SWAN: Alleviating Garbage Collection Interference through Spatial Separation in All Flash Arrays

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Image: https://clipartix.com/swan-clipart-image-44906/
All Flash Array (AFA)

• What is AFA?
  • Storage infrastructure that contains only flash memory drives
    • Also called Solid-State Array (SSA)

https://images.google.com/
https://www.purestorage.com/resources/glossary/all-flash-array.html
# SSDs for Enterprise

<table>
<thead>
<tr>
<th>Manufacturer</th>
<th>Product Name</th>
<th>Seq. Read Throughput</th>
<th>Seq. Write Throughput</th>
<th>Capacity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intel</td>
<td>DC P4800X</td>
<td>2.5 GB/s</td>
<td>2.2 GB/s</td>
<td>1.5 TB</td>
</tr>
<tr>
<td></td>
<td>DC D3700</td>
<td>2.1 GB/s</td>
<td>1.5 GB/s</td>
<td>1.6 TB</td>
</tr>
<tr>
<td></td>
<td>DC P3608</td>
<td>5 GB/s</td>
<td>3 GB/s</td>
<td>4 TB</td>
</tr>
<tr>
<td>Samsung</td>
<td>PM1633a</td>
<td>3.5 GB/s</td>
<td>3 GB/s</td>
<td>1.6 TB</td>
</tr>
<tr>
<td></td>
<td>SM883</td>
<td>6.3 GB/s</td>
<td>0.9 GB/s</td>
<td>960 GB</td>
</tr>
</tbody>
</table>

## Previous Solutions

<table>
<thead>
<tr>
<th>Solutions</th>
<th>Write Strategy</th>
<th>How Separate User &amp; GC I/O</th>
<th>Disk Organization</th>
</tr>
</thead>
<tbody>
<tr>
<td>Harmonia [MSST’11]</td>
<td>In-place write</td>
<td>Temporal (Idle time)</td>
<td>RAID-0</td>
</tr>
<tr>
<td>HPDA [IPDPS’10]</td>
<td>In-place write</td>
<td>Temporal</td>
<td>RAID-4</td>
</tr>
<tr>
<td>GC-Steering [IPDPS’18]</td>
<td>In-place write</td>
<td>Temporal</td>
<td>RAID-4/5</td>
</tr>
<tr>
<td>SOFA [SYSTOR’14]</td>
<td>Log write</td>
<td>Temporal</td>
<td>Log-RAID</td>
</tr>
<tr>
<td>SALSA [MASCOTS’18]</td>
<td>Log write</td>
<td>Temporal</td>
<td>Log-RAID</td>
</tr>
<tr>
<td>Purity [SIGMOD’15]</td>
<td>Log write</td>
<td>Temporal</td>
<td>Log-RAID</td>
</tr>
<tr>
<td><strong>SWAN (Proposed)</strong></td>
<td>Log write</td>
<td>Temporal</td>
<td><strong>2D Array</strong></td>
</tr>
</tbody>
</table>

1. Traditional RAID
2. Log-(based) RAID
3. SWAN
Comparison of RAID Schemes

1. Traditional RAID

APP

RAID 4/5

In-place write

Rand. I/O

Rand. I/O

SSD SSD SSD SSD

GC

2. Log-based RAID

APP

Log-RAID

log-structured write

Seq. I/O

Rand. I/O

Log-structured write

SSD SSD SSD SSD

GC

3. SWAN

APP

SWAN

log-structured write

Seq. I/O

Rand. I/O

Reduced GC effect

SSD SSD SSD

Front-end

Back-end
Summary of SWAN

1) Provide full write performance of an array of SSDs up to network bandwidth limit

2) Alleviate GC interference through separation of I/O induced by application and GC of AFA

3) Introduce an efficient way to use SSDs in All Flash Array

9:15 AM, Session Track 1, on July 12th Friday