USCellular

United States Cellular Corporation provides a comprehensive range of wireless products and services, excellent customer support, and a high-quality network to 5.0 million customers in 23 states. The Chicago-based company had 7,000 full- and part-time associates as of June 30, 2013.
Who am I?

Lead Infrastructure Architect at USCellular

Oracle OCP since Oracle 7

Member of the IOUG Conference Committee
• Infrastructure Track Member 2011
• Infrastructure Track Lead 2012
• Engineered System Manager 2013

IOUG Collaborate Speaker 2012 & 2013

Contributor to IOUG’s Exadata Tip Booklet
Exadata System

X2-2 Storage Expansion (HC Disks)

X2-2 Full Rack (HP Disks)

ZFSSA 7410 Storage Array

4 Databases

ODS – Primary loaded via GoldenGate, some batch loading. Mixed workloads on access. Majority of workload on server.

EDW – Warehouse with atomic layer in 3NF with some star schema built in

DW – Traditional Warehouse, star schema.

Misc – Small adhoc workload

All Databases are
• Multi-instance
• Have Physical Standby’s
• Backed up to the ZFSSA
Previous Solution – ODS Only

10gR2 Database built around Oracle’s Reference Architecture

Monolithic Unix Server
• 24 cores,
• 384 GB RAM
• 10gE Networking
• 8 8G FC SAN connectivity

Enterprise Grade Storage Array
• 15K SAS drives (short armed disks)
• Lots of cache
• Dedicated to Database

Note: The 2 solutions had similar architectures, loaded via GoldenGate and Informatica and mixed workload applications accessing. The Exadata based system is from a newer billing system, which is 2-3x the amount of changes to load via GG. We also have a lot more applications accessing the ODS. The new workload is larger than what the previous hardware could handle.
What Did We See - Exadata ODS

What? Writes are supposed to be fast! Wait until later slides.

<table>
<thead>
<tr>
<th>Event</th>
<th>Wait Time</th>
<th>Summary Avg Wait Time (ms)</th>
</tr>
</thead>
<tbody>
<tr>
<td>User I/O cell single block physical read</td>
<td>1.49 ms</td>
<td>2.12</td>
</tr>
<tr>
<td>DB CPU</td>
<td>20.93</td>
<td></td>
</tr>
<tr>
<td>User I/O cell smart table scan</td>
<td>10.27</td>
<td>4.56</td>
</tr>
<tr>
<td>User I/O cell list of blocks physical read</td>
<td>4.09</td>
<td>1.71</td>
</tr>
<tr>
<td>Configuration: free buffer walls</td>
<td>7.15</td>
<td>2.70</td>
</tr>
<tr>
<td>User I/O direct path read</td>
<td>3.32</td>
<td>0.81</td>
</tr>
<tr>
<td>Administrative: Backup: MML write backup piece</td>
<td>1.12</td>
<td>0.77</td>
</tr>
<tr>
<td>User I/O direct path write temp</td>
<td>58.29</td>
<td>15.49</td>
</tr>
<tr>
<td>System I/O db file parallel write</td>
<td>17.15</td>
<td>4.59</td>
</tr>
</tbody>
</table>

1.49 ms single block reads
While doing 42K read IOPS and 11K write iops over an hour period.

Note: The other databases were active on the Exadata System during this time.
### Comparison to Old system

<table>
<thead>
<tr>
<th>Metric</th>
<th>Exadata ODS</th>
<th>Monolithic Hardware ODS</th>
<th>Comparison</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single Block Reads</td>
<td>1.5 ms</td>
<td>3.8 ms</td>
<td>&gt; 2x</td>
</tr>
<tr>
<td>Log File Synch Waits</td>
<td>.85 ms</td>
<td>5.7 ms</td>
<td>&gt; 6x</td>
</tr>
</tbody>
</table>

**Note:** The Exadata ODS is over twice the workload as the previous version. In addition, the Exadata system is shared with several databases, while the Monolithic Hardware was dedicated.
Write Back Flash Enablement

Design to accelerate write intensive workloads.

From previous slide, we had lots of “free buffer waits”. Enabled this feature on X2-2.

**Result:** No more “free buffer waits”.

<table>
<thead>
<tr>
<th>#</th>
<th>Class</th>
<th>Event</th>
<th>Warts</th>
<th>%Timeouts</th>
<th>Total(s)</th>
<th>Avg(ms)</th>
<th>%DB time</th>
<th>Avg</th>
<th>Min</th>
<th>Max</th>
<th>Std Dev</th>
<th>Cnt</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>User I/O</td>
<td>cell smart table scan</td>
<td>14,284,936</td>
<td>53.33</td>
<td>230,906.11</td>
<td>16.16</td>
<td>35.90</td>
<td>24.30</td>
<td>60.09</td>
<td>9.53</td>
<td>19.12</td>
<td>6</td>
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<tr>
<td>2</td>
<td>User I/O</td>
<td>cell single block physical read</td>
<td>48,230,613</td>
<td>0.00</td>
<td>210,661.68</td>
<td>4.55</td>
<td>34.15</td>
<td>7.15</td>
<td>5.31</td>
<td>21.00</td>
<td>6.82</td>
<td>6</td>
</tr>
<tr>
<td>3</td>
<td>DB CPU</td>
<td></td>
<td>75,089.31</td>
<td>11.67</td>
<td>43.12</td>
<td>3.90</td>
<td>9.98</td>
<td>4.34</td>
<td>10.37</td>
<td>5.84</td>
<td>6</td>
<td>6</td>
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<tr>
<td>4</td>
<td>User I/O</td>
<td>direct path read</td>
<td>4,690,822</td>
<td>0.00</td>
<td>54,744.09</td>
<td>11.65</td>
<td>8.51</td>
<td>9.98</td>
<td>4.34</td>
<td>10.37</td>
<td>5.84</td>
<td>6</td>
</tr>
<tr>
<td>5</td>
<td>Cluster</td>
<td>gc buffer busy acquire</td>
<td>268,463</td>
<td>0.00</td>
<td>14,779.13</td>
<td>55.05</td>
<td>2.30</td>
<td>667.60</td>
<td>15.56</td>
<td>2118.01</td>
<td>954.64</td>
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<tr>
<td>6</td>
<td>System I/O</td>
<td>log file sequential read</td>
<td>85,273</td>
<td>0.00</td>
<td>11,675.35</td>
<td>136.92</td>
<td>1.82</td>
<td>108.10</td>
<td>34.63</td>
<td>141.03</td>
<td>41.74</td>
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<tr>
<td>7</td>
<td>Administrative</td>
<td>Backup: MML write backup piece</td>
<td>1,835,436</td>
<td>0.00</td>
<td>8,092.09</td>
<td>4.16</td>
<td>1.26</td>
<td>4.26</td>
<td>3.60</td>
<td>4.50</td>
<td>0.25</td>
<td>6</td>
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<tr>
<td>8</td>
<td>Cluster</td>
<td>gc or block lost</td>
<td>5,598</td>
<td>0.00</td>
<td>6,836.16</td>
<td>1221.18</td>
<td>1.06</td>
<td>1044.20</td>
<td>662.23</td>
<td>1253.03</td>
<td>294.07</td>
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<tr>
<td>9</td>
<td>Cluster</td>
<td>gc current block busy</td>
<td>10,064</td>
<td>0.00</td>
<td>6,057.47</td>
<td>650.22</td>
<td>1.03</td>
<td>453.70</td>
<td>16.65</td>
<td>1126.37</td>
<td>367.97</td>
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<tr>
<td>10</td>
<td>User I/O</td>
<td>direct path read temp</td>
<td>159,540</td>
<td>0.00</td>
<td>6,558.04</td>
<td>41.55</td>
<td>1.02</td>
<td>57.56</td>
<td>30.41</td>
<td>84.71</td>
<td>38.39</td>
<td>6</td>
</tr>
</tbody>
</table>
Maintenance Activities

Preventative Maintenance Operations
- Battery replacement
- Proactive disk replacement

Unplanned Operations
- Disk Replacement
- Flash Drive Replacement
- Motherboard Replacements

Patching
- All patches for over a year...

All Have Been Done in a Rolling Fashion!
What This Means to Us

More Flexibility in System Use
• We are less concerned about unplanned activities on the system. The users can go after the system when they need to, not during certain windows.
• Maintenance activities have less impact on system availability.

More Use of the Data
• Exadata’s Flash reduces the i/o contention of the mixed workloads within the database and between competing databases
• More concurrent users mean more business questions being answered.

Faster Access to the Data
• Faster I/O means less time waiting for queries to return, more time to analyze the results