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Common Anti-Patterns for Optimizing Big Data Oracle Databases

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Real World Performance Team
March 19th, 2015

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Agenda

1. Is this session for YOU?
2. About the Real World Performance Team
3. Your mission, should you choose to accept it …
4. Use of Weapons
5. Solution (or How to use a Model S P85D to pickup groceries)
6. 3 takeaways for achieving Extreme Performance

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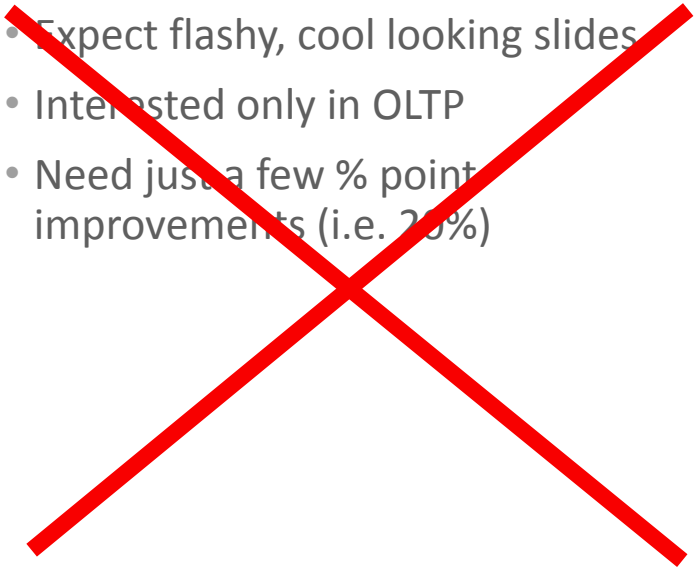
Anti-Patterns

An anti-pattern (or antipattern) is a common response to a recurring problem that is usually ineffective and risks being highly counterproductive.

— Wikipedia

Is this session for YOU?

- Expect flashy, cool looking slides
- Interested only in OLTP
- Need just a few % point improvements (i.e. 20%)



- Design/Develop/Operate Decision support systems (i.e. Data Warehouse/Mart, Big Data,…)
- Require **orders of magnitude** (10x, 100x, 1000x) improvements
- Prefer an Interactive Session
- Reproduce in your own environment

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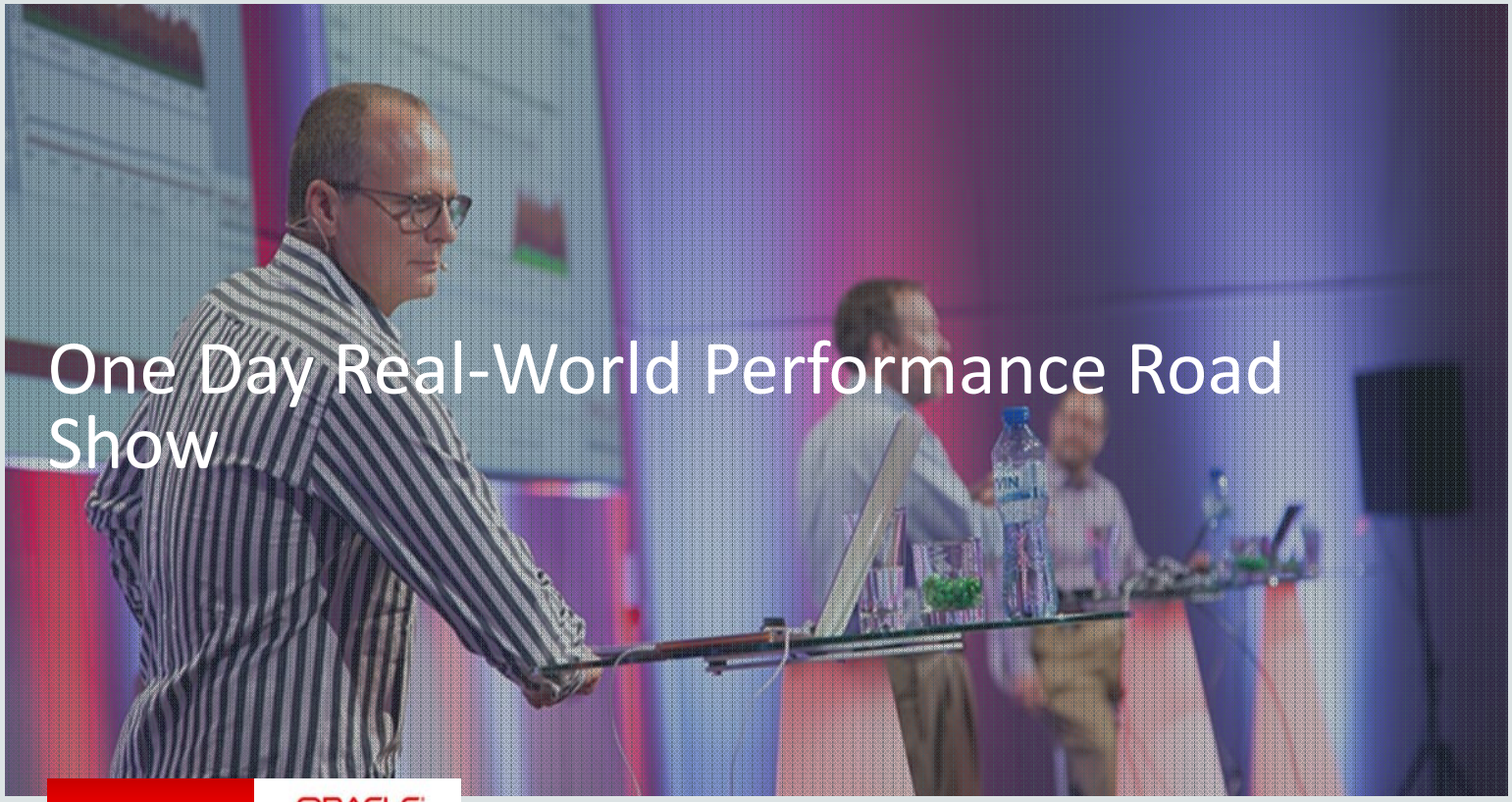
Real-World Performance

Who We Are

- Part of the Database Development Organization
- Global Team located in USA, Europe, Asia
- 300+ combined years of Oracle database experience
- Innovate to achieve exceptional Database Performance
- Our methods:
  - Use the product as it was designed to be used
  - Numerical and logical debugging techniques
  - Educate others about the best performance methods and techniques
  - Avoid and eliminate “tuning” by hacking/guessing/luck

One Day Real-World Performance Road Show



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ORACLE REAL-WORLD PERFORMANCE

Real-World Performance Tour in Association with IOUG

Featuring Andrew Holdsworth, Tom Kyte and Graham Wood

- Europe 2015
  - Feb 13th Norway
  - Mar 17th Slovenia/Croatia
  - Mar 19th Great Britain
  - Mar 23rd Denmark
  - Mar 25th Austria
  - Mar 27th Turkey
- USA—TBD
- ASIA
  - May 20th Beijing
  - May 22th Shangai
- South America—TBD

Real-World Performance

Online Video Series

- Real-World Performance Engineers discussing and demonstrating performance issues, root causes and when to apply the correct techniques
  - The Optimizer
  - Core DB Performance
  - Extreme OLTP
  - Extreme DW
- http://www.oracle.com/goto/oll/rwp

Real-World Performance Training

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REAL-WORLD PERFORMANCE

Real-World Performance Classroom Training

Classroom Training

- 4 Day Class of Intensive Performance Training
  - Topics: The Optimizer, Core DB Performance, Extreme OLTP and DW
  - Classroom, Demos, Hands On, Test and Quizzes
  - Training given by Real-World Performance Engineers
  - Designed for Architects, Developers and DBAs
  - 4 months training in 4 days
- Contact RWP or your local Oracle team to apply

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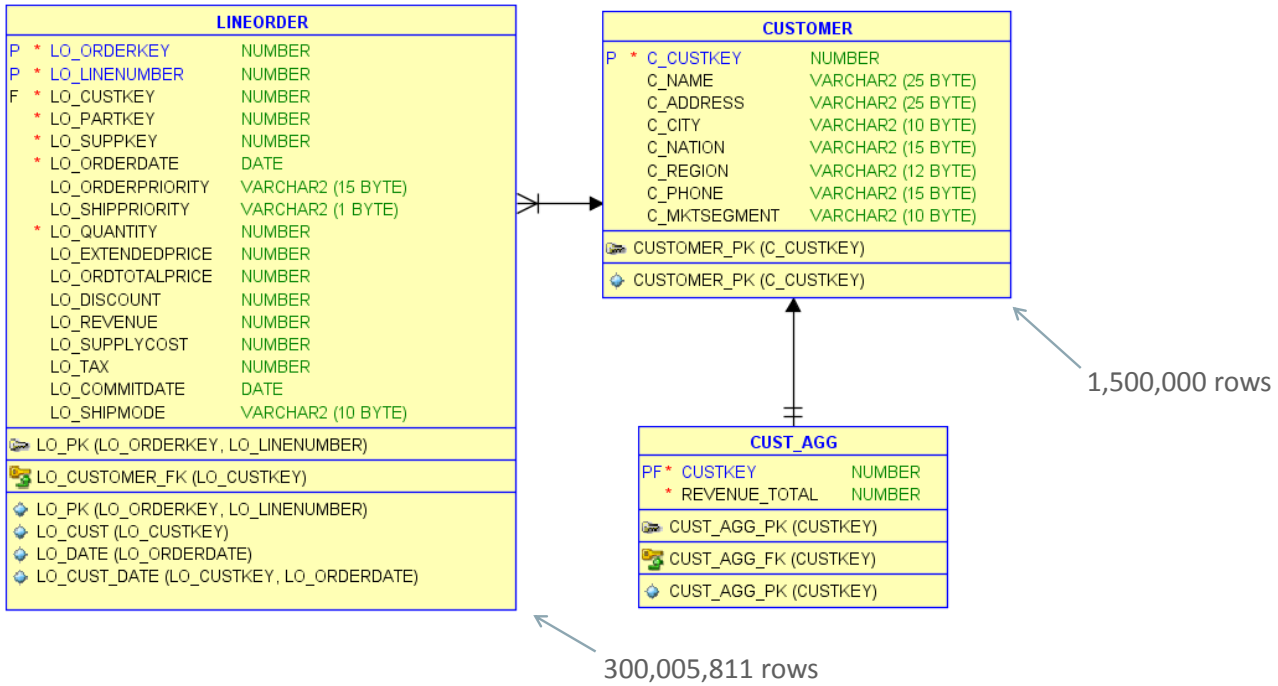
Your mission, should you choose to accept it …

- Current environment does not meet SLAs
- Business expects data volume to increase drastically in the future
- Legacy application and DB migrated to new powerful hardware but performance/scalability goals have not been reached
- Business expects 1000x better performance for a mission-critical BI process
- Your mission, should you choose to accept it, is to meet the 1000x goal

BI process details

- Identifies the most valuable customers for each month
- Currently the process takes about 26 minutes
- Implemented in Java, data in Oracle 12.1.0.2 on Exadata x3-8
- Uses 3 tables

ERD



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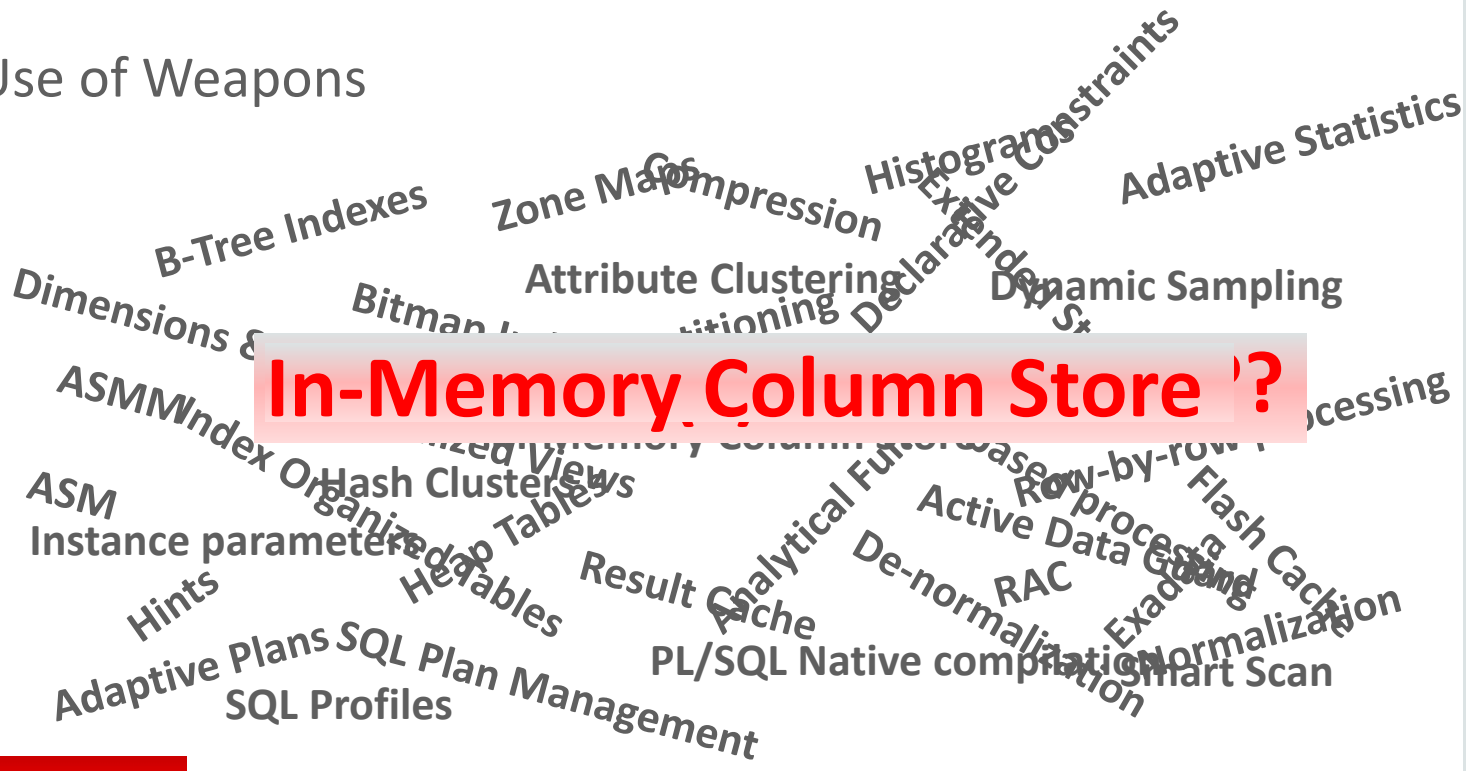
Use of Weapons



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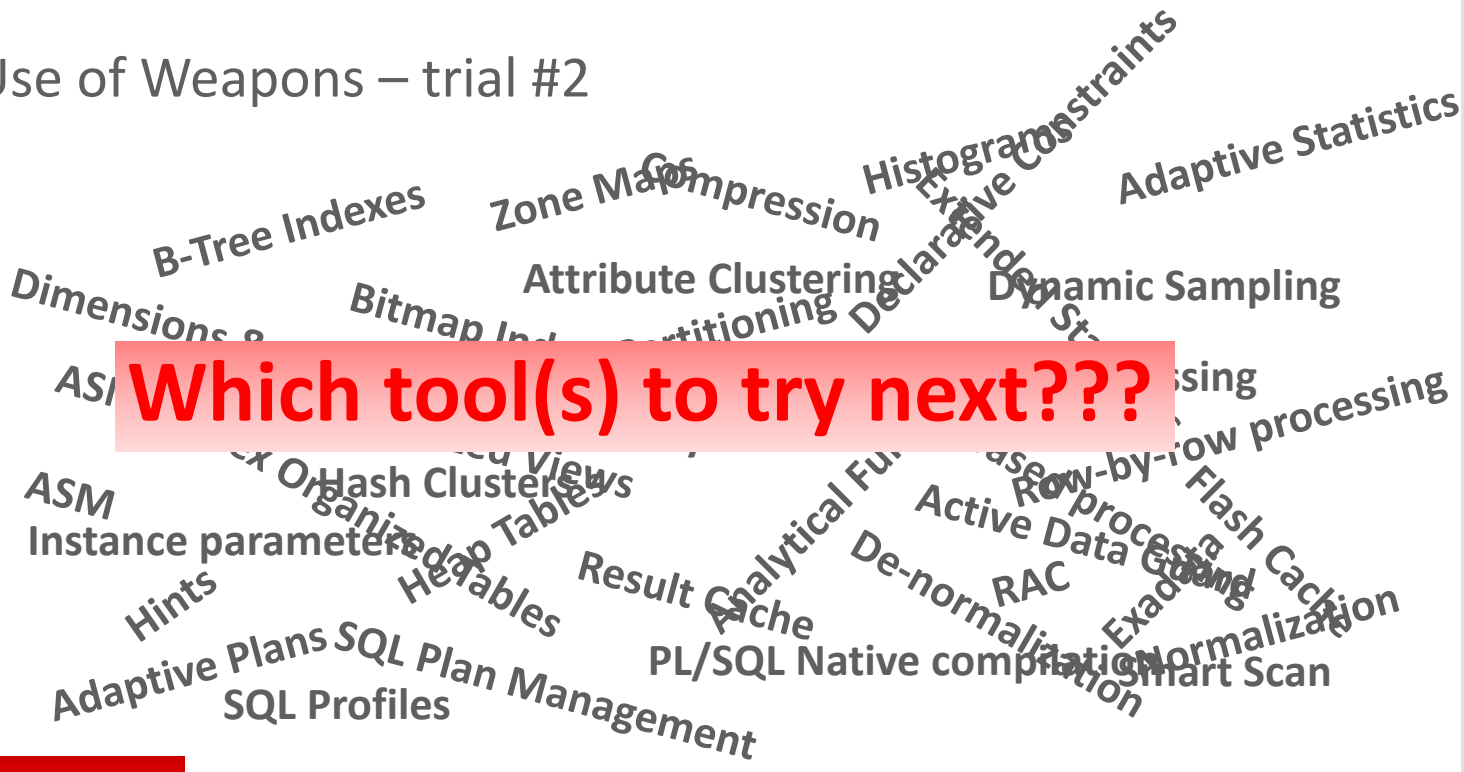
Is In-Memory the solution ?

```
SQL> Alter table lineorder inmemory memcompress for query;
Table altered.

SQL>   SELECT
2          segment_name, INST_ID
3        , populate_status
4        , round(BYTES_NOT_POPULATED /1024/1024/1024, 2) as gb_not_populated
5    FROM gv$im_segments
6    where owner='APPS1000X'
7    order by segment_name, inst_id
8  ;

SEGMENT_NAME            INST_ID POPULATE_ GB_NOT_POPULATED
-------------------- ---------- --------- ----------------
CUSTOMER                     1 COMPLETED                0
LINEORDER                    1 COMPLETED                0
```

Use of Weapons – trial #2



Anti-Pattern #1 - Trial and Error approach

- Time consuming
- Relies on luck
- Limits understanding of the root cause of a performance bottleneck
- Instead, “Look before you leap” principle

Look before you leap

The universal experience of programmers
who have been using measurement tools
has been that their intuitive guesses fail.

- Donald Knuth

Look before you Leap

WORKLOAD REPOSITORY report for

DB Name	DB Id	Instance	Inst num	Startup Time	Release	RAC
SSB	906471671	SSB1	1	15-Feb-15 17:02	12.1.0.2.0	YES

Host Name	Platform	CPUs	Cores	Sockets	Memory (GB)
slcg02db01.us.oracle.com	Linux x86 64-bit	160	80	8	2019.52

	Snap Id	Snap Time	Sessions	Cursors/Session	Instances
Begin Snap:	3724	16-Feb-15 13:14:25	135	1.2	1
End Snap:	3725	16-Feb-15 13:40:26	135	1.2	1
Elapsed:		26.02 (mins)			
DB Time:		13.42 (mins)			

Load Profile

	Per Second	Per Transaction	Per Exec	Per Call
DB Time(s):	0.5	9.7	0.00	0.00
DB CPU(s):	0.5	9.7	0.00	0.00

Look before you Leap

- Notice elapsed time >> db time
- Notice db cpu >> sql execution elapsed time
- Notice sum of all sql times << db cpu
- We can only account for ***34%*** of the total elapsed time

Where is the missing time?!

- java process OS stats

```
$ time java demo
 4.608u 2.780s 26:08.47 0.4%
```

- If 50% time is not spend in the App nor in the database, where is it?
- What is between the App and the DB?
- 3.3 M SQL*Net roundtrips to/from client = 2,109/sec

Anti-Pattern #2 – Stay inside your Comfort Zone

- Don’t choose your tool solely based on what you are comfortable with, or what is currently in vogue, …
- Choose the tool that can achieve the goal
- When processing large amounts of data, move the processing close to the source of the data

Eliminate the bottleneck – network round-trips

One way to eliminate network round-trips is to move the data processing logic into the database, i.e. using PL/SQL.

```
SQL> exec find_high_value_customers
```

Eliminate the bottleneck - network round-trips

```
SQL>create or replace procedure find_high_value_customers as
  2      revenue_total cust_agg.revenue_total%type;
  3  begin
  4
  5    execute immediate 'truncate table cust_agg';
  6
  7    for c in (select c_custkey, c_name  from customer)
  8    loop
  9        revenue_total := 0;
 10
 11        for lo in ( select lo_revenue
 12                      from lineorder
 13                     where lo_orderdate between date'1996-12-01' and date'1996-12-31'
 14                       and lo_custkey = c.c_custkey)
 15        loop
 16            revenue_total := revenue_total + lo.lo_revenue;
 17        end loop;
 18
 19        insert into cust_agg (custkey, revenue_total) values (c.c_custkey,revenue_total);
 20    end loop;
 21
 22    delete cust_agg where revenue_total < 200000000;
 23    commit;
 24
 25  end;
 26  /

Procedure created.

Elapsed: 00:00:00.07
```

Look before you Leap – PL/SQL

WORKLOAD REPOSITORY report for

DB Name	DB Id	Instance	Inst num	Startup Time	Release	RAC
SSB	906471671	SSB1	1	15-Feb-15 17:02	12.1.0.2.0	YES

Host Name	Platform	CPUs	Cores	Sockets	Memory (GB)
slcg02db01.us.oracle.com	Linux x86 64-bit	160	80	8	2019.52

	Snap Id	Snap Time	Sessions	Cursors/Session	Instances
Begin Snap:	3728	16-Feb-15 14:45:56	134	1.2	1
End Snap:	3729	16-Feb-15 14:51:39	135	1.2	1
Elapsed:		5.71 (mins)			
DB Time:		5.72 (mins)			

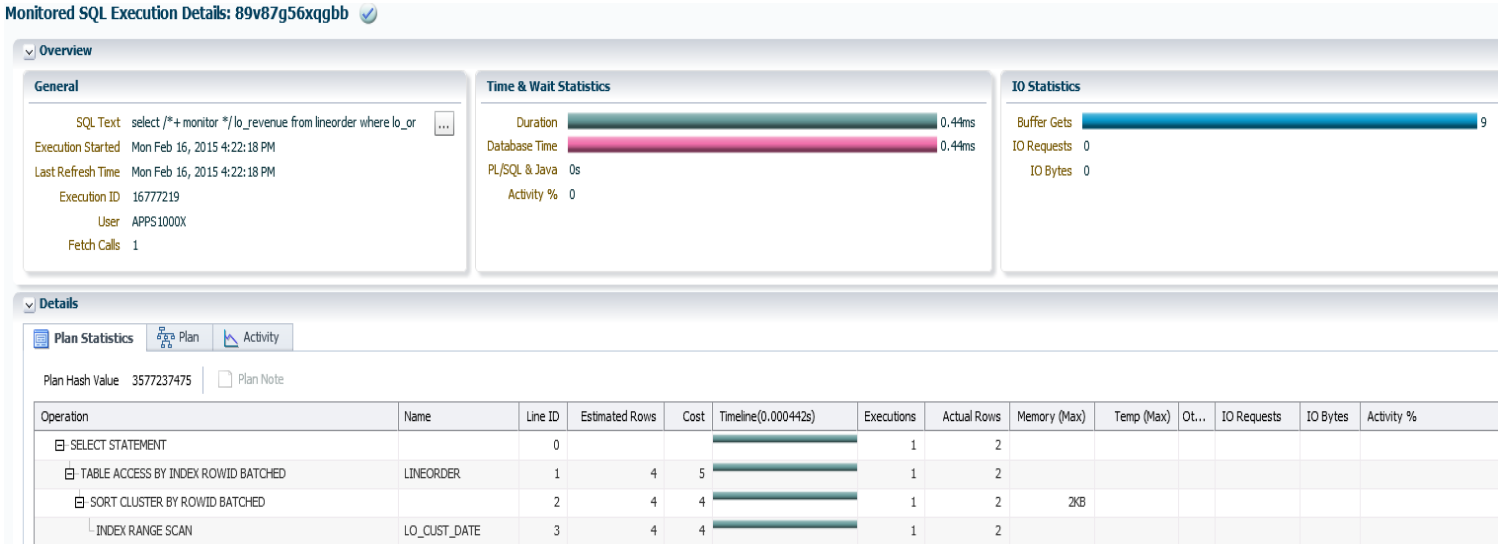
Load Profile

	Per Second	Per Transaction	Per Exec	Per Call
DB Time(s):	1.0	9.3	0.00	0.63
DB CPU(s):	1.0	9.2	0.00	0.63

Why did the performance improve?

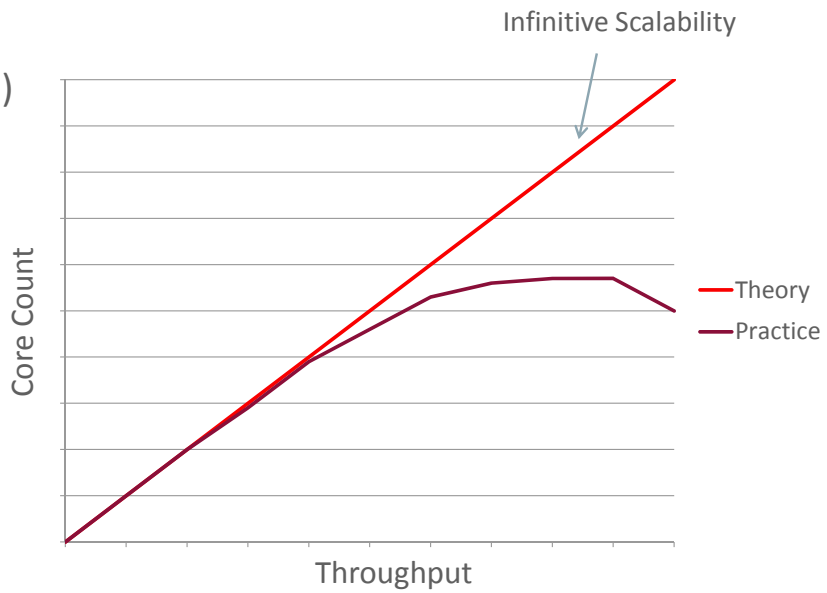
- AWR
  - elapsed time ≈ db time
  - db cpu ≈ sql execution elapsed time
  - sum of all sql times ≈ db cpu
  - Pl/sql time ≈ 21% of baseline + ≈ 70% of missing time (network round trips)
  - SQL*Net roundtrips to/from client reduced from about 3,300,000 to 287
  - Network traffic reduced from 514 MB to 0.3MB (330KB)
  - Not about Java vs PL/SQL, or App vs DB
  - Use the tool that can achieve the goal
  - Approx. 5x improvement

Can we tune the query?



Anti-Pattern #3 – Throw Hardware at it

- Use Faster CPUs?
  - Intel® Xeon® E7-8870 (2.40 GHz)
  - 384 GFLOPs
- More CPUs



Identify the bottleneck

- What is the alternative?
- Can the goal be accomplished using a different approach/algorithm?

Anti-Pattern #4 – Looking only at the tree…

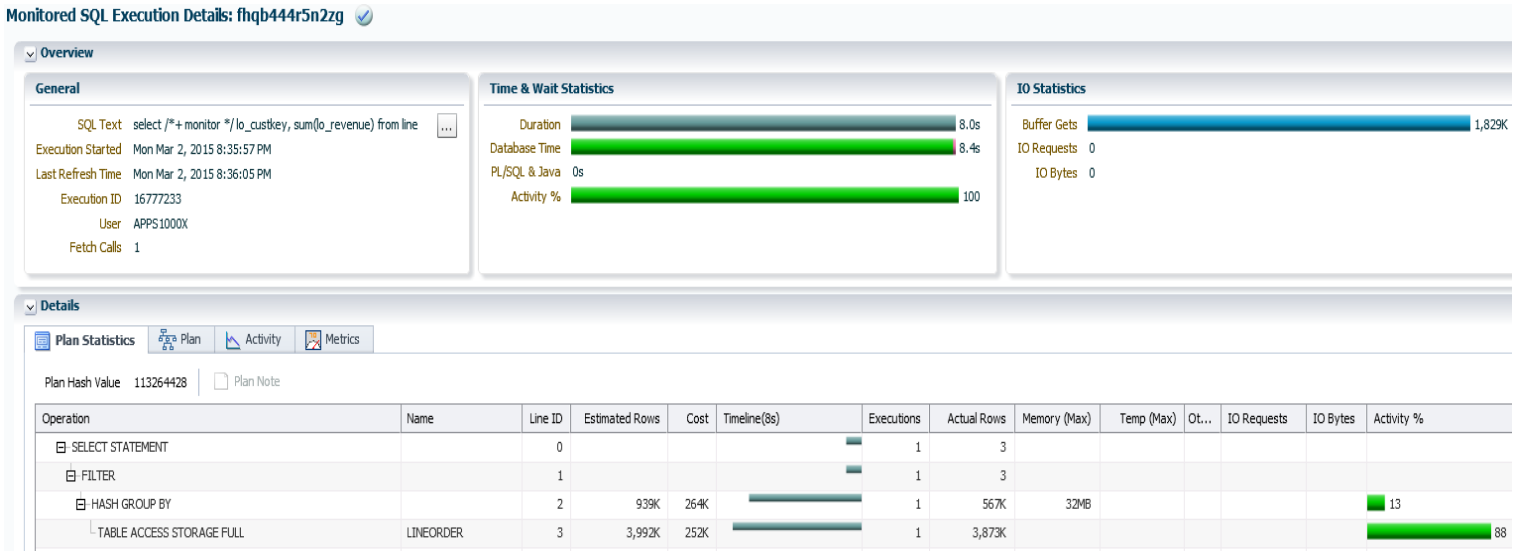
- Miss the forest for the trees
- Row-by-row processing = Slow-by-slow processing
- How to use a Tesla Model S P85D to pickup groceries
- Applying OLTP specific algorithms to Big Data Systems
  - Another example of Anti-Pattern #2 – Stay inside your Comfort Zone

Eliminate the bottleneck – row-by-row processing

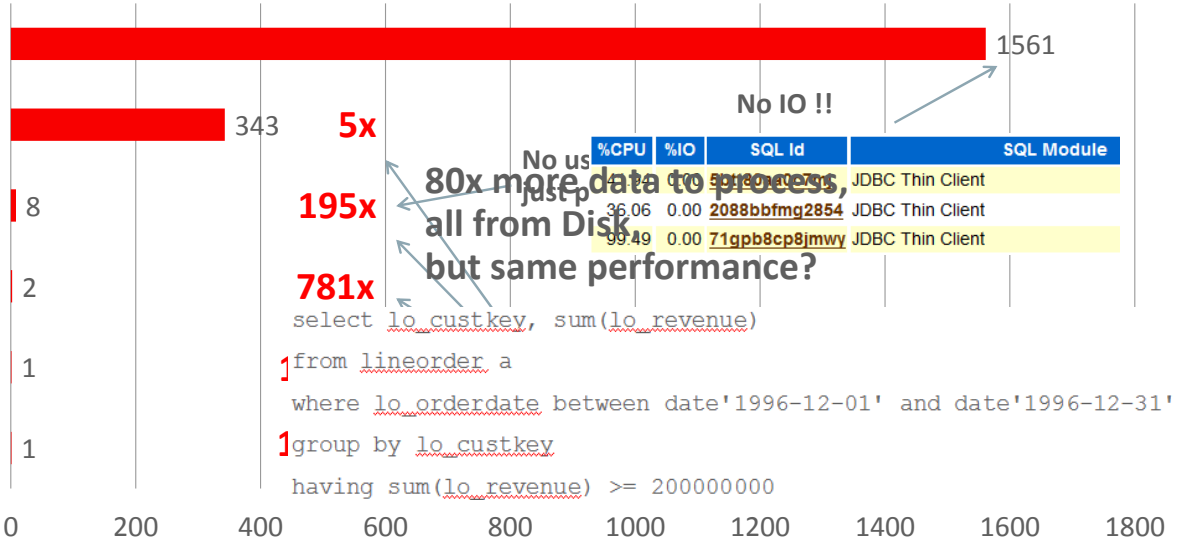
- Replace row-by-row with set-based processing
- Just tell the database what data you want, not how to get to it !

```
select lo_custkey, sum(lo_revenue)
from lineorder a
where lo_orderdate between date'1996-12-01' and date'1996-12-31'
group by lo_custkey
having sum(lo_revenue) >= 200000000
;
```

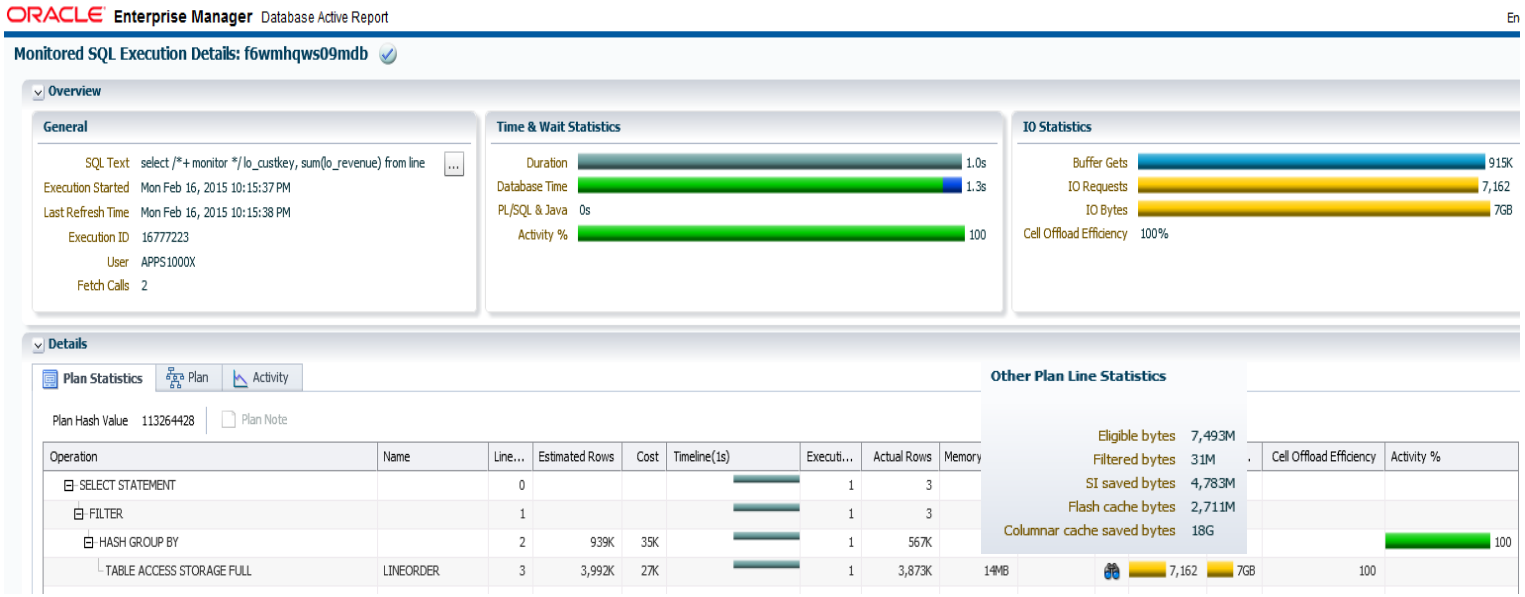
Set based processing



Results Comparison (Elapsed seconds)



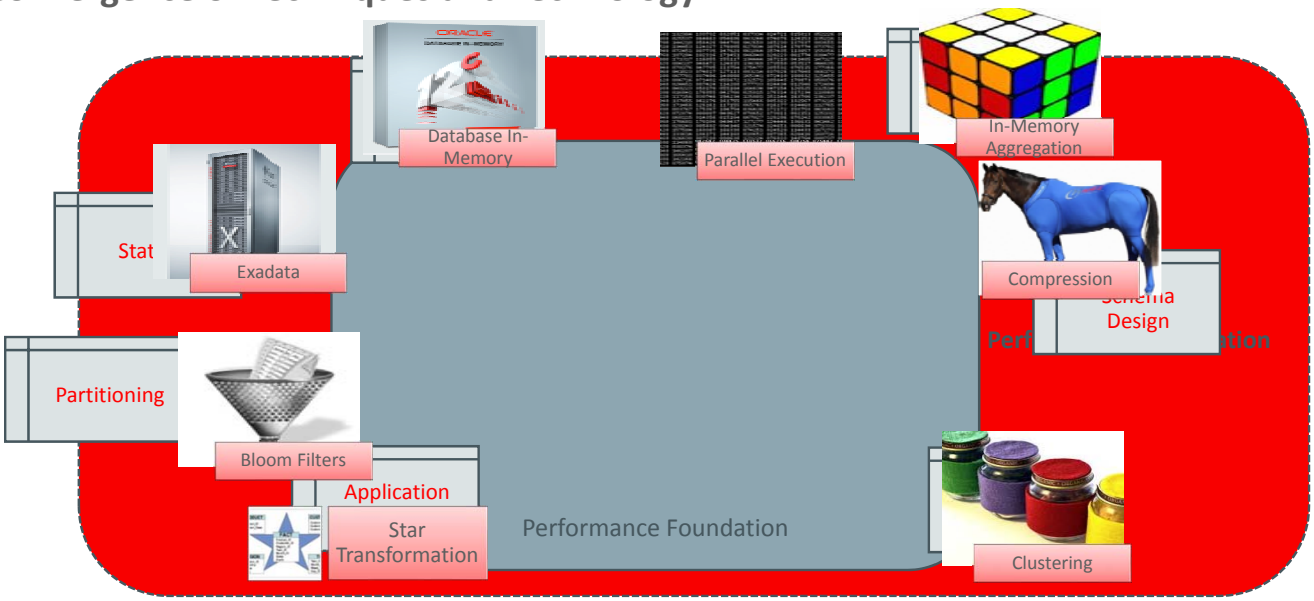
Set based processing (IO & Exadata)



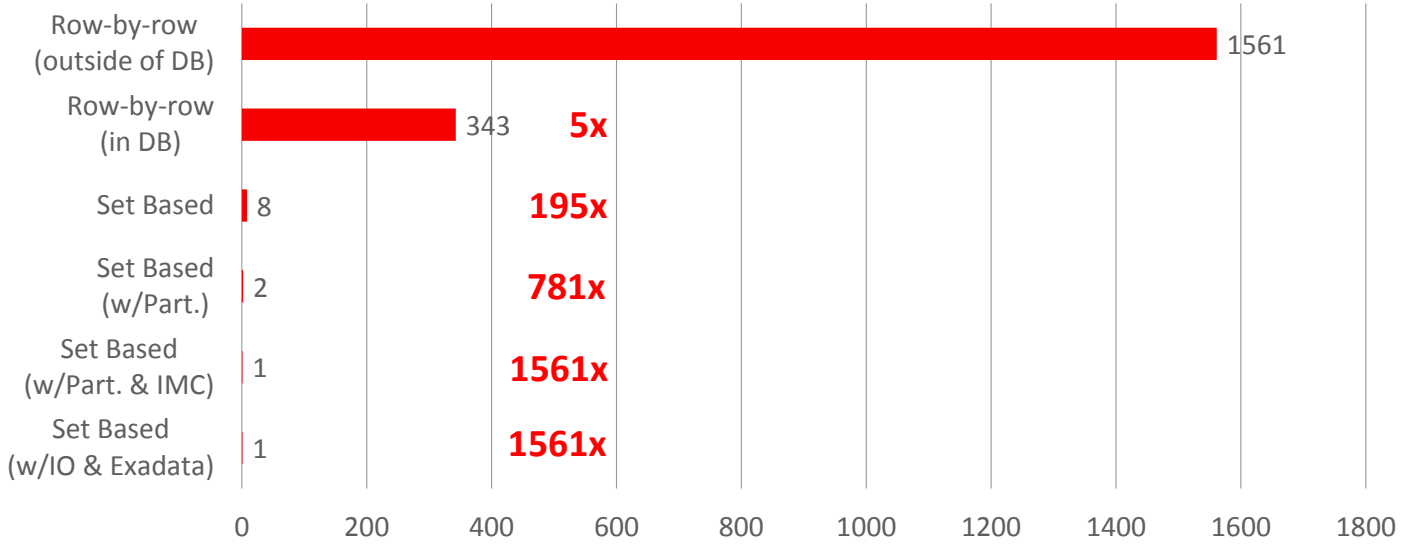
Use of Weapons

Real World Performance

Convergence of Techniques and Technology



Where is the biggest bang for the buck (ROI)?



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1. Look before you leap

It is a capital mistake to theorize before one has data. Insensibly one begins to twist facts to suit theories, instead of theories to suit facts.

— Sherlock Holmes,

"The Adventures of Sherlock Holmes"

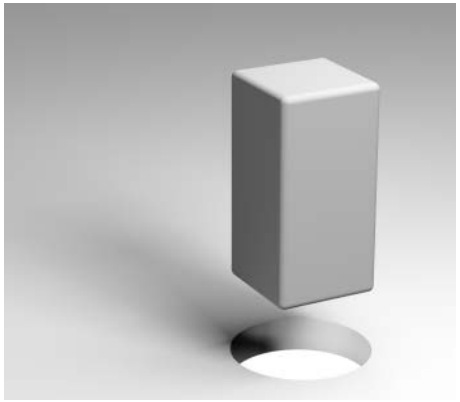
by Sir Arthur Conan Doyle

The truth is out there*

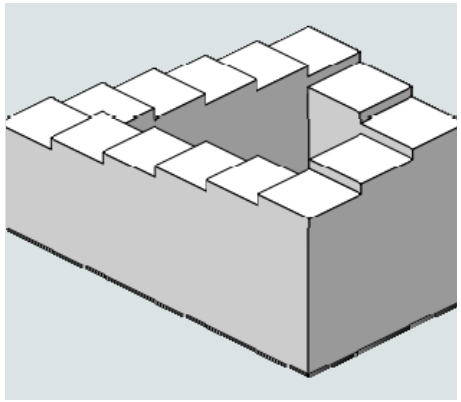
- EM
- EM Express Performance Hub
- AWR
- ADDM
- ASH
- SQL Monitor

- SQL Trace
- SQL Compiler Trace
- SQL Test Case Builder
- SQLTXPLAN
- SQLD360
- etc.

2. Root Causes of Suboptimal Database Performance



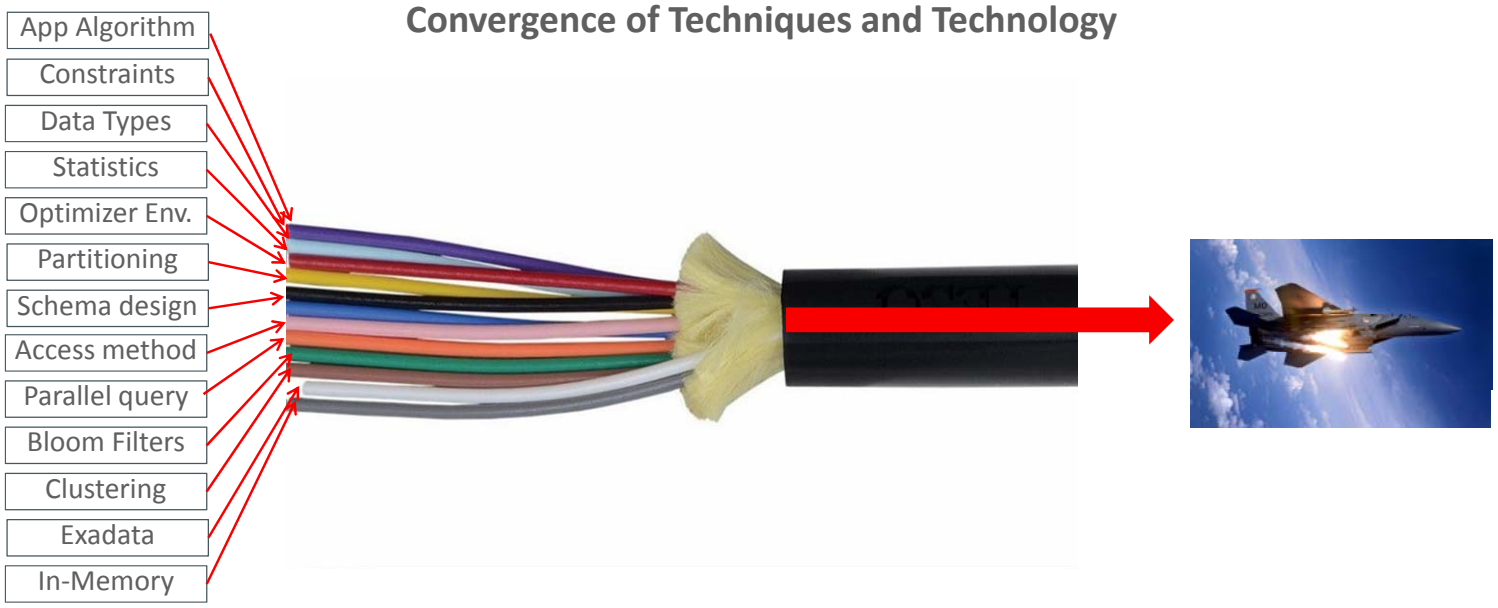
The database is not being used as it was designed to be used



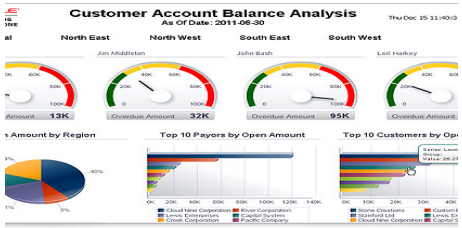
The application architecture/code design is suboptimal

There is a suboptimal algorithm in the database

3. Extreme Performance is multi-faceted



Recent Results 1000X Projects



Baseline:	~ 4.3 Hours
Code Changes:	4.3 Hours
Correct Usage:	29 secs
Bug Fixes:	11.5 secs
Final:	11.5 secs
Speed up:	**1346x**

Baseline:	~ 2.4 Days
Code Changes:	27 Mins
Correct Usage:	7.5 Mins
Bug Fixes:	3 Mins 27 Secs
Final:	3 Mins 27 Secs
Speed up:	**1002x**

Baseline:	4.06 hours
Code Changes:	3.65 Secs
Correct Usage:	3.65 Secs
Bug Fixes:	3.65 Secs
Final:	3.65 Secs
Speed up:	**4007x**

Environment Setup

- Create a new*1 or use an existing DB
- Create objects using DDL provided in the Appendix
- Generate Data using dbgen*2
- Import data (i.e. using external tables)
- Have fun

*1 i.e. http://www.oracle.com/technetwork/database/enterprise-edition/databaseappdev-vm-161299.html

*2 i.e. download from https://github.com/electrum/ssb-dbgen

Hardware and Software
Engineered to Work Together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