



COMPARING THE PERFORMANCE OF HDD, SSD AND NVME STORAGE DEVICES

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HARD DISK DRIVES

- Electro-mechanical data storage device that uses magnetic storage to store and retrieve digital information.
- One or more rigid rapidly rotating disks coated with magnetic material.
- Hard disk drives have been around for more than 50 years.
- Over that period, their storage capacity were increased while decreasing their physical size.



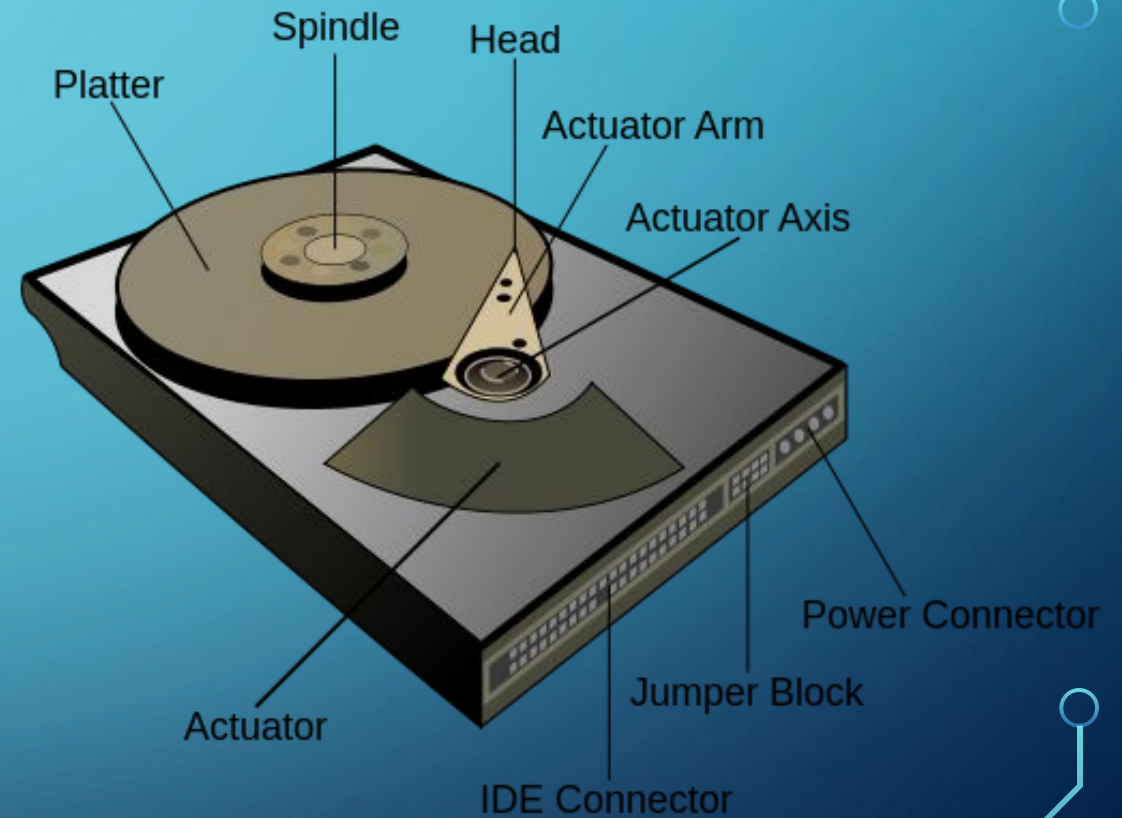
HDD (CONT'D)

- HDDs rely on spinning disks, or platters, to read and write data.
- There is a moving disk (platter) and a large header that can read data and write off of them as the disk spins.
- Mechanical Hard Disk, are slower and cheaper than other storage types.
- Have moving parts.
- Works similarly to an old record player.



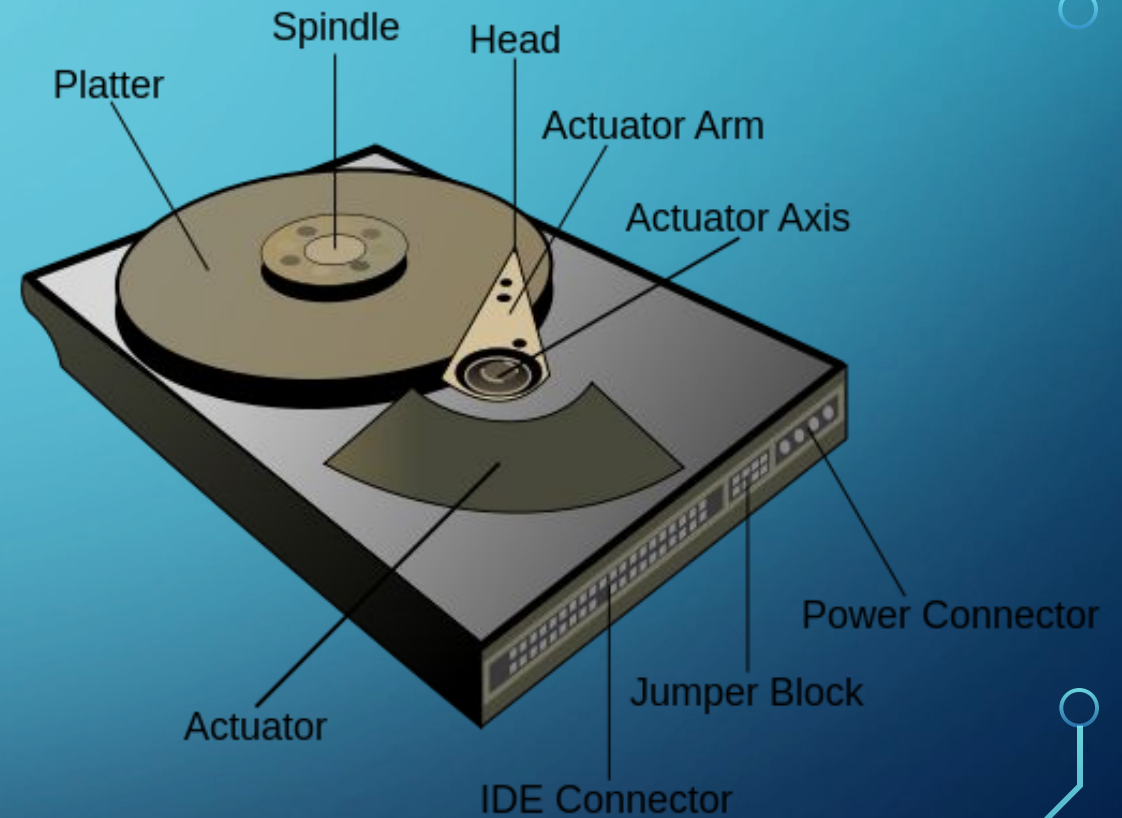
DESIGN

- A typical HDD design consists of:
 1. A spindle that holds flat circular disks.
 2. Platters, which hold the recorded data.
 3. A header that can read/ write data as the disk spins.
- Platters are made from a non-magnetic material (aluminum alloy, glass, or ceramic).
- It is coated with a layer of magnetic material typically 10–20 nm in depth.
- With an outer carbon layer for protection.



DESIGN (CONT'D)

- The platters in modern HDD are spun at speeds varying from 4,200 to 15000 rpm.
- Information is written/ read from a platter by a device called read-and-write heads.
- They are positioned so close to the magnetic surface (tens of nms away) for detecting and modifying the magnetization of the material passing immediately beneath it.
- An actuator arm moves the heads on an arc, covering almost the entire surface of the platter as it spins



HDD (CONT'D)

- Typically, the faster the hard drive spins (7200 RPM, 10,000 RPM, etc.), the faster the storage drive can be read.
- Modern HDDs are 3.5-inch for desktops, and 2.5-inch for laptops.
- Unfortunately, there is a limit to how fast a hard drive can read the data.
- There's also a latency that comes with waiting for the head to physically move.
 - Recalling that mechanical parts presents a drawback in any electronic system.
- Bigger and heavier, more fragile than other types.

IMPROVEMENT OF HDD CHARACTERISTICS OVER TIME

Parameter	Started with (1957)	Developed to (2019)	Improvement
Capacity (formatted)	3.75 megabytes ^[16]	16 terabytes ^[17]	4-million-to-one ^[18]
Physical volume	68 cubic feet (1.9 m ³) ^{[c][6]}	2.1 cubic inches (34 cm ³) ^{[19][d]}	56,000-to-one ^[20]
Weight	2,000 pounds (910 kg) ^[6]	2.2 ounces (62 g) ^[19]	15,000-to-one ^[21]
Average access time	approx. 600 milliseconds ^[6]	2.5 ms to 10 ms; RW RAM dependent	about 200-to-one ^[22]
Price	US\$9,200 per megabyte (1961) ^[23]	US\$0.032 per gigabyte by 2015 ^[24]	300-million-to-one ^[25]
Data density	2,000 bits per square inch ^[26]	1.3 terabits per square inch in 2015 ^[27]	650-million-to-one ^[28]
Average lifespan	c. 2000 hrs MTBF ^[citation needed]	c. 2,500,000 hrs (~285 years) MTBF ^[29]	1250-to-one ^[30]

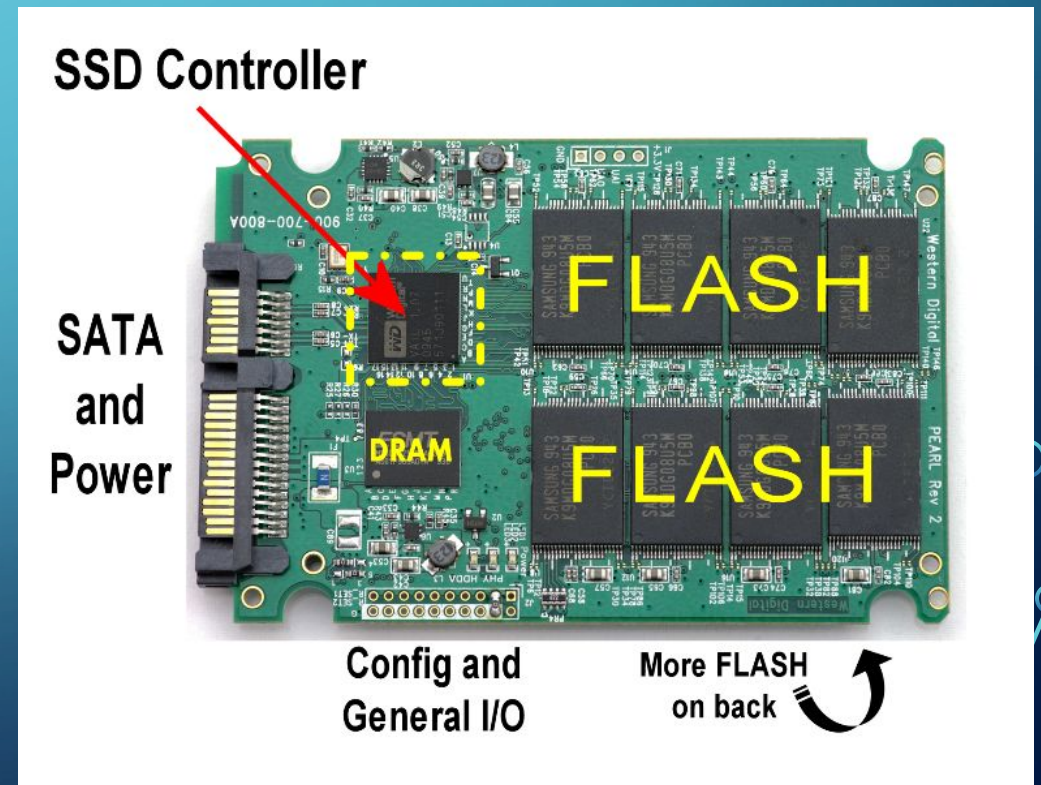
SOLID-STATE DRIVERS (SSD)

- Does not have moving parts !
- Use semiconductor chips to store and access memory.
- An SSD has a huge array of semiconductors that can be charged or uncharged.
 - the computer will read as a '1' or '0' in binary and convert that to actual files or data.
- Non-volatile behavior.
 - retain their charged or uncharged state even after



CHARACTERISTICS

- Two major components: controller & memory model.
- The primary memory component in an SSD was traditionally DRAM volatile memory, but since 2009 it is more commonly NAND flash non-volatile memory.
- The controller bridges the NAND memory components to the host computer.
- A non-volatile NAND flash memory is used in the construction of SSDs.
 - Lower cost compared with DRAM.
 - Ability to retain the data without a constant power supply, ensuring data persistence through sudden power outages.



ADVANTAGES

1. Higher Speed (500 MB/s vs 30-150 MB/s for HDD).
2. Low I/O latency (20 ms vs 400-500ms for HDD)
3. Virtually no access time (0.1 ms vs 5.5-8 ms of HDD).
4. Higher durability (shock-resistant).
5. Less power consumption (2-5 Watts vs 6-15 Watts of HDD).

•DISADVANTAGES:

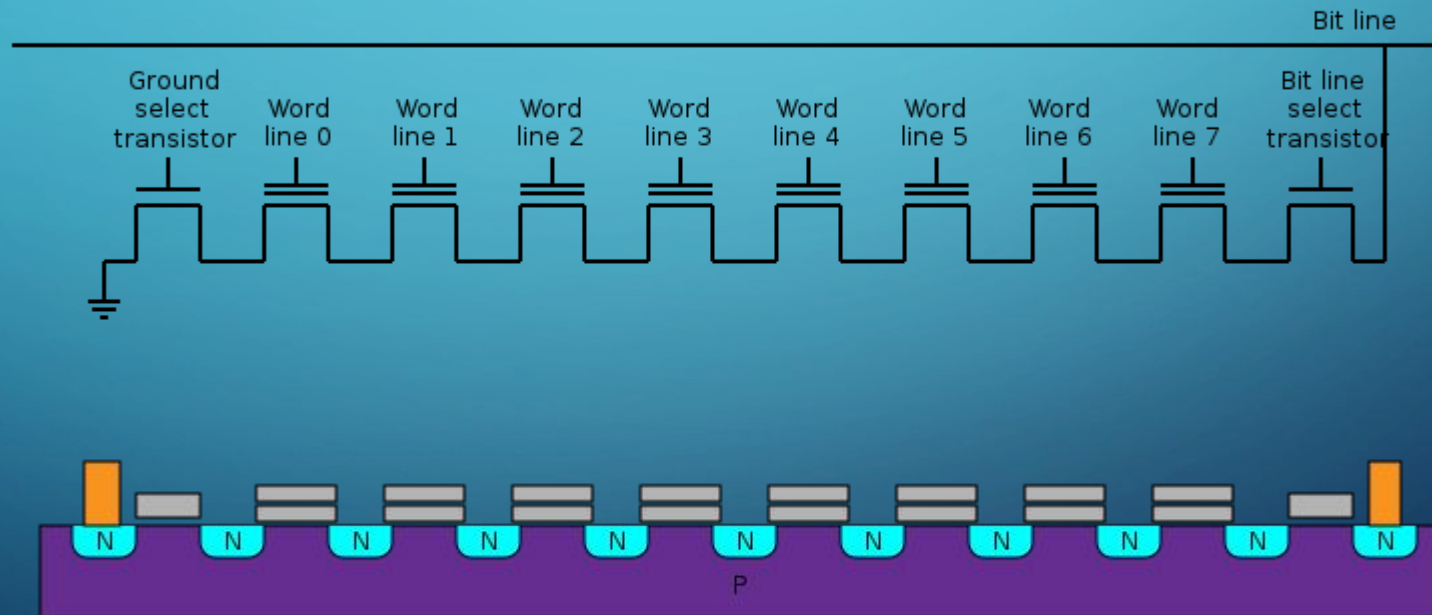
1. Costlier (1.5 times more expensive than HDD).

WEAR LEVELING

- Block wearing occurs when a certain block is programmed and erased repeatedly more often than other blocks.
- In this case the block will wear out before other blocks.
 - Thereby prematurely ending the life of the SSD.
- For this reason, SSD controllers use a technique called **wear leveling** to distribute writes efforts as evenly as possible across all blocks in the SSD.
- Also, modern SSDs contain spare cells that will replace cells that go bad.
 - Called bad block management, and it's why the larger the SSD, the longer its lifespan.

NAND FLASH

- NAND flash uses floating-gate transistors connected in a way that resembles a NAND gate.
- Several transistors are connected in series, and the bit line is pulled low only if all the word lines are pulled high



NON-VOLATILE MEMORY EXPRESS (NVME)

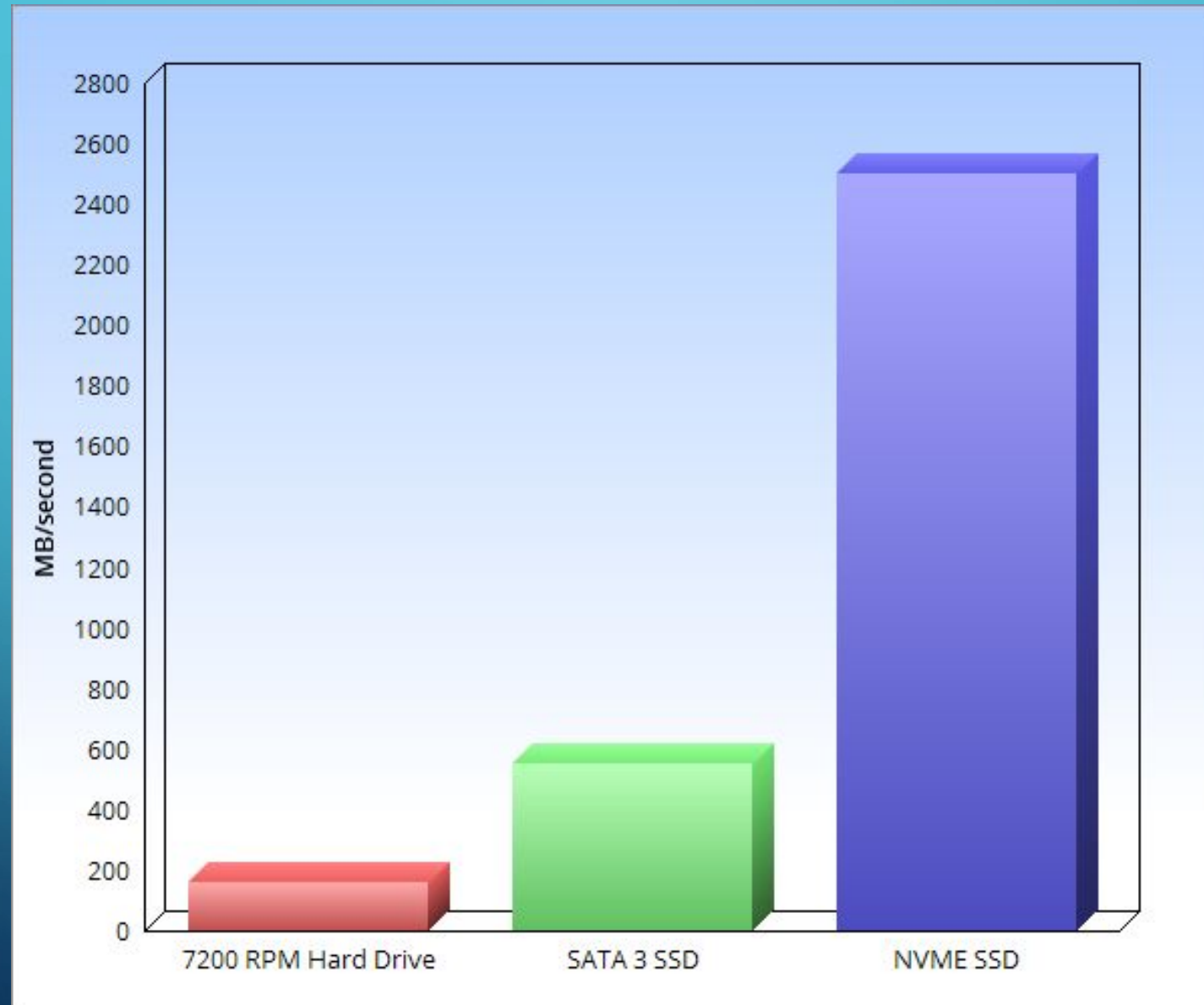
- It is a new protocol for accessing high-speed storage media that brings many advantages compared to legacy protocols.
- Efficiently support the needs of enterprise and client systems utilizing PCI Express (instead of SATA) solid state drives.
- Very useful for larger file transfers.
- SSDs are very fast as pre-stated.
- However, their only limitation is the SATA III connection that hard drives

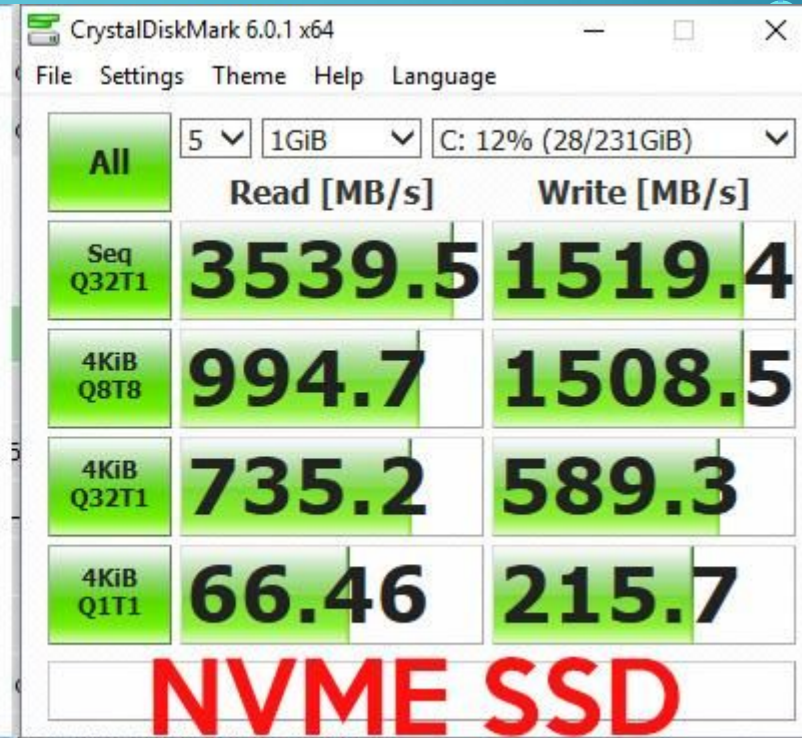
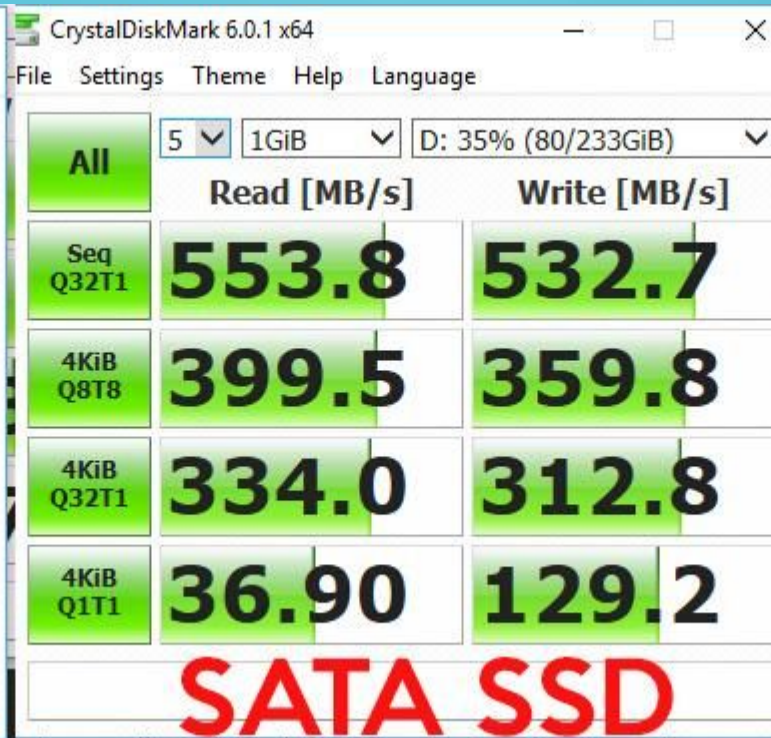
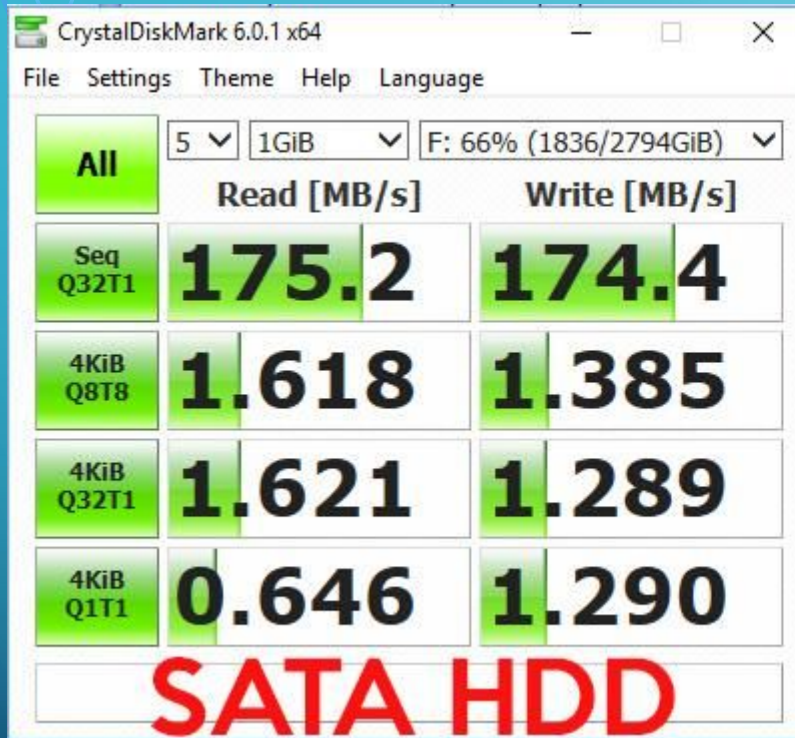


DEFINITION

- NVMe is an open standard developed to allow modern SSDs to operate at the read/write speeds their flash memory is capable of.
- PCIe interfaced rather than going through the slower SATA.
- It is a description of the bus the component used to communicate with the PC, not a new type of flash memory (still SSD).
- As stated previously, the throughput of the normal SATA III SSD is 500 MB/s.
- However, NVMe drives, on the other hand, provide write speeds as high as 3500MB/s.

STORAGE PERFORMANCE COMPARISON





Read/ Write speed comparison among HDD, SATA SSD
& NVME SSD

SUMMARY

- NVMe's are only useful for those larger file transfers.
 - When large files are transferred regularly (ex. for photo and video editing).
- Otherwise, a standard SATA 3 SSD is still considered because a much bigger size can be gained for the same price.
- Also, for gaming, both NVMe and SATA 3 will offer very similar boot speeds.
- They are both so fast that other hardware, such as RAM and CPU performance, ends up being the bottleneck.
- And of course, all of those are much faster than the traditional spinning

QUESTIONS?

