Oracle Advanced Compression: Throw Away Half of Your Disks and Run Your Database Faster

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Agenda

• Data Growth Challenges
• Advanced Compression Feature Overview
  • Table Compression
  • Unstructured Data Compression
  • Backup Compression
  • Data Guard Network Transport Compression
• Competitive Analysis
• Questions and Answers
Challenges

- Explosion in Data Volumes
  - Government Regulations (Sarbanes-Oxley, etc)
  - User Generated Content (Web 2.0)
  - Application Consolidation
- IT Managers Must Support Larger Volumes of Data with Limited Technology Budgets
  - Need to optimize storage consumption
  - Also maintain acceptable application performance
- Intelligent and Efficient Compression Technology can Help Address These Challenges
Introducing Advanced Compression Option

- Oracle Database 11g introduces a comprehensive set of compression capabilities
  - Structured/Relational data compression
  - Unstructured data compression
  - Compression for backup data
  - Network transport compression

- Reduces resource requirements and costs
  - Storage System
  - Network Bandwidth
  - Memory Usage
Table Compression

- Introduced in Oracle Database 9i Release 2
  - Compression during bulk load operations (Direct Load, CTAS)
  - Data modified using conventional DML not compressed
- Optimized compression algorithm for relational data
- Improved performance for queries accessing large amounts of data
  - Fewer IOs
  - Buffer Cache efficiency
- Data is compressed at the database block level
- Compression enabled at either the table or partition level
- Completely transparent to applications
OLTP Table Compression

- Oracle Database 11g extends table compression for OLTP data
  - Support for conventional DML Operations (INSERT, UPDATE)
- New algorithm significantly reduces write overhead
  - Batched compression ensures no impact for most OLTP transactions
- No impact on reads
  - Reads may actually see improved performance due to fewer IOs and enhanced memory efficiency
OLTP Table Compression Process

Legend

- Header Data
- Uncompressed Data
- Free Space
- Compressed Data
Block-Level *Batch* Compression

- Patent pending algorithm minimizes performance overhead and maximizes compression
- Individual INSERT and UPDATEs do not cause recompression
- Compression cost is amortized over several DML operations
- Block-level (Local) compression keeps up with frequent data changes in OLTP environments
  - Competitors use static, fixed size dictionary table thereby compromising compression benefits
- Extends industry standard compression algorithm to databases
  - Compression utilities such as GZIP and BZ2 use similar adaptive, block level compression
### Employee Table

<table>
<thead>
<tr>
<th>ID</th>
<th>FIRST_NAME</th>
<th>LAST_NAME</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>John</td>
<td>Doe</td>
</tr>
<tr>
<td>2</td>
<td>Jane</td>
<td>Doe</td>
</tr>
<tr>
<td>3</td>
<td>John</td>
<td>Smith</td>
</tr>
<tr>
<td>4</td>
<td>Jane</td>
<td>Doe</td>
</tr>
</tbody>
</table>

### Initially Uncompressed Block

#### Header

<table>
<thead>
<tr>
<th>ID</th>
</tr>
</thead>
<tbody>
<tr>
<td>1•John•Doe, 2•Jane•Doe, 3•John•Smith, 4•Jane•Doe</td>
</tr>
</tbody>
</table>

Free Space

```sql
INSERT INTO EMPLOYEE
VALUES (5, 'Jack', 'Smith');
COMMIT;
```
## OLTP Table Compression

### Employee Table

<table>
<thead>
<tr>
<th>ID</th>
<th>FIRST_NAME</th>
<th>LAST_NAME</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>John</td>
<td>Doe</td>
</tr>
<tr>
<td>2</td>
<td>Jane</td>
<td>Doe</td>
</tr>
<tr>
<td>3</td>
<td>John</td>
<td>Smith</td>
</tr>
<tr>
<td>4</td>
<td>Jane</td>
<td>Doe</td>
</tr>
<tr>
<td>5</td>
<td>Jack</td>
<td>Smith</td>
</tr>
</tbody>
</table>

### Compressed Block

**Header**

- John\(=0\)
- Doe\(=1\)
- Jane\(=2\)
- Smith\(=3\)

- 1\(=0\) 2\(=2\) 1\(=1\) 3\(=0\) 4\(=3\) 2\(=2\)
- 1\(=0\) 5\(=5\) 3\(=3\)

**Free Space**
OLTP Table Compression

Uncompressed Block

<table>
<thead>
<tr>
<th>Header</th>
</tr>
</thead>
<tbody>
<tr>
<td>1•John•Doe</td>
</tr>
<tr>
<td>John=W</td>
</tr>
</tbody>
</table>

Compressed Block

<table>
<thead>
<tr>
<th>Header</th>
</tr>
</thead>
<tbody>
<tr>
<td>John=0</td>
</tr>
<tr>
<td>1•0•1</td>
</tr>
<tr>
<td>5•Jack•3</td>
</tr>
</tbody>
</table>

Free Space

Local Symbol Table

More Data Per Block
Table Compression Syntax

OLTP Table Compression Syntax:

```sql
CREATE TABLE emp (  
    emp_id NUMBER  
    , first_name VARCHAR2(128)  
    , last_name VARCHAR2(128)  
) COMPRESS FOR ALL OPERATIONS;
```

Direct Load Compression Syntax (default):

```sql
CREATE TABLE emp (  
    emp_id NUMBER  
    , first_name VARCHAR2(128)  
    , last_name VARCHAR2(128)  
) COMPRESS [FOR DIRECT_LOAD OPERATIONS];
```
OLTP Table Compression

Best Practices

- Compress your 10 Largest Tables
  - 80/20 Rule – 20% of your Tables Consume 80% of your Space
- Better Compression with Bigger Block Sizes
  - Higher Probability of Duplicate Values
- B-Tree Index Compression
  - Validate Index and Review INDEX_STATS
    - INDEX_STATS.OPT_CMPR_COUNT
    - INDEX_STATS.OPT_CMPR_PCTSAVE
- Bitmap Indexes are Highly Compressed
  - Good for low and medium cardinality
OLTP Table Compression

Getting Started with Compression

• Compression Advisor
  • Shows projected compression ratio for uncompressed tables
  • Reports actual compression ratio for compressed tables

```
SQL> SET SERVEROUTPUT ON
SQL> EXEC dbms_tabcomp.getratio(tabname=>'SH.HZ_PARAM_TAB_C',sampling_percent=>20)
Sampling table : SH.HZ_PARAM_TAB_C
Sampling percentage : 20%
Compression ratio by block count : 4.23837209302325581395348837209302325581
Compression ratio by row count : 4.2432432432432432432432432432432432

PL/SQL procedure successfully completed.
SQL> SQL> 
```
OLTP Table Compression

Getting Started with Compression

- Monitoring Compression
- DBA_TABLES
  - COMPRESSION (ENABLED/DISABLED)
  - COMPRESS_FOR (ALL OPERATIONS / DIRECT LOAD OPERATIONS)

```
SQL> SELECT table_name, compression, compress_for
       2   FROM user_tables
       3   WHERE compression = 'ENABLED';

TABLE_NAME    COMPRESSION COMPRESS_FOR
--------------- ----------- ------------------
SALES_COMPRESS ENABLED   DIRECT LOAD ONLY
HZ_PARAM_TAB_C  ENABLED   FOR ALL OPERATIONS

Elapsed: 00:00:00.29
SQL>
```
Table Compression Results
Real World Compression Overview

- Data from Oracle’s implementation of Oracle Applications
  - Compressed the 10 Largest Tables
    - Two copies of each table: Compressed and Uncompressed
  - Oracle Enterprise Linux
  - Oracle Database 11g Release 1

- Test Queries
  - Full Table Scan
  - Index Range Scan
  - DML Operations (Insert, Update, Delete)
Real World Compression Results

Storage Utilization

More than 70% Storage Savings

MB

Storage Utilization

No Compression  Compression
Real World Compression Results

Table Scan Performance

Computation is 2.5x Faster
Real World Compression Results

Table Scan Reads

- Compression performs 3.5x fewer reads

No Compression vs Compression

Physical Reads

- No Compression
- Compression

ORACLE
Real World Compression Results

Index Range Scan Performance

No Performance Impact on Index Scans

Time (seconds)
Real World Compression Results

DML Performance

Time (seconds)

Compression has less than 3% overhead
Introduction to SecureFiles

• SecureFiles is a new 11g feature designed to break the performance barrier keeping file data out of databases
• Next-generation LOB
  • Superset of LOB interfaces allows easy migration from LOBs
  • Transparent deduplication, compression, and encryption
  • Leverage the security, reliability, and scalability of database
• Enables consolidation of file data with associated relational data
  • Single security model
  • Single view of data
  • Single management of data
  • Scalable to any level using SMP scale-up or grid scale-out
SecureFiles Deduplication

- Enables storage of a single physical image for duplicate data
- Significantly reduces space consumption
- Dramatically improves writes and copy operations
- No adverse impact on read operations
  - May actually improve read performance for cache data
- Duplicate detection happens within a table, partition or sub-partition
- Specially useful for content management, email applications and data archival applications
SecureFiles Compression

- Huge storage savings
  - Industry standard compression algorithms
  - 2-3x compression for typical files (combination of doc, pdf, xml)

- Allows for random reads and writes to Compressed SecureFile data

- Can be specified at a partition level

- Automatically detects if SecureFile data is compressible
  - Skips compression for already compressed data
  - Auto-turn off compression when space savings are minimal or zero

- Two levels of compression provide different compression ratios

- SecureFiles Compression is independent of table or index compression
SecureFiles Compression Syntax

Compression Syntax
CREATE TABLE docs (  
doc_id NUMBER,  
doc BLOB)  
    LOB(image) STORE AS SECUREFILE  
(TABLESPACE lob_tbs COMPRESS);

Deduplication Syntax
CREATE TABLE images (  
image_id NUMBER,  
image BLOB)  
    LOB(image) STORE AS SECUREFILE  
(TABLESPACE lob_tbs DEDUPLICATE);
Data Pump Compression

- Metadata compression available since Oracle Database 10g
- Oracle Database 11g extends compression to table data during exports
  - No need to decompress before import
- Single step compression of both data and metadata
  - Compressed data directly hits disk resulting in reduced disk space requirements
  - Internal tests reduced dump file size up to 75%
- Compression factor comparable to GNU gzip utility
- Application transparent
  - Complete Data Pump functionality available on compressed files
Data Pump Compression

- Performance cost: ~10% overhead
- Compression Ratio: comparable to gzip

<table>
<thead>
<tr>
<th>Compression Method</th>
<th>OE/SH Schemas</th>
<th>Spatial Table</th>
<th>Spatial Schema</th>
</tr>
</thead>
<tbody>
<tr>
<td>exdp compression=none</td>
<td>6.0 MB</td>
<td>26.6 MB</td>
<td>443 MB</td>
</tr>
<tr>
<td>expdp compression=all</td>
<td>1.5 MB (74.7%)</td>
<td>9.9 MB (62.7%)</td>
<td>140 MB (68.4%)</td>
</tr>
<tr>
<td>gzip –cv1</td>
<td>1.1 MB (82.7%)</td>
<td>11.4 MB (57.1%)</td>
<td>162 MB (63.4%)</td>
</tr>
<tr>
<td>gzip –cv6</td>
<td>835 KB (86.2%)</td>
<td>10.2 MB (61.7%)</td>
<td>142 MB (68.0%)</td>
</tr>
<tr>
<td>gzip –cv9</td>
<td>818 KB (86.5%)</td>
<td>10.1 MB (62.0%)</td>
<td>141 MB (68.2%)</td>
</tr>
<tr>
<td>compress</td>
<td>1.6 MB (74.2%)</td>
<td>13.8 MB (48.1%)</td>
<td>198 MB (55.3%)</td>
</tr>
</tbody>
</table>
Backup Compression

• Fast RMAN Compression
  • Compresses the backup set contents before writing them to disk or tape
  • No extra decompression steps are required during recovery when you use RMAN compression
  • High performance, industry standard compression algorithm
    • 40% faster backup compression versus Oracle Database 10g
  • Suitable for fast, incremental daily backups
  • Reduces network usage
FAST RMAN Compression Configuration

RMAN> CONFIGURE COMPRESSION ALGORITHM 'zlib';

RMAN Compression Syntax

RMAN> backup as COMPRESSED BACKUPSET database archivelog all

DataPump Syntax

PROMPT> expdp hr FULL=y
   DUMPFILE=dpump_dir:full.dmp COMPRESS
RMAN Compression Results
RMAN Compression Overview

- Data from Oracle’s implementation of Oracle Applications
  - 3.5 GB Database
  - Oracle Enterprise Linux
  - Oracle Database 11g Release 1
- Test 1: Slow I/O (16 MB/s)
  - 11g RMAN without Compression
  - 10g RMAN with Compression
  - 11g RMAN with FAST Compression
- Test 2: Fast I/O (200 MB/s)
  - 11g RMAN without Compression
  - 10g RMAN with Compression
  - 11g RMAN with FAST Compression
Backup Compression Results

Backup Size Comparison

Compression reduced backup size by 6x

GB

No Compression  10g Compression  11g Compression
Backup Compression

Backup Speed Comparison
Slow I/O (Tape)

11g Compression reduces backup time by almost 3x
Backup Compression

Backup Speed Comparison
Slow I/O (Tape)

11g Compression is almost 2.5x faster than 10g Compression
Backup Compression

Backup Speed Comparison
Fast I/O (Disk)

11g Compression is almost 2.5x faster than 10g Compression
Oracle Data Guard

- Redo Shipping
  - Send redo data over network from primary to standby
  - Size of redo data typically small (transactional) and not network-bound
- Gap Resolution
  - After network outage – resynchronize standby
  - Size of redo data much larger
Network Compression

*Oracle Data Guard Redo Transport Services*

- Fast re-sync of standby database after network outages
- Lower bandwidth networks (<100Mbps)
  - 15-35% less time required to transmit 1 GB of data
  - Bandwidth consumption reduced up to 35%
- High bandwidth networks (>100 Mbps)
  - Compression will not reduce transmission time
  - But will reduce bandwidth consumption up to 35%
Competitive Analysis
## Competitive Analysis – DB2

<table>
<thead>
<tr>
<th></th>
<th><strong>Oracle</strong></th>
<th><strong>IBM DB2</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Block level compression</td>
<td>Table/partition level compression dictionary</td>
<td></td>
</tr>
<tr>
<td>- Adaptive / dynamic compression</td>
<td>- Unlimited compression values</td>
<td>- New data may not be compressed / offline rebuild symbol table</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Max 4K values per table</td>
</tr>
<tr>
<td>Zero decompression overhead</td>
<td>Some decompression overhead</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Minimal compression overhead</td>
<td>- More compression overhead</td>
</tr>
<tr>
<td></td>
<td>- Batched compression</td>
<td>- Transactional compression</td>
</tr>
<tr>
<td>Index compression</td>
<td>None</td>
<td>None</td>
</tr>
<tr>
<td>Unstructured data compression and de-duplication (SecureFiles)</td>
<td>None</td>
<td>None</td>
</tr>
</tbody>
</table>
Competitive Analysis – DB2

- Even without compression, Oracle needs less disk space than DB2:
  - Oracle uses variable length representation for numbers – DB2 uses fixed length
  - DB2 has more overhead for VARCHAR data

- SAP BW data needs 30-50% less disk space if stored in Oracle
## Competitive Analysis – Teradata

<table>
<thead>
<tr>
<th></th>
<th>Oracle</th>
<th>Teradata</th>
</tr>
</thead>
<tbody>
<tr>
<td>Block level compression</td>
<td>Field level compression</td>
<td></td>
</tr>
<tr>
<td>- Dynamic compression</td>
<td>- Admin must define compression values</td>
<td></td>
</tr>
<tr>
<td>values</td>
<td>- Max 255 compression values</td>
<td></td>
</tr>
<tr>
<td>- Unlimited values</td>
<td></td>
<td></td>
</tr>
<tr>
<td>All data types supported</td>
<td>Limited data type support</td>
<td></td>
</tr>
<tr>
<td>- Minimal compression</td>
<td>- More compression overhead</td>
<td></td>
</tr>
<tr>
<td>overhead</td>
<td>- Transactional compression</td>
<td></td>
</tr>
<tr>
<td>- Batched compression</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Backup compression</td>
<td>None</td>
<td></td>
</tr>
<tr>
<td>Unstructured data</td>
<td>None</td>
<td></td>
</tr>
<tr>
<td>compression and de-duplication (SecureFiles)</td>
<td>None</td>
<td></td>
</tr>
</tbody>
</table>
## Competitive Analysis – Hardware Based Compression

<table>
<thead>
<tr>
<th>Oracle</th>
<th>Hardware Compression</th>
</tr>
</thead>
<tbody>
<tr>
<td>Database specific compression algorithm</td>
<td>Generic compression algorithm - deficient for databases</td>
</tr>
<tr>
<td>Fine grained compression – compress at tablespace, table or partition level</td>
<td>No fine grained compression - compress at file level</td>
</tr>
<tr>
<td>Improved read performance in several cases – no decompression overhead</td>
<td>Poor read performance – significant decompression overhead</td>
</tr>
<tr>
<td>Improved memory efficiency - data stays compressed in memory</td>
<td>No memory benefits - data needs to be decompressed</td>
</tr>
<tr>
<td>Batched algorithm for minimal compression overhead</td>
<td>Data updates are very expensive</td>
</tr>
<tr>
<td>Benefits automatically cascade to all environments</td>
<td>Benefits limited to specific hardware environment</td>
</tr>
</tbody>
</table>
Competitive Analysis

Compression: Oracle vs Competition
Top 10 Tables in an ERP Application
Summary

- Advanced Compression Option contains comprehensive data compression capabilities for all types of data
  - Structured, Unstructured, Backup, Network Transport
- Reduces storage consumption by 2 to 4 times
- Improves read performance
- Enhances memory, buffer cache utilization
- Complete application transparency
- Benefits diverse application workloads