies go together like butter and popcorn. Sometimes, the hype swirling around a would-be blockbuster is justified. Other times, it's a bunch of hot air blowing from studios looking to earn their budgets back. Admit it, though, those taglines, teasers, and trailers can make it awfully difficult to check our hopes and expectations. That's the same struggle one experiences upon taking in the hype now swirling around virtual reality filmmaking. The buzz may have escaped you so far, but it eventually will reach you. When it does, expect to hear how cinematic VR will forever change how filmmakers tell stories and how we experience them.

For an example, just track down a video from Story Studio, which Oculus launched last year to create VR films, featuring pioneers in this new medium. Chris Milk, one VR filmmaker, describes VR films as going “right to your human core.” Saschka Unseld, Story Studio creative director, says his VR film experience “felt like a memory of me being somewhere vs. a memory of me watching a film.” In another video, “Virtual Reality: The Birth of a Medium,” Shari Frilot, chief curator for Sundance Film Festival’s New Frontier program, talks about the “massive opportunity” VR presents “to rewire and tell ourselves a different story,” one that could help “reorganize ourselves and consciences” in a way that helps “us understand ourselves on a larger scale.”

Already, numerous VR production companies and studios have surfaced and major film schools are teaching cinematic VR techniques. In addition, numerous apps exist that let anyone with even cardboard VR goggles and a smartphone see for themselves what so many are jazzed about. This isn't to insinuate VR



Baobab Studios' VR film “Invasion!” lets users take on the body of a white rabbit that must save Earth from an alien invasion.

feature films will be playing at the local megaplex anytime soon, primarily because filmmakers are still learning what works and doesn't in VR films, and often, they're having to build the tools needed because they don't yet exist. Oculus Founder Palmer Luckey himself told *The Guardian* it will be decades until VR storytelling is nearly as refined as film.

That said, the potential VR lends to explore new forms of storytelling is being depicted as limitless. Eric Darnell—co-director of “Antz” and the “Madagascar” franchise, chief creative officer of VR content at Baobab Studios, and director of the VR short “Invasion!”—offers an example of cinematic VR's allure. “We asked Alvy Ray Smith, one of the founders of Pixar, to be an advisor for Baobab Studios, and he simply wasn't interested,” Darnell says. That was before Baobab convinced him to try VR. “After he did, he was a convert and enthusiastically agreed to come aboard,” Darnell says. “The point is that

VR is difficult to describe effectively to someone who has never tried it, but, invariably, those that do can see the potential immediately.”

With that, prepare to enter the “dramatic,” “revolutionary,” “mind-blowing,” “amazing,” “unfathomably immersive” world of cinematic VR storytelling.

### A Whole New World

Rather than watch stories play out frame by frame, VR films enable viewers to step into 360-degree environments and become part of the story, sometimes even helping determine how the story unfolds. As such, filmmakers are being forced to think in entirely new ways from traditional filmmaking, including deciding where and how to focus viewers' attentions in a 360-degree realm that tempts them to look everywhere rather than focusing on one point of interest.

Brooke Chapman, production supervisor at VR content creator Jaunt, says from a cinematic view, filmmakers

## Making The Film Festival Rounds

With each year, cinematic VR films are making a bigger presence at major film festivals, including Sundance, SxSW, and the recent Tribeca Film Festival where nearly 30 VR films played in Storyscapes, Virtual Arcade, and Playground at TFI Interactive exhibitions. We spoke with Loren Hammonds, Tribeca Film Festival programmer, about VR films at Tribeca.

**Q: What type of reactions did VR films get at this year's festival?**

**LH:** Audiences were primarily moved and delighted by the VR experiences. Our showcase was rather wide-ranging, so we saw spontaneous dancing with Tyler Hurd's "Old Friend," laughter with Baobab Studios' "Invasion!," blood-curdling screams with BetterVR's "Killer Deal," and plenty of tears after Penrose's "Allumette." And that's just to name a few.

**Q: How have viewers' reactions shifted over time?**

**LH:** I think things have shifted from confusion to wonder. At this point, a greater number of our audience members have had at least some exposure to the mobile VR technology that Samsung Gear VR provides, so the reactions are less about sheer amazement and more about the curiosity of the approaches in storytelling that are being used in this new medium. I believe that this will continue as even more original voices start to experiment with VR.

**Q: Will Tribeca expand the presence of VR films in coming years?**

**LH:** It all depends on the content being produced within a given year. With the first year of the Virtual Arcade, we were thrilled to have such an amazing number of fantastic projects to choose from, and I think we were able to curate a remarkable program because of this. I'm confident that these creators will continue to create amazing experiences and, in addition, the number of unique artists with something to say will try working within VR. If this happens, then

we will definitely continue to expand to accommodate the very best work to share with our audiences.



VR films are making an increasingly bigger presence at international film festivals, including the Tribeca Film Festival where about 30 VR films played this year at spots such as the TFI Interactive exhibition.



From Penrose Studios, "Allumette" has an engrossing story and animation that have made it arguably the most highly regarded VR film to date. It was one of the films on display at the Tribeca Film Festival.

can take cameras into places viewers couldn't necessarily travel to and capture the environments in extreme detail that transfers the viewer there. "There's nothing you can describe to someone about VR that's really going to get them to wrap their heads around it the way they would if they just put on the goggles," she says. At the least, Darnell says VR films get viewers out of their "seats" and into the middle of the action and virtual environment. "Take things a step further, and the characters in the story can even be aware of the viewer's

presence," he says. "From here, there's the possibility to let the viewer be part of the action, to be part of the story."

Being part of the story is what separates VR film from "classic" mediums such as cinema, theater, and literature, says Baobab CEO Maureen Fan. For example, in "Invasion!" viewers assume the body of a fluffy white bunny. "At first, we weren't sure if viewers would really buy into the idea that they were a bunny," she says. Baobab learned, though, there's a power in characters recognizing and accepting the viewer into their world,

she says. When a fellow bunny spots the viewer, makes eye contact, and happily hops over, she says, audiences are thrilled. In "Invasion!" viewers can communicate sans keyboards, mice, or game controllers. "Many people would actually copy the bunny's actions," Fan says. "It's amazing to see that kind of real, physical engagement with an animated character."

Henrik Leichsenring of Henrik & Sofia, makers of the VR horror film "11:57," feels VR's ability to put viewers in the middle of the filmmaker's world is a huge advantage to directors to spark details



Henrik Leichsenring, half of the Henrik & Sofia team that made the VR horror film “11:57,” believes ultimately most people will consume cinematic VR films either alone or in different degrees of social interaction in “couch mode” or online.

that make viewers want to watch the film again. “Your story doesn’t have to be linear, either,” he says. “You could make your viewer do passive or active actions that will affect the storyline,” something that can give individual viewers a slightly different version of the film depending on their attention in a scene.

Often, “presence” and “immersive” are used to describe the VR film experience. Leichsenring says these are apt but don’t fully define what VR films offer. “In a way it’s a bit similar to dreaming,” he says. “If you fall over in your dream, you get a sensational feeling with real physical reactions. You would get that in VR, too. Even if you’re completely aware that you’re watching a film, your body is not.”

“Empathy” is another often-used descriptor. Elli Raynai, director of the VR film “I Am You,” which gives viewers another person’s perspective through her eyes, sees empathy as providing VR films their biggest potential. “You’re no longer just showing people a frame of a story; you’re actually dropping them into a place,” something that’s extremely powerful because it can provide viewers memories that are difficult to forget, he says. Milk told *The Guardian* that generally when a protagonist looks at the camera, it’s done for comedic purposes. In VR films, that same technique can make viewers feel as if the protagonist is “looking into your soul,” he says.

with dolphins in ‘The Click Effect’ or standing next to one of the last northern white rhinos on Earth in ‘The Ark.’ It’s just an altogether different type of encounter,” he says.

### A Long Way From Talkies

While not everything about VR films is a total departure from traditional filmmaking, there are notable, important differences, and as Raynai says, VR filmmakers are still largely trying to discover the medium’s “cinematic language.” This includes accounting for the impact camera movement has on viewers.

“Properly crafting and editing a VR film in is incredibly important,” says Neville Spiteri, CEO and co-founder of VR film studio/distributor Wevr and the film technical director and digital effects supervisor on such films as “Apollo 13” and “Terminator 2/3D.” “A poorly produced experience coupled with latency in head-tracking can have the user walk away from the film queasy and nauseous, which will

Loren Hammonds, Tribeca Film Festival programmer, says the sense of immersion and empathy many VR films produce isn’t achievable in traditional film. “The documentaries in our film program are, in my opinion, often at the very highest levels of filmmaking but still can’t approximate the feeling that you can get while floating underwater

ultimately leave a negative impression on audiences.” Such a negative experience can make it tough to win back viewers. VR technology, however, has reached a point where directors can deliver films without causing nausea, though “it’s entirely incumbent upon the creators” to follow best practices in VR production to ensure a quality experience, Spiteri says.

Deciding how to tell stories can also pose challenges to VR filmmakers who are used to conceptualizing a story by focusing on “the frame.” Jessica Brillhart, Google’s principal filmmaker for VR, writes that this approach can lead to “asking a lot of the wrong questions,” such as how to force viewers to look at specific points of interest or how to discourage them from looking elsewhere. “If these are the questions that are most important to you, VR is not your medium,” she writes. “You’ll end up spending a considerable amount of wasted time and energy attempting to control something that you fundamentally can’t.”

Raynai sees VR films as being more similar to theater than traditional film because “you’re staging an event.” Trying to transplant stories made for traditional films can fall flat, he says, because “the acting becomes really strange and unbelievable.” Similarly, Darnell says the viewer isn’t a



Neville Spiteri, co-founder and CEO of Wevr, a VR studio/distributor that worked on “Waves,” a VR film starring comedian Reggie Watts, says, “with traditional films on the silver screen, you can only become so immersed since your viewing area is flat. When you’re in VR, you’re completely immersed in the setting, as the viewing area is wrapped around you.”

captive audience, such as with traditional film. “They’re free to pay attention to whatever they want,” he says. For example, someone might spend an entire film watching the clouds roll by, he says. Darnell sees his job as “providing enough

interest in the story and characters that the audience makes the choices I want them to make when I want them to.”

In “Invasion!,” Darnell attempted to build tension in one scene by delaying the appearance of an alien spaceship

from behind a stand of a trees. Just as he might do in a cinematic film, he had the craft and score get louder and louder before the ship ever appeared. “But after a few seconds, almost every viewer looked away from the spot where the ship would finally appear, even though the sound of the ship was spatialized so that it was coming from right behind those trees,” he says. Darnell realized the ship needed to appear much earlier than it would in a cinematic film in which a viewer would have nowhere else to look. “If I didn’t do this, I would have lost the viewer, and the viewer would have missed an important story beat,” he says.

Leichsenring says viewers take on more responsibility in VR films because a screen dividing them and the hero is missing. “This can cause awkward intrusive sensations unless you define the viewer’s role or break the fourth wall,” he says. As such, filmmakers must decide in the narrative if they want viewers to play a role or be an observer and plan shots accordingly, he says.

Creatively, Darnell says, “the challenge is integrating the classic, centuries-old components of storytelling with this brand-new medium.” The question is how to put a viewer in the middle of a story without sacrificing such storytelling components as structure, rhythm, pacing, and engaging characters—all components that can have a powerful emotional impact on viewers. Giving viewers too much control in how the story unfolds, he says, could risk damaging that emotional impact.

### Technical Issues

Beyond storytelling challenges, VR filmmakers face other challenges, including expensive tools, if the tools exist at all. Often, filmmakers build their own to bring their vision to reality. An often-cited example is the brush-like Quill tool Story Studio built to compose “Dear Angelica,” a film described as letting viewers step into a painting.

“The biggest challenge VR filmmakers face—and independent VR filmmakers in particular—is getting their hands on

## The Episodic Potential Of VR

In addition to films, VR studios and directors are taking VR storytelling into the realm of episodic programming. Samsung, for example, has partnered with Wevr and Skybound Entertainment and its president David Alpert, who is also executive producer of “The Walking Dead,” to create “Gone,” billed as the first narrative VR series.

Available via the Samsung Milk VR platform, “Gone” features multiple episodes written by JT Petty (“Outlast,” “Splinter Cell,” “The Burrowers”) and lets viewers “experience the dread and

panic of a couple whose child vanishes.” Viewers seek clues in a 360-degree environment and run across “hotspots” that unveil events occurring at different times and with new perspectives, thus shaping how the viewer experiences the story. Missing a

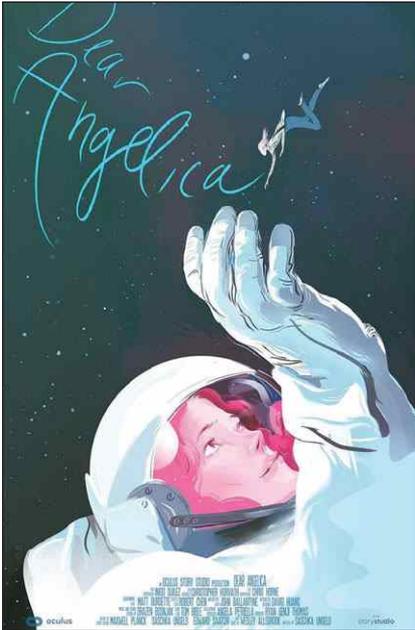
hotspot could mean missing a key aspect of the story. Robert Kirkman, Skybound partner and “The Walking Dead” creator, told *Fast Company* that VR enables trying to “tell a story when you don’t know where the viewer is looking. We’re defining what’s possible in camera. It’s kind of awesome.”

Along the same lines, Conde Nast Entertainment is partnering with director/producer Doug Liman (“Bourne Identity”) on “Invisible” for release later this year. The six-part series comes from Jaunt and the 30 Ninjas production company Liman founded. It’s penned by Oscar winner Melisa Wallack (“Dallas Buyers Club”). Set in Manhattan, the series tells “the secrets of a prominent New York City family, the Ashlands, blessed with a supernatural gift passed down through generations.”

Jaunt president Cliff Plumer touts episodic series such as “Invisible” as “the future of mainstream VR content.” Liman, meanwhile, states that in terms of storytelling, while he’s “always been interested in breaking the rules,” with VR “we’ll be creating them. That’s something you never get to do.”



In addition to films getting the VR treatment, filmmakers are working on episodic series. One example is “Gone” from Samsung, Wevr, and Skybound Entertainment, whose president is David Alpert, also executive producer of “The Walking Dead.”



Because VR filmmaking is still in its very early stages, filmmakers are often having to build the tools needed to create their films. Oculus' Story Studio, for example, built a tool called Quill to help make "Dear Angelica" possible.

the right tools to both create and publish their works," Spiteri says. "Ramping up on the learnings around how to craft the film to best work in the VR format is also a factor." Yet another is filmmakers finding the right platforms to promote their work.

"Technically, there just aren't the VR authoring tools available to produce content as efficiently as we'd like," Darnell says. "As far as cost goes, making great animation is always hard and perhaps even more difficult in VR. You simply need the time and talent to do it right, and that's always going to be expensive." Fan adds that "there's not much you can get off the shelf right now." Baobab workers have had to create their own VR pre-production tools, she says.

Chapman says among the rigs currently available, live streaming is available in only some, thus some shoots pose a "Schrödinger's camera" scenario in the sense of "did you ruin the shot or was it already ruined?" While "the technology just isn't there yet," she says, it's come a

long way in the past six months. "Live streaming is going to be coming out widely on our camera in the next month and a half, and that's going to be a huge thing for us," she says.

Although having to develop tools can be frustrating, Chapman says, it's also often exciting. "I think what really drew me to this space is the futurism of the technology right now," she says. "The idea that in a month's time I could have tools that I could be using in a major production and relying on that I don't know right now, and they're going to be workhorses for me in three months' time—it's hard to see where the road map is going to go for even two years."

Kamal Sinclair, director of New Frontier's Lab Programs, says while many projects in recent years have shared a "North Star" sensibility of "where we can go with the medium?," no one has yet to crack the code completely. She cites a residency program New Frontier and Jaunt partnered on to help Lynette Wallworth make her VR film "Collisions." "It was like trying to rub two sticks together to make that film," Sinclair says. "All the things as a filmmaker you're used to having at your fingertips just didn't exist," including real-time monitoring. "It was so archaic in many ways," she says. A more recent residency was like a quantum leap in terms of available toolsets, she says.

Leichsenring says because VR is still in a grassroots state where filmmakers are allowed to fail and experiment, they'll learn from each other to improve the experience. "The tools to create VR films are already being made for all types of wallets, and with the way technology is progressing today, it will be affordable tomorrow."

### Share & Share Alike

The learning Leichsenring says is taking place among VR filmmakers is a consistent theme among many in the VR film community. Many believe that for the medium to succeed, there must be enough good content to attract viewers, which means sharing what works and what doesn't. "It's vastly important

we build a community, not just of technologists and filmmakers, but people who are both," says Chapman. "There's so much to do in this space, and there's so much to learn, and a lot of it comes from practical use of things and realizing, 'OK, next time I won't do that. Next time, that doesn't work.'"

Chapman cites Jaunt's own ONE rig, which integrates 24 cameras. "Things get complicated because of that on the storytelling side," she says. While the operation is simple, there are issues like "How do you light without getting lens flare in three of the cameras?" or "How do you move the camera without having a steady-cam operator right up on your camera?," she says. "Those are technical challenges, and that's something we need more people with experience in all those fields and all those places to come to the



Jaunt notes that its ONE rig is the first professional-grade stereographic cinematic VR camera built from the ground up. It has 24 cameras to record 3D video in all directions.

space and say, 'Well what if we try this? What if we hack it together like this?'"

Spiteri says Wevr spends a lot of time sharing what it learns with filmmakers so they feel comfortable, learn the ins and outs, and carry that forward to "collectively move the medium forward." For example, Wevr is often presented scripts that must be rewritten for VR before they can be produced because of how they initially were conceptualized.

## What's Playing

Although cinematic VR filmmakers are just beginning to explore this new medium, there's already a good amount of available and upcoming content to try, even using cardboard goggles, smartphones, and apps. The following are some examples, with many having played at various film festivals.

- "Invasion!." Ethan Hawke provides narration in this 4-minute animated short from Baobab Studios that tells the story of two rabbits trying to save Earth from menacing aliens. Notably, the viewer assumes the identity of one of the rabbits.
- "Clouds Over Sidra" and "Waves Of Grace." Director Gabo Arora and pioneering VR filmmaker Chris Milk co-directed these documentaries. The former provides a look into the life of a 12-year-old girl living in a refugee camp along with 130,000 other Syrians.
- "The Click Effect." This 7-minute experience takes viewers under water with two marine researchers chronicling the click communication used by dolphins and sperm whales.
- "Allumette." This 20-minute story from Penrose Studios loosely based on a Hans Christian Andersen story is arguably the most heralded VR film to date. Wired.com called it VR's first masterpiece.
- "Dear Angelica." From Oculus' Story Studio, this film about a teenager reflecting on stories her mom told her as a child required Oculus to build a tool that let illustrators paint scenes from within VR. The film was rendered in real-time, and the end result is described as stepping inside of paintings.
- "Waves." This 10-minute film from Wevr features comedian and band leader Reggie Watts in what's described as a "dream-within-a-dream meta-ride down the rabbit hole" through various galaxies and dimensions.
- "Collisions." This 15-minute documentary has appeared at Sundance and the World Economic Forum. It tells the story of indigenous Australian elder Nyarri Morgan, who in the 1950s witnessed Australia's testing of the atomic bomb.
- "Lost." This 5-minute animated story about a giant robot searching for his severed hand in a dark forest is Story Studio's first film. Viewers explore the scenery in 360 degrees and can perform such actions as crouching behind foliage while viewing the robot.
- "Notes On Blindness: Into Darkness." This companion piece to the feature film "Notes On Blindness" provides a VR experience based on the audio diaries of John Hull, who went blind partway through his life. The experience is said to give viewers an understanding of what it means to be blind.
- "SENS." Billed as the first graphic novel to be adapted to VR, this film tells the story of an anonymous wanderer roaming a barren universe with arrows guiding him where to go. It's described as an "immersive toboggan" experience that reveals numerous surprises.



"Notes On Blindness: Into Darkness" is a VR experience based on the audio diaries of John Hull, who went blind partway through his life. When talking about the project, Kamal Sinclair of Sundance's New Frontier program says, "everyone we spoke with agreed [it] was native to virtual reality."

Raynai says he's found considerable openness through Toronto-based VR meetups and online via groups such as the 360° VR Video Professionals Group on Facebook. Sharing tips and techniques will only inspire better content, he says. Though Raynai hasn't encountered many filmmakers unwilling to share what they're doing, he's sure they do try to protect their creations. "I can only say that we've shared everything we learned with 'I Am You' and will continue to do so on all future projects," he says.

Beyond being vital, Sinclair says sharing is something New Frontier and Sundance promote. "Sundance's whole ethos is 'create community and have that community share,'" she says. She points to Vrse's Milk and Aaron Koblin as examples of this mentality. "From the very beginning, they were saying, 'We know this will get competitive, but if we try to compete this early in the game, we may not see this medium take off.' It really is in the best interest of everyone that's invested in this space to be generous in that way," she says.

Spiteri agrees that reaching a mainstream audience is key for the medium to flourish long-term. "We're all incredibly excited with how the first adopters of the hardware and software are embracing the medium with open arms, and that's something that we'd love for the casual user to experience in the near future, too," he says. "It's important for everyone to see just how transformative VR is to film, gaming, and even other industries like real estate, shopping, and traveling." Already, he says, hardware manufacturers and content creators "are in this for the long-haul, and it benefits everyone involved that people experience VR however they can, whether that's through a cardboard experience or a Vive kiosk in a mall."

## That's A Wrap

Only history will decide what long-term relevance this era of VR filmmaking will represent to overall cinema. "Right now, there's just so much to learn and discover," Darnell says. "All we can do is approach our work with open eyes and an open mind." Fan believes people will

## New Frontier: Putting The VR In Sundance

Within the Sundance Institute is New Frontier, a program celebrating its 10th anniversary this year. Essentially, New Frontier exists to foster new forms of storytelling, including virtual reality films, by bringing the creative and technology worlds together. Kamal Sinclair, director of New Frontier's Lab Programs, says computing enthusiasts are exactly who New Frontier wants to connect with more deeply. "We obviously have a strong base within the film community and certain aspects of the larger storytelling community," she says. Technologists, though, represent that "part of the engine that creates the future of storytelling."

New Frontier has been a major supporter of VR films dating to 2012 when Chief Curator Shari Frilot visited Nonny de la Pena's research lab at USC and experienced her VR film "Hunger in Los Angeles." Frilot was so impressed that she pushed de la Pena to show the film at New Frontier's exhibition at that year's Sundance Film Festival, a move that reportedly prompted Palmer Luckey, then de la Pena's intern, to build a mobile version of USC's VR headset. This year, New Frontier featured 30-plus VR experiences.

Sinclair says that Frilot pushing for VR in 2012 was somewhat risky because Sundance is a 40,000-person festival but "Hunger in Los Angeles" was a "one-person-at-a-time" experience. "And that was before Palmer came up with the [Oculus Rift] prototype, so it was like, 'How are we going to get this thing that there's no mobility for because it's a \$50,000 headset and would USC even let it off campus?'" New Frontier remains passionate about VR films, she says, because something about Frilot's first experience demonstrated VR as an important opportunity to enter into a story in a way that had never before been done.

Initially, New Frontier had to scrounge for story-oriented VR content. A breakthrough occurred in 2014 when it asked the makers of "Clouds" to port their documentary into the Vive Kit 2 as an experiment, "and it

worked," Sinclair says. Around the same time, VR filmmaker Chris Milk ported his 360-degree project featuring musician Beck into the VK2. "But that was it. That was all we had," she says.

In 2015, stories and VR really started to come together, says Sinclair, who cites a moment when a major studio head saw "Perspective," an



As part of its 10th anniversary this year, the Sundance Film Institute's New Frontier program recently held a Slithering Screens event at the Museum of Modern Art that included a screening of Lynette Wallworth's VR film "Collisions."

experience that gives viewers the perspective of a man and woman in a college assault situation. "He came out with tears in his eyes and said, 'One, I have to call my college-aged kids, and two, I just thought [VR] was a roller-coaster ride. I didn't know it could be used for heightened storytelling.' It was like, 'Boom!'" Sinclair says.

Although VR has the potential to be "an empathy machine" or "a brainwashing machine," Sinclair says, it depends on who is using the tool. She says Sundance is committed to "getting world-class storytellers, independent voices, diverse voices using these tools to show us the scope, scale, and spectrum of what this medium can be before we start putting it in a box."

view this period as one of discovery and exploration that will ultimately define how content is created and consumed.

"It's hard to not look at the history of film and try to draw parallels between then and now because that's just where most of us come from," Chapman says. "I think [cinematic VR] now is closer to the beginning of the studio era than to the very beginning of film. There was an

era of film where everything was in black and white, then it had sound, then it had color, and then it was in 3D. Now it surrounds you and you can move through it. The next step is you can interact with it. What's beyond that, I have no idea."

Similarly, Spiteri says the "rules" of VR are still being written. Creators are experimenting with what's exactly possible with today's technology,

finding which content people are most gravitating toward, and crafting new experiences and stories based on that. "In just a few years, we'll look back at today's content and see how far we've come with creating immersive and, even in some cases, empathetic experiences and how today's experimentation of content greatly impacted 21st century storytelling," he says. ■

**CPU**  
Game Of The Month

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**G2A**.COM



Dark Souls III is not my kind of game. I never played the first Dark Souls, Dark Souls II, or the spiritual second-cousin to this franchise, Bloodborne, because of the games' reputations for being brutally difficult. There are not many games like this out there, which is a double-edged sword, both for people who might want to play it and the developer. The audience of people who want a cliché sword-and-sorcery RPG with a combat system that's as tight as Street Fighter and as punishing as a hungover ride on a wooden roller coaster is small but dedicated.

Most of the reviews for Dark Souls III have been written by these hardcore fanatics, who do their beloved franchise no favors by suggesting—if only between the lines—that you shouldn't play it if you aren't a WASD wizard. If you count yourself among these people, then you can stop reading now. This game is tough, the controls are rock-solid, the gear is plentiful and powerful, there are upgrades and perks galore, and, just when you start to get comfortable, the game gobbles you up and spits you out. You'll love it.

If you're not one of those people, however, Dark Souls III is a good entry point to the series because the story, such as it is, stands on its own. But there are areas where the game seems thinner than most. For instance, you'll meet NPCs who spout trite exposition at you without moving their mouths (for the record, this counts as two gripes). The other NPCs just open and close their

## The Lords Of Cinder Won't Go Quietly

BY ANDREW LEIBMAN

G2A.com Price: \$46.24 (PC), \$54.86 (XOne, PS4)  
ESRB: (M)ature • FromSoftware • [www.darksouls3.com](http://www.darksouls3.com)

mouths in a loop. Several characters have their mouths completely obscured by helmets. The color palette is largely gray, brown, and a muted version of other earth tones. There are constant reminders that this game is a console-first title. And the difficulty curve of Dark Souls III is just nuts.

"That's the point," you say.

Why are Souls fanatics still reading this? Go back to the game, try a new class, and explore the places you missed the first time. There's a multiplayer mode and four different endings to see. From what I could discern, the story is about a darkness falling, and someone linking fire, somehow, which resulted in a catastrophe, but I shouldn't get upset about it because the Lords of Cinder who relish killing me over and over again didn't mean to do it. It's nice to see Destiny's writing team is still able to put food on the table, though.

As bad as the story seems, I have to admit, it's not the point. It took me a while to see what all the fuss was about. A few hours of deep controller-throwing frustration. But then something clicked and I stopped trying to not die. The game has a rhythm of paralyzing dread, close calls, stupid mistakes, demoralizing defeat, and too-brief periods of raw exhilaration. Your heart will race and the adrenaline will make your hands shake. You'll feel silly having to remind yourself it's just a videogame. But you'll keep playing, because Dark Souls III is one heck of a videogame. ■





Gearbox Software and 2K's *Battleborn* is what Gearbox refers to as a "hero shooter," and what most players will recognize as an FPS MOBA hybrid. Its FPS elements are immediately apparent, and Gearbox is well known for making quality first-person shooters. (See all of the *Borderlands* series.) In that regard, *Battleborn* doesn't fall far from the tree, so to speak, as it leans heavily on a similar cel-shaded art style and a futuristic sci-fi theme and story, and of course Gearbox's irreverent sense of humor is present and accounted for at all times.

The MOBA (multiplayer online battle arena) components of the game are also quickly manifested, in that each game you play, whether in campaign or in multiplayer, starts your character off at level one, no matter how much time you've spent playing it. (There are opportunities to customize your character's appearance and add new augments to the helix skill tree, however, to distinguish vets from nubs.) As you play, you level up quickly from the first level to level 10; if you play your cards right, you can potentially hit level 10 every time out. The advantage of leveling up is that at each level increase, *Battleborn* lets you choose one of two character enhancements from a helix-shaped skill tree that gives you more effective special abilities and so on.

I first played *Battleborn* during the recent public beta, and while I enjoyed the multiplayer experience quite a bit, I had some reservations about the campaign mode. In fairness, I should point out the campaign levels available to players in the beta were only partial levels and were plucked out of the game without context; this is likely part of the issue that gave me pause. The full version of the game gives each campaign level a great deal more meaning, as you get to play the full level and you get cool animated intros and occasional story interludes that resemble the old *Aeon Flux* cartoon stylistically.



## Symphony Of Destruction

BY CHRIS TRUMBLE

G2A.com Price: \$30.30 (PC); XOne and PS4 also available  
ESRB: (T)een • 2K Games • [2k.com/games/battleborn](http://2k.com/games/battleborn)

Although I still prefer a more traditional FPS style for single-player and co-op play, having a fully fleshed-out story supporting the action on-screen and seeing how the levels work together to advance the story (and to help you unlock new characters and so forth) gives *Battleborn*'s campaign much more appeal.

I still have one gripe where the campaign is concerned; *Battleborn* gives you a limited number of respawns, and once they are gone, you are done, even if you managed to whittle the level's final boss down to 1% health before you got smoked. The levels are much lengthier than the abbreviated versions we saw in the beta, and starting over at square one after having died in the final boss fight is a much tougher choice than just picking up from your last checkpoint. (The game's soldier character, Oscar Mike, would probably say, "Suck less, scrub!" And I would deserve it.)

The multiplayer is still a lot of fun; each game takes place in a long, linear level where teams start out on opposite ends of the board in a base and have to deal with each other and various environmental hazards throughout the game, as they march toward the goal of whatever game type they are in (most kills, most robots sacrificed, etc.) Characters are leveling up at varying speeds based on their skill and that of their opponents, and so as the game progresses, things get increasingly hectic and fun. As with most MOBA-style games, *Battleborn*'s characters each excel in specific roles; some are tanks, some are DPS, and some are healers. Team play is paramount, so heading in with people you know is likely to give you an advantage.

*Battleborn* is colorful, fast, and a lot of fun to play, whether on your own or with lots of friends (and/or enemies). ■





In the recent PC port of last year's PS4-exclusive *Everybody's Gone To The Rapture*, something unsettling has happened to the residents of the rural town of Yaughton, in Shropshire England. For those who've played The Chinese Room's freshman effort, *Dear Esther*, you'll immediately recognize the unique blend of voiceovers triggered in certain areas, limited interactivity, and a walking pace that's maddeningly just shy of leisurely.

The CryEngine-based game looks good, and we often found ourselves pausing to take in the stunning scenery. As you wander through the twisting roads, kempt neighborhoods, and lush idyllic countryside, you'll come across abandoned cars, numerous dead birds, vacant homes, wads of bloody Kleenex, and an eerie silence broken only by radio chatter and an occasional soaring melody or melancholy choral piece composed by the talented Jessica Curry. The gorgeous scenery was juxtaposed with the conspicuous absence of anything living that's larger than a butterfly, effectively setting the mood.

Your only clue about how to play *Everybody's Gone To The Rapture* occurs in the first recorded message you encounter, at the locked gates of the observatory. "Follow the light," it says. And sure enough, an orb of tumbling golden light hovers, spins, and zooms around the environment to show you where to turn your attention next. As you follow, you'll tease light orbs into revealing a snippet of conversation occurring between two or more people-shaped motes of light.



## Meandering To The Rapture

BY ANDREW LEIBMAN

G2A.com Price: \$19.05 (PC); PS4 version also available  
ESRB: (M)ature • The Chinese Room • [www.thechineseroom.co.uk](http://www.thechineseroom.co.uk)

The main characters, Stephen and Kate, have made a disturbing discovery, and the couple disagrees about how to handle the unfolding events. Things go from strange to bad to much much worse. But all of this has already happened; you're just a passive observer, getting a glimpse of past events—the aftermath. Ladies and gentlemen: You're touring the museum of the apocalypse. Please keep your hands inside the vehicle at all times.

Having enjoyed *Gone Home*, *The Stanley Parable*, *The Vanishing Of Ethan Carter*, and *Dear Esther*, we can say that we're fans of the derisively-dubbed "walking simulator" genre, but the considerably larger scope of *Everybody's Gone To The Rapture* acts against the interests of the story in a few ways. The first problem is the large map. Or maybe it just feels large because you can only move at a snail's pace. There are so many interesting-looking places to explore, but when you commit to leaving the beaten path, backtracking and finding your way back can be time-consuming because of the walking pace. We ultimately relented and just went where the light wanted us to. What should have been a prime example of nonlinear storytelling quickly became an on-rails shooter, sans the shooting.

The game also features more than a few technical hiccups common to console ports, such as zero support for multi-monitor widescreen resolutions and an uneven frame rate, and we also experienced a handful of crashes.

Despite its shiny veneer, this is a narrative-driven game, one where characterization is as important, if not more important, than the plot. Go into this game knowing this and all of the above, and chances are good you will find it a rewarding experience. ■

# DOOM

Bethesda Softworks and id Software recently launched DOOM, the 2016 reboot of id's 1993 smash hit, and we have to say: It's about time.

First things first; shooters have obviously changed a lot since '93, so we were curious to see how closely id would stick to the old formula and how well that gameplay would hold up. As to the first question, id told people from the start that the game would be about fast-paced run-and-gun-style play, and not about cover mechanics and the like, and the company delivered on that promise. Instead of giving you cover and opportunities for your health to regenerate, the game rewards players who take the fight to the enemy while punishing the timid. Your otherworldly enemies will not stand idly by while you take a break on the other side of a doorway—they will gather strength and then rush you, even on the default difficulty setting, “Hurt Me Plenty.” (There are three higher skill levels, including one called “Ultra-Nightmare” that includes permadeath.)

The flip side is that DOOM's demon hordes drop health power-ups on occasion, which makes killing them the fastest way to repair the damage they do to you. Additionally, the game has a new feature called “Glory Kills,” in which you launch a melee attack against a stunned enemy (you will know they're stunned when they start glowing) and perform one of several satisfyingly gruesome finishing moves. Glory Kills *always* yield health power-ups, so you can see where this is headed.

As to the second question (will this style of gameplay hold up?), the answer is resoundingly affirmative. DOOM of 2016 is an interesting blend of the old and new. It is a corridor shooter with a dash of exploration and some collectibles thrown in, and while in principle these things would seem to clash with DOOM's “push-forward combat” style, the game sidesteps pacing problems nicely. It borrows the “area lockdown” mechanic found in the Dead Space series and a few other titles that forces you to clear an area before you can

## Let's Make Shooters Great Again

BY CHRIS TRUMBLE

G2A.com Price: \$36.60 (PC), \$56 (XOne); PS4 also available  
ESRB: (M)ature • Bethesda Softworks • doom.com

progress, so combat is high-octane speed fights, followed by all the time you need to explore each area at your leisure and find all the hidden goodies, like weapon and armor power-ups and hidden, playable old-school DOOM levels.

DOOM looks and sounds fantastic. Mars is a pretty hellish landscape in its own right, both by nature and by virtue of the portal the UAC has opened to, you know, Hell. Environments, enemies, and weapon effects alike are crisp and gorgeously foreboding. The sound is excellent as well, with a driving soundtrack that you might mistake for Trent Reznor's work if you didn't know better.

Also, there's a cool twist to the old story this time—you are still a lone marine on a one-man mission to drive back the darkness and save humanity, but this time you're a “Doom Marine,” a super soldier who has been locked sleeping in a vault for a very long time, surrounded by glowing runes of unknown origin.

DOOM's campaign is excellent in every respect. The other two play modes are Multiplayer and SnapMaps; Multiplayer is just what it sounds like, and SnapMaps is where you go to build, upload, and play on maps created by id and the community using DOOM's level editor. As you can guess, SnapMaps is a mixed bag; Multiplayer is another unique blend of old and new. It's the old arena style of multiplayer shooter play, where you move at full speed the entire time and survive purely by your knowledge of the map's spawn points and your fast-twitch reflexes, but it adds many of the customization and interaction features found in Halo and other modern shooters. (Things like wildly customizable armor and weapons, medal stand emotes, and a level-up system that grants access to more diverse loadouts and equipment.)

Personally, I enjoy a more tactical approach to mayhem, but I believe people who liked (or would have liked) Unreal Tournament, Quake, or any of the other games of this ilk will really enjoy DOOM's Multiplayer mode.

In short, DOOM is one of only a handful of games that manages to strike the proper balance between WHAT WAS and WHAT IS in the gaming world, and more importantly, it's a very good game. ■



## Q&A With Eric Jardine

# Examining The Pros & Cons Of The Dark Web

Late last year, the Center for International Governance Innovation polled about 24,000 people in 24 countries for a survey concerning Internet security, privacy rights, trust, and the Dark Web. When asked if the Dark Web should be shut down, a staggering 71% of those surveyed agreed it should. Although that's certainly a high percentage, the sentiment isn't exactly surprising given that most attention the Dark Web (or Dark Net) attracts is negative in nature, and often extremely so. Commonly, the Dark Web is described as the darkest corner of the Web where everyone and everything operates in anonymity—a fact that enables various seedy undertakings, including marketplaces for illegal goods and services, terrorist communication and recruitment, hackers for hire, and worse.

Eric Jardine is a research fellow at CIGI specializing in international relations, political violence (terrorism and insurgency), and Internet governance. His background includes research, studies, papers, books, and other efforts focused on the Dark Web, Tor Project and Tor browser, terrorism, cyberterrorism, insurgencies, counterinsurgencies, rebel groups, cyber protests, and more. Among his research papers is "The Dark Web Dilemma: Tor, Anonymity and Online Policing." We talked to Jardine about CIGI's recent survey, the Dark Web, Tor, and why everything concerning the Dark Web isn't necessarily negative.

*(You can read our entire conversation at [www.computerpoweruser.com/20937](http://www.computerpoweruser.com/20937))*

**Q:** Your background includes areas that are currently very relevant, including terrorism, insurgencies, cyberterrorism, Tor, and the Dark Net. What led to your interest in these areas?

**EJ:** When I was doing my dissertation, I was looking at rebel groups, insurgencies, this sort of thing. All the cases I was looking at were all pre-Internet. I was delving into history. As I finished that project up and moved into a professional position out of my Ph.D., I sort of emerged from the cave and started to look around and noticed that groups that exist now have a lot of similarities with groups from history, but they were also starting to use these new technologies, like the Dark Web and the Internet in general, to facilitate their campaigns. That was sort of the natural transition for me. I had an interest in the way in which non-state actors, be they criminal or political, use technologies. They transitioned, and then I transitioned a little bit later.



**Q:** What types of similarities have groups like those you research and study shared throughout history?

**EJ:** The way I look at it is there's a lot of continuity in what rebel groups—non-state groups, criminal organizations, what have you—do. The way the Internet

factors in, it's sort of an amplification tool. The Internet hasn't really devised anything new that rebel groups are able to do; it has just amplified what they're able to do. Rebel groups or insurgencies or territory organizations that are trying to publicize their propaganda, that goes back to the beginning of recorded history for what rebel groups do. They try to get their message out. They rely on the sort of tacit support of the population at the very minimum. Groups like ISIS today trying to use Twitter, YouTube, these sorts of things to get out a political message is simply using a new technology for an old purpose.

At the margin, I'd say you do have an emergence of some new tactics that some groups take advantage of. That would be things like trying to hack technologies back in the homeland. So last year, there was a story about ISIS attempting to attack the U.S. power grid. That's new in the sense that the groups don't have to leave their country, and the resource barriers are a lot lower. They weren't ultimately successful in this effort, but it does show the Internet has changed things, but it has changed

more of the scope and cost of these efforts rather than what groups are able to do. That's also where the Dark Web fits in because the big concern about ISIS and attacks on the U.S. power grid is that while right now the groups have high motivation but very low capacity, the problem with the Dark Web is that it tends to—because of online marketplaces for hackers and more—minimize that barrier between motivation and ability. So the worry is that groups like ISIS and others might rent skilled hackers on the Dark Web and augment their capacity.

**Q: What is your definition of the Dark Web?**

**EJ:** Well, my definition sort of hinges on one word, and that would be “anonymity.” For me, the Dark Web is everything that's anonymous. And that means you need to use a special browser to reach or access the Dark Web, and it means there are special websites that are hosted anonymously. So anonymity for me is really the key. Some people say the Dark Web is everybody using the Tor browser or the Dark Net is everybody who's using the Tor browser to access Dark Web websites and things like that. It gets a little bit like parsing terms; sometimes it's useful and sometimes it just adds to the confusion. For me, it really boils down to if you're using something like Tor to access either the surface Internet—like your everyday, run-of-the-mill news sites and other things—or Dark Web websites and you're surfing the Web with the closest thing to anonymity you can get. Therefore, you're participating in the Dark Web. That would be from a law enforcement perspective, as well.

**Q: How does the Dark Web fit in with your research into terrorism, insurgencies, cybersecurity, cyberterrorism, etc.?**

**EJ:** I'm basically a researcher by trade, so I like to delve into questions about how do people use the Dark Net. For what reasons? Questions of that sort.

So I've done studies for CIGI about the pros and cons of the [Tor] network called “The Dark Web Dilemma” because I really see there being both pros and cons. I've done other work looking at whether political repression and increases of the level of repression in a country drive use of the Tor network. One of the handy things about Tor is it provides country-level statistics on people accessing the network. So you're actually able to look in statistical terms to see if repression matters. For me, because the way that technology gets used is constantly evolving, it continually presents new opportunities to delve in and look and see what's happening.

**Q: The recent survey CIGI sponsored found that 71% of about 24,000 people from 24 countries agree the Dark Web should be shut down. To what extent are the negative things people associate with the Dark Web true?**

**EJ:** There's no doubt the Dark Web is used for some pretty bad things. I think the 71% figure comes from sort of people's knee-jerk reaction to hearing about some of the ways it can be used. Illegal marketplaces, for example. Silk Road, which was covered in the media, is one example. Then you have hackers for hire and that sort of thing. You have child abuse imagery sites. I think people rightfully have a pretty bad view of how this technology can be used for these sorts of purposes.

In terms of whether or not the problem is overblown, there's an interesting study by two computer scientists in the U.K., Gareth Owen and Nick Savage, and they really pointed to one of the troubling aspects, indeed probably the most troubling aspect of the Deep Web, which is that when they looked and categorized Dark Web websites—Tor-hidden services hosted on the Tor network—they found that about 2% of the sites were dedicated to child abuse. When they began to track traffic to these sites—they weren't able to de-anonymize their network or anything, they were just looking at what signals were going where—they found that 83% of the

site visits actually went to that 2% of sites. So on that small portion of the network that is the Tor-hosted hidden services, you have a huge clustering of activity on child abuse imagery sites. So I think this knee-jerk reaction that this technology has some pretty terrible uses and should be shut down, I don't think it's unwarranted. The technology has its severe problems, and those can't be ignored. That being said, I also think there are beneficial uses to the technology, as well.

**Q: What are some examples of beneficial uses?**

**EJ:** The [Tor] Project is always in this constant back and forth with critics at the social side of things and governments at the technological side. The government tries to crack anonymity, and Tor tries to maintain it. But in response to Gareth Owen and Nick Savage's study, there was a discussion on one of the Tor blogs about patterns of user traffic of the Tor browser. What they basically put forward was that only 1 to 2% of all Tor traffic on a given day—so that's 2.5 to 3 million Tor users per day—actually goes to Tor-hidden surfaces.

That's not to minimize the problem of child abuse imagery on the Dark Web to any extent, but it's basically saying that most Tor traffic and most Tor users aren't even going anywhere close to Tor-hidden websites. They're just going to the Surface Web. They're looking at health information, the news, all manners of things, but they're staying on the Surface Web. Now, you can still get yourself in trouble on the Surface Web, and you'd still be participating in the Dark Web as far as I define it as sort of hinging on anonymity, but it sort of shows you that most of the traffic most of the time is likely actually benign rather than honest to goodness nefarious traffic going to those abuse sites. So that's one example that, in terms of broad aggregate use of the network, it's maybe not as all bad as some figures would tell you.

Then, in terms of Dark Web websites themselves, you have a shift going on

recently where ProPublica and other media organizations have set up Dark Web websites. They've done so in order to give whistleblowers and those living under repression regimes the chance to tell their stories and to view news. That's a useful addition. Facebook has now set up a Dark Web website so people can access the service in that way. In some of my other research, you also have a statistically significant correlation between heightened repression and use of the network over time and across countries. That goes to show that, put in a bad spot, people do tend to gravitate to this technology because of content restrictions imposed by governments, because of concern over government surveillance, spying, and more.

I think there are clear reasons why people would use this technology for good purposes, and most of them hinge on, let's say, more ephemeral concerns that are hard to quantify. Concerns over freedom of expression. Concerns over privacy. Concerns over social justice. It's harder to quantify than, say, "There are child abuse imagery sites, and it has this many users, and it's terrible." It's a tough message for Tor to try and sell, but I think there are positive uses for the technology.

**Q** : Will how people view the Dark Web change over time, even given its positive uses?

**EJ** : I think over time people will come to have a more benign view of the Dark Web. It got off on the wrong foot by being called the "Dark Web" and by the first movers in the space being criminals. That set people's pre-conditions going forward. But if you look at just Tor usage as an example—I'm just completing a book with a co-author in which we look at some of the effects of things like the Snowden disclosures on usage of Tor—there's a humongous spike. Usage is sort of plodding along, and then you have the 2013 disclosures. By September of that year, Tor usage had like quadrupled or more.

I think people in general terms are concerned about privacy and do want to be able to access content unrestricted,

and they are increasingly realizing that you need to take technological steps to do that. Right now, most people will choose private search engines like DuckDuckGo or private VPNs to try and maintain their privacy or their access to information across borders, but as governments and

that are essentially social in nature. It's that some people do bad things, to put it into really crude, black-and-white kind of terms. And they happen to use this technology. That's why I see what we're dealing with is largely a social problem. The technology is just an enabler of what

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companies respond to those technologies with new tricks, I think eventually there's going to be a split where either the network goes mostly dark—and that's not necessarily a bad thing, it just means people are using anonymizing technologies—or it goes the other way and basically technologies like Tor get pushed further and further to the margin. Pushing the technologies is going to have some severe consequences for people's ability to exercise some basic rights like privacy and free expression online.

**Q** : You've stated that addressing certain aspects of the Dark Web isn't just a technological problem but also a societal problem. What do you mean by that?

**EJ** : The way I see it, the technology is neutral. When we end up with problems, we're ending up with problems

would be going on anyway. It can amplify it, it can morph the character slightly, but at its root it's really a problem of society and society as it transfers into sort of a digital age where a lot more of what we do occurs online.

That's why I advocate for this notion of policing the Dark Web. Because if it is a social problem, we need to deal with societal problems as we always have, which is to try and minimize the costs and maximize the benefits. Viewing it as a strict technological problem doesn't really do that. What it basically says is that you need to keep tweaking the code until you figure out a way to not let criminals use it but only let human rights activists. But just like the problem with trying to build backdoors into encryption, you can't be exclusive like that. That's not the way in which the technology works. It's going to be dual-use, and people are the problem. ■



# LAN PARTY LISTINGS

**06.10-12.16**

FortCON 2016  
Fort Wayne, IN  
[fortlan.org](http://fortlan.org)

**06.11.16**

KCGame On 69  
Kansas City, MO  
[kcgameon.com](http://kcgameon.com)

**06.17-19.16**

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

**06.18.16**

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

**06.18.16**

Willamette Valley Gamers LAN  
Eugene, OR  
[www.wvgamers.com](http://www.wvgamers.com)

**07.08-10.16**

LANFest MLP'016\*  
Hamburg, NY  
[lanfest.intel.com/events/mlp016-summer](http://lanfest.intel.com/events/mlp016-summer)

**07.15-17.16**

Ancient City Con  
Jacksonville, FL  
[www.wardogz.org](http://www.wardogz.org)

**07.15-18.16**

PDXLAN 28\*  
Portland, OR  
[pdxlan.net](http://pdxlan.net)

**07.16.16**

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

**07.23.16**

Willamette Valley Gamers LAN  
Eugene, OR  
[www.wvgamers.com](http://www.wvgamers.com)

**07.28-31.16**

MillionManLAN  
Louisville, KY  
[www.lanwar.com/LWEventHome.asp?EventID=133](http://www.lanwar.com/LWEventHome.asp?EventID=133)

**07.30.16**

KCGame On 70  
Kansas City, MO  
[kcgameon.com](http://kcgameon.com)

**08.12-14.16**

DreamHack Montreal  
Montreal, QB  
[montreal.dreamhack.com](http://montreal.dreamhack.com)

**08.20.16**

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

**08.20.16**

Willamette Valley Gamers LAN  
Eugene, OR  
[www.wvgamers.com](http://www.wvgamers.com)

**09.16-18.16**

Ready Set FightCon  
Tigard, OR  
[readysetfightcon.com](http://readysetfightcon.com)



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**09.17.16**

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

**09.23-24.16**

CPU LAN  
Lincoln, NE  
[www.computerpoweruser.com](http://www.computerpoweruser.com)

**09.23-25.16**

PONG Expo LAN 2016  
Menomonie, WI  
[pong.uwstout.edu](http://pong.uwstout.edu)

**09.23-25.16**

Wardogz LAN Group  
Orange Park, FL  
[www.wardogz.org](http://www.wardogz.org)

**09.24.16**

Willamette Valley Gamers LAN  
Eugene, OR  
[www.wvgamers.com](http://www.wvgamers.com)

**10.08.16**

KCGame On 71  
Kansas City, MO  
[kcgameon.com](http://kcgameon.com)

**10.15.16**

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

**10.22.16**

Willamette Valley Gamers LAN  
Eugene, OR  
[www.wvgamers.com](http://www.wvgamers.com)

**10.28-30.16**

Baselan 30  
Eugene, OR  
[www.aybonline.com](http://www.aybonline.com)

**11.04-06.16**

LAN In The Highlands  
Latrobe, PA  
[www.clubconflict.com](http://www.clubconflict.com)

**11.04-06.16**

Maryland LAN Gamers  
Greenbelt, MD  
[www.marylandlangamers.net](http://www.marylandlangamers.net)

**11.04-06.16**

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

**11.19.16**

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

**12.03.16**

KCGame On 72  
Kansas City, MO  
[kcgameon.com](http://kcgameon.com)

**12.17.16**

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

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## Q&amp;A With Jonathan Lin

Here Comes GIGABYTE's  
30th Anniversary Mod Challenge

**Q** : GIGABYTE recently announced a big new mod contest to celebrate its 30th anniversary, correct? For starters, congratulations on 30 years!

**JL** : Thank you very much! We are extremely excited to hold this event, and we are looking forward to all the great designs the community will come up with. With all the support we've received from our fans, we thought this would be a great opportunity to give back.

**Q** : What kind of prizes are up for grabs in this contest?

**JL** : Without going into too many details, we will be giving away around \$10,000 worth of cash and prizes. This includes our latest X99 motherboards set to release soon, our GIGABYTE graphics cards, and more hardware components provided by our valued sponsors, including Kingston, ENERMAX, Corsair, EKWB, Intel, and NVIDIA. Just to sweeten the pot some more, the final grand prize winner will receive a free trip for two to CES 2017 in Las Vegas.

**Q** : Wow, OK, so when does the contest start, and how should people who are interested in entering get started?

**JL** : The contest started on Monday, May 23, with the concept stage. Participants can submit their mod ideas on the contest website at [event.gigabyte.us/mod2win](http://event.gigabyte.us/mod2win). In addition, we are very lucky to be working with our friends over at Modders-Inc., which will host all the required worklogs during phase two of this event.

**Q** : How should modders submit their concepts? Are you looking for designs in software like SketchUp, or will a detailed description get the job done?



**JL** : A full design done through software like SketchUp or AutoCAD is acceptable. But if not, we will also accept hand-drawn sketches that are well detailed and can show the full mod concept at several different angles. We will require a visual medium of some sort, so just a detailed description is out of the question.

**Q** : Gotcha, and what's the deadline for submitting these initial concepts?

**JL** : The deadline for all concept submissions is the end of the day on Monday, June 27.

**Q** : And in this initial round, entries will be vying to get through to round two, right? What will judges be looking for?

**JL** : Yes! Judges will be looking for unique and original concepts. We are looking for modders who are able to bring their concepts to reality and move on to round two where the building begins, so it certainly has to make sense. One thing that

is also required for their build is that we are looking for some element of watercooling, so that needs to be in the final blueprint. The judges will choose three winners based on these criteria to receive a build kit to jumpstart their mod. Build kit winners will receive a GIGABYTE X99P-SLI, a GIGABYTE GTX 960, and an EKWB waterblock for all the essentials to complete their build. But don't be discouraged if you don't receive a build kit! In phase two, the building stage welcomes all contestants who think they have what it takes to win the grand prize. We even welcome modders who have already started on a current build, as long as they began work on it within the past year.

**Q** : Your announcement mentioned some kind of giveaways during phase two?

**JL** : In the spirit of celebrating GIGABYTE's 30th Year Anniversary and to share the fun with our fans all over, we will be doing giveaways regularly throughout the contest with the help of our sponsors. You don't have to participate in the contest to be included in our giveaways, just look out for our announcements or visit the contest website for more ways to win! However, we are only extending our giveaways to individuals residing in North America.

**Q** : Alright, and how long does phase two last? When do the final contestants have to complete their projects?

**JL** : The build phase starts immediately after the concept phase and will last until November. All final mod submissions need to be in by the end of the day on Monday, Nov. 14. Judges will make their final decisions to crown the grand prize winner on Wednesday, Nov. 23. May your frame rates be high and temperatures low! ■

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