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

Implementation Best Practices of Dell™ Compellent™ Data Progression with Oracle® OLTP workloads

Wendy Chen and Tom Dau

Database Solutions Engineering

Dell Product Group

October 2012

October 2012| Rev 2.0

Acknowledgements

The authors would like to thank the following people for their contribution during the development and review of this whitepaper:

Connie Sheldon

Contents

Figures

Tables

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.

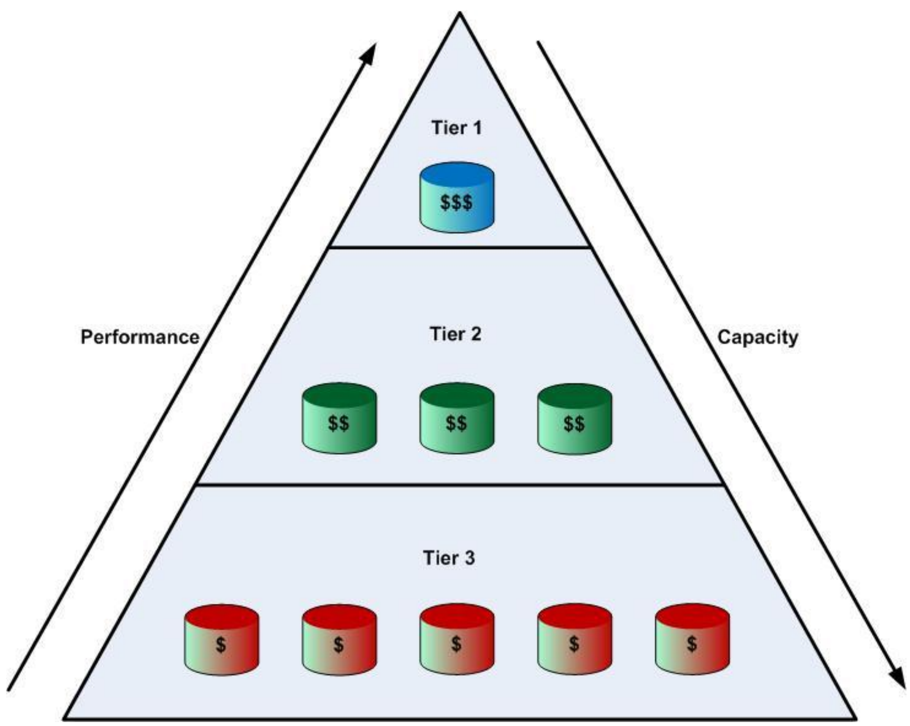
Introduction

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 changed 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 type 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

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

Technology overview

Dell Compellent Automated Tiered Storage – Data Progression

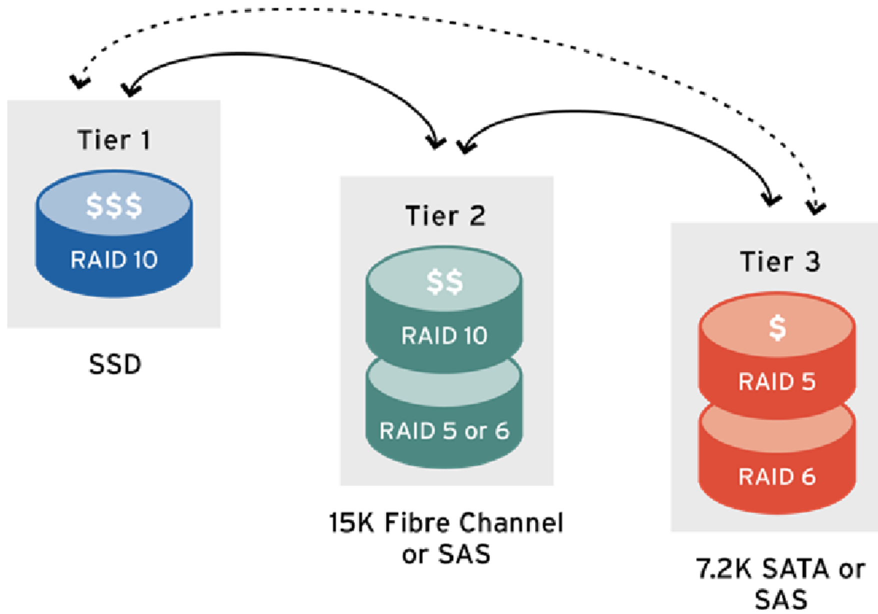
The Dell Compellent Storage Center Storage Area Network (SAN) provides a highly efficient and flexible foundation for enterprise and the cloud. Dell Compellent storage features an innovative Dell Fluid Data architecture to put the right data in the right place at the right time. It enables the storage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

Figure 2. Dell Compellent Automated Tiered Storage - Data Progression



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 PowerEdgeT620 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 can be 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 OLTP type of Oracle databases with Dell Compellent Data Progression with SSD drives.

- Applications with the most random data requirements can gain greatest benefit from SSD drives over hard disk drives. Typical Oracle OLTP workloads are dominated with small and random I/O’s. Therefore Oracle OLTP type of database is a suitable candidate to deploy with SSD drives as the top tier in a multi-tier storage infrastructure.
- Within Oracle datafiles, database objects have different IO access patterns. For example, indexes of OLTP databases typically are more IO intensive than other database objects. Compellent Data Progression is able to identify the frequently accessed data blocks and automatically move these hot data blocks to the top SSD tier, while identifying and moving less accessed data blocks to lower storage tiers for the best performance / cost optimization.
- Oracle online redo log is an IO intensive component of an Oracle database. However, the online redo log IO operations are primarily consisted of sequential writes, which benefit little from SSD drives. The 15K RPM SAS or Fibre Channel drives can well serve the IO requirements of online redo logs. Therefore, it is recommended to place online redo log files on the 15K RPM SAS or Fibre Channel storage tier only.
- Oracle archived redo log file, which is usually stored in the Flash Recovery Area, can be stored on SATA or lower cost Fibre Channel drives with slower rotational speed. By using Compellent Data Progression, one can control the writes to Flash Recovery Area directed to the 15K RPM SAS or Fibre Channel storage tier, and the replays of Flash Recovery Area stored on the SATA or lower cost Fibre Channel storage tier.

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

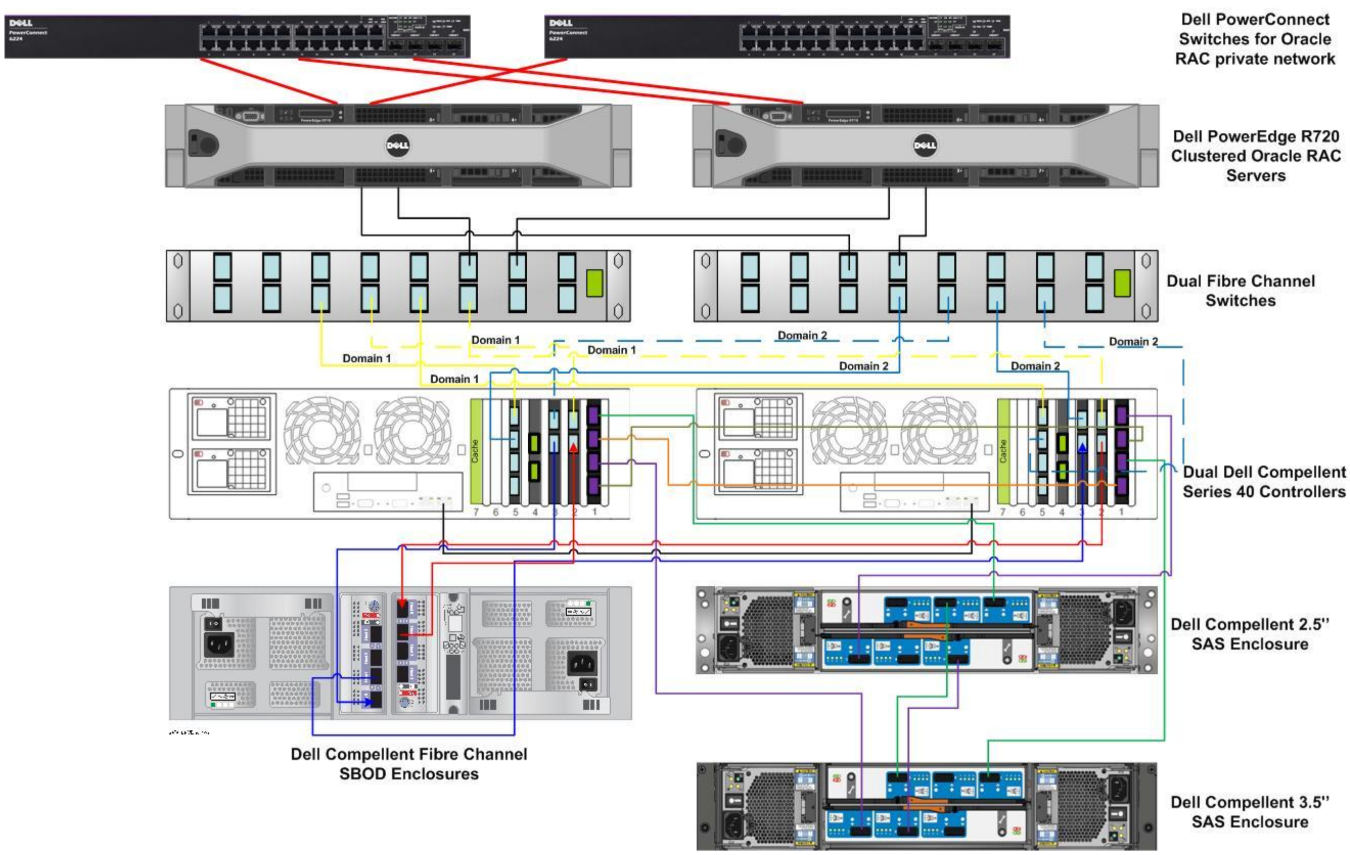
Quest Software’s Benchmark Factory TPC-C was used in the tests. Benchmark Factory TPC-C is a load-generating utility that simulates OLTP users and transactions on a database for a given number of users. The database configuration used in the tests was a 2-node Oracle 11*g* R2 (11.2.0.3) Real Application Cluster (RAC). The database schema was populated by Benchmark Factory. The TPC-C test runs conducted simulated loads from 100 to 3,000 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 11*g* 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
- Redundant Dell Compellent Series 40 controllers
- Dell Compellent SBOD Fibre Channel enclosure populated with 8 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

HARDWARE AND SOFTWARE CONFIGURATIONS FOR BENCHMARK FACTORY TEST	
Server	Two PowerEdge R720 servers, each with: • Two Intel Xeon 8-core 2.20 GHz CPU's • 64 GB of RAM • 4 Gb QLogic dual-port QLE2462 HBA for SAN traffic
External Storage	Two Dell Compellent Series 40 controllers connected with • 7 plus 1 spare 136GB SSD disks in a Dell Compellent SBOD Fibre Channel enclosure • 23 plus 1 spare 136GB 15K RPM SAS disks in a Dell Compellent 2.5'' SAS enclosure • 11 plus 1 spare 932GB 7K RPM SAS disks in a Dell Compellent 3.5'' SAS enclosure • Firmware: Storage Center 6.1.2
Volume Configuration	Four volumes for database files; Four volumes for online redo log files; Four volume for Flash Recovery area
OS	Oracle Enterprise Linux 5 Update 7
Storage Network	Two Brocade 5300 Fibre Channel switches
Test Software	Quest Benchmark Factory 6.1.1 with Oracle 64 bit 11.2.0.3 EE RAC

The Oracle database in the test configuration was implemented using Oracle Automatic Storage Management (ASM). Three ASM disk groups were created to host the Oracle data with a total of 12 storage volumes:

- 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.
- REDO disk group consists of four 25GB volumes to host the online redo log files.

Three storage tiers were configured in the Dell Compellent backend:

- Tier 1 – 7 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.

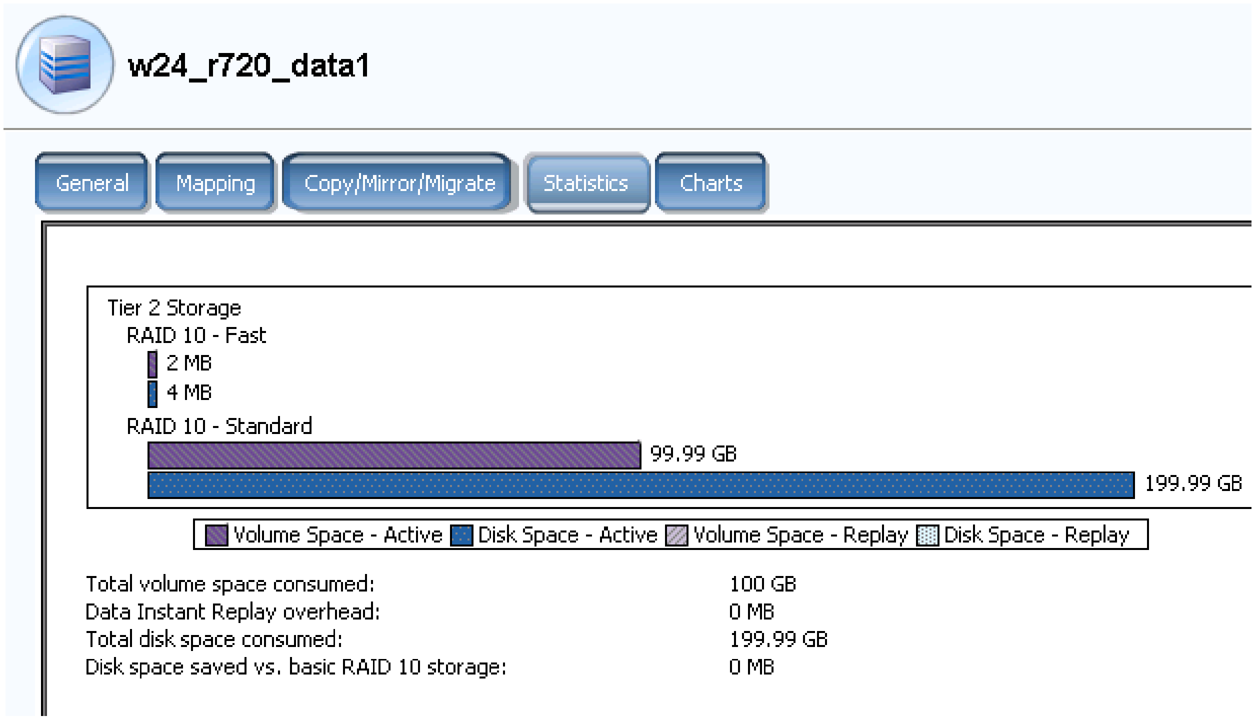
To study the performance advantage of Data Progression, we compared between a baseline configuration without storage tiering and the configuration after Data Progression rearranged data placement to the three storage tiers. The test details are outlined in the sections below.

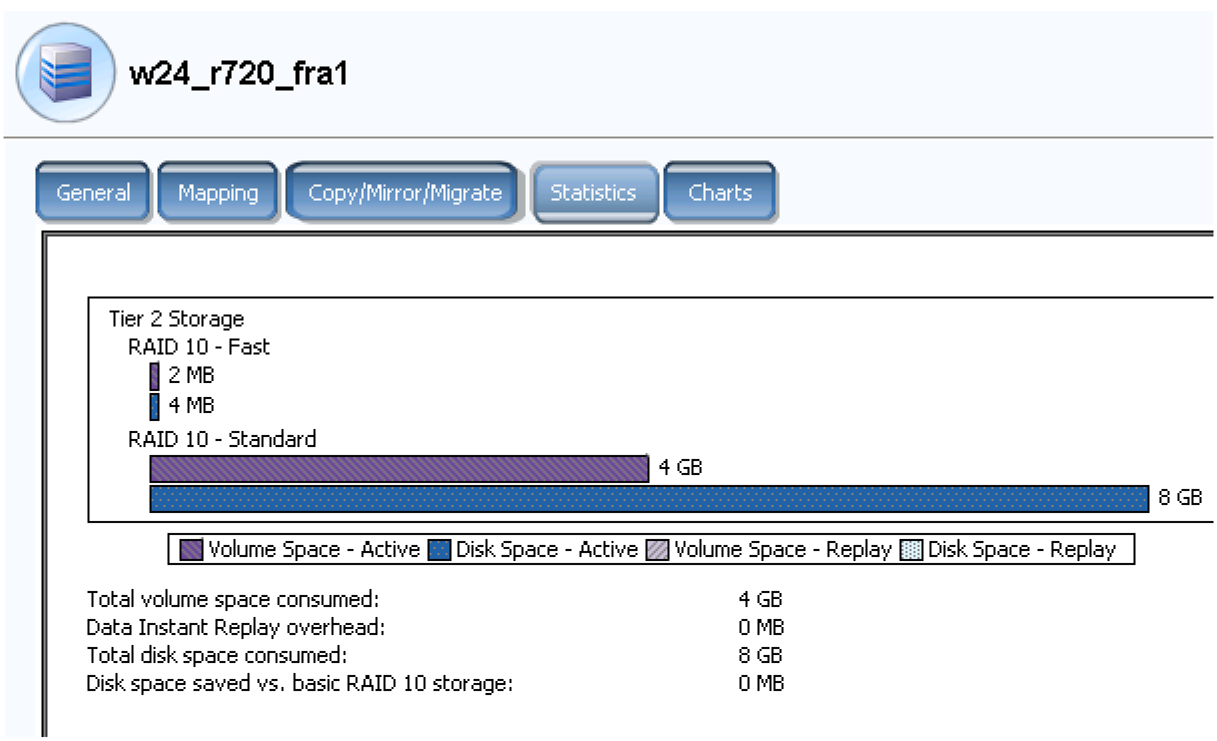
Baseline configuration without Data Progression

In the baseline configuration, all 12 Oracle storage volumes reside in the tier 2 15K RPM SAS drives with RAID 10. Data Instant Replay is not configured on the volumes. The baseline configuration represents the configuration where Data Progression is not implemented. All read and write IOs to the Oracle volumes are directed to the 15 K RPM SAS drives configured with RAID 10.

Figure 4 shows the volume distribution of one of the DATA volumes and one of the FRA volumes in the baseline configuration. All 12 Oracle volumes in the baseline configuration have similar type of volume distribution. As you can see, all data pages reside on RAID 10 of tier 2 storage, and there're no replay pages.

Figure 4. Volume distribution of the baseline configuration without Data Progression





Benchmark Factory TPC-C test, which consists of approximately 70% of read IOs and 30% of write IOs, was conducted on the baseline configuration. The TPC-C test runs simulated workloads from 100 to

2,200 concurrent users in an increment of 100. Test metrics include transaction per second (TPS) and average transaction response time in seconds. Test results are discussed in the *Test Results* section below.

Enabling Data Progression and simulating read-only workload

Following the TPC-C test of the baseline configuration, Data Progression and Data Instant Replay are enabled on the Oracle storage volumes except the REDO volumes. As discussed in the previous section *Oracle Database with Dell Compellent Data Progression*, Oracle online redo log files benefit most from placing on the 15K RPM SAS or Fibre Channel storage tier. Therefore, for our test, the 4 REDO volumes remain on the 15K RPM SAS drives with RAID 10 configuration. Data Instant Replay is not enabled on the 4 REDO volumes. The 4 DATA volumes and the 4 FRA volumes are grouped together in a consistency group with a scheduled daily Data Instance Replay.

The Data Progression storage profile assigned to the DATA volumes and the FRA volumes are shown in Table 2. In this configuration, the DATA volumes span on all 3 tiers of the storage. The FRA volumes span on tier 2 and tier 3 storages.

Table 2. Oracle volume placement with Data Progression

		Writeable Data	Replay Data
Tier 1 SSD	RAID 10	DATA disk group volumes	
	RAID 5-5		DATA disk group volumes
Tier 2 15K RPM SAS	RAID 10	DATA disk group volumes, FRA disk group volumes	
	RAID 5-9		DATA disk group volumes
Tier 3 7K RPM SAS	RAID 10-DM		
	RAID 6-10		DATA disk group volumes, FRA disk group volumes

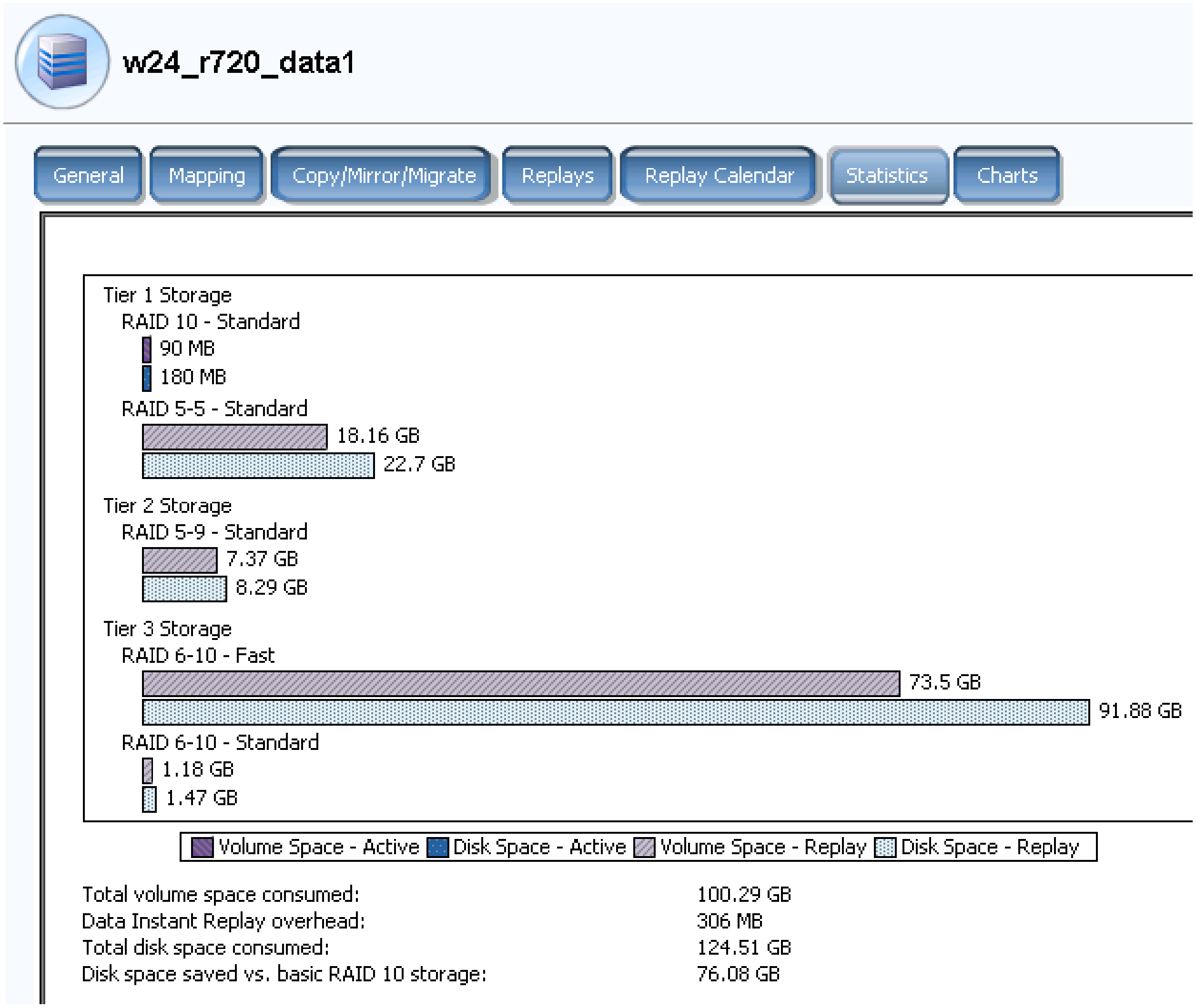
Dell Compellent storage continuously captures user characteristics of each data block including creation time, location, access frequency, and data type. This data enables Data Progression to determine what data pages should be moved to a different storage tier or a different RAID level within an existing tier. In order to generate sufficient IO activities to enable Data Progression data movement, a read-only Oracle TPC-C workload was conducted on the test environment during a five day period. The purpose of the read-only TPC-C workload includes:

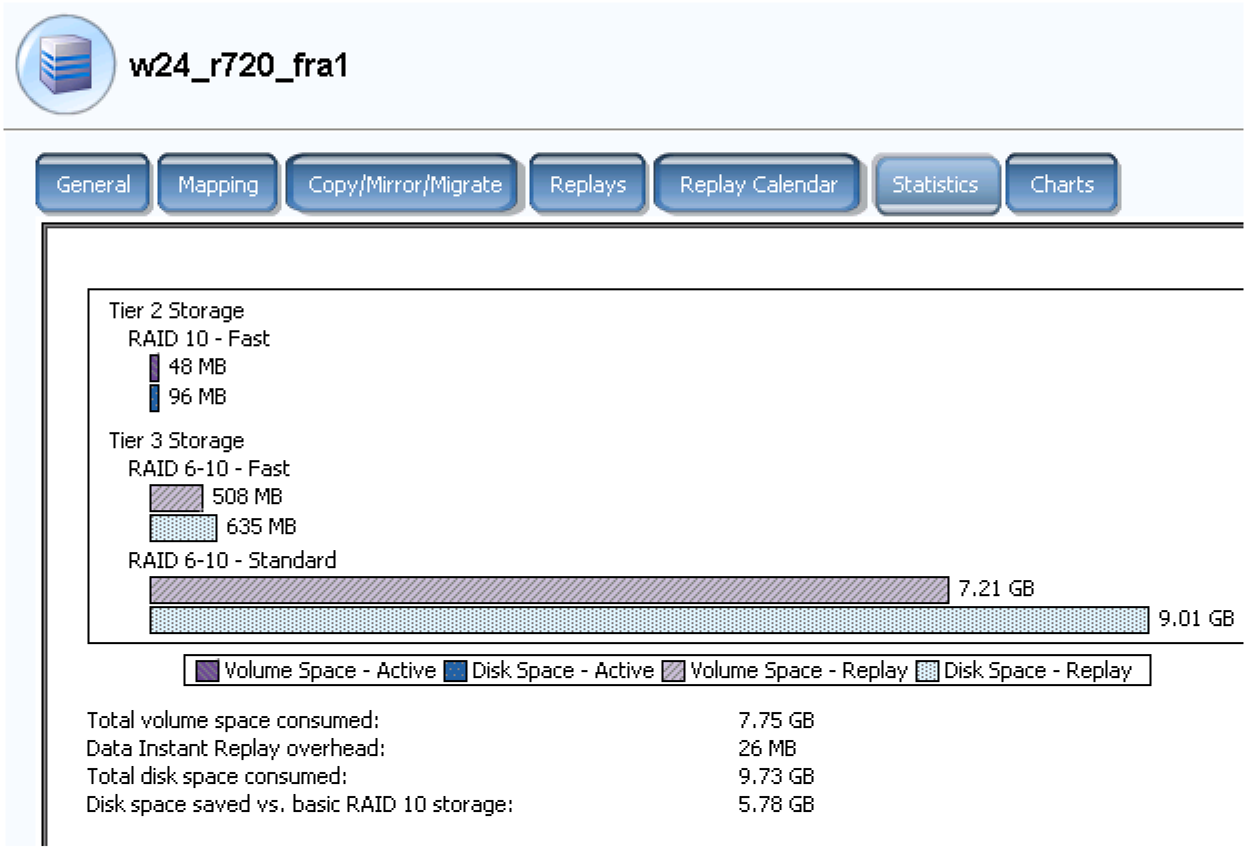
- Read-only stress load doesn't make any data updates. The original data set is preserved for the post Data Progression TPC-C performance test, which can enable an apple-to-apple comparison with the baseline configuration.
- Read-only stress load can generate sufficient IO activities on the storage array and in turns creates access frequency of data blocks.
- The mostly read and write database objects represented by the read-only TPC-C workload and the typical TPCC workload (30% writes and 70% reads) are almost identical. This enables the read-only TPCC workload to generate the same type of data access frequency as the typical TPC-C workload, so Data Progression can move the correct data set for the post Data Progression TPC-C test.

Tiered storage configuration with Data Progression

At the end of the read-only stress load, the Oracle database volumes which were assigned with Data Progression storage profiles have shown significant data redistributions among storage tiers and RAID levels. Figure 5 shows the new volume distribution of the same database volumes illustrated in Figure 4.

Figure 5. Volume distribution of the tiered storage configuration created by Data Progression





The volume distribution of the DATA volume shows that Data Progression effectively redistributes its data pages to span on all three tiers. Data pages that are moved to tier 1 represent the most active data pages that can benefit from the high performing SSD drives in the tier 1 storage. Data pages that are moved to tier 3 represent less active data pages. Moving less frequently accessed data pages to lower cost disk drives in tier 3 helps reduce the storage space in higher tiers and lower the total cost of storage. Similarly, the volume distribution of the FRA volume shows that Data Progression redistributes its data pages to tier 2 and tier 3 as defined in the storage profile.

Benchmark Factory TPC-C test, which consists of approximately 70% of read IOs and 30% of write IOs, was conducted again on the tiered storage configuration after the redistributions of data pages by Data Progression. The test simulated workloads from 100 to 3,000 concurrent users in an increment of 100. The test result is compared with the baseline test result in the following section.

Test Results

Figure 6 shows the comparison of TPS between the baseline configuration and the tiered storage configuration as user load increases. Figure 7 shows the comparison of average response time (second) of each configuration as user load increases.

Figure 6. Oracle TPC-C Transaction per second (TPS) vs. user load

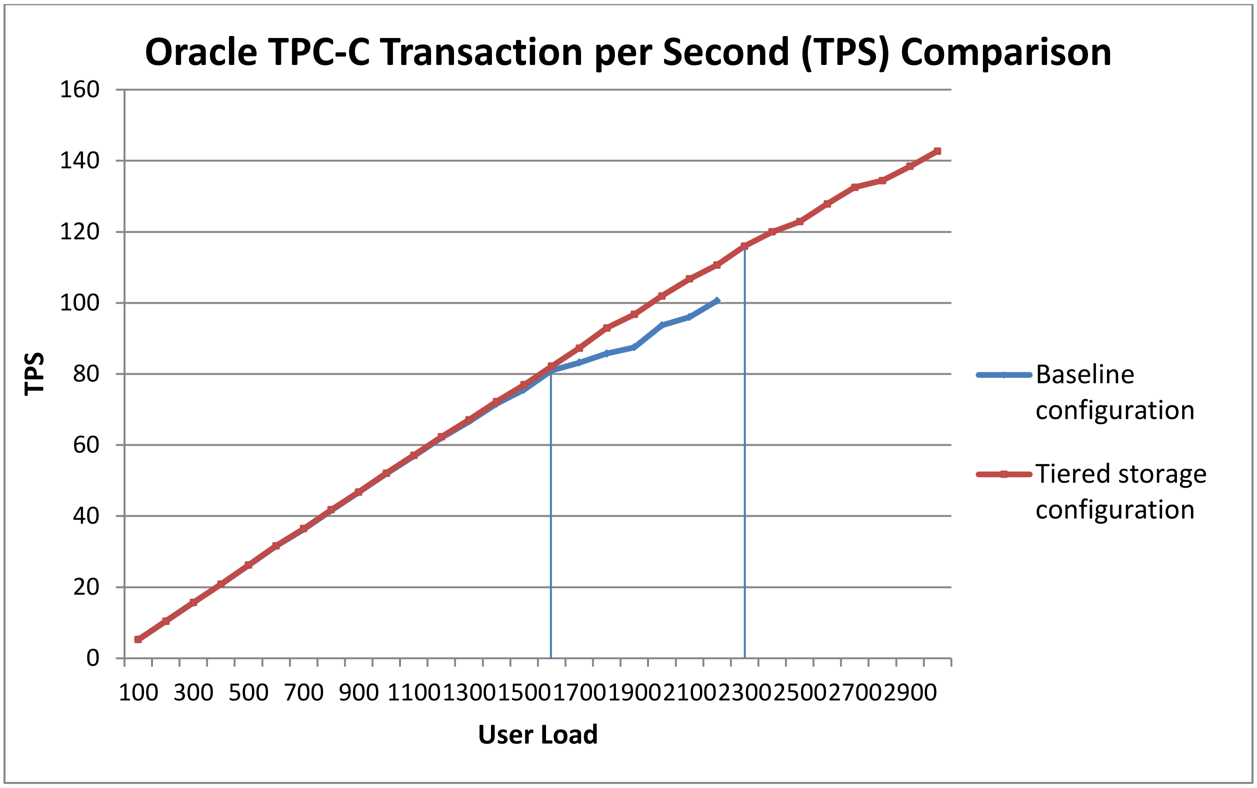
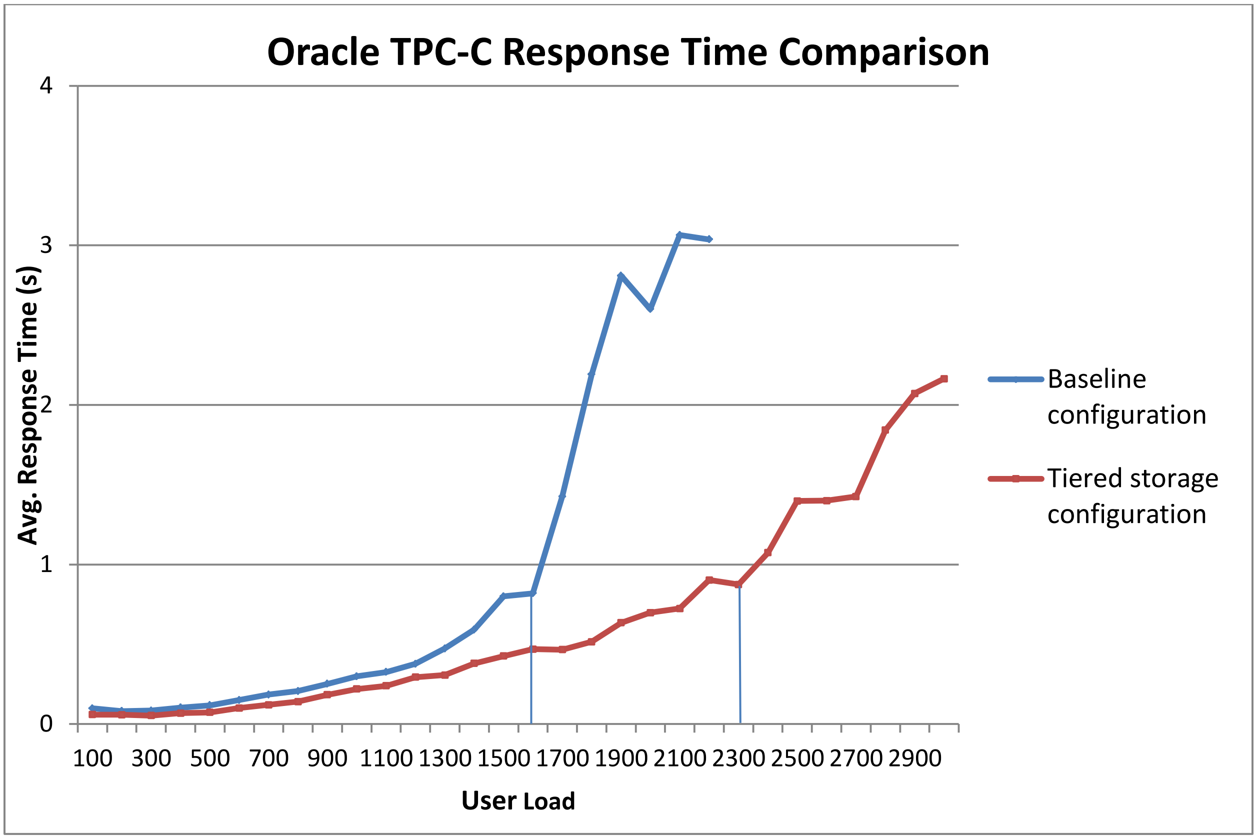


Figure 7. Oracle TPC-C average response time (second) vs. user load



The blue lines in Figures 6 and 7 represent 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 red lines in these Figures represent the results from the tiered storage configuration, in which Data Progression automatically moves data pages among the three storage tiers according to the access frequency.

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.

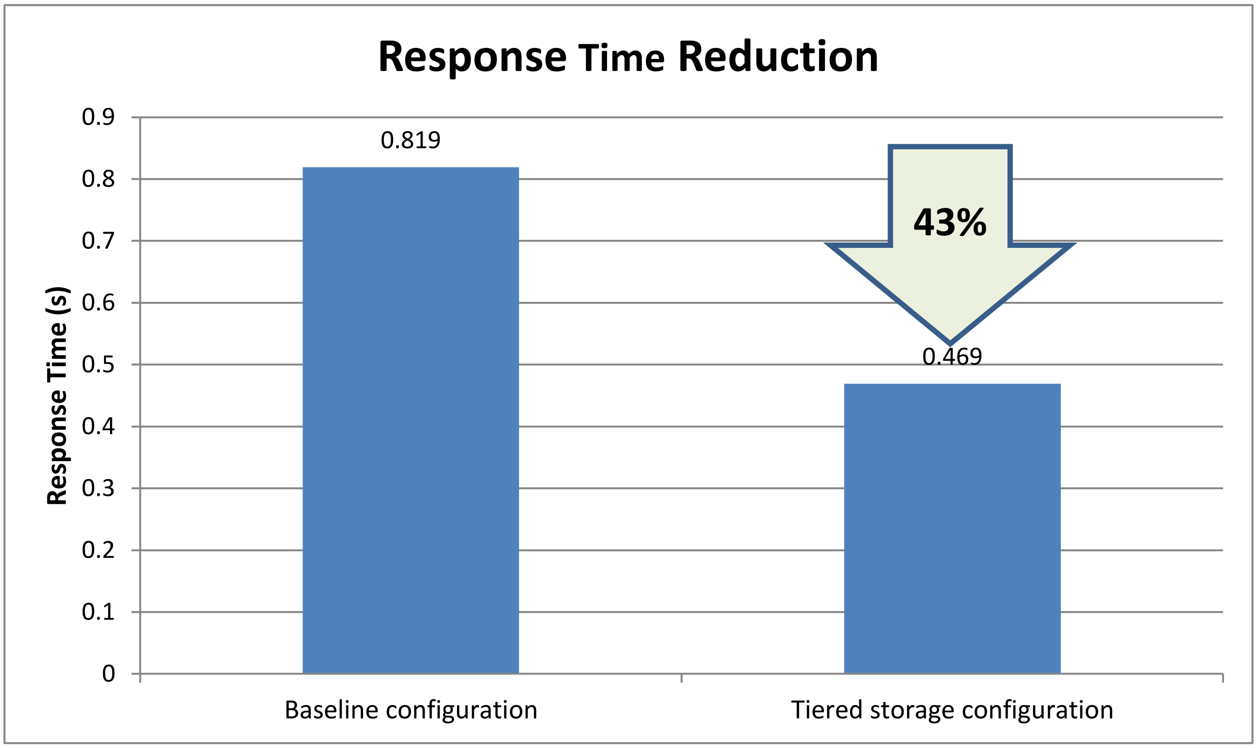
As illustrated in Figure 6, application throughput in TPS improves by implementing Dell Compellent Data Progression as compared to a traditional configuration of placing all Oracle volumes on one type of storage media. Figure 6 shows that for OLTP workload, moving active data set to the tier 1 SSD drives can achieve higher throughput.

Figure 6 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 5.

The baseline configuration without Data Progression supports 1600 concurrent users when it meets the SLA of around 1 second response time. At the 1600 concurrent user load, the response time of the baseline configuration is 0.819 second; the response time of the tiered configuration is 0.469 second.

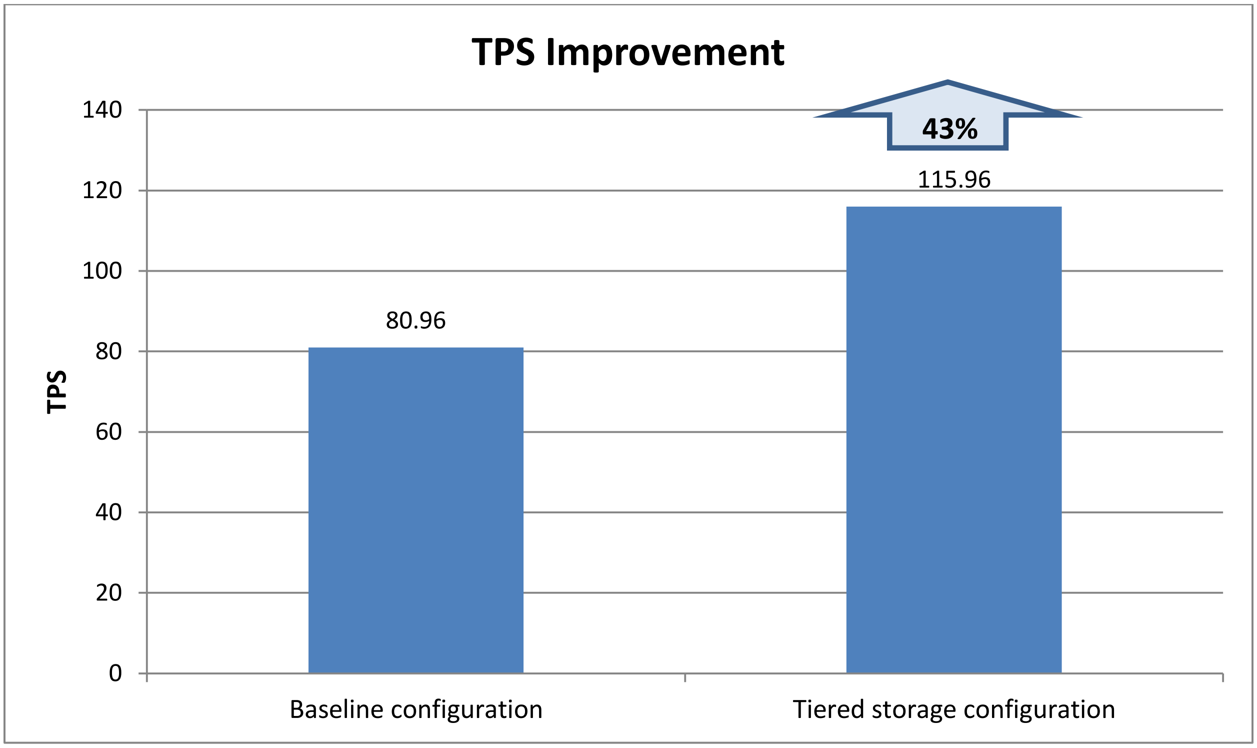
As illustrated in Figure 8, using Data Progression to move active data sets in OLTP applications from SAS disks to SSD disks can reduce transaction response time by 43 percent.

Figure 8. Dell Compellent Data Progression reduces transaction response time of Oracle OLTP workload



While meeting the SLA of around 1 second response time, the baseline configuration is able to deliver TPS of 80.96; the tiered configuration delivers TPS of 115.96. Based on these data, we can conclude that Dell Compellent Data Progression improves throughput in TPS of OLTP applications by 43 percent as compared to the baseline configuration, by moving active data set to tier 1 SSD drives. This is illustrated in the Figure 9 below.

Figure 9. 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 43 percent as compared to a non-tiered configuration in OLTP workload by moving active data sets to the top tier SSD disk drives.
- Dell Compellent automated storage tiering Data Progression improves TPS by 43 percent as compared to a non-tiered configuration in OLTP workload by moving active data sets to the top tier SSD disk drives.

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.

References

1. *Oracle Best Practices on Compellent Storage Center*, a Dell technical white paper.

2. *The architectural advantages of Dell Compellent automated tiered storage*, a Dell technical white paper.
http://content.dell.com/us/en/gen/d/business~solutions~power~en/documents~ps2q11cse-20110332-comp2.pdf.aspx

3. *Storage Center 6.1 System Manager User Guide*.