# Simplified Database Storage Management That Lowers Management Costs And Yields High Storage Utilization

*An Oracle & 3PAR White Paper*
*April 2008*


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# EXECUTIVE SUMMARY

Information Technology organizations are faced with the challenge of managing complex database environments while simultaneously maintaining optimal performance and curbing growing cost of database storage. Implementing multiple layers of technology in traditional database environments results in tedious, labor-intensive processes for database file management, storage provisioning, and performance tuning. Endless administration cycles are wasted without ever attaining optimized performance and capacity utilization. The end result is high cost of database storage.

To address these costly challenges, a powerful solution is now available from Oracle and 3PAR that dramatically reduces the high cost of database storage. This joint solution – Oracle Database 11g with ASM with 3PAR InServ Storage Servers with Thin Provisioning – simplifies database storage management and enables resource optimization, resulting in unmatched cost of database storage.

These two solutions work together to create a simplified database storage management environment:

- **Oracle Database 11g with Automatic Storage Management (ASM)** – an easy to manage, high-quality service database with automated database file management.

- **3PAR InServ Storage Servers with Thin Provisioning** – an intelligent and broadly scalable disk array with automated storage administration and dynamic storage provisioning.

Together, the combined Oracle and 3PAR solution provides a comprehensive approach to both database file management and block-level data management.

Tests by Oracle and 3PAR demonstrate that the combined Oracle and 3PAR solution delivers a dramatic reduction in management cost while increasing resource utilization.

The combined solution greatly simplifies database administration, and storage provisioning and configuration, and automates performance tuning. Tedious, manual tasks are eliminated. Database and storage administrators are relieved of repeatedly performing onerous and error-prone tasks related to follow-on storage planning and provisioning and to the management of hundreds of files. Manual I/O tuning is eliminated with automated load balancing both at the database layer and at the storage array layer. This results in workflow and workload reduction for administrators across the IT organization.

The end result is a 30% reduction in resources required for storage provisioning tasks and a projected 65% increase in productivity for database administrators based on the elimination or reduction of typical administrative tasks.

Best of all, the combined Oracle and 3PAR solution ends over-provisioning. Users can start with a small, cost-effective footprint and scale capacity and performance in a granular and independent way, both at the database and storage array layer, as needed. Thus, IT managers purchase and add only what is needed, when it's needed. Moreover, pooling of storage resources both at the database and storage array layer eliminates wasted storage. Lastly, high-performance RAID-5 cuts the space requirement by 70% or more.

The end result is a dramatic increase in disk utilization, resulting in 50% less wasted storage. Moreover, physical capacity is purchased to meet today's demands rather than projected demands since capacity can be added later, simply and seamlessly. This can result in a saving of millions of dollars for base capacity and related costs such as housing, powering, cooling and software licenses.

# INTRODUCTION

IT organizations are faced with the challenge of managing complex database storage environments while simultaneously curbing the growing cost of database storage. To address this challenge, a simpler database storage management solution that simplifies storage configuration, automates storage management and enables dynamic provisioning is needed.

This white paper addresses the challenges inherent to database storage management in traditional database environments and proposes Oracle 11g with ASM and 3PAR InServ Storage Server with Thin Provisioning as a powerful solution. Together, Oracle and 3PAR deliver a dramatic reduction in management cost while increasing resource utilization, as demonstrated by recent tests conducted by Oracle and 3PAR using this combined solution.

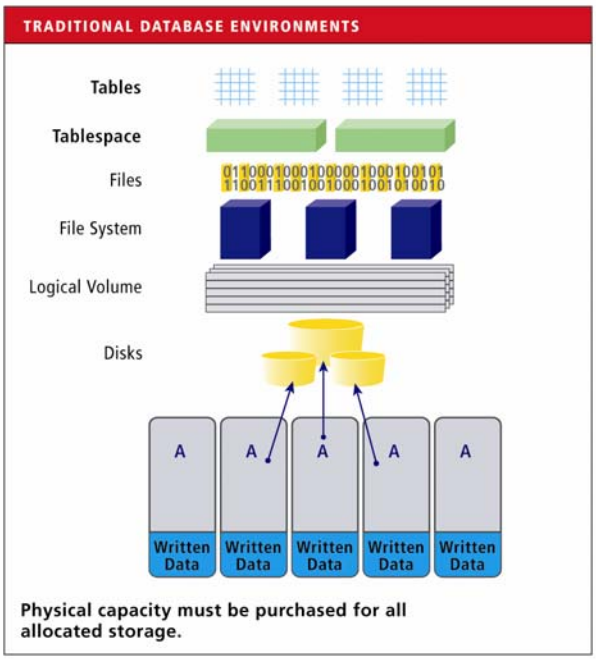



**Figure 1a**

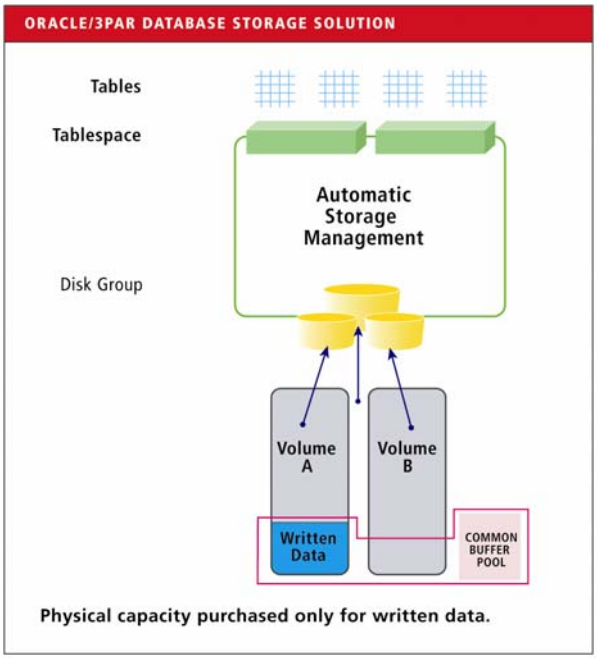



**Figure 1b**

# THE CHALLENGES

Tedious, manual administration of multi-layered, complex database environments is the challenging, often thankless, job of database and system administrators. Managing rapid growth while maintaining optimal performance and keeping management costs in check becomes the day-to-day juggling act. According to a survey conducted by Oracle, database administrators typically spend 55% of their time on ongoing database administration tasks, such as performance tuning, space management, and system resource tuning.

The problem is that management of a dynamic, high-performance database and its associated storage is simple in concept, but highly complex in reality. The ongoing process of provisioning and configuring storage and mapping and managing database files is labor intensive, tedious, and subject to human error. The result is that database and storage administrators' waste endless cycles on administration without ever attaining optimized performance and capacity utilization.

Here are the common database storage management issues found in IT organizations:

### Complex database storage administration

Multiple layers of technology introduce unnecessary management and performance overhead. Database administrators must manage the file system and volume manager, as well as hundreds to thousands of data files – sometimes just for one database. These files must be mapped and re-mapped on an ongoing basis as changes occur. This manual process is labor intensive and subject to human error.

### Complex storage provisioning, configuration and management

Terabytes of storage capacity must be allocated annually to support rapid database growth, yet manual storage provisioning tasks may involve as many as 20 separate steps and several administrators across many IT groups, taking days or even weeks to complete. It becomes an unwieldy challenge to plan, initialize, allocate, manage, and tune scores or hundreds of disks while assuring performance and scaling a growing application environment.

### Complex performance tuning

Storage layout and configuration can have a significant impact on overall database performance, yet scaling the database storage environment – while simultaneously load balancing and assuring database performance – is complex. Given the complexity of laying out data in order to maximize throughput, inevitably some disk subsystems are overtaxed while others are underutilized. Achieving this balance to delivering optimal performance is virtually impossible to do with manual tuning.

### Low resource utilization

With traditional storage infrastructures, physical storage capacity is dedicated when a volume is provisioned. Since storage must be set aside before the actual demand is known, a significant amount of allocated storage goes unused and is therefore wasted. A recent article by Glasshouse Technologies demonstrates this problem. A detailed analysis of 750 host systems at large and small companies revealed that up to 75% of allocated storage capacity at these sites went unused. This failure to utilize storage resources wastes capital, floor space, electric power and cooling resources, driving up overall data center costs.

# THE SOLUTION

Together, Oracle and 3PAR offer a unique solution that automates the provisioning, configuration and tuning of database storage and enables storage capacity consumption on an as-needed basis, when data is actually written to disk. This joint solution dramatically simplifies database storage management and enables resource optimization, resulting in unmatched cost of database storage.

Two solutions work together to create a simplified database storage management environment:

- **Oracle Database 11g with Automatic Storage Management (ASM)** – an easy to manage, high-quality service database designed for Enterprise Grid Computing.

- **3PAR InServ Storage Servers with Thin Provisioning** – an intelligent and broadly scalable disk array with automated storage administration and dynamic storage provisioning capabilities.

This combined solution yields a complete, simplified database storage management solution. Each component brings complementary technologies that together create a tightly integrated, highly efficient solution.

## Oracle Database 11g

Oracle Database 11g is designed for Enterprise Grid Computing. Oracle 11g provides an integrated suite of application infrastructure software designed to run enterprise applications on computing grids (multiple computing resources that act as one virtual resource). It automates the installation, maintenance, load balancing, availability, scaling, and security of Oracle databases and application servers on grids.

Oracle Database 11g cuts costs while providing the highest quality of service. It allows IT to rapidly respond to the needs of the business while greatly lowering risk. Above all, it's easy to deploy and manage.

### Auto Extend

Oracle 11g provides the flexibility to initially consume small amounts of capacity and to granularly extend the capacity by growing database files automatically in accordance with database table growth. Once configured with auto extend, Oracle handles database growth automatically.

### Automatic Storage Management (ASM)

A unique feature of Oracle 11g is Automatic Storage Management. Automatic Storage Management provides a vertical integration of the file system and volume manager for Oracle database files, greatly simplifying storage management for Oracle Databases. Instead of managing hundreds or thousands of database files, Oracle Database Administrators manage only a small number of disk groups. Disk groups are a set of disk devices that Oracle manages as a single, logical unit. An administrator can define a particular disk group as the default disk group for a database, and Oracle automatically allocates storage and creates or deletes the files associated with the database object.

Automatic Storage Management partitions all available storage into uniformly sized megabyte units and spreads database files evenly across all disks in a disk group. Spreading out the database files delivers optimal performance and resource utilization while eliminating the need for manual I/O tuning.

Automatic Storage Management helps database administrators manage a dynamic database environment by allowing them to grow the database size without having to shut down the database to adjust the storage allocation.

## 3PAR InServ Storage Server – an Intelligent Disk Array

The 3PAR InServ Storage Server is an intelligent disk array that provides automated load balancing and granular capacity and performance scaling. The 3PAR InSpire architecture intelligently spreads workload widely, even for small volumes, over all its internal resources, providing automated tuning for availability and performance. Moreover, users can start with a small, cost-efficient footprint, avoiding the cost premiums associated with today's monolithic arrays. Users can scale both capacity and performance in a granular and independent way, as needed. IT managers add only what is needed, when it is needed.

### Thin Provisioning

3PAR Thin Provisioning further enhances the flexibility of the InServ Storage Server by enabling allocation on demand. Physical disk capacity is drawn from a common pool only as actual writes occur. This eliminates the issue of allocated but unused capacity that creates wasted space and leads to artificially high storage costs. Administrators can now provision once for an application's lifetime. IT Organizations can now pay for only what they use, when they use it.

## How It Works

The Oracle and 3PAR solutions together offer a complete solution for simplified database storage management:

- Oracle's ASM and Auto-Extend manage data at the database file level, allocating, striping, and rebalancing data files as needed
- 3PAR's Thin Provisioning manages data at the block level, dedicating disk space only as data is written.

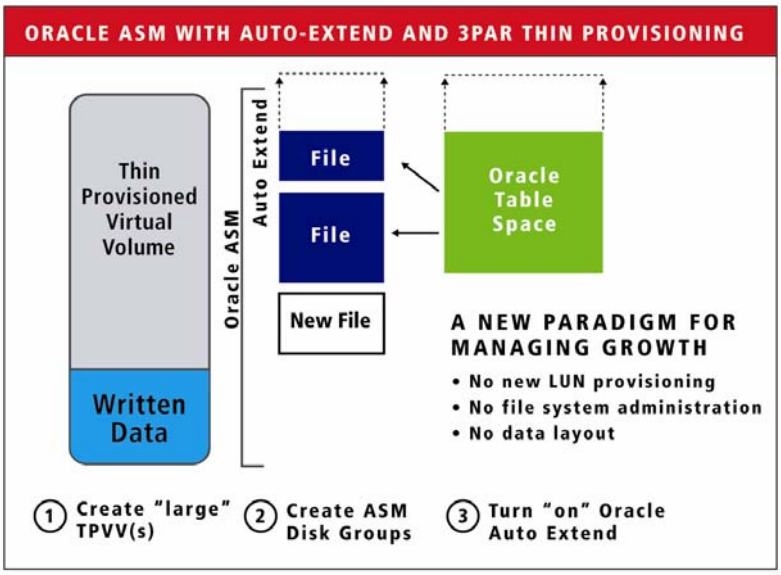



**Figure 2**

Together, the two solutions lower management costs and increase utilization.

# SOLUTION BENEFITS

Together, Oracle and 3PAR create an integrated database storage management solution that delivers two major benefits:

- Reduced management costs
- High resource utilization

Recent tests by Oracle and 3PAR using this combined solution illustrate these benefits. (See Appendix for details on Tested Configuration.)

## Major Benefit: Lower Management Costs

The combined Oracle and 3PAR solution greatly simplifies database administration, and storage provisioning, configuration, and management, while automatically tuning performance. Tedious, manual tasks are eliminated. Database and storage administrators are relieved of repeatedly performing onerous and error-prone tasks related to follow-on storage planning and provisioning and to the management of hundreds of files. This results in workflow and workload reduction for administrators across the IT organization.

**The end result is a 30% reduction in resources required for storage provisioning tasks and a projected 65% increase in productivity for database administrators based on the elimination or reduction of typical administrative tasks.**

## Reduced Complexity in Database Administration

With ASM, Oracle database administrators no longer need to manage the file system, volume manager, and hundreds or thousands of database files. Instead, Oracle database administrators can now manage only a small number of disk groups – a set of disk devices that Oracle manages as a single, logical unit. This means a profound reduction in the management workload of a database administrator.

Administration tasks are greatly simplified. For example, as illustrated in Figure 3, the process for database setup is simplified and number of steps is reduced by 30%. Similar simplicity is achieved with other tasks, including disk removal, disk migration, and space management.

Administrators are relieved from undertaking complex considerations, such as architecting data layout to avoid hot spots, and the overhead of managing multiple layers of technology is eliminated.

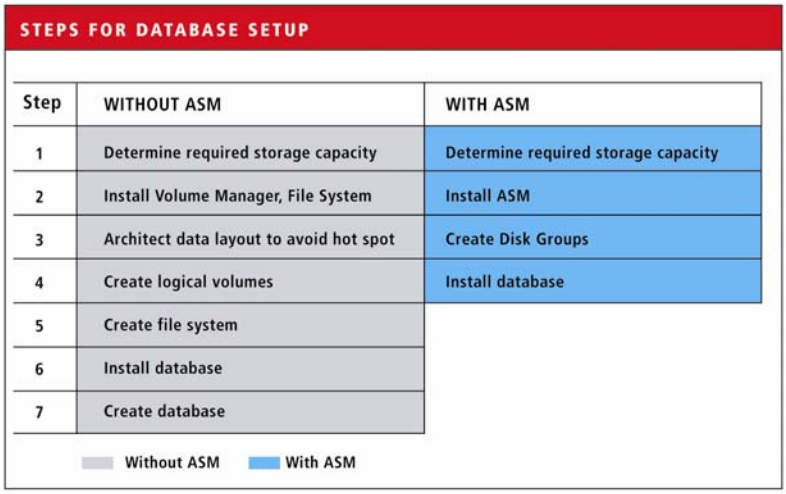



**Figure 3**

## Reduced Complexity in Provisioning Storage

The 3PAR InServ storage platform delivers storage provisioning of application-tailored volumes simply and within a few seconds. Volume layout happens seamlessly with built-in intelligence that spreads volume data across all available system resources – drives, loops, controller nodes – based on required database application service levels.

Moreover, the 3PAR InServ storage platform provides unique flexibility for IT organizations that require full control over data layout. For example, administrators can use the powerful, yet simple-to-use provisioning rules to specify

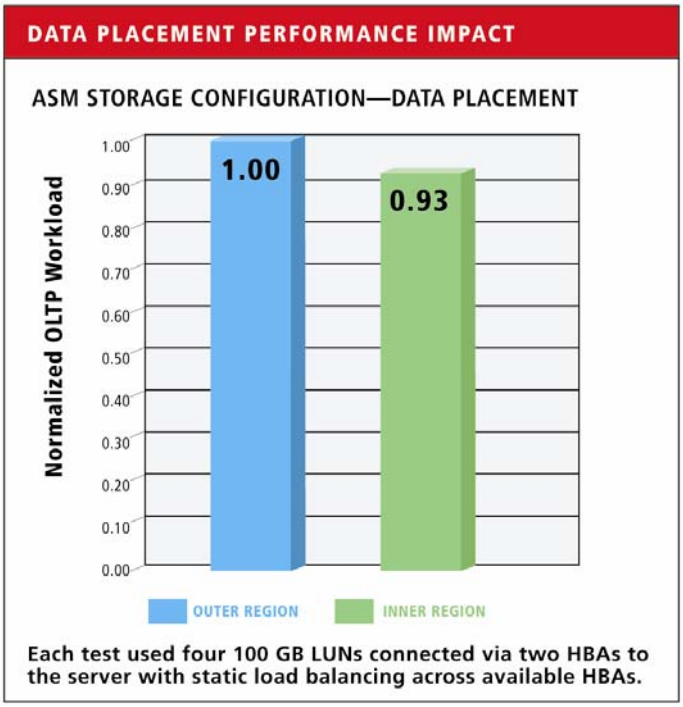



**Figure 4**

whether the inner or outer regions of a disk drive should be used for data placement. Once selected, the rules are applied automatically during volume provisioning. IT organizations with performance-sensitive databases can utilize this unique flexibility of the 3PAR InServ platform to place database files and log files on higher-performance outer regions while the archive logs and backup files can be placed on lower-performance inner regions (Figure 4). Database and storage administrators are relieved of planning and managing complex data layouts.

## Reduced Complexity in Storage Configuration and Management

With traditional database storage environments, administrators are required to configure and manage scores or hundreds of storage volumes to attain high performance. However, with 3PAR InServ Storage Servers, high levels of performance can be achieved with only four 3PAR Virtual Volumes configured to an ASM Disk Group (see Figure 5). This translates directly into reduced complexity.

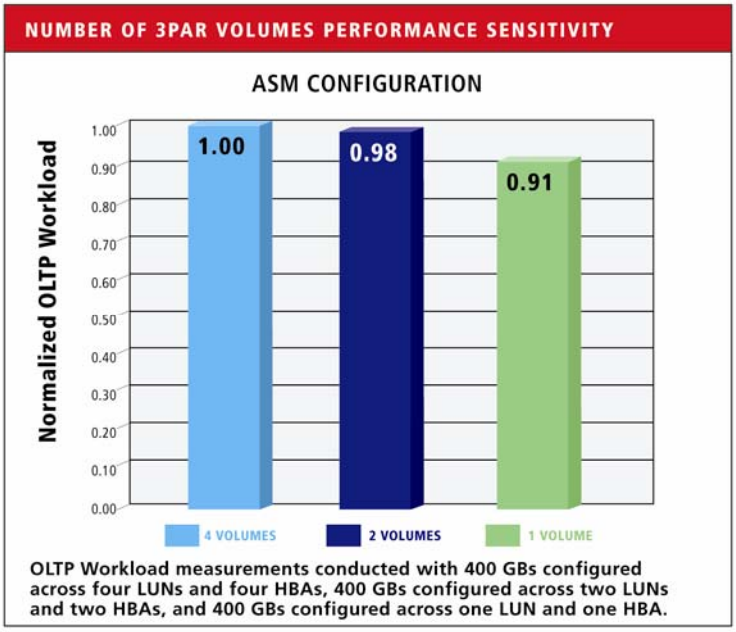
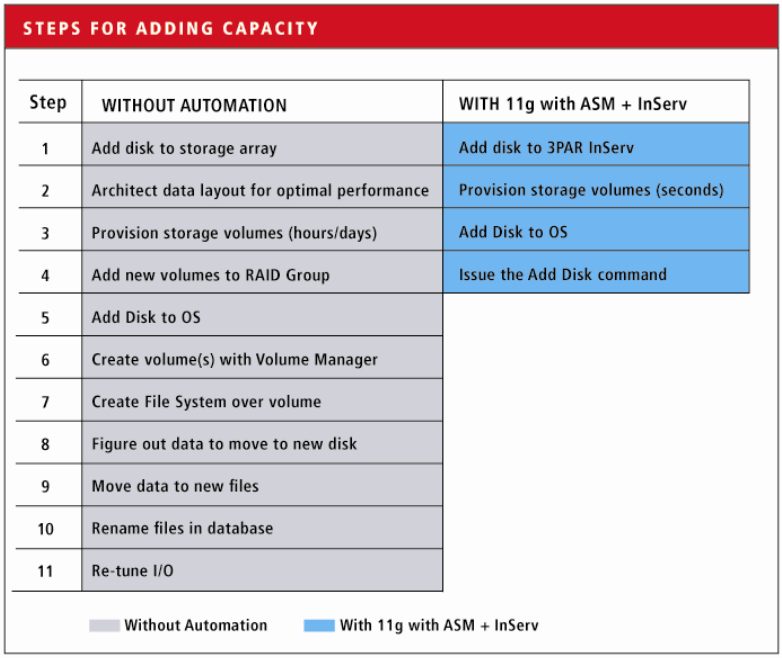



**Figure 5**

## Granular, Seamless Scalability

High-growth environments require the flexibility to scale the storage infrastructure vertically as the database grows or horizontally as business needs require additional applications. The modular, building-block approach of the Oracle and 3PAR solution uniquely provides this flexibility.

For vertically scaling database storage, Oracle ASM enables non-disruptive storage configuration changes,




| Step | WITHOUT AUTOMATION | WITH 11g with ASM + InServ |
|---|---|---|
| 1 | Add disk to storage array | Add disk to 3PAR InServ |
| 2 | Architect data layout for optimal performance | Provision storage volumes (seconds) |
| 3 | Provision storage volumes (hours/days) | Add Disk to OS |
| 4 | Add new volumes to RAID Group | Issue the Add Disk command |
| 5 | Add Disk to OS | |
| 6 | Create volume(s) with Volume Manager | |
| 7 | Create File System over volume | |
| 8 | Figure out data to move to new disk | |
| 9 | Move data to new files | |
| 10 | Rename files in database | |
| 11 | Re-tune I/O | |

**Figure 6**

allowing dynamic database growth. Moreover, ASM automatically performs an online rebalance of data whenever storage configuration is adjusted, moving data only in proportion to added storage. 3PAR InSpire architecture allows users to add disk capacity or controller nodes for performance in a granular and independent fashion. Added resources are automatically put to work as new storage volumes are allocated. Thus, users can start with a small, cost-effective storage footprint and scale capacity and performance granularly as needed.

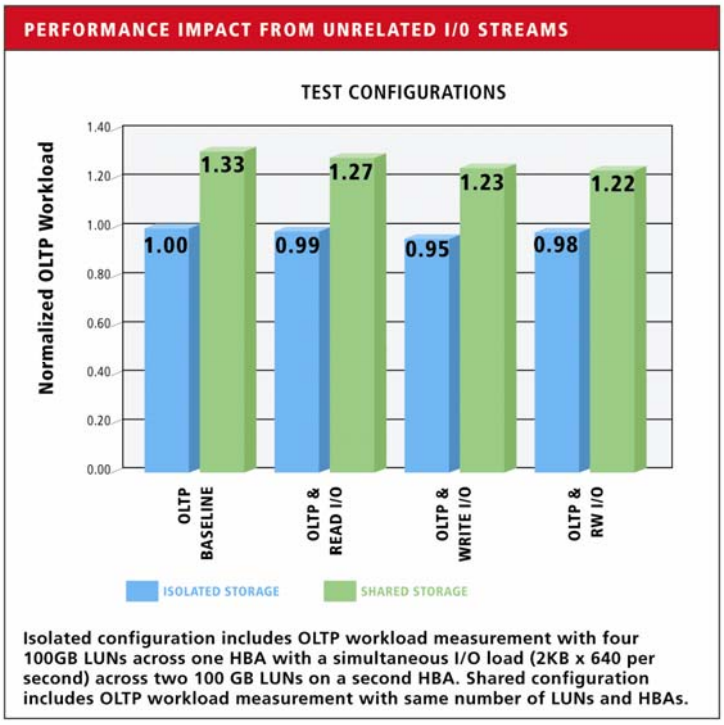



**Figure 7a**

For horizontally scaling the storage infrastructure to support additional applications, administrators can scale application support simply by provisioning and sharing the existing storage hardware resources while being assured of optimal performance, as demonstrated by test results in Figure 7. With automated load balancing of I/O, both at the database level and at the array level, the Oracle and 3PAR solution minimizes disk contention.

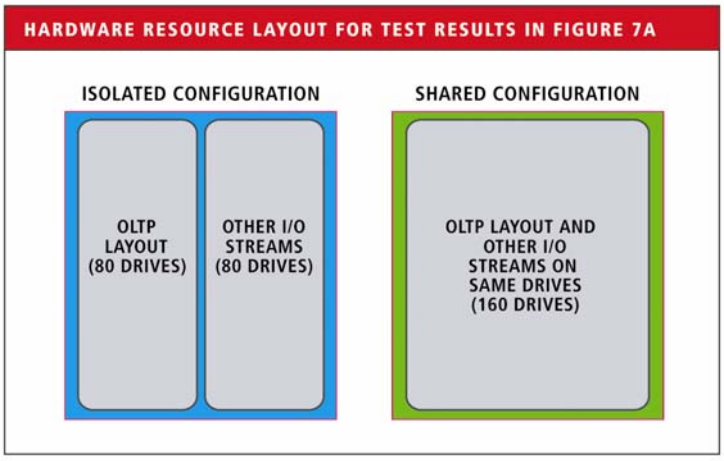



**Figure 7b**

Together, Oracle and 3PAR deliver the flexibility for granular and seamless scalability, whether for scaling database storage or whether for adding and supporting new unrelated applications on shared hardware resources. Administrators are relieved from planning and architecting data layout or from managing separate hardware infrastructures for different applications.

## Hands-Off Performance Tuning

Performance is automatic. The two solutions work together to provide even load balancing. Oracle ASM partitions all available storage into uniform-sized megabyte units and spreads database files evenly across all disks in a disk group, leveraging the performance of all allocated disks. Dynamic online storage reconfiguration assures data is efficiently rebalanced and relocated to maintain an evenly balanced load. Removal of intermediate layers of technology eliminates performance overhead and enables ASM to deliver near raw disk performance.

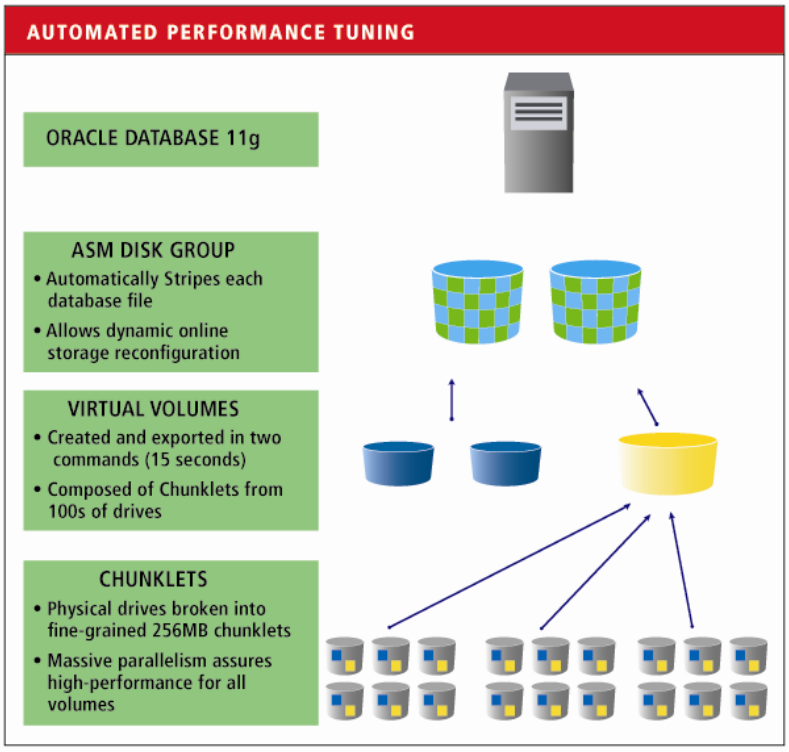



**Figure 8**

The 3PAR InServ platform intelligently spreads data widely, even for small volumes, over all its internal resources – disks, fibre channel loops, controllers, etc. The resulting massive parallelism assures high performance for all volumes.

Combined, the two solutions eliminate the need for manual I/O tuning. Database administrators no longer have to perform complex optimizations tasks, even when an environment scales.

## Major Benefit: High Resource Utilization

The combined Oracle and 3PAR solution ends over-provisioning. Users can start with a small, cost-effective footprint and scale capacity and performance in a granular and independent way, both at the database and storage array layer, as needed. Thus, IT managers purchase and add only what is needed, when it's needed. Moreover, pooling of storage resources both at the database and storage array layer eliminates wasted storage. Lastly, high-performance RAID-5 cuts the space requirement by 70% or more.

**The end result is a dramatic increase in disk utilization, resulting in 50% less wasted storage. Moreover, physical capacity is purchased to meet today's demands rather than projected demands since capacity can be added later, simply and seamlessly. This can result in a saving of millions of dollars for base capacity and related costs such as housing, powering, cooling and software licenses.**

### Optimum Disk Utilization with High-Performance

Storage no longer has to be purchased and set aside before actual demand is known. With Oracle-3PAR solution, storage capacity is pooled allowing disk capacity to be shared among several Oracle database instances while Thin Provisioning allocates the physical storage as data is actually written. This eliminates the issue of allocated but unused capacity that wastes space.

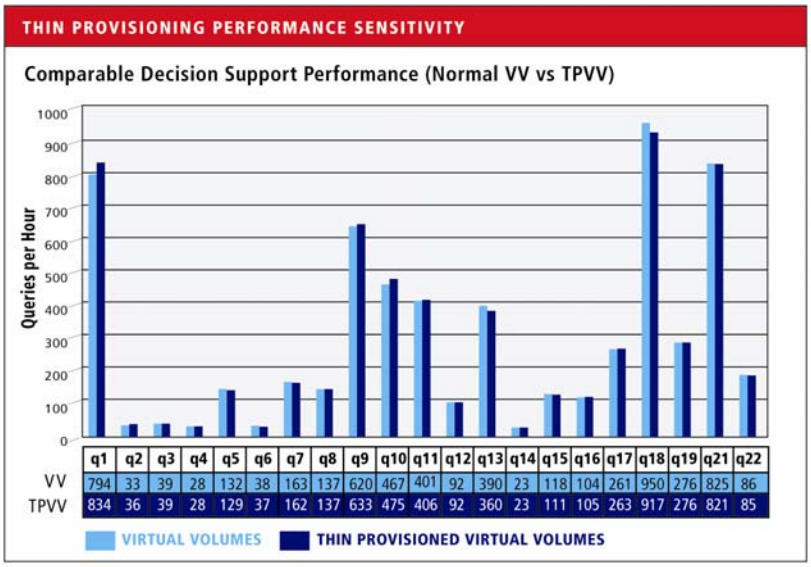


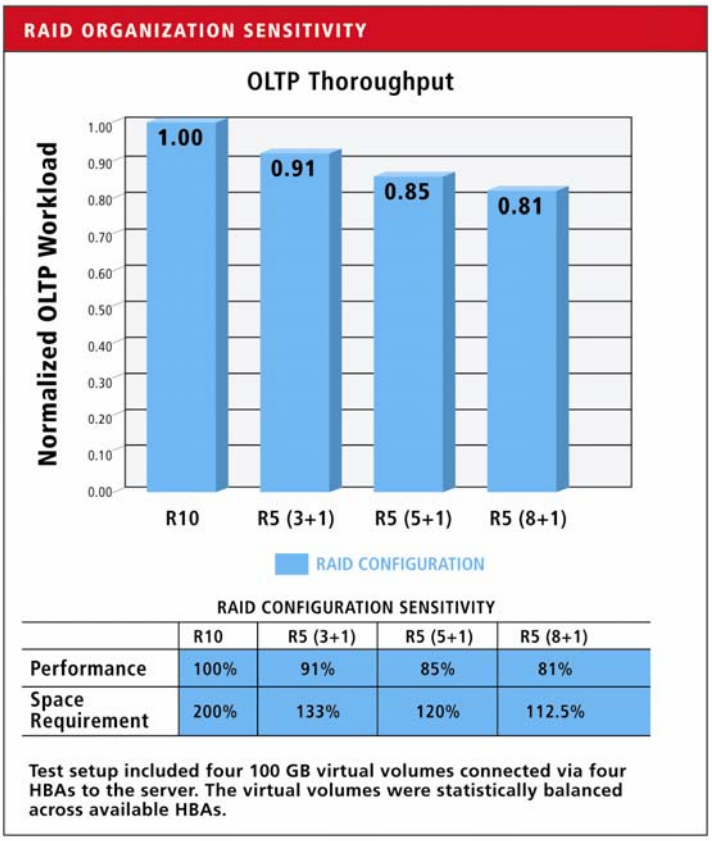

**Figure 9**

The combined Oracle and 3PAR solution with Thin Provisioning is well suited for database applications, including Decision Support. Decision Support Systems require high performance to process complex queries on large volumes of data. As demonstrated in Figure 9, Thin Provisioning delivers the high performance typically available with standard base volumes for decision support queries. Moreover, for the test results in Figure 9, the direct benefits of Thin Provisioning were realized. The Oracle Database supporting the decision support workload was provisioned with 400GB of logical capacity, but only consumed about 280GB of physical disk capacity, representing immediate capacity savings of 30 percent relative to the configuration with standard base volumes. Administrators can now achieve high disk utilization while assuring performance where it matters[1].

[1] Although a performance difference of up to 25 to 30 percent in elapsed time may result for the initial data load with Thin Provisioning, this impact can be minimized by initially pre-allocating only the necessary amount of logical capacity for the load operation.

### High-Performance RAID 5 Enables Dramatic Capacity Savings

Traditionally, RAID implementations on storage arrays have resulted in RAID 5 delivering significantly reduced performance relative to a RAID 1 algorithm. Thus, database storage administrators generally prefer RAID 1 configurations for high-performance database storage, even in light of the high capacity overhead (50%) associated with RAID 1. With the 3PAR InServ platform, administrators can achieve significant RAID 5 capacity savings while simultaneously obtaining nearly the same performance as RAID 1 – a compelling proposition for most IT organizations.




RAID CONFIGURATION SENSITIVITY

| | R10 | R5 (3+1) | R5 (5+1) | R5 (8+1) |
|---|---|---|---|---|
| Performance | 100% | 91% | 85% | 81% |
| Space Requirement | 200% | 133% | 120% | 112.5% |

Test setup included four 100 GB virtual volumes connected via four HBAs to the server. The virtual volumes were statistically balanced across available HBAs.

**Figure 10**

# SUMMARY

Automated database storage management is the database storage solution for next-generation data centers. Oracle and 3PAR address the complexity and key storage provisioning and tuning challenges inherent to traditional database storage architectures today. Together, the combined Oracle and 3PAR solution provides a comprehensive approach to both database file management and block-level data management that delivers

### Lower management costs

- Reduced complexity for database administrator
- Reduced complexity in storage provisioning
- Reduced complexity in storage configuration and management
- Granular, seamless scalability
- Hands-off performance tuning

### High resource utilization

- Optimum disk utilization with high performance
- Dramatic capacity savings with high-performance RAID-5

# APPENDIX

## Tested Configuration

The following test configuration was used:

- Performance Test
  - OLTP workload using 1 GBs for SGA (400 warehouses and 40 drivers).
  - Decision Support workload for Thin Provisioning performance measurement.
- Database – Presented test results were originally demonstrated with Oracle 10g Release 1 with ASM. All documented results and benefits apply using Oracle 11g.
- Host – Sun E-6500 with 15 CPUs with 22GB memory. Only 8 or 12 CPUs were used for most tests.
- HBAs – 4 S-Bus 1 Gigabit HBAs
- Storage – 3PAR InServ S400 (4 controller nodes and 160 10K, 18GB drives)

**About Oracle Corp.**

Oracle is the world's largest enterprise software company. For more information about Oracle, visit our website at www.oracle.com.

**About 3PAR**

3PAR® (NYSE Arca: PAR) is the leading global provider of utility storage, a category of highly-virtualized, tightly-clustered, and dynamically-tiered storage arrays built for utility computing. Organizations use utility computing to build cost-effective virtualized IT infrastructures for flexible workload consolidation. 3PAR Utility Storage gives customers an alternative to traditional arrays by delivering resilient infrastructure with increased agility at a lower total cost to meet their rapidly changing business needs. As a pioneer of thin provisioning—a green technology developed to address storage underutilization and inefficiencies—3PAR offers products designed to minimize power consumption and promote environmental responsibility. With 3PAR, customers have reduced the costs of allocated storage capacity, administration, and SAN infrastructure while increasing adaptability and resiliency. 3PAR Utility Storage is built to meet the demands of open systems consolidation, integrated data lifecycle management, and performance-intensive applications. For more information, visit www.3PAR.com.

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