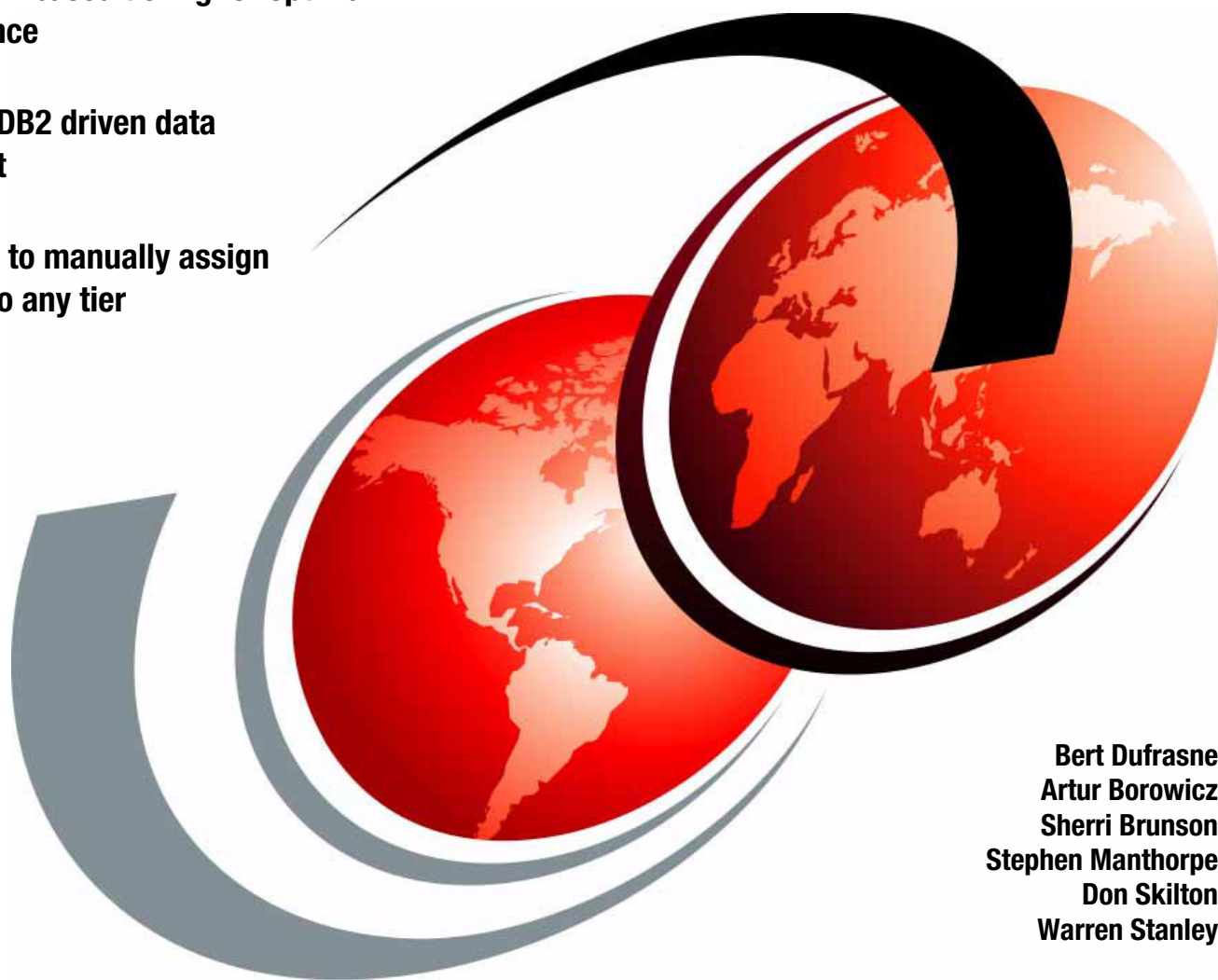


IBM DS8870 Easy Tier Application

Application-based tiering for optimal performance

IBM z/OS DB2 driven data placement

Capability to manually assign volumes to any tier



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International Technical Support Organization

DS8870 Easy Tier Application

January 2015

Note: Before using this information and the product it supports, read the information in “Notices” on page v.

Second Edition (January 2015)

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Preface

This IBM® Redpaper™ publication describes the concepts, functions, and practical usage of IBM Easy Tier® Application.

IBM Easy Tier Application is part of the overall Easy Tier offering. Initially, the overall Easy Tier function was designed to automate data placement throughout the storage system disks pool. It enables the system, automatically and without disruption to applications, to relocate data (at the extent level) across up to three drive tiers. The process is fully automated. Easy Tier also automatically rebalances extents among ranks within the same tier, removing workload skew between ranks, even within homogeneous and single-tier extent pools.

The Easy Tier Application feature allows for direct data placement, when desired. The storage administrators can use the DS command-line interface (DS CLI) to directly assign distinct application volumes to a particular storage tier. Easy Tier Application also features a software-defined storage data placement interface that can enable specific applications running on IBM System z® to direct more optimal placement of the data by communicating important information about current workload activity and application performance requirements. Specifically, with DS8870 R7.4, it is possible for IBM DB2® applications in IBM z/OS® environments to give hints of data placement to Easy Tier, at the dataset level.

This paper is aimed at those professionals who want to understand the Easy Tier Application concept and its underlying design. It also provides guidance and practical illustrations.

If you want to become familiar with the general concept of Easy Tier, see the *IBM System Storage DS8000 Easy Tier*, REDP-4667.

Other Easy Tier features are described in the following publications:

- ▶ *IBM System Storage DS8000 Easy Tier Server*, REDP-5013
- ▶ *IBM System Storage DS8000 Easy Tier Heat Map Transfer*, REDP-5015

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Easy Tier Application overview

This chapter starts with a summary of the Easy Tier functions in general and briefly describes how Easy Tier evolved over seven generations. The remaining sections provide an overview of Easy Tier Application and describe its business case and the potential application performance improvements that it can enable in an IBM DS8870 environment.

For more information about Easy Tier in the DS8000 family, see *IBM System Storage DS8000 Easy Tier*, REDP-4667.

1.1 Easy Tier generations

Easy Tier is a DS8000 built-in dynamic data relocation feature that allows host-transparent movement of data among the storage system resources. This feature improves configuration flexibility and performance tuning and planning. Over time, new and improved functions developed. The evolution of Easy Tier advanced functions throughout its seven generations is summarized in Figure 1-1.

Easy Tier / DS8000 Model	Microcode Release	Tier Support	Auto Mode (Sub Volume)	Manual Mode (Full Volume)
Easy Tier 1 DS8700	R5.1	Two tier SSD + ENT SSD + NL	<ul style="list-style-type: none"> Promote Swap 	<ul style="list-style-type: none"> Dynamic extent pool merge Dynamic volume relocation
Easy Tier 2 DS8700 DS8800	R6.1 R6.1	Any two tiers SSD + ENT SSD + NL ENT + NL	<ul style="list-style-type: none"> Promote Warm/Cold Demote Swap Auto Rebalance (Hybrid pool only) 	<ul style="list-style-type: none"> Rank depopulation Manual volume rebalance
Easy Tier 3 DS8700 DS8800	R6.2 R6.2	Any three tiers SSD + ENT + NL	<ul style="list-style-type: none"> Auto Rebalance (Homogeneous Pool) ESE Volume support 	
Easy Tier 4 DS8700 DS8800 DS8870	R6.3 R6.3 R7.0	Full support for FDE (encryption) drives	<ul style="list-style-type: none"> Automatic data relocation capabilities for all FDE disk environments 	<ul style="list-style-type: none"> Support for all manual mode command for FDE environments
Easy Tier 5 DS8870	R7.1	Easy Tier Application Easy Tier Heat Map Transfer Easy Tier Server	<ul style="list-style-type: none"> Storage administrators can control data placement via CLI Provides directive data placement API to enable software integration Learning data capture and apply for heat map transfer for remote copy environments Unified storage caching and tiering capability for AIX servers 	
Easy Tier 6 DS8870	R7.3	Tier 0 support for High Performance Flash Enclosures Easy Tier Server support for Flash Adapter 90 on POWER 940+ servers	<ul style="list-style-type: none"> Intra-tier rebalance for heterogeneous Flash storage pools (HPFE and SSD) 	
Easy Tier 7 DS8870	R7.4	Easy Tier Application API for System z Easy Tier Control	<ul style="list-style-type: none"> Allow applications from zOS to give hints of data placement at dataset level Allow customer to control learning and migration behavior at pool and volume level to adapt to different workload requirement 	

Figure 1-1 Easy Tier generations

The *first generation* of Easy Tier introduced automated *storage performance* management by efficiently boosting Enterprise class performance with solid-state drives (SSDs) and automating storage tiering from Enterprise class drives to SSDs, therefore optimizing SSD deployments with minimal costs. It also introduced *dynamic volume relocation* and *dynamic extent pool merge*. Dynamic volume relocation allows a DS8000 volume to be migrated to another extent pool, and dynamic extent pool merge allows an extent pool to be merged with another extent pool, both without any disruption of the host operations.

The *second generation* of Easy Tier added automated *storage economics* management by combining Enterprise class drives with Nearline drives with the objective to maintain Enterprise-tier performance while shrinking the physical footprint and reducing costs with large-capacity Nearline drives. The second generation also introduced intra-tier performance management (*auto-rebalance*) for hybrid pools and *rank depopulation*. Rank depopulation allows you to remove an allocated rank from an extent pool and relocate the allocated extents to the other ranks in the pool. During the rank depopulation process, the affected volumes, which have extents on the rank to be depopulated, remain accessible to hosts.

The *third generation* of Easy Tier introduced further enhancements that provided automated storage performance and storage economics management across all three drive tiers, which allows you to consolidate and efficiently manage more workloads on a single DS8000 system. It also introduced support for auto-rebalance in homogeneous pools and support for *thin provisioned* (extent space-efficient (ESE) volumes).

The *fourth generation* of Easy Tier enhanced the support of *Full Disk Encryption* (FDE) drives. IBM Easy Tier can perform volume migration, auto performance rebalancing in homogeneous and hybrid pools, hot spot management, rank depopulation, and thin provisioning (ESE volumes only) on encrypted drives and the non-encrypted drives.

The *fifth generation* of Easy Tier added three new features:

- ▶ *Easy Tier Application*, the topic of this publication, is an application-aware storage utility to help deploy storage more efficiently by enabling administrators to assign logical volumes to a specific tier. This can be useful when certain data is accessed infrequently but needs to be always highly available.
- ▶ *Easy Tier Server* is a unified storage caching and tiering capability that can be used when attaching the storage system to AIX servers with any supported direct-attached flash. Easy Tier can manage the data placement across direct-attached flash within IBM POWER® servers with AIX and DS8870 storage tiers by placing a copy of the hottest data on the application host direct-attached flash, while maintaining the persistent copy of data on DS8870 and still supporting DS8870 advanced functions.
- ▶ *Easy Tier Heat Map Transfer* can take the data placement algorithm on the Metro Mirror/Global Copy/Global Mirror (MM/GC/GM) primary site and reapply it to the MM/GC/GM secondary site through the Easy Tier Heat Map Transfer utility. With this capability, DS8000 systems can maintain application-level performance at an application secondary site when it takes over in supporting a workload after a failover from the primary site to the secondary site.

The *sixth generation* of Easy Tier provides more flash storage support:

- ▶ Support for flash cards, which are installed in *high-performance flash enclosures*, including intra-tier rebalancing for heterogeneous flash storage pools.
- ▶ *Easy Tier Server* adds support to locally cached frequently used DS8870 data on IBM POWER 940+ servers with Flash Adapter 90 storage.

The *seventh generation* of Easy Tier provides the following enhancements:

- ▶ Enhanced Easy Tier Application Support for IBM System z applications (only DB2 initially) to communicate performance requirements for optimal dataset placement, by communicating application performance information (hints) to the Easy Tier Application API. The application hint sets the intent, and Easy Tier moves the dataset to the correct tier.
- ▶ Control improvements, where the administrator can pause and resume Easy Tier monitoring (learning) at the extent pool and volume levels, and can reset Easy Tier learning for pools and volumes. The administrator can also pause and resume migration at the pool level.
- ▶ Volumes can be excluded from the Nearline tier, which extends the capability to also pin volumes to the SSD tier.

1.2 Easy Tier Application

Easy Tier Application was introduced with the fifth generation of Easy Tier for the IBM DS8870. It provides external interfaces for optimized application for data placement on storage resources. The goal of Easy Tier Application is to make the data placement more efficient by integrating it more closely with client applications.

Easy Tier Application allows storage administrators (through the DS command-line interface (DS CL)) and specific applications to intervene with the overall Easy Tier logic through directive data placement requests, as shown in Figure 1-2 on page 5.

The ability to override Easy Tier smart data placement that results from continuous workload learning gives clients additional flexibility in terms of specific application data placement on the DS8870 storage system. The application data can be assigned to the specific storage tier, and the migration method is selected based on the client's defined strategy.

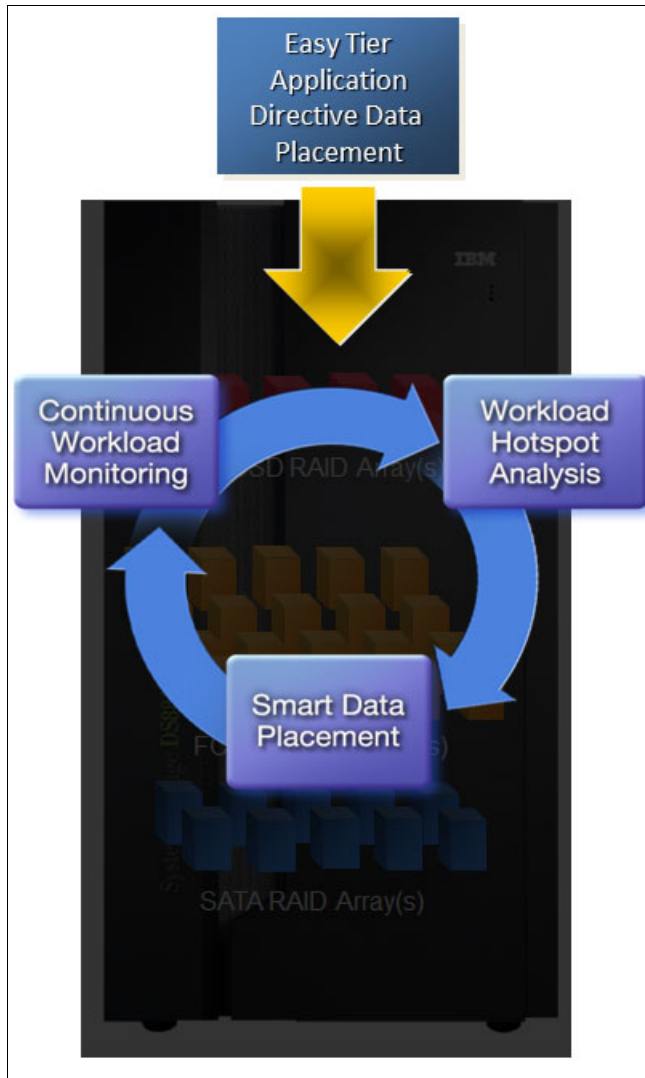


Figure 1-2 Easy Tier Application

1.3 Use cases for Easy Tier Application

Database workload seldom remains static. New users define new queries, existing users change their focus to different areas, and the business cycle presents its own peaks in the workload. Aggregates and indexes are data structures that make queries run faster. The Easy Tier Application allows you to assign the indexes and aggregates to be placed on flash (flash cards and flash drive) tiers by using directive data placement and rebalancing the workload. This improves the performance of static and non-static data and enhances the application performance and related cost requirements.



Easy Tier Application concepts and logical architecture

This chapter describes the concepts and logical architecture that form the basis of the Easy Tier Application feature and its implementation on the DS8870. This chapter also describes the Easy Tier Application data placement mechanism.

2.1 Easy Tier Application components

Easy Tier Application is based on a client/server architecture, as shown in Figure 2-1 on page 9. The application data placement request is issued from the host layer and routed to the Easy Tier Application server in the DS8870 storage system.

Easy Tier Application consists of the following components:

- ▶ DS command-line interface (DS CLI)

Specific DS CLI commands can be run by the storage administrator or integrated into the customer application to generate directive data placement requests. For specific examples, see 3.2, “Easy Tier Application management by using the DS CLI” on page 19.
- ▶ ESSNI

ESSNI is the communication channel between the host layer and Easy Tier Application on the DS8870 storage system. The directive data placement requests are received by ESSNI and sent to the Easy Tier Application server.
- ▶ z/OS Data Facility Storage Management System (DFSMS) functions

With DS8870 R7.4, IBM DB2 for System z applications use specific DFSMS functions to communicate directive data placements to Easy Tier (Figure 2-2 on page 9).
- ▶ Easy Tier Application server

Easy Tier Application server is the software component in the Easy Tier software stack to process the directive data placement requests. Additionally, Easy Tier Application generates migration advice (based on the selected method) and tracks the related data placement progress.
- ▶ Easy Tier

Easy Tier takes the migration advice from Easy Tier Application and the advice from the other components (extent based) into consideration to generate a migration plan and initiate data migration. The placement is done on extent granularity.
- ▶ Tiered storage resources

DS8870 Easy Tier supports a maximum of three tiers in one hybrid storage pool. These tiers can consist of any of these three disk classes:

 - Flash class:
 - Flash cards (in the High Performance Flash Enclosure)
 - Solid-state drives (SSD)
 - Enterprise class drives (ENT):
 - 10K RPM serial-attached SCSI (SAS)
 - 15K RPM SAS
 - Nearline drives (NL):
 - 7.2K RPM NL-SAS

Note:

- ▶ Flash cards are treated as the same tier as flash drives (SSD). However, the intra-tier auto-rebalance (micro-tiering) function of Easy Tier can exploit the higher IOPS capability of the flash cards.
- ▶ The 15K enterprise disks are treated as the same tier as 10K. However, the intra-tier auto-rebalance (micro-tiering) function of Easy Tier can exploit the IOPS capability of the 15K enterprise disks.

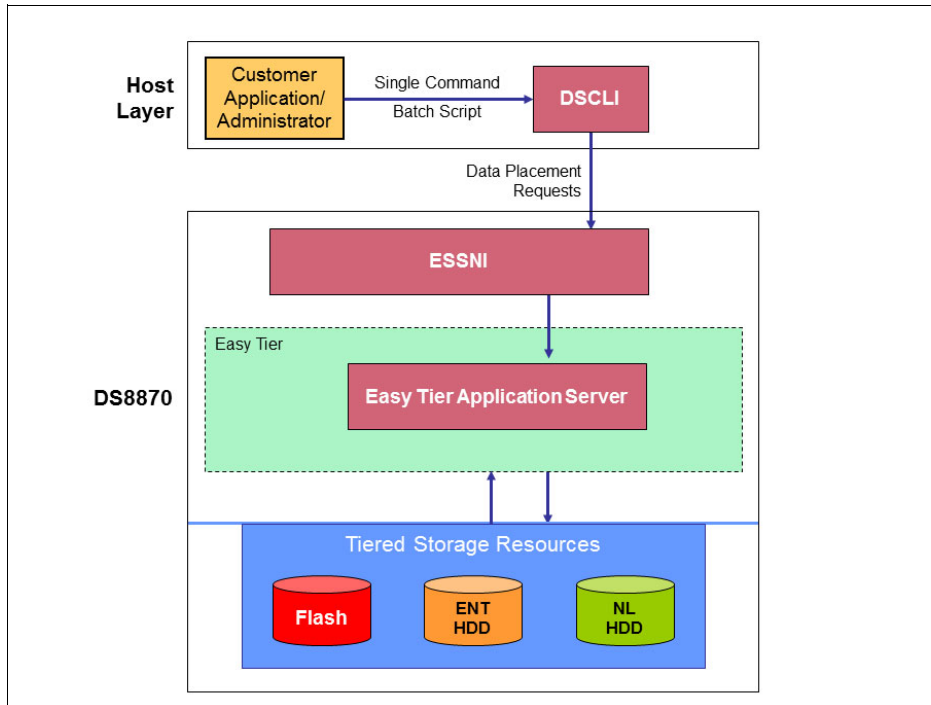


Figure 2-1 Easy Tier Application components

In Figure 2-2, we provide details of the Easy Tier architecture for System z applications that provide data placement hints to the Easy Tier API (by using DFSMS; the ESSNI is not used here). Currently, this is limited to DB2 for System z.

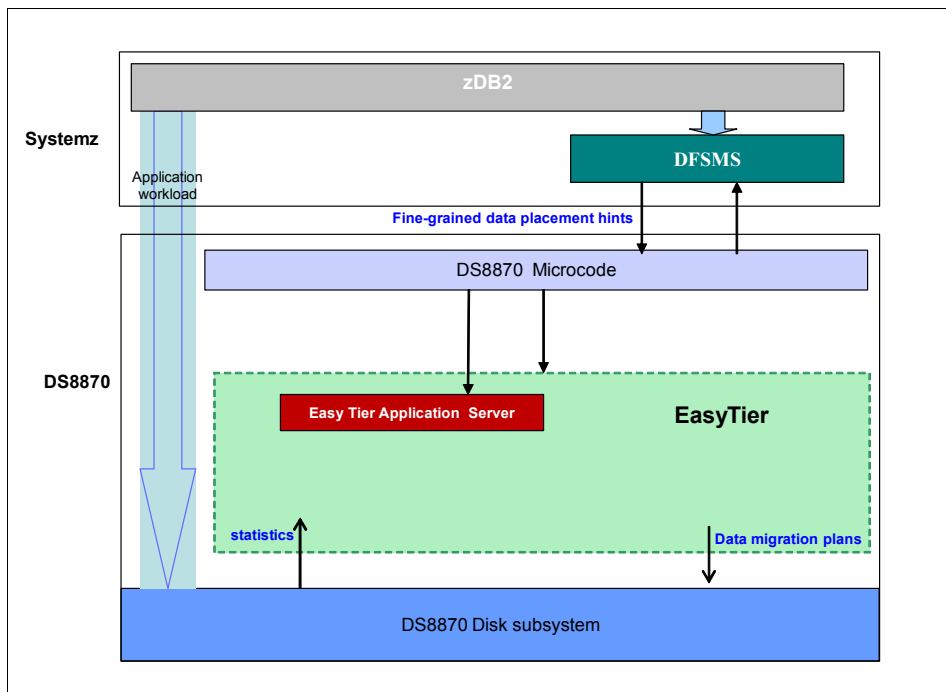


Figure 2-2 Easy Tier Application architecture

2.2 Easy Tier application design

The Easy Tier data placement actions and directive data placement requests work together, as described in this section.

2.2.1 Easy Tier data placement actions

DS8000 Easy Tier is a built-in, dynamic data relocation feature that allows host-transparent movement of data among the storage system resources. This feature improves configuration flexibility and performance tuning and planning.

Note: For more information about Easy Tier in the DS8000 family, see *IBM System Storage DS8000 Easy Tier*, REDP-4667:

<http://www.redbooks.ibm.com/abstracts/redp4667.html>

Easy Tier has two modes, Automatic Mode and Manual Mode:

► Automatic Mode

Easy Tier Automatic Mode can automatically and economically optimize data placement on different tiers in a DS8000 storage system. In Automatic Mode, Easy Tier dynamically manages the capacity in *homogeneous* extent pools (single-tier) and *hybrid* extent pools (multitier, containing up to three different disk tiers). These tiers can consist of any of these three disk classes: Flash, ENT, and NL.

Easy Tier Automatic Mode can be enabled for all extent pools (including single-tier pools), for only multitier pools, or no extent pools, which means they are disabled. Extent pools that are handled by Easy Tier are referred to as *managed* pools. Extent pools that are not handled by Easy Tier Automatic Mode are referred to as *non-managed* pools. Easy Tier Automatic Mode supports regular and thin-provisioned extent space-efficient (ESE) volumes.

Table 2-1 summarizes the logical tier definition in allowed multitier configurations.

Table 2-1 Logical tier definition in multitier configurations

Configuration	Flash (flash cards or flash drives: SSDs)	Enterprise (10K or 15K)	Nearline
Flash, Enterprise, and Nearline	Tier 0	Tier 1	Tier 2
Flash and Enterprise	Tier 0	Tier 1	N/A
Flash and Nearline	Tier 0	N/A	Tier 1
Enterprise and Nearline	N/A	Tier 1	Tier 2

Easy Tier Automatic Mode manages the data relocation both across different tiers (*inter-tier* management) and within the same tier (*intra-tier* management). Inter-tier management aims to relocate the extents of each logical volume to the most appropriate storage tier based on their performance characteristics within the extent pool. Intra-tier capabilities perform an automatic workload rebalancing on the ranks within a single tier of an extent pool.

► Manual Mode

In Manual Mode, Easy Tier also offers significant advantages. Administrators can relocate volumes, merge extent pools, rebalance ranks on request, and depopulate ranks transparently to host applications. Additionally, you can control Easy Tier at the pool level or volume level. This mode applies to both homogeneous and hybrid extent pools.

Note: Easy Tier Automatic Mode and Manual Mode are not exclusive. Therefore, you can use Manual Mode capabilities even if Automatic Mode is active.

Three levels, *hot*, *warm*, and *cold*, are used to describe different priority levels that can be applied to data or extents on a DS8000 storage system:

- Hot data refers to data that has more I/O workload compared to other extents in the same extent pool and in the same tier. Hot data is the data with the highest benefit to be promoted to a higher tier to achieve performance improvement.
- Cold data is data that has either low workload levels or no workload activity at all. Cold data does not benefit from a higher tier and is not promoted. It is demoted to the lowest available tier.
- Warm data is the rest of the workload that is not hot or cold and can either be promoted or demoted, depending on the precise workload levels and configuration.

Easy Tier Automatic Mode monitors the I/O statistics and calculates a metric, which is also referred to as a *heat map*, to identify the amount of hot/warm/cold data for each volume and then defines a migration plan.

Up until the availability of the Easy Tier Application feature, when Easy Tier determined the correct storage tier for a specific extent based on the extent heat and resource usage, the following actions were taken to move the data between different storage tiers or within a storage tier (see Figure 2-3 on page 12):

- *Promote & Swap* moves hot data to higher performing tiers.
- *Warm Demote* prevents the performance overload of a tier by demoting warm extents to the lower tier. Warm demote is triggered when bandwidth or IOPS thresholds are exceeded.
- *Cold Demote* recognizes and demotes cold extents to the adjacent lower-cost tier. Cold demotion occurs only between hard disk drive (HDD) tiers, that is, between Enterprise and Nearline disks.
- *Expanded Cold Demote* (for HDD tiers) demotes some of the sequential workload from the Enterprise tier to the Nearline tier to better use its bandwidth capabilities and to spread the bandwidth demand across both tiers.
- *Auto-Rebalance* redistributes the extents within a tier to balance the usage across all ranks of the same tier for maximum performance.

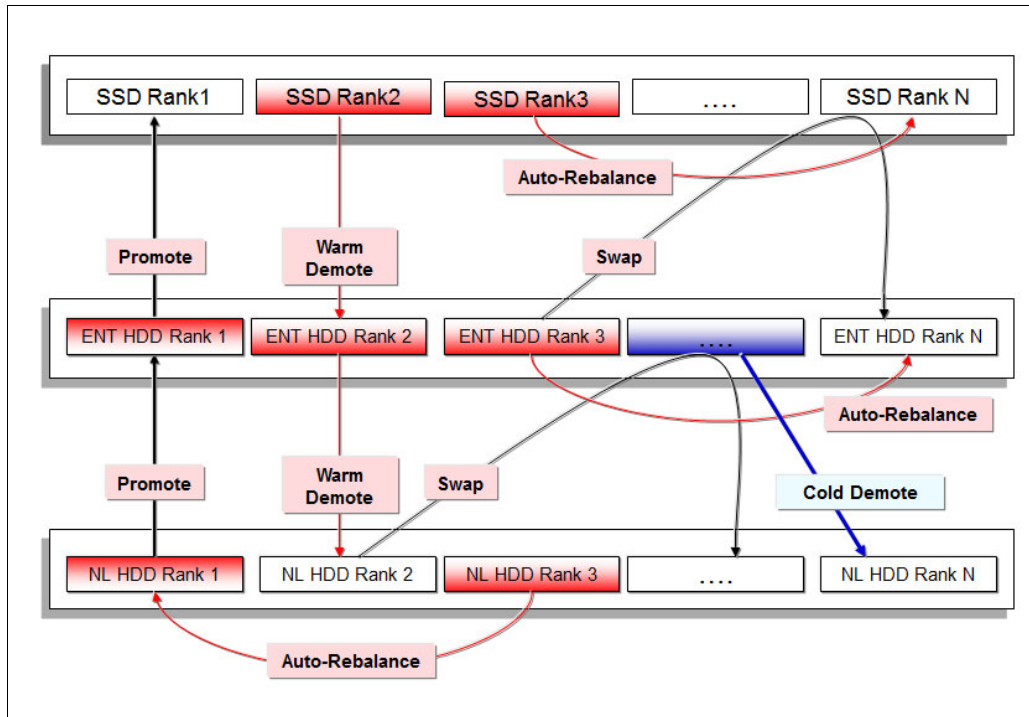


Figure 2-3 Easy Tier data placement actions before Easy Tier Application

Important: Migrations can happen only between adjacent tiers. For example, there is no promotion or demotion from the nearline tier to the flash tier in a three-tier extent pool.

2.2.2 Easy Tier Application directive data placement

With Easy Tier Application, a storage administrator can now give direct data placement directives for application volumes to be on specific storage tiers, as shown in Figure 2-4.

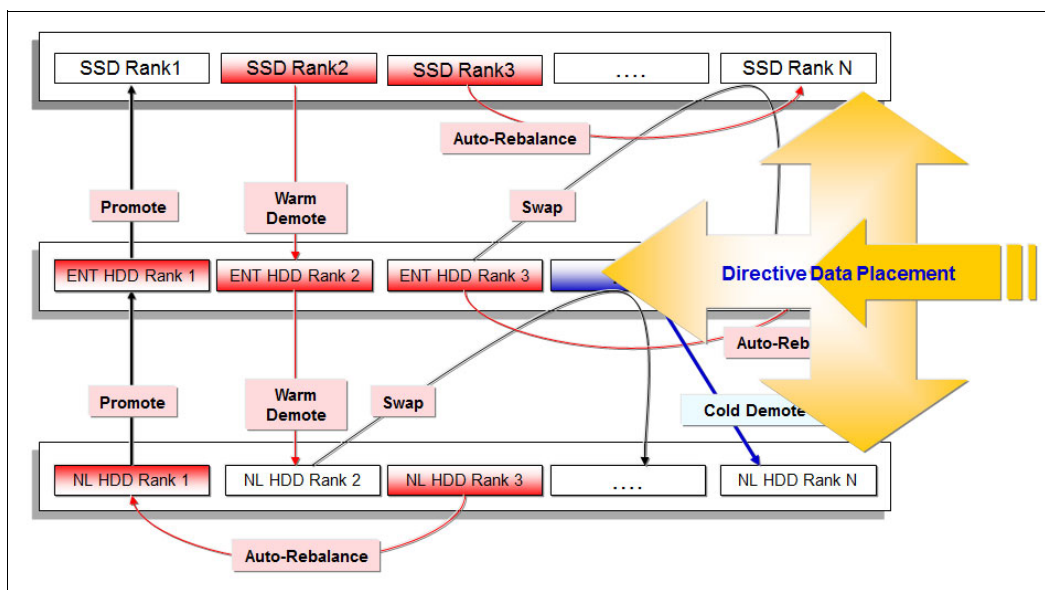


Figure 2-4 Easy Tier data placement actions with Easy Tier Application

Directive data placement with the DS CLI

With the DS CLI, the storage administrator can perform the following directive data placement actions:

- ▶ *Assign* a DS8870 volume to a specific tier.
For an Assign request, Easy Tier Application generates migration advice for extents of the volume based on the selected *Heat Order* or *Access Order* toward the specified target tier. Additionally, Easy Tier Application keeps the migrated data in the target tier until the volume is unassigned.
- ▶ *Exclude* a DS8870 volume from an NL tier.
With these requests, Easy Tier Application stops any plans to migrate extents of the volume to NL, and moves off NL any volume extents that are already on that tier.
- ▶ *Unassign* a DS8870 volume from a previous tier assignment.
For *Unassign* requests, Easy Tier Application clears the assign status of the volume and lets Easy Tier Automatic Mode manage it based on the existing automatic tier management algorithms.

The directive data placement works at the DS8870 volume level. Both fixed block (FB) and count key data (CKD) volumes can be assigned to a certain tier by using Easy Tier Application. However, Track Space Efficient volumes are not supported.

The directive data placement is issued from the DS CLI by running the **managefbvol** or **manageckdvol** command, as described in Chapter 3, “Easy Tier Application implementation and usage” on page 17.

Although a DS8870 volume is the minimum granularity of application data to be assigned or unassigned by Easy Tier Application, the data migration still occurs at the extent level.

In Easy Tier Application, in addition to setting the target tier of the volumes for directive data placement, two data migration types, Heat Order and Access Order, exist:

- ▶ **Heat Order:**
Data migration begins with the hottest extents based on the Easy Tier heat map. Hotter extents are migrated to the assigned tier first. This is the default option.

Note: When Heat Order is used, Easy Tier Application migrates all extents of the volume to the assigned tier in any possible situation.

- ▶ **Access Order:**
Data migration starts only for extents that are accessed after a directive data placement request is made.

Note: When Access Order is used, the extents of the volume are not migrated until they are accessed. If you want to pre-stage volume data on a specific tier *before* it is accessed, you must use the Heat Order option.

The unassign request from Easy Tier Application releases the previous volume assignment from a certain tier, even if the data migration of assign volumes is not complete. After they are unassigned by Easy Tier Application, the volume extents that were migrated to the target tier are not migrated off immediately. They are managed by the other Easy Tier data placement mechanisms while Easy Tier Automatic Mode is still enabled.

Important: Until Release 7.4, the unassign action was also used to reset the volume assignment status if the assigning failed because of an error condition. For more information, see 3.4, “Troubleshooting for Easy Tier Application” on page 29. With DS8870 R7.4, Easy Tier Application prevents the assignment failure. Error conditions are handled automatically by Easy Tier Application, and you do not need to manually fix the error.

Directive data placement with API for System z

With DS8870 R7.4, you can now use the Easy Tier Application API with DB2 for System z. DB2 for System z can proactively advise (communicating *temperature hints*) Easy Tier on the intended use of datasets.

Note: The API for System z is not a public API. Therefore, it cannot be used by third-party developers.

The access frequency of a particular dataset defines what we call its *temperature*. Temperature hints can provide an application a way to manage the temperature and tier location of a dataset without specifying a tier explicitly. This approach is useful when the Easy tier management of a dataset is to be modeled on the management that is used for an existing dataset. DB2 in performing a table space reorg can *query the temperature* for a dataset. The temperature values are used by Easy Tier to make decisions for migration to an appropriate tier.

With DS8870 R7.4, the *lease time* for a hint from an application begins immediately, and it runs for 12 hours. When assigning requests from the DS CLI, the lease time is infinite.

The API transactions for data placement hints, to set temperature, and to query temperature are all performed *asynchronously*. DFSMS is used as the interface for issuing the API transactions (Figure 2-2 on page 9).

Resource management

For Easy Tier Application, data migration to the assigned tier is based on *best effort* service. Easy Tier gives preference to fulfilling the Easy Tier Application request. The time that is necessary to complete the migration of all extents to the target tier as directed by Easy Tier Application depends on many factors, which include but might not be limited to the following factors:

- ▶ Overall workload on the DS8870 storage system. For example, at most 12 extents per 5 minutes (per processor complex) can be migrated for Easy Tier Application.
- ▶ Migration advice for other data placement actions in the entire migration plan that is generated by Easy Tier Automatic Mode.
- ▶ Manual actions that are performed with Easy Tier Manual Mode.
- ▶ Capacity constraints.

For Release 7.4, new DS CLI assign requests and API hints are not accepted unless Easy Tier can reserve the space on the target tier and the migration bandwidth is sufficient. Acceptance does not mean that the request was executed, but only that resources are reserved. After it is committed, the DS CLI assign request persists and survives an Easy Tier restart, storage controller failover/fallback, or machine cold restart. If the DS CLI assign request cannot be accepted, it is rejected but the API hint remains in effect.

Note: DS8870 Release 7.4 introduces a new algorithm as part of Easy Tier, which is known as *space reservation manager* (SRM), to manage space reservation and creation automatically.

SRM performs these functions:

- ▶ SRM preserves space for Easy Tier activities on each tier to avoid Easy Tier deadlock.
- ▶ SRM manages a list of the coldest extents on each tier of each extent pool. It creates space for Easy Tier Automatic Mode and Easy Tier Application by moving the coldest extents around so that the performance effect to the target tier is minimized.
- ▶ SRM moves data to an upper tier or a lower tier based on the space requirement and the available space on each pool tier.

Working with Easy Tier Automatic Mode

Different data placement actions are taken by Easy Tier Automatic Mode, with migration strategies from various perspectives. Sometimes, these strategies conflict with each other.

For example, an Easy Tier Application directive data placement request attempts to assign data on the Flash tier while the Warm Demote attempts to move the extent off the Flash tier because the Flash tier is overloaded. In these situations, an arbitrating component in Easy Tier performs conflict resolution. It gives preference to the migration advice with higher priority and thus overwrites the ones with lower priority. Conflict resolution policies are determined according to the following system-level priorities:

- ▶ System health goal
The highest priority of Easy Tier is given to maintaining healthy system performance by not overloading devices, such as ranks and device adapters, beyond their performance capabilities. In Easy Tier, this goal is achieved by Warm Demote operations and additional checks that are imposed by the system that ensure that the system is not overloaded for a certain configuration and workload.
- ▶ Application goal
The second highest priority is given to application requests that arrive at Easy Tier in the form of Easy Tier Application directive data placement requests.
- ▶ Performance goal
The next highest priority is given to the performance goal that aims at automatically placing data on the correct device types based on configuration, device capabilities, and workload characteristics.
- ▶ Capacity goal
The least priority is given to the system capacity goal that aims at migrating cold data to correct tiers to meet capacity goals. This goal is achieved by Cold Demote migrations.

Therefore, the arbitrating component in Easy Tier gives Easy Tier Application requests higher priority over other data replacement requests except for Warm Demote. However, the auto-rebalance function is allowed to move the extents of a volume assigned by Easy Tier Application to another rank within the same tier.

Working with Easy Tier Manual Mode

Easy Tier Manual Mode provides the following extended capabilities for logical configuration management: *Dynamic volume relocation*, *manual volume rebalance*, *dynamic extent pool merge*, and *rank depopulation*.

Easy Tier Manual Mode capabilities are user initiated and performed transparently to the attached host systems:

- ▶ **Dynamic volume relocation**

Dynamic volume relocation to another extent pool for the assigned volume is treated as an unassign action from the Easy Tier Application point of view. The assignment is reset during the relocation, which means that the volume extents are initially placed on the default tier (normally the ENT) in the target, multitier extent pool regardless of the assigned tier in the original extent pool.

- ▶ **Dynamic extent pool merge**

Dynamic extent pool merge can be performed when volumes are assigned or being assigned by Easy Tier Application in the extent pools that are involved.

- ▶ **Rank depopulation**

The ranks in the tier that is the target tier of volume assignment by Easy Tier Application can be depopulated and removed from the extent pool. However, the rank depopulation reduces the available capacity on the target tier, which might cause volume assignment to be pending.

Working with Easy Tier Server

Easy Tier Server, which offers the possibility to cache the hottest data in AIX server direct-attached flash drives, is not aware of the volume assignment by Easy Tier Application in DS8870 storage systems. Therefore, the volumes that are assigned to a specific tier by Easy Tier Application can benefit from Easy Tier Server, as well. No matter which tier the volume is assigned to, the data of the volume can still be prompted to use AIX server direct-attached flash drives if Easy Tier Server decides to do so.

For more information about Easy Tier Server, see *IBM System Storage DS8000 Easy Tier Server*, REDP-5013.

Working with Easy Tier Heat Map Transfer feature

The Easy Tier Heat Map Transfer feature provides a utility to retrieve the heat map from the Metro Mirror/Global Copy/Global Mirror (MM/GC/GM) primary site periodically and to reapply the heat map to the secondary site. The volume assignment status by Easy Tier Application at the primary DS8870 storage system is not transferred to the secondary site, which gives you the flexibility to assign corresponding volumes independently at the secondary site. In addition, with this flexibility, you can handle situations where the primary site configuration and the secondary site configuration do not match.

For more information about the Easy Tier Heat Map Transfer feature, see *IBM System Storage DS8000 Easy Tier Heat Map Transfer*, REDP-5015.



Easy Tier Application implementation and usage

This chapter covers the Easy Tier Application implementation and the DS command-line interface (CLI) commands that are used to manage and monitor Easy Tier Application. The API for System z is also described. The Easy Tier Application benefits are explained.

3.1 Prerequisites

Easy Tier Application is available at no additional cost, and no separate license is required for it. To use Easy Tier Application, the following conditions must be met:

- ▶ The Easy Tier Licensed Internal Code (LIC) feature is installed and enabled on the DS8870 storage system.

Note: Easy Tier is a no-additional charge feature of the DS8870 storage system. However, as with any other acquired licensed function, the Easy Tier licensed function must first be ordered from IBM. The required Easy Tier activation codes can then be obtained from the IBM Disk Storage Feature Activation (DSFA) website at the following location:

<http://www.ibm.com/storage/dsfa>

These codes are then applied by using the correct DS CLI or GUI command.

For more information about how to obtain and activate DS8000 license keys, see Chapter 10, “IBM System Storage DS8000 features and licensed functions”, in *IBM System Storage DS8870 Architecture and Implementation*, SG24-8085.

- ▶ The extent pool that contains a volume that is to be assigned by Easy Tier Application must be managed by Easy Tier Automatic Mode. The following settings are required:
 - Easy Tier Automatic Mode is enabled for the extent pool:
 - For a single-tier extent pool, *ETAutoMode* must be set to **all**.
 - For a multitier extent pool, *ETAutoMode* must be set to either **tiered** or **all**.
 - Easy Tier monitoring is enabled (*ETMonitor* is set to either **automode** or **all**).

Note: For more information about how to enable and configure Easy Tier Automatic Mode, see *IBM System Storage DS8000 Easy Tier*, REDP-4667, which is at the following website:

<http://www.redbooks.ibm.com/abstracts/redp4667.html>

- ▶ The DS CLI is required so that administrators can generate directive data placement requests to Easy Tier Application on the DS8870 storage system.

Important: To find the compatible version of the DS CLI for the required Licensed Machine Code (LMC) version on DS8870 storage systems, see the following website:

<http://www.ibm.com/support/docview.wss?uid=ssg1S1004204>

The DS CLI can be installed on many different operating systems. For more information about how to install the DS CLI and configure the related environment, see the IBM System Storage DS8000 Knowledge Center at the following website:

http://www-01.ibm.com/support/knowledgecenter/HW213_7.2.0/com.ibm.storage.ssic.help.doc/f2c_ichomepage.htm

- ▶ If directive data placement is to be performed by customer applications by using the API on IBM System z, you need LMC 7.7.40.xx (bundle version 87.40.xx.xx) or later.

3.2 Easy Tier Application management by using the DS CLI

The following DS CLI commands are the most frequently used commands with Easy Tier Application:

▶ **manageextpool**

The **manageextpool** command is used to manage Easy Tier migration and the monitoring and learning process in the extent pool level.

▶ **chrank**

The **chrank** command can be used to rank depopulation from the extent pool when rank is used to provision a volume (extents are migrated to other ranks in the same extent pool).

▶ **managefbvol**

The **managefbvol** command is used to assign specific fixed block (FB) volumes to any of the storage tiers in their storage pool, or to unassign previously assigned volumes. The user can also control the monitoring and learning Easy Tier process on the volume level.

▶ **manageckdvol**

The **manageckdvol** command is used to assign specific count key data (CKD) volumes to any of the storage tiers in their storage pool, or to unassign previously assigned volumes. The user can also control the Easy Tier monitoring and learning process on the volume level.

▶ **chextpool**

The **chextpool** command clears all previous volume assignments on certain tiers within an extent pool.

▶ **showfbvol**

The **showfbvol** command is used to query the assign/unassign status and tier distribution information of an FB volume.

▶ **showckdvol**

The **showckdvol** command is used to query the assign/unassign status and tier distribution information of a CKD volume.

▶ **showextpool**

The **showextpool** command is used to query the tier distribution information of an extent pool.

In this chapter, illustrations of several of the DS CLI commands are provided. For a detailed description of each command, see the *Command-Line Interface User's Guide for the DS8000 series*, GC27-4212 at the following website or run **help** in the DS CLI:

<http://publibfp.dhe.ibm.com/epubs/pdf/c2742124.pdf>

3.2.1 Assigning volumes to the target tier

Note: To make the examples more readable, some of the command output lines and the syntax description of the commands are truncated.

Assigning volumes to a specific tier with Easy Tier Application is done by running **managefbvol** for FB volumes and **manageckdvol** for CKD volumes. The command parameters are the same for both FB and CKD environments.

The command parameters for an FB volume are shown:

```
managefbvol -action tierassign [-assignorder etdata | access] [-tier ssd | ent | n1 | nlexclude] <volume ID>
```

The command parameters for a CKD volume are shown:

```
manageckdvol -action tierassign [-assignorder etdata | access] [-tier ssd | ent | n1 | nlexclude] <volume ID>
```

The **-action** parameter specifies the action that the **managefbvol** or **manageckdvol** commands take. For example, if **-action** is set to **tierassign**, this action is a volume assigning action for Easy Tier Application.

The **-assignorder** parameter specifies the data migration types. If the value is set to **etdata**, the data migration performs in Heat Order, which means that hotter extents are migrated to the target tier first. If the value is set to **access**, the data migration performs in Access Order, which means that the extents are not migrated until they are accessed. For more information about Heat Order and Access Order, see 2.2.2, “Easy Tier Application directive data placement” on page 12.

The **-tier** parameter specifies the target tier for the volume to be assigned. The options can be **ssd** (solid-state drives), **ent** (Enterprise class drives), **n1** (Nearline drives), and **nlexclude** (exclude NL tier). For more information about the supported storage tiers, see 2.1, “Easy Tier Application components” on page 8.

In Example 3-1, one FB volume (volume ID 4D00) is assigned to the SSD tier with Heat Order.

Example 3-1 Assigning a volume to the target tier

```
dscli> managefbvol -action tierassign -assignorder etdata -tier ssd 4D00  
CMUC00430I managefbvol: The tierassign action for FB volume 4D00 has completed.
```

3.2.2 Monitoring the volume assignment status and progress

To monitor the volume assignment status and progress, run either the **showfbvol** or **showckdvol** command with the **-tier** parameter. The output of the commands shows Easy Tier Application-related information:

► **tierassignstatus**

The information that is shown in this field indicates the Assign/Unassign status of the volume. The possible values are listed in Table 3-1 on page 21.

Table 3-1 Assign status description

tierassignstatus	Description
Assign Pending	An ASSIGN request is accepted but migration was not started.
Assigning	A migration is in progress for an ASSIGN request.
Assigned	A volume is assigned to the specific tier.
Unassign Pending	An UNASSIGN request is accepted but the previous assignment is not released.
Error	The ASSIGN action failed; to learn why, see the tierassignerror field.
Assign Pending Hardware Condition	Introduced in DS8870 R7.4, the ASSIGN request is accepted, but due to a configuration reason, the request cannot continue. It replaces the Error condition.

► tierassignerror

The information in this field helps identify the possible reason if tierassignstatus shows Error. The following errors are possible:

- Easy Tier not active
- Target Tier not available
- Tier definitions have changed

Important: As noted in Table 3-1, with DS8870 R7.4, Easy Tier Application prevents the assignment failure. The error conditions are handled automatically by Easy Tier Application. A new status indicator, “assign pending hardware condition”, is used to describe the error condition. You do not need to manually fix the error by issuing an unassign action. When the error condition is resolved later, the tier assignment continues to be processed.

For more troubleshooting information, see 3.4, “Troubleshooting for Easy Tier Application” on page 29.

► tierassignorder

The information in this field shows the data migration type (either ETdata or Access) that is specified in the **assign** command.

► tierassigntarget

The output information in this field shows the target tier (SSD, ENT, or NL) that is specified in the **assign** command.

► %tierassigned

The output information in this field shows the percentage of the volume that is assigned.

► Tier Distribution

The output information in this section shows the tier assigned percentage allocation among all tiers (SSD, ENT, and NL) of the volume.

Example 3-2 on page 22 shows the output of the **showfbvol** command with the **-tier** option on an FB volume (volume ID 4D00) before any Assign/Unassign action.

Example 3-2 Volume status without any Assign/Unassign action taken

```
dscli> showfbvol -tier 4D00
Name                ITS0_ETAppVol
ID                  4D00
accstate            Online
datastate           Normal
configstate         Normal
deviceMTM           2107-900
datatype            FB 512
addrgrp             4
extpool             P5
exts                100
captype             DS
cap (2^30B)         100.0
cap (10^9B)         -
cap (blocks)        209715200
volgrp             V5
ranks               4
dbexts              0
sam                 Standard
repcapalloc         -
eam                 managed
reqcap (blocks)     209715200
realextensts        100
virtualextents     0
migrating           0
perfgrp             PG0
migratingfrom       -
resgrp              RGO
tierassignstatus  -
tierassignerror  -
tierassignorder  -
tierassigntarget -
%tierassigned    0
====Tier Distribution=====
Tier %allocated
=====
ENT          100
```

In Example 3-3, tierassignstatus changed to Assign Pending. After you run the **managefbvol** command to trigger the volume assignment, the tierassignorder and tierassigntarget change to ETdata and SSD, as shown in Example 3-1 on page 20. No data was migrated yet.

Example 3-3 Assign Pending status

```
dscli> showfbvol -tier 4D00
Name                ITS0_ETAppVol
ID                  4D00
accstate            Online
datastate           Normal
configstate         Normal
deviceMTM           2107-900
datatype            FB 512
addrgrp             4
```

```

extpool          P5
exts             100
captype         DS
cap (2^30B)     100.0
cap (10^9B)     -
cap (blocks)    209715200
volgrp          V5
ranks           4
dbexts          0
sam             Standard
repcapalloc     -
eam             managed
reqcap (blocks) 209715200
realextenst    100
virtualextents 0
migrating       0
perfgrp         PGO
migratingfrom   -
resgrp          RGO
tierassignstatus Assign Pending
tierassignerror -
tierassignorder ETdata
tierassigntarget SSD
%tierassigned    0
=====Tier Distribution=====
Tier %allocated
=====
ENT          100

```

When `tierassignstatus` changes to `Assigning`, the extent migration starts. The migration progress can be tracked by running `showfbvol` with the `-tier` option, as shown in Example 3-4.

Example 3-4 Data migration starts when tierassignstatus changes to Assigning

```

dsccli> showfbvol -tier 4d00
Name          ITSQ_ETAppVol
ID            4D00
accstate      Online
datastate     Normal
configstate   Normal
deviceMTM     2107-900
datatype      FB 512
addrgrp       4
extpool       P5
exts          100
captype       DS
cap (2^30B)   100.0
cap (10^9B)   -
cap (blocks)  209715200
volgrp        V5
ranks         5
dbexts        0
sam           Standard
repcapalloc   -
eam           managed

```

```

reqcap (blocks) 209715200
realextenstents 100
virtualextents 0
migrating 0
perfgrp PGO
migratingfrom -
resgrp RGO
tierassignstatus Assigning
tierassignerror -
tierassignorder ETdata
tierassigntarget SSD
%tierassigned 48
=====Tier Distribution=====
Tier %allocated
=====
SSD 48
ENT 52

```

When tierassignstatus changes to Assigned, the Assign action is completed, which means that all extents in the volume are on the target tier, as shown in Example 3-5.

Example 3-5 Assign action completes

```

dscli> showfbvol -tier 4D00
Name          ITSQ_ETAppVol
ID            4D00
accstate      Online
datastate     Normal
configstate   Normal
deviceMTM     2107-900
datatype      FB 512
addrgrp       4
extpool       P5
exts          100
captype       DS
cap (2^30B)   100.0
cap (10^9B)   -
cap (blocks) 209715200
volgrp        V5
ranks         1
dbexts        0
sam           Standard
repcapalloc   -
eam           managed
reqcap (blocks) 209715200
realextenstents 100
virtualextents 0
migrating     0
perfgrp       PGO
migratingfrom -
resgrp        RGO
tierassignstatus Assigned
tierassignerror -
tierassignorder ETdata
tierassigntarget SSD
%tierassigned 100

```

```

=====Tier Distribution=====
Tier %allocated
=====
SSD          100

```

The **showextpool** command with the **-tier** parameter is used to query the tier distribution information of an extent pool. In the output of the **showextpool** command with the **-tier** parameter, the Tier Distribution section includes the following information about each tier:

- ▶ Capacity of the tier (Cap)

The output information in this field shows the total capacity of each tier in an extent pool.
- ▶ Allocated percentage (%allocated)

The output information in this field shows the total percentage of the tier capacity that is occupied either by Easy Tier automatic tier migration or Assign requests from Easy Tier Application.
- ▶ Assigned percentage (%assigned)

The output information in this field shows the total percentage of the tier capacity that is occupied *only* by Assign requests from Easy Tier Application, which is a subset of %allocated.

The sample output of the **showextpool** command with the **-tier** parameter is shown in Example 3-6.

Example 3-6 The sample output of the showextpool command with the -tier option

```

dscli> showextpool -tier p5
Name          EasyTierPool_3Tiers
ID            P5
stgtype       fb
totlstor (2^30B) 19079
availstor (2^30B) 18056
resvdstor (2^30B) 0
rankgrp       1
numranks      6
numvols       38
status        below
%allocated    5
%available    94
configured    19079
allowed       19079
available     18056
allocated     1023
reserved      0
%limit        100
%threshold    15
virextstatus   full
%virallocated 100
%viravailable  0
virconfigured 606
virallowed    606
viravailable   0
virallocated  606
virreserved   0
%virextlimit  -

```

```

%virextthreshold -
encryptgrp -
%allocated(ese) 1
%allocated(rep) 0
%allocated(std) 5
%allocated(over) 0
%virallocated(ese) 100
%virallocated(tse) 0
%virallocated(init) 0
%migrating(in) 0
%migrating(out) 0
numtiers 3
etmanaged yes
=====Tier Distribution=====
Tier Cap (GiB/mod1) %allocated %assigned
=====
SSD 2121 18 5
ENT 4068 2 0
NL 12890 5 0

```

3.2.3 Unassigning volumes

A volume assignment by the Easy Tier Application can be released by running an *Unassign* request. To unassign the volume in this example, run **managefbvol** (for an FB volume) or **manageckdvol** (for a CKD volume) with the **-tierunassign** option, as shown in Example 3-7.

Example 3-7 Unassign a volume

```

dscli> managefbvol -action tierunassign 4D00
CMUC00430I managefbvol: The tierunassign action for FB volume 4D00 has completed.

```

After the Unassign request is issued, the tierassignstatus field in the **showfbvol** or **showckdvol** output shows Unassign Pending, which means that the Unassign request was accepted, as shown in Example 3-8.

Example 3-8 Unassign Pending status

```

dscli> showfbvol -tier 4D00
Name          ITSQ_ETAppVol
ID            4D00
accstate      Online
datastate     Normal
configstate   Normal
deviceMTM     2107-900
datatype      FB 512
addrgrp       4
extpool       P5
exts          100
captype       DS
cap (2^30B)   100.0
cap (10^9B)   -
cap (blocks) 209715200
volgrp        V5
ranks         1
dbexts        0

```

```

sam                Standard
repcapalloc        -
eam                managed
reqcap (blocks)    209715200
realextenst        100
virtualextents    0
migrating          0
perfgrp           PGO
migratingfrom      -
resgrp            RGO
tierassignstatus Unassign Pending
tierassignerror  -
tierassignorder Unknown
tierassigntarget Unknown
%tierassigned    0
=====Tier Distribution=====
Tier %allocated
=====
SSD                100

```

Then, in the **showfbvol** or **showckdvol** output, the **tierassignstatus**, **tierassignorder**, and **tierassigntarget** fields are all cleared with the **%tierassigned** field reset to 0. The Unassign action completed and the previous volume assignment cleared successfully, as shown in Example 3-9.

Example 3-9 Unassign action completed

```

dscli> showfbvol -tier 4D00
Name                ITSQ_ETAppVol
ID                  4D00
accstate            Online
datastate           Normal
configstate         Normal
deviceMTM           2107-900
datatype            FB 512
addrgrp             4
extpool             P5
exts                100
captype             DS
cap (2^30B)         100.0
cap (10^9B)         -
cap (blocks)        209715200
volgrp             V5
ranks               1
dbexts              0
sam                 Standard
repcapalloc         -
eam                 managed
reqcap (blocks)     209715200
realextenst         100
virtualextents     0
migrating           0
perfgrp            PGO
migratingfrom       -
resgrp             RGO
tierassignstatus -

```

```

tierassignerror -
tierassignorder -
tierassigntarget -
%tierassigned 0
=====Tier Distribution=====
Tier %allocated
=====
SSD          100

```

To unassign all volumes from a previous assignment within an extent pool, run **chextpool** with the **-tierunassign** option, which is the fastest method, as shown in Example 3-10.

Example 3-10 Unassign all volumes in an extent pool

```

dscli> chextpool -tierunassign p5
CMUC00001I chextpool: Extent pool P5 successfully modified.

```

The extents of the volume remain on the previously assigned tier after the Unassign action completes until Easy Tier automode starts to move them off the tier or other Assign requests are issued on them by Easy Tier Application.

3.3 Easy Tier Application management by using the API for System z

The Easy Tier Application software-defined storage data placement API allows applications on System z (DB2 only, initially) to proactively instruct Easy Tier of the intended use of datasets. This capability removes the requirement for applications and administrators to manage hardware resources directly. The programming needs to be done only one time, and then the application with Easy Tier enforces the policy.

With DS8870 R7.4, and z/OS 1.13 , z/OS 2.1 or higher, and DB2 V10 or V11 (with small programming enhancement, APAR PI35321), DB2 can query source data sets of a table space reorganization and then set the desired tier location for target datasets of the reorg using interna DFSMS functions, which interface with the Easy Tier Application API.

For example, to optimize the target datasets for a DB2 database reorganization, the performance of the target datasets does not need to be learned by Easy Tier. Instead, DB2 communicates information (hints) to Easy Tier Application to model the target datasets based on the source datasets, so that the tier level of the target datasets approximates the tier level of the source almost immediately.

The effect of the directive data placement during a DB2 re-org (described above) is illustrated in Figure 3-1 on page 29.

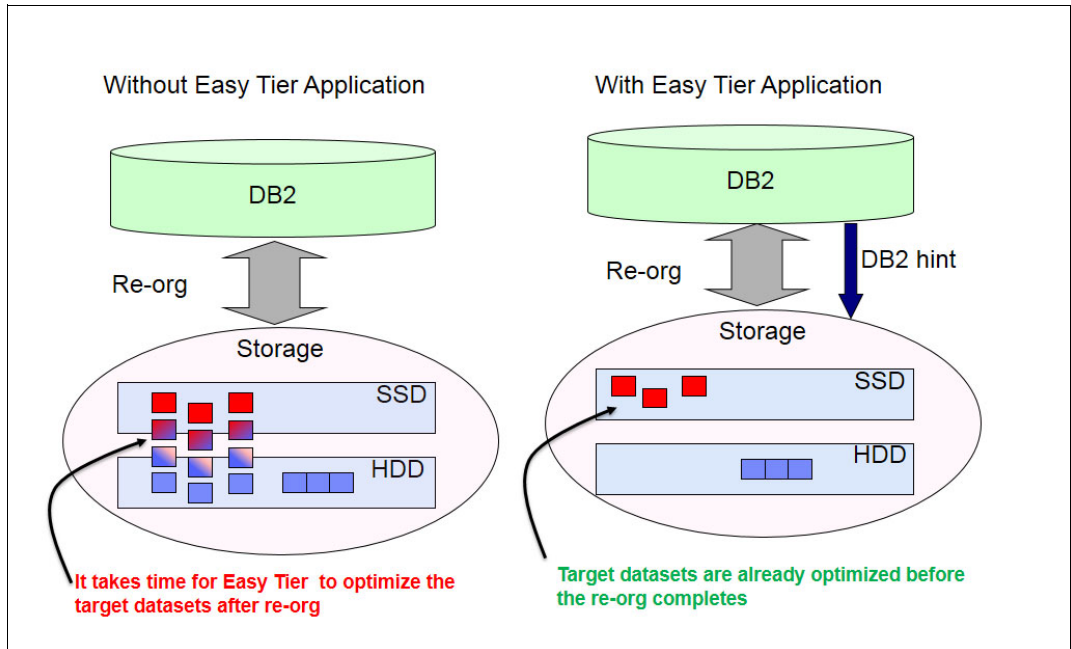


Figure 3-1 Directive data placement during DB2 re-org

3.4 Troubleshooting for Easy Tier Application

This section describes several error scenarios with the error messages that are shown in the tierassignerror field, as described in 3.2.2, "Monitoring the volume assignment status and progress" on page 20, and the methods to solve the problems.

Note: Not all error scenarios are covered in this section. For more information about handling error messages, contact your IBM service support representative (SSR).

General rules

Typically, when assigning an action for one volume results in an error (the tierassignstatus field of the volume shows Error), the volume is not managed by Easy Tier Application. If the Assign of a volume fails with errors, Easy Tier Application does not try to migrate extents of the volume to or maintain them on the target tier while Easy Tier Automatic Mode manages the data placement if it is still active for this pool.

The Unassign action can be used to release the previous volume assignment to a specific tier and clear the error state of an assigned or being assigned volume by Easy Tier Application. After the Unassign action completes, the volume can be assigned again to any tier in the pool.

Important: Before DS8870 R7.4, for all the assignment failures described next (Easy Tier not active, Target tier not available, and Tier definitions have changed), even though the condition is later resolved, any new assignment requests for the affected volumes are rejected. You needed to send an unassign request to fix it.

However, with DS8870 R7.4, Easy Tier Application prevents the assignment failure. The error conditions are handled automatically by Easy Tier Application. A new status indicator, "assign pending hardware condition", is used to describe the error condition. You do not need to manually fix the error by issuing an **unassign** action. When the error condition is resolved, the tier assignment processing continues.

Easy Tier not active

The "Easy Tier not active" assignment failure status indicator means that the extent pool that is involved in the Assign action that is issued from Easy Tier Application is no longer managed by Easy Tier Automatic Mode. These cases happen if Easy Tier Automatic Mode is turned off for this pool after the data placement requests for the volumes in this pool are accepted by Easy Tier Application:

- ▶ For the single-tier extent pool, it happens if the ETAutoMode is changed to **tiered** or **none**.
- ▶ For the multitier extent pool, it happens if the ETAutoMode is changed to **none**.

All volumes in this pool that are managed by Easy Tier Application, whether they are assigned to a specific tier or not, show an error in the `tierassignerror` field.

Target tier not available

The "Target Tier not available" assignment failure status indicator means that the target tier of the volume assignment by Easy Tier Application no longer exists in the pool. Depopulating the last rank of the target tier can cause this error to occur for the volumes that are being assigned to that tier. Although the error state can be reset by triggering Unassign requests for the volumes, it is better to avoid this situation by planning the capacity of the target tier and by retaining enough capacity for the required volume assignment by Easy Tier Application.

Tier definitions have changed

The "Tier definitions have changed" assignment failure status indicator means that the tier definitions of the extent pool that are involved in the Assign action of Easy Tier Application changed. These cases happen during extent pool merge or when adding tiers to the extent pool. As shown in Table 2-1 on page 10, the tier definitions are different in various multitier configurations. For example, NL tier is tier 1 in a two-tier extent pool that contains Flash and NL ranks. After adding ENT ranks to this pool, it becomes a three-tier extent pool, in which the NL tier is now tier 2. In this case, before adding the ENT ranks to the extent pool, if the volume was assigned to the NL tier (tier 1 in a two-tier configuration), then after adding the ENT ranks, the error message, "Tier definitions have changed", shows in the `tierassignerror` field of this volume. A similar example during dynamic extent pool merge is described in "Dynamic extent pool merge" in "Working with Easy Tier Manual Mode" on page 16.

When the "Tier definitions have changed" error occurs, the volume must be unassigned and then assigned to the specific tier again. An Unassign does not lead to any immediate migration, as in the previous case, after adding the new ENT ranks to the extent pool completes, so the volume can be reassigned to the NL tier with little effort because most of the extents are on the ranks of the NL tier.

In R7.4, Easy Tier Application can adjust to the tier definition change, and this error does not occur. So, in the previous example, the migration of the extents to NL continues after adding the ENT ranks.

3.5 Storage Tier Advisor Tool enhancement for Easy Tier Application

Storage Tier Advisor Tool (STAT) analyzes the performance data that is collected by the Easy Tier monitoring function. STAT provides a graphical representation of the distribution of data and related workload across tiers with a suggested capacity configuration for the different tiers.

Note: For more information about using STAT, see *IBM System Storage DS8000 Easy Tier*, REDP-4667, at the following website:

<http://www.redbooks.ibm.com/abstracts/redp4667.html>

In the System Summary report of the STAT output, the assigned capacity by Easy Tier Application can be identified easily by its dark purple color in the Data Management Status bar of each extent pool, as shown in Figure 3-2. With Release 7.4, STAT can show the received hints, failed hints, expired hints, requests for System z, and DSCL1 in a summary.

If an Assign action is ongoing, the action is indicated by a light purple color in the Data Management Status bar of each extent pool.

The percentage figures that represent the workload distribution in each tier are based on a moving average of all I/Os for large and small blocks.

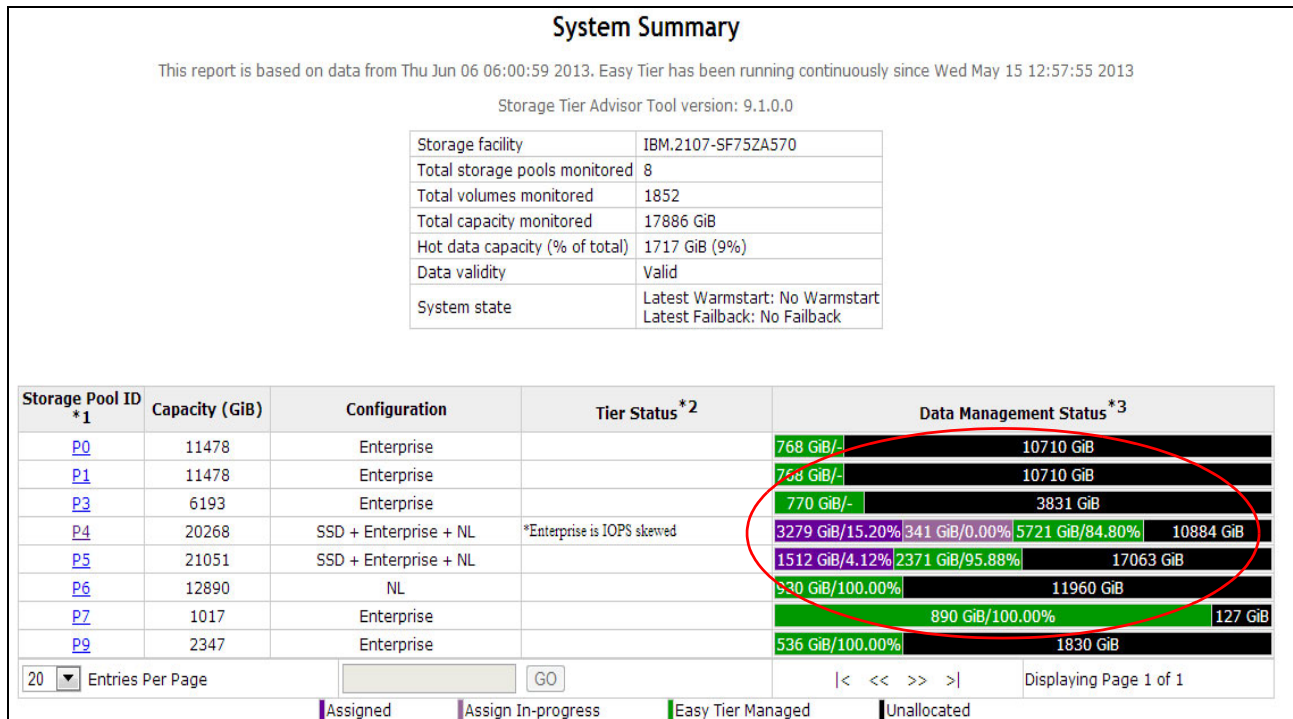


Figure 3-2 System Summary report of the STAT output

If you click the extent pool name, a Performance Statistics and Improvement Recommendation page with more information about the selected extent pool opens, as shown in Figure 3-3.

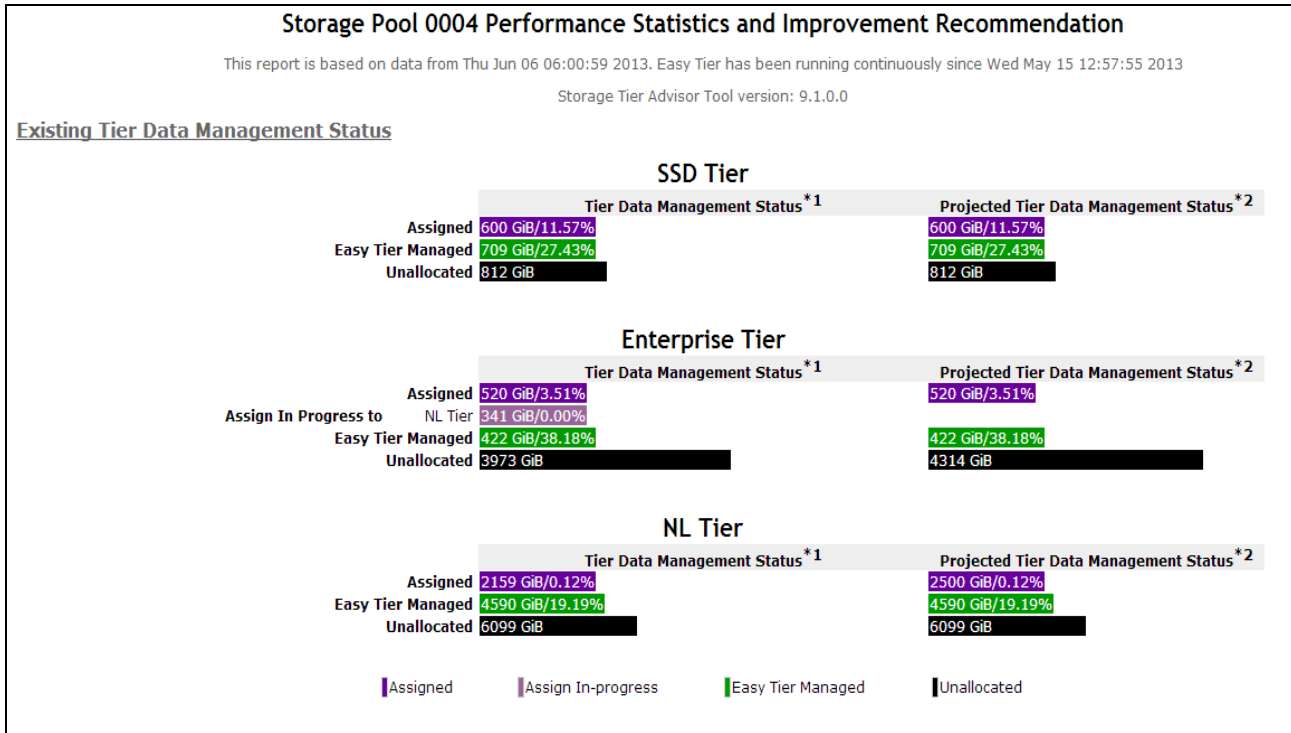


Figure 3-3 Assigned capacity on each tier for the selected extent pool

In this view, the capacity that is assigned and being assigned by Easy Tier Application on each tier is identified by dark and light purple in the Tier Data Management Status part of the Existing Tier Data Management Status section. Also, the expected status of the data under different management in each tier of the extent pool after the Assign in-progress operations complete is displayed in the Projected Tier Data Management Status part (using the same color indications).

3.6 Easy Tier Application benefits

By using Easy Tier Application, the data distribution in the DS8870 storage system can reflect the I/O pattern and your requirements based on your own design and planning. Easy Tier Application enables administrators to apply their insights to data placement easily according to the business importance of the applications.

The potential benefits of Easy Tier Application directive data placement can be, but are not limited to, the following areas:

- Performance

Identified *hot spots* or performance-critical data can be assigned to a Flash tier by Easy Tier Application to obtain customer application performance improvement without involving learning cycles, such as predictable workloads at month, quarter, or year end.

In our testing, by using a simulated random access workload with a 70/30 read/write ratio in an online transaction processing (OLTP) database environment and by assigning volumes to a Flash tier, we experienced more than 15 times improvement in response time, as shown in Figure 3-4.

Disclaimer: The Easy Tier Application workload tests that were conducted for this publication demonstrate only Easy Tier Application feature behavior and concepts under a random workload. These tests are not meant for benchmarking purposes and the results might vary depending on the workload that is used and the systems in the environment.

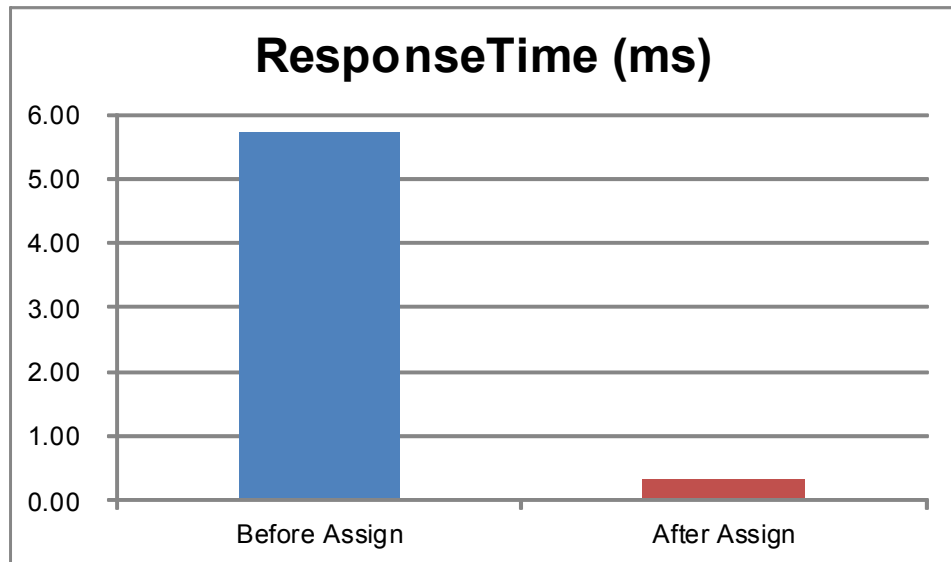


Figure 3-4 Performance improvement with Easy Tier Application

- ▶ Cost-efficiency

The predictable performance and the cost of applications that are assigned to specific tiers help reduce storage administration costs. Non-critical data can be assigned automatically to a lower-cost tier to save more expensive storage resources for critical data.

- ▶ Quality of service (QoS)

Easy Tier Application can be used to meet QoS requirements for certain applications. Applications can be classified by cost and performance considerations and aligned to the corresponding storage tiers (Flash, ENT, or NL) so that the data distribution matches the cost and performance characteristics.

- ▶ Disaster recovery (D/R) scenario testing simplified

To emulate a production-level environment on local and remote sites, all practice volumes can be assigned to a specified tier during the tests in both locations. At the end of the tests, the volumes are unassigned and Easy Tier optimizes the storage performance based on a real I/O workload.

Related publications

The publications that are listed in this section are considered suitable for a more detailed discussion of the topics that are covered in this paper.

IBM Redbooks

For information about ordering these publications, see “How to get Redbooks publications” on page 36. Certain documents referenced here might be available in softcopy only.

- ▶ *DS8000 I/O Priority Manager*, REDP-4760
- ▶ *DS8800 Performance Monitoring and Tuning*, SG24-8013
- ▶ *IBM System Storage DS8000 Easy Tier*, REDP-4667
- ▶ *IBM System Storage DS8000 Easy Tier Heat Map Transfer*, REDP-5015
- ▶ *IBM System Storage DS8000 Easy Tier Server*, REDP-5013
- ▶ *IBM System Storage DS8870 Architecture and Implementation*, SG24-8085
- ▶ *IBM System Storage DS8870*, TIPS1180

You can search for, view, download, or order these documents and other Redbooks, Redpapers, web docs, draft and additional materials, at the following website:

ibm.com/redbooks

Other publications

These publications are also relevant as further information sources:

- ▶ *DS8870 Introduction and Planning Guide*, GC27-4209
- ▶ *Command-Line Interface User's Guide*, GC27-4212

Online resources

These websites are also relevant as further information sources:

- ▶ Documentation for the DS8000 system:
<http://www.ibm.com/systems/storage/disk/ds8000/index.html>
- ▶ IBM Disk Storage Feature Activation (DSFA):
<http://www.ibm.com/storage/dsfa>
- ▶ IBM System Storage Interoperation Center (SSIC):
<http://www.ibm.com/systems/support/storage/config/ssic/index.jsp>
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IBM DS8870 Easy Tier Application



Application-based tiering for optimal performance

IBM z/OS DB2 driven data placement

Capability to manually assign volumes to any tier

This IBM Redpaper publication describes the concepts, functions, and practical usage of IBM Easy Tier Application.

IBM Easy Tier Application is part of the overall Easy Tier offering. Initially, the overall Easy Tier function was designed to automate data placement throughout the storage system disks pool. It enables the system, automatically and without disruption to applications, to relocate data (at the extent level) across up to three drive tiers. The process is fully automated. Easy Tier also automatically rebalances extents among ranks within the same tier, removing workload skew between ranks, even within homogeneous and single-tier extent pools.

The Easy Tier Application feature allows for direct data placement, when desired. The storage administrators can use the DS command-line interface (DS CLI) to directly assign distinct application volumes to a particular storage tier. Easy Tier Application also features a software-defined storage data placement interface that can enable specific applications running on IBM System z to direct more optimal placement of the data by communicating important information about current workload activity and application performance requirements. Specifically, with DS8870 R7.4, it is possible for IBM DB2 applications in IBM z/OS environments to give hints of data placement to Easy Tier, at the dataset level.

This paper is aimed at those professionals who want to understand the Easy Tier Application concept and its underlying design. It also provides guidance and practical illustrations.

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