



Easy Tier on the DS8000

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IBM Storage Tiering Capabilities

■ Tiering concept

- Storage tiering has been around for years
 - Driven by differing Disk technology (SSD, FC/SAS, SATA/NL-SAS) prices based on capacity and performance characteristics
 - Goal is to reduce overall storage costs

■ LUN and sub-LUN tiering capabilities exist in the IBM portfolio

- Manual and automated LUN level
 - TPC R5.1 Tiered Storage Optimization with SVC
 - Easy Tier Manual Mode within a DS8000
- Automated sub-LUN level
 - Easy Tier with SVC, V7000 and DS8000

Overview of Easy Tier

- **Easy Tier provides automatic volume management capabilities**
 - Sub-volume drive tiering
 - Data movement and placement is based on [historical data access patterns](#)
 - Automated drive utilization balancing in an attempt to remove hot spots or populate new, empty ranks
 - No manual input or expertise required to optimize performance

- **Easy Tier provides**
 - Storage Tier Advisor Tool (STAT) for I/O analysis and projected benefits
 - A command line interface and a GUI for setup and management
 - Manual command based volume relocation

- **Easy Tier is a licensed feature for the DS8700/DS8800/DS8870**
 - [No charge](#) – but you still have to order the feature and activate the license
 - Supported by all server platforms with no additional software or host configuration

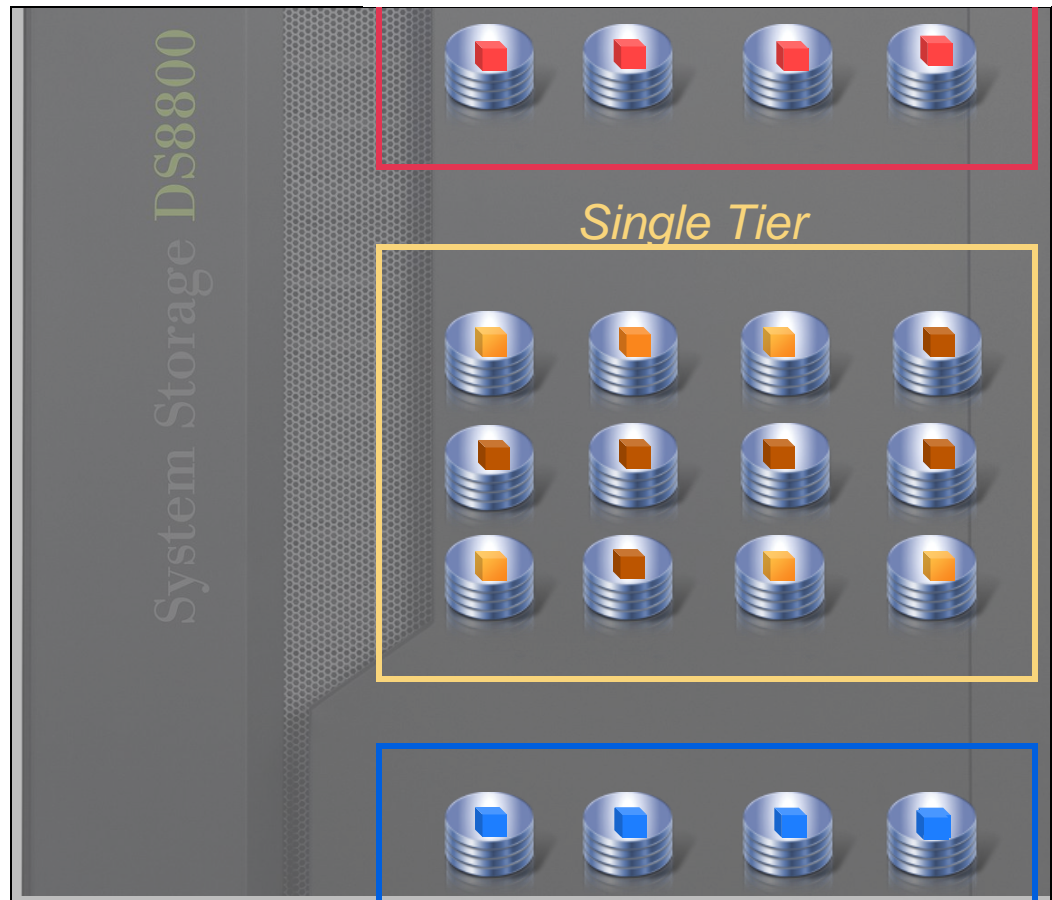
DS8000 Easy Tier at a Glance

- Monitors real time performance of each 1GiB extent (sub-volume) to determine the data 'temperature'
- Creates extent migration plan for optimal data placement every 24 hours based on performance statistics
- Migrates extents one tier at a time across heterogeneous tiers and within a homogeneous tier according to migration plan(s) over 24 hour period
- A limited number of extents are chosen for migration every 5 minutes to avoid performance impact
- **DS8000 value = better performance optimization and ease of use**



Easy Tier intra-tier Rebalancing

- Continuous rebalancing *within* each tier maintains peak performance across all drives
- Automatic rebalance of data across all ranks when additional capacity added to the pool
- Easy Tier complements other performance optimization features
 - Advanced caching algorithms
 - Storage Pool Striping (wide striping)
 - I/O Priority Manager for QoS
- DS8000 value = automatic performance balance and ease of use



Easy Tier manual functions

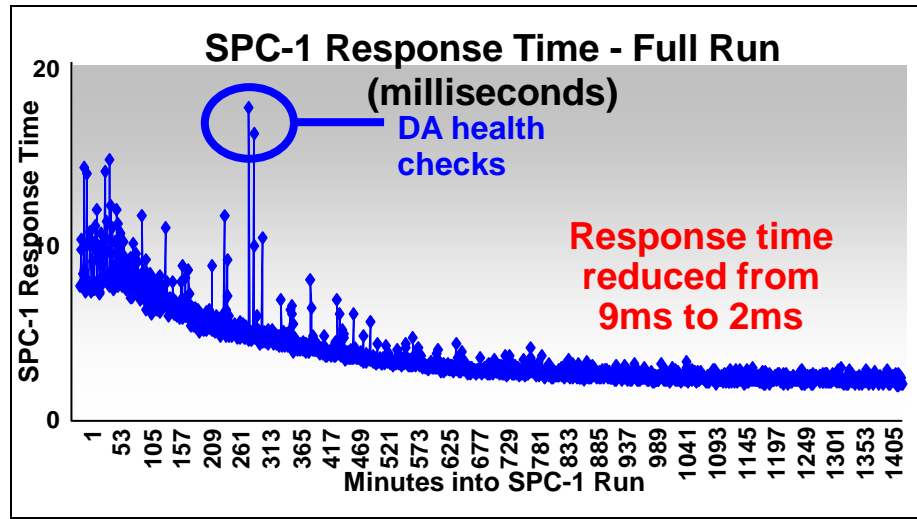
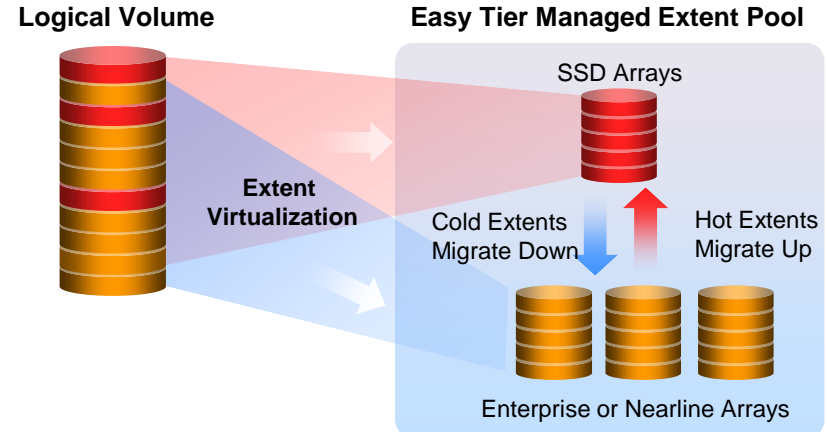
- Rank depopulation
 - Allow removal of ranks from pool
- Dynamic extent pool merge
- Manual volume rebalance
 - “Restripe” volume across ranks in an unmanaged pool
- Dynamic volume migration
 - Move a volume between or within pools

Easy Tier Supported Versions

- **Easy Tier 1 (DS8700 R5.1)**
 - Automated cross-tier performance management for *SSD/HDD hybrid pools*
 - Manual mode management support for *dynamic extent pool merge* and *dynamic volume relocation*
- **Easy Tier 2 (DS8700/DS8800 R6.1)**
 - Automated cross-tier performance or storage economics management for hybrid pools with *any 2 tiers* (SSD/ENT, SSD/NL or ENT/NL)
 - Automated *intra-tier performance management* (auto-rebalance) in hybrid pools
 - Manual mode management support for *rank depopulation* and optimized *volume restriping* within non-managed pools (manual volume rebalance)
- **Easy Tier 3 (DS8700/DS8800 R6.2)**
 - Automated cross-tier performance and storage economics management for hybrid pools with *3 tiers* (SSD/ENT/NL)
 - Automated *intra-tier performance management* in both hybrid (multi-tier) as well as *homogenous (single tier) pools (auto-rebalance)*
 - *Thin Provisioning support* for Extent Space Efficient (ESE) Volumes
- **Easy Tier 4 (DS8800 R6.3 / DS8870 R7.0)**
 - Support for *encryption capable environments*
 - DS8800 and DS8870 have FDE capable SSD and nearline drives

Easy Tier V1 Benefits

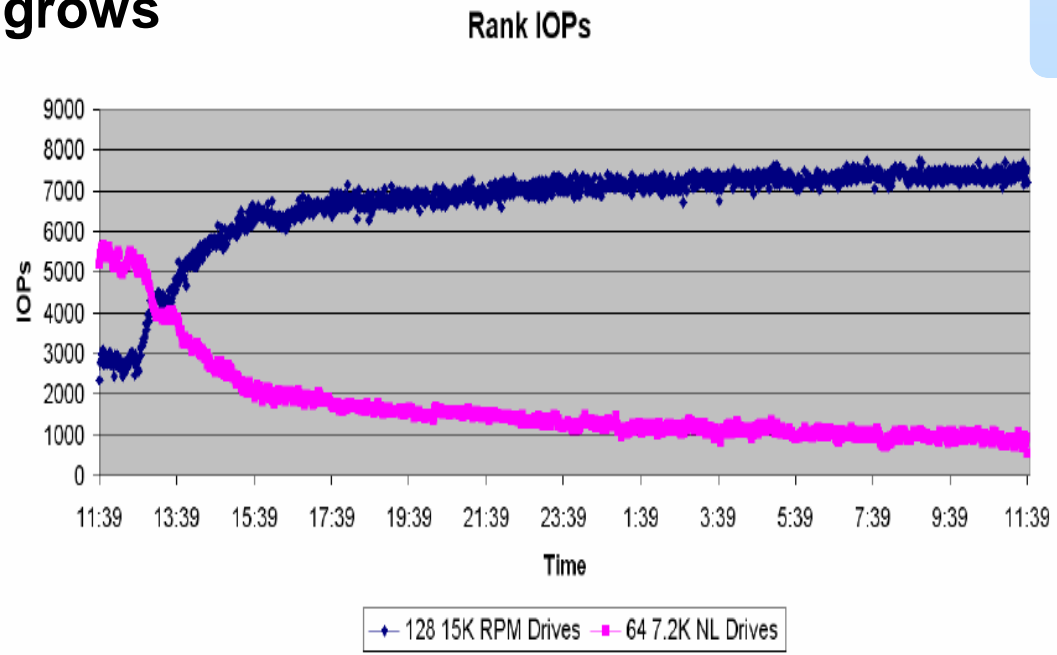
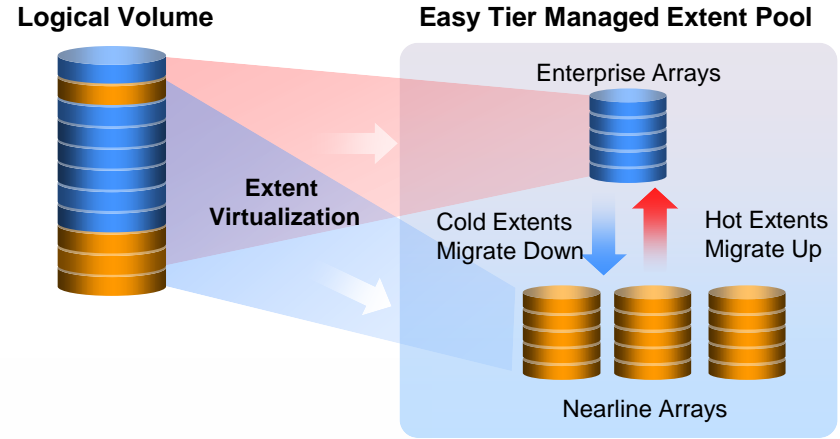
- Relocating just 5% of the data from HDDs to SSDs, reduced average I/O response time from 9ms to 2ms!
- Optimizing use of expensive SSDs



Source: IBM and Storage Performance Council, April 2010: http://www.storageperformance.org/results/benchmark_results_spc1#a00092

Easy Tier V2 Benefits

- **“Any two tier” offered support for combining Enterprise Class and Nearline Class to maintain performance with lower \$/GB as data grows**

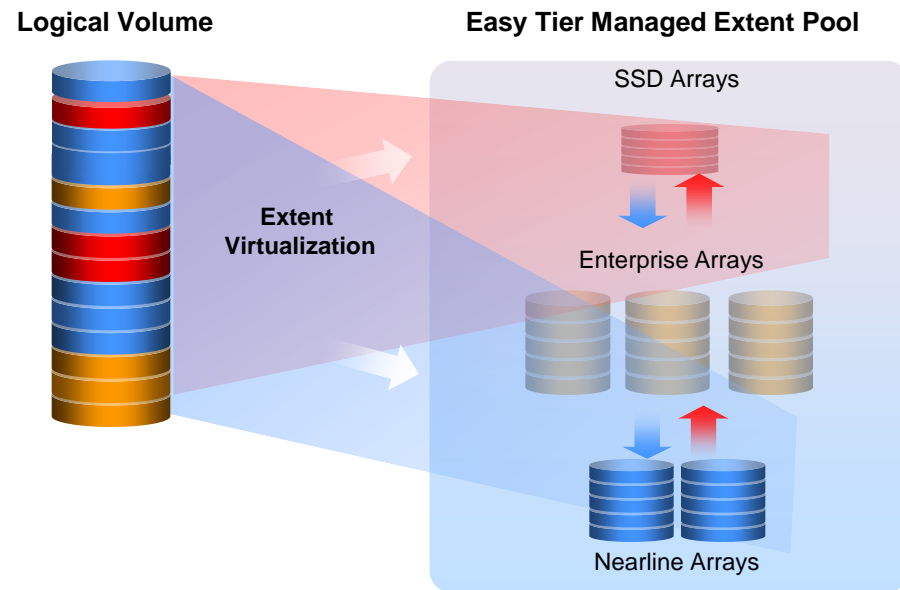


Source: IBM and Storage Performance Council, April 2010: http://www.storageperformance.org/results/benchmark_results_spc1#a00092

Easy Tier V3 Benefits

Combining the benefits across tiers and within a tier

- **3-tier support combines the benefits**
 - Faster performance when and where it's needed with SSDs
 - Cost savings (reduced footprint and \$/GB) for cold data
- **Plus, auto rebalancing supports single-tier (homogenous) as well as mixed tier pools**
 - Rebalance after new resources are added or removed from the storage pool
 - Ensures balanced rank utilization to distribute natural performance skew
- **Easy Tier support for thin provisioned volumes**

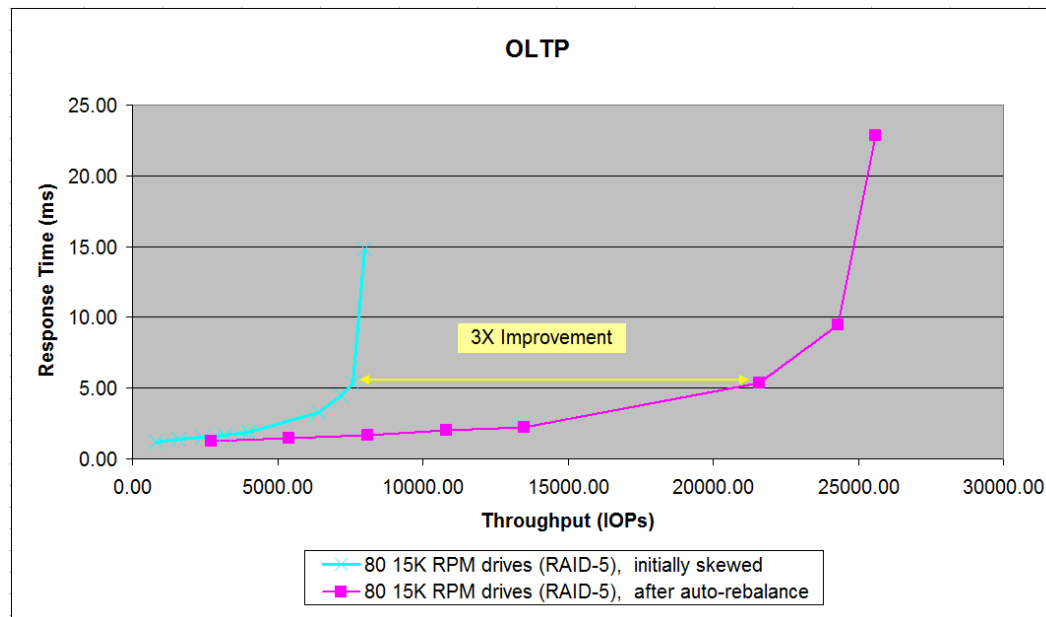


Easy Tier intra-tier Rebalancing – Improved Throughput

Supports single-tier and multi-tier systems

Performance gain on single-tier pool

- The re-balanced system showed a **3x** throughput improvement and equal or better response times without any operator activity!

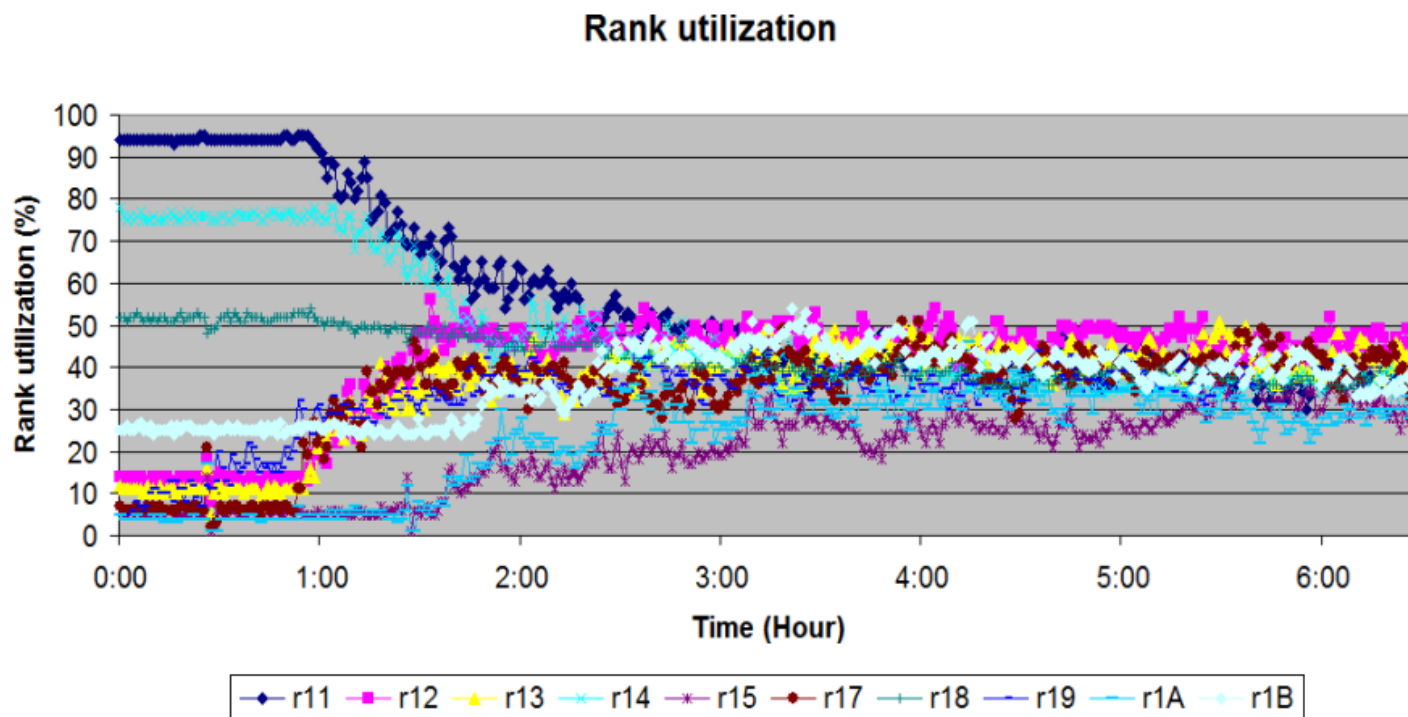


All performance data contained here were obtained in the specific operating environment and under the conditions and/or configuration described above and is presented as an illustration. Details are available in the "IBM System Storage DS8800 and DS8700 Performance with Easy Tier 3rd Generation" whitepaper. Performance obtained in other operating environments may vary and customers should conduct their own testing

Easy Tier intra-tier Rebalancing – Balanced Utilization

Balanced Rank utilization on single-tier pool

- The re-balanced system shows flattened rank utilization across all the ranks, all without any operator activity!



All performance data contained here were obtained in the specific operating environment and under the conditions and/or configuration described above and is presented as an illustration. Details are available in the "IBM System Storage DS8800 and DS8700 Performance with Easy Tier 3rd Generation" whitepaper. Performance obtained in other operating environments may vary and customers should conduct their own testing

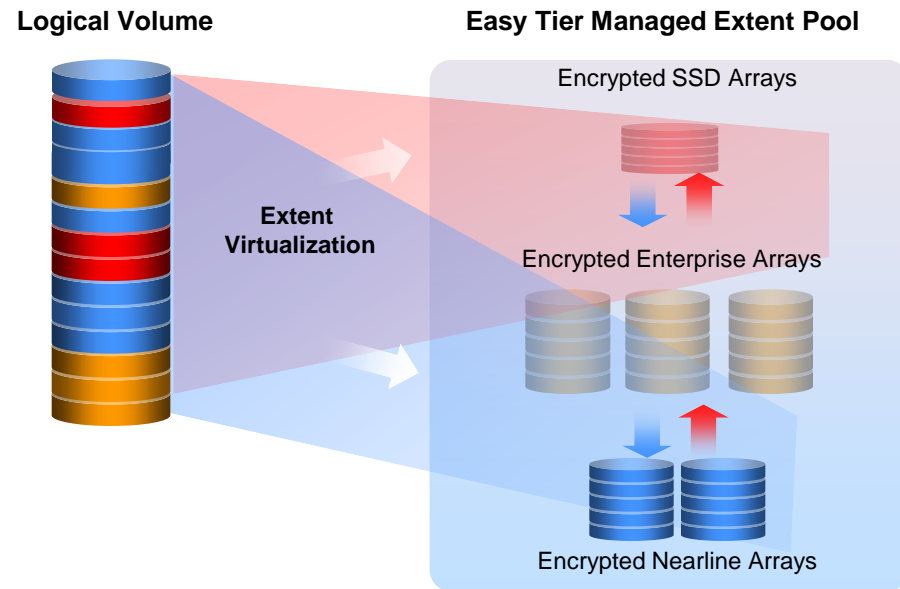
Easy Tier 4 available with DS8000 R6.3 and DS8870 R7.0

- Announcement Date: April 10, 2012 – R6.3; Oct 3, 2012 – R7.0
- General availability date: April 20, 2012 – R6.3; Oct 19, 2012 R7.0
- Easy Tier 4 enhanced tiering capabilities
 - Three tier support for Encryption capable 400GB SSD and 3TB NL-SAS drives
- Easy Tier 4 enhancements apply to DS8800 and DS8870
 - Encrypting 400GB SSDs and 3TB NL-SAS available on DS8800
 - All drives on the DS8870 are encryption capable

Easy Tier V4 Benefits

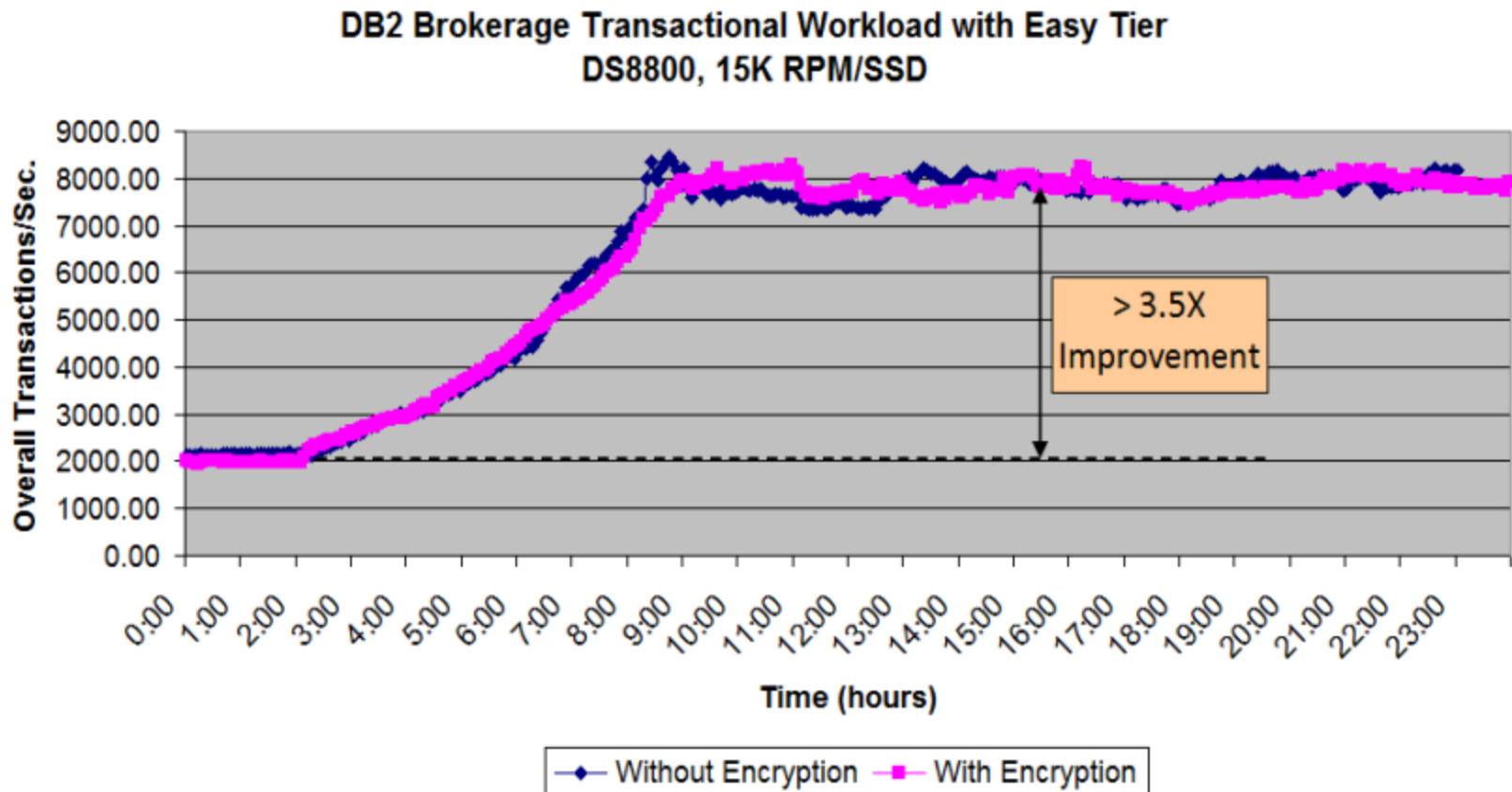
Combining the benefits of security and automated tiering

- **Now** 3-tier support combines advanced tiering with superior security for the ultimate in efficiency and data protection
 - Faster performance when and where it's needed with encrypting SSDs
 - Cost savings (reduced footprint and \$/GB) for cold data on encrypting NL-SAS
 - Encryption support across all tiers for improved data at rest security
 - Equivalent drive and application performance when encryption or non-encryption drives are utilized

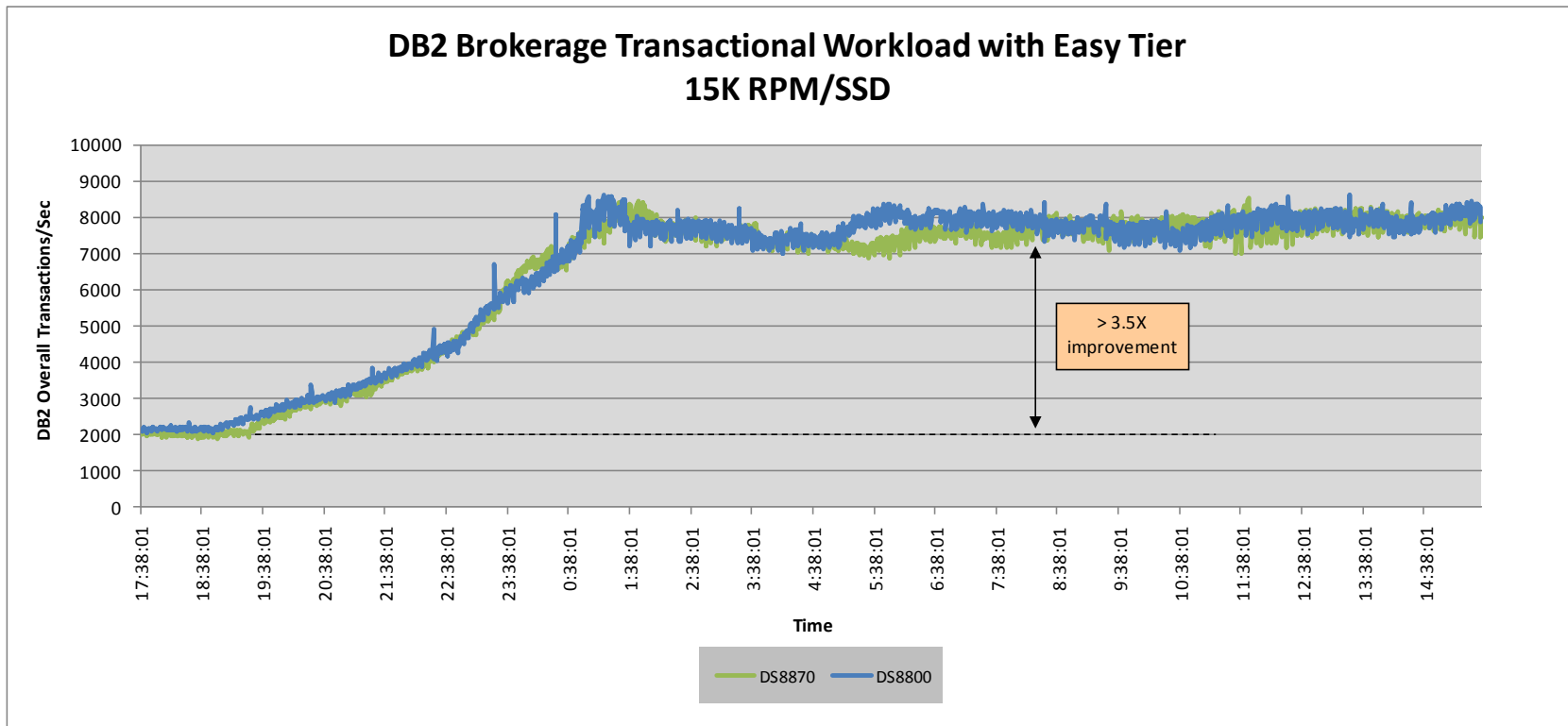


Easy Tier V4 Application Performance

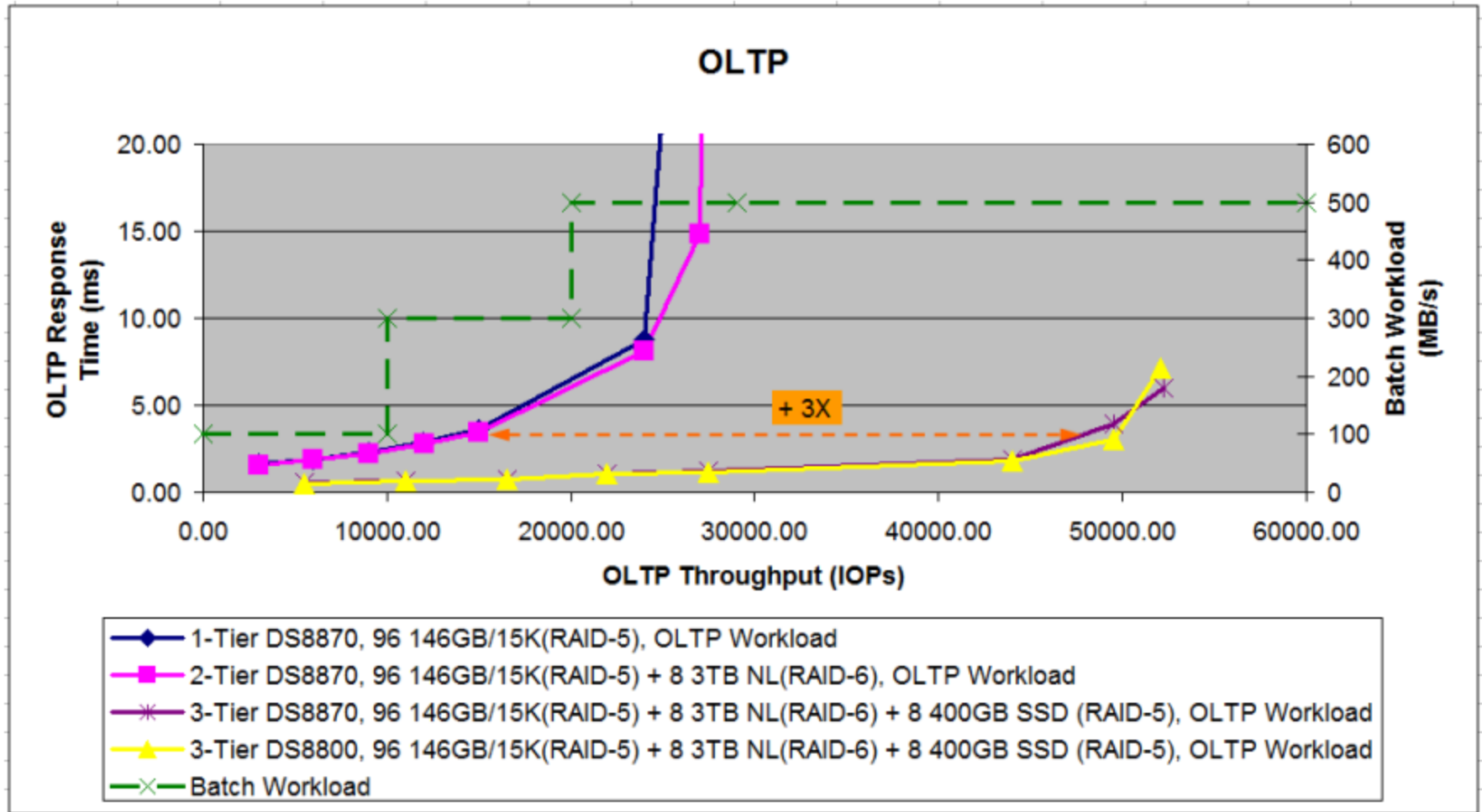
- **Equivalent performance with or without encryption drives in the DS8800**



Easy Tier with 2 Tier: SSD/15K RPM Application Transaction Rate – DS8870



Easy Tier with 3 Tier: SSD/15K RPM/NL



DS8000 Easy Tier – Tier Combinations Summary

DS8700:

	SSD	ENT FC 15K	SATA
SSD + ENT FC 15K + SATA 7.2K	Tier 0	Tier 1	Tier 2
SSD + ENT FC 15K	Tier 0	Tier 1	N/A
SSD + SATA 7.2K	Tier 0	N/A	Tier 1
ENT FC 15K + SATA 7.2K	N/A	Tier 1	Tier 2

DS8800/DS8870: SSD/ENT/NL New encryption capable options

	SSD	ENT SAS 10K/15K	NL SAS
SSD + ENT SAS + NL SAS 7.2K	Tier 0	Tier 1	Tier 2
SSD + ENT SAS 10K/15K	Tier 0	Tier 1	N/A
SSD + NL SAS 7.2K	Tier 0	N/A	Tier 1
ENT SAS 10K/15K + NL SAS 7.2K	N/A	Tier 1	Tier 2

Disk Drive Options

■ DS8870

- All SAS-2
- 400 GB SSD FDE
- 146 GB/15,000 RPM FDE
- 300 GB/15,000 RPM FDE
- 600 GB/10,000 RPM FDE
- 900 GB/10,000 RPM FDE
- 3 TB/7,200 RPM FDE

■ Maximum of 1,536 drives

■ Drives install in groups of 16

- SSD drives available in groups of 8 or 16
- Nearline drives available in groups of 8

■ DS8800

- All SAS-2
- 300 GB SSD
- 400 GB SSD + FDE option
- 146 GB/15,000 RPM + FDE option
- 300 GB/15,000 RPM + FDE option
- 450 GB/10,000 RPM + FDE option
- 600 GB/10,000 RPM + FDE option
- 900 GB/10,000 RPM + FDE option
- 3 TB/7,200 RPM + FDE option

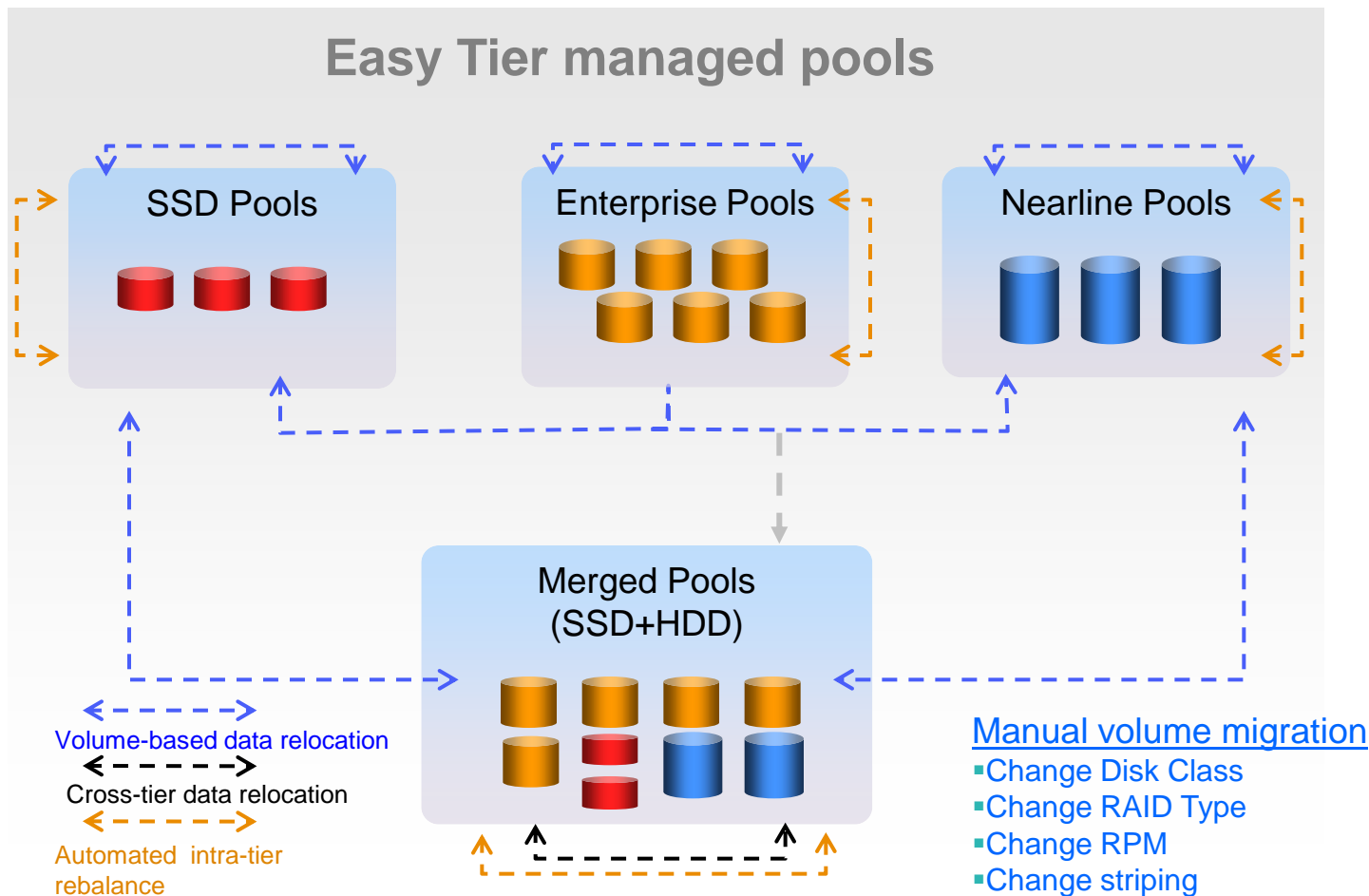
■ Maximum of 1,536 drives

■ Drives install in groups of 16

- SSD drives available in groups of 8 or 16
- Nearline drives available in groups of 8



Summary of Easy Tier Migration Capabilities



Storage Tier Advisor Tool (STAT)

- System Summary Report
 - Support pool configurations with up *3 tiers* (SSD – ENT – NL)
 - Tier status: *Existing Tier SSD/ENT/NL is IOPS/BW overloaded/skewed*

- Storage Pool Performance Statistics and Improvement Recommendation
 - *Existing Tier Status* showing rank utilization for each tier
 - *Recommended SSD, Enterprise, NL Configurations*
 - Expanding 1-tier HDD and any 2-tier configurations to 3-tier configurations
 - Expanding existing tiers when tiers are BW or IOPS overloaded
 - *Volume Heat Distribution*
 - Showing capacity and heat distribution by tier (hot data - warm data - cold data)

- Systemwide Recommendation
 - *Recommended SSD Configuration*
 - *Recommended Enterprise Configuration*
 - *Recommended NL Configuration*

Download STAT (no charge) and run on Windows

<https://www-304.ibm.com/support/docview.wss?uid=ssg1S4000876&wv=1>

Additional Easy Tier – Details and Considerations

Superior volume management leads to higher efficiency and flexibility

- **No-charge feature available on all 242x M/T Models 941/94E, 951/95E, and 961/96E**

- **Feature Codes:**
 - (#0713) Easy Tier attach indicator
 - (#7083) Easy Tier indicator

- **Consideration**
 - Secondary of a remote copy relationship is unaware of primary systems performance optimization
 - On a failover, secondary will have to re-learn the optimized environment
 - Track Space Efficient (TSE) volumes are not Easy Tier managed

DS8000 Easy Tier – Ease of Use

Base extent pool design offers tremendous simplicity, flexibility, efficiency

- All the capacity in the DS8000 is organized into *extent pools*
- *Extent pools contain consistent 1GB extents*
- *Extents are the building blocks for all volumes*

Extent Pool (animation)



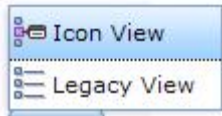
Why this is important

Practical design offers unique storage efficiency and management effectiveness

- Consistent extent size makes volume creation and dynamic expansion very easy
- Consistent extent size makes extent pools very flexible in terms of size, data type, and allocation
- This design enables Easy Tier to perform effective tiering by dynamically distributing extents across tiers or within a tier

* Extents are 1GB (fixed block) or 0.94 GB (CKD)

DS8000 Easy Tier - Simplified configuration for Auto-tiering



Storage Image Properties [?] [x]

This page displays the properties for the r6gui1h storage image. Make the appropriate modifications and then click OK or Apply to save your changes.

General | **Hardware** | **Advanced**

MTS: IBM.2107.75NR561 | Emulated MTS: IBM.2421.75NR561

WWNN: 5005076309FFC5D6 | Firmware level: 7.6.20.128

Easy Tier

Auto mode is managing

- Tiered Pools
- All Pools
- No Pools

I/O Priority Manager

- Manage
- Send SNMP Traps
- Monitor
- Disable

Monitor

- Auto Mode Volumes
- All Volumes
- No Volumes

OK Apply Cancel

Performance design is done through QoS

The only mandatory EasyTier parameter

Unlike other auto-tiering designs, EasyTier tunes itself autonomously and reacts to workload changes with no admin interaction: *No buttons principle*.

Easy Tier Impact: Avg. Read RT Impact

arrays 0x0

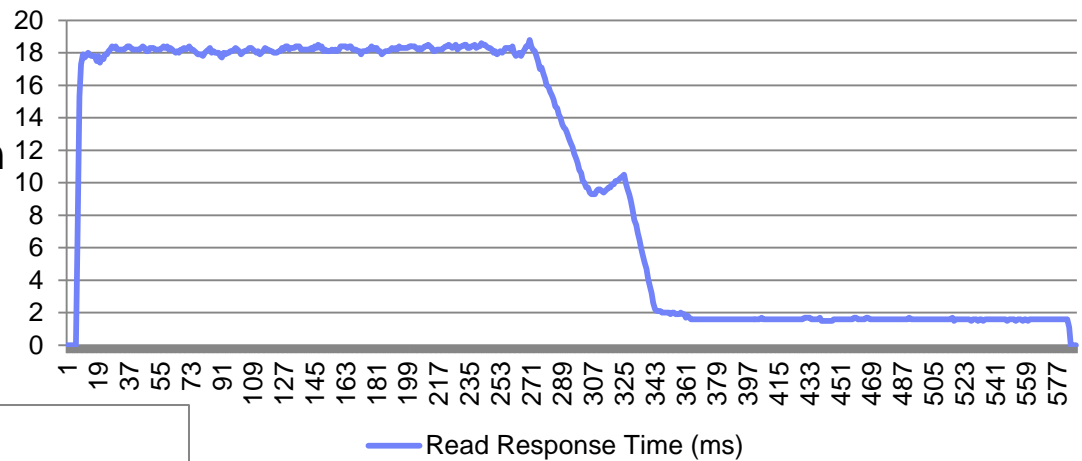
Average of Avg Read Resp Time (ms)



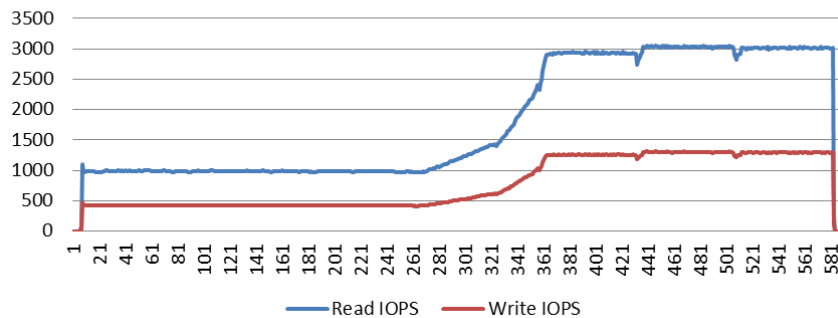
DS8000 Easy Tier Impact: Large Banking Customer

- **Effects of Easy Tier (7.8 % SSD Capacity added, 1.5 TB SSD to 21 TB SAS Pool)**
- **Read Response Time reduced by 91 % (18 ms → 1.6 ms)**
- **Read IOPS +597 %**
- **Write IOPS +30 %**
- **Traffic Profile**
R:W 70:30, 8K blocks, random

Test AIX002
(589 * 5 Minutes = 49h)



Test AIX002
(589 * 5 Minutes = 49h)



DS8000 Value

■ **Easy Tier**

- Enables the consolidation of more workloads onto the DS8000 by automating storage performance and economics of management across all 3 drive tiers
- Security for data at rest with encrypting drives
- Automatic rebalancing of extents for consistent performance
- Manual Mode provides significant functional capabilities to storage administrators

■ **Storage Tier Advisor Tool (STAT)**

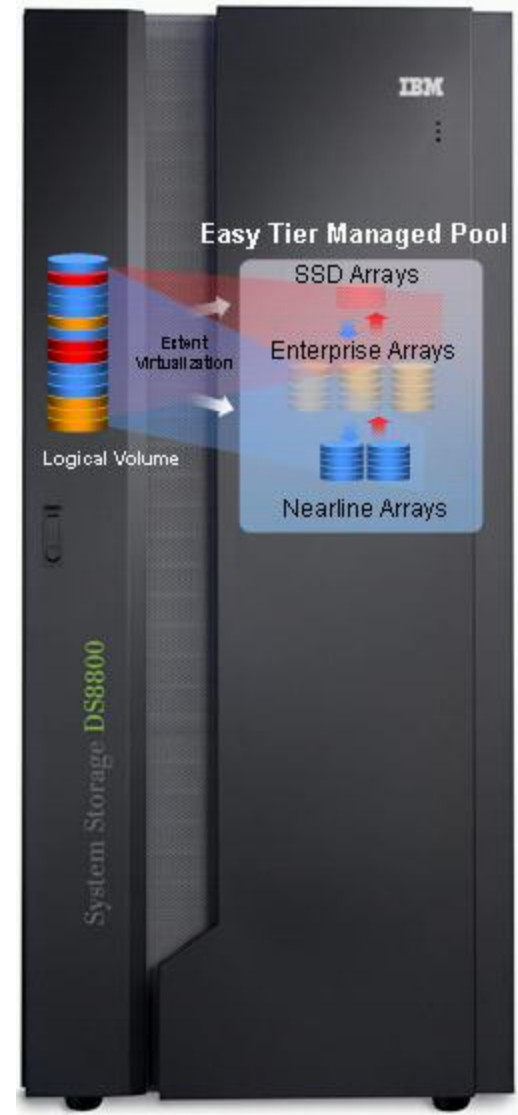
- Provides an understanding of what application data can benefit the most from relocation to SSDs, Enterprise (SAS/FC) drives or Nearline SAS drives

■ **I/O Priority Manager (QoS)**

- Provides tremendous scalability to manage more applications effectively and efficiently with a single DS8000 system

■ **Ease of Use**

- Common management across IBM storage portfolio
- Simplified logical configuration setup and management



DS8000 – Easy to enable Easy Tier

■ License

- Order Easy Tier feature code #7083
- Download license key from DSFA and apply it to the DS8000

<https://www-03.ibm.com/storage/dsfa/ds8000/selectMachine.wss>

■ Enable Easy Tier

- Storage Image Properties (DS GUI)
- chsi –Etautomode all | tiered | none storage_image_id
 - Auto Mode
 - all Automatically manage all single and multi-tier pools
 - tiered Automatically manage multi-tier pools only
 - none Do not automatically manage any pools
- chsi –Etmonitor all | automode | none storage_image_id
 - Monitor
 - automode Only volumes managed by Easytier auto mode are monitored
 - all All volumes in the system are monitored.
 - none No volume is monitored.

Storage Image Properties

This page displays the properties for the r6gt then click OK or Apply to save your changes.

General Hardware **Advanced**

MTS
IBM.2107.75NR561

WWNN
5005076309FEC5D6

Easy Tier

Auto mode is managing

Tiered Pools

All Pools

No Pools

Monitor

Auto Mode Volumes

All Volumes

No Volumes

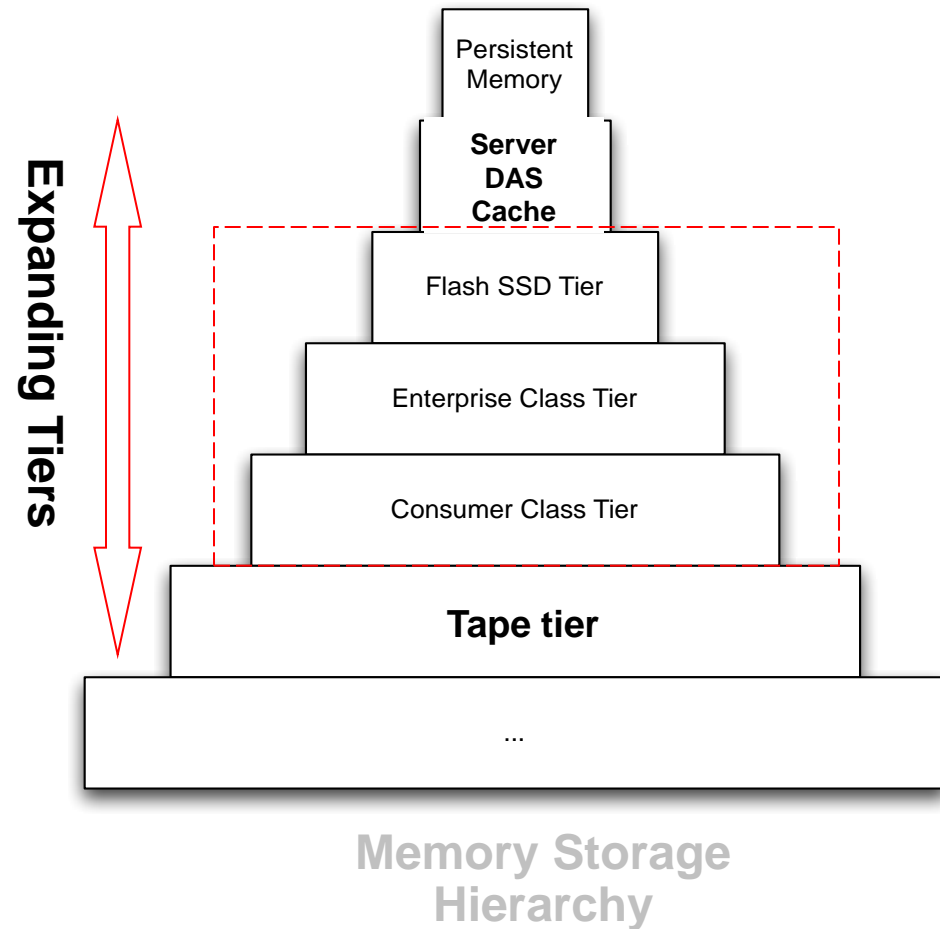
Futures - Expanding the tiers

Expanding tier Up

1. Closer to the computing power.
2. Higher performance.
3. Fewer transport layer.

Expanding tier Down

1. Massive capacity.
2. Cheaper in \$/G.
3. Saving Power (offline storage).



EasyTier Cooperative Caching Technology Demonstrated At IBM Edge Conference



<http://www-01.ibm.com/common/ssi/cgi-bin/ssialias?subtype=ca&infotype=an&appname=iSource&supplier=877&letternum=ENUSZG12-0163>

Storage Tier Advisor Tool

STAT – System Summary

IBM System Storage™ DS8000



IBM


[Summary Report](#)
[Systemwide Recommendation](#)

System Summary

The data is collected from Thu Sep 29 09:18:32 2011 to Tue Oct 04 09:47:34 2011

Storage Tier Advisor Tool version: 8.2.0.0

Storage Facility	SF75TV180ESS01 SF75TV180ESS11
Total Storage Pools Monitored	7
Total Volumes Monitored	5470
Total Capacity Monitored	30311G
Hot Data Capacity (% of Total)	14048G (46%)
Data Validity	Valid
System State	Latest Warmstart: No Warmstart Latest Failback: No Failback

Storage Pool ID *1	Capacity (GB)	Configuration	Tier Status*2
0000	5906	SSD + Enterprise	
0001	4143	Enterprise	
0002	14466	Enterprise + NL	
0004	20842	SSD + Enterprise + NL	
0005	12922	NL	
0008	772	Enterprise	
0009	1544	Enterprise	

20 Entries Per Page |< << >> >| Displaying Page 1 of 1

*1. Storage Pool ID is the id to represent the extent pool inside DS8000, which is specified during the extent pool creation.

*2. Tier Status is the status of each tier on the extent pool, and Tier IOPS skewed means the standard deviation of the current IOPS utilization of ranks in the tier exceeds a pre-specified threshold (which is 10% of the average IOPS utilization across ranks in the tier), Tier IOPS/BW overloaded means there is at least one rank in the tier with IOPS/BW exceeding IOPS/BW threshold.

STAT – Recommended Pool Configuration for 3 Tier

IBM System Storage™ DS8000




Recommended SSD Configuration

STEC_300G_R5_W6 ▾

Storage Pool ID	SSD Configuration	Predicted Pool Performance Improvement	Predicted System Performance Improvement	Estimated Migration Time Range	Predicted Pool Capacity Increase (GB)
0004	Performance Improved by Existing Spare SSD Capacity (1574GB)	69% ~ 89%	68% ~ 88%	2 hour(s) ~ 14 hour(s)	-

Recommended Enterprise Configuration

15K_ENT_146G_R5_W6 ▾

Storage Pool ID	Enterprise Configuration	Predicted Pool IOPS Improvement	Predicted System IOPS Improvement	Estimated Migration Time Range	Predicted Pool Capacity Increase (GB)

Recommended NL Configuration

7.2K_NL_3T_R6_W5 ▾

Storage Pool ID	NL Configuration	Cold Data Capacity (GB)	Predicted Pool Capacity Increase (GB)
0004	Existing SATA Rank(s) Free Capacity (12922GB)	3274	-

[Summary Report](#)

[Systemwide Recommendation](#)

STAT: Volume heat distribution bars for different tiers

■ Hot Data; Warm Data; Cold Data

Volume Heat Distribution

Volume Heat Distribution				
Volume ID *5	Configured Size *6	Tier	Capacity on Tier *7	Heat Distribution *8
0x0010	3000G	SSD Tier	500G	100G (Cold) 400G (Hot)
		Enterprise Tier	500G	100G (Cold) 400G (Hot)
		SATA Tier	2000G	600G (Cold) 400G (Warm) 1000G (Hot)
0x0011	1500G	SSD Tier	250G	50G (Cold) 200G (Hot)
		Enterprise Tier	250G	50G (Cold) 200G (Hot)
		SATA Tier	1000G	300G (Cold) 200G (Warm) 500G (Hot)
0x0012	3000G	SSD Tier	500G	100G (Cold) 400G (Hot)
		Enterprise Tier	500G	100G (Cold) 400G (Hot)
		SATA Tier	2000G	600G (Cold) 400G (Warm) 1000G (Hot)
0x0013	2000G	SSD Tier	0G	
		Enterprise Tier	0G	
		SATA Tier	2000G	400G (Cold) 200G (Warm) 1400G (Hot)
0x0014	1000G	SSD Tier	0G	
		Enterprise Tier	0G	
		SATA Tier	1000G	200G (Cold) 100G (Warm) 700G (Hot)

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*5. Volume ID is the id to represent the volume inside DS8000, which is specified during the volume creation.

*6. The configured capacity of the volume.

*7. The 'Capacity on SSD' column represents the amount of data that has already migrated to SSD drives.

*8. The 'Heat Distribution' column shows the heat distribution of the data in this volume. The blue portion of the bar represents the capacity of the cold data, the orange portion of the bar represents the capacity of the warm data, and the red portion of the bar represents the capacity of the hot data or the data on SSD.

STAT: Expanded tier recommendation when tiers are overloaded

Storage Pool ID *1	Capacity (GB)	Configuration	Tier Status *2
0001	35922	Enterprise	
0002	5931	Enterprise	
0003	6455	Enterprise	
0004	49241	SSD + Enterprise	*SSD is BW overloaded
0005	45158	SSD + Enterprise + NL	
0007	2572	Enterprise	

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Recommended SSD Configuration

STEC_300G_R5_W6

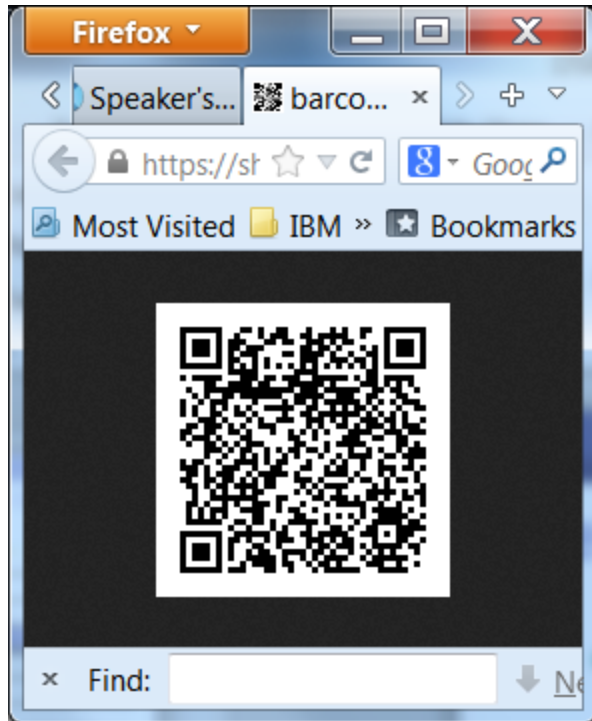
Storage Pool ID	SSD Configuration	Predicted SSD Tier Bandwidth Utilization (current is 97%)	Predicted Pool Performance Improvement	Predicted System Performance Improvement	Estimated Migration Time Range	Predicted Pool Capacity Increase (GB)
0004	Adding 1 STEC_300G_R5_W6 Rank(s)	50%	-	-	1 hour(s) ~ 4 hour(s)	1574
0004	Adding 2 STEC_300G_R5_W6 Rank(s)	30%	-	-	1 hour(s) ~ 6 hour(s)	3148
0004	Performance Improved by Adding 1 STEC_300G_R5_W6 Rank(s)	-	45% ~ 65%	0% ~ 18%	1 hour(s) ~ 6 hour(s)	1574

References

- **IBM System Storage DS8000 Easy Tier Redpaper**
REDP-4667
<http://www.redbooks.ibm.com/abstracts/redp4667.html?Open>
- **IBM System Storage DS8000: Architecture and Implementation**
SG24-8886
<http://www.redbooks.ibm.com/abstracts/sg248886.html?Open>
- **IBM System Storage DS8870: Architecture and Implementation**
SG24-8085
<http://www.redbooks.ibm.com/redbooks/pdfs/sg248085.pdf>
- **IBM System Storage DS8800 and DS8700 Performance with Easy Tier 3rd Generation**
WP102024
<http://tucgsa.ibm.com//gsa/home/s/s/spadmin/web/public/docs/disk/white%20papers/Easy%20Tier%203rd%20Gen%20Whitepaper.pdf>
- **IBM® System Storage™ DS8870™ Performance Whitepaper**
WP102191
<http://tucgsa.ibm.com//gsa/home/s/s/spadmin/web/public/docs/disk/white%20papers/Easy%20Tier%203rd%20Gen%20Whitepaper.pdf>

References (cont.)

- **Access this presentation, and the online evaluation, at the SHARE website:**



System z Social Media Channels

Top Facebook pages related to System z:

- [IBM System z](#)
- [IBM Academic Initiative System z](#)
- [IBM Master the Mainframe Contest](#)
- [IBM Destination z](#)
- [Millennial Mainframer](#)
- [IBM Smarter Computing](#)

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- [System z Advocates](#)
- [SAP on System z](#)
- [IBM Mainframe- Unofficial Group](#)
- [IBM System z Events](#)
- [Mainframe Experts Network](#)
- [System z Linux](#)
- [Enterprise Systems](#)
- [Mainframe Security Gurus](#)

Twitter profiles related to System z:

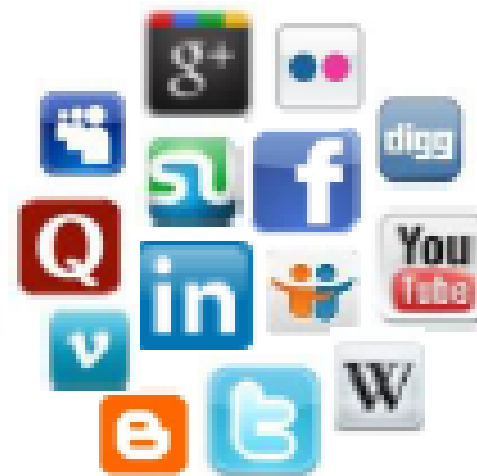
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- [IBM DB2 on System z](#)
- [Millennial Mainframer](#)
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- [IBM Smarter Computing](#)

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- [Destination z](#)
- [IBM Smarter Computing](#)

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- [Smarter Computing](#)
- [Millennial Mainframer](#)
- [Mainframe & Hybrid Computing](#)
- [The Mainframe Blog](#)
- [Mainframe Watch Belgium](#)
- [Mainframe Update](#)
- [Enterprise Systems Media Blog](#)
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