Oracle DW Strategy

- Best Database for BI/DW
  - 30 years of innovation
  - No other database can compare on the breadth and sophistication of Oracle’s database features
- Within complete solutions
  - Complete database platform capabilities: ELT and Analytics
  - Complete BI and Performance Management solutions from Oracle
  - Broadest array of third-party technologies and solutions
- On the right hardware infrastructure
Complete Solutions

Performance Mgmt: Hyperion
BI Applications: Bus Obj, Cognos
BI Tool: Business Objects, Cognos
Middleware: IBM, BEA
Database: ORACLE

Performance Mgmt: ORACLE
BI Application: ORACLE
BI Tool: ORACLE
Middleware: ORACLE
Database: ORACLE

Benefits:
• Integrated stack
• Continued best-of-breed
• Top-to-bottom performance optimization
Oracle Data Warehouse Platform

### Analytics
- Multi-Dimensional Calculations
- Time Series
- Statistics
- Data Mining

### Intelligent Query Processing
- Materialized Views
- Bitmap Indexes
- Partition Elimination
- Star Query Optimization

### Scalable Data Management
- Parallel Execution
- Partitioning
- RAC
- Automatic Storage Mgmt
- Compression

### Data Integration
- Bulk ETL
- Real-Time ETL
- Data Quality

### Workload Management

### Metadata Management

### Security
Oracle10g for Data Warehousing
Continuous Innovation

Oracle 7.3
- Partitioned Tables and Indexes
- Partition Pruning
- Parallel Index Scans
- Parallel Insert, Update, Delete
- Parallel Bitmap Star Query
- Parallel ANALYZE
- Parallel Constraint Enabling
- Server Managed Backup/Recovery
- Point-in-Time Recovery

Oracle 8.0
- Hash and Composite Partitioning
- Resource Manager
- Progress Monitor
- Adaptive Parallel Query
- Server-based Analytic Functions
- Materialized Views
- Transportable Tablespaces
- Direct Loader API
- Functional Indexes
- Partition-wise Joins
- Security Enhancements

Oracle 8i
- List and Range Partitioning
- Table Compression
- Bitmap Join Index
- Self-Tuning SQL Optimization
- New Analytic Functions
- Grouping Sets
- External Tables
- MERGE
- Multi-Table Insert
- Proactive Query Governing
- System Managed Undo

Oracle 9i
- Self-tuning SQL Optimization
- SQL Access Advisor
- Automatic Storage Manager
- Self-tuning Memory
- Change Data Capture
- SQL Models
- SQL Frequent Itemsets
- SQL Partition Outer Joins
- Statistical functions
- and much more ...

Oracle 10g
- Self-tuning SQL Optimization
- SQL Access Advisor
- Automatic Storage Manager
- Self-tuning Memory
- Change Data Capture
- SQL Models
- SQL Frequent Itemsets
- SQL Partition Outer Joins
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Oracle for Data Warehousing
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Oracle 8.0
- List and Range-List Partitioning
- Table Compression
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Oracle10
- Self-tuning SQL Optimization
- SQL Access Advisor
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- SQL Frequent Itemsets
- SQL Partition Outer joins
- Statistical functions
- and much more...

Oracle11g
- New composite partitionings
- Virtual column partitioning
- REF partitioning
- Cube-based Materialized Views
- SQL Pivot and Unpivot
- Query Result Cache
- SQL Plan Management
- General Linear Models
- Advanced Compression Option
- OWB included with DB

Oracle 11g includes new composite partitionings, virtual column partitioning, REF partitioning, cube-based materialized views, SQL pivot and unpivot, query result cache, SQL plan management, general linear models, advanced compression option, and OWB included with DB.
Continuous R+D Investment in VLDW
Continuous Customer Success in VLDW

- Over the past 12+ years, Oracle has steadily introduced major architectural advances for large database support
- Data warehouses have grown exponentially with these new technologies

<table>
<thead>
<tr>
<th>Year</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>1995</td>
<td>Oracle Release 7.3</td>
</tr>
<tr>
<td>1997</td>
<td>Oracle8</td>
</tr>
<tr>
<td>1999</td>
<td>Oracle8i</td>
</tr>
<tr>
<td>2001</td>
<td>Oracle9i</td>
</tr>
<tr>
<td>2003</td>
<td>Oracle9iR2</td>
</tr>
<tr>
<td>2005</td>
<td>Oracle10g</td>
</tr>
<tr>
<td>2007</td>
<td>Oracle11g</td>
</tr>
</tbody>
</table>

- First 1TB Database built in lab
- First 1TB customer: Acxiom
- First 10TB customer: Amazon.com
- First 30TB customer: France Telecom
- First 100TB customer: Yahoo!
- Over 100 Terabyte customers
Long-standing dichotomy in the DW Market

- “Big brain” Workloads
  - Sophisticated database optimization techniques
    - Advanced Indexing
    - Dimensional query optimizations
    - Materialized views
    - Partition pruning
  - Algorithms and access paths determine performance
- Powerlifting workloads
  - Brute-force query execution
    - Large amounts of hardware
    - Query parallelism, hash partitioning
  - Hardware capabilities determine performance
Established Architectural Solutions

Atomic Data Layer
- Base data warehouse schema
- Atomic-level data, 3nf design
- Supports general end-user queries
- Data feeds to all dependent systems

Data Mart Layer
- Application-specific performance structures
- Summary data / materialized views
- Dimensional view of data
- Supports specific end-users, tools, and applications
Half-Solutions are not the answer

- Enterprise DW solutions must provide both pieces
  - A solution that only provides one part will be limited to simple applications and unable to support growing
  - “If all you have is a hammer …”
“Big Brain” Strategy
Oracle aggressively continues “Big Brain” strategy

- **VLDB**
  - Composite Range-Range
  - Composite List-Range
  - Composite List-List
  - Composite List-Hash
  - REF Partitioning
  - Virtual Column Partitioning
  - Compression enhancements

- **Performance**
  - Query Result Cache

- **Manageability**
  - Partition Advisor
  - Interval Partitioning
  - SQL Plan Management
  - Automatic SQL Tuning with Self-Learning Capabilities
  - Enhanced Optimizer Statistics Maintenance
  - Multi-Column Optimizer Statistics
  - ASM Fast Resync, Fast VLDB Startup and other enhancements

- **SQL**
  - SQL Pivot and Unpivot
  - Continuous Query Notification

- **OLAP**
  - Materialized view refresh and SQL rewrite
  - Continued database integration
    - Cube metadata in the Data Dictionary
    - Fine-grained data security on cubes
  - Simplified application development
    - Fully declarative cube calculations
    - Cost-Based Aggregation
    - Simpler calculation definitions

- **Data Mining**
  - Simplified development and deployment of models
    - Supermodels: data preparation combined with mining model
    - Additional packaged predictive analytics
    - Integration in database dictionary
  - New algorithms: “General Linear Models”
    - Encapsulates several widely used analytic methods
    - Multivariate linear regression; logistic regression

- **ETL**
  - OWB Repository installed with Database by default
  - Seibel connector
  - Graphical creation of views, materialized views
## Oracle Partitioning: Ten Years of Development

<table>
<thead>
<tr>
<th></th>
<th>Core functionality</th>
<th>Performance</th>
<th>Manageability</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Oracle8</strong></td>
<td>Range partitioning</td>
<td>“Static” partition pruning</td>
<td>Basic maintenance operations: add, drop, exchange</td>
</tr>
<tr>
<td></td>
<td>Global range indexes</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Oracle8i</strong></td>
<td>Hash and composite range-hash partitioning</td>
<td>Partition-wise joins “Dynamic” pruning</td>
<td>Merge operation</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Oracle9i</strong></td>
<td>List partitioning</td>
<td></td>
<td>Global index maintenance</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Oracle9i R2</strong></td>
<td>Composite range-list partitioning</td>
<td>Fast partition split</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Oracle10g</strong></td>
<td>Global hash indexes</td>
<td></td>
<td>Local Index maintenance</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Oracle10g R2</strong></td>
<td>1M partitions per table</td>
<td>“Multi-dimensional” pruning</td>
<td>Fast drop table</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Oracle Database 11g</strong></td>
<td>More composite choices REF Partitioning Virtual Column</td>
<td></td>
<td>Interval Partitioning Partition Advisor</td>
</tr>
</tbody>
</table>

**Interval Partitioning**

**Partition Advisor**

**More composite choices**

**REF Partitioning**

**Virtual Column**
**Partitioning in Oracle Database 11g**

**Virtual Column-Based Partitioning**

**ORDERS**

<table>
<thead>
<tr>
<th>ORDER_ID</th>
<th>ORDER_DATE</th>
<th>CUSTOMER_ID</th>
<th>REGION</th>
</tr>
</thead>
<tbody>
<tr>
<td>9834-US-14</td>
<td>12-JAN-2007</td>
<td>65920</td>
<td>US</td>
</tr>
<tr>
<td>8300-EU-97</td>
<td>14-FEB-2007</td>
<td>39654</td>
<td>EU</td>
</tr>
<tr>
<td>3886-EU-02</td>
<td>16-JAN-2007</td>
<td>4529</td>
<td>EU</td>
</tr>
<tr>
<td>3699-US-63</td>
<td>02-FEB-2007</td>
<td>18733</td>
<td>US</td>
</tr>
</tbody>
</table>

- **REGION** requires **no storage**
- **Partition by** ORDER_DATE, REGION

```sql
ORDERS
REGION AS (SUBSTR(ORDER_ID,6,2))
```
Partitioning in Oracle Database 11g
Complete Composite Partitioning

• Range – range
• List – list
• List – hash
• List – range

- RANGE-RANGE
  Order Date by Order Value

- LIST-RANGE
  Region by Order Value

- LIST-LIST
  Region by Customer Type
Advanced Compression

Compress Large Application Tables
• Transaction processing, data warehousing

Compress All Data Types
• Structured and unstructured data types

Typical Compression of 2-4X
• Cascade storage savings throughout data center

Up To
4X Compression
Database Result Cache

- Automatically Caches results of queries, query blocks, or pl/sql function calls
  - Cache is shared across statements and sessions on server
  - Significant speed up for read-only / read-mostly data
  - Full consistency and proper semantics
    - Cache refreshed when any underlying table updated

Q2: Uses result transparently
SQL Query Result Cache

- Retail customer data (~50 GB)
- Concurrent users submitting queries randomly
  - executive dashboard application with 12 heavy analytical queries
- Cache results *only* at in-line view level
  - 12 queries run in random, different order with 4 queries benefiting from the cache

**Relative average response time**

<table>
<thead>
<tr>
<th>Users</th>
<th>No cache</th>
<th>Cache</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 Users</td>
<td>100</td>
<td>76</td>
</tr>
<tr>
<td>4 Users</td>
<td>100</td>
<td>75</td>
</tr>
<tr>
<td>8 Users</td>
<td>100</td>
<td>75</td>
</tr>
</tbody>
</table>
Transparent “Big Brain” Features

- Materialized Views
  - Transparent rewrites of expensive queries
    - Including rewrites on remote objects
  - Incremental automatic refresh
- Bitmap Indexes
  - Optimal storage
  - Ideal for star or star look-a-like schemas
- SQL Access Advisor – based on workload
  - Materialized view advice
  - Index advice
  - Partition advice
Integrated Analytics

- Bring the analytics to the data
- Leverage core database infrastructure
## Native Support for Pivot and Unpivot

<table>
<thead>
<tr>
<th>SALESREP</th>
<th>Q1</th>
<th>Q2</th>
<th>Q3</th>
<th>Q4</th>
</tr>
</thead>
<tbody>
<tr>
<td>100</td>
<td>230</td>
<td>240</td>
<td>260</td>
<td>300</td>
</tr>
<tr>
<td>101</td>
<td>200</td>
<td>220</td>
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</tr>
<tr>
<td>102</td>
<td>260</td>
<td>280</td>
<td>265</td>
<td>310</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SALESREP</th>
<th>QU</th>
<th>REVENUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>100</td>
<td>Q1</td>
<td>230</td>
</tr>
<tr>
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</tr>
<tr>
<td>102</td>
<td>Q4</td>
<td>310</td>
</tr>
</tbody>
</table>
Native Support for Pivot and Unpivot

```sql
select * from quarterly_sales
unpivot
(include nulls
(revenue for quarter in (q1,q2,q3,q4)))
order by salesrep, quarter ;
```
# Native Support for Pivot and Unpivot

## SALES_BY_QUARTER

<table>
<thead>
<tr>
<th>SALESREP</th>
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<th>REVENUE</th>
</tr>
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<tbody>
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<td>240</td>
</tr>
<tr>
<td>100</td>
<td>Q3</td>
<td>160</td>
</tr>
<tr>
<td>100</td>
<td>Q4</td>
<td>90</td>
</tr>
<tr>
<td>100</td>
<td>Q3</td>
<td>100</td>
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<tr>
<td>100</td>
<td>Q4</td>
<td>140</td>
</tr>
<tr>
<td>100</td>
<td>Q4</td>
<td>70</td>
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<tr>
<td>101</td>
<td>Q1</td>
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<td>310</td>
</tr>
</tbody>
</table>

```sql
select * from sales_by_quarter
pivot (sum(revenue) for quarter in ('Q1','Q2','Q3','Q4'))
order by salesrep ;
```
**Business Intelligence Analysis**

**Typical Architecture Today**

- **Materialized Views**
  - Sales by Region
  - Sales by Date
  - Sales by Product
  - Sales by Channel

- **BI Tool**
- **Relational Star Schema**
- **SQL**
- **Query Rewrite**
- **Region**
- **Date**
- **Product**
- **Channel**
New in Oracle Database 11g
Cube-Organized Materialized Views

Materialized Views

OLAP Cube

BI Tool

Region

Product

Date

Channel

Query Rewrite

Automatic Refresh

SQL
Oracle Warehouse Builder
Packaging

Enterprise ETL Option
- Performance
- Productivity
- Reusability
- Metadata Management

Data Quality Option
- Data Profiling
- Anomaly Detection
- Business Rules
- Audit

ERP/CRM Connectors
- Oracle EBS
- PeopleSoft
- Siebel
- SAP

Core Features
(No extra cost with database SE/SE1/EE)
Self Managing Database

Auto-Tuning

Advisory

Instrumentation

Storage  Backup  Memory  Apps/SQL  Schema  RAC  Recovery  Replication
“Powerlifting” Strategy
Parallel Execution

```
select c.cust_last_name, sum(s.amount_sold)
from customers c, sales s
where c.cust_id = s.cust_id
group by c.cust_last_name;
```
Typical Customer DW Platform

- Where is the performance bottleneck?
Only Balanced Configurations Drive Optimized Performance

An Unbalanced Configuration

100% Possible Efficiency

Database CPUs Memory Actuators LUNs Disks Raid < 50% Achieved Efficiency

A Balanced Configuration

100% Possible Efficiency

Database CPUs Memory Actuators LUNs Disks Raid 100% Achieved Efficiency
Full Range of Options

Custom Solutions
Flexibility for the most demanding data warehouse

Reference Configurations
Documented best-practice configurations for data warehousing

Optimized Warehouse
Scalable systems pre-installed and pre-configured: create-table ready

Pre-configured, Pre-installed, Validated

Complete Flexibility
Building Block Scale-Out

- Add power in a balanced fashion
Provide linear hardware scalability

Orion I/O Throughput

- One building block
- Two building blocks
- Three building blocks
- Four building blocks

MBytes/Sec
Reduce Risk & Accelerate Deployment

Custom Configuration

- Testing and Validation
- Installation and Configuration
- Acquisition of Components
- Pre-Implementation System Sizing

Reference Configuration

- Testing and Validation
- Installation and Configuration
- Acquisition of Components

Oracle Optimized Warehouse

- Faster Deployment
- Lower Risk
- Increased Flexibility

< 1 Week to implement
Oracle DW Strategy

- Best Database for BI/DW
  - 30 years of innovation
  - No other database can compare on the breadth and sophistication of Oracle’s database features

- Within complete solutions
  - Complete database platform capabilities: ELT and Analytics
  - Complete BI and Performance Management solutions from Oracle
  - Broadest array of third-party technologies and solutions

- On the right hardware infrastructure
#1 for Data Warehousing

**Oracle**

Other
11%

NCR Teradata
10%

Microsoft
15%

IBM
23%

Source: IDC, 2007 – Data Warehouse Platform Tools 2006 Vendor Shares

**Worldwide Data Warehouse Management Market Share, 2006**
Q & A