

# WD BLACK™ PCIe SSD



## MEETING THE NEEDS OF NEXT-GENERATION APPLICATIONS WITH PCIe SSDS



### POWERING NEXT-GENERATION APPLICATIONS

It's a brave new world. In just a few short years, the applications and tools we use on our PCs have changed dramatically. We've moved into a new age where we are now much more visual, need easy access to large amounts of information, and want to get things done in the blink of an eye. With next-generation applications and processes, we are accessing, moving, manipulating, and storing orders of magnitude more data than ever before. Performance and speed are key.

Today's users want a clear and lag-free video experience with life-like, higher resolution applications and features such as 360-degree views. This requires moving far more data into the processor and memory much more quickly. Video-oriented applications are just the tip of the iceberg, however. Gaming, graphic arts design, and video editing and rendering all demand substantially more data than they did in the past. And virtual reality (VR), which is expected to be common by 2018, will demand even greater system and storage performance. In fact, IDC forecasts that the VR hardware market will surpass \$2 billion this year<sup>1</sup>. As the quality of the VR experience improves, the technology will impact all types of applications for both consumer and business activities. Business applications include next-generation prototyping, advanced healthcare, and use of VR simulation to create "social laboratories."

To keep pace with these advances, consumers and organizations need next-generation storage performance. This is where solid-state drives (SSDs) using a PCI Express (PCIe) interface change the game. PCIe SSDs deliver faster and better performance on most measurable aspects<sup>2</sup> when compared with the traditional Serial Advanced Technology Attachment (SATA) interface. They can also be used to improve existing hard disk drive (HDD)-based system performance, with the installation of a PCIe drive directly on the motherboard on newer systems. In this instance, the SSD would serve as the primary drive to execute all operations on the drive such as boot up, application launch, and loading of critical information to the system. The HDD would function merely as a pure storage device.

The PCIe SSD performance gains are further enhanced with NVMe (Non-volatile Memory Express) technology. NVMe is an optimized, high-performance, scalable host controller interface specifically designed for PCIe-based SSDs, while SATA, in contrast, was designed for mechanical drive characteristics. This new technology improves performance in a number of ways, including increased bandwidth, more IOPS and reduced latency. NVMe can also handle 64,000 queues simultaneously, compared with the SATA protocol Advanced Host Controller Interface (AHCI), which can handle only one queue at any given time. That means NVMe is much more efficient when it comes to reading/writing data, resulting in a drive that generates lower write amplification and a longer lifespan.

<sup>1</sup>IDC Forecasts Virtual Reality Hardware to Soar Past the \$2 Billion Mark in 2016." <http://www.idc.com/getdoc.jsp?containerId=prUS41199616>. Date Published: April 21, 2016.

<sup>2</sup>NVMe Introduction." [http://www.nvmexpress.org/wp-content/uploads/NVMe\\_Overview.pdf](http://www.nvmexpress.org/wp-content/uploads/NVMe_Overview.pdf)





## THE MARKET IS MOVING TO PCIe

Use of SSDs with the PCIe interface is increasing substantially, especially for users needing higher performance. There are several proof points for this assertion. According to research firm TrendFocus, sales of PCIe-based SSDs grew more than 32% from the first calendar quarter of 2015 to the same period in 2016. And Technavio projected PCIe SSD sales will grow at a compound annual growth rate greater than 33% from 2016 to 2020. Use of PCIe SSD products in notebooks will also see dramatic growth. DRAMeXchange expects that 50% of notebooks will have SSDs in 2018. The availability of small form factor PCIe SSD products specifically for notebooks allows smaller devices to deliver big performance. And articles in vertical market publications such as PC Gamer and Photography Life recommend use of the technology, underscoring its performance benefits.

The strengths of PCIe SSD technology are inherent in its design. It starts with the scalability of the PCIe interface. These devices can scale quite substantially by using additional "lanes" for data transfer, which increases total bandwidth. A lane is a link between two devices (commonly the SSD and the system) that creates a bidirectional data stream. Even with these advances, PCIe is compatible with existing operating systems and devices.

An important design difference between SATA and PCIe is the connection type. Simply put, PCIe SSDs are attached to what is effectively the system backplane, while SATA drives are connected via a controller. The backplane provides greater performance through much higher data throughput and lower latency. SATA drives also connect to PCIe backplanes. However, that combines a physical hardware form factor with a software protocol, which slows down the data. In contrast, PCIe is all about electrical signaling.

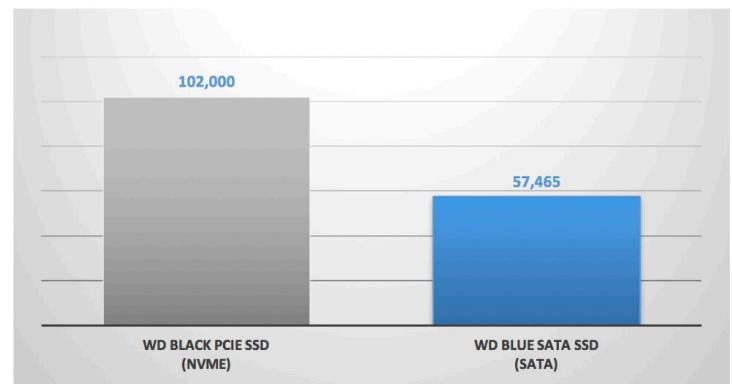
Another drawback is that we have reached the ceiling on SATA performance, which caps out at 600 MB per second. This results in a very real system bottleneck. The introduction of PCIe solutions, however, breaks through these performance barriers. Three generations of PCIe are listed in the table below, with details on how the different implementations perform. The majority of products available today will use the 3.X standard.

Version	Transfer rate	Bandwidth per lane per direction	Total bandwidth for x4 link
PCIe 1.X	2.5 GTps	~250 MBps	~1 GBps
PCIe 2.X	5.0 GTps	~500 MBps	~26 GBps
PCIe 3.X	8.0 GTps	~1 GBps	~4 GBps

**Note:** The SATA interface has higher overhead compared with PCIe 3.X due to different encoding redundancy overhead, 8b/10b encoding vs. 128b/130b, respectively.

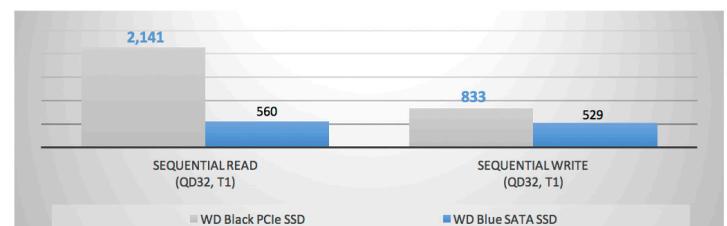
As many new and existing applications use ever-larger data sets, newer and faster storage will have a noticeable positive impact on these workloads. Running tests using standard benchmarks provide a quantifiable measure of the magnitude of the difference between SATA devices and those using PCIe. The charts below show the result of PCMark Vantage tests when they are run on a SATA drive and a PCIe drive.

Figure 1 shows the overall PCMark Vantage score. The speed difference is startling: The PCIe solution provides more than double the overall performance of the SATA device. This means faster loading of applications and data, and overall better system performance.



**Figure 1: Overall PCMark Vantage Score**

Figure 2 looks at sequential performance as measured by PCMark Vantage tests. This data is a good example of performance when a larger file is either read or written. This test is very meaningful, as the size of data files will increase going forward and the ability to read or write this data quickly will have more impact on system performance both now and in the future.



**Figure 2: Sequential Performance (MBps)**

The data from these two tests makes the PCIe advantage even more obvious. The PCIe solution has a more than 400% advantage on sequential reads, a common task when data is brought into the system. Tests by Western Digital (WD) show that copying a 12 GB folder from one SATA SSD to another SATA SSD took an average of 108 seconds but only an average of 68 seconds from one PCIe SSD to another PCIe SSD, an up to 63% improvement.



## HOW PCIe SSD DEVICES PROVIDE REAL USER BENEFITS

The overall design and technology advantages of PCIe are substantial, as are the proven performance benefits as shown in the figures above. However, for many users, what is important is how these advantages impact their specific usage patterns and applications. Four common use cases that benefit from PCIe SSD products follow:

### **PC gamers**

According to *PC Gamer*, an SSD is now an essential component for a gaming PC, and for many gamers, the performance of PCIe has become impossible to ignore. For many current games, the reduced loading times that are possible using a PCIe SSD are very attractive. Based on recent laboratory tests by WD, a PCIe SSD loads up to 23% faster than a SATA SSD<sup>3</sup>. Gamers are also seeing much faster movement between levels, or "chapters," when new data must be loaded into the system. Importantly, PCIe SSD is essential to help plan for systems of the future. As new game releases utilize larger data files and improved graphics create larger data sets, the difference in performance between SATA SSD and PCIe SSD will become only more apparent.

### **Musicians, artists and multimedia specialists**

These users are creative types that push the bounds of technology. But their system of choice must provide the performance and capacity they need so they can focus on the creative process, not the system. These users are now developing more complex, more detailed and higher fidelity output, resulting in much larger files and projects. The ability to manipulate and load these large files faster is an important benefit PCIe SSD delivers. In a recent test published by *Photography Life*, a PCIe SSD provided 25 times the performance of a 7,200 rpm SATA drive using CrystalDiskMark benchmark software. This translates to more uninterrupted focus on creative activities and the ability to quickly access prior or other work when necessary.

### **Designers and engineers**

These users have always been a key part of the overall power user segment. This has not changed as architects, designers, engineers and construction professionals have come to rely on their PCs to an even greater extent. Their need for the highest performance storage solutions is being driven by two key trends. First, average file sizes have increased substantially with the latest versions of applications increasing the number of layers, details and resolution permitted. Second, an increasing amount of collaboration results in larger files as more individuals contribute to specific projects or files. The ability to load new files or versions of a file more quickly saves time and helps boost productivity.

### **The power user**

A more generic group is so-called power users who consistently push the boundaries of performance. A growing number of video-centric users fall into this group, as well as marketing professionals who manipulate large volumes of content or individuals who collect large media files. Data analysts, who are increasingly accessing and manipulating big data, also are in this category. While many of the largest databases with private data will stay on servers, a number of very large files are downloaded for local analysis. Both types benefit from the performance gains from PCIe SSD solutions.

### **WD Delivers on the Promise of PCIe SSD**

WD Black PCIe SSD instills users with the confidence that their PC is ready for the future of high-intensive applications. While the advantages of PCIe SSDs meet both current and future demands for speed and performance, they are also benefitting from other new technologies. For example, motherboard and chipset manufacturers are building products that are NVMe/PCIe compatible, making it easy to optimize SSD performance. Many older systems don't support the latest PCIe interface.

### **Summary**

The demands of the latest generation of applications—which, compared with earlier applications, rely on much larger data sets and the ability to move much more information within systems—are the catalyst for PCIe SSD adoption. The upgrade and migration to SSDs has been underway for more than two years. However, optimizing the speed and performance of these drives requires moving away from devices using the older and slower SATA interface to the latest generation of storage products that utilize the PCIe backplane connection.

The performance of PCIe SSDs is further improved by the transition from the AHCI protocol to NVMe, a specific enhancement for SSDs that takes what is already excellent performance and brings it up a notch. For many users, improving performance levels and ensuring their existing systems will continue to meet their needs into the future makes the PCIe SSD with NVMe the right choice.

<sup>3</sup>Based on WD internal testing; WD Black PCIe SSD vs. WD Green SSD.