Diagnosing Performance Issues on Cray ClusterStor Systems
CUG 2018
Patti Langer, Cray Inc.
There must be a better way
Topics

● Overview of Cray® View for ClusterStor™
● Review of customer reported problem
● Using View for ClusterStor
● Summary
● Q&A
Overview of View for ClusterStor
Components of View for ClusterStor

**Run-time Variability**
Real-time and historical views of data to understand what is impacting a user's job(s)

**Problem Resolution**
A unified view of system activity provides administrators with the ability to pinpoint problem areas within their systems

**Trend Analysis**
Data-driven analysis and visualization from historical data helps identify trends that can then be used to shape changes to the system

**Alerting**
Threshold engine enables customized alerts based on any metric
Customer Reported Problem
Overview of Reported Problem

● The problem
  ● 100% utilization of MDS which caused significant performance degradation
  ● Impacting both users and system throughput

● The complexities
  ● Site has both a Cray XC and Cray Cluster System attached to storage

● The cost
  ● Months of time to debug and find the root cause
Problem Identification

● **Problem isolation**
  ● Several tests are run, isolating issue to stdout redirection to Lustre
  ● A reproducible test case is created
  ● Workaround is to redirect stdout to non-Lustre filesystem

● **Cray engineer engaged**
  ● Information requested to determine MDS performance and throughput
Problem Isolation

● **Initial results**
  - Requests were being processed….slowly
    - No lock contention
    - Request queues not backed up
  - Problem not specific to the MDS

● **Further information requested and analyzed**
  - Metadata operation statistics are collected from MDS
  - Information manually correlated with poorly performing job
## Summary of Metadata Operations for Job

<table>
<thead>
<tr>
<th>Operation</th>
<th>Count w/out workaround</th>
<th>Count with workaround</th>
<th>Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Open</td>
<td>9883</td>
<td>4135</td>
<td>239%</td>
</tr>
<tr>
<td>Close</td>
<td>9575</td>
<td>4078</td>
<td>235%</td>
</tr>
<tr>
<td>Unlink</td>
<td>6024</td>
<td>961</td>
<td>627%</td>
</tr>
<tr>
<td>Mkdir</td>
<td>2000</td>
<td>4</td>
<td>50000%</td>
</tr>
<tr>
<td>Rmdir</td>
<td>2000</td>
<td>3</td>
<td>66667%</td>
</tr>
<tr>
<td>Getaddr</td>
<td>131598</td>
<td>31116</td>
<td>423%</td>
</tr>
<tr>
<td>Statfs</td>
<td>2009</td>
<td>201</td>
<td>1000%</td>
</tr>
<tr>
<td>Sync</td>
<td>830725</td>
<td>0</td>
<td>infinite</td>
</tr>
</tbody>
</table>
Root Cause Identified

- Large number of sync operations
  - 4600 syncs per second
  - With a total of 830725 sync operations

- Causing 100% utilization of the MDS
Challenges

- **Working in a complex environment**
  - Required running the reproducible test case several times to isolate the critical issue

- **Involvement from multiple teams**
  - Additional overhead with communication and data analysis

- **Time to root cause analysis**
  - From problem identification to root cause took 5 months
View for ClusterStor: Bringing the Pieces Together
Problem Isolation

- The Administrator is notified of performance degradation
Overall System Performance of ClusterStor

Write performance degradation begins
View for ClusterStor Home Page

![ClusterStor Home Page View](image)
### Job Summary Table

#### Jobs

<table>
<thead>
<tr>
<th>Job ID</th>
<th>apid</th>
<th>User ID</th>
<th>Application</th>
<th>Start Time</th>
<th>End Time</th>
<th>Duration</th>
<th>Avg. I/O Size</th>
<th>Metadata Ops</th>
</tr>
</thead>
<tbody>
<tr>
<td>2183675</td>
<td>15729</td>
<td></td>
<td>astipek.job</td>
<td>2018-04-30 14:44:51</td>
<td>—</td>
<td>—</td>
<td>2.0kB</td>
<td>1.1M</td>
</tr>
<tr>
<td>2183695</td>
<td>22569</td>
<td></td>
<td>dmoen.job</td>
<td>2018-04-30 14:49:24</td>
<td>—</td>
<td>—</td>
<td>2.1MB</td>
<td>46.9k</td>
</tr>
<tr>
<td>2183597</td>
<td>7862</td>
<td></td>
<td>jthomsber.job</td>
<td>2018-04-30 14:37:36</td>
<td>2018-04-30 14:37:38</td>
<td>2s</td>
<td>2.0MB</td>
<td>56.0</td>
</tr>
</tbody>
</table>
Job Detail Information for 2183675

Metadata operations increase with job start
Job Detail Information for 2183675

Breakdown Metadata Operations for system snx11253 job: 2183675

Metadata Operations

- 2183675 MOT0000 sync: 1.2181 MIO
- Other operations:
  - getattr: 362
  - setattr: 256
  - open: 256
  - close: 89
  - unlink: 0
  - mkdir: 0
  - rmdir: 0
  - getattrib: 0

Graph shows the number of metadata operations over time.
Root Cause Identified

● Large number of sync operations
  ● ~6000 syncs per second
  ● With a total of 1.2M sync operations

● Causing 100% utilization of the MDS
Bringing the Pieces Together

● Data available to the Administrator
  ● View collects and correlates information from multiple sources
  ● No need for root access to ClusterStor system

● Reduce need to run reproducible test case
  ● Information persisted and available near real-time and historical

● Reduce need to engage an expert

● Reduce time from problem identification to root cause
Summary

- It’s all about enabling Administrators to better understand application storage performance

- View for ClusterStor enables Administrators to
  - Proactively monitor and understand performance trends
  - Shorten time from problem identification to root cause
  - Improve system availability
Legal Disclaimer

Information in this document is provided in connection with Cray Inc. products. No license, express or implied, to any intellectual property rights is granted by this document.

Cray Inc. may make changes to specifications and product descriptions at any time, without notice.

All products, dates and figures specified are preliminary based on current expectations, and are subject to change without notice.

Cray hardware and software products may contain design defects or errors known as errata, which may cause the product to deviate from published specifications. Current characterized errata are available on request.

Cray uses codenames internally to identify products that are in development and not yet publicly announced for release. Customers and other third parties are not authorized by Cray Inc. to use codenames in advertising, promotion or marketing and any use of Cray Inc. internal codenames is at the sole risk of the user.

Performance tests and ratings are measured using specific systems and/or components and reflect the approximate performance of Cray Inc. products as measured by those tests. Any difference in system hardware or software design or configuration may affect actual performance.

The following are trademarks of Cray Inc. and are registered in the United States and other countries: CRAY and design, SONEXION, URIKA and YARCDATA. The following are trademarks of Cray Inc.: CHAPEL, CLUSTER CONNECT, CLUSTERSTOR, CRAYDOC, CRAYPAT, CRAYPORT, DATAWARP, ECOPHLEX, LIBSCI, NODEKARE, REVEAL. The following system family marks, and associated model number marks, are trademarks of Cray Inc.: CS, CX, XC, XE, XK, XMT and XT. The registered trademark LINUX is used pursuant to a sublicense from LMI, the exclusive licensee of Linus Torvalds, owner of the mark on a worldwide basis. Other trademarks used on this website are the property of their respective owners.
Q&A

Patti Langer
planger@cray.com