GreenDM: A Versatile Hybrid Drive for Energy and Performance
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Motivation
• What opportunities can SSDs bring?
  ✔ Performance boost
  ✔ Energy saving
  ✔ Reliability concern

Data Management
VLBA 0 1 2 3  n
<table>
<thead>
<tr>
<th>VLBA</th>
<th>PE Flags</th>
</tr>
</thead>
<tbody>
<tr>
<td>map_bio</td>
<td>VE</td>
</tr>
</tbody>
</table>

Power Management
• Disk spin-down when idle for long
• Shift workloads to the fast and low-power SSD

Reducer writes to the SSD
• Conditional migration drops
  ✔ The SSD is full
  ✔ Concurrent accesses on the same extent
  ✔ The meta-data is being flushed
  ✔ The MCPL is reached

Implementation Details
• Concurrency control
  ✔ Atomic counter
• Meta-data management
  ✔ Periodic flush
  ✔ Statistics export
  ✔ Debugfs
• Development cost
  ✔ Kernel V.S.User

High SSD Hit-ratio
• Mapping effect (WL shift)
• Stable results (11%, 440%)
• ES = I/O size
  ✔ no big migration penalty
  ✔ No split overhead

Aged SSDs unpredictable
• Run in-order without TRIM
• New SSDs stable results
• Aged SSDs unstable results
• GCs result in variations

GreenDM wins in Video-server WL
GreenDM wins in Web-search WL

Future Work
• To build cost model
  ✔ Performance, Energy, Reliability, Security
• To scale
  ✔ More drives and across the Network

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