Abstract

By introducing Enterprise Flash Drives to EMC® Symmetrix® and CLARiiON® storage systems, EMC revitalized the importance of tiered storage. Optimizing the use of these tiers provides performance benefits and cost savings. Precise for Storage Tiering helps match workloads with the appropriate tier in real time and predict the impact of tiering strategies without disturbing productivity.
Table of Contents

Executive summary .................................................................................................................. 4
Introduction .......................................................................................................................... 4
  Audience .......................................................................................................................... 4
The business of IT .................................................................................................................. 4
  Application performance .................................................................................................... 4
  Accelerating application performance with Enterprise Flash Drives ......................... 5
Technology overview ........................................................................................................ 5
Getting started: Connecting storage to the business .................................................. 6
Using Precise for Storage Tiering .................................................................................... 6
  Recommendations mode ..................................................................................................... 6
  Simulation mode ................................................................................................................ 7
    Object simulation ............................................................................................................ 7
    Datafile simulation ......................................................................................................... 7
    Storage device simulation ............................................................................................. 8
    Transaction simulation ................................................................................................ 9
    User simulation .............................................................................................................. 9
    Database simulation ...................................................................................................... 10
    Storage simulation ....................................................................................................... 11
System configuration and administration ........................................................................ 12
Conclusion .......................................................................................................................... 12
References .......................................................................................................................... 12
Executive summary

The traditional process of iterative tuning, application changes, or database redesign to increase application performance is time-consuming and expensive. EMC redefined storage performance by introducing Enterprise Flash Drives. Flash drives are a distinctly faster storage media available for EMC® Symmetrix® V-Max™, Symmetrix DMX-4, and CLARiiON® CX4 arrays. The introduction of Flash Drives gives IT a new option for improving application performance.

There is no question that reducing end-user response time via Flash drives has a direct impact on the performance of the business. The challenge for IT is in maximizing this impact by targeting data sets containing the most important business transactions for promotion to top-tier storage types.

EMC and Precise Software have developed a solution that identifies critical data and accurately predicts the performance impact as well as the associated cost of migrating that data to another tier of storage. Precise for Storage Tiering uses EMC Solutions Enabler to capture detailed performance characteristics of application and database calls as they interact with SATA, Fibre Channel (FC), or Flash drives. This information is used to predict the performance improvements possible by migrating critical business data to Flash drives. Precise can also predict the performance impact and cost savings realized by migrating non-critical data to SATA. Once the data is moved, Precise for Storage Tiering can be used to verify the accuracy of these predictions.

Precise for Storage Tiering is available through the EMC Select program. Precise for Storage Tiering supports Oracle and Microsoft SQL Server environments on both EMC Symmetrix and CLARiiON arrays.

Introduction

This white paper outlines the process to effectively improve application performance by bringing business awareness to storage tiering decisions. The ability to understand the business impact of storage tiering allows companies to optimize storage for high performance at the lowest possible cost.

Audience

The intended audience for this paper includes application owners, storage administrators, and database administrators.

The business of IT

Application performance

The modern enterprise relies on complex applications—with transaction paths crossing client, Web, database, middleware, networking, and storage elements—for critical business operations. Application slowdowns are a painful and chronic problem that costs companies revenue, resources, and operating budget. Traditional approaches to Application Performance Management focus on technology silo monitoring for infrastructure problems, with no linkage to business impact.

Precise focuses on the overall response time of application transactions, and not on hardware, network, or application silos. This innovative approach, called Transaction Performance Management, gives business and IT the ability to clearly see where critical transactions spend time as they move across the application infrastructure, and how well they are performing against business expectations.
This is accomplished by collecting performance information about business transactions and correlating it to the servers, applications, files, storage devices, and LUNs being accessed. This correlation connects business to every tier of the infrastructure that supports it, allowing IT to understand how IT performance impacts the business.

**Accelerating application performance with Enterprise Flash Drives**

Performance tuning usually consists of modifications to existing applications, a database redesign, or even additional server deployments. Each of these methods, while effective, can be expensive and time-consuming. Why change application code, modify a schema, or deploy more CPUs if you can achieve a greater performance return with Flash Drives?

Both EMC Symmetrix and CLARiiON storage systems offer an in-the-box tiering solution, allowing different drive technologies (Flash, FC, SATA) and consolidating multiple tiers of applications in a single frame. By simply optimizing the placement of data on each of these three tiers, customers can dramatically improve performance while simultaneously reducing storage costs.

Traditionally a proof of concept or an in-depth analysis had to be undertaken in order to identify the data most appropriate for each of these tiers, usually based on frequency of access. This cannot always emulate the exact data flow in production environments, and does not account for the dynamic nature of business data. This often results in incorrect placement of data objects.

By connecting business transactions directly to the storage devices they access, Precise takes the guesswork out of tiering decisions.

Precise for Storage Tiering provides recommendations to ensure the correct files or objects are located on the correct tier. This practice continuously ensures the optimal placement of database files or objects over all Symmetrix and CLARiiON tiers available, and increases database performance by placing the most critical data on EMC Enterprise Flash Drives, leaving less important data on FC or SATA drives.

“With Precise for Storage Tiering, available through the EMC Select program … organizations can target EFD implementations where they will get the highest return on investment [and] deploy more cost-effective storage solutions where performance requirements are lower.”

Brian Babineau  
*Senior Analyst*  
*Enterprise Strategy Group*

**Technology overview**

Storage represents one end of the “final mile” in every business transaction. Ensuring that storage is performing at peak efficiency is just as important to end-user response time as optimizing application or database performance. EMC Symmetrix and CLARiiON with Flash drives lower latency by eliminating the mechanical delays, associated with spinning drives delivering as much as a six-fold improvement in response time over FC. How this translates into performance improvements for a business transaction, or for an entire application, is dependent on several factors: data access patterns, disk cache hits, available bandwidth, and scarcity of other system resources. But why guess the benefits?

Designed for non-intrusive monitoring of production environments, Precise for Storage Tiering reports directly on end-user response times, and identifies storage performance latency device by device (and database object by database object). EMC Solution Enabler APIs are used to map I/O activity between database files and storage devices. This allows a direct connection to be established between storage devices, files, database objects, SQL statements, applications, and transactions.

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Optimizing Tiered Storage Workloads with Precise for Storage Tiering  
*Applied Technology*
This information, along with performance metrics for each business transaction served, is stored in the Precise performance management database (PMDB™). This historical record of performance is used by Precise for Storage Tiering, which is also equipped with detailed models representing the performance characteristics of various EMC storage products, including Flash, FC, and SATA drives. Based on the historical performance information in the PMDB, Precise accurately predicts the performance impact of any data migration on database or storage tiers at the file, transaction, database object, or program level. This allows customers to choose storage tiering strategies that maximize performance and minimize cost for their critical database activity.

Precise for Storage Tiering supports custom and packaged applications, middleware, databases, storage, and more—across all major OS, application, server, and EMC storage platforms (Symmetrix or CLARiiON). Transaction types supported include web-based, client-server, a business-to-business service request, or even a high-priority batch job trying to fit into an ever-decreasing window.

**Getting started: Connecting storage to the business**

Precise for Storage Tiering requires the installation of EMC’s Solution Enabler 6.5.2 (or later). Once installed, it monitors the performance characteristics of all business transactions as they make their way into storage and captures them in the Precise PMDB. In a typical application environment, two or three days of data collection is enough to enable accurate predictions. These predictions plainly show the performance improvement possible for actual business transactions had each of them been run on a different tier of storage (such as Flash). This simulation component allows IT to conduct what-if scenarios by selecting certain entities to move to Flash. For example, IT can simulate:

- Migrating the entire database instance
- Migrating data used by an individual transaction
- Migrate data used by batch jobs
- Migrating tablespaces
- Migrating data files
- Migrating database objects

The result of the simulation is a graphical display of the predicted performance improvement.

**Using Precise for Storage Tiering**

Precise for Storage Tiering considers the following database-related objects in its simulations: Applications (executables) that run database transactions, business users, database objects, database datafiles, and storage devices.

Precise for Storage Tiering presents users with a series of multiple tabs, each providing simulation results of a different layer in the database stack. There are two modes of operation: recommendations mode and simulation mode.

**Recommendations mode**

In recommendations mode, Precise automatically identifies the candidate files, objects, or devices associated with a given database instance that would experience the maximum benefit of migration to Flash. This mode is useful for storage administrators or other business users who are unfamiliar with the technical details of an application or database.

Precise can focus on performance improvements, cost savings, or both. It will display the amount of time objects spent waiting on query results, along with I/O time improvements that would be realized. As shown in Figure 1, this information can be reported based on objects, datafiles, and storage devices.
Figure 1. Recommendations mode

**Simulation mode**

In simulation mode, the user enters a specific transaction, user, database object, file, or device, and the optimizer reports the predicted performance improvement. This is useful where the application or database is well known and the line of business has identified the critical components for which they want to test the effectiveness of Flash.

**Object simulation**

When running an object-based simulation, users are presented with a list of tablespaces encountered during the database analysis (Figure 2). Not only does the simulator display improved values per individual tablespace, it also displays aggregated improvement over all tablespaces encountered in the analysis.

Figure 2. Database objects

Once the data is migrated to Flash, Precise for Storage Tiering can validate the effectiveness of the migration as part of an ongoing storage optimization process. Figure 3 shows two separate charts that display the actual performance improvement for database objects after an actual migration to Flash.
Figure 3. Validating predictions

Results matter. As you can see, the time spent in the database is drastically reduced thanks to the deployment of Flash drives.

Datafile simulation

When running a datafile-based simulation, Precise looks at all datafiles associated with the selected database instance (Figure 4). For each database file, you can see how frequently it is accessed, how much time it spends waiting for storage (measure I/O time), and the predicted response time improvements for transactions they service. In this example, the files on the L: drive will experience the largest total I/O time improvement, while the G: drive files will realize the greatest percentage improvement.

Figure 4. Datafiles

Storage device simulation

For storage device simulations, the simulator presents a list of storage devices connected to a given database instance (Figure 5). The report clearly shows that the device ending in 098 will realize a two-thirds reduction I/O time if it were migrated to Flash. Transactions using this device will reduce the response time accessing the device by 66 percent!
Figure 5. Storage device

Transaction simulation
The Transaction simulation tab allows the user to select a specific transaction or program accessing the database and EMC storage. Precise displays a table detailing the time the selected program spent waiting on the database, along with the predicted time if the data used by this program was migrated to Flash (Figure 6).

Figure 6. Transaction simulation result display

User simulation
For a user simulation, details about the business users that access the application are analyzed. For ERP and CRM applications such as PeopleSoft, SAP or Oracle E-Business Suite, visibility into the actual business end user, and not the database user, is provided. This allows an administrator to simulate the response time improvement for transactions executed by a specific user once the data they access is migrated.

Figure 7. Selecting a business user
The User tab displays improvements sorted by both the transaction or statements encountered by this user if the data they access is migrated to Flash (Figure 8).
Figure 8. User simulation results display

Database simulation

In the Database tab, database objects are put to the test. This can either be a database schema object or a datafile used by the database instance (Figure 9).

Figure 9. Selecting a database schema of a datafile

The database simulation displays improvements sorted by both the statements encountered and the applications encountered by the simulator (Figure 10). The blue line shows the actual time spent waiting for I/O. The green line shows the predicted time spent waiting for I/O if the data for this table is migrated to Flash. During the time period shown where the blue line spikes, our database spent an enormous time waiting for storage. During this time we can see that migrating to Flash would have yielded a substantial improvement.
Figure 10. Database simulation results display

Storage simulation
The final simulation available is the Storage tab. Storage simulation allows the user to select a database instance. From this instance the simulator will display all storage devices that this database instance touched during the analysis. The user can choose either to simulate the migration of all devices to Flash drives or select particular devices to migrate (Figure 11).

Figure 11. Storage device selection dialog box

In addition to showing the improvements in a tabular fashion (Figure 12), running the simulation will present a graph displaying I/O savings over the time. Along with the graph, time improvement data is displayed sorted by either the storage devices selected, SQL statements encountered, or the complete program transactions that ran during the database analysis.
System configuration and administration

Required hardware
- EMC Symmetrix (DMX-4 or V-Max)

Required software
- EMC Solutions Enabler 6.5.2 or later must be installed on the management host
- Precise for Storage Tiering 8.5

Supported applications
- SAP
- Oracle E-Business Suite
- PeopleSoft
- Seibel
- J2EE
- .Net

Support databases
- Oracle
- Microsoft SQL Server

Conclusion
Efficient use of all available storage is the main goal of every storage architect. Providing tiered storage in its arrays allows EMC customers to match business requirements with the right level of storage performance. By introducing Enterprise Flash Drives, EMC has added another tier of storage to accommodate the most performance-sensitive business data. Precise for Storage Tiering allows EMC customers to make the best use of Enterprise Flash Drive technology as part of their overall storage strategy.

References
For more information on Enterprise Flash Drives and database optimization please research EMC’s website and Precise Software’s website.