

Will SSD replace HDD?

Scott Kipp

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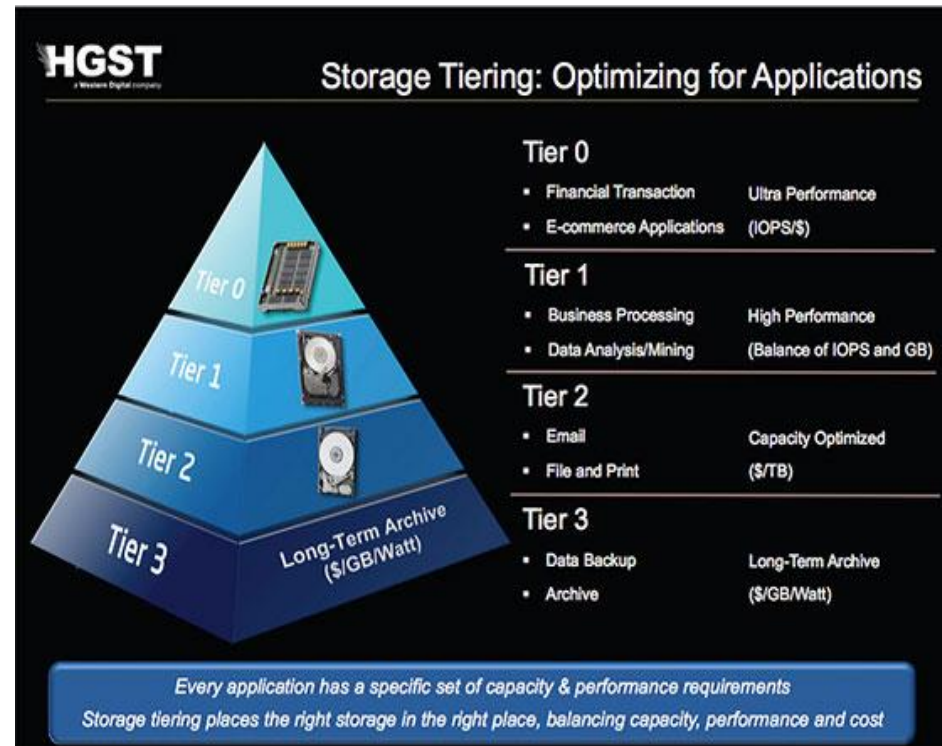
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SSD vs HDD

HDD the workhorse of data storage

- The battle for storage has been going on for decades with hard disk drives (HDD) dominating because of cost and capacity
 - Tier 0 is Flash or SSD
 - Tier 1 is Latency HDD
 - Tier 2 is Capacity HDD
 - Tier 3 is tape or virtual tape
- Solid State Disk (SSD) has made incredible gains over the last decade to challenge HDD
 - Some analysts predict a quick demise of disk drives
- Let's investigate

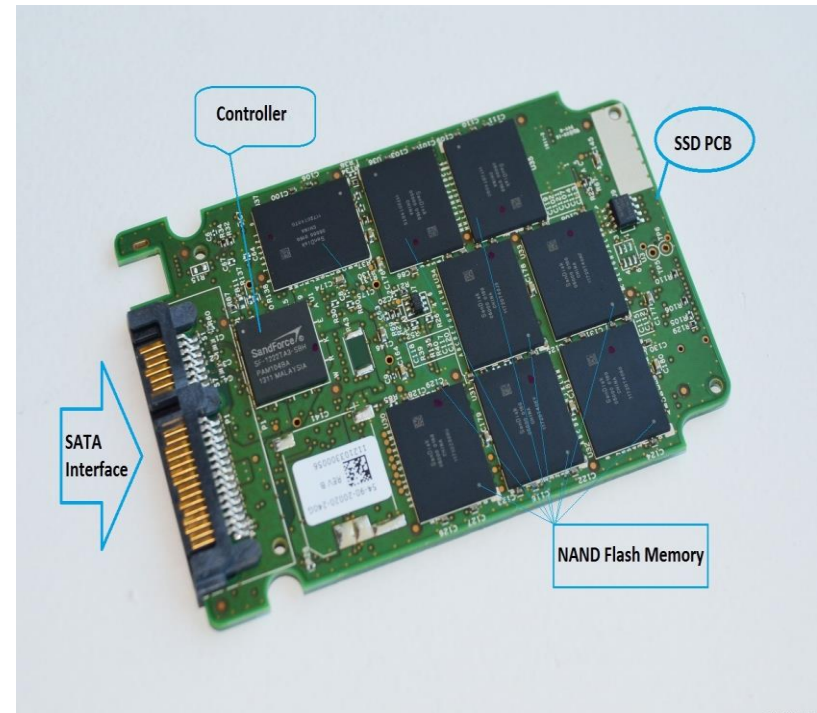


SOURCE: HGST

Two Drive Types

HDD have only moving parts in compute chain besides cooling

- Hard Disk Drives (HDD) are the workhorse of data storage
- Solid State Drives are touted as the revolutionary technology to replaced HDD



Ways to Compare SSD and HDD

- Capacity
- Cost
- Throughput
- IOPs
- Latency
- Market Share

HDD Capacity

Capacity Drives often 3.5" while Latency Drives are 2.5"

- HDD Capacity is determined by the Capacity/disk and the number of disks
- HDD can hold up to 10 disks, but usually a few disks
- Each 2.5" disk can support up to 1TB¹
- Record currently is 10TB
- 20TB HDD by 2020²

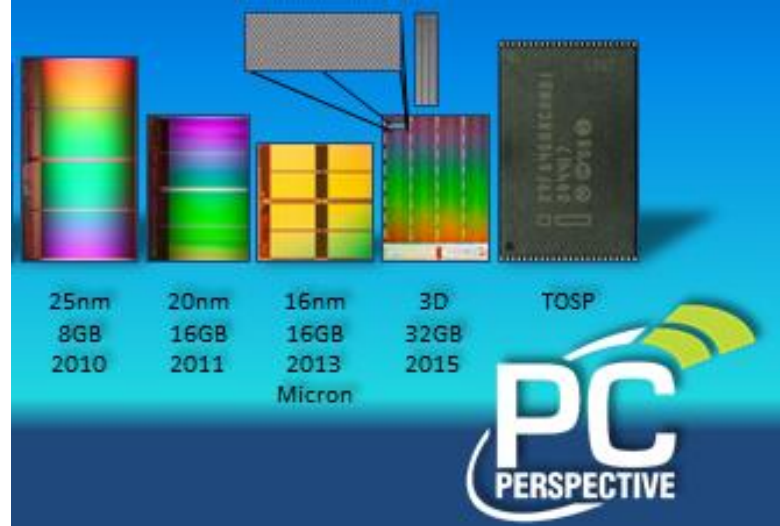


SOURCE: 1. [HTTP://WWW.STORAGENEWLETTER.COM/RUBRIQUES/HARD-DISK-DRIVES/GOOD-JOB-FOR-SEAGATE-2-5-INCH-HARD-DISK-PLATTER-AT-1TB/](http://www.storagenewsletter.com/rubriques/hard-disk-drives/good-job-for-seagate-2-5-inch-hard-disk-platter-at-1tb/)

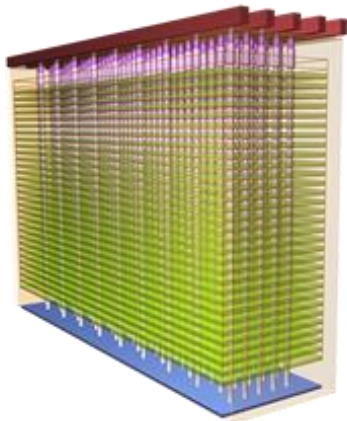
2. [HTTP://WWW.COMPUTERWORLD.COM/ARTICLE/2604311/COMPUTER-HARDWARE/WD-LEAPFROGS-SEAGATE-WITH-WORLD-S-HIGHEST-CAPACITY-10TB-HELIUM-DRIVE-NEW-FLASH-DRIVES.HTML](http://www.computerworld.com/article/2604311/computer-hardware/wd-leapfrogs-seagate-with-world-s-highest-capacity-10tb-helium-drive-new-flash-drives.html)

Flash Chip Capacity

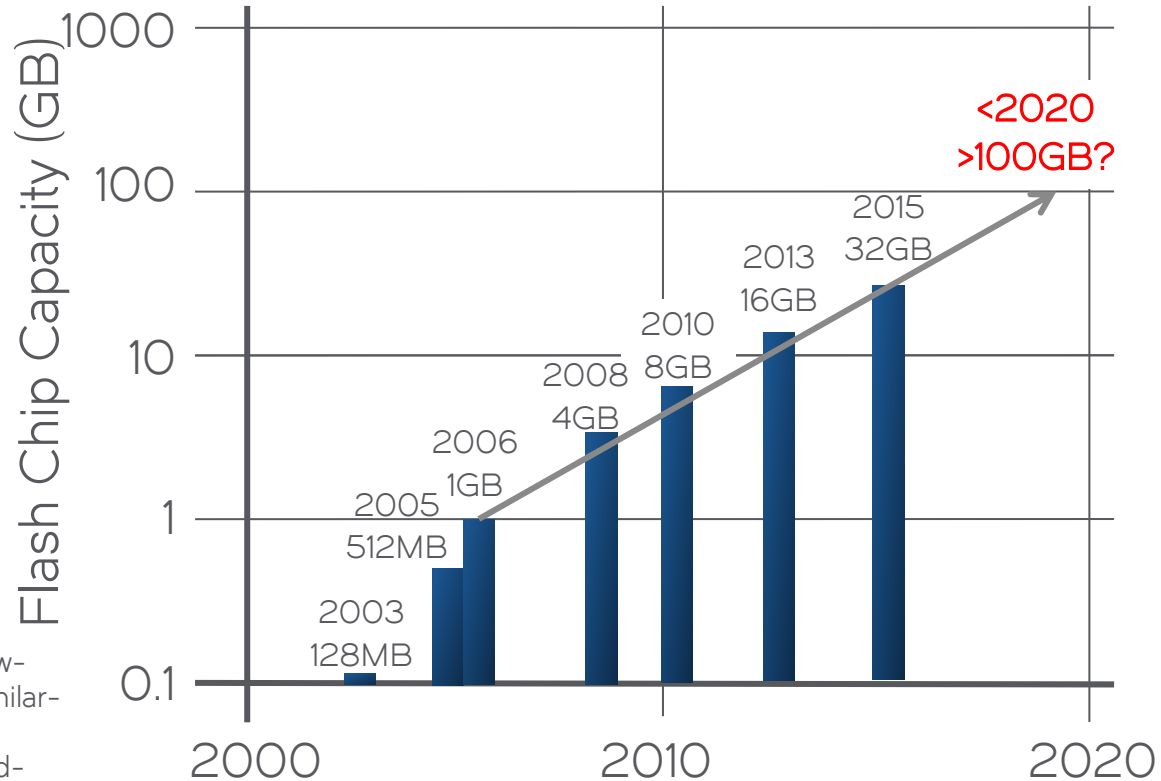
Doubling Capacity Every Couple Years



- 3D NAND technology doubling capacity to surpass HDD¹
- 48 layer SSD Chip now in development²



48 Layer
3D NAND



1. <http://www.pcmag.com/reviews/Editorial/Intels-new-3D-NAND-will-cost-less-may-offer-effectively-similar-write-speeds>

2. <http://www.storagenewsletter.com/rubriques/solid-state-ssd-flash-key/special-report-on-flash-memory-summit-2015/>

SSD Capacity Record

- SSD Capacity is determined by the Capacity/die and the number of die
- SSD can hold up to 500 die¹
- Each die can support up to 32GB¹
- Record currently is 8TB
- 16TB HDD in 2016¹
- Surpassing HDD Capacity next year!

14 chips visible
Multiple die/chip
Up to 500 die/SSD



SOURCE: 1. [HTTP://ARSTECHNICA.COM/GADGETS/2015/08/SAMSUNG-UNVEILS-2-5-INCH-16TB-SSD-THE-WORLDS-LARGEST-HARD-DRIVE//](http://arstechnica.com/gadgets/2015/08/samsung-unveils-2-5-inch-16tb-ssd-the-worlds-largest-hard-drive/)

Capacity and Cost Comparison

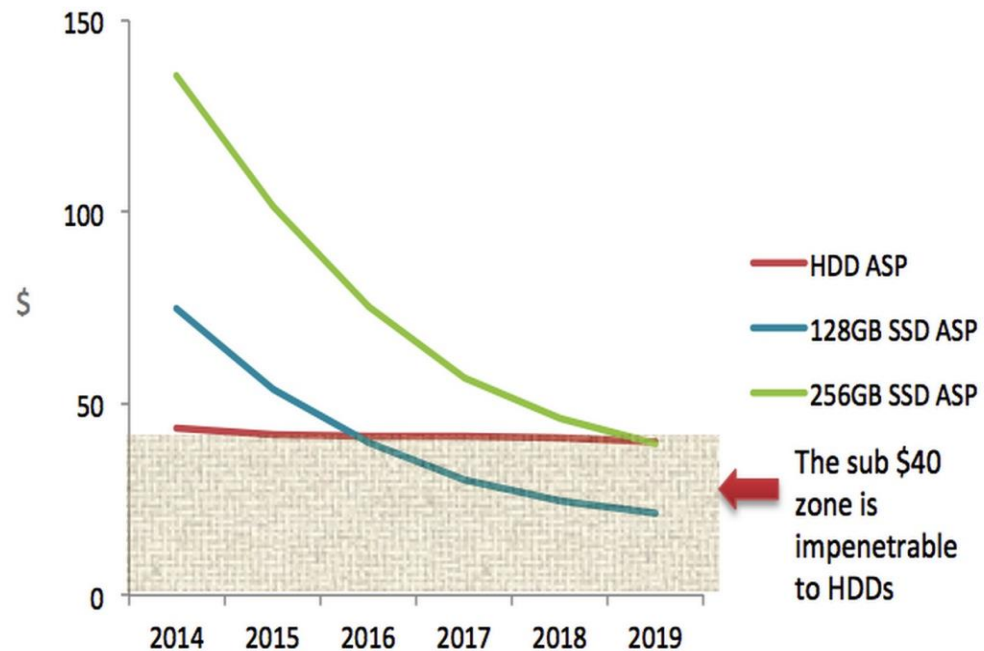
- While SSD is setting records for capacity, most HDD have significantly higher capacity than SSD
- Multi-Terabyte HDD readily available
- Most SSD under 1TB because of cost, but that could change with 32GB dies becoming common next year
 - 20 32GB chips would give you a 6.4TB SSD
- Where is cost going?

- Amazon search:

	SSD	HDD
120GB	\$48	\$20
250GB	\$98	\$22
500GB	\$165	\$49
1TB	\$345	\$53
2TB		\$79
4TB		\$135

IDC Analysis

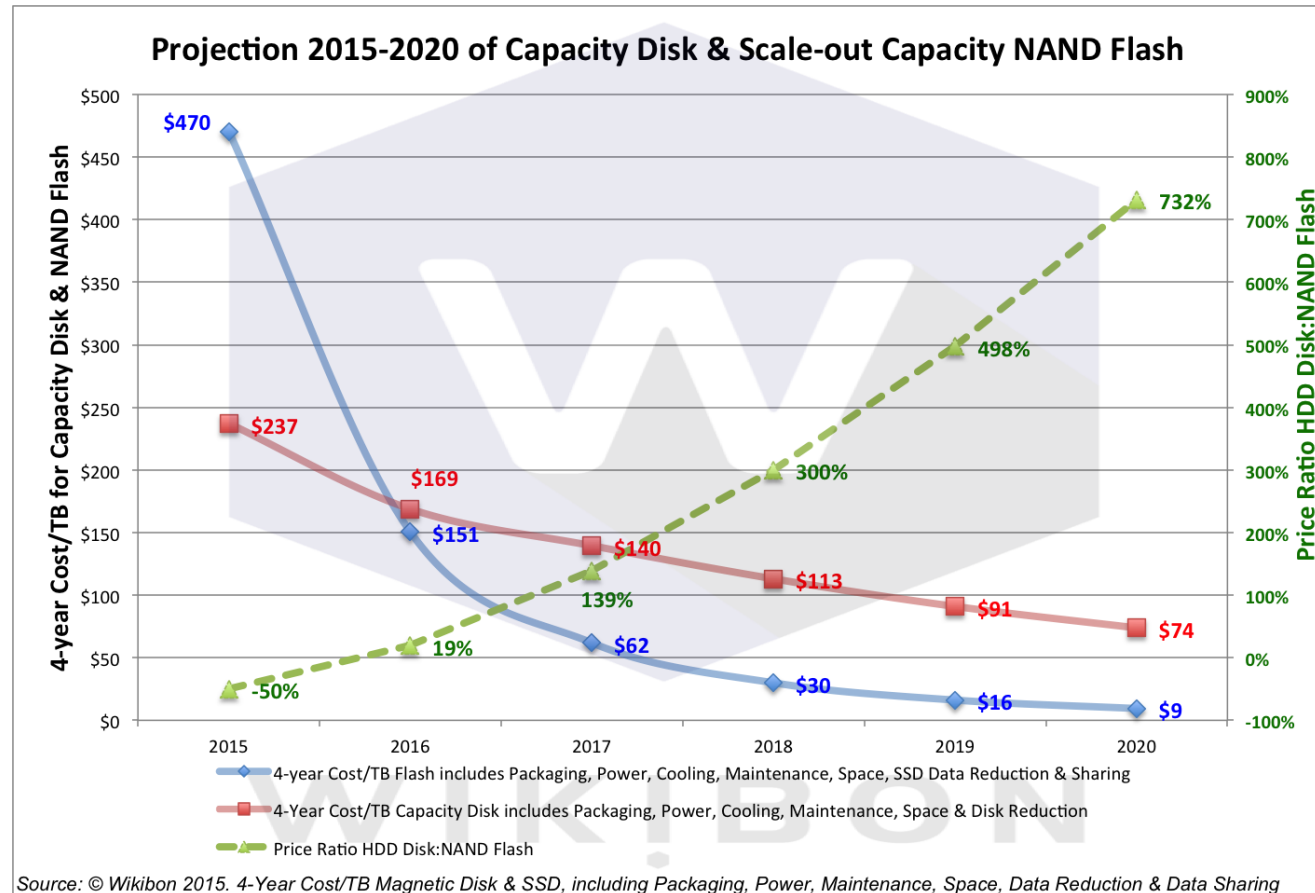
- The \$40/limit has been broken – see previous slide
- SSD is on trajectory to dominate low capacity applications



Source: IDC, Worldwide Solid State Drive Forecast, 2015-2019, doc #256038, May 2015

Wikibon Analysis

- TCO could be lower with NAND Flash All Flash Arrays (AFA) if you consider the power savings and performance gains due to Flash
- Flash doesn't need to be limited to SSD



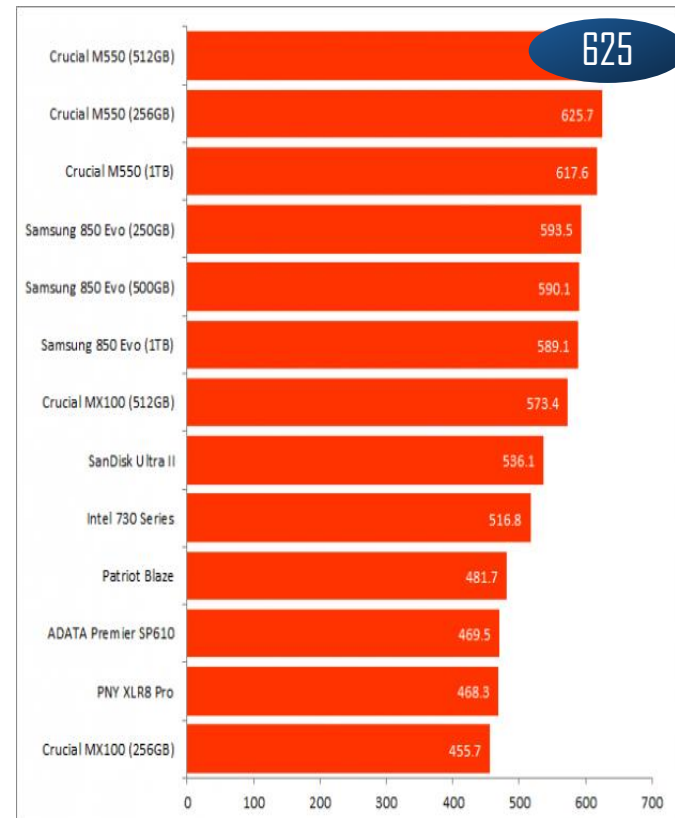
Throughput Comparison

Large File Test – Read Write Average Test

- HDD up to 262 MB/s (2 Gb/s)
- SSD up to 625MB/s (5 Gb/s)



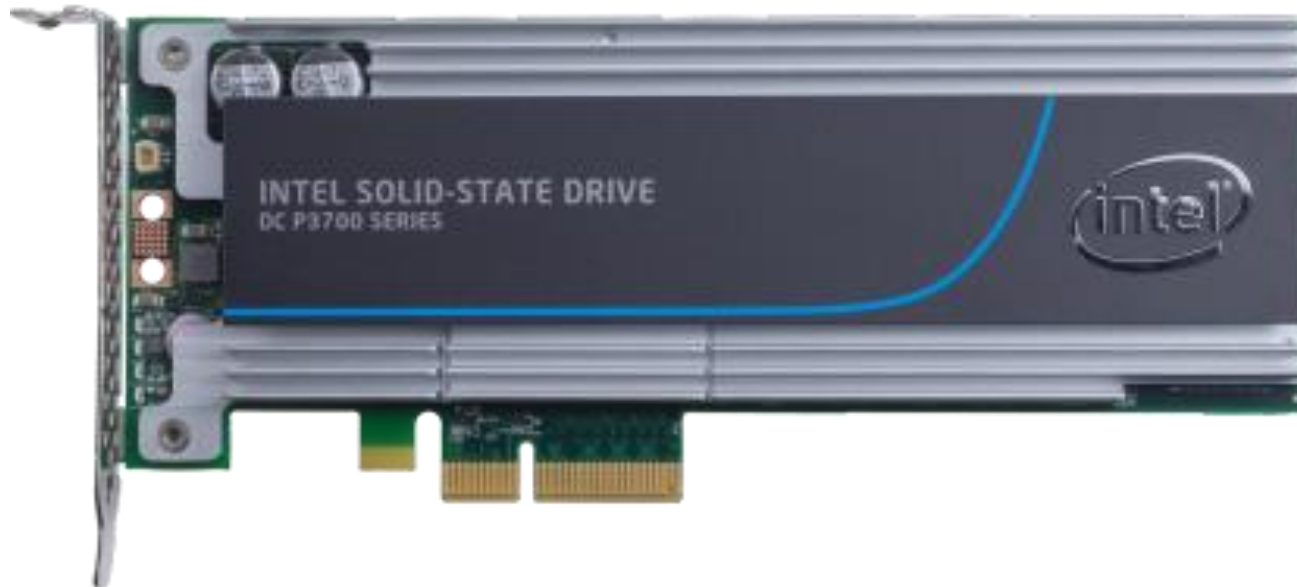
Source: <http://www.expertreviews.co.uk/storage/internal-hard-drives/1402655/best-hard-drive-2015-the-top-hdds-for-speed-and-price>



<http://www.expertreviews.co.uk/storage/ssds/1402654/best-ssd-2015-buying-guide-and-all-the-top-picks>

Performance SSD and AFA

- Intel is delivering up to 2.8 GB/s or 22.4 Gb/s on a PCIe SSD



IOPS and Latency Comparison

- Disk Drive performance is often measured in Input/Output Operations Per Second (IOPS)
- SSD and All Flash Arrays (AFAs) really shine in the IOPS category
- Latency is a key factor that affects IOPS
 - Seek Latency
 - Rotational Latency

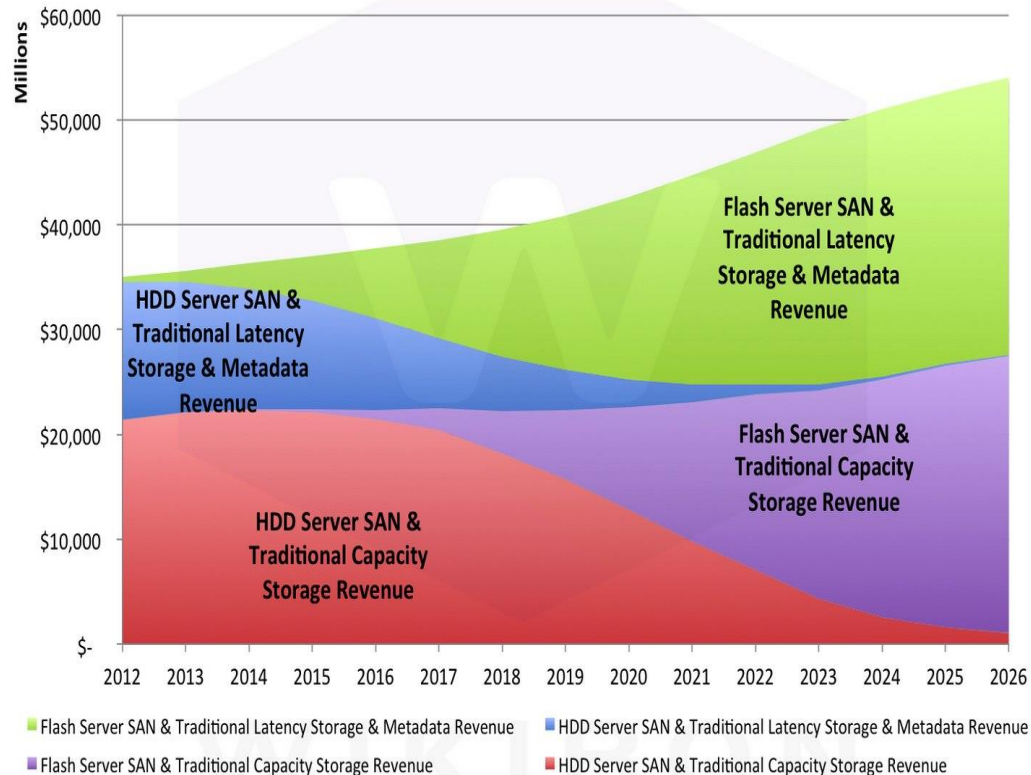
	HDD	SSD	AFA
IOPS	100s	1,000s	>1,000,000
Seek Latency	0.2-0.8mS	0.1mS	0.1mS
Rotational Latency	2-7 mS	0mS	0mS

[HTTPS://EN.WIKIPEDIA.ORG/WIKI/IOPS](https://en.wikipedia.org/wiki/IOPS)

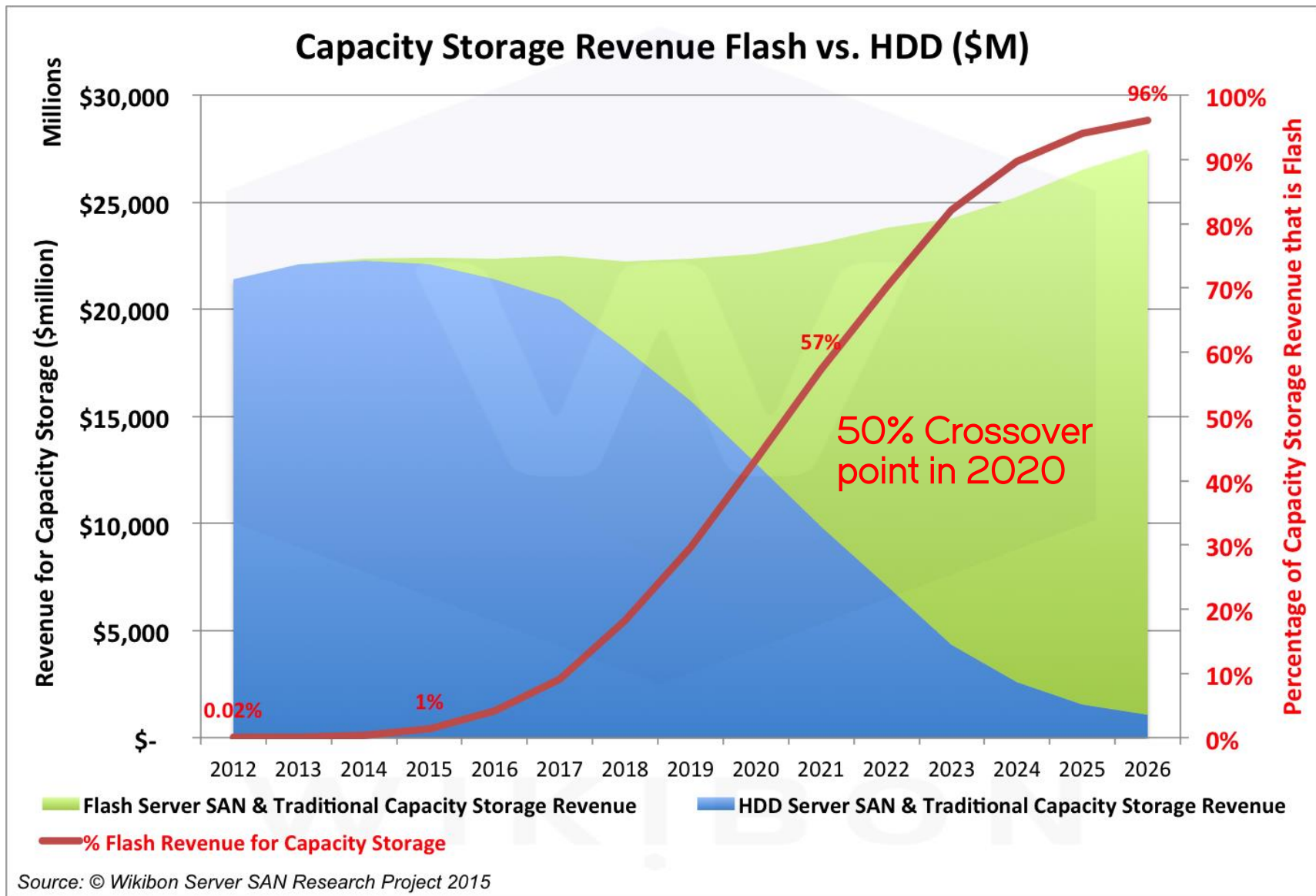
[HTTPS://EN.WIKIPEDIA.ORG/WIKI/HARD_DISK_DRIVE_PERFORMAN
CE_CHARACTERISTICS](https://en.wikipedia.org/wiki/Hard_Disk_Drive_Performance_Characteristics)

Wikibon Analysis

- Wikibon expects Flash to take over most latency market storage applications over the next few years
- Capacity storage (target of this study group) is expected to be dominated by HDD through 2020



Capacity Storage Close-up



SSD for Performance, not Capacity

- SSD is making great strides in capacity improvements
- Cost/GB still significantly higher for SSD and this study group is targeting capacity markets (low cost/GB)
- HDD should have significant cold storage market share for next several years but it is in a declining market

Thank you