Automatic Workload Repository: Soup to Nuts

Graham Wood
Doug Burns
Background

- Independent Oracle Consultant
- Oracle ACE Director
- Oak Table Network
- The guy with the plushy toys
- http://oracledoug.com
Graham Wood

Background

- Performance guy
- Joined Oracle in 1986
- Architect in Oracle RDBMS dev
- Created Statspack and AWR
- Real World Performance Group
- Oak Table Member
Real World Performance at OOW13

Why is my SQL slow?  Mon 13:45 Moscone South 102
Dilemmas in Middleware  Tue 15:45 Moscone South 102
Program Agenda

- Basics
- AWR Reports
- Case Study
- Administration and Diagnostics
- Conclusions
Program Agenda

- Basics
- AWR Reports
- Case Study
- Administration and Diagnostics
- Conclusions
AWR Basics
Is this the Soup?

- Repository for snapshots of Oracle performance data
- Introduced with Oracle 10g
- Licensed as part of Diagnostic Pack
- On by default
- Self-managing
AWR Basics

Snapshots

- Capture performed by MMON process
- Captures data from V$ performance views
  - Cumulative data e.g. V$SYSSTAT
  - Data based on deltas e.g. V$SQL
  - Active Session History
  - Metrics
AWR Basics

Snapshots

- Process controlled by AWR metadata
- Settings visible in DBA_HIST_WR_CONTROL
- Metadata set using DBMS_WORKLOAD_REPOSITORY package
- Can also do manual snapshots
AWR Basics

Snapshots

- Stores data in AWR tables in SYSAUX tablespace
  - WRH$$_xxx$$ for data
  - WRM$$_xxx$$ for metadata
- Access data directly using DBA_HIST_xxx views
- Large tables are partitioned for ease of management
  - Especially for purge
  - Partition size depends on retention
  - No license requirement
AWR Basics
Default configuration

SQL> select * from dba_hist_wr_control;

<table>
<thead>
<tr>
<th>DBID</th>
<th>SNAP_INTERVAL</th>
<th>RETENTION</th>
<th>TOPNSQL</th>
</tr>
</thead>
<tbody>
<tr>
<td>4001518076</td>
<td>+00000 01:00:00.0</td>
<td>+00008 00:00:00.0</td>
<td>DEFAULT</td>
</tr>
</tbody>
</table>

- One hour default snapshot interval
- Eight day default retention
  - Data automatically purged after retention period
- Default TOPNSQL is 200 for each dimension
AWR Basics

Recommended configuration

- One hour or 30 minute snapshot interval
  - If you think you need less, you are probably using the wrong data
  - Attend Active Session History Deep Dive Moscone S Rm 104 Wed 15:30

- Retention based on business cycles
  - Default (8 days) is great for a play database on a laptop
  - 30+ days for your important databases
  - 60/90 days commonly used

```sql
EXECUTE DBMS_WORKLOAD_REPOSITORY.MODIFY_SNAPSHOT_SETTINGS
  ( interval => 60, retention => 60*24*90);  -- 90 days
```
AWR Reports

- How many AWR reports are there?
  - awrrpt.sql
AWR Reports
Use the report based on the scope of the problem

- How many AWR reports are there?
  - awrrpt.sql Instance AWR report
  - awrddrpt.sql Compare period report
  - awrgrpt.sql RAC AWR report
  - awrgdrpt.sql RAC Compare period report
  - awrsqrlrpt.sql AWR SQL history report
  - ashrpt.sql ASH report
  - addmrpt.sql ADDM report
AWR Report

Beware!

- AWR averages data over the whole snapshot interval
- Can mislead investigations
AWR Report

Beware!

- AWR averages data over the whole snapshot interval
- Can mislead investigations
- Event histograms help by allowing outliers to be identified
AWR Reports

Analyzing the AWR report

- Scope the problem before starting to analyze the data
- “AWR Report is very long”
- But you are not expected to read it all
- Top few pages contains high level summary
- Summary leads you to where to look next
AWR Reports

Analyzing the AWR report

- Look at the system overview unless you know the system well
  - CPU cores
  - Memory
  - OS
  - Oracle version
  - RAC?
  - Connected sessions

- Are any resources maxed out?
AWR Reports

Analyzing the report

- If resource is maxed out, target that first
  - DB CPU/sec => DB cores
  - Paging/Swapping/High System time

- Otherwise focus on where DB Time is spent
  - Top events
  - Time model
  - Top SQL
AWR Reports
Analyzing the report

- Or use Tyler Muth’s AWR Formatter for Chrome as a helper
  http://tylermuth.wordpress.com/2011/04/20/awr-formatter/
- Or RUN THE ADDM REPORT
AWR Reports

- Findings at top of report
- Full ADDM report towards end of report
Real World Performance Issue
Recent Client Performance Issue

REAL World Performance is messy

- Regular early morning intensive batch data load
- Loads two different data sets of around 500 million rows each into two new partitions
- Various aggregation and reporting steps at end of run
- One of the aggregation jobs had been running for over an hour rather than a few minutes and had been killed
- On a Saturday morning (of course)
- When my replacements were all out of signal range (of course)
Overall Approach
Performance Analysis is Informed Common Sense

- Asking sensible questions
  - How long does this usually run for?
    - Few minutes
  - When did it start running slowly?
    - This morning
    - Ran just fine every other day, including the previous day
- Start with the appropriate tools
- Use other tools for deeper analysis depending on the results
The right tool for the job
AWR, ASH and ADDM are a suite of different tools

- Performance of a specific job has changed from one day to the next
- Overall system performance seems fine
- Probably a SQL statement or two has changed execution plan
  - But let's not start guessing!
- SQL Monitor screen might show long-running statement
  - No, because the problem happened some time ago
- ASH data (including DBA_HIST_ACTIVE_SESS_HISTORY)
  - Shows a long-running SQL_ID in second period, but not why
Basic AWR report

- History of performance statistics
- The old way …
  - Run two AWR (or even Statspack) reports
  - Print them off
  - Sit at desk with them laid side-by-side
  - Read through massive reports trying to spot the differences
- The better way …
  - AWR Compare Period Report
AWR Compare Period Report

Summary

- Shows the database instance and version information
- Usually the same, but could be different databases and instances (more later)
- Shows the two periods we are comparing
AWR Compare Period Report

Load Profile

- Similar to Load Profile section of basic report
- Shows both values side-by-side for immediate easy comparison
- Calculates percentage differences between two activity periods

Load Profile

<table>
<thead>
<tr>
<th></th>
<th>1st per sec</th>
<th>2nd per sec</th>
<th>%Diff</th>
<th>1st per txn</th>
<th>2nd per txn</th>
<th>%Diff</th>
</tr>
</thead>
<tbody>
<tr>
<td>DB time:</td>
<td>2.2</td>
<td>1.4</td>
<td>-35.1</td>
<td>400.4</td>
<td>287.7</td>
<td>-28.1</td>
</tr>
<tr>
<td>CPU time:</td>
<td>0.2</td>
<td>0.0</td>
<td>-85.0</td>
<td>36.9</td>
<td>6.9</td>
<td>-81.4</td>
</tr>
<tr>
<td>Redo size:</td>
<td>756.8</td>
<td>730.3</td>
<td>-3.5</td>
<td>138,301.2</td>
<td>146,142.9</td>
<td>7.2</td>
</tr>
<tr>
<td>Logical reads:</td>
<td>7,085.3</td>
<td>176.8</td>
<td>-97.5</td>
<td>1,276,133.7</td>
<td>35,376.3</td>
<td>-97.2</td>
</tr>
<tr>
<td>Block changes:</td>
<td>4.6</td>
<td>2.5</td>
<td>-47.2</td>
<td>835.6</td>
<td>491.1</td>
<td>-41.2</td>
</tr>
<tr>
<td>Physical reads:</td>
<td>2,258.4</td>
<td>126.3</td>
<td>-94.4</td>
<td>406,761.9</td>
<td>25,265.6</td>
<td>-93.8</td>
</tr>
<tr>
<td>Physical writes:</td>
<td>11.5</td>
<td>1.7</td>
<td>-84.8</td>
<td>2,064.5</td>
<td>347.2</td>
<td>-83.2</td>
</tr>
<tr>
<td>User calls:</td>
<td>3.3</td>
<td>3.0</td>
<td>-8.9</td>
<td>586.4</td>
<td>594.2</td>
<td>1.3</td>
</tr>
<tr>
<td>Parses:</td>
<td>0.9</td>
<td>0.8</td>
<td>-17.0</td>
<td>168.7</td>
<td>155.6</td>
<td>-7.7</td>
</tr>
<tr>
<td>Hard parses:</td>
<td>0.0</td>
<td>0.0</td>
<td>-80.0</td>
<td>8.3</td>
<td>2.5</td>
<td>-69.9</td>
</tr>
<tr>
<td>W/A MB processed:</td>
<td>1,131,743.6</td>
<td>720,864.2</td>
<td>-36.3</td>
<td>203,839,692.8</td>
<td>144,261,176.9</td>
<td>-36.3</td>
</tr>
<tr>
<td>Logons:</td>
<td>0.1</td>
<td>0.1</td>
<td>-16.7</td>
<td>11.0</td>
<td>10.1</td>
<td>-7.7</td>
</tr>
<tr>
<td>Executes:</td>
<td>2.4</td>
<td>1.7</td>
<td>-26.8</td>
<td>423.4</td>
<td>344.8</td>
<td>-18.6</td>
</tr>
<tr>
<td>Transactions:</td>
<td>0.0</td>
<td>0.0</td>
<td>-100.0</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Top Timed Events

- Where we are spending Time!
- Different events
- Different wait times
- Different contribution to DB Time
- Events that appear in one period and not the other
# AWR Compare Period Report

## Top Timed Events

Top Timed Events

- Events with a "-" did not make the Top list in this set of snapshots, but are displayed for comparison purposes

<table>
<thead>
<tr>
<th>Event</th>
<th>Wait Class</th>
<th>Waits</th>
<th>Time(s)</th>
<th>Avg Time(ms)</th>
<th>%DB time</th>
<th>Event</th>
<th>Wait Class</th>
<th>Waits</th>
<th>Time(s)</th>
<th>Avg Time(ms)</th>
<th>%DB time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data Guard Broker Wait</td>
<td>Other</td>
<td>5,084</td>
<td>5,041.91</td>
<td>991.72</td>
<td>62.97</td>
<td>Data Guard Broker Wait</td>
<td>Other</td>
<td>5,090</td>
<td>5,043.95</td>
<td>990.95</td>
<td>97.41</td>
</tr>
<tr>
<td>direct path read temp</td>
<td>User I/O</td>
<td>6,304,781</td>
<td>2,252.10</td>
<td>0.36</td>
<td>28.13</td>
<td>CPU time</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CPU time</td>
<td></td>
<td></td>
<td>737.91</td>
<td></td>
<td>9.22</td>
<td>Backup: MML create a backup piece</td>
<td>Administrative</td>
<td>6</td>
<td>27.46</td>
<td>4,576.56</td>
<td>0.53</td>
</tr>
<tr>
<td>direct path read</td>
<td>User I/O</td>
<td>14,722</td>
<td>94.74</td>
<td>6.44</td>
<td>1.18</td>
<td>Backup: MML commit backup piece</td>
<td>Administrative</td>
<td>6</td>
<td>14.06</td>
<td>2,342.99</td>
<td>0.27</td>
</tr>
<tr>
<td>Backup: MML create a backup piece</td>
<td>Administrative</td>
<td>6</td>
<td>20.76</td>
<td>3,460.15</td>
<td>0.26</td>
<td>Backup: MML shutdown</td>
<td>Administrative</td>
<td>2</td>
<td>13.82</td>
<td>6,908.71</td>
<td>0.27</td>
</tr>
<tr>
<td>Backup: MML commit backup piece</td>
<td>Administrative</td>
<td>6</td>
<td>13.93</td>
<td>2,322.16</td>
<td>0.17</td>
<td>direct path read</td>
<td>User I/O</td>
<td>2,907</td>
<td>8.45</td>
<td>2.91</td>
<td>0.18</td>
</tr>
<tr>
<td>Backup: MML shutdown</td>
<td>Administrative</td>
<td>2</td>
<td>13.72</td>
<td>6,860.34</td>
<td>0.17</td>
<td>direct path read temp</td>
<td>User I/O</td>
<td>85</td>
<td>0.12</td>
<td>1.46</td>
<td>0.00</td>
</tr>
</tbody>
</table>
AWR Compare Period Report

SQL by Elapsed Time

- Single job running more slowly than usual
- Check SQL statement Elapsed Time Changes
- Shows statements that appear in either or both of the snapshot intervals
## SQL by Elapsed Time

### Top SQL Comparison by Elapsed Time
- Ordered by absolute value of Diff column of 'Elapsed Time % of DB time' descending
- ‘#Plans’ column indicates the number of distinct execution plans for the statement in 1st and 2nd periods and in both periods combined
- ‘1st Total’ and ‘2nd Total’ show respective running totals for ‘1st’ and ‘2nd’ columns of ‘Elapsed Time % of DB time’
- DB time First: 1,007.07 seconds. Second: 1,177.82 seconds
- Captured SQL Elapsed Time First: 3,325.94 seconds. Second: 460.31 seconds
- Captured PL/SQL Elapsed Time as a % of DB time First: 41.86%. Second: 9.30%
- Captured PL/SQL Elapsed Time as a % of DB time First: 58.48%. Second: 90.43%
- Common SQL Elapsed Time as a % of DB time First: 82.41%. Second: 97.58%

<table>
<thead>
<tr>
<th>SQL Id</th>
<th>Elapsed Time % of DB time</th>
<th>Elapsed Time (ms) per Exec</th>
<th>#Exec/sec (DB time)</th>
<th>CPU Time (ms) per Exec</th>
<th>I/O Time (ms) per Exec</th>
<th>Physical Reads per Exec</th>
<th>#Rows Processed per Exec</th>
<th>#Executions</th>
<th>#Plans</th>
</tr>
</thead>
</table>
| db1rte941.447c | 32.53 | 32.53 | -32.53 | 2,004.374 | 0.00 | 484.472 | 2,250.224 | 8,059.628.00 | 1.00 | 1 | 3/2/2 | SELECT NVL(MAX(LEVEL), 0) FROM...
| 22wmxm3n4x1h | 33.90 | 30.49 | 33.40 | 83.46 | 29.49 | 180.034 | 180.035 | 0.00 | 0.00 | 7 | 6 | 0 | 0.00 | 0.00 | 0.00 | 0.00 | 24 | 24 | begin_prop_value = sys.dba...
| 22wmxm3n4x1h | 3.50 | 90.59 | 6.65 | 90.46 | 2.48 | 180.040 | 180.041 | 0.00 | 0.00 | 6 | 7 | 0 | 0 | 0.00 | 0.00 | 0.00 | 0.00 | 2 | 2 | SELECT objid, attribute_v...
| bcdsRdpVc1ky | 4.00 | 90.46 | 0.90 | 97.98 | 2.40 | 180.041 | 180.037 | 0.00 | 0.00 | 6 | 7 | 0 | 0 | 0.00 | 0.00 | 0.00 | 0.00 | 2 | 2 | BEGIN dbms_sid.do_control_raw...
## Summary

- Run for a specific SQL_ID over a specific period of time
- Shows overall information for Elapsed Time and Application Instrumentation
- Shows that there are two different Execution Plans!

### SQL Summary

<table>
<thead>
<tr>
<th>SQL Summary</th>
<th>SQL Text</th>
</tr>
</thead>
<tbody>
<tr>
<td>SQL Id</td>
<td>Elapsed Time (ms)</td>
</tr>
<tr>
<td>startted1234c</td>
<td>4,894,383</td>
</tr>
</tbody>
</table>

### SQL ID: ctgr1qtksd47c

<table>
<thead>
<tr>
<th>Plan hash Value</th>
<th>Total Elapsed Time (ms)</th>
<th>Executions</th>
<th>1st Capture Snap ID</th>
<th>Last Capture Snap ID</th>
</tr>
</thead>
<tbody>
<tr>
<td>10000012164</td>
<td>4,894,383</td>
<td>1</td>
<td>7138</td>
<td>7138</td>
</tr>
<tr>
<td>123456789012</td>
<td>0</td>
<td>0</td>
<td>7138</td>
<td>7138</td>
</tr>
</tbody>
</table>

**Back to Top**
AWR SQL Report

Summary

**SQL Summary**

<table>
<thead>
<tr>
<th>SQL Id</th>
<th>Elapsed Time (ms)</th>
<th>Module</th>
<th>Action</th>
<th>SQL Text</th>
</tr>
</thead>
<tbody>
<tr>
<td>ctgr1qtksd47c</td>
<td>4,894,383</td>
<td>PL/SQL Developer</td>
<td>SQL Window - New</td>
<td>SELECT NVL(MAX(LEVEL), 0) FROM (SELECT NODE_ID, PARENT_NODE_ID FROM r...)</td>
</tr>
</tbody>
</table>

**SQL ID: ctgr1qtksd47c**

- 1st Capture and Last Capture Snap IDs refer to Snapshot IDs within the snapshot range
- SELECT NVL(MAX(LEVEL), 0) FROM (SELECT NODE_ID, PARENT_NODE_ID FROM r...)

<table>
<thead>
<tr>
<th>#</th>
<th>Plan Hash Value</th>
<th>Total Elapsed Time (ms)</th>
<th>Executions</th>
<th>1st Capture Snap ID</th>
<th>Last Capture Snap ID</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1069591954</td>
<td>4,894,383</td>
<td>1</td>
<td>7138</td>
<td>7139</td>
</tr>
<tr>
<td>2</td>
<td>1911798165</td>
<td>0</td>
<td>0</td>
<td>7138</td>
<td>7139</td>
</tr>
</tbody>
</table>
AWR SQL Report

Plan Statistics

- All sections appear for all different plans
- Long Elapsed Time so this is the culprit
- Lots of User I/O Wait Time

Plan 1 (PHV: 1069591954)

<table>
<thead>
<tr>
<th>Stat Name</th>
<th>Statement Total</th>
<th>Per Execution</th>
<th>% Snap Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elapsed Time (ms)</td>
<td>4,694,382</td>
<td>4,594,382.84</td>
<td>18.95</td>
</tr>
<tr>
<td>CPU Time (ms)</td>
<td>953,397</td>
<td>953,370.08</td>
<td>64.87</td>
</tr>
<tr>
<td>Executions</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Buffer Gets</td>
<td>60,256,865</td>
<td>60,256,855.00</td>
<td>03.65</td>
</tr>
<tr>
<td>Disk Reads</td>
<td>12,653,360</td>
<td>12,653,360.00</td>
<td>77.34</td>
</tr>
<tr>
<td>Parse Calls</td>
<td>1</td>
<td>1.00</td>
<td>0.01</td>
</tr>
<tr>
<td>Rows</td>
<td>1</td>
<td>1.00</td>
<td></td>
</tr>
<tr>
<td>User I/O Wait Time (ms)</td>
<td>4,195,382</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cluster Wait Time (ms)</td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Application Wait Time (ms)</td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Concurrency Wait Time (ms)</td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Invalidations</td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Version Count</td>
<td>4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shareable Mem(KB)</td>
<td>120</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Execution Plans

- This is the bad guy!
- Standard Execution Plan format
- CONNECT BY query that connects NODEs and EDGEs in a hierarchical tree
Execution Plans

- This is the usual plan!
- Same SQL statement operating against different partitions
- With different stats
- Uses a different CONNECT BY method that sorts to TEMP
- Quick fix solution – Hint!

### Execution Plan

<table>
<thead>
<tr>
<th>Id</th>
<th>Operation</th>
<th>Name</th>
<th>Rows</th>
<th>Bytes</th>
<th>TempSpec</th>
<th>Cost (%CPU)</th>
<th>Time</th>
<th>Pstart</th>
<th>Pstop</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>SELECT STATEMENT</td>
<td></td>
<td>1</td>
<td>28</td>
<td></td>
<td>23267 (100)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>SORT AGGREGATE</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>CONNECT BY WITH FILTERING</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>HASH JOIN</td>
<td>319K</td>
<td>13M</td>
<td>8736K</td>
<td>10357</td>
<td>00:01:30</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>PARTITION RANGE SINGLE</td>
<td>257K</td>
<td>5237K</td>
<td></td>
<td>2035 (1)</td>
<td>00:00:40</td>
<td>66</td>
<td>66</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>TABLE ACCESS FULL</td>
<td>NODE</td>
<td>297K</td>
<td>5237K</td>
<td>2035 (1)</td>
<td>00:00:40</td>
<td>66</td>
<td>66</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>PARTITION RANGE SINGLE</td>
<td>1806K</td>
<td>31N</td>
<td></td>
<td>948 (2)</td>
<td>00:00:14</td>
<td>66</td>
<td>66</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>TABLE ACCESS FULL</td>
<td>EDGE</td>
<td>1305K</td>
<td>31N</td>
<td>948 (2)</td>
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Colored SQL
Even an AWR fan curses it sometimes!

- TOPNSQL defines how many statements AWR should capture
  - Over multiple dimensions
- AWR doesn't (and probably shouldn't) capture (by default)
  - Infrequently executed SQL statements that don't consume resources
- Which means that you often won't find the 'Good Guy' for comparison with the 'Bad Guy'
- dbms_workload_repository.add_colored_sql allows you to specify a SQL_ID that will always be captured if it is in the cursor cache
AWR is a suite of analysis tools
But it's not the only tool

- Working our way through different tools
- Looking at different aspects of overall system and session performance
- Deciding which are the most important
- Wouldn’t it be great if we had a tool that did that for us?
ADDM

AWR Report use case

- What did ADDM say?
- Host CPU was the issue
- Latch issue ranked third
AWR Administration and Diagnostics

It is self-managing!

- Drop and recreate AWR
  - catnoawr.sql
  - catawr.sql
- Extract and Load
  - awrextr.sql
  - awrload.sql
AWR Administration and Diagnostics

Ah, Nuts

- Diagnose errors and performance issues
  - "Troubleshooting: AWR Snapshot Collection issues (Doc ID 1301503.1)"
    - Identifying snapshot errors
      - WRM$_SNAP_ERROR
      - Not starting
      - Not completing
  - Tracing snapshots
AWR Administration and Diagnostics

Ah, Nuts

- Diagnose errors and performance issues
  - New in 11.2.0.2 WRM$_SNAPSHOT_DETAILS

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AWR Soup to Nuts
It IS More Than Just AWR RPT

- On by default and self-managing
- Basket of tools for investigating performance issue
- Scope of issue should lead to choice of tool
- Drill down based on DB Time
- Remember to ask ADDM
Slide Title: Arial, 28 PT
Two-Line Max
Subtitle: Arial, 20 pt, One-Line Max

- Bullets are sentence case. Use Arial, 20 pt font.
  - Sub-bullets are Arial, 18 pt font.
- Keep bullets short.
- One idea per bullet.
- No more than five bullets.
- NOTE: Arial is the ONLY font that should be used in the Oracle corporate presentation template. Times and other serif fonts are not acceptable.

To ensure that slides are properly formatted to this template, see pages 7 and 8 for instructions.
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ANNOUNCEMENT
ALL CAPS,
ARIAL 44 PT,
4-LINE MAX
Case Study Example with Photograph

Solutions

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Case Study Example with Screenshot

Solutions

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Solutions

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Case Study Example with Graphic

Consumer Value
Intent, Expectation, Perception

Solution Approach
People, Process, Technology

Business Value
Acquisition, Retention, Efficiency
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“This slide format serves to call attention to a quote from a prominent customer, executive, or thought leader regarding a particular topic.”

Insert Author Name Here
Position Title,
Company Name
Vertical Bar Chart

Contextual information about the chart

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Series 1  | Series 2  | Series 3
---|---|---
Category 1 | 2 | 1
Category 2 | 4 | 3
Category 3 | 3 | 2
Category 4 | 5 | 4
Horizontal Bar Chart

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Contextual information about the chart

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Line Chart

Contextual information about the chart

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Pie Chart

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Hardware and Software

Engineered to Work Together