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 on 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

Worldwide Enterprise HDD Shipments in OEM Storage Forecast

- 3.5in. capacity-optimized HDD
- 2.5in. 10,000rpm performance-optimized HDD
- 2.5in. 15,000rpm performance-optimized HDD

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

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

<table>
<thead>
<tr>
<th>CPU per Array</th>
<th>380F/380</th>
<th>480F/480</th>
<th>680F/680</th>
<th>880F/880</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 x Intel CPUs, 12 cores per Array, 1.7GHz</td>
<td>2 x dual-socket Intel CPUs, 32 cores per Array, 1.8GHz</td>
<td>2 x dual-socket Intel CPUs, 32 cores per Array, 1.8GHz</td>
<td>2 x dual-socket Intel CPUs, 64 cores per Array, 2.1GHz</td>
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</tr>
<tr>
<td>System Memory/Cache per Array</td>
<td>128 GB</td>
<td>192 GB</td>
<td>384 GB</td>
<td>768 GB</td>
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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 1/2 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