

HDD & Storage System Trends

EPA ENERGY STAR and SNIA Data Center Storage Stakeholder Meeting

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HDD Trends

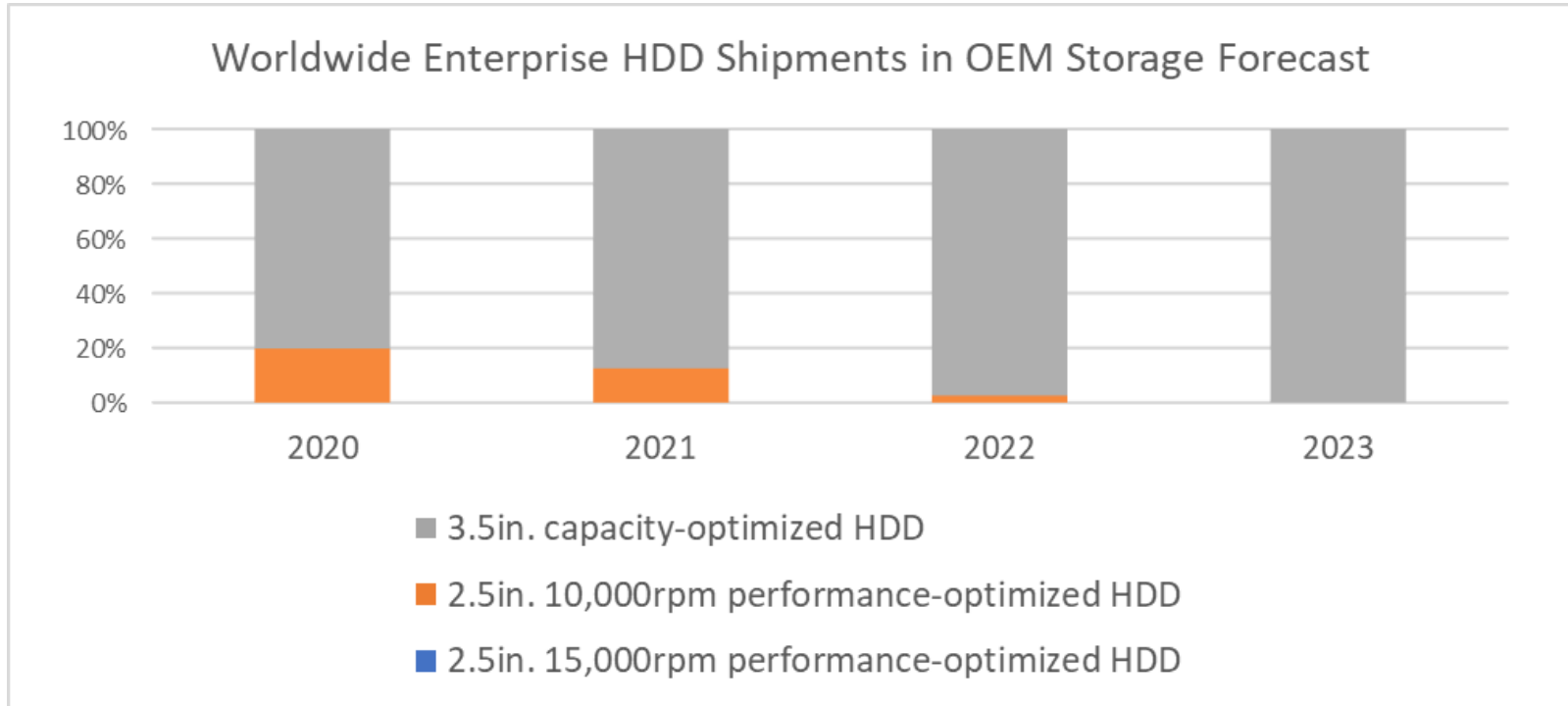
- 10K and 15K RPM HDD markets are declining
 - No new 10K and 15K HDDs are being announced
 - Falling SSD prices have resulted in SSDs replacing 15K HDDs in External Storage
 - By 2023, IDC estimates SSDs will also have replaced 10K HDDs in External Storage

- 7200 RPM HDD capacity growth is continuing
 - Three vendors announced new 16TB+ HDDs in 2019
 - Energy assisted magnetic recording will fuel continued capacity growth
 - Three vendors have announced energy assisted magnetic recording to ship in 2020
 - Two vendors plan to release MAMR (microwave assisted recording) HDDs
 - One vendor plans to release a HAMR (heat assisted magnetic recording) HDD
 - Vendors are predicting 40TB+ HDDs by 2025

More HDD Trends

- 7200 RPM HDD get non-volatile write caching
 - Three vendors have announced 7200 RPM HDDs with non-volatile write caching
 - Implementations differ but the effect is to improve the write IOPS of the drive by:
 - Placing new write data into the non-volatile cache and signaling completion to the host
 - Seek/rotational optimizing the de-stage of data in the non-volatile cache
 - Write IOPS improvement may be limited on storage systems that have their own non-volatile caches and implement their own seek/rotational optimizations
- Multi-actuator 7200 RPM HDDs in development
 - Three vendors have announced plans for multi-actuator HDDs
 - Conceptually ½ capacity drive in a single drive cannister
 - A single spindle motor rotates all the platters
 - ½ platters are accessed by one actuator and the other ½ by a second actuator
 - Provides approximately twice the IOPs and bandwidth of a single actuator drive

IDC HDD Mix Forecast



Source: IDC Worldwide Hard Disk Drive Forecast Update, 2019–2023, December 5, 2019

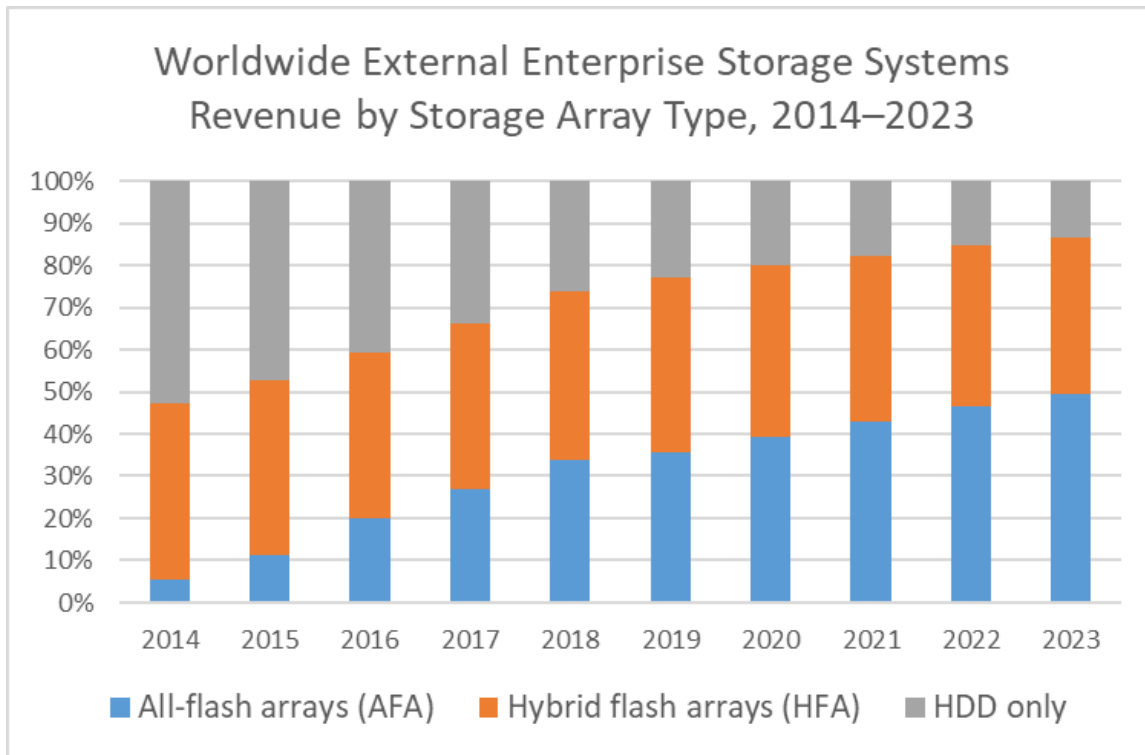
IDC Array Type Definitions

- All-flash array (AFA).
 - An AFA is defined as a network storage system that can **only support flash media** as persistent storage and is available under a unique SKU.
- Hybrid flash array (HFA).
 - An HFA is defined as an external storage system that **can (but does not necessarily) use a mix of CFMs or SSDs and HDDs** to meet performance and capacity requirements.
- HDD-only array
 - HDD-only external storage systems **only support HDDs** as persistent media.

Storage System Trends

- AFA growing rapidly to 49% of revenue by 2023
 - Some growth from SSD only capable designs
 - Some growth from AFA models constructed by software restricting HFA to SSD only
- HDD-only declining rapidly to only 14% of revenue by 2023
- HFA declining slowly and still 37% of revenue by 2023
 - Falling SSD prices enable HFA configurations with more flash resulting in closer to AFA performance for hot data
 - While is 37% of the revenue HFA is likely a higher percentage of the storage systems units shipped than AFA (HFAs are typically lower cost than AFA)

IDC Array Type Mix Forecast



Source: Worldwide and U.S. External Enterprise Storage Systems Forecast Update, 2019–2023, December 2019

Vendor Example – Dell Unity XT Arrays

- Unity XT Arrays announced April 2019
- Both AFA and HFA versions announced with similar compute and memory
 - AFA optimized for Flash performance
 - HFA optimized for Hybrid performance with an increasing percentage of Flash
- Unity XT HFA supports SSDs, 10K & 7200 RPM HDDs but not 15K RPM HDDs

	380F/380	480F/480	680F/680	880F/880
CPU per Array	2 x Intel CPUs, 12 cores per Array, 1.7GHz	2 x dual-socket Intel CPUs, 32 cores per Array, 1.8GHz	2 x dual-socket Intel CPUs, 32 cores per Array, 1.8GHz	2 x dual-socket Intel CPUs, 64 cores per Array, 2.1GHz
System Memory/Cache per Array	128 GB	192 GB	384 GB	768 GB

Impact on Storage System Energy Efficiency Standards

- 7200 RPM HDDs will be the only HDD on storage systems by 2023 =>
 - Hot band IOPs/Watt standards that don't support passing with 7200 RPM HDD configurations may not address over ½ of the storage systems sold by 2023 (51% of storage system revenue will be from configurations with HDDs representing an even higher percentage of storage systems units sold)
- HFAs are being designed to deliver AFA like performance with SSDs =>
 - Testing HFA with HDD-only will not match typical usage models
 - Optimal HFA performance with HDD-only will require extreme HDD configs

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