ENABLING SERVER PERFORMANCE WITH LOWER-COST, BETTER-PERFORMING SSDs

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MEET TOM

38 YEARS OLD, MARRIED, 2 KIDS

DEGREE IN COMPUTER SCIENCE

IT MANAGER AT LARGE DATA CENTER THAT PROVIDES CLOUD HOSTING SERVICES
TOM’S NEW ASSIGNMENT

DATA CENTER READINESS FOR INCREASED USER ACCESS AND PERFORMANCE DEMANDS
STORAGE I/O IS KEY CHALLENGE

ENTERPRISE SSD’S ARE A KEY TECHNOLOGY ELEMENT THAT WILL ENABLE TODAY’S AND TOMORROWS DATACENTER
CLIENT MLC SSDS ARE THE SOLUTION!

TOM REPLACES THE HDDs WITH CLIENT MLC SSDs IN HIS STORAGE RACKS

HIS BOSS PRAISES HIM THAT HE INCREASED COMPUTING POWER WITHOUT INCREASING FOOTPRINT
ONE YEAR LATER...

WHAT TOM SEES

WHAT TOM WANTS
Comprehensive error recovery can lead to performance degradation and latency problems.
ARE MLC SSDs NOT GOOD ENOUGH FOR HIS ENTERPRISE ENVIRONMENT?
File Server: MLC or eMLC?

- **Required Endurance = 1 DWPD**
- **Unused endurance**
- **Insufficient endurance requires multiple drives (TCO)**

Diagram shows the cost comparison between MLC and eMLC, with the cost difference marked as $\Delta$. The required endurance is aligned with the DWPD (5-year Life) on the x-axis and the Relative Component Cost (Normalized to MLC) on the y-axis.
### File Server: MLC or eMLC?

#### 90/10% Read/Write 1 DWPD

<table>
<thead>
<tr>
<th></th>
<th>Client MLC 200GB</th>
<th>eMLC 200GB</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drive Acquisition Cost</td>
<td>$240</td>
<td>$800</td>
</tr>
<tr>
<td>Drive writes/day</td>
<td>0.4</td>
<td>7.7</td>
</tr>
<tr>
<td>Calculated Life (in years)</td>
<td>2.2</td>
<td>44.3</td>
</tr>
<tr>
<td>Replacement rate/year</td>
<td>0.46</td>
<td>0.02</td>
</tr>
<tr>
<td>5 year cost of ownership</td>
<td>$548</td>
<td>$800</td>
</tr>
</tbody>
</table>

#### 1 Petabyte Install Base

- **Initial Cost of Drives**:
  - Client MLC: $1
  - eMLC: $1

- **Total Cost of Ownership**:
  - Client MLC: $4
  - eMLC: $4

- **Increase**:
  - Client MLC: 233%
  - eMLC: 46%
What if?

\[
\frac{dp}{dt} + \nabla \cdot (p + \frac{p \mu_h}{\sigma}) \leq 0
\]

\[
p = \text{matter density of the universe}
\]

- Riemann flat
- \( R \) tensor proportional

\[
\Lambda = \text{cosmological constant} \quad - \Lambda \quad - \Lambda H^2 = 3 \Lambda \mu H^2 - t_2
\]
WE CAN EXTEND THE ENDURANCE OF MLC?

WE CAN ACHIEVE OPTIMAL COST AT EVERY ENDURANCE POINT WITH MLC-EE
FILE SERVER: THE ADVANTAGE OF MLC-EE

- **Unused endurance**
- **Required Endurance = 1 DWPD**
- **Insufficient endurance requires multiple drives**

### Chart Details

- **DWPD (5-year Life)**
- **Relative Component Cost (Normalized to MLC)**
  - 0.8 1.0 1.2 1.4 1.6 1.8 2.0 2.2 2.4 2.6 2.8 3.0 3.2

- **Units**
  - Vertical: 0, 1, 10, 100
  - Horizontal: 0.8, 1.0, 1.2
FILE SERVER: MLC OR MLC-EE?

90/10% Read/Write

<table>
<thead>
<tr>
<th>Drive Acquisition Cost</th>
<th>Entry MLC 200GB</th>
<th>MLC-EE 200GB</th>
</tr>
</thead>
<tbody>
<tr>
<td>$240</td>
<td>$300</td>
<td></td>
</tr>
<tr>
<td>Drive writes/day</td>
<td>0.4</td>
<td>1.2</td>
</tr>
<tr>
<td>Calculated Life (in years)</td>
<td>2.2</td>
<td>6.6</td>
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<tr>
<td>Replacement rate/year</td>
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</table>

1 Petabyte Install Base

![Bar graph showing comparison between Entry MLC and MLC-EE for initial cost of drives and total cost of ownership.](chart)

ENDURANCE = MONEY
THE MORAL OF THE STORY

ENDURANCE EQUALS MONEY

NO MORE WORRY ABOUT FLASH WEAR OUT

NO MORE WORRY ABOUT DEGRADING PERFORMANCE

NO MORE WORRY ABOUT HIGH TOTAL COST OF OWNERSHIP
THANK YOU!

SMART STORAGE SYSTEMS

Making NAND Better