National College of Ireland

Data Storage and Management

Project A

# Report on Utilization of SSDs in big data and predictive analytics

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## Abstract:

Big data applications handle large amount of datasets, challenges come in the way when scaling comes into picture. Companies need fast processing throughput of the data, that requires low latency and high IOPS, SSD seems a good match for it. SSD are being used because they offer high performance and low power consumption than HDDs. In this paper we will see utilisation of solid state device in big data and predictive analytics.

## Introduction:

To stay competitive, each and every company whether it is a small scale or large scale should be able to figure out how to leverage huge amount of raw data that is being generated every other day. Big data is not a buzz word anymore, every decision that a company makes will be data driven. To harness the power of big data and analytics, companies need to have an IT infrastructure, storage and network element where they can be able to handle complex, large and continuous datasets. To process big data, high performance storage systems are in high demand. Currently, till now most of the storage systems which are designed for high speed data processing is made on hard disk drives (HDD). For processing large of amount data, HDDs consumes high power consumption and low random access performance. Also, emerging trends like Internet of things, data mining, online transaction processing and edge computing we saw a need for SSDs.

## SSD Innovation:

**NAND**: It is a type of non-volatile data where the data does not wipe out even if the power is gone. In the neophyte stage of the SSD innovation, the manufacturers had reduced the size of the data cells so that they can increase the density in 2 dimensions while simultaneously lowering cost/gigabit (Robb, 2018).
**SLC, MLC and TLC:** Single level cell (SLC) with 1bit/cell were followed by multilevel cell (MLC) and 3 level (TLC) designs. As the cells continued to shrink, the performance came down. Due to this and many other factors, future prospects looked dull (Robb, 2018).
**3 Dimensions:** Flash moved from 2 dimensions to 3 dimensions, the 3D NAND of Vertical NAND (V-NAND) flash chips stack layers of cells vertically, empowering massive leaps in density, faster read/write times and greater tolerance(Robb, 2018).
**Persistent Memory (PMEM):** Here the read write processes is faster and more efficient and it enables data being written in smaller sizes. After this **SCM** came into picture, it claims to be 1000 times faster than the traditional flash(Robb, 2018).
**NVMe:** Non-volatile memory express reduces latency, it boosts input/ouput operations and reduces the power consumption (Robb, 2018).

## Utilisation of solid state Flash storage in big data and predictive analysis:

In a data warehouse where all the data is being forced into the warehouse without examining the data, localized processing can be done using distributed big data processing nodes so that it can release the architectural stress. Now question comes into picture which storage technology should be used HDD or SSD. SSD has an upper hand because it offers high input/output per second (IOPS), high speed and high sequential read and write speeds.

It is very tempting to replace HDD with SSD in a big data, but to do that it would be very expensive. It will be better if it is used wherever it is necessary to save on system cost (Harbaugh, 2018).

**A Study performed by Cloudera Team** (Kambatla and Chen 2014):
Almost all computing tasks fall in two categories which are Input/output intensive or compute intensive. A team of Cloudera did an experiment to study MapReduce workload by deploying one SSD versus HDDs to approximate the equivalent theoretical total sequential write/read bandwidth, isolating performance differences.

Hadoop clusters which were using SSD surpassed HDD clusters by the margin of 70% under few workloads. SSDs achieved lower latency with twice the actual sequential input/output size. Bigger files are chopped into small files that means sequential access will not be the factor that will limit, this is what Hadoop's purpose is to achieve (Kambatla and Chen 2014).

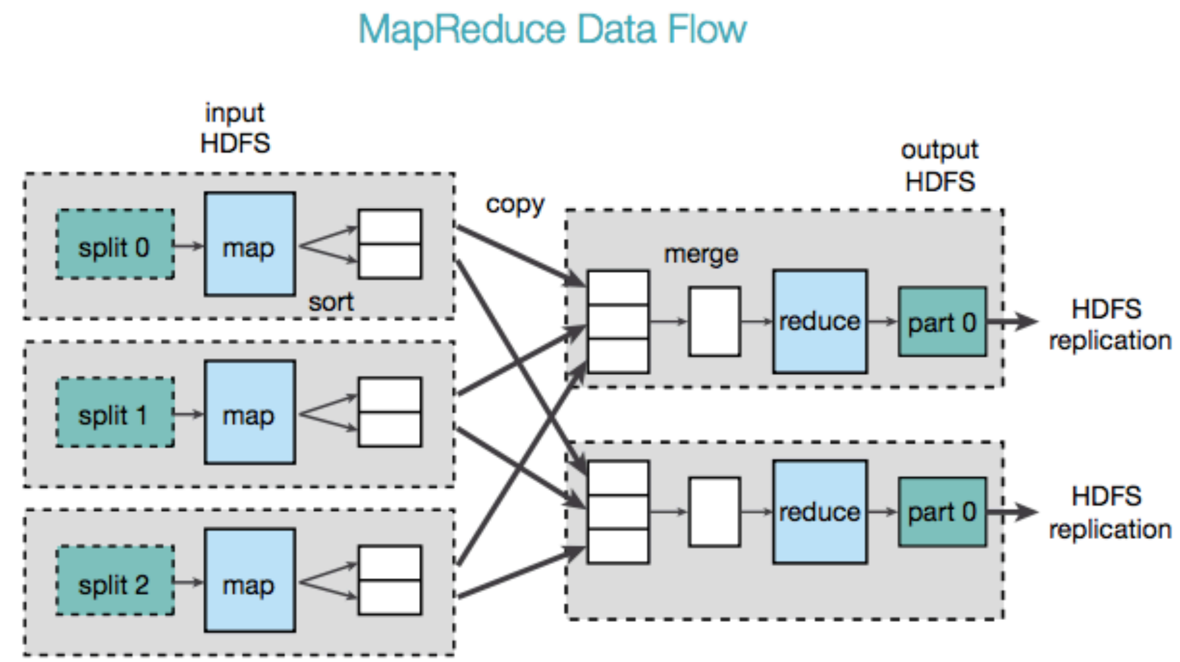


Fig.1 Mapreduce Data flow (Harbaugh 2018)

There are three stages in MapReduce: Map, shuffle and Reduce. In shuffle stage of MapReduce, the results which are obtained by performing the shuffle operations are stored in a single file on the local disk. Using mapred.local.dir parameter when the shuffle results which were obtained to SSD the performance skyrockets. It also increases the Write/Read scheduling. Combining HDD with SSD is most cost effective solution for Hadoop performance. It will be ideal for compute intensive workloads to use the new PCIe SSDs using NVMe protocol, this will be helpful in processing the real time data such as IOT sensor data. Also, it will be helpful for Hadoop to schedule jobs if the storage latency is removed (Harbaugh, 2018)

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Every company relies on hundreds of software to run a business, so whenever there is a delay or failure it can directly impact the business of the company. Due to this projects come on a standstill and call centers experience backups. Storage is a part of problem and the solution. So taking the help from advancement of predictive analytics and flash storage, the issues can be detected beforehand. This what HPE Nimble Storage is trying to do to solve this issue (Furlong, 2018).

## Non-volatile memory Express (NVMe) (Gupta, 2018):

Non-volatile memory Express (NVMe) is the new access standard for PCI Express SSDs. It is a protocol especially built for SSDs to retrieving high-speed storage media and it functions across PCIe bus to transfer data back and forth to and from SSD (Gupta, 2018).
NVMe takes advantage of the SSDs ability to read or write lots of things at once by parallelizing instructions. It works like a multi-core processor that can split certain workloads over multiple cores in order to get things done faster.

**NVMe Architecture:**
NVMe achieves high performance and low latency. It can have multiple input/output queues upto 64 thousand with each and every queue having 64 thousand entries. Whereas SATA and SAS can support only single queues and SATA have 32 entries and SAS can have 254 entries.

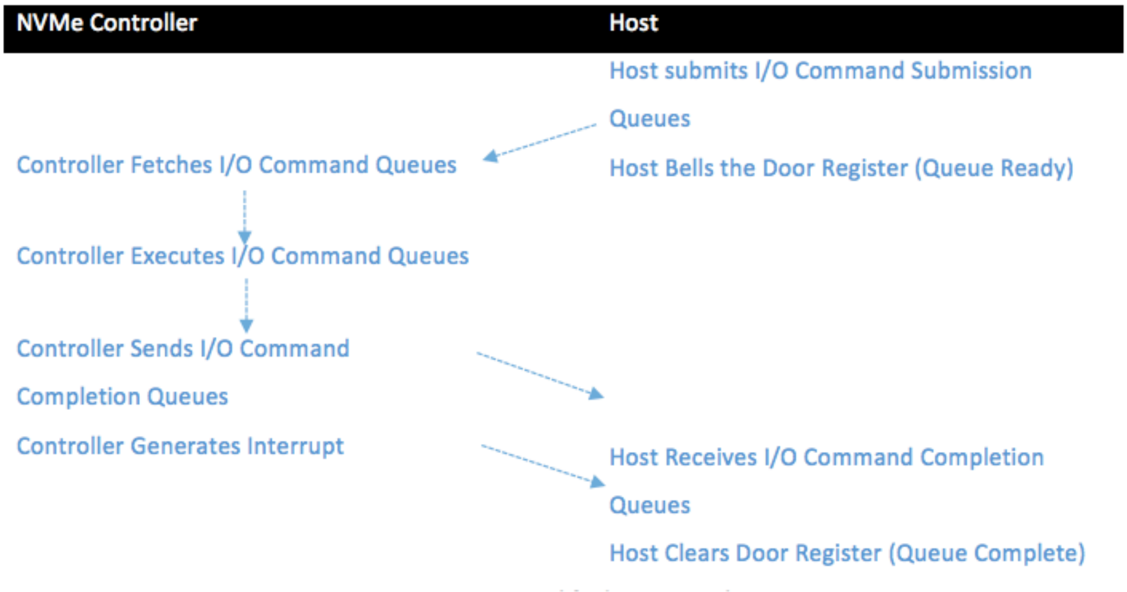


Fig. 2 NVMe Architecture Harbaugh, L. (2018)

The figure above shows the communication between NVMe controller and Host. The architecture explains that architecture allows applications to start, execute and finish multiple input/output request at the same time. Also, at the same time use the beneath media platform efficiently to maximise the speed and minimum latency. As seen the figure above the host writes Input/output command queues and the doorbell registers the command. NVMEs controllers grabs them and process it and sends completed queues followed by an interrupt to host. The host notes down thee I/O command queues and clears door register (Gupta, 2018).

## SATA SSDs versus NVME SSDs

A lot of common tasks on an SSD might seem nearly instantaneous especially for users migrating from a mechanical hard drive but if a user is working with larger files or hitting at the drive with lots of requests at once Here in this scenario although SATA SSDs will still give better performance in these situations than the old spinning hard drive did. It are limited in a couple of ways: 1) SATA has an upper transfer limit about 600 megabytes per second, flash storage technology used in SSDs has been capable of much faster speeds for quite a while but because of the SATA speed limit even top-end SATA 3 drives will not give speed higher than 600 megabytes per second. 2) SATA drives communicate with the rest of the computer using a standard called the advanced host controller interface (AHCI) or a HCI. HCI was not designed with keeping SSDs in the mind, it was a way to make mechanical hard drives work a bit faster and enable features like hot swapping.

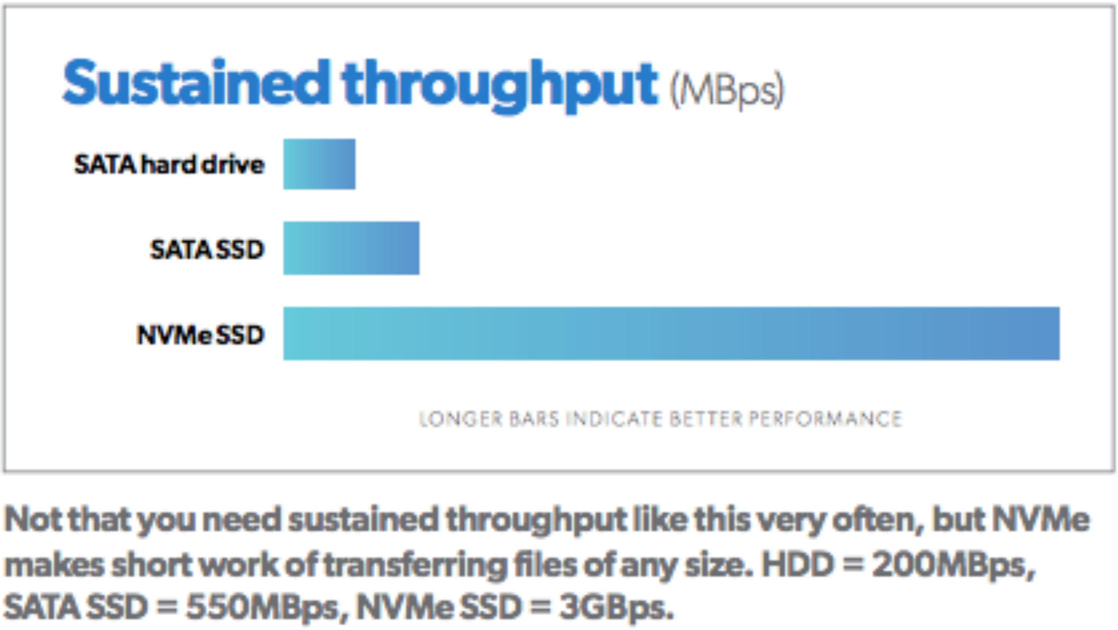


Fig.3 NVMe throughout in MBps (Jacodbi, 2018)

But, HCI was optimized for slow read/write heads that can only deal with so much data at a time. It is not that SSDs are capable of accessing tons of their own data at once, drive manufacturers rolled out SSDs that use the much faster PCI Express bus which has a speed limit of nearly 3 gigabytes per second with an x4 card and connects more directly to the CPU than SATA reducing latency. But, in order to reach their potential they needed a faster way of accessing data than a HCI.

The biggest difference between NMVe and AHCI is command queuing which refers to how many requests for data a drive can handle at one time. HCI can handle one queue at a time with up to 32 pending commands, a sensible number for a hard drive with a slow moving head. But, very inefficient for a faster SSD NVMe relieves this bottleneck by providing over 65,000 queues that can handle over 65,000 commands each. The cost of NVME is really high as compare SATA but it slowly and steadily the cost of NVMe is decreasing. Despite its heavy price tag enterprises are using it take out blistering performances out of their storage. The reliability of SDDs are high as they do not have any mechanical parts.

## Conclusion:

As the data is increasing day by day, companies are always in search for peak capacity storage devices with a decent price tag. SSDs which are connected to traditional legacy storage protocols can experience high latency and lower performance. As SATA interface is becoming bottleneck the new NVMe standard is helping the SSD performance to next level. For high demanding and compute intensive enterprise, NVMe is the only protocol that stands out and the SSD value proposition will continue to strengthen in the future.

## References:


Robb, D. (2018) 'SSD and Flash in Enterprise Storage Environments' *Enterprise Storage*. [online] Available at: https://www.enterprisestorageforum.com/storage-hardware/ssd-in-enterprise-storage-environments.html [Accessed 21 Dec. 2018].

Jacodbi, L. (2018) 'NVMe SSDs: EVERYTHING YOU NEED TO KNOW ABOUT THIS INSANELY FAST STORAGE', *PCWorld*, 36(9), p93-98.

Harbaugh, L. (2018) 'Big Data SSD Architecture: Where SSD Performance Pays Off', *Samsung Business Insights*. Available at: https://insights.samsung.com/2016/02/23/big-data-ssd-architecture-digging-deep-to-discover-where-ssd-performance-pays-off/ [Accessed 20 Dec. 2018].

Kambatla, K. and Chen, Y. (2014) 'The Truth About MapReduce Performance on SSDs', *USENIX*, pp.118-126. Available at: https://www.usenix.org/conference/lisa14/conference-program/presentation/kambatla [Accessed 20 Dec. 2018].

Gupta, R. (2018) 'What is NVMe™ and why is it important?, *Western Digital,* 6 February. Available at https://blog.westerndigital.com/nvme-important-data-driven-businesses [Accessed 21 December].

Furlong, J. (2018) 'Flash Storage & Predictive Analytics: A Winning Combination', *Insight*. Available at: https://www.insight.com/en_US/learn/content/2018/02272018-flash-storage-and-predictive-analytics--a-winning-combination.html [Accessed 21 Dec. 2018].