Solid State Drive Based Energy Efficient Cloud Storage

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CIS 4911 - Senior Project
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Outline

- Background
- Proposed Approach
- Implementation
- Web Interface
- Evaluation
Current System
Proposed Approach
## Feasibility Study

<table>
<thead>
<tr>
<th>Disk-State</th>
<th>Inc. from Inactive</th>
<th>Disk-State</th>
<th>Inc. from Inactive</th>
</tr>
</thead>
<tbody>
<tr>
<td>HDD-Inactive:</td>
<td>+0</td>
<td>SSD-Inactive:</td>
<td>+0</td>
</tr>
<tr>
<td>HDD-Idle:</td>
<td>+4</td>
<td>SSD-Idle:</td>
<td>+0.7</td>
</tr>
<tr>
<td>HDD-Active (Read):</td>
<td>+7.2</td>
<td>SSD-Active (Read):</td>
<td>+3.5</td>
</tr>
<tr>
<td>HDD-Active (Write):</td>
<td>+7.6</td>
<td>SSD-Active (Write):</td>
<td>+5.1</td>
</tr>
</tbody>
</table>
Cache Management Policy

**LRU (Least Recently Used)**
Assumes that pages that aren’t used for a long time will not be used in the near future

**LFU (Least Frequently Used)**
Pages that are used less frequently should be evicted first

Changes to accommodate policies:
- Replace hash table with a radix tree ordered by sectors
- Use linked list to manage LRU and LFU schemes
Dynamic Spin-down Daemon

- Daemon
- TCP/IP
- Server
- User space
- Kernel space
- procfs
- cache miss or timeout
- DM Cache
- SSD
- HDD
- hdparm()
Measuring Power

Watts Up? Pro
Web Application

Purpose: display data from measurements

Important Features:

- View current power
- View past power tests
View Past Power

- Tests
  - ID
  - Seconds
  - Watts
  - has

- Machine
  - ID
  - Name

- Test Information
  - ID
  - Notes
  - Rank
  - User
  - Test Name
  - ID
  - Name
  - has

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View Past Power

### Load Test

<table>
<thead>
<tr>
<th>Test Name</th>
<th>Start Time</th>
<th>End Time</th>
<th>Notes</th>
<th>Rank</th>
</tr>
</thead>
<tbody>
<tr>
<td>dmc-pagecache-8g-warm-read</td>
<td>2012-10-26 12:57:29.0</td>
<td>2012-10-26 12:58:38.0</td>
<td>B/W: 165833 IOPS: 41458.25</td>
<td>1</td>
</tr>
<tr>
<td>iscsi-pagecache-8gb-read</td>
<td>2012-10-26 18:04:59.0</td>
<td>2012-10-26 18:06:39.0</td>
<td>B/W: 104040 IOPS: 26010</td>
<td>1</td>
</tr>
</tbody>
</table>
View Current Power

```bash
jorge@visa:~$ cd portal
jorge@visa:~/portal$ ./temporary
```

![Power Monitoring Chart](image)

- **Power (watts)**
  - Ranges from 146.8 to 132.2 Watts

- **Time (seconds)**
  - Duration from 4 to 22 seconds
View Current Power

JavaScript Files

Data Store

JSON Example:

```
{ total: 50, data: [ { power:100, time:0 }, ... ] }
```

JSON

JSP Files

WebApp.java

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Evaluation Setup

- Collected power consumption measurements from a client and server node
- Three configurations:
  - Baseline
  - DM-Cache
  - DM-Cache with daemon modifications
- Two types of benchmarks
  - Simple file operations
  - Workload emulation
IOZone: Micro Benchmarks

Energy - Writes

- iSCSI-W
- DMC-MISS
- DMC-HIT

Energy - Reads

- iSCSI-R
- DMC-MISS
- DMC-HIT

Joules

Server

Client
Evaluation

Filebench: Synthetic Workload

Client Power Consumption

Server Power Consumption

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SSD Energy

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Conclusion

- Leveraged existing client-side caching and added new cache eviction policies
- Implemented disk spin-down daemon to exploit idle disk periods
- Developed a web application to display power consumption graphs
- Presented experiments showing the benefits of client-side SSD caching