

# DFSMShsm Best Practices

# notices

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## edition

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## examples

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## contacting global technical support

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To log in to the Rocket Customer Portal, go to:  
[www.rocketsoftware.com/support](http://www.rocketsoftware.com/support)

If you do not already have a Rocket Customer Portal account, you can request one by clicking **Need an Account?** on the Rocket Customer Portal login page.

Alternatively, you can contact Global Technical Support by email at [support@rocketsoftware.com](mailto:support@rocketsoftware.com).

## introduction

DFSMSHsm best practices is a very general topic with many variables unique to each different shop and DFSMSHsm environment. The topics covered in this document were written to provide you with a set of guidelines on DFSMSHsm best practices; you must apply the concepts in this document according to your specific needs when trying to setup and tune a DFSMSHsm environment. The information and report samples provided in this document are shown using the Rocket HSM Reporter/Manager and Rocket FastAudit products.

This DFSMSHsm Best Practices document is written based solely on the author's personal opinions, observations, and experience. This is not an agreed upon or approved IBM document.

## background

DFSMSHsm is a policy-based data life cycle management solution for z/OS environments. DFSMSHsm manages millions of data assets by moving data through a three-tiered storage hierarchy. DFSMSHsm moves data from the most available and expensive primary storage to less expensive secondary and tertiary storage. In addition, DFSMSHsm provides data protection services for onsite and offsite recovery.

## availability

Availability on a 24x7 basis is important to all data centers. DFSMSHsm is one of several structures that provide access to data. Others include, but are not limited to, ICE catalogs, WVDS, VTOC, VTOCIX, tape management database, and security database. Any one of these can become a single point of failure for all data sets under its control and an unplanned outage can cause serious disruption for one or more applications.

Ensuring the availability of millions of data assets managed by DFSMSHsm requires daily analysis and audits of information regarding its various functions: Automatic Space Management, Availability Management, Recycle, Autodump, ABARS, and on-demand tasks such as data recall. To maximize productivity, DFSMSHsm administrators require automated reporting and audit tools that provide pertinent information in an easy-to-use interactive format.

## importance

Businesses rely on DFSMSHsm to move inactive data to lower-cost storage; making room for new allocations of active data. In addition, DFSMSHsm performs other data management tasks to protect data assets and retain them for the appropriate amount of time. Some of these data assets are critical to subsequent production processing and to the recovery of data, including databases that have become corrupted.

## risks and exposures

When data assets are not available, production jobs may fail and applications may be unavailable. When data is not retained properly, fines may be levied and your business may not pass an audit. When disaster strikes, you are counting on the backup and recovery processes you have put in place to recover data needed to resume processing. You depend on DFSMSHsm in all of these scenarios. Therefore it makes good business sense to ensure that this highly important system is healthy and working as designed. It also makes sense to equip your DFSMSHsm administrator with the right tools to get the job done in the most cost effective manner possible.

## starting the product started task

It is recommended that you always start the product-started task after the HSM-started task is fully up, initialized, and accepting requests.

## DFSMSHsm administration, tuning and reporting

### control data set administration and management

Administration/Management of control data sets (CDSs) is critical. As an administrator you want to know that the HSM CDSs are successfully backed up at minimum once a day and that key scheduled tasks and work are completed.

- **Panel-HSMSTSYS**

o <b>Keyword</b>	<b>Parm Value</b>
o CDSVERSIONBACKUP(MCDSBACKUPDSN	h/q.MCDS.BACKUP
o CDSVERSIONBACKUP(BCDSBACKUPDSN	h/q.BCDS.BACKUP
o CDSVERSIONBACKUP(OCDSBACKUPDSN	h/q.OCDS.BACKUP
o CDSVERSIONBACKUP(PORNBACKUPDSN	h/q.JRNL.BACKUP
o CDSVERSIONBACKUP(BACKUPDEVICECATEGORY	(DASD
o CDSVERSIONBACKUP(DATAMOVER	(HSM
o CDSVERSIONBACKUP(BACKUPCOPIES	(0005

The sample above is taken from the DFSMSHsm active ARCCMDxx member defining the HSM CDS and Journal backup data set names. The backups are written to DASD with HSM as the data mover and 5 backup versions are being kept.

## control data set allocation

Allocation of CDSs has always been a topic of mixed discussion:

- ❖ Should they be allocated as single clusters?
- ❖ Should they be allocated as multiple clusters?
- ❖ Should they support RLS?
- ❖ Should they be defined to support Extended VSAM?

There is no single way or solution on how a site should define and implement the CDSs, but there are several questions you can ask yourself to assist with determining the best solution.

- ❖ RLS or Non-RLS - If this is a shared HSM environment RLS should be used.
- ❖ Extended VSAM - If you are planning to manage a lot of HSM data to reduce the risk of encountering the 4Gb limit, extended VSAM should be considered.
- ❖ Single Cluster Vs. Multi Cluster - the answer here is dependent upon the HSM experience and knowledge available. Single cluster CDSs may be easier to install and manage but multi-cluster CDSs provide better HSM performance.
  - A single HSM CDS cluster works much like a single lane road; only one record action can be performed at a time to the CDS.
  - A multi-cluster is like a multi-lane highway, multiple record actions can be performed at the same time to the CDS, thus increasing performance.
    - The author's recommendation is 4split multi-cluster CDSs with RLS and Extended VSAM, this ensures the CDSs are positioned and ready for future growth.

Monitoring and tuning of multi-cluster CDSs should also be considered. At a minimum, once or twice a year a site with multi-cluster CDSs should LISTCAT each cluster monitoring the amount of records stored. Many times multi-cluster CDSs were set up and implemented years ago, and over time, one or two of the clusters do more than 70% of the work, reducing the expected performance.



## control data set reorganization

- ❖ Reorganizing CDSs is always a topic with many discussions. One side of the discussion is that you should never reorganize HSM CDSs unless you are going to make changes to the current allocation. The other side of the discussion is to reorganize the CDS to ensure continuous space for inserting new records.
- ❖ Both discussions have valid points but the real decision comes down to individual company policy. Some sites can and do reorganize on a scheduled basis and some sites do not have that flexibility because the DFSMSHsm started task is always active.
  - Rocket HSM Reporter/Manager provides the ability to reorganize the HSM control data sets while the started task is active. Having the Rocket product perform the reorganization removes nearly all of the human intervention, reducing the risk of CDS corruption caused by human error. This allows the site to continue to maintain 100% availability of the DFSMSHsm environment because the task is still active throughout the reorganization process.
  - When deciding to reorganize a DFSMSHsm control data set or all the control data sets with Rocket HSM Reporter/Manager, you should adhere to the following guidelines:
    - Decide if you are going to reorganize a single control data set or all the control data sets.
    - Decide which process you will use (proprietary code or IDCAMS).
      - If moving, renaming, or changing attributes of the CDS, IDCAMS must be used.
      - If just reorganizing a CDS either IDCAMS or proprietary code can be used.
    - Be familiar with the reorganization process. Perform several tests of the reorganization process on a test LPAR, reviewing and verifying the expectations and test results.
      - Setup and test JCL and process thoroughly.
    - Schedule a time when technical staff is still available (before the start of the business day or just after the end of the business day) and when HSM activity is not heavy.

## daily DFSMShsm scheduled functions

### ❖ DFSMShsm Control Data set Backups

- Backup of the DFSMShsm CDSs should be the first thing scheduled and performed every day and is usually the first thing completed before starting the other remaining automatic functions.
- There are two types of backup scenarios that can be used, backup to tape or backup to disk. Either process is acceptable with more sites writing the backup to disk nowadays.
- At a minimum, a week's worth of backups should be kept and available in the event of disaster or corruption. It is always better to have backups kept longer or more backups available in the event that recovery of a CDS is needed further back.
- Recovery of a control data set applying journaling data should be scheduled and practiced on a test LPAR. This will ensure that the process works and that technical staff are familiar with the process, expectations, and results.

### ❖ Primary/Secondary Migration

- This is a process where the scheduling decision is made by each site. The following identifies the different scenarios and considerations.
  - IBM recommends running Secondary Space Management first then Primary Space Management. For sites with a small number of ML1 volumes, running Secondary before Primary would allow HSM to move ML1 data to ML2 freeing space for new allocations to ML1.
  - For sites that have a high number of ML1 volumes defined or a large amount of ML1 space constantly available and ML1 space is not an issue, these sites may opt to run primary space management first, then secondary space management because space is always available for new migration allocation.
  - For sites where there are a large number of primary volumes, the currently defined start/stop time for primary space management is not long enough for HSM to touch each volume in the defined time. IBM provides a patch that for sites experiencing this difficulty.
    - The site has 200 primary volumes but HSM is only able to process 105 of the 200 volumes. The customer can define the following patch in the ARCCMDxx member, this patch extends space management to 38 hours, picking up space management on the next volume rather than starting back on the first volume.
      - o `PATCH .MCVT.+414 X"00021560' VER(.MCVT.+414 X'0000C4E0')`
    - *Day 1 - volumes 1-105 get process during PSM window*
    - *Day2 - volumes 1-705 are viewed as completed "today" (within past 38hours), volume 105-200 are then processed.*

#### ❖ DFSMShsm Daily Incremental Backup

- DFSMShsm daily incremental backup is the process where HSM checks the change bit of the data set and if the data set has recently been updated/changed and the backup date is prior to the bit date, HSM issues a backup of the data set. The backup criteria are managed within the DFSMS Management Class defined criteria.
- When HSM daily incremental backup is run, all data selected for backup is written directly to tape.
- Sites can implement different backup scenarios pertaining to business needs and available resource usage. Some scenarios may be:
  - Backup all changed data every day.
  - Backup critical data every day and test data 1 to 2 times a week (as defined in backup procedures and policies).
  - Backup only certain data.
- For sites allowing users to issue an HSM backup of a data set, it should be known when this command is used the backup is written to ML1 first and during daily backup this data is then written to tape. Sites where ML1 space is an issue should monitor the available space in this pool to ensure a successful backup data.

#### ❖ EXPIREBV

- EXPIREBV is a DFSMShsm command that reads through all the backup records inside the BCDS and releases/deletes DFSMShsm backup versions of data no longer needed as defined.
  - MGMTCLAS retain days extra backup versions
  - Expired ABARS versions
  - Flags when a data set is detected as un-cataloged (primary or migrated version)
  - Updates the BCDS to store date of EXPIREBV run
    - EXPIREBV does require a fair amount of HSM resources and can have a negative effect to HSM performance so it is not a process that needs to run every day.
    - Sites can monitor the HSM tape usage and BCDS growth; if these numbers start to grow drastically the site can schedule the execution of EXPIREBV to run at a desirable time, for example during off-peak hours.

## DFSMSHsm recycle

- ❖ DFSMSHsm recycle is the process where HSM reads the data on active HSM-owned tapes (ML2 and Backup), writes active data to a new tape, and releases the old tape back into inventory in scratch status for new use. Recycle provides sites the ability to better manage HSM-owned tape by allocating ownership of the tapes for active data only (inactive data is scratched).
- ❖ Sites today use physical tape for migrated and/or HSM backup data, virtual tape for migrated and/or backup data, or a mixture of physical and virtual tapes for this HSM-managed data.
- ❖ When defining the recycle percentage for recycle the following should be noted:
  - For virtual tape the recycle percentage should be set at 10% free.
  - For physical tape the recycle percentage should be set at 30-40% free.
    - **Truth or Myth** — Some sites are under the impression because they have HSM tapes in a VTL they have unlimited tape availability.  
**Myth** — though there could be thousands of tapes defined, the weak link is the back-end storage.
    - **Truth or Myth** — We aggressively migrate HSM data to the VTL because it uses fewer resources than physical tape.  
**Myth** — VTLs do process data faster but other additional cycles are used, for example cache for loading data, loading of complete tape to memory, and hardware decompression.
  - Consider using smaller virtual volume size, this allows tapes to free up quicker, reducing the need to recycle.  
Note: smaller tapes can cause excessive tape spanning.

Many shops run recycle differently; some recycle schedules are defined as follows —

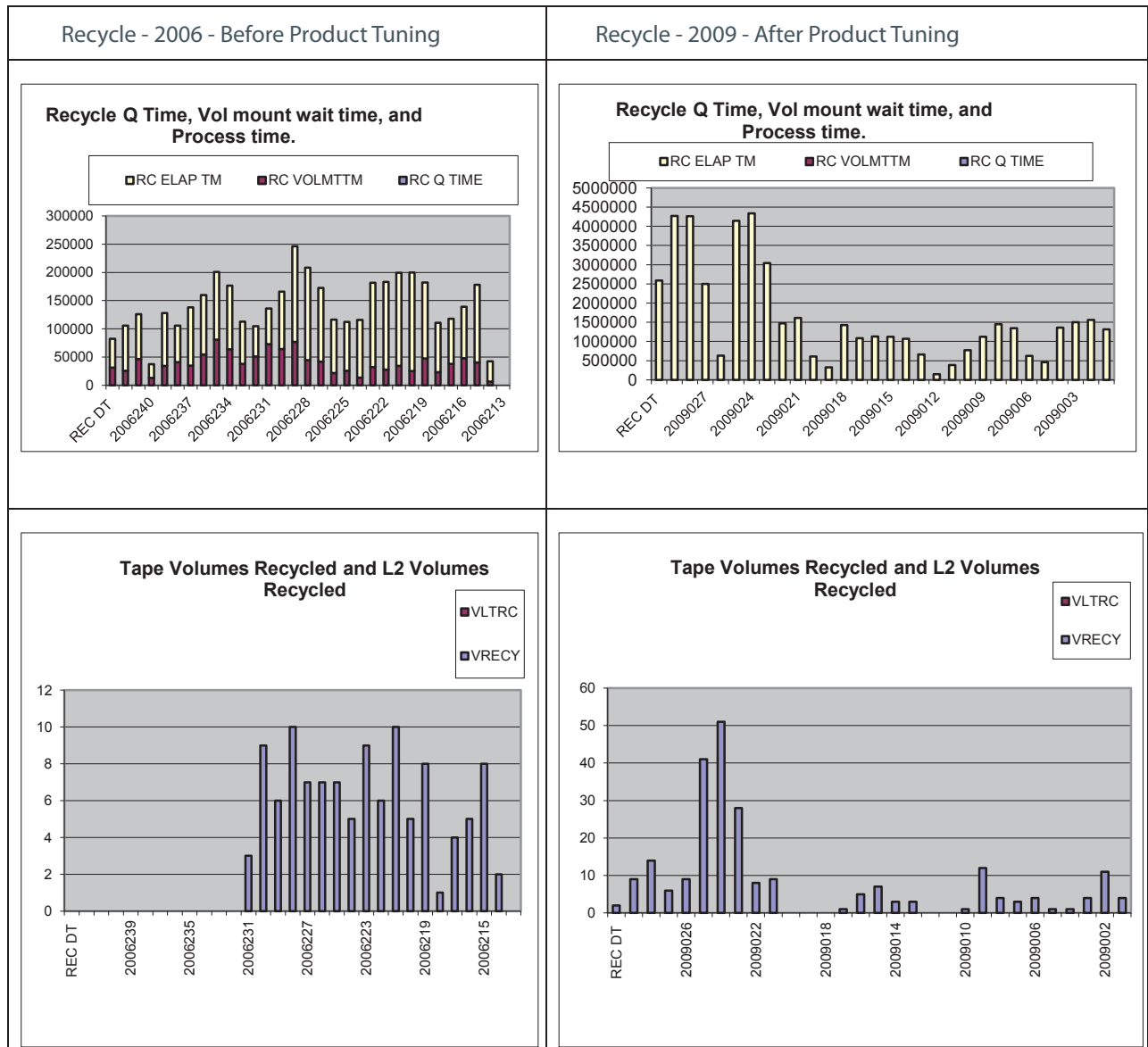
- ❖ Run one per week at a specific time
- ❖ Run on these days at a specific time
- ❖ Shared HSM environment — run recycle on this HSM instance on this day only
- ❖ Shared HSM environment — run recycle only on this HSM instance continually

There are many other different scenarios. There is no set right or wrong setup for recycle, it is dependent on your site and what you are looking to achieve:

- ❖ Are you constantly running out of HSM tapes?
- ❖ Are you constantly adding tapes to HSM?
- ❖ Are you experiencing sudden unexplained growth of your HSM-owned tapes?

These are some of the early warning questions that, when answered, can help you understand how the recycle task is performing and determine if additional actions are required.

The following is an actual report from HSM Reporter/Manager on a customer site. The customer was constantly adding tapes to HSM and without understanding the reasons or causes for the growth.



There were several issues noted during this analysis:

❖ 2006 Analysis -

- Limited tape devices available
  - HSM constantly waited hours for a free tape device for a mount tape
- On average 4-5 tapes would only be recycled daily (Monday - Sunday)

❖ 2009 Analysis -

- Corrected hardware constraint by rescheduling of other work and tasks
- Increased completed tape recycle daily to 6-10+ (Monday - Friday)
- Increased weekend recycles to 40 to 50+ tapes Saturday & Sunday)

With the correct reports, you can set up your HSM tasks so that they run more efficiently. Knowing the constraints for hardware and resources and scheduling tasks accordingly ensures your HSM environment is performing at its optimum level.

## interval migration

- ❖ Interval migration is the process where once an hour the HSM started task touches every volume above the SMS-defined threshold, looking for eligible data to migrate to bring the occupancy below, and have the function enabled through SMS. It is recommended for high usage pools where volume contents can be migrated to tape or deleted as soon as possible.
- ❖ When deciding if volumes or groups of volumes should have interval migration enabled, you should take the following into considerations:
  - Interval migration will use additional DFSMSHsm resources
  - Interval migration will run hourly
  - You should not define High Threshold/Low Threshold greater than 15 digits
    - Not Recommended - High-90/Low-10
    - Recommended - High-90/Low-75
- ❖ One of the easiest ways to see and know what the threshold settings are is provided in HSM Reporter/Manager. One of the reports provided is the called the HLTHVST report. This report reads the HSM internals and key SMS internals. Selecting and viewing the VOLR000 status displays key information when you want to quickly know the status of volumes and defined limits.

### HLTHDTLS

Cmd	Volser	S	H	M	S	E	Lspace	Lspace	A	Auto BackUp	Auto BUp	A
		M	M	V	D	N	Date	Time	M	Date	Time	B
ARCHV1		Y	Y	N	N	N	06/18/2009	00:12:26	Y	08/23/2000	07:15:48	Y
HSM001		N	1	N	Y	N	1099001	00:00:00	N	1900001	00:00:00	N
HRMD00		Y	Y	N	N	N	09/08/2006	14:45:38	Y	01/11/2013	01:14:20	Y
HRMD01		Y	Y	N	N	N	04/06/2010	15:53:14	Y	01/11/2013	01:14:20	Y

❖ Panel Table Layout -

- Cmd-command line
- Volser-display primary volume information
- SM-defined as SMS managed
- HM-defined as HSM managed
- MV-indicated if HSM has it in its mounted volume table
- SD-indicates if volume is ML1 and SDSP is present
- EN-indicates if volume is a ML1 and has a SDSP on the volume
- Lspace Date-last time space management touched the volume
- Lspace Time-last time space management touched the volume
- AB- SMS or HSM management for automatic backup indicator

Cmd	Volser	I	Hi Thr	Lo Thr	Cur Occ
ARCHV1	Y	M	85	1	100
HSM001			85	1	95
HRMD00	N		85	60	42
HRMD01	Y		85	60	39

- IM-indicator for volume defined for interval migration
- Hi Thr-defined High Threshold limit set
- Lo Thr-defined Low Threshold limit set
- Curr Occ- current occupancy of volume

❖ If Interval Migration is turned on for a volume you must pay close attention to the defined Hi and Low Threshold limits. Interval migration will continually hit a volume above the defined High limit trying to move data until the Low threshold limit is achieved.

- Example : In the above screen the defined limits are 85/1, this means every hour when HSM checks this volume and it is above the 85 limit it will use resources to continually read the volume looking for a data set to move until it brings the occupancy to below 1 (Low Threshold set limit).

❖ For sites wanting to run Interval Migration but less frequent than hourly, a PATCH command can be added to the ARCCMDxx member. To calculate the new value of the MGCB record, start with the desired number of hours for your interval, multiply by 61, than add 30.

- If you want interval to run every 2 hours (not every hour) the patch would read as follows:
  - $(2*60)+30=150$
  - PATCH .MGCB.+60 X'0096' /\* interval runs every 2 hours \*/

- ❖ Sites also have the ability to run interval migration twice per hour but this requires two hosts to do so. To do this, issue the following patches to start the space check on the primary host on the hour and start the space check on the non-primary host 30 minutes after the hour.
  - Ifor the primary host
    - PATCH .MGCB.+60 X'005A' /\* 90 minutes — default \*/
  - INon-primary host
    - PATCH .MGCB.+62 X'001E' /\* 30 minutes after the hour \*/
    - PATCH .MGCB.+60 X'003C' /\* 60 more minutes to middle of next hour \*/
  - IO n both the primary and non-primary host, issue the following patches to set the minimum number of minutes between successive migrations of the same volume to one-half the hourly value:
    - PATCH .MCVT.+422 X'000F' /\* 15 minutes - SMS \*/
    - PATCH .MCVT.+496 X'000F1' /\* 15 minutes — non-SMS \*/

## DFSMSHsm log and PDO files

- ❖ DFSMSHsm log files are used to track HSM activity-- the activity that is written to the log file reporting all the actions pertaining to the work HSM attempted on the data set(s) and the return code. The PDO file contains some of the same information as the data stored in the log file (but not all of the same information), but also contains additional diagnostic information that IBM may use when troubleshooting a reported HSM problem or issue.
- ❖ Logging (Log or PDO files) are not mandatory for HSM to be active.
- ❖ When deciding to turn on logging, you must consider the following:
  - ISV or 3rd party software requiring certain HSM information for reporting.
  - Overhead when using log files. There is an additional overhead of 5-10 percent resource usage when writing log files.
  - Correct definition and swapping of log data sets.
    - Depending on the ISV, some products require that the log contain a full 24hour period of HSM activity for reporting.
  - An exclusive enqueue is issued by the HSM started task on the LOGx.
  - When doing a SWAPLOG the LOGx and LOGy need to reside on the same volume.
  - The HSM LOGy can be analyzed using ARCPRLOG and ARCPEDIT programs.
  - A recommendation is to write the HSM LOGy file to a GDG allowing further analysis before "zeroing data".
  - If writing a LOG, define it as DISP=MOD. This allows HSM to append new data to the existing LOG when restarting HSM during the day.
  - If writing a PDO, define it as DISP=OLD because a PDA is automatically swapped at HSM startup.



## DFSMShsm patches and patches of interest

- ❖ Patches are applied via the DFSMShsm PATCH command; they are often also included in the ARCCMDxx member.
  - Patches supply functionality not available using standard HSM commands
  - Some patches are for tuning and other diagnostic information
  - Supported Patches are documented in the DFSMShsm Implementation and Customization guide.
- Having a product that displays and lists all patches and active status assists to ensure the patches that are active are known and needed. Below is a sample of just such a report in HSM Reporter/Manager product.

```

HSMPatch ----- Rocket HSM Reporter/Manager-----
DFSMShsm Active Patches:                                     Row 40 of 90

Patch Command          Patch Active          Verify Command
PATCH .ABRCB.+1F X'02'      N
PATCH .ABRCB.+1F X'03'      Y
PATCH .ABRCB.+A8 BITS(.....1..)      N
PATCH .ABRCB.+494 X'nnnnnnnn'      N          VERIFY(.ABRCB.+494 X'000001
PATCH .ABRCB.+82 BITS(1.....)      N
PATCH .ABRCB.+1C X'F4F5F4'      N
PATCH .ABRCB.+81 BITS(.....1..)      N
PATCH .ABRCB.+82 BITS(.1.....)      N
PATCH .MCVT.+195 BITS(.....1..)      N
PATCH .MCVT.+315 X'00'          Y          VERIFY(.MCVT.+315 X'0F')
PATCH .MCVT.+391 X'nn'          Y          VERIFY(.MCVT.+391 X'00')
PATCH .MCVT.+4B6 X'0F'          N          VERIFY(.MCVT.+4B6 X'19')
PATCH .MCVT.+4B7 X'14'          N          VERIFY(.MCVT.+4B7 X'19')
PATCH .MCVT.+53 BITS(.....1..)      N
PATCH .MCVT.+3CA X'0014'        Y          VERIFY(.MCVT.+3CA X'000F')
    
```

- ❖ One good tuning patch to have defined is `PATCH.MCVT.+52 bits(.. 1.....)`. This allows TS0 users to perform other tasks while recall takes place in the background and will also alter the default for tape data set recalls from wait to a no-wait state.
- ❖ `PATCH.MCVT.+321 'SHORT' Verify(.MCVT.-F321 'HSMACT')` will change the HLQ of HSM DASD activity log from HSMACT to SHORT.
- ❖ `PATCH.MCVT.+595 BITS(.....1)` prevents data sets greater than 64K tracks from migrating and backing up to ML1.

## DFSMSHsm SETSYS commands

The way DFSMSHsm works is established by a set of parameters, most of them identified by the DFSMSHsm SETSYS command. These command parameters are contained in the HSMPARM DD statement in the ARCCMDxx started procedure.

The following report is taken from HSM Reporter/Manager and is the site's own interpretation of their DFSMSHsm SETSYS values. This is a guideline and not a rule. The report below displays the current SETSYS values as defined in the current active ARCCMDxx member at this site.

Sample report is available on the next page.

{This space intentionally left blank}

- **HSMSTSYS** ----- Rocket - HSM Reporter/Manager
- **DFSMSshm SETSYS Values:**

o <b>Keyword</b>	▪ <b>Parm Value</b>
• CMD=	DV
• UID=	DFHSM
• HOST=	1
• LOGSW=	No
• EMERG=	No
• STARTUP=	Yes
• PDA=	Yes
• CDS SHR=	Rls
• NODEBUG	
• NOSWAP	
• SMF (	240
• BACKUPPREFIX (	HSM
• MIGRATEPREFIX (	HSM
• MAXRECALLTASKS (	10
• TAPEMAXRECALLTASKS (	4
• MAXBACKUPTASKS (	1
• MAXDUMPTASKS (	2
• CSALIMITS (MAXIMUM (	100
• CSALIMITS (ACTIVE (	90
• CSALIMITS (INACTIVE (	30
• CSALIMITS (MWE (	4
• AUTOBACKUPSTART (	01:10 08:15 09:15
• AUTODUMPSTART (	21:30 22:30 23:30
• PRIMARYSPMGMTSTART (	00:12 06:00
• SECONDARYSPMGMTSTART (	00:05 02:30
• CDSVERSIONBACKUP (MCDSBACKUPDSN	HSM.MCDS.BACKUP
• CDSVERSIONBACKUP (BCDSBACKUPDSN	HSM.BCDS.BACKUP
• CDSVERSIONBACKUP (OCDSBACKUPDSN	HSM.OCDS.BACKUP
• CDSVERSIONBACKUP (JRNLBACKUPDSN	HSM.JRNL.BACKUP
• CDSVERSIONBACKUP (BACKUPDEVICECATEGORY (	DASD
• CDSVERSIONBACKUP (DATAMOVER (	HSM
• CDSVERSIONBACKUP (BACKUPCOPIES (	0005
• CDSVERSIONBACKUP (LATESTFINALQUALIFIER (	D0004205
• RECYCLETAPEALLOCATION (	NOWAIT
• RECYCLEOUTPUT (BACKUP (	CXCART
• RECYCLEOUTPUT (MIGRATION (	CXCART
• RECYCLEPERCENT (	50
• ML2RECYCLEPERCENT (	535
• MAXRECYCLETASKS (	1
• PARTIALTAPE (	MARKFULL
• ABARSPROCNAME (	BRMABARS
• ABARSBUFFERS (	1
• ABARSUNITNAME (	CXCART
• ARECOVERML2UNIT (	CXCART

For additional information on SETSYS parameters reference the DFSMSshm Storage Administration Reference manual (SC35-0389).

## Knowing DFSMShsm Resource Usage

As you know DFSMShsm is constantly working, HSM may be doing primary space management, secondary space management, recycle, backup, requests from users or the system, and more. Doing this work requires the DFSMShsm started task to use system resources. What you should be interested in knowing and understanding is:

- ❖ How much resources are being used daily by the DFSMShsm started task(s)?
- ❖ How much resources are being wasted by the DFSMShsm started task(s)?
- ❖ How can I get better performance from the DFSMShsm started tasks(s)?

In many shops the understanding is everything is good as long as the work performed by DFSMShsm shows a return code of zero. In actuality, this is good but is HSM actually doing too much work.

The first area you will want to review is the work DFSMShsm performed--what was successful and what was not successful.

**CollSumm**

Cmd	HSM Action	Return Code	Count	Description
	ABACKUP	0	2	Aggregate backup
	BACK-UP	0	660	BACKUP OK
	BACK-UP	19	153	DATA SET IN USE
	BACK-UP	68	1	BKUP FAILED BECAUSE OF DFDSS ERR
	DELETE	0	11	BACKUP OK
	DELETED	0	14	MIGRATION OK
	EXBACKV	0	501	BACKUP VER WAS SCRATCHED SUCCESSFULLY
	EXPIRED	0	958	MIGRATION OK
	EXPIRED	70	248	SMS DS ERROR
	MIG-RCN	0	1	MIGRATION OK
	MIGRATE	37	966	NO SPACE ON MIG VOL
	MIGRATE	0	110	MIGRATION OK
	MIGRATE	58	650	MIGRATION OR DBA DBU FAILED
	MIGRATE	6	1142	DUPLICATE DSN IN MCDS

In the above partial Collection Summary Report (Coi/Summ) HSM Reporter/Manager provides a quick view and status of the many different requests the DFSMShsm task performed, what was successful and what was unsuccessful. This report can be modified quickly to your specific needs:

- ❖ Successful only
- ❖ Unsuccessful only
- ❖ Specific DFSMShsm action
- ❖ Return code number
- ❖ Days in range
- ❖ Start/Ending date

The purpose of this report is so technical personnel can quickly have an understanding of the work HSM initiated and the status of the action. Each action provides drill down to the detailed data set level allowing technical staff to know the data set(s), making a better decision for corrective or alternative actions.

Everyone is aware that HSM failures are not good and are the number one cause for wasting DFSMSHsm resources. In nearly every scenario: what failed yesterday, failed again today, and will fail again tomorrow. DFSMSHsm will attempt to perform the same action to the data set(s) every day until the action is successful.

The below **CollCost** screen sample reports some of the costs DFSMSHsm wasted daily on data sets failing actions. As stated, prior data sets that failed DFSMSHsm actions yesterday likely failed again today and will fail again tomorrow and continue failing until the error is corrected.

**CollCost**

HSM Functions Costs: Row 12 of 28 More >

Cmd	HSM Action	Return Code	Records Count	Tracks Read	Bytes Read	CPU .01 Seconds	Recycle # Tapes	Estimated Cost
	EXPIRED	39	1	0	0	1		\$ .45
	MIGRATE	24	1	0	0	1		\$ .45
	MIGRATE	73	5	0	0	1		\$ .45
	MIGRATE	44	63	393216	0	59		\$ .15
	MIGRATE	58	9218	80216064	0	169		\$11.42
	MIGRATE	14	7	393216	0	1		\$ .45
	MIGRATE	19	41	851968	0	3		\$ .91
	MIGRATE	37	8180	46333952	0	6432		\$16.08
	MIGRATE	6	16915	132775936	0	236		\$ .59
	RECALL	68	3	0	0	6		\$ .02
	RECALL	81	2	0	0	4		\$ 01
	RECALL	2	34	65536	0	1		\$9.45
	RECALL	69	3	17013	714468	7		\$ .02
	RECOVER	28	1	0	0	1		\$ .45

Wasted CPU resources and costs

A second area to think about is "Are You Having HSM Do Too Much Work". A site might be backing up too much data daily or be migrating data too aggressively. Looking at aggressive migration policies it is cheaper to have the system catalog expire data than having HSM expire data. Having the system expire the data alleviates the need for HSM to move it through its process and using HSM resources. Small data sets that are constantly being created and scratched are primary candidates for this action.


The screen sample below details only successful DFSMSHsm work for a 24hour period and the CPU costs associated with the action.

**CollCost**

**HSM Functions Costs: Row 11 of 1**

**Line Commands are . . . : S**

Cmd	HSM Action	Return Code	Records Count	Tracks Read	CPU .01 Seconds	Recycle # Tapes	Estimated Cost
	PARTREL	0	3825	88326520		604	\$1.51
	MIG1TO2	0	1066	100298	665		\$1.66
	RECYCLE	0	6839	0	1427		\$3.57
	RECALL	0	1041	12675756	6696		\$16.74
	MIGRATE	0	1654	26750505	23195		\$57.99
	BACK-UP	0	9312	172707574	62773		\$156.93
	EXBACKV	0	8866	140640256	1061110779		\$75796.57



Having the ability to apply a CPU cost to DFSMSHsm actions provides you with the ability to better tune and manage your DFSMSHsm environment(s) and managed data.

In the screen sample above, this HSM environment use about 16,000 dollars of resource time daily to backup data. This data was likely a mix of production, test, and user data (and more). This also equated to about 4+ million dollars of system resources used annually by DFSMSHsm for backing up this data. One way to reduce daily HSM consumption of resources would be to have HSM perform certain backups of certain data and management classes on different scheduled bases. For example, if you have HSM backup changed so that production data is backed up daily and test and user data is backed up by HSM once or twice per week instead of 5+ times a week, this would reduce your daily DFSMSHsm resource usage because you will be backing up test and user data less frequently.

In some shops a simple procedure change like this could save thousands to millions of dollars of resource usage annually.

## data set thrashing

This is the second most common waste of system resources. HSM Reporter/Manager provides you with the ability to run canned thrashing reports or create custom thrashing reports as you need them.

Rocket FastAudit has an internal procedure available where it will list all data sets meeting a predefined thrashing criterion.

### MgrtAud

#### Migrated Data sets Audit

Thr	Times	MgmtCla			
Cmd	Data set Name		Idx	Migrtd	Name
	SC.MVF0302F.JCL		6	11	TSODATA
	SC.MVF0302F.PARMLIB		6	11	TSODATA
	SC.MVF0302F.DBRMLIB		6	11	TSODATA
	SC.IEB.UNLOAD		7	11	TSODATA
	SC.ASAPTEST.BACKUP		6	14	TSODATA
	SCVGE.TEST.SAKDPENU		6	40	MCAGGT
	SCVGE.TEST.SAKDLOAD		6	40	MCAGGT
	SCVGE.TEST.SAKDPARM		6	40	MCAGGT
	SCVGE.TEST.SAKDMSGGS		6	41	MCAGGT
	SCVGE.TEST.SAKDJCL.BKUP		6	41	MCAGGT
	SCVGE.TEST.SAKDCNTL		6	42	MCAGGT
	SCSCVGE.TEST.SAKDJCL		6	44	MCAGGT
	SCVGE.TEST.SAKDCLST.BKUP	6	45	MCAGGT	
	SCVGE.TEST.SAKDCLST		6	51	MCAGGT

## aged data

Aged data or data that is migrated and infrequently used is another area often overlooked that easily uses CPU cycles throughout the residence of the data. Aged data in most cases encompasses migrated data but can also include HSM backed up data.

Aged migration data is data that moves through the HSM cycle from primary DASD to ML1 to ML2. Once it is on ML2 it can take weeks, months, and years until it has finally rested on a tape volume that is seldom accessed. As this data is moved around to different tapes, recycle is busy reading and moving unexpired data from tape to tape; this data is constantly being read by recycle and being moved off the current tape to the new HSM tape.

### MGRTDsns

#### Migrated Data sets:

Cmd	Data set Name	Days Since Migrated	MgmtClas Name
	GOVT.GOVTDGD.G0201V00	4370	MCPROD
	GOVT.GOVTDGD.G0202V00	4370	MCPROD
	GOVT.GOVTDGD G0203V00	370	MCPROD
	SC.T.MACSAVE	4370	MCTSO
	SC.ABARS.LOAD	4370	MCTSO
	SC.LAB.MIG3	4469	MCTSO
	SC.LAB.SKIP.ONE	4469	MCTSO
	SCT.LAB.SKIP.THREE	4469	MCTEST
	SCT.LAB.ZZZZ	4518	MCTEST
	SC.LAB.SKIP.TWO	4518	MCTSO

The above report sample shows the data sets total days migrated and the SMS management class of the data reported. In this example, looking at the MGMTCLAS=MCTEST you should be able to determine if this test data that has been migrated over 10 years and not referenced, is still needed. This same process can be applied to the MGMTCLASS=MCTSO-- employees no longer working for the company are candidates for deletion and if they are still employed, determine if this data is still needed.

The data represented MGMTCLASS=MCPROD may still be valid data that needs to be retained for a long period of time. Knowing what this data is and removing data not needed assists in reducing HSM overhead and costs along with making the CDSs and HSM owned data easier to manage.



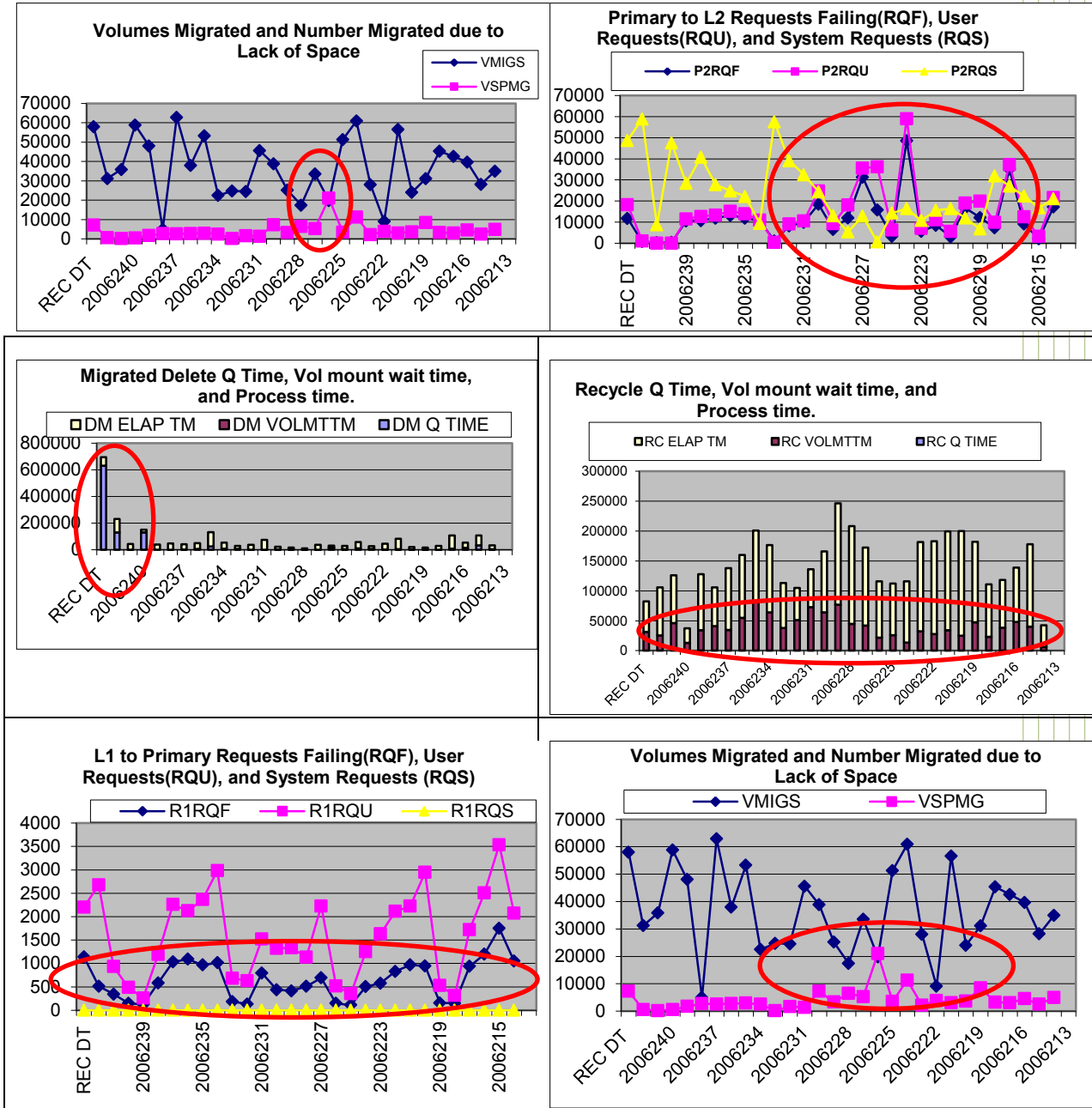
## monitoring DFSMShsm performance

As changes, corrections and updates are made to the DFSMShsm environment, monitoring performance and throughput becomes very important and vital. Important values to monitor would be data through put, wait/mount times, and HSM requests and where they came from (user/system).

Graphs/charts are the easiest way to get an understanding on the DFSMShsm performance, where waste is happening and where additional tuning may be needed.

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In the following charts, circled areas point out where performance may have been impacted and the likelihood of resource waste has occurred. Knowing this will assist with better tuning options, increasing DFSMSshsm performance and throughput.



You can easily see spikes and dips thus alerting you to possible areas where additional research may be needed to determine the cause or where additional tuning may be needed to increase performance.

Important areas to monitor on a scheduled basis would not only include successful and unsuccessful HSM work, but the following areas should also be part of the scheduled monitoring and tuning:

- ❖ The HSM Startups, ABENDs, and Shutdowns chart provides a general picture of your HSM system's stability.
- ❖ The HSM Step Time for the HSM ASCB chart can be useful for determining the CPU resources used by your HSM system.
- ❖ The Volumes Migrated and Number Migrated Due to Lack of Space chart shows the level of volume migration occurring and shows how many migrations were forced due to lack of space.
- ❖ The Data set Restores Requested and Failed chart shows the number of restores and indicates what proportion of them are not working correctly and require further investigation.
- ❖ The Volume Restores Requested and Failed chart shows the number of restores and indicates what proportion of them are not working correctly and require further investigation.
- ❖ The System Requested Dump Copies, User Requested Dump Copies, and Failing Copies chart gives an indication of the level of dump copies occurring, how they were requested, and the proportion of them that fail.
- ❖ The System Requested Volume Dumps, User Requested Volume Dumps, and Failing Dumps chart gives an indication of the level of volume dump occurring, how they were requested, and the proportion of them that fail.
- ❖ The Tape Volumes Recycled and L2 Volumes Recycled chart provides a general picture of recycle activity on your HSM system.
- ❖ The Number of Volumes Backed Up chart provides an overview of volume backup activity.
- ❖ The Tracks Read and Written chart shows the level of read and write activity (in terms of tracks). Nearly equal read and write activity levels and days with an unusually high amount of activity can indicate thrashing.
- ❖ The DSNs Moved chart shows how many data sets were moved. You can use this data, along with the number of tracks or gigabytes read and written, to estimate the average size of the data sets processed by HSM.
- ❖ The Total Age in Days of Data sets Processed chart shows the average age of the data sets processed by HSM.
- ❖ Primary to Level 1 migrations
- ❖ Primary to Level 2 migrations
- ❖ Level 1 to Primary migrations
- ❖ Level 2 to Primary migrations

## DFSMSHsm control data set auditing

HSM Control Data set health is another area where DFSMSHsm Best Practices should be included and is just as important as HSM Administration, Tuning, and Reporting.

Depending on the type of data set and the action being performed, there are at a minimum 3 internal HSM records for each migrated and backup data set.

- ❖ Migrated Sequential data set
  - MCA, MCD, MCV
    - Additional TTOC record for data set on ML2
- ❖ Migrated VSAM data set
  - MCO, MCD, MCV
    - Additional TTOC record for data set on ML2
- ❖ Backup data set
  - MCB, MCC, MCT

These records do not include the additional HSM records for HSM Dumps and ABARS created backups.

It is important to know and understand if one of these records or chains is broken or not correct that there is an increased risk of data accessibility failure for the data set(s).

Auditing DFSMSHsm control data sets and HSM-owned tapes is critical. Auditing the CDSs ensures that these chained records are healthy and accurate, thus ensuring data accessibility when the data is needed.

## frequency of auditing

The more frequently you audit, the sooner you know about imposing issues, and the healthier your CDSs will be.

There are two viable auditing solutions available: native DFSMSHsm Enhanced Audits and Rocket FastAudit. Provided below are some personal key points that should be known when deciding what auditing tool you choose to use.

- ❖ Enhanced Audits
  - Executes and runs in the same DFSMSHsm address space
  - Only one audit can run at a time
  - A minimum of 17 audits must be executed to completely audit a MCDS
    - Some audits may require to be run multiple times depending on the environment.
  - Allow you to run with automated FIX or NOFIX option
    - When running with F/Xoption, fixes are built using the catalog as the rule

Rocket FastAudit

- Executes outside the DFSMSHsm address space
- One complete audit procedure for each CDS.
- One audit procedure audits the complete CDS.
- ❖ Supports equivalent NOF1X, Automatic Fix, or User Custom Fix

The following table details the single FastAudit catalog procedure executed and the equivalent HSM Enhanced audits that you would need to execute to produce the same audit results.

<b>FastAudit MCDS Audits (MFAAUDal)</b>	<b>FastAudit BCDS Audit (MFAAUDbd)</b>	<b>Fastaudit OCDS Audit (MFAAUDod)</b>
Equivalent Enhanced Audits Run	Equivalent Enhanced Audits Run	Equivalent Enhanced Audits Run
AUDIT MCDS AUDIT DIRECTORYCONTROLSVOLUMES(allm11,a llm12) AUDIT VOLUMECONTROLS(MIGRATION) AUDIT DATA SETCONTROLS(MIGRATION) AUDIT OCDS(ML2) AUDIT MEDIACONTROLS(SDSP) AUDIT MEDIACONTROLS VOLUMES(allm11) AUDIT MEDIACONTROLS VOLUMES(allm12) some analysis AUDIT MASTERCATALOG AUDIT USERCATALOG (all user catalogs)	AUDIT BCDS AUDIT DIRECTORYCONTROLS VOLUMES(allspikallcycle) AUDIT VOLUMECONTROLS(BACKUP) AUDIT DATA SETCONTROLS(BACKUP) AUDIT OCDS(spill,cycle) AUDIT MEDIACONTROLS VOLUMES(spill,cycle) AUDIT MEDIACONTROLS VOLUMES(m/lbkup)	AUDIT OCDS(DAILY) AUDIT OCDS(SPILL) AUDIT OCDS(ML2) AUDIT OCDS(ALL)
<b>FastAudit HSM Tape Audit (MFAAUDrm)</b>	<b>FastAudit MediaControls (MFAAUDFT)</b>	
Equivalent Enhanced Audits Run	Equivalent Enhanced Audits Run	
AUDIT VOLUMECONTROLS(MIGRATION) AUDIT VOLUMECONTROLS(BACKUP) AUDIT VOLUMECONTROLS(RECOVERABLE)	AUDIT DIRECTORYCONTROLS and AUDIT MEDIACONTROLS	

As demonstrated in the table above, one single FastAudit procedure audits the complete CDS including all the catalogs and HSM managed tapes. This provides you with a complete understanding of the health of the HSM control data set and HSM-owned and managed data.

The questions remaining are: How are these audits executed?

- ❖ How much resource do they use?
- ❖ How long do the audits run?
- ❖ How are these audits executed — In the table above in bold lettering is the catalog procedure or job that you will run to execute the different audits. Each audit job run is like executing each equivalent Enhanced audit, only you are executing a batch procedure to perform the same function.
- ❖ How much resource do they use — Unlike Enhanced audits, FastAudit does not run or execute in the HSM address space. FastAudit executes outside the HSM address space so there is no negative affect to any other scheduled or requested HSM work or system resources.
- ❖ How long do the audits run — Because the audits do not run in the HSM address space, each audit completes in minutes instead of hours. Because Enhanced audits run in the HSM address space, the first thing that happens when any Enhanced audit is initiated is a hold to the BACKVOLCDS command (if BACKVOLCDS is held, no scheduled or automatic HSM tasks are started until the command is initiated and the CDSs are backed up). Because FastAudit runs outside the HSM address space and completes faster this command is never held.

**ErrsCost**

**Auditing Errors Cost**

<b>Audit</b>	<b>CPU</b>	<b>Tape</b>	<b>Errors</b>	<b>Est. #</b>	<b>Est. #</b>	<b># Tape</b>	<b>Estimated</b>	<b>Estimated</b>
<b>Type</b>	<b>Cost</b>	<b>Cost</b>	<b>Count</b>	<b>CDS Reads</b>	<b>CPU Sec</b>	<b>Vols</b>	<b>CPU Cost</b>	<b>Tape Cost</b>
<b>MCDS</b>	<b>.25</b>	<b>100.00</b>	<b>1885</b>	<b>476905</b>	<b>11</b>	<b>5</b>	<b>\$2.98</b>	<b>\$500.00</b>
<b>BCDS</b>	<b>.25</b>	<b>100.00</b>	<b>150</b>	<b>59250</b>	<b>1</b>	<b>0</b>	<b>\$0.37</b>	<b>\$0.00</b>
<b>OCDS</b>	<b>.25</b>	<b>100.00</b>	<b>50</b>	<b>1600</b>	<b>0</b>	<b>94</b>	<b>\$1.00</b>	<b>\$9400.00</b>
<b>HSMTAPE.</b>	<b>.25</b>	<b>100.00</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>190</b>	<b>\$0.00</b>	
	<b>\$19000.00</b>							
<b>Total</b>	<b>.25</b>	<b>100.00</b>	<b>2085</b>	<b>537755</b>	<b>12</b>	<b>289</b>	<b>\$3.36</b>	
	<b>\$28900.00</b>							

As in HSM Reporter/Manager, FastAudit also provides an estimated cost for wasted system resources. The Errors Cost Report (ErrCost) provides you with an estimated cost for HSM reading corrupted records in the CDS over a 24hour period. This information is extremely helpful especially when working on HSM tuning and performance.

Looking at the above report, over a 24-hour period HSM has read, updated, and inserted records in the CDSs HSM 537 thousand times, wasting \$3.36 in CPU resource time and almost 29 thousand dollars in tape waste. Although this does not sound like much CPU waste, multiply this by 365 days and the \$3.36 daily is now \$1226.40/ annually.

If your shop has more than 2085 errors in the CDSs, then this number can easily increase with the number of errors and the amount of work HSM does daily.



## additional auditing

HSM control data set audits are not the only audits available or that should be done. True, CDS audits ensure that all the data managed by HSM is available and all the chained records within the CDSs are complete and accurate.

There are four audit products available on the market today, all four products do audit the HSM CDSs, at least 2 audit HSM-managed tape and only one product provides audits and reports on the DFSMS constructs.

### AudRMenu

#### DFSMS Auditing Reports:

Report Name	Description
1 Errors Cost Report	Estimated Corruption Costs Report
2 Migration Data sets Audit	Migration Data sets Thrashing Report
3 SMS Volumes Audit	SMS Managed Volumes Threshold Report
4 Storage Groups Audit	Storage Groups Threshold Report
5 Migrate Dsns Need Bkup	Migrate Dsns Needing a Backup Report
6 VSAM Dsns Need Bkup	VSAM Dsns Changed, Not Backed Up Report

## ❖ Explanation of different DFSMS Audits —

- Migration Data sets Audit

- This audit procedure starts the new DFSMS auditing. The migration data sets audit report audits the Migration Control Data set and flags data sets with a high-thrashing rate. The data sets listed in this audit report can help you better tune your DFSMSHsm environment(s).

- SMS Volumes Audit

- This procedure references the DFSMS definitions noting the High-Threshold Limit defined. It then audits all the defined Storage Groups and reports all volumes found above the defined high-threshold limit. This audit report helps you in two ways:
  - Reduce constant resource waste occurring during hourly interval migration.
  - Notify administrators of the possibility of allocation abends due to lack of free space.

- Storage Group Audit

- This performs a similar audit as performed at the volume level, only this audit is at the DFSMS Storage Group level. Like the volume auditing, this audit flags and reports Storage Groups that are above the defined DFSMS definitions. This audit report helps administrators in two ways:
  - Reduce constant resource waste occurring during hourly interval migration.
  - Notify administrators of the possibility of allocation abends due to lack of free space.

- Migrated DSNs Need Backup Audit

- This procedure audits the Migration Control Data set (MCDS) and the Backup Control Data set (BCDS) verifying that every data set in the MCDS has a valid backup in the BCDS. Data sets found migrated in the MCDS without a valid backup copy found in the BCDS are flagged and reported as an audit error. This is a critical audit report for helping administrators:
  - Ensure a valid HSM backup is available for all migrated data.
  - Ensure the ability to recover migrated data due to corruption or human error.
  - Ensure the ability to rebuild lost data due to corruption or human error.
  - Reduce the risk of loss to business revenue due to disaster.



- VSAM Dsns Need Bkup Audit
  - This audit procedure reads each VSAM data set that has migration copies controlled by DFSMSHsm and the backup copy is either obsolete or does not exist. Like the Migrated DSN Audit this is a critical audit report for helping administrators:
    - Ensure a valid HSM backup is available.
    - Ensure the ability to recover data due to corruption or human error.
    - Ensure the ability to rebuild lost data due to corruption or human error.
    - Reduce the risk of loss to business revenue due to disaster.

As you can see, auditing the DFSMSHsm CDSs is not only critical but ensures all HSM-owned and -managed data is accessible, but auditing of the DFSMS environment is also as critical and helpful.

## summary

In this document we have shown and demonstrated some DFSMSHsm best practices. We have shown you examples of some known areas where, with proper HSM management and tuning, you can improve daily HSM resource efficiency.

Aside from the DFSMSHsm best practices, we also provided you with information on DFSMS and DFSMSHsm auditing. We showed you how auditing not only HSM, but SMS too, will help ensure data accessibility and data availability along with reducing resource usage and waste.

We hope this document helps you with understanding your DFSMSHsm and DFSMS environments. Please contact us with any questions or recommended topics you would like to see.

Contact one of our System z storage experts at [mainstar.rocketsoftware.com](http://mainstar.rocketsoftware.com) or send us an email [mainstar@rocketsoftware.com](mailto:mainstar@rocketsoftware.com)



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