Optimizing an Oracle® Database with Dell™ Compellent™ Automated Tiered Storage

A Dell Technical White Paper

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Optimizing an Oracle Database with Dell Compellent Automated Tiered Storage

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Executive summary

Enterprise data can be categorized based on criteria such as performance needs, access frequencies, I/O patterns, and business values. With the exponential data growth, the traditional “one size fits all” data storage strategy of storing all data into a uniform storage media has become costly and less efficient. To solve this challenge, many IT organizations have adopted the tiered storage solution. Tiered storage is a data storage environment consisting of multiple storage media types forming storage tiers. Storage tiers can differ in cost, performance and capacity. Tiered storage solution enables the alignment of different categories of data to different storage tiers, with the goal of reducing total storage cost and preserving performance. In this paper, we will examine the automated tiered storage solution, Data Progression, offered by Dell Compellent storage systems. Data Progression automatically moves data to the optimum storage tier and/or RAID level based on actual use and performance needs. This paper describes how users can leverage Data Progression to optimize Oracle database performance. It provides recommended best practices to implement Oracle databases with Dell Compellent Data Progression.
Introduction

Today’s storage devices come in many choices ranging from high performance and high cost storage devices such as the flash memory-based Solid State Drives (SSD), to slower performance and less expensive storage devices like the mechanical hard disk drives (HDD). While it would be ideal to store all data in the high speed devices, it would be unnecessary and impractical given the different categories of data, the high cost of the fast disk drives, and the exploded data growth.

- Majority of enterprise data is less transactional and not frequently accessed. Transactional or frequently changing data represents only a small percentage of the entire data storage. It is cost effective to store only the frequently accessed data in the high performance storage devices.
- Pricing for the high performance storage devices such as SSDs is still higher than HDDs for comparable storage capacity. It may be impractical to store all data on SSDs for many customers.
- The exponential data growth rate leads to the huge storage capacity requirement. As a result, companies need to seek new ways to store data more efficiently and more cost effectively to control the total storage cost. Storing all data in a single type of storage media cannot meet the goal of reducing storage cost while preserving application performance at the same time.

The above factors lead to the increasing adoption of the tiered storage architecture (Figure 1).

Figure 1. Architecture of the tiered storage infrastructure

A tiered storage environment consists of two or more types of storage media with the fast and more expensive disk devices forming the top tiers, and slower performance and lower cost storage devices forming the lower tiers. Tiered storage aligns different categories of data to different storage tiers. For example, mission-critical or frequently accessed data might be stored on the high performing SSD drives in tier 1 or the SAS drives in tier 2; infrequently used data might be stored to the slower and less
expensive SATA drives in tier 3. However, assigning data to a particular storage tier may be an ongoing and complex activity which may take a lot of time and effort from the administrators if it is done manually. Automation is a must to support the tiered storage infrastructure. An automated storage tiering solution can meet the right balance between performance and storage cost by dynamically identifying and moving hot data to higher-performance storage tiers, while moving cold data to slower, lower-cost storage tiers.

Many types of applications can benefit from the automated storage tiering solution. Among them, an Oracle® database is a prime candidate.

- Database storage space represents a large percentage of the overall data storage. Industry research indicates that the average databases are growing at a double digit annual growth rate. The driving forces of the rapid database growth rate can be contributed by the factors such as the increased business demands, the regulatory and legal requirements resulted longer data retention period, and the high availability requirements with duplicated copies of data, etc. Managing and retaining the overall database storage usage imposes a big challenge on IT organizations. The automated storage tiering solution can help address this challenge.
- Storage needs for Oracle databases differ from one database to another. Oracle database I/O workloads can be classified as Online Transaction Processing (OLTP), or Decision Support System (DSS), or a mix of the two. OLTP workload is typically used by the transactional processing applications represented with a small set of active data, which can benefit from placing on the high-performance storage media. DSS applications are typically used by the reporting and data analysis applications represented with a large set of older data that can be stored in the high capacity and low cost storage media to reduce the storage cost.
- Oracle databases also differ in terms of Service Level Agreement (SLA). Some databases are mission critical while others are less important. IT organizations can take advantage of the automated storage tiering solution to align databases to different storage tiers, in order to minimize the storage cost while satisfying SLAs and meeting the expected performance level.
- Furthermore, within an Oracle database, components have different I/O characteristics. For example, online redo log files have high I/O demands. Indexes in OLTP characteristics of databases are typically I/O intensive comparing to other database objects. For DSS type of databases, partitions of older data are usually less accessed. An automated storage tiering solution can help place different components of an Oracle database to the most optimal storage tier.

Dell solutions for Oracle database

Dell solutions for Oracle products are designed to simplify operations, improve usability, and provide cost-effective scalability as your needs grow over time. In addition to providing server and storage hardware, Dell solutions for Oracle include:

- **Dell Configurations for Oracle**—in-depth testing of Oracle configurations for high-demand solutions; documentation and tools that help simplify deployment
- **Integrated Solution Management**—standards-based management of Dell solutions for Oracle that can lower operational costs through integrated hardware and software deployment, monitoring, and updating
- **Oracle Licensing**—licensing options that can simplify customer purchase
- **Dell Enterprise Support and Infrastructure Services for Oracle**—planning, deployment, and maintenance of Dell solutions for Oracle database tools
Optimizing an Oracle Database with Dell Compellent Automated Tiered Storage

For more information concerning Dell Solutions for Oracle Database, visit www.dell.com/oracle.

Technology overview

Dell Compellent Automated Tiered Storage - Data Progression

The Dell Compellent Storage Center Storage Area Network (SAN) provides a highly efficient and flexible foundation for enterprise and the cloud. Dell Compellent storage features an innovative Dell Fluid Data architecture to put the right data in the right place at the right time. It enables the storage system to dynamically adapt the changing business environment.

Dell Compellent Storage Center provides a fully virtualized storage platform that includes:

- Storage virtualization that abstracts and aggregates all resources across the entire array, providing a high-performance pool of shared storage.
- Thin provisioning and automated tiered storage to deliver optimum disk utilization and intelligent data movement.
- Space-efficient snapshots and thin replication for continuous data protection without wasted capacity.
- Built-in automation and unified storage management to streamline storage provisioning, management, migration, monitoring and reporting.

Dell Compellent pioneered the automated storage tiering solution in its Storage Center products in 2004. The Data Progression feature (Figure 2) delivers sub-LUN automated storage tiering to move data dynamically, intelligently, and efficiently among multiple storage tiers and RAID levels. Data Progression is a licensed feature that leverages cost and performance differences between storage tiers, allowing the maximum use of lower cost and higher capacity SATA or SAS (7.2K RPM) drives for stored data, while maintaining performance oriented SSD drives, Fibre Channel or SAS (15K RPM) drives for frequently-accessed data.
Unlike many newcomers to the storage tiering market, Dell Compellent Data Progression is built right into the virtualized storage platform. It realizes the full potential of automated tiered storage.

- **True Virtualization.** Dell Compellent engineered its Fluid Data architecture from the ground up to include Data Progression. Fluid Data was architected to provide truly virtualized storage that spans all disks in the storage environment. Fluid Data provides an ideal foundation for tiered storage. With Fluid Data, there are no constraints on where data can reside, as data is not confined to conventional disk group. Data can be moved without limitation to a tier with a particular drive type or performance level, or to a particular RAID level within a storage tier.

- **Build-in Feature.** Dell Compellent Data Progression is built right into the storage platform; it does not require additional hardware or server-side agents to operate.

- **Fine Granularity.** Dell Compellent Fluid Data facilitates a highly granular approach for Data Progression to migrate data in small sizes of 512 KB, 2 MB or 4MB. The granular approach optimizes tiering by moving less data in the backend and placing data with a greater level of precision.

- **Real Time Intelligence.** Dell Compellent captures real-time use characteristics of each data block at 512 byte level. This information provides the intelligence to determine whether and when blocks of data should be moved from one storage tier, or one RAID level, to another.

- **Snapshot Integration.** Dell Compellent Data Progression is tightly integrated with the Dell Compellent snapshot feature - Data Instant Replay. In the Dell Compellent architecture, new data is written by default to tier 1, RAID 10 storage to provide the best write performance. Replays move to a lower storage tier with RAID 5 or 6 protections. When new data needs to be written to an existing block that has been migrated to a lower tier, writes are redirected to the tier 1, RAID 10 storage to guarantee superior write performance.

- **True Automation.** Dell Compellent Data Progression provides fully automated sub-LUN tiering. Administrators use policy-based profiles to drive placement and movement of data.
Data migration occurs automatically at a set time or on demand. The migration process does not affect data availability or application performance.

**Dell 12th Generation PowerEdge Servers**

Dell 12th Generation PowerEdge servers are the newest addition to the PowerEdge server family. Dell 12th Generation PowerEdge servers can help improve IT experience with these notable features:

- Manage anywhere anytime with agent-free server management
- Reduce maintenance time with auto-update for replacement parts
- Control cooling costs with better power monitoring and control
- Tailor network to applications with fabric flexibility
- Access information quicker via SATA, SAS, SSD and PCI Express Flash drives
- Data protection using best-in-class RAID
- Protect data at rest with malware resistance and faster encryption
- Keep data safer with firmware signing and encrypted credentials
- Accelerate high-performance computing (HPC) and virtual desktop infrastructure (VDI) through integrated graphics processing unit (GPU) technology
- Deliver more throughput with major I/O performance enhancements
- Better application performance with dual internal RAID controller options for PowerEdge T620 and R720
- No compromise on performance with greater memory density and capacity along with Intel Xeon E5 processors

Dell PowerEdge 12th Generation servers feature the Intel® Xeon® E5-2600 series processors based on the Sandy Bridge-EP architecture which deliver more computations per second. Intel Xeon E5-2600 series processors provide up to 8 physical cores or 16 logical cores through hyper-threading, and up to 20 MB cache. Intel Xeon E5-2600 series processors also include features such as the new Intel advanced vector extensions, and the optimized turbo boost technology.

Dell PowerEdge 12th Generation servers include the express flash PCIe solid state drives to deliver better internal storage performance by connecting directly to the processor via PCIe bus. These PCIe solid state drives have up to 3x performance of standard SAS SSDs and 1000x performance of 15K SAS hard drives.

The PowerEdge R720 (12th generation) servers were used in the test configuration for this paper. The R720 server is a two-socket, 2U rack server emphasizing performance and scalability. R720 servers are designed for mid-to-large-size data centers, and are ideal for use as a virtualization or database server. Some highlighted features of the R720 include:

- Large memory footprint 24 DIMMs (768GB)
- Dual SD cards for redundant hypervisor
- CacheCade RAID enhancement to boost I/O
- Internal storage capacity up to 16 x 2.5 HDD or 8 x 3.5 HDD
- Maximum of four optional PCIe flash SSD drives
- Redundant power supply units (PSU)
- Hot plug and swappable PSU, HDDs, and fans
Oracle Databases with Dell Compellent Data Progression

Dell Compellent Data Progression is configured by assigning Storage Profiles to volumes. Storage Profiles define the RAID level and storage tiers on which data blocks of a volume can be stored. If Data Progression is licensed, data can be migrated between RAID levels within a tier and between tiers. If Data Progression is not licensed and a system uses RAID 10 and RAID 5, data is migrated up or down within a tier but cannot be migrated between tiers.

Dell Compellent Data Progression is tightly integrated with the Dell Compellent Data Instant Replay. Data Instant Replay creates space-efficient snapshots of data volumes. To utilize Data Progression effectively, it is recommended to take Data Instant Replay of the volumes on a regular basis. New data is written by default to tier 1, RAID 10 storage to provide the best write performance. Replays move to a lower tier with RAID 5 or 6 protection levels during the next migration cycle. Over time, infrequently accessed data blocks move to a lower storage tier and RAID level. Moving read-only data from RAID 10 to RAID 5 or RAID 6 maintains the same read performance while freeing up storage space on the higher tier or RAID level.

Elements of an Oracle database have unique I/O characteristics. The following general guidelines can be followed in configuring Oracle databases with Dell Compellent Data Progression.

- Oracle datafiles and online redo log files can be stored on the higher performing SAS or Fibre Channel drives with 15K RPM.
- Oracle archived redo log files and Flash Recovery Area can be stored on SATA or lower cost Fibre Channel drives with slower rotational speed.
- If SSD drives are implemented, it is recommend using them for the high I/O elements of OLTP type of databases including indexes and online redoing log files. It is not cost effective to use SSD for DSS type of databases.

To measure the performance benefit of Dell Compellent Data Progression for Oracle databases, Dell engineers conducted a series of benchmark stress tests with OLTP database in various tiering configurations. The test tools, configurations and results are detailed below.

Test tools and configurations

Quest Software’s Benchmark Factory TPC-C was used in the tests. Benchmark Factory TPC-C is a load-generating utility that simulates OLTP users and transactions on a database for a given number of users. The database configuration used in the tests was a 2-node Oracle 11g R2 (11.2.0.3) Real Application Cluster (RAC). The database schema was populated by Benchmark Factory. The TPC-C test runs conducted simulated loads from 100 to 8,000 concurrent users in an increment of 100. Test outputs include metrics such as the average transaction response time and transaction per second (TPS).

The test configuration consists of the following components:

- PowerEdge R720 servers running Oracle Enterprise Linux 5 Update 7 x86_64, and Oracle 11g R2 Real Application Cluster (RAC) database Enterprise Edition (EE) version 11.2.0.3.0
- Redundant Dell PowerConnect™ Gigabit Ethernet switches for Oracle cluster interconnect private network
- Server-storage interconnect using redundant Brocade® 5300 Fibre Channel switches
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- Redundant Dell Compellent Series 40 controllers
- Dell Compellent SBOD Fibre Channel enclosure populated with 5 SSD drives for tier 1 storage
- Dell Compellent 2.5” SAS enclosure populated with 24 15K RPM SAS drives for tier 2 storage
- Dell Compellent 3.5” SAS enclosure populated with 12 7K RPM SAS drives for tier 3 storage

An architecture overview of the test configuration is shown in Figure 3.

Figure 3. Configuration architecture of Oracle RAC database and Dell Compellent storage system

The hardware and software details of the test configuration are summarized in Table 1.

Table 1. Hardware and software configurations for Benchmark factory test

<table>
<thead>
<tr>
<th>HARDWARE AND SOFTWARE CONFIGURATIONS FOR BENCHMARK FACTORY TEST</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Server</strong></td>
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<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td><strong>External Storage</strong></td>
</tr>
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<td></td>
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<td></td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>
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- Firmware: Storage Center 5.4.3

<table>
<thead>
<tr>
<th>Volume Configuration</th>
<th>Four volumes for database files; Four volumes for index files; Four volumes for online redo log files; Four volume for Flash Recovery area; Five volumes for OCR and CSS.</th>
</tr>
</thead>
<tbody>
<tr>
<td>OS</td>
<td>Oracle Enterprise Linux 5 Update 7</td>
</tr>
<tr>
<td>Storage Network</td>
<td>Two Brocade 5300 Fibre Channel switches</td>
</tr>
<tr>
<td>Test Software</td>
<td>Quest Benchmark Factory 6.1.1 with Oracle 64 bit 11.2.0.3 EE RAC</td>
</tr>
</tbody>
</table>

The Oracle database in the test configuration was implemented using Oracle Automatic Storage Management (ASM). Five ASM disk groups were created to host the Oracle data:

- DATA disk group consists of four 100GB volumes to host datafiles.
- FRA disk group consists of four 100GB volumes to host the Flash Recovery Area which stores the archived redo log files.
- GRID disk group consists of five 1GB volumes to host Oracle Grid Infrastructure files.
- INDEX disk group consists of five 50GB volumes to host the Index tablespaces.
- REDO disk group consists of five 50GB volumes to host the online redo log files.

Three storage tiers were configured in the Dell Compellent backend:

- Tier 1 - 4 plus 1 spare 136GB SSD drives.
- Tier 2 - 23 plus 1 spare 136GB 15K RPM SAS drives.
- Tier 3 - 11 plus 1 spare 932GB 7K RPM SAS drives.

To study the performance advantage of storage tiering versus no storage tiering, as well as to compare different tiering options, a number of configurations were tested by assigning different storage profiles to volumes. These configurations are outlined in the sections below.

**Baseline configuration - no storage tiering**

In the baseline configuration, all Oracle volumes reside in the tier 2 15K RPM SAS drives as shown in Table 2. This represents the configuration where storage tiering is not implemented.

**Table 2.** Oracle volume placement of the baseline configuration

<table>
<thead>
<tr>
<th>Tier 1 SSD</th>
<th>Writeable Data</th>
<th>Replay Data</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>RAID 10</td>
<td></td>
</tr>
<tr>
<td></td>
<td>RAID 5-9</td>
<td></td>
</tr>
<tr>
<td>Tier 2 15K RPM SAS</td>
<td>RAID 10</td>
<td>DATA disk group volumes, FRA disk group volumes, GRID disk group volumes, INDEX disk group volumes, REDO disk group volumes</td>
</tr>
<tr>
<td></td>
<td>RAID 5-9</td>
<td>DATA disk group volumes, FRA disk group volumes, GRID disk group volumes, INDEX disk group volumes, REDO disk group volumes</td>
</tr>
<tr>
<td>Tier 3 7K RPM SAS</td>
<td>RAID 10-DM</td>
<td></td>
</tr>
<tr>
<td></td>
<td>RAID 6-10</td>
<td></td>
</tr>
</tbody>
</table>
Tiering configuration #1
In the second configuration, Oracle volumes were assigned with the storage profiles shown in Table 3. In this configuration, online redo log files were assigned in the tier 1 SSD drives. The rest of the Oracle volumes spanned in tier 2 and tier 3.

Table 3. Oracle volume placement of the tiering configuration #1

<table>
<thead>
<tr>
<th>Tier 1 SSD</th>
<th>Writeable Data</th>
<th>Replay Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>RAID 10</td>
<td>REDO disk group volumes</td>
<td></td>
</tr>
<tr>
<td>RAID 5-9</td>
<td>REDO disk group volumes</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Tier 2 15K RPM SAS</th>
<th>Writeable Data</th>
<th>Replay Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>RAID 10</td>
<td>DATA disk group volumes, FRA disk group volumes, GRID disk group volumes, INDEX disk group volumes</td>
<td></td>
</tr>
<tr>
<td>RAID 5-9</td>
<td>DATA disk group volumes, GRID disk group volumes, INDEX disk group volumes</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Tier 3 7K RPM SAS</th>
<th>Writeable Data</th>
<th>Replay Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>RAID 10-DM</td>
<td></td>
<td></td>
</tr>
<tr>
<td>RAID 6-10</td>
<td>FRA disk group volumes</td>
<td></td>
</tr>
</tbody>
</table>

Tiering configuration #2
In the third configuration, Oracle volumes were assigned with the storage profiles shown in Table 4. In this configuration, volumes of the index tablespace were assigned in the tier 1 SSD drives with the rest of the Oracle volumes spanned in tier 2 and tier 3.

Table 4. Oracle volume placement of the tiering configuration #2

<table>
<thead>
<tr>
<th>Tier 1 SSD</th>
<th>Writeable Data</th>
<th>Replay Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>RAID 10</td>
<td>INDEX disk group volumes</td>
<td></td>
</tr>
<tr>
<td>RAID 5-9</td>
<td>INDEX disk group volumes</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Tier 2 15K RPM SAS</th>
<th>Writeable Data</th>
<th>Replay Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>RAID 10</td>
<td>DATA disk group volumes, FRA disk group volumes, GRID disk group volumes, REDO disk group volumes</td>
<td></td>
</tr>
<tr>
<td>RAID 5-9</td>
<td>DATA disk group volumes, GRID disk group volumes, REDO disk group volumes</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Tier 3 7K RPM SAS</th>
<th>Writeable Data</th>
<th>Replay Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>RAID 10-DM</td>
<td></td>
<td></td>
</tr>
<tr>
<td>RAID 6-10</td>
<td>FRA disk group volumes</td>
<td></td>
</tr>
</tbody>
</table>

Tiering configuration #3
Oracle volumes in the fourth configuration were assigned with the storage profiles shown in Table 5. In this configuration, volumes of both index tablespace and online redo log files were assigned in the tier 1 SSD drives with the rest of the Oracle volumes spanned in tier 2 and tier 3.

Table 5. Oracle volume placement of the tiering configuration #3

<table>
<thead>
<tr>
<th>Tier 1 SSD</th>
<th>Writeable Data</th>
<th>Replay Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>RAID 10</td>
<td>INDEX disk group volumes, REDO disk group volumes</td>
<td></td>
</tr>
<tr>
<td>RAID 5-9</td>
<td>INDEX disk group volumes,</td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
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<table>
<thead>
<tr>
<th>Tier 2 15K RPM SAS</th>
<th>RAID 10</th>
<th>DATA disk group volumes, FRA disk group volumes, GRID disk group volumes</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>RAID 5-9</td>
<td>DATA disk group volumes, GRID disk group volumes</td>
</tr>
<tr>
<td>Tier 3 7K RPM SAS</td>
<td>RAID 10-DM</td>
<td>FRA disk group volumes</td>
</tr>
<tr>
<td></td>
<td>RAID 6-10</td>
<td></td>
</tr>
</tbody>
</table>

**Test Results**

For each of the four configurations described in the previous section, Benchmark Factory TPC-C tests were conducted. Each TPC-C test run simulated loads from 100 to 8,000 concurrent users in an increment of 100. Test metrics include transaction per second (TPS) and average transaction response time in seconds.

Figure 4 shows the comparison of TPS of each test configuration as user load increases. Figure 5 shows the comparison of average response time (second) of each test configuration as user load increases.

**Figure 4.  Transaction per second (TPS) vs. user load**

![Transaction per Second (TPS) Comparison](image-url)
Figure 5. Average response time (second) vs. user load

Response Time Comparison

The purple line in Figures 4 and 5 represents the results from the baseline configuration, in which no storage tiering is implemented and all Oracle volumes reside on the 15K RPM SAS disk drives. The green line in these Figures represents the results from the tiering configuration #1, in which online redo logs reside in tier 1 SSD drives and the rest of the Oracle volumes reside in tier 2 and tier 3. The red line in these Figures represents the results from the tiering configuration #2, in which indexes reside in tier 1 SSD drives and the rest of the Oracle volumes reside in tier 2 and tier 3. The blue line in these Figures represents the results from the tiering configuration #3, in which both indexes and online redo logs reside in tier 1 SSD drives and the rest of the Oracle volumes reside in tier 2 and tier 3.

In a typical Oracle OLTP environment, 1 second application response time is generally acceptable. Therefore, when analyzing the test results, an average transaction response time of 1 second was chosen as the Service Level Agreement (SLA). All data beyond 1 second average transaction response time was discarded from the analysis.

As illustrated in Figure 4, application throughput in TPS improves by implementing Dell Compellent Data Progression as compared to a traditional configuration of placing all Oracle volumes on one type of storage media. Figure 4 shows that for OLTP workload, placing indexes in the tier 1 SSD drives can achieve even higher throughput as compared to placing online redo logs in SSD drives. However, when placing both indexes and online redo logs in the tier 1 SSD drives, performance gain is not linearly improved as compared to placing indexes alone in SSD.
Figure 5 shows that Data Progression improves the Oracle database throughput by supporting higher concurrent user loads while meeting the SLA at the same time. This is in line with the results shown in Figure 4.

The baseline configuration without Data Progression supports 3600 concurrent users when it meets the SLA of 1 second response time. At the same 3600 concurrent user load, the response time of the tiered configuration #1 is 0.329 second; the response time of the tiered configuration #2 is 0.134 second; the response time of the tiered configuration #3 is 0.139 second. As illustrated in Figure 6, using Data Progression to move online redo logs in OLTP applications from SAS disks to SSD disks can reduce transaction response time by 65 percent. Using Data Progression to move indexes from SAS disks to SSD disks can reduce transaction response time by 86 percent, while moving both indexes and online redo logs from SAS disks to SSD disks can achieve very similar reduction in transaction response time by 85 percent. The transaction response time of the tiered configuration #2 and the tiered configuration #3 is almost identical for up to 5,000 user loads. For loads beyond 5,000 concurrent users, the tiered configuration #3 is able to sustain lower response time as compared to the tiered configuration #2, allowing it to deliver higher throughput.

Figure 6. Dell Compellent Data Progression reduces transaction response time of Oracle OLTP workload

While meeting the SLA of 1 second response time, the baseline configuration is able to deliver TPS of 181; the tiered configuration #1 delivers TPS of 220; the tiered configuration #3 delivers TPS of 287; the tiered configuration #3 delivers TPS of 317. Based on these data, we can conclude that Dell Compellent Data Progression improves throughput in TPS of OLTP applications by 22 percent as compared to the baseline configuration, by moving online redo logs to tier 1 SSD drives. Data Progression improves TPS by 59 percent as compared to the baseline configuration, by moving indexes.
to tier 1 SSD drives. Data Progression delivers even higher improvement in TPS of 75 percent by moving both indexes and online redo log files to tier 1 SSD drives. This is illustrated in the Figure 7 below.

Figure 7. Dell Compellent Data Progression improves application throughput in TPS of Oracle OLTP workload

From this study of configuring Oracle databases with Dell Compellent Data Progression, we may conclude the following:

- Dell Compellent automated storage tiering Data Progression reduces transaction response time by 86 percent as compared to a non-tiered configuration in OLTP workload by moving indexes to the top tier SSD disk drives.
- Dell Compellent automated storage tiering Data Progression improves TPS by 59 percent as compared to a non-tiered configuration in OLTP workload by moving indexes to the top tier SSD disk drives.
- If moving both indexes and online redo logs to the SSD tier using Data Progression, it can achieve a higher TPS improvement by 75 percent as compared to a non-tiered configuration in OLTP workload.
- Relocating both indexes and online redo logs to SSD drives does not achieve linear performance gains as compared to relocating indexes only to SSD drives. Transaction response time is almost identical whether moving indexes alone or moving both indexes and online redo logs for up to 5,000 user loads. Therefore, moving indexes only to SSD drives provides the highest ROI if the targeted user load is under 5,000.
Summary
The Dell Compellent sub-LUN tiering solution Data Progression can cost-effectively address the explosive data growth of Oracle databases, while delivering more superior performance for OLTP applications. This paper demonstrates these benefits through lab testing. It also discusses the best practices for deploying automated storage tiering in an OLTP environment using Data Progression.

To learn more about Dell Oracle solutions, visit www.dell.com/oracle or contact your Dell representative for up-to-date information on Dell servers, storage, and services for Oracle solutions.

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