Real World Exadata

Presented by: Kerry Osborne

March 7, 2012

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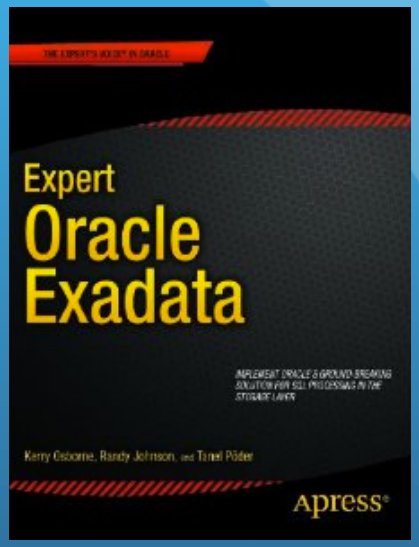
whoami -

Worked with Oracle Since 1982 (V2)
Working with Exadata since early 2010
Work for Enkitec (www.enkitec.com)
(Enkitec owns a Half Rack – V2/X2)
Many Exadata customers and POCs
Many Exadata Presentations (many to Oracle)
Exadata Book



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OakTable.net

ORACLE ACE Director

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What's the Point?

- Part 1: Real World Statistics
- Part 2: How To Be Sure Your Getting What You Paid For

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Poll – How Many In The Audience Are Already Using Exadata?

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Part 1: Statistics*

- 51 Database Machines
- 22 Companies
- Revenues ~$50M to ~$25B
- non-RAC to 16 node RAC cluster
- Basic (mini) – X2-8

* Not a statistically significant or random sample

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Sizes

Number of Racks:*

```
Full    - 11 or 22%
Half    - 12 or 24%
Quarter - 27 or 53%
Basic   -  1 or  2%
```

Average Size: 0.468

Number of Companies:

```
Full    -  3 - 11%
Half    -  9 - 33%
Quarter - 15 - 55%
```

Company Sizes:

```
Large (>$1B)    - 10 - 45%
Medium          -  5 - 23%
Small (<$200M)  -  7 - 32%
```

* A few have additional storage cells

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Models

Generations:

```
V1    -  3 or  6%
V2    - 10 or 20%
X2-2  - 28 or 73%
X2-8  -  1 or  2%
```

Drives Types:*

```
Hi Perf -  6 or 12%
Hi Cap  - 45 or 88%
```

* Flash Cache tends to cover up drive deficiencies

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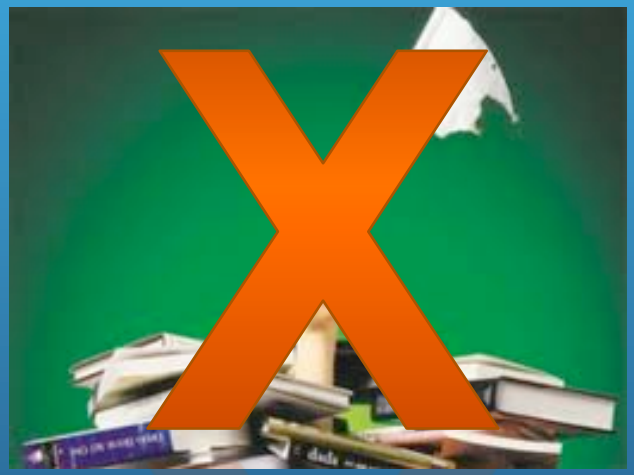
Workload (DW, OLTP, Mixed)

This one is hard because there are few “pure” workloads!

Primary Usage:

```
DW       – 29 or 57%
OLTP     – 20 or 40%
Mixed    –  2 or  4%
```



Primary Application:

```
Custom      - 30 – 59%
PeopleSoft – 10 - 20%
eBiz        -  5 – 10%
Other       -  6 – 12%
```

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Consolidations

Most Companies in this Sample are Consolidating on Exadata

```
Yes     - 34 or 67%
No      - 16 or 31%
Unknown -  1 or  2%
```

Types:

- DW and OLTP
- Combining Many Disparate Systems
- “Cloud” Initiatives
- Unconsolidated Consolidations
  - Consider 1 Full Rack -> 4 X 2-Node RAC Clusters

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Multiple Racks

Most Companies in this Sample Bought More than One Rack

```
Single   -   3 or 14%
Multiple -  19 or 86%
```

Note: 4 of the 19 companies w/ multiple Exadatas started with a single DBM

Why?

- Patching
- Dev / Test
- DR

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Part 1a: Stories

- common migration strategies
- recommended parameter/configuration settings
- suitability for various workloads (OLTP vs. DW vs. mixed)
- indexing strategies
- compression strategies
- organizational challenges presented by Exadata

Common Migration Strategies

Logical

- Data Pump
- exp / imp
- Golden Gate
- CTAS Across DBLink

Physical

- RMAN
- TTS
- Dataguard Physical Standby
- ASM Rebalance

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Digression: Fork Lift Migrations

- Just Say No!
- 9i RBO to 11gR2 on Exadata
  - pour some more salt on the wounds
- Good News is Exadata Can Cover Up Many Sins
- Bad News is it Can't Cover Up Everything
- Typical Results (2-3X Faster Than Before)

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Digression: Fork Lift Migrations

Top 5 Timed Foreground Events

Event	Waits	Time(s)	Avg wait (ms)	% DB time	Wait Class
DB CPU		21,685		49.1	
SQL*Net more data from dblink	52	7,296	1.E+05	16.5	Network
Streams miscellaneous event	12,525	6,274	501	14.2	Other
enq: TM - contention	671	5,478	8164	12.4	Applicatio
cell single block physical rea	3,935,035	2,231	1	5.1	User I/O

Digression: Fork Lift Migrations

```
ENKITEC@IOP> @offload_percent
Enter value for sql_text:
Enter value for min_etime:
Enter value for min_avg_lio:

     TOTAL  OFFLOADED OFFLOADED_%
---------- ---------- -----------
        41          3       7.32%

1 row selected.

Elapsed: 00:00:01.79
ENKITEC@IOP> @fsxo

SQL_ID         CHILD  PLAN_HASH  EXECS  AVG_ETIME AVG_PX OFFLOAD IO_SAVED_%        AVG_LIO
------------- ------ ---------- ------ ---------- ------ ------- ---------- --------------
0q3s48vg6ddhg      5 1556289656      2      88.74      0 No             .00     13,404,990
0sxmqjfv2xzf3      0 3139973520      1       6.54      0 No             .00        892,423
1n4rfxtg6zg4x      0 3889350093      1       8.85      0 No             .00        656,485
1r5u1bq8xq2xj      0 1092323636      1      19.73      0 No             .00      4,297,589
1vgh9gswphvdy      1 1599020674  2,787        .08      0 Yes          100.00        659,786
1vgh9gswphvdy      3 1599020674  5,944        .09      0 Yes          100.00        661,692
1vgh9gswphvdy      4 1599020674  3,877        .07      0 Yes          100.00        661,985
22nu7gq6awt2j      1 4032143122      2      27.85      0 No             .00      4,102,245
238fx4v7gsv95      1 3046949154      2      84.78      0 No             .00     13,323,956
2b8c16v3cjsua      1 1543662060      2      92.80      0 No             .00     14,404,649
2pbxscctg6cnj      1 3046949154      2      84.28      0 No             .00     13,323,720
```

Common Configuration

- Auto DOP - Off
- SPM - Off
- Buffer Cache – Smaller than on non-Exadata
- Flash – All Flash Cache
- Huge Pages – enabled (no AMM)
- parallel_max_processes < default
- Backups – generally RMAN to recovery area then to tape

Suitability for Various Workloads

- OLTP
  - Good
- Mixed
  - Excellent
- DW
  - Killer

Indexing Strategies

Some Suggestions We've Heard
Drop All Indexes
Don't Change Anything

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Indexing Strategies

- Single Row Access (OLTP) Needs Indexes
- Most Workloads are Mixed
- Optimizer Doesn't Know About Smart Scans
- Challenge is to Use Indexes When Appropriate
- You Probably Need Fewer Indexes
- You May Have to Get Creative
  - optimizer_use_invisible_indexes
  - optimizer_index_cost_adj

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Compression Strategies

- HCC Provides Exceptional Compression Ratios
  - 10X is pretty good guess
  - 6X – 60X in Practice
- Oddly Enough Many are Not Using HCC
- HCC Not Appropriate for Active Data
- HCC Needs Partitioning
  - Requires Direct Path Loads
  - Update Move
  - Single Row Update Locks Entire CU
  - Falls Back to OLTP

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Organizational Challenges

- Who Should Manage The Beast
- General Thinking is DBA's (DMA's ?)
- It is 11g DB with ASM After All
- Patching Requires More Knowledge Than Most DBAs Have
  - Linux
  - Network
  - Hardware
  - Storage
- Best Approach for Most is Combination of Sysadmin / DBA
- SAN Guys are Out of the Picture
- CAB Story – "What happens if I run out of space?"

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Part 2: How to Know You're Getting What You Paid For

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How to Tune an Exadata
(radio edit)

Check to see if you're getting Smart Scans!

If you're not, figure out why and correct the situation!

It's Pretty Simple.

3 things you'll need to know:

- the Optimizations
- the Requirements
- how to Measure

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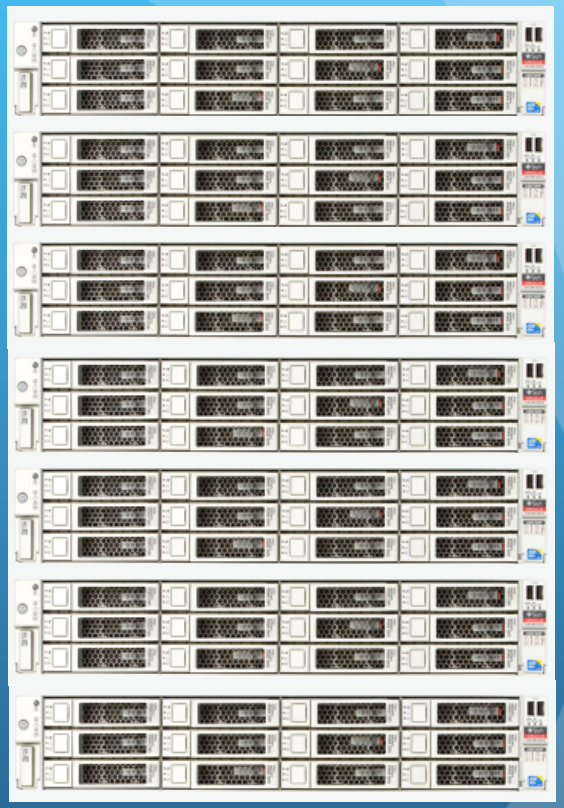
What is Exadata?

Exadata Storage Servers



Exadata Database Servers

Infiniband

11gR2 / ASM

iDB / RDS

cellsrv

*Half Rack

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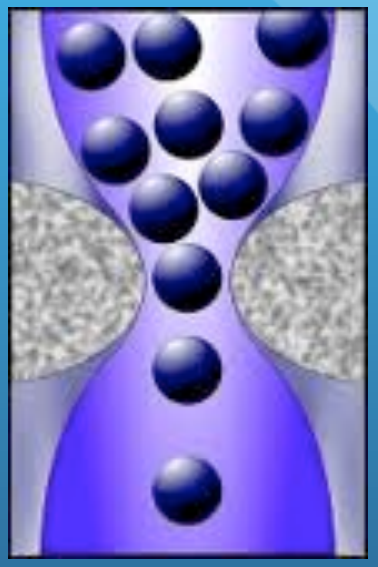
The Big Ah Ha!

The Bottleneck on Many (Most) Large Databases is between the Disk and the DB Server(s)!

How to Speed Up?

Make the Pipe Bigger/Faster
Reduce the Volume



* The fast way to do anything is not to do it!

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Offloading – The "Secret Sauce"

Offloading vs. Smart Scan
(what's the difference)

Offloading – generic term meaning doing work at the storage layer instead of at the database layer

Smart Scan – query optimizations covered by "cell smart table/index scan" wait events

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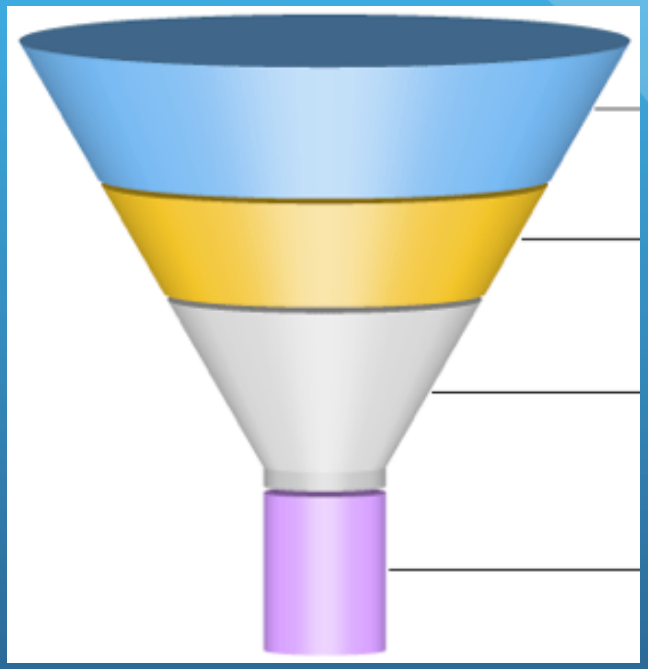
Smart Scan Optimizations

Column Projection
Predicate Filtering
Storage Indexes
Simple Joins
Function Offloading
Virtual Column Evaluation
HCC Decompression
Decryption



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Smart Scan Requirements

Full Scan
Direct Path Read
Object Stored On Exadata Storage

Why?

Very Simple Explanation:

Various full scan functions()
- kcbldrget() – direct path read function
  - kcfis_read() – kernel file intelligent storage read (Smart Scan)

*why it's there: checkpointing and non-block data return

How to Tell if You got a Smart Scan

Millsap It!
- (10046 trace)
- most fool proof?

TP It!
- Tanel's snapper
- v$sesstat, v$session_event
- great if it's happening now

~~Wolfgang It!~~
- unfortunately this doesn't work
- 10053 trace (and the optimizer) has no idea

Rahn It!
- DBMS_SQLTUNE.REPORT_SQL_MONITOR
- probably best

KO It!
- My fsx.sql script
- V$SQL family of views: IO_CELL_OFFLOAD_ELIGIBLE_BYTES
- saved in AWR so works on historical data as well

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Requirement 1: Full Scans

- Table
- Partition
- Materialized View
- Index (FAST FULL SCAN Only)

```
SYS@shareprd1> @op_event_awr.sql
Enter value for event: cell smart%

EVENT                     OPERATION                                COUNT(*)
------------------------- ---------------------------------------- ----------
cell smart index scan     INDEX STORAGE FAST FULL SCAN                    124
                          INDEX STORAGE SAMPLE FAST FULL SCAN             234

cell smart table scan     MAT_VIEW ACCESS STORAGE FULL                      1
                          TABLE ACCESS STORAGE FULL                     27747
```

* Query from DBA_HIST_ACTIVE_SESS_HISTORY

Requirement 2: Direct Path Reads

Bypass buffer cache – direct to PGA
Decision not part of optimizer's job
Traditionally Used by Parallel Slaves
Non-Parallel Also Possible
- Serial Direct Path Reads (adaptive)
- algorithm not fully documented (but more aggressive in 11g) *
  - size of segment (table or index or partition)
  - size of buffer cache
  - number blocks already in buffer cache
  - _small_table_threshold
  - _very_large_table_threshold

* See MOS Note: 50415.1 - WAITEVENT: "direct path read"

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Requirement 3: Exadata Storage

Kind of Goes Without Saying

- Possible to have non-Exadata storage or mixed
- ASM Diskgroup has an attribute: cell.smart_scan_capable
- Must be set to TRUE for Smart Scans to work
- Can’t add non-Exadata storage without changing to FALSE

Demo Time

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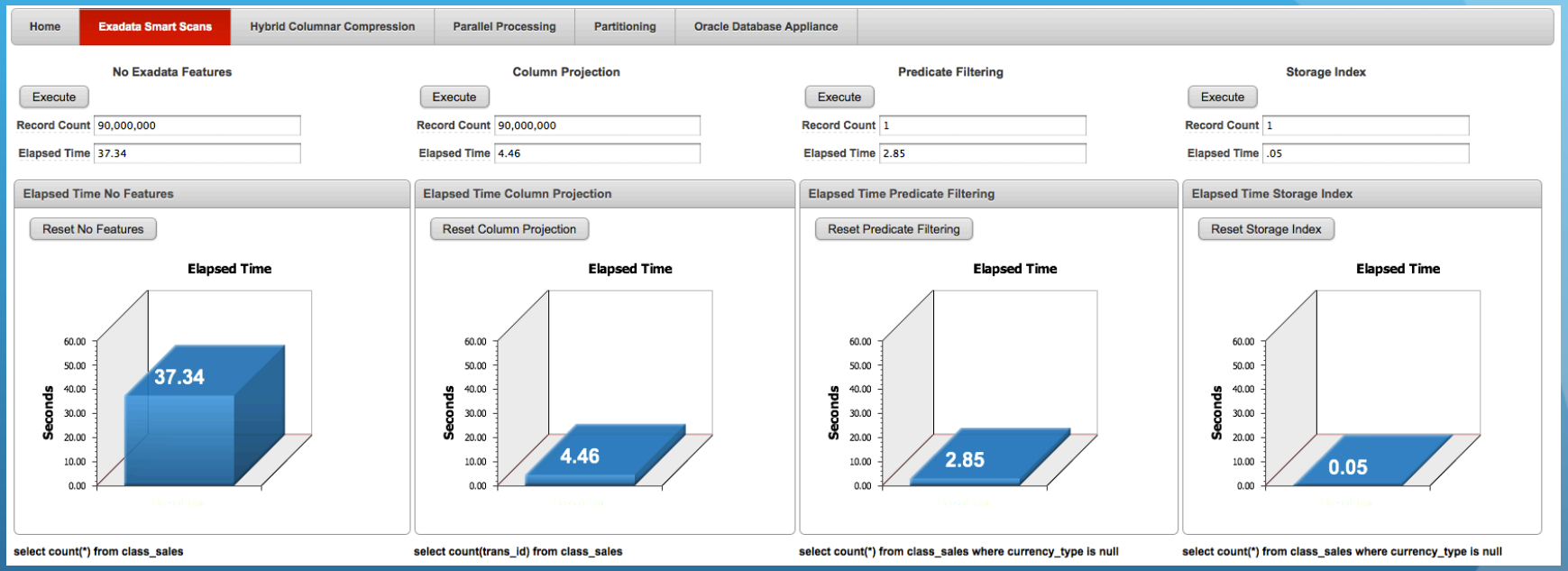
```
------------------------------
select /*+ parallel 2 */ a.col2, sum(a.col1) from kso.skew a, kso.skew b where rownum < 30000000 group by a.col2

Global Information
------------------------------
 Status              :  DONE (ALL ROWS)
 Instance ID         :  1
 Session             :  SYS (1278:795)
 SQL ID              :  6f2dhcj7m3k2b
 SQL Execution ID    :  16777216
 Execution Started   :  03/07/2012 15:04:19
 First Refresh Time  :  03/07/2012 15:04:19
 Last Refresh Time   :  03/07/2012 15:04:33
 Duration            :  14s
 Module/Action       :  sqlplus@enkdb01.enkitec.com (TNS V1-V3)/-
 Service             :  SYS$USERS
 Program             :  sqlplus@enkdb01.enkitec.com (TNS V1-V3)
 Fetch Calls         :  2

Global Stats
=========================================================================================================
| Elapsed |   Cpu   |    IO    | Application |  Other   | Fetch | Buffer | Read | Read  | Write | Write |  Cell   |
| Time(s) | Time(s) | Waits(s) |  Waits(s)   | Waits(s) | Calls |  Gets  | Reqs | Bytes | Reqs  | Bytes | Offload |
=========================================================================================================
|      27 |      23 |     3.56 |        0.00 |     0.33 |     2 |  73767 | 3071 | 676MB |  1228 | 246MB |  -3.09% |
=========================================================================================================

Parallel Execution Details (DOP=2 , Servers Allocated=4)
=================================================================================================================================================================
|      Name      | Type  | Server# | Elapsed |   Cpu   |    IO    | Application |  Other   | Buffer | Read | Read  | Write | Write |  Cell   |          Wait Events          |
|                |       |         | Time(s) | Time(s) | Waits(s) |  Waits(s)   | Waits(s) |  Gets  | Reqs | Bytes | Reqs  | Bytes | Offload |          (sample #)           |
=================================================================================================================================================================
| PX Coordinator | QC    |         |    7.40 |    7.23 |          |        0.00 |     0.17 |   1058 |      |     . |       |     . |    NaN% |                               |
| p000           | Set 1 |       1 |    8.11 |    6.72 |     1.22 |             |     0.16 |    765 | 1123 |  61MB |   614 | 123MB | -66.67% |                               |
| p001           | Set 1 |       2 |    8.55 |    7.13 |     1.42 |             |          |    655 | 1103 |  59MB |   614 | 123MB | -66.67% | direct path read temp (1)     |
| p002           | Set 2 |       1 |    1.55 |    1.12 |     0.43 |             |          |  35646 |  428 | 278MB |       |     . |  38.65% |                               |
| p003           | Set 2 |       2 |    1.61 |    1.12 |     0.50 |             |          |  35643 |  417 | 278MB |       |     . |  38.27% |                               |
=================================================================================================================================================================

SQL Plan Monitoring Details (Plan Hash Value=1100917592)
=================================================================================================================================================================================================================
| Id |               Operation               |     Name     |  Rows   | Cost |   Time    | Start  | Execs |   Rows   | Read | Read  | Write | Write |  Cell   | Mem  | Temp | Activity |      Activity Detail      |
|    |                                       |              | (Estim) |      | Active(s) | Active |       | (Actual) | Reqs | Bytes | Reqs  | Bytes | Offload | (Max) | (Max) |   (%)    |       (# samples)         |
=================================================================================================================================================================================================================
|  0 | SELECT STATEMENT                      |              |         |      |         6 |     +9 |     1 |        1 |      |       |       |       |         |       |       |          |                           |
|  1 |   HASH GROUP BY                       |              |       2 | 331G |         7 |     +8 |     1 |        1 |      |       |       |       |     13M |       |       |    14.81 | Cpu (4)                   |
|  2 |    COUNT STOPKEY                      |              |         |      |         6 |     +9 |     1 |      30M |      |       |       |       |         |       |       |          |                           |
|  3 |     PX COORDINATOR                    |              |         |      |         6 |     +9 |     5 |      30M |      |       |       |       |         |       |       |    11.11 | Cpu (3)                   |
|  4 |      PX SEND QC (RANDOM)              | :TQ10001     |      1P | 175G |         7 |     +8 |     2 |      30M |      |       |       |       |         |       |       |     7.41 | Cpu (2)                   |
|  5 |       COUNT STOPKEY                   |              |         |      |         7 |     +8 |     2 |      30M |      |       |       |       |         |       |       |          |                           |
|  6 |        MERGE JOIN CARTESIAN           |              |      1P | 175G |        13 |     +2 |     2 |      30M |      |       |       |       |         |       |       |          |                           |
|  7 |         PX BLOCK ITERATOR             |              |     32M | 24649 |         1 |     +2 |     2 |       2 |      |       |       |       |         |       |       |          |                           |
|  8 |          TABLE ACCESS STORAGE FULL    | SKEW         |     32M | 24649 |        13 |     +2 |     2 |       2 |    3 |   3MB |       |       |  47.09% |       |       |          |                           |
|  9 |         BUFFER SORT                   |              |     32M | 331G |        13 |     +2 |     2 |      30M | 2223 | 117MB |  1228 | 246MB |     205M |  258M |       |    51.85 | Cpu (13)                  |
|    |                                       |              |         |      |           |        |       |          |      |       |       |       |         |       |       |          | direct path read temp (1) |
| 10 |          PX RECEIVE                   |              |     32M | 10683 |         7 |     +2 |     2 |      64M |      |       |       |       |         |       |       |     7.41 | Cpu (2)                   |
| 11 |           PX SEND BROADCAST           | :TQ10000     |     32M | 10683 |         2 |     +1 |     2 |       4 |      |       |       |       |         |       |       |     3.70 | Cpu (1)                   |
| 12 |            PX BLOCK ITERATOR          |              |     32M | 10683 |         1 |     +2 |     2 |      32M |      |       |       |       |         |       |       |          |                           |
| 13 |             INDEX STORAGE FAST FULL SCAN | SYS_C003992 |     32M | 10683 |         2 |     +1 |    26 |      32M |  845 | 557MB |       |       |  38.65% |       |       |     3.70 | Cpu (1)                   |
=================================================================================================================================================================================================================
```

Exadata Software Performance



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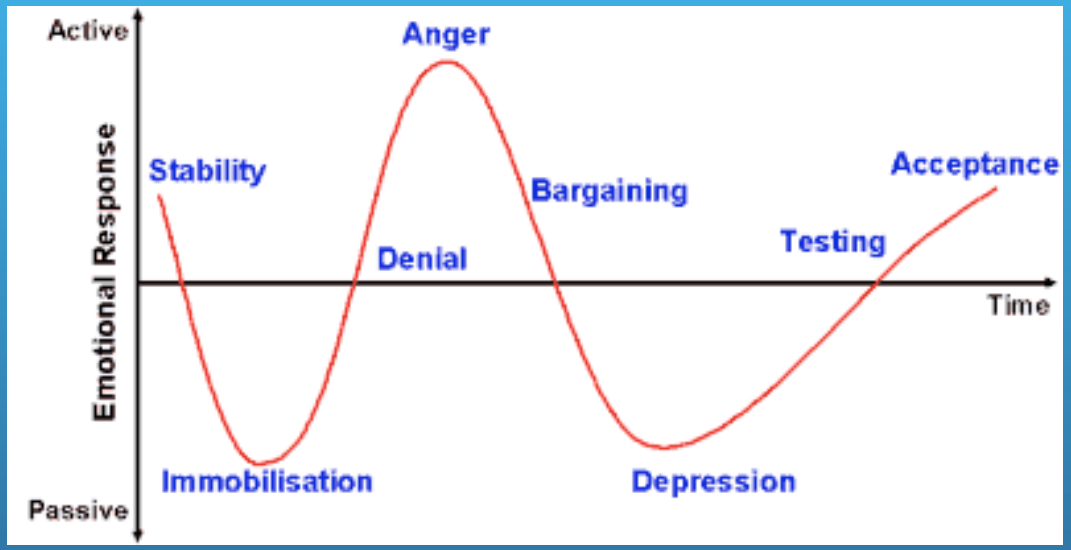
High Transaction Volume: Telco Provider

- Customer Runs Dell, 16 Core Machines in Multiple RAC Instances
- Very High Volume of OLTP and Data Warehouse Type Queries on Same Database
- Performance Differences Were Too Excessive to Graph

SQL	Current	Exadata	Times Faster
Process 1: 6-Month Data Volume	52 min	19.5 sec	160 x
Process 2: 3-Month Data Volume	51 min	11.5 sec	269 x
Process 3: 1-Year Data Volume	50 min	37.5 sec	81 x
Process 4: 2-Month Data Volume	48 min	9.4 sec	308 x
Update SCN_CALL_PARTY_LOG	13 min	1.05 sec	744 x
Update SCN_CALL_PARTY_IDENT_LOG	7 min	.23 sec	1871 x
Select SCN_CALL_PARTY_EXTDATA_LOG	6.75 min	.47 sec	868 x

The Kübler-Ross grief cycle



Exposure to Exadata

Questions?

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