For many organizations, the purchase of additional storage hardware each year shows no sign of slowing. The user and departmental need for more information and data appears insatiable, so many IT organizations are forced to continually add more storage. Regulatory requirements are also changing how and why data is being retained, as organizations are required to store more information for much longer periods. However, this approach of constant storage spending is running up against real-world budget restrictions, not to mention the impact that data growth is having on response times and application performance.

Research bears this fact out. In a recent survey of Oracle User Group members, nearly 40% of the respondents indicate that reducing costs is their primary reason behind implementing tiered storage. But even with the right storage and compression capabilities, deciding which data should reside where, and when to migrate data from one tier to another, remains a serious challenge. That's why forward-looking IT organizations are adopting advanced strategies for managing data growth with innovative database technologies that automate compression and storage tiering while improving database performance.

Oracle Database 12c provides a rich feature set and database options that optimize database storage to reduce continuous demand and work together to help you implement an information lifecycle management (ILM) solution in order to comply with increasing data storage demands and new regulatory requirements for data retention and protection.

This white paper provides details on the key features that are used to optimize database storage for Oracle workloads and can be used to implement an Oracle Database ILM solution.

ORACLE DATABASE 12C STORAGE OPTIMIZATION TECHNOLOGY

Database storage optimization is a critical activity for nearly every organization. The traditional approach of simply adding more disk storage is becoming increasingly difficult to justify, and cost is no longer the only issue. With Oracle Database 12c Storage Optimization, IT departments can manage the impact of data growth with a unique set of technologies that used together provide an effective approach to information lifecycle management.
Data Partitioning
Partitioning enables tiered storage, which allows data to be saved to the most cost-effective storage for better resource utilization.

- **Oracle Partitioning option**
The use of Oracle Partitioning option enables large database tables and indexes to be subdivided into smaller objects that can be managed at a finer level of granularity to improve data access performance.

Database Compression Technologies for all Data Types
Oracle is a pioneer in database compression technology. More than a decade ago, Oracle introduced Basic Table Compression, which compresses data at the block level, allowing you to store up to 4x or more data per block using direct path operations. Today, Oracle Database 12c provides a comprehensive set of compression capabilities across all types of data without changes to your application to help customers improve query performance while reducing storage costs.

- **Advanced Row Compression**
Advanced Row Compression, a feature of Oracle Advanced Compression, uses a unique compression algorithm specifically designed to work with OLTP applications that allows for normal, conventional path operations to be compressed without the limitations of direct path operations. It minimizes the overhead of write operations on compressed data, making it suitable for transactional and data warehouse environments, extending the benefits of compression to all application workloads. The benefits of Advanced Row Compression go beyond disk storage cost savings. One significant advantage is the ability to read compressed blocks directly, in memory, without uncompressing the blocks. This helps improve performance due to the reduction in I/O, and the reduction in system calls related to the I/O operations. Further, the buffer cache becomes more efficient by storing more data without having to add memory. Using the Advanced Row Compression feature can provide a 2x to 4x reduction in storage across all environments.

- **Hybrid Columnar Compression**
Hybrid Columnar Compression is an approach Oracle developed for organizing data within a block. Unlike other organization methods that are either row or column based, this new technology utilizes both row and column approaches for organizing data. In this way, performance issues from using a columnar organizational approach only is mitigated, while the compression benefits of columnar storage are gained. With average storage savings of 10x, IT managers can dramatically reduce and often eliminate the need to purchase additional storage for several years. Hybrid Columnar Compression is supported on the Oracle Exadata Database Machine, which is designed for extreme performance. It is also supported on Oracle Axiom and ZFS Storage Appliance (ZFSSA), helping to further differentiate Oracle Engineered Systems.

Automatic Compression and Storage Tiering
Oracle Advanced Compression incorporates a number of new features that work together to optimize database storage. When the use of the Heat Map feature, which collects data usage information at the row and segment level, is combined with the Automatic Data Optimization (ADO) feature, administrators can create and apply ILM policies. This is based on the usage patterns of their users’ data, and enables automatic compression and storage tiering. It also reduces storage costs and improves application performance.

**Heat Map**
Heat Map gives you a detailed view of how your data is being accessed, and how access patterns are changing over time.

**Automatic Data Optimization**
Automatic Data Optimization allows organizations to create policies for data compression and data movement and to implement tiering of compression and storage. Oracle Database periodically evaluates ADO policies, and uses the information collected by Heat Map to determine which policies to execute.
Oracle Database Information Lifecycle Management Solution

Oracle Database 12c Storage Optimization technologies address the critical business problem of information lifecycle management. The need for consistent management of information throughout its useful life enables a business to utilize information more effectively and helps meet compliance demands. Using a combination of Advanced Data Optimization, Heat Map, Hybrid Columnar Compression, and Advanced Compression and Partitioning options, organizations can implement an automated, consistent, and documented ILM approach for Oracle Database environments.

At the core of an Oracle Database ILM solution is the ability to define multiple data classes and tiers of storage, and assign different portions of data to different tiers based on the desired cost, performance, and security for each portion. The key steps in deploying an ILM solution using Oracle Database 12c include:

- Define data classes or types of data
- Create logical tiers
- Define the data lifecycle

The first step to building an Oracle Database ILM solution is to define the data classes or types of data that need lifecycle management. To really understand your data you must analyze it to determine which objects are associated with which applications, where those objects are physically located (what is the class of storage), if the objects have been compressed, and the granularity of the object (table vs. partitioned).

Next, create logical storage tiers by identifying and creating various storage tiers from expensive higher-performance storage or high-capacity, lower-cost storage.

Finally, define the data lifecycle by describing how data migrates across logical storage tiers over its lifetime. A lifecycle definition may include one or more lifecycle stages that select a logical storage tier based on data attributes such as compression, read-only, or retention for data residing in that lifecycle stage.

PROVEN APPROACHES FOR ORACLE STORAGE OPTIMIZATION

There are a number of usage models that can result in improved storage optimization using Oracle Database 12c. The most prevalent examples are included here.

By using Oracle Partitioning, more active data partitions can be placed on faster, higher-performance storage where less active and historic data can be placed on lower-cost storage. Data compression can also be applied as desired on a partition-by-partition basis—in both OLTP and data warehousing applications. In this scenario, the business can meet all of its performance, reliability, and security requirements, but at a significantly lower cost than in a configuration where all data is located on tier-one storage.
With OLTP applications, Advanced Row Compression is best suited for the most active tables and partitions to ensure that newly added or updated data will continue to be compressed as data manipulation language (DML) operations are performed.

When using Oracle Exadata Database Machine or with Oracle ZFS Storage Appliance or Axiom Storage, a combination of Advanced Row Compression, Hybrid Columnar “Warehouse” Compression (also referred to as “Query” Compression), or Hybrid Columnar “Archive” Compression can be utilized on a partition-by-partition basis depending on how frequently the data within the partition is accessed or manipulated.

Hybrid Columnar Warehouse Compression should be used with tables and partitions that either aren’t being modified or are being lightly modified. Hybrid Columnar Warehouse Compression is intended for query applications, but can tolerate data that may be lightly updated using conventional DML operations such as INSERT and UPDATE (with a reduced compression ratio on the updated data). Hybrid Columnar “Archive” Compression is meant for archive data that is read-only data and infrequently accessed. The main purpose of “Archive” compression is to achieve very high compression rates to reduce storage consumption.

Together these features provide a storage optimization solution that reduces storage costs, improves query performance and automates the management of the data life cycle in Oracle databases.

For more information, visit www.oracle.com/database12c