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Agenda

- Control Data Sets
- Recall
- Migration
- Audit
- Recycle
- Tape
- Throughput
- Availability
- Performance
- Reporting
- Miscellaneous
To improve overall DFSMShsm performance, access the CDSs using Record Level Sharing (RLS)

Customers report significant performance improvements after switching to RLS

Actual customer data, Bank 1, comparing nonRLS and RLS, with 1 yr elapsed:

<table>
<thead>
<tr>
<th>Function</th>
<th>Increase in GBytes moved</th>
<th>Decrease in Window size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Auto Backup</td>
<td>33%</td>
<td>-25%</td>
</tr>
<tr>
<td>Migrate -&gt; ML2</td>
<td>18%</td>
<td>-36%</td>
</tr>
</tbody>
</table>

Actual customer, Bank 2, AUDIT before and after:
- Before: Couldn’t complete in 24 hrs
- After: Complete within 4 hrs

If you tried RLS and didn’t see an improvement, it is most likely a configuration problem
Control Data Sets

GRS Star

- *Internal* performance testing has shown a significant improvement in CDS I/O intensive functions when using **GRS Star** as opposed to GRS Ring

- **GRS Star** – A parallel sysplex implementation of Global Resource Serialization
  - Resource name list is placed in the coupling facility so that any request for a resource can be resolved with a single interaction

- **GRS Ring** – A resource request must be passed to every participating member of the sysplex (ring)
Control Data Sets
CDS Reorg

• Try to keep Reorganizing the CDSs to a minimum
  ★ V1R12 CA Reclaim

• CDS Performance will be degraded for 2-3 weeks after a REORG
  • VSAM will perform a large number of CI / CA splits to create space for record insertions
  • Don’t panic when HURBA / HARBA ratio increases during first few days

• Use FREESPACE(0 0) so that VSAM can create free space where it is needed

! Make sure all DFSMSShsm hosts in HSMplex are shutdown
  • This is one of the leading causes of breaking the CDSs
  • Use DISP=OLD in REORG job to prevent DFSMSShsm from starting
Control Data Sets

Duplex CDS Backup Copies

- Create disk backup copies in parallel using PIT copy
- Use CB Exit to schedule a DFSMSdss dump job to create multiple copies of the disk backup copies

SETSYS EXITON(CB) CDSVERSIONBACKUP(DASD)
Control Data Sets
Health Checks / Journal Format

• Enable DFSMSHsm Health Checker checks
  • HSM_CDSB_BACKUP_COPIES: Ensures that at least four CDS backup copies are being maintained
  • HSM_CDSB_DASD_BACKUPS: When backing up to disk, ensures that all CDS Backup copies exist
  • HSM_CDSB_VALID_BACKUPS: Determines if the number of valid backup copies has dropped below four

• Allocate the journal as a Large Format Sequential data set if you have to back up the CDSs more than once a day due to the journal filling up
Control Data Sets

CDS Recovery

- Keep journal and disk backups separate from MCDS, BCDS and OCDS
- Minimize CDS Loss
  - Dual Copy / Remote Copy
  - Raid 5 or Raid 6
- Have documented and Tested CDS Recovery Plans
- Review “Data Recovery Scenarios” in DFSMSshsm Storage Administration manual
Recall Prioritization

- **RP Exit** can be used to prioritize data set Recall, Delete and Recover requests
- Priority range 0 – 100
  - Default priority is 50
- All Wait-type requests are prioritized higher than noWait-type requests
- Recall and Delete requests are on the same queue

<table>
<thead>
<tr>
<th>DSN</th>
<th>Priority</th>
</tr>
</thead>
<tbody>
<tr>
<td>CUSTMR.DS1</td>
<td>100</td>
</tr>
<tr>
<td>PROD05.DS1</td>
<td>80</td>
</tr>
<tr>
<td>USERME.DS9</td>
<td>50</td>
</tr>
<tr>
<td>UTIL01.DS2</td>
<td>20</td>
</tr>
<tr>
<td>CLEANUP.DS7</td>
<td>10</td>
</tr>
</tbody>
</table>
Recall
Common Recall Queue

- NonCRQ environment – Each host processes own requests
Recall
Common Recall Queue (cont)

- CRQ - All requests are placed onto a shared queue from which all hosts can select requests for processing
  - Implemented using a Coupling Facility List Structure
Recall

Common Recall Queue (cont)

- Advantages of CRQ
  - Workload balancing
  - Tape mount optimization
  - Quiesce Activity w/o impacting Recall
  - Priority optimization
  - Flexible configurations
  - Request persistence
Recall
Common Recall Queue (cont)

- **Workload balancing**
  - Requests are evenly distributed among hosts until the maximum tasking level has been reached

![Diagram of workload balancing with HSM 1, HSM 2, HSM 3, HSM 4, and CRQ]
Recall

Common Recall Queue (cont)

• Tape Mount Optimization
  • A recall task will process all requests in the CRQ that require the same tape
  ★ Only a single tape mount is required
Recall
Common Recall Queue (cont)

- Quiesce activity in preparation for a shutdown without holding Recall Activity
  - HOLD CQ(RECALL(SELECTION))
  - Places Recalls onto CRQ, but does not process any
Recall

Common Recall Queue (cont)

- Priority Optimization
  - Highest priority requests in the HSMplex are processed first
Recall

Common Recall Queue (cont)

- Flexible Configurations
  - Hosts not connected to tape drives can be configured to only select non-tape requests
Recall

Common Recall Queue (cont)

• Request Persistence
  • Outstanding Recall requests from unavailable hosts are processed by available hosts
Remigrating a data set to tape that was not updated since the Recall…

### Without FSM
1. Migrate
2. Recall for Read *(no change)*
3. Remigrate - Move to a new location
4. Recycle
5. Scratch Tape

### With FSM
1. Migrate
2. Recall for Read *(Keep a pointer to the location on tape)*
3. Remigration - Reconnect to Original Tape
Advantages

- No actual data movement for reconnection
- Recycle workload reduced
- SMS, nonSMS data sets supported
- Reconnection done automatically and is transparent to user

DFSMShsm V1R7 updated this support to no longer rely on Data Set Change Indicator in VTOC to be OFF

```setsys tapemigration(reconnect(\texttt{none} | \texttt{all} | \texttt{ml2direct}))```

- \texttt{ALL} – Reconnect when data is eligible for either ML1 or ML2
- \texttt{ML2DIRECT} – Only reconnect when data is eligible for ML2

```setsys migrationcleanupdays(recalldays statdays reconnectdays)```

- \texttt{reconnectdays} – Number of days to keep records for migrated data sets that are candidates for reconnection
Migration
Duplex Tape Error Handling

**SETSYS DUPLEX(MIGRATION(Y ERRORALTERNATE(CONT | MARKFULL)))**

- For duplexing of migration tapes, both the original and the alternate will be marked full and two new tapes will be mounted

- Ensures that the original and alternate tapes are always identical
  - Greatly reduces the need for Tape Copies
  - No delay in creating the alternate copy
  - Certain abends require a tape copy to be created
Migration
V1R13 On Demand Migration

Interval Migration Today

HSM CPU Spike from SMS Scan and Space Check on all volumes in SMSplex
Migration

V1R13 On Demand Migration

SETSYS ONDEMANDMIGRATION(Y)

No Spike!
• In the Management class, pay attention to “Primary Days Non-usage” and “Level 1 Days Non-usage”
• “Level 1 Days Non-usage” includes time spent on Primary
• Example
  • Primary Days Non-usage = 4
  • Level 1 Days Non-usage = 4

  • This results in data sets being migrated directly to ML2 after 4 days
  • In this case, “Level 1 Days Non-usage” should be ‘8’
Migration
Small Data Set Packing

• The benefits of utilizing Small Data Set Packing
  • More efficient use of ML1 space
    • A migrated data set can take as little of 2K of space in an SDSP
    • As much as 24:1 compaction
  • More efficient migration processing of data to ML1
    • No need to perform a data set allocation, open & close for each migration data set
    • Only performed once for the SDSP
Recent enhancements that make SDSPs more efficient

- **V1R12**
  - CA Reclaim – Reduces the need to re-org SDSPs
- **V1R13**
  - Updated SDSP selection algorithm
    - DFSMShsm now selects SDSPs based on highest freespace
    - Prior release select SDSPs based on ADDVOL order, so certain SDSPs were overused
  - Updated serialization logic
    - SDSPs can now have multiple concurrent ‘readers’
  - Updated location of MM exit invocation
    - MM exit can be used to skip a data set for ML1 -> ML2 processing
    - Exit is now invoked up front, before serialization / queuing of data set
• Do not make significant SMS configuration changes all at one time:
  • Expire after Days Non-usage
  • Expire after Date/Days
  • Level 1 Days Date/Days

• Example
  • You need to decrease Level 1 Days Date/Days from 100 to 70
  • If that change is made all at once, there will be a significant spike in ML1 -> ML2 workload
  • Instead, make the change gradually
    • 100 -> 90
    • 90 -> 80
    • 80 -> 70
Audit Mediacontrols can resume processing of a migration or backup tape if:

- AUDIT MEDCTL of a volume is held
- DFSMShsm is stopped
- SETSYS EMERGENCY has been specified

**RESUME** parameter of AUDIT MEDCTL VOLUMES(*tapevolser*) FIX command

- AUDIT cannot resume after ABENDS or I/O errors

**RESUME** only valid when auditing a tape volume
- Valid only when **FIX** parameter is specified

AUDIT MEDCTL VOLUMES(A00342) RESUME FIX ODS('HSM.FIX')
Recycle
Limiting Workload

• Use the LIMIT parameter to match RECYCLE workload to your scratch tape needs:
  
  • LIMIT(50): Process enough input tapes to return a net gain of 50 scratch tapes
  • Example: Read 60 input, create 10 output

• Use PERCENTVALID(0) to reclaim empty tapes when no drives available
In a VTS environment

- Disk backed by Tape:
  - \texttt{SETSYS PARTIALTAPE} should be \texttt{MARKFULL}
  - \texttt{REUSE}
    - \textit{Causes the complete virtual volume to be staged when DFSMSHsm reuses it}
    - \textit{Perhaps worse yet, it causes a ‘hole’ in the physical tape from which the virtual tape came}
  - \texttt{MARKFULL}
    - \textit{Only used portion of virtual volume de-staged to back-end tape}
    - \textit{Does increase the number of virtual volumes required by DFSMSHsm}

- Disk only:
  - \texttt{SETSYS PARTIALTAPE} should be \texttt{REUSE}
    - \textit{Above issues do not exist}
Volume size considerations

- Using a larger size (4GB)
  - Multiple concurrent Recall requests from same volume are single threaded
    - *Can slow down overall throughput*
    - *Reduces mounts, which is positive when the tape has moved to physical tape*
  - Multitasking RECYCLE may be limited if there are fewer larger tapes to recycle
  - AUDIT and TAPECOPY/TAPEREREPLACE are not multitasked, so no impact
  - Reduce instances of reaching 40 volume limit
Connected Sets

- **Connected Set** - sequence of tape volumes connected by valid spanning data
  - Slows down recall and recycle activity
  - More difficult for tape library ejections
  - Spanning data sets cannot be reconnected during migration

You can minimize the occurrence of connected sets with the judicious use of `SETSYS TAPEUTILIZATION(PERCENTFULL)` and `TAPESPANSIZE` parameters

- **Never** use `TAPEUTILIZATION(NOLIMIT)`
Tape
Connected Sets (cont)

- You can determine if you have connected set by issuing
  `LIST TTOC SELECT(CONNECTED)`

- Periodically use the CHECKFIRST(N) parameter on generic RECYCLE commands if a significant number of
  connected sets that meet the PERCENTVALID criteria are not being recycled

- You can break a connected set by doing the following
  - `LIST TTOC(volser)` to get a list of data sets
  - Delete a spanning backup data set using BDELETE
  - Recall a spanning migrated data set
Collocate migrated data sets for same aggregate together to reduce mounts during ABACKUP.
Fast Replication

HSM function that manages Point-in-Time copies

- Combined with DB2 BACKUP SYSTEM, provides non-disruptive backup and recovery to any point in time for DB2 databases and subsystems (SAP)

★ Recovery at all levels from either disk or tape!

- Entire copy pool, individual volumes and …
- Individual data sets

☆ Fast Replication
Fast Replication
DFSMShsm Advantages

- New Source Volumes always included in backup
- Copy Pool Backup Storage Group disallows allocations on target volumes
- Managed creation/expiration of tape copies
- DFSMShsm ensures valid tape copies
- Data set level recovery from physical backup copies
- Catalog capture during FlashCopy enables deleted data sets to be recovered
- Managed retry of failed volume recoveries
Fast Replication Data Integrity

Scenario: FlashCopy Relationship is Withdrawn

- **Time 1**
  - Initiate FC

- **Time 2**
  - Start Dump

- **Time 3**
  - Withdraw Relationship

Tape is corrupt. Data copied after the withdraw is residual.

*DFSMShsm prevents this!*

*(When Withdraw done with DFSMShsm)*
In general, there is a performance ‘knee’ for DFSMShsm functions, i.e. – the average throughput decreases per task after a certain number of tasks have been started:

- The knee for most functions is at 7-8 tasks
- For Fast Replication the knee is at 24 of the possible 64 tasks
- Contention for the SYSZTIOT can be one cause
Multiple Address Space HSM (MASH)
- Each LPAR can have multiple active DFSMSHsm address spaces
- Up to 39 active DFSMSHsms in an HSMplex
  - HSMplex – All DFSMSHsms’s sharing the same control data sets

Potential benefits of spreading out the DFSMSHsm workload to more hosts
- Maintain tasks at optimal level
- Increase overall tasking level
- Hosts can be assigned different WLM Velocity Goals
- Recall hosts via Common Recall Queue
  - Start hosts just to process Recall requests during high recall activity
- Reduces SYSZTIOT contention for disk/tape allocations
- Increased availability
Throughput
MASH (cont)
In an HSMplex, **Secondary Host Promotion** enables secondary DFSMShsm hosts to take over the *unique* functions being performed by a disabled Primary and/or Secondary Space Management DFSMShsm host.

A Primary DFSMShsm host is the only host in an HSMplex that performs:

- Hourly space checks
- Automatic CDS backup
- Automatic movement of backup versions from ML1 to tape
- Automatic backup of migrated data sets
- Expiration of dump copies
- Deletion of excess dump VTOC copy data sets

There is generally only a single DFSMShsm host that performs SSM.

Without SHP, when either the Primary or SSM host is disabled, the above functions are not performed.
Availability
Secondary Host Promotion (cont)

HSMplex

HSM 1
Primary=Y
Promote=N

HSM 2
Primary=N
Promote=Y

HSM 3
Primary=N
Promote=Y

Control Data Sets

MCDS
BCDS
OCDS
Journal
Availability
Secondary Host Promotion (cont)

DFSMShsm host must be on a system within a HSMplex that has XCF active and configured in multisystem mode

• SETSYS PLEXNAME(HSMplex_name_suffix)
  • Default: ARCPLEX0
  • Must be specified if more than one HSMplex within a sysplex. Must be specified on all hosts in that HSMplex.
  • Must be specified in ARCCMDxx member

• SETSYS PROMOTE(PRIMARYHOST(Y|N) SSM(Y|N))
  • Default: No
  • PRIMARYHOST(Y) is ignored for Primary host
  • A SSM host cannot be promoted for another SSM host. ARC1521I issued if SSM(Y) specified on a SSM host
Performance

SMF Consolidation Processing

• Specifying **DDCONS(NO)** on SMF parameters to avoid DD name consolidation during DFSMShsm shutdown
  • DFSMShsm shutdown has been reported to take up 45 minutes due to DD consolidation
  • DDCONS is specified in SMFPRMnn parmlib member
  • See *MVS Initialization and Tuning Reference* for more information

• Pros of DDCONS(NO):
  • Faster HSM shutdown
  • Less likelyhood of periodic slowdowns

• Cons of DDCONS(NO):
  • Lots more SMF type 30 records
  • Higher SMF filling/swapping rates
Performance
Avoid LOG Overhead

• Use **HOLD LOG** to avoid DFSMSHsm logging overhead
  • Command can be added to PARMLIB
• Turns off writing to the LOGX/LOGY data sets
• Information available elsewhere, such as FSR records in SMF, Activity Logs, PDA trace data
• Reduces DFSMSHsm overhead activity

✓ **Some ISV products require the LOGX/LOGY data sets as input**
DFSMSHsm Reporting Generator

Generate reports of DFSMSHsm **functions** and **inventory** using DFSMSrmm Report Generator

- DFSMSrmm Report Generator is an easy-to-use ISPF application
  - Create and customize reports specific to your needs
  - *Available without a DFSMSrmm license*
    - Option on ISMF panel to create ‘Storage Management’ reports
    - Sample Reports shipped in SYS1.SAMPLIB

**DFSMSHsm reporting based on**

- DFSMSHsm Function Statistics Record (FSR)
- DFSMSHsm ABACKUP/ARECOVER Function Statistics Record (WWFSR)
- DFSMSHsm Inventory (control data set) data via DCOLLECT
Migration Age of **zero** when data set is recalled

<table>
<thead>
<tr>
<th>DSN</th>
<th>AGE</th>
<th>SIZE KB</th>
<th>MC NAME</th>
</tr>
</thead>
<tbody>
<tr>
<td>HSMATH0.SMS.VBGPS1</td>
<td>0000</td>
<td>36830</td>
<td>MCLASS1</td>
</tr>
<tr>
<td>HSMATH0.SMS.VSMALNA</td>
<td>0000</td>
<td>159</td>
<td>MCLASS1</td>
</tr>
<tr>
<td>HSMATH0.SMS.VSMALNB</td>
<td>0000</td>
<td>159</td>
<td>MCLASS1</td>
</tr>
<tr>
<td>HSMATH0.SMS.VSMALNC</td>
<td>0000</td>
<td>159</td>
<td>MCLASS1</td>
</tr>
<tr>
<td>HSMATH0.SMS.VSMALND</td>
<td>0000</td>
<td>159</td>
<td>MCLASS1</td>
</tr>
<tr>
<td>HSMATH0.SMS.VSMALNE</td>
<td>0000</td>
<td>159</td>
<td>MCLASS1</td>
</tr>
<tr>
<td>HSMATH0.SMS.VSMALNF</td>
<td>0000</td>
<td>159</td>
<td>MCLASS1</td>
</tr>
<tr>
<td>HSMATH0.SMS.VSMALNG</td>
<td>0000</td>
<td>159</td>
<td>MCLASS1</td>
</tr>
<tr>
<td>HSMATH0.SMS.VSMALNH</td>
<td>0000</td>
<td>159</td>
<td>MCLASS1</td>
</tr>
<tr>
<td>HSMATH0.SMS.VSMALNI</td>
<td>0000</td>
<td>159</td>
<td>MCLASS1</td>
</tr>
<tr>
<td>HSMATH0.SMS1.PS.TEST0</td>
<td>0000</td>
<td>3</td>
<td>MCLASS1</td>
</tr>
<tr>
<td>HSMATH0.SMS1.PS.TEST1</td>
<td>0000</td>
<td>3</td>
<td>MCLASS1</td>
</tr>
<tr>
<td>HSMATH0.SMS2.PS.TEST2</td>
<td>0000</td>
<td>3</td>
<td>MCLASS1</td>
</tr>
</tbody>
</table>

Other fields included in the sample report:
- Date; Elapsed time
- Target volume
- Return Code / Reason Code
FSRSTAT is a REXX sample program that reads DFSMSShsm FSR records, and generates a statistical summary report.

- Shipped with DFSMSShsm
  - SYS1.SAMPLIB(ARCTOOLS)
- Since it is written in REXX:
  - Does not require any special programs or languages (SAS, MICS, etc.)
  - It can be easily modified and customized to meet your needs
  - It can be slow, consider running in batch using PGM=IKJEFT01
  - Requires input data to be converted to RECFM=VB format
### DFSMShsm Reporting

**FSRSTAT**

#### FSR records by Size (KB)

<table>
<thead>
<tr>
<th>Size</th>
<th>Records</th>
<th>KB</th>
<th>Percent</th>
<th>Cumulative Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-&gt; 49</td>
<td>49</td>
<td>84320</td>
<td>45.9%</td>
<td>45.9%</td>
</tr>
<tr>
<td>50-&gt; 149</td>
<td>149</td>
<td>16568</td>
<td>9.0%</td>
<td>54.9%</td>
</tr>
<tr>
<td>150-&gt; 749</td>
<td>749</td>
<td>26290</td>
<td>14.3%</td>
<td>69.2%</td>
</tr>
<tr>
<td>750-&gt; 29MB</td>
<td>2958</td>
<td>43066</td>
<td>23.4%</td>
<td>92.7%</td>
</tr>
<tr>
<td>30MB -&gt; 7GB</td>
<td>7313</td>
<td>13464</td>
<td>7.3%</td>
<td>100.0%</td>
</tr>
</tbody>
</table>

**Average** 12343.72 KB

- **Nearly half!**

#### By rate (KB/sec)

<table>
<thead>
<tr>
<th>Rate</th>
<th>Records</th>
<th>KB</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-&gt; 499</td>
<td>499</td>
<td>137052</td>
<td>74.6%</td>
</tr>
<tr>
<td>500-&gt; 999</td>
<td>999</td>
<td>10318</td>
<td>5.6%</td>
</tr>
<tr>
<td>1000-&gt; 1499</td>
<td>1499</td>
<td>6073</td>
<td>3.3%</td>
</tr>
<tr>
<td>1500-&gt; 1999</td>
<td>1999</td>
<td>4550</td>
<td>2.5%</td>
</tr>
<tr>
<td>2000-&gt; 2499</td>
<td>2499</td>
<td>6443</td>
<td>3.5%</td>
</tr>
<tr>
<td>2500-&gt; 2999</td>
<td>2999</td>
<td>3219</td>
<td>1.8%</td>
</tr>
<tr>
<td>3000-&gt; 9999</td>
<td>9999</td>
<td>16053</td>
<td>8.7%</td>
</tr>
</tbody>
</table>

**Average** 808.55 KB/sec

- **Smaller Data Sets**
- **Larger Data Sets**

**Misleading**
• Penalize a user who continuously Recalls hundreds/thousands of data sets on a frequent basis by periodically moving all their requests to the bottom of the queues:

ALTERPRI USERID(anyuser) LOW
2.1111 "z/OS V1R12.0 MVS System Messages, Vol 2 (ARC-ASA)" IBM Library Server - Mozilla Firefox: IBM Edition

2.1111 ARC1846E

ARC1846E (AUTO DUMP | FAST REPLICATION BACKUP DUMP | FAST REPLICATION BACKUP DUMPONLY | *****) HAS FAILED FOR {COPY POOL cpname | *****}, RC=retcode

Explanation: Automatic Dump, Fast Replication Backup Dump, or FAST REPLICATION Backup DUMPONLY for copy pool cpname ended before normal completion of the operation. The reason for an early end is explained as determined by the retcode. (If ***** appears in the message, see the previous message to determine the command type and copy pool name.)

Retcode Meaning

2

The specified backup copy was already successfully dumped.

Done

http://www-03.ibm.com/systems/z/os/zos/bkserv/lookat/lookatalerts.html
Summary

- Improve performance
- Work smarter
- Exploit new functions
- Exploit technology