HDD & Storage System Trends
EPA ENERGY STAR and SNIA Data Center Storage Stakeholder Meeting

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HDD Trends (2020 Updates)

• 10K and 15K HDD markets are declining – being replaced by SSDs
  – Falling SSD prices have resulted in SSDs replacing 15K HDDs in External Storage
  – By 2024, IDC estimates SSDs will also have replaced 10K HDDs in External Storage

• 7.2K capacity growth continues with Energy Assisted Magnetic Recording (EAMR)
  – 18 and 20TB HDDs based on EAMR released
  – MAMR (microwave assisted recording) & HAMR (heat assisted magnetic recording) in development

• 7.2K HDDs get non-volatile write caching
  – Improving random write performance in some cases

• 7.2K HDDs get multi-actuators
  – First dual-actuator HDD released
  – Conceptually two ½ capacity HDDs in one drive - delivering ~2X IOPs and BW of a single actuator
IDC HDD Mix Forecast

HDD Trends – Drive Level Efficiency* Improvements

• 10K and 15K HDD markets are declining – being replaced by SSDs
  – SSDs may use 2-3x the power but provide as much as 1000x > IO/s and 10x > MB/s of 10K/15K HDD
  – SSDs may be 6x or more > capacity than 10K/15K HDD => fewer drives required for a given capacity
  – Yielding significantly **improved IO/s/W and MB/s/W and Idle GB/W**

• 7.2K capacity growth continues with Energy Assisted Magnetic Recording (EAMR)
  – Higher capacity at ~ the same power consumption => **improved Idle GB/W**

• 7.2K HDDs get non-volatile write caching
  – Improving random write performance => **Improved IO/s/W** for some cases

• 7.2K HDDs get multi-actuators
  – The performance of ~2 7.2K HDDs without a 2X power increase => **Improved IO/s/W and MB/s/W**

❖ Storage system design choices will affect the drive energy efficiency gains at the storage system level - e.g. max configuration, performance targets, data service choices, etc.
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.
IDC Array Type Mix Forecast

Worldwide External Enterprise Storage Systems
Revenue by Storage Array Type, 2015–2024

December 2020
Storage System Trends – Efficiency Improvements

• AFA growing rapidly to [51%] of revenue by 2024
  – AFA => huge efficiency gains over 10K/15K based storage especially with data reduction
  – Many fewer drives, enclosures, fans, etc + much greater performance

• HDD-only declining rapidly to only [12%] of revenue by 2024
  – 7.2K HDD only arrays may not meet Energy Star 2.0 IO/s/W targets

• HFA declining slowly and still 37% of revenue by 2024
  – SSD price erosion => larger SSD content => improved IO/s/W, MB/s/W, idle GB/W
IDC AFA Type Mix Forecast

Worldwide External Enterprise Storage Systems Revenue by AFA Array Type, 2018–2024

Source: IDC Worldwide NVMe-Based All-Flash Array Forecast, 2020–2024: Market Developing Faster than Originally Anticipated, August 2020
Vendor Example – Dell NAFA Arrays

- In 2019, Dell announced PowerMAX NVMe SSD based storage systems
- In 2020, Dell announced PowerStore, PowerScale (F600), and ECS (EXF900), NVMe SSD based storage systems
- PowerStore NAFA – Higher power => more performance/more space efficiency
  - More powerful CPUs and more memory for more performance from NVMe SSDs
  - Hardware compression offload improves data reduction efficiency

<table>
<thead>
<tr>
<th>PowerStore Model</th>
<th>1000</th>
<th>3000</th>
<th>5000</th>
<th>7000</th>
<th>9000</th>
</tr>
</thead>
<tbody>
<tr>
<td>CPU per Array</td>
<td>4 x Intel CPUs, 32 cores, 1.8 GHz</td>
<td>4 x Intel CPUs, 48 cores, 2.1 GHz</td>
<td>4 x Intel CPUs, 64 cores, 2.1 GHz</td>
<td>4 x Intel CPUs, 80 cores, 2.4 GHz</td>
<td>4 x Intel CPUs, 112 cores, 2.1 GHz</td>
</tr>
<tr>
<td>System Memory/Cache per Array</td>
<td>384 GB</td>
<td>768 GB</td>
<td>1,152 GB</td>
<td>1,536 GB</td>
<td>2,560 GB</td>
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NAFA Trend – Energy Implications

• NAFA generally are higher power AND higher performance than SAFA
  – U.2 NVMe SSDs may reach 25W vs U.2 SAS SSDs more typically reaching 15W
  – Some future EDSFF NVMe form factors support up to 40W operations
  – This additional SSD power delivers additional performance
  – Additional controller power required to deliver additional SSD performance

• NVMe SSD drive capacities will exceed SAS SSD capacities
  – 15TB is a common high cap SAS SSD offered with a few 30TB SAS SSDs on the market
  – Vendors are already shipping 38TB and 49TB NVMe SSDs

• EDSFF form factor is more dense than U.2 form factor
  – For example, E3 thin are approximately ½ the width of a U.2 drive
  – As many as 2x E3 as U.2 fit in the same chassis => more power AND performance from the chassis

• New interface, e.g. PCIe Gen 4/5, deliver faster busses enabling > IO/s and MB/s