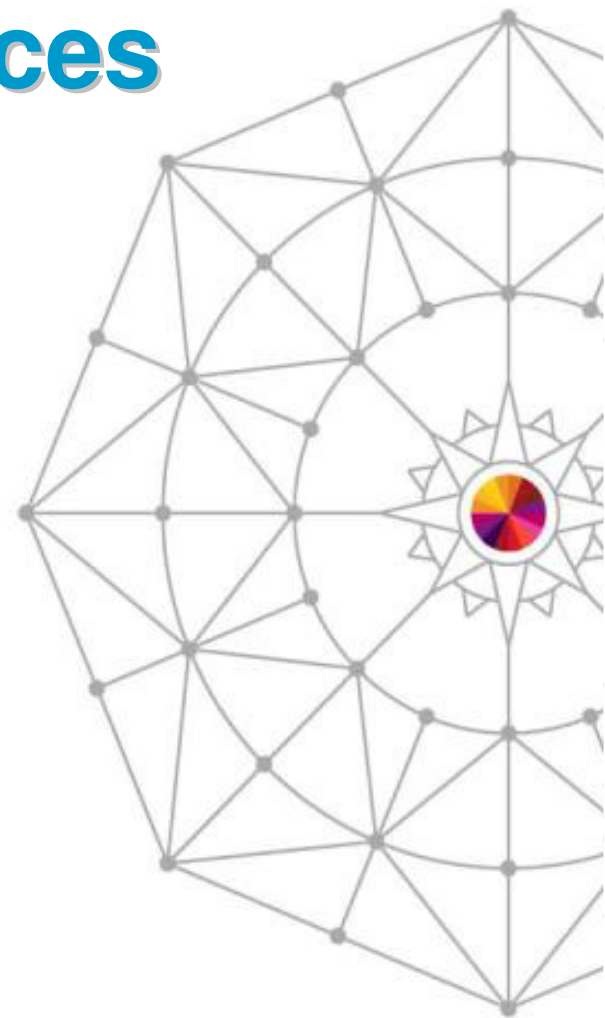


DFSMSHsm Best Practices

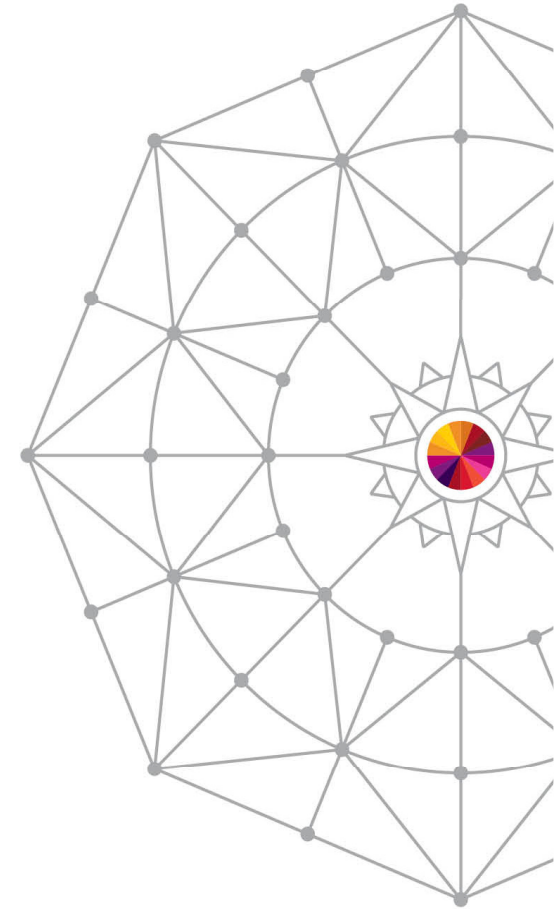
Glenn Wilcock
IBM

March 12, 2014
Session 15075



Agenda

- Control Data Sets
- Recall
- Migration
- Audit
- Recycle
- Tape
- Throughput
- Availability
- Performance
- Reporting
- Miscellaneous



Control Data Sets

Record Level Sharing

- 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:

Function	Increase in GBytes moved	Decrease in Window size
Auto Backup	33%	-25%
Migrate -> ML2	18%	-36%

- 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

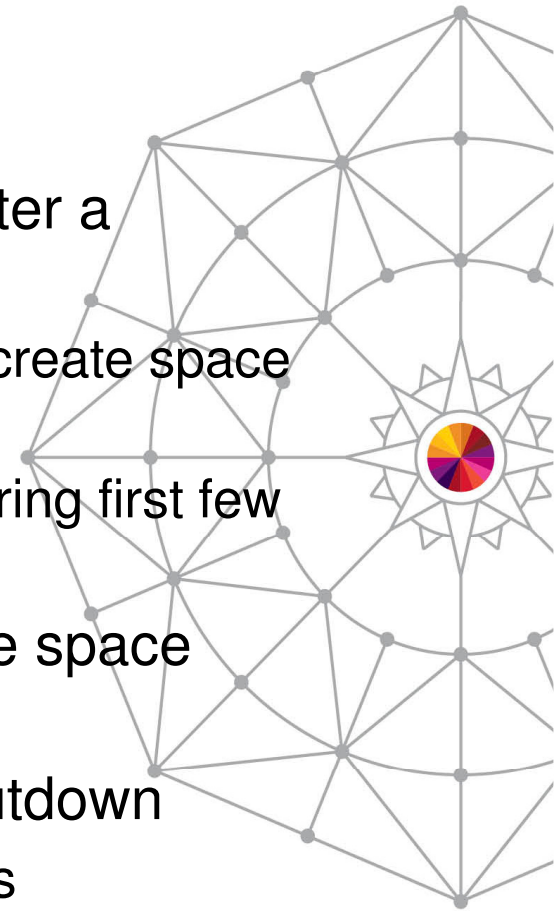
- *Internal* performance testing has shown a significant improvement in CDS I/O intensive functions when using **GRS Star** as opposed to **GRS Ring**
 - **GRS Star** – A parallel sysplex implementation of Global Resource Serialization
 - Resource name list is placed in the coupling facility so that 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

- 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 DFSMSHsm hosts in HSMplex are shutdown
 - This is one of the leading causes of breaking the CDSs
 - Use DISP=OLD in REORG job to prevent DFSMSHsm from starting

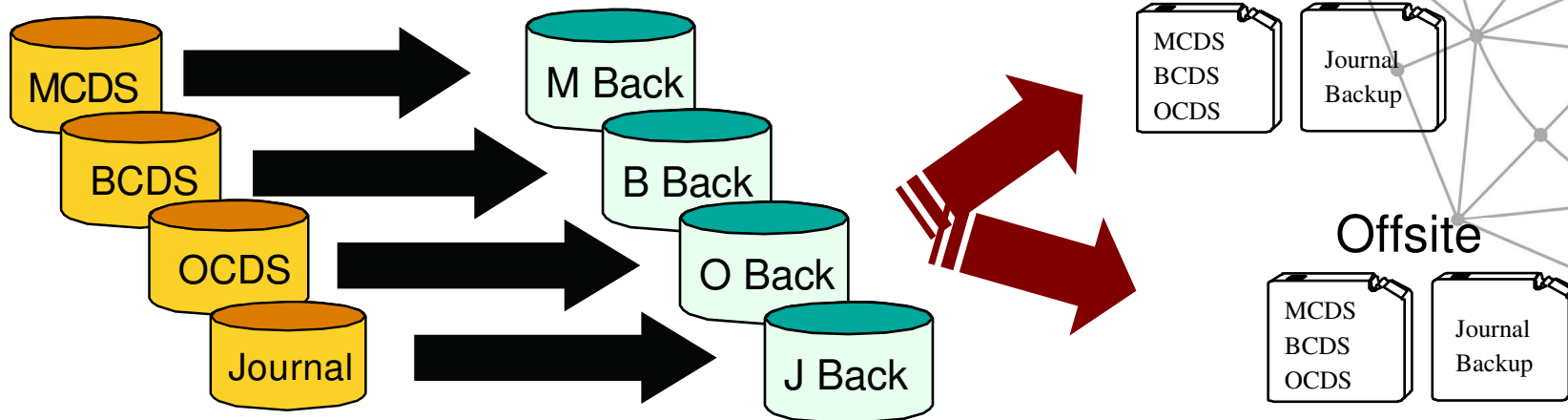


Control Data Sets

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

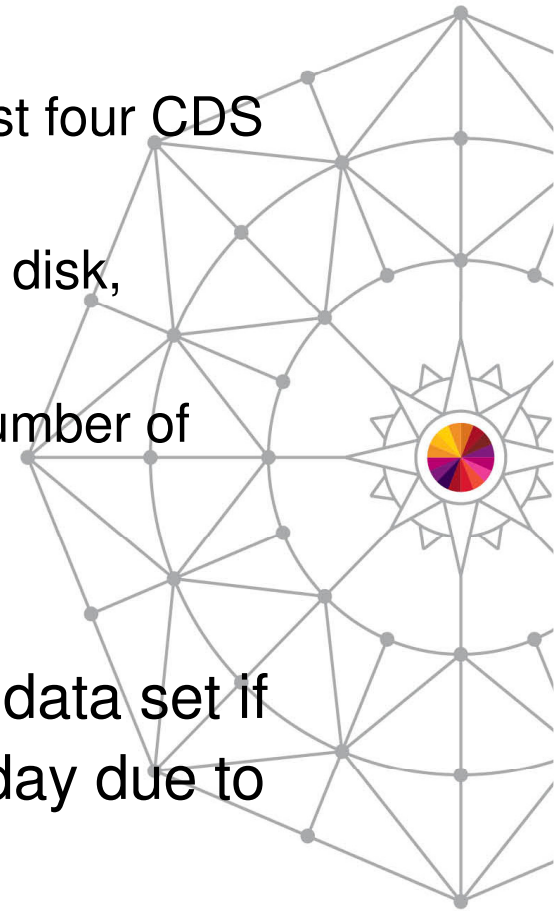
SETSYS EXITON(CB) CDSVERSIONBACKUP(DASD)



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

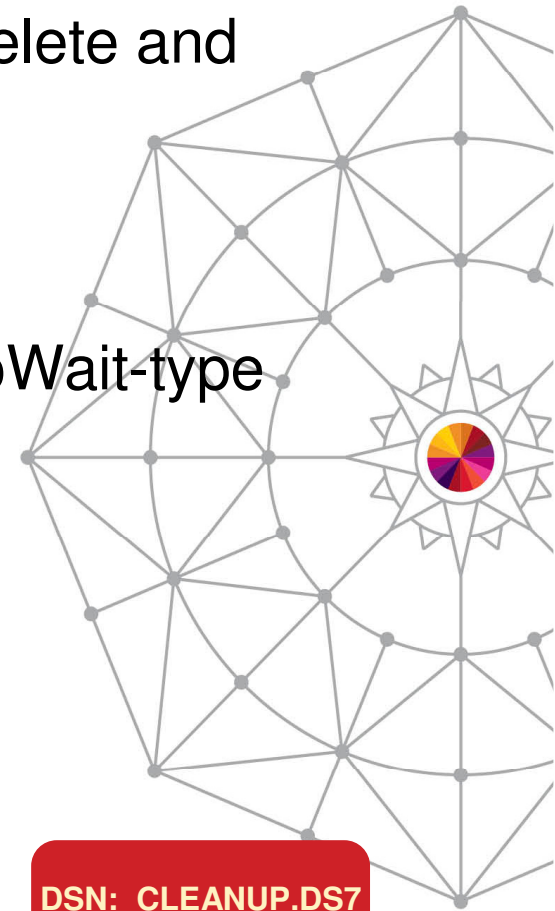
CDS Recovery

- Keep journal and disk backups separate from MCDS, BCDS and OCDS
- Minimize CDS Loss
 - Mirror
 - Highly reliable disk
- Have documented and Tested CDS Recovery Plans
- Review “Data Recovery Scenarios” in *DFSMSHsm 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



DSN: CUSTMR.DS1
Priority: 100

DSN: PROD05.DS1
Priority: 80

DSN: USERME.DS9
Priority: 50

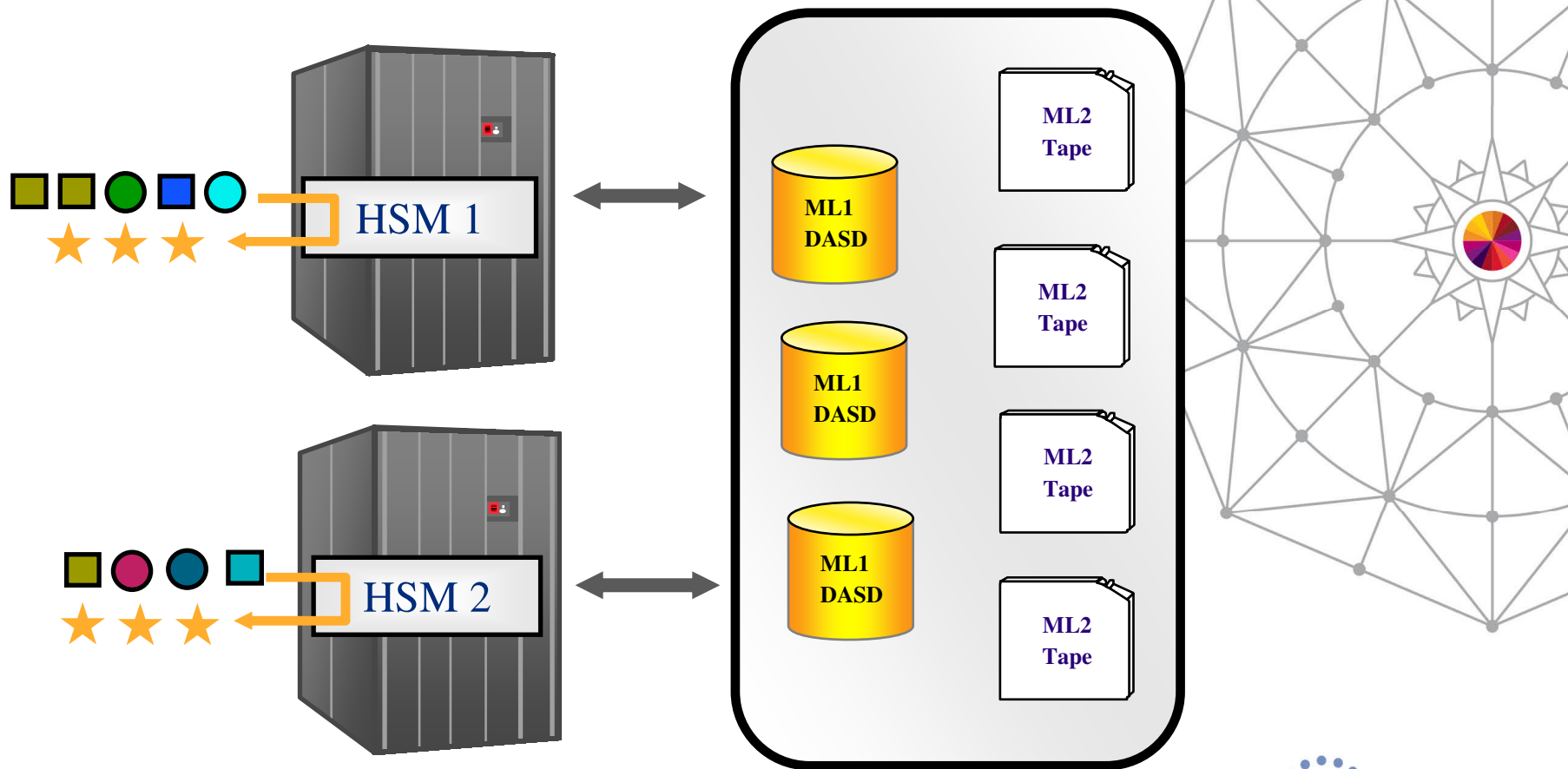
DSN: UTIL01.DS2
Priority: 20

DSN: CLEANUP.DS7
Priority: 10

Recall

Common Recall Queue

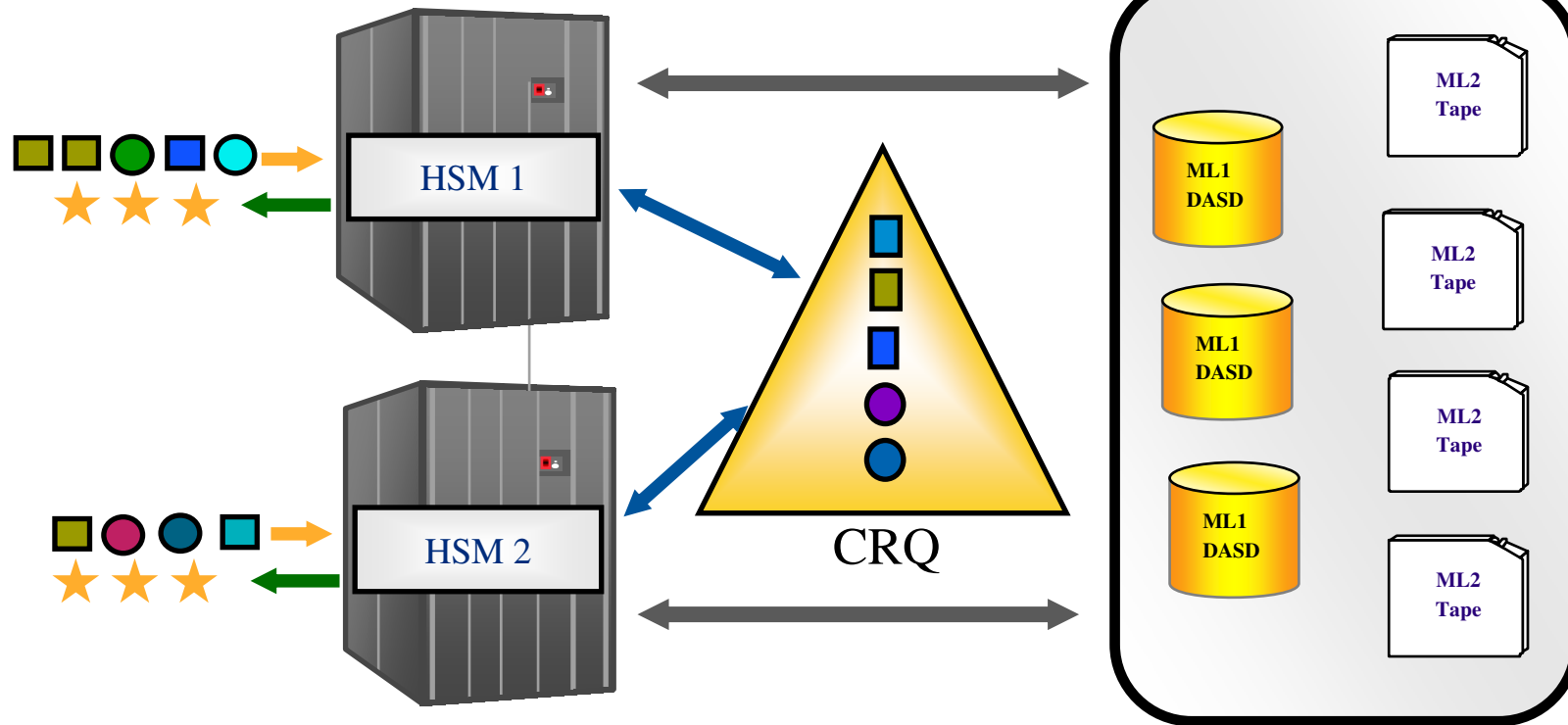
- NonCRQ environment – Each host processes own requests



Recall

Common Recall Queue (cont)

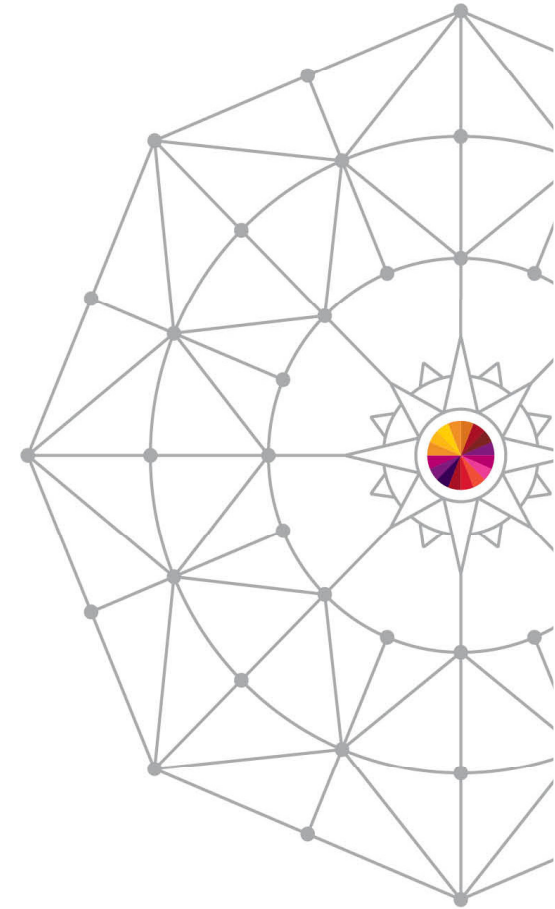
- CRQ - All requests are placed onto a shared queue from which all hosts can select requests for processing
 - Implemented using a Coupling Facility List Structure



Recall

Common Recall Queue *(cont)*

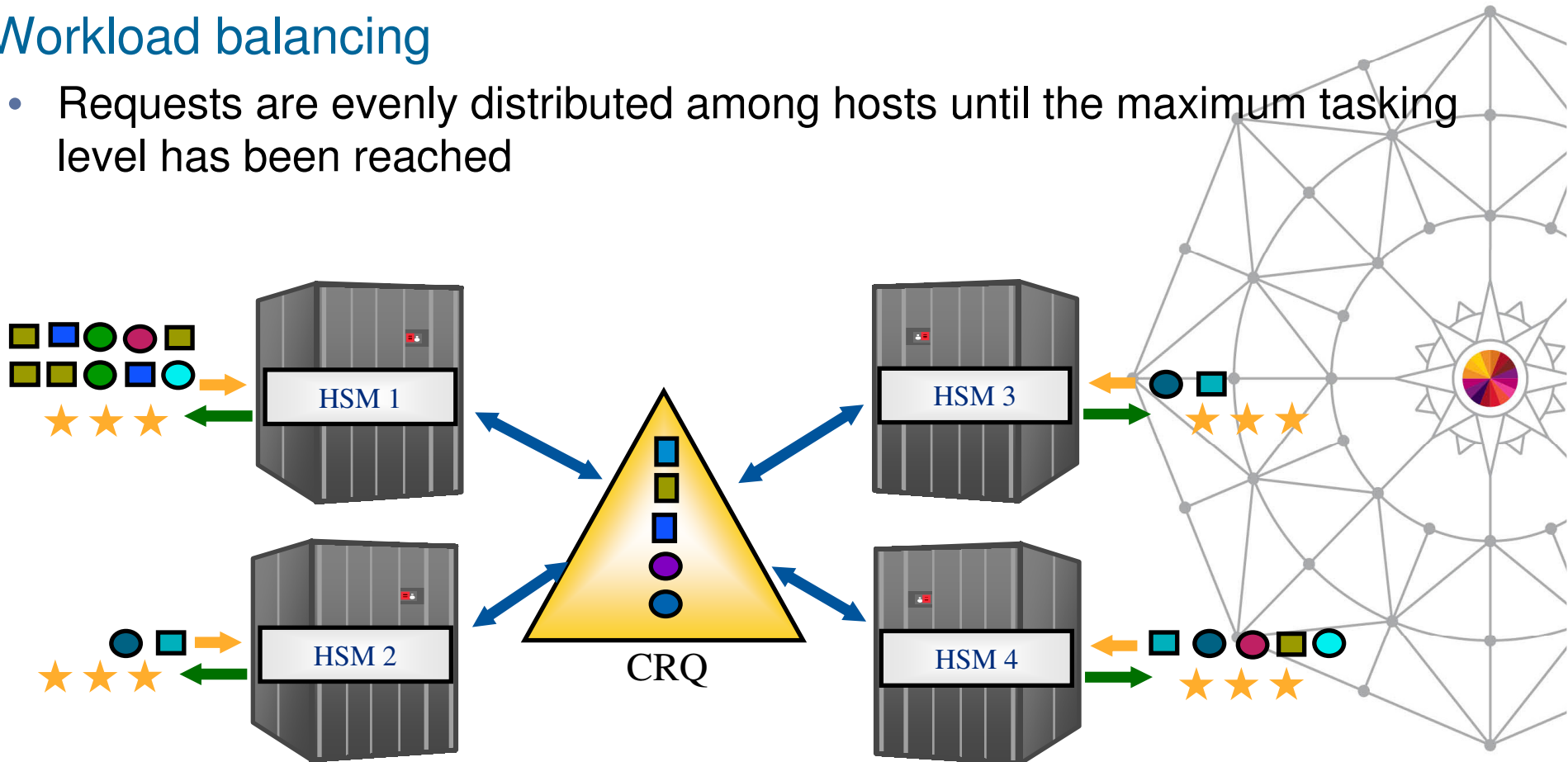
- **Advantages of CRQ**
 - Workload balancing
 - Tape mount optimization
 - Quiesce Activity w/o impacting Recall
 - Priority optimization
 - Flexible configurations
 - Request persistence



Recall

Common Recall Queue (cont)

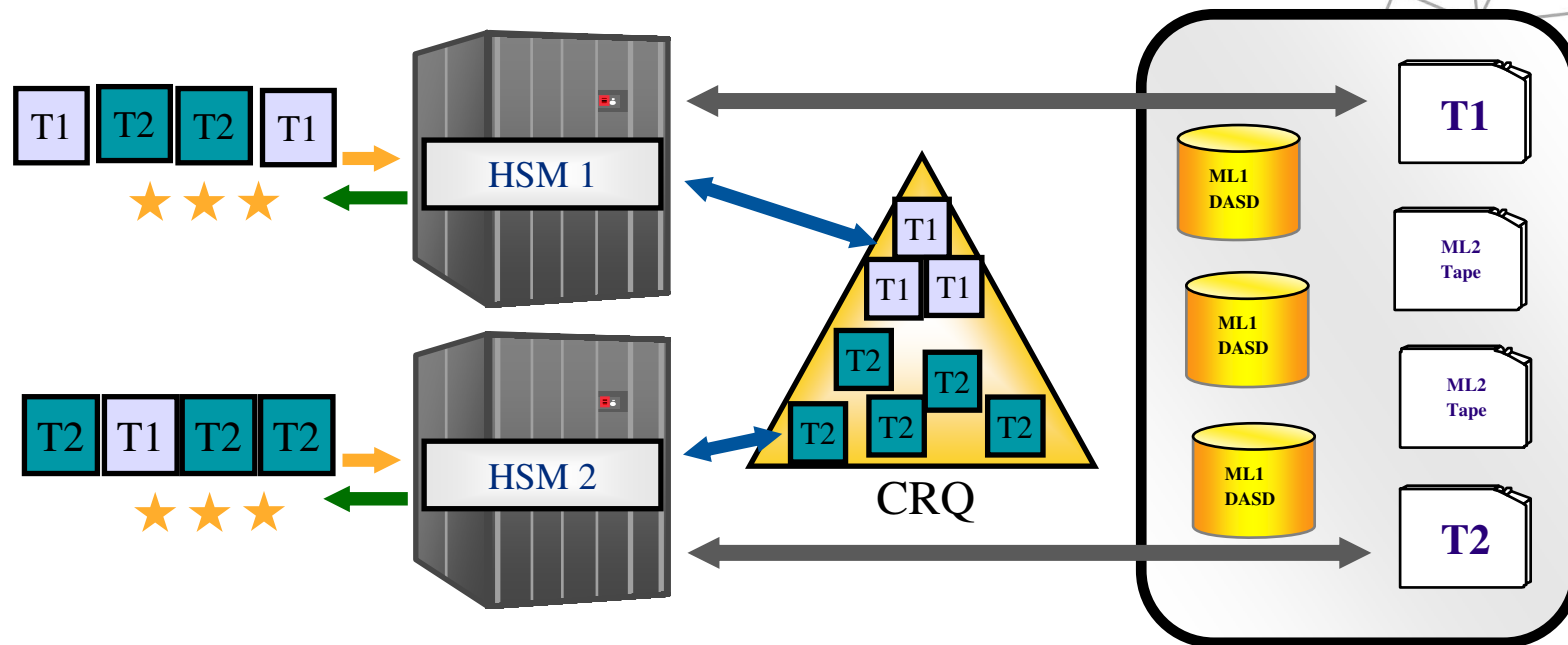
- Workload balancing
 - Requests are evenly distributed among hosts until the maximum tasking level has been reached



Recall

Common Recall Queue (cont)

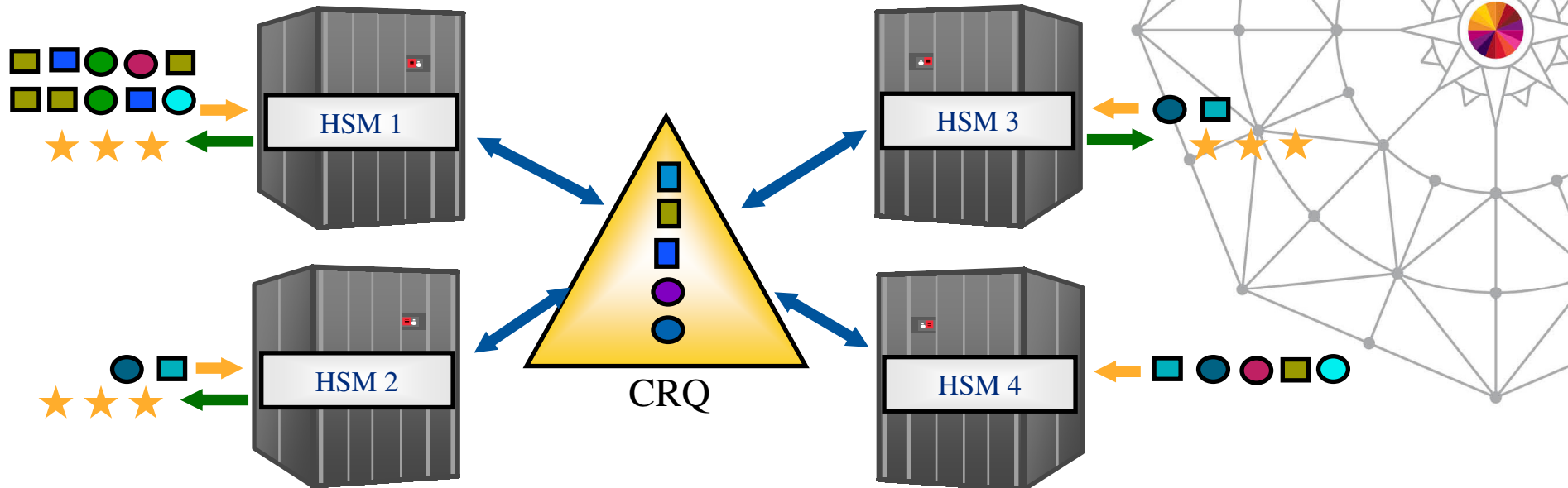
- Tape Mount Optimization
 - A recall task will process all requests in the CRQ that require the same tape
 - ★ Only a single tape mount is required



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

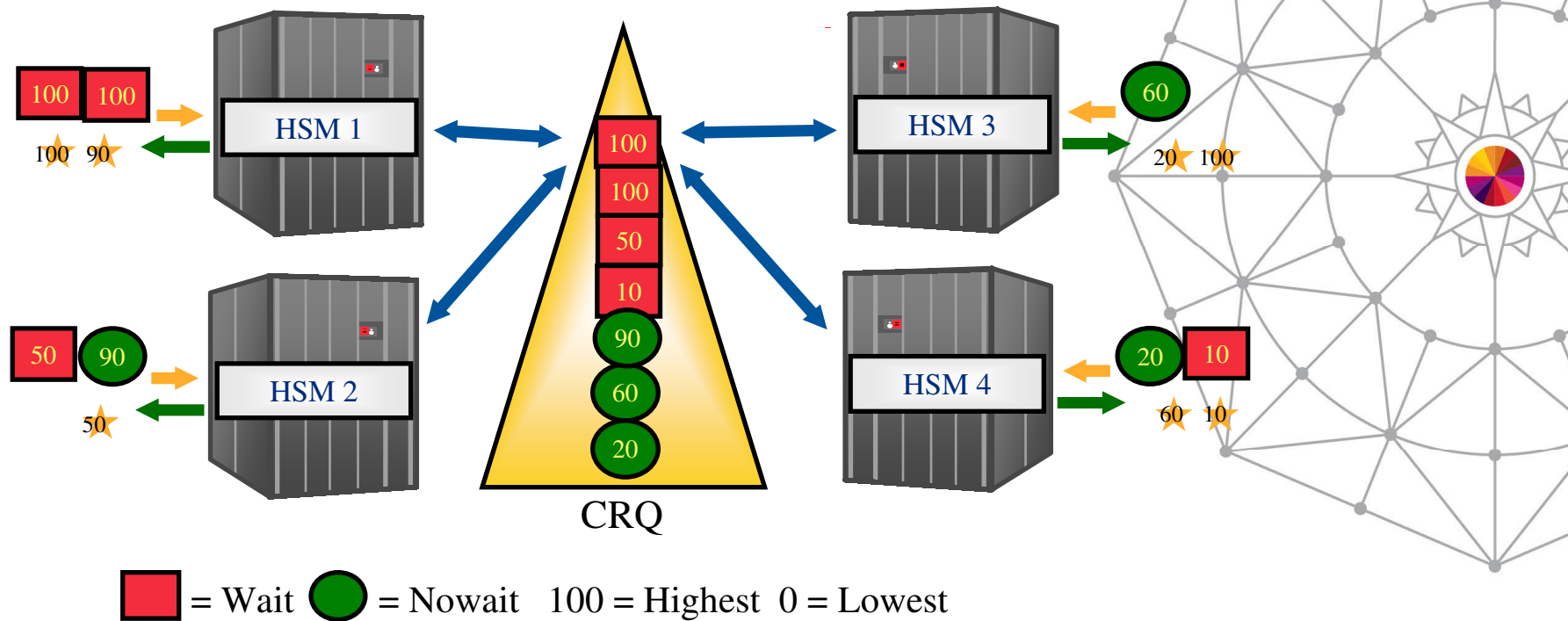


HOLD CQ(RECALL(SELECTION))

Recall

Common Recall Queue (cont)

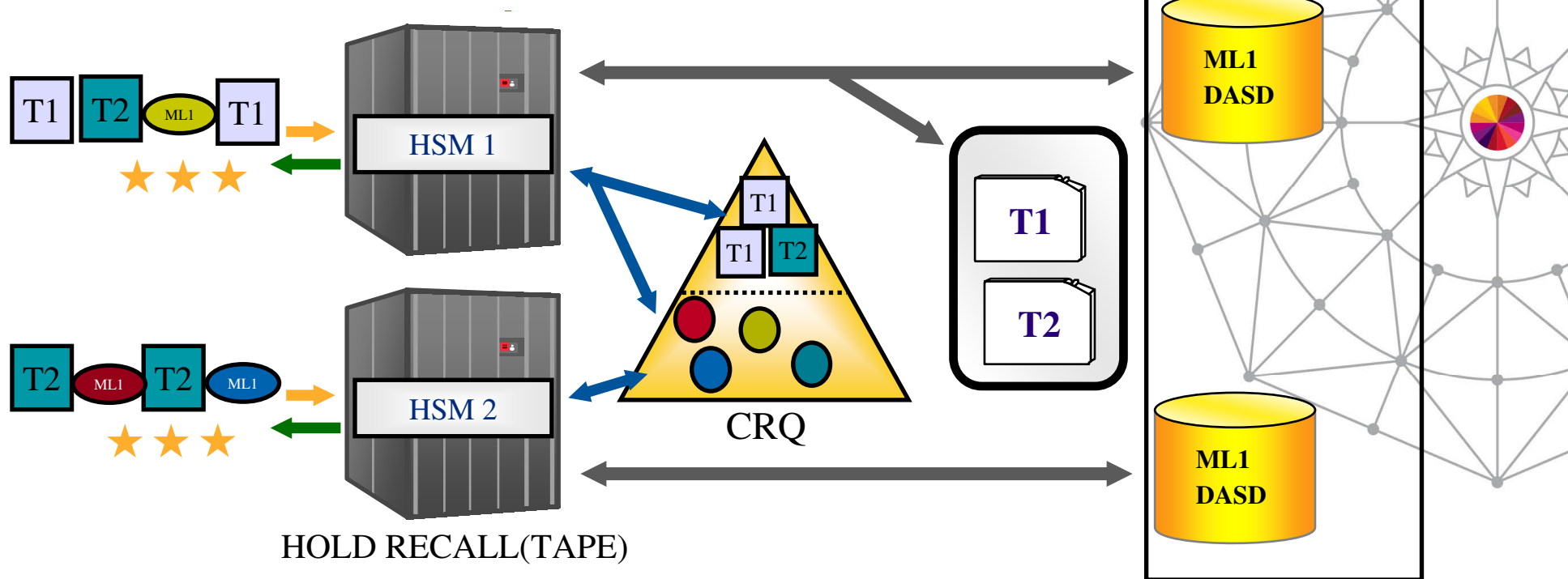
- Priority Optimization
 - Highest priority requests in the HSMplex are processed first



Recall

Common Recall Queue (cont)

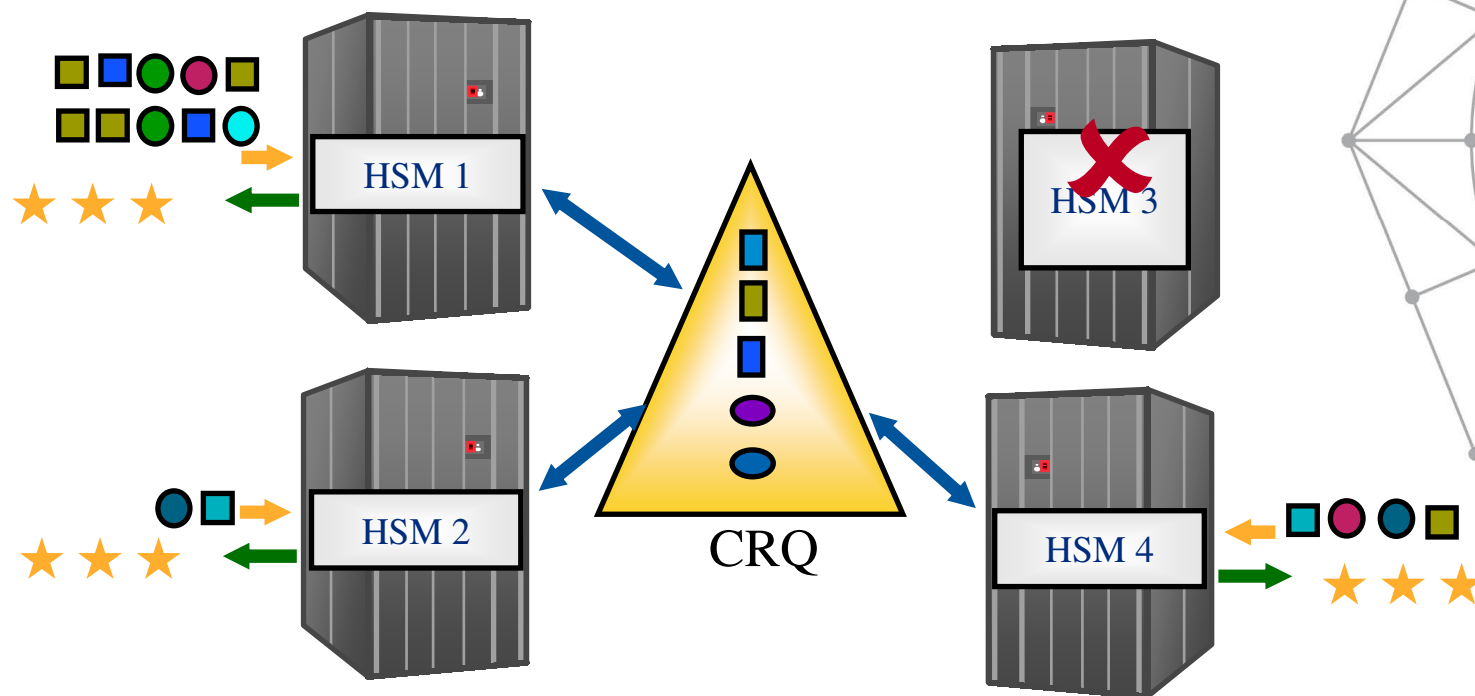
- Flexible Configurations
 - Hosts not connected to tape drives can be configured to only select non-tape requests



Recall

Common Recall Queue (cont)

- Request Persistence
 - Outstanding Recall requests from unavailable hosts are processed by available hosts

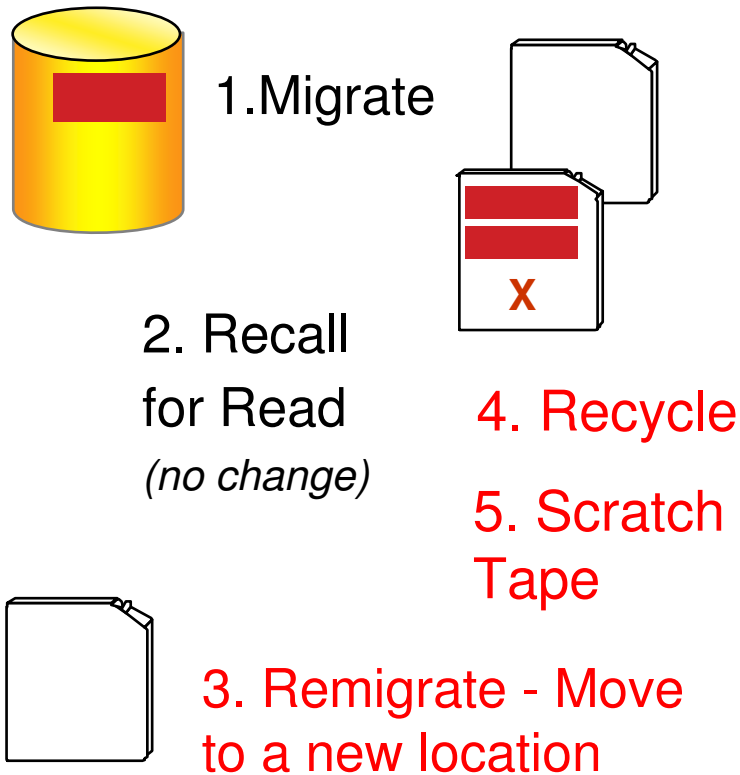


Migration

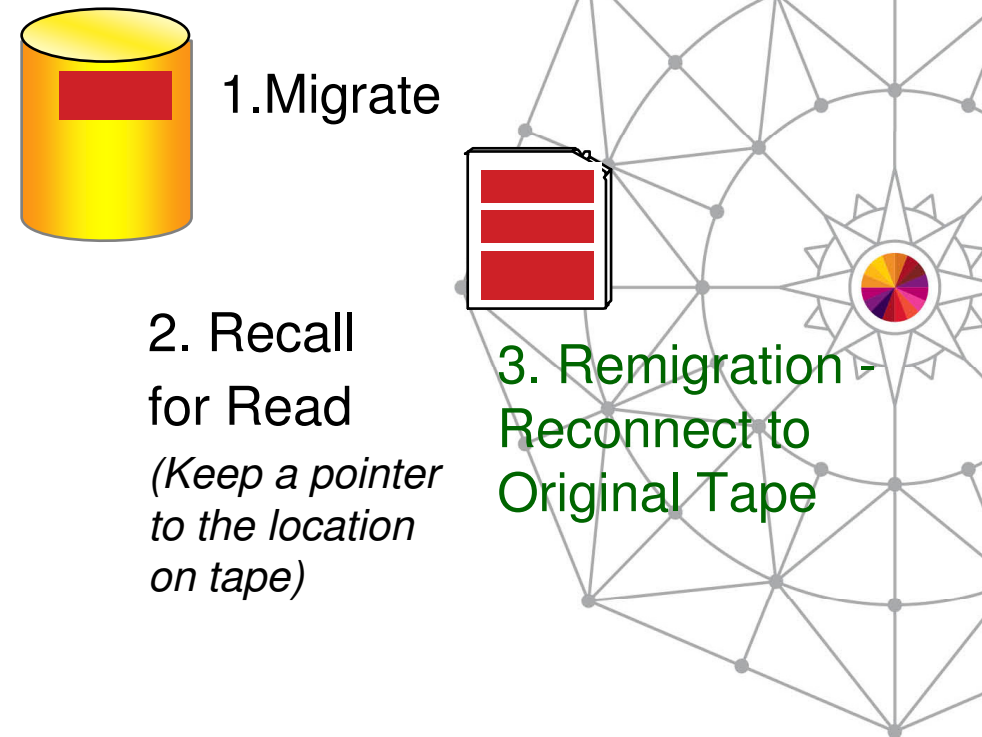
Fast Subsequent Migration

Remigrating a data set to tape that was not updated since the Recall...

Without FSM



With FSM



Migration

Fast Subsequent Migration *(cont)*

★ Advantages

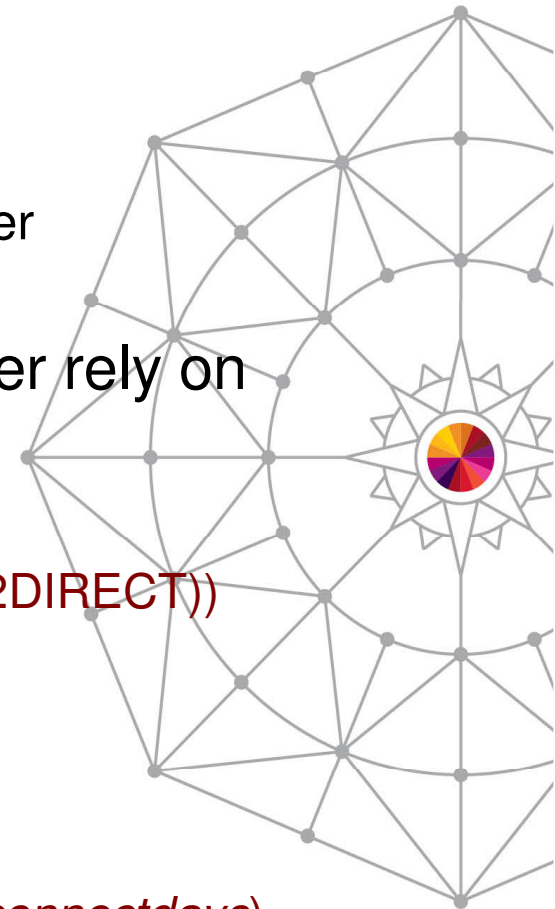
- No actual data movement for reconnection
 - Recycle work load reduced
 - SMS, nonSMS data sets supported
 - Reconnection done automatically and is transparent to user
- DFSMSHsm V1R7 updated this support to no longer rely on Data Set Change Indicator in VTOC to be OFF

SETSYS TAPEMIGRATION(RECONNECT(**NONE** | ALL | ML2DIRECT))

- **ALL** – Reconnect when data is eligible for either ML1 or ML2
- **ML2DIRECT** – Only reconnect when data is eligible for ML2

SETSYS MIGRATIONCLEANUPDAYS(*recalldays statdays reconnectdays*)

- *reconnectdays* – Number of days to keep records for migrated data sets that are candidates for reconnection

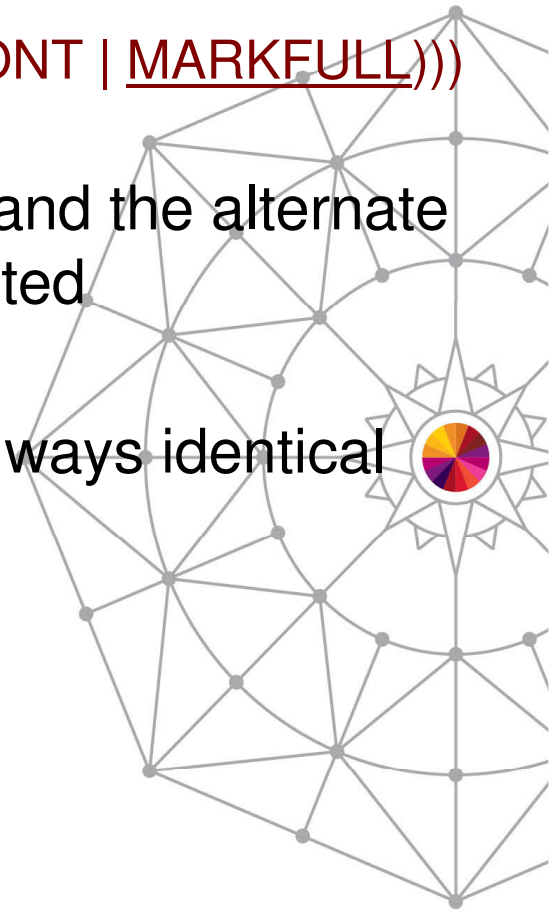


Migration

Duplex Tape Error Handling

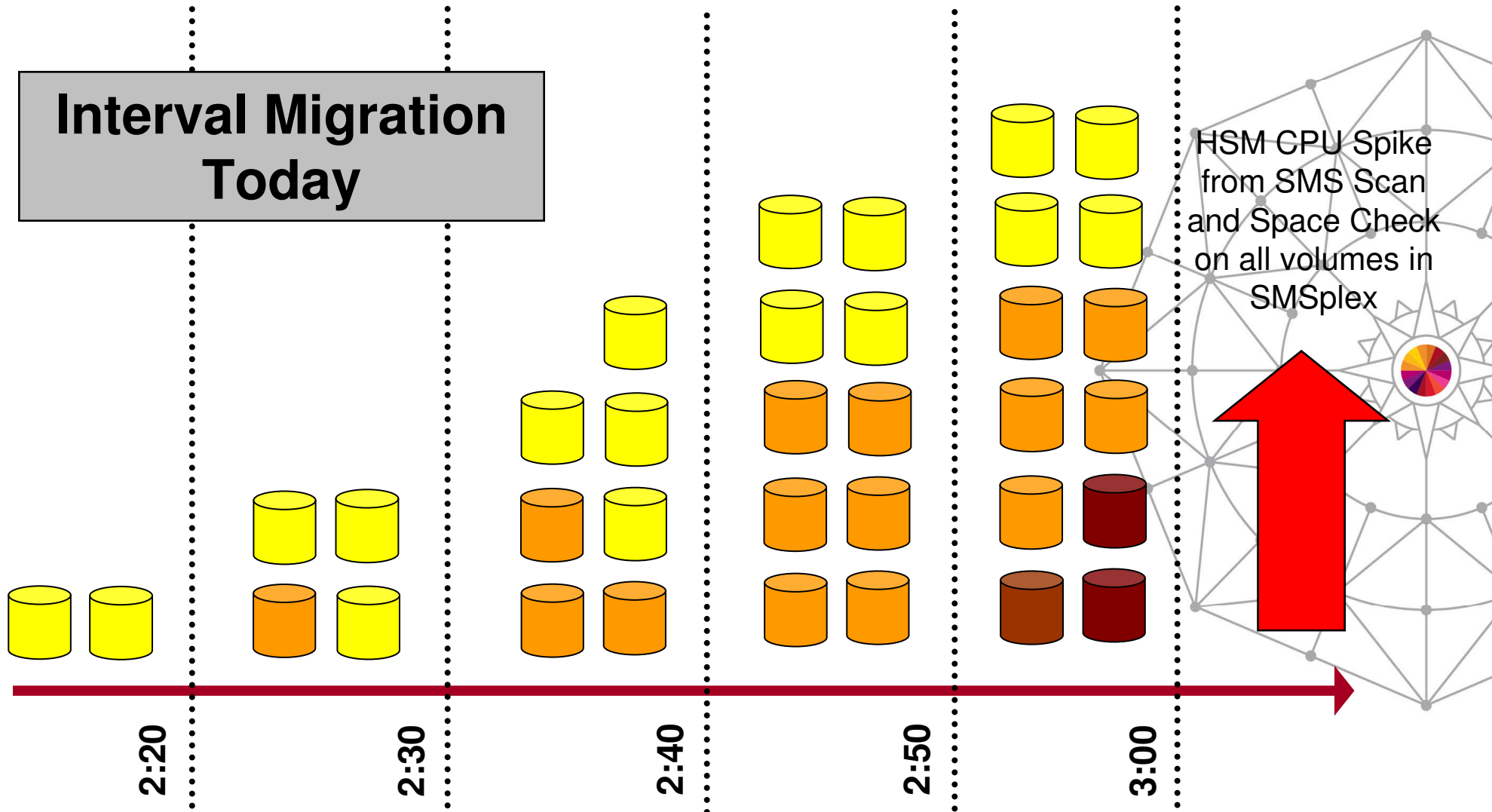
```
SETSYS DUPLEX(MIGRATION(Y ERRORALTERNATE(CONT | MARKFULL)))
```

- 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



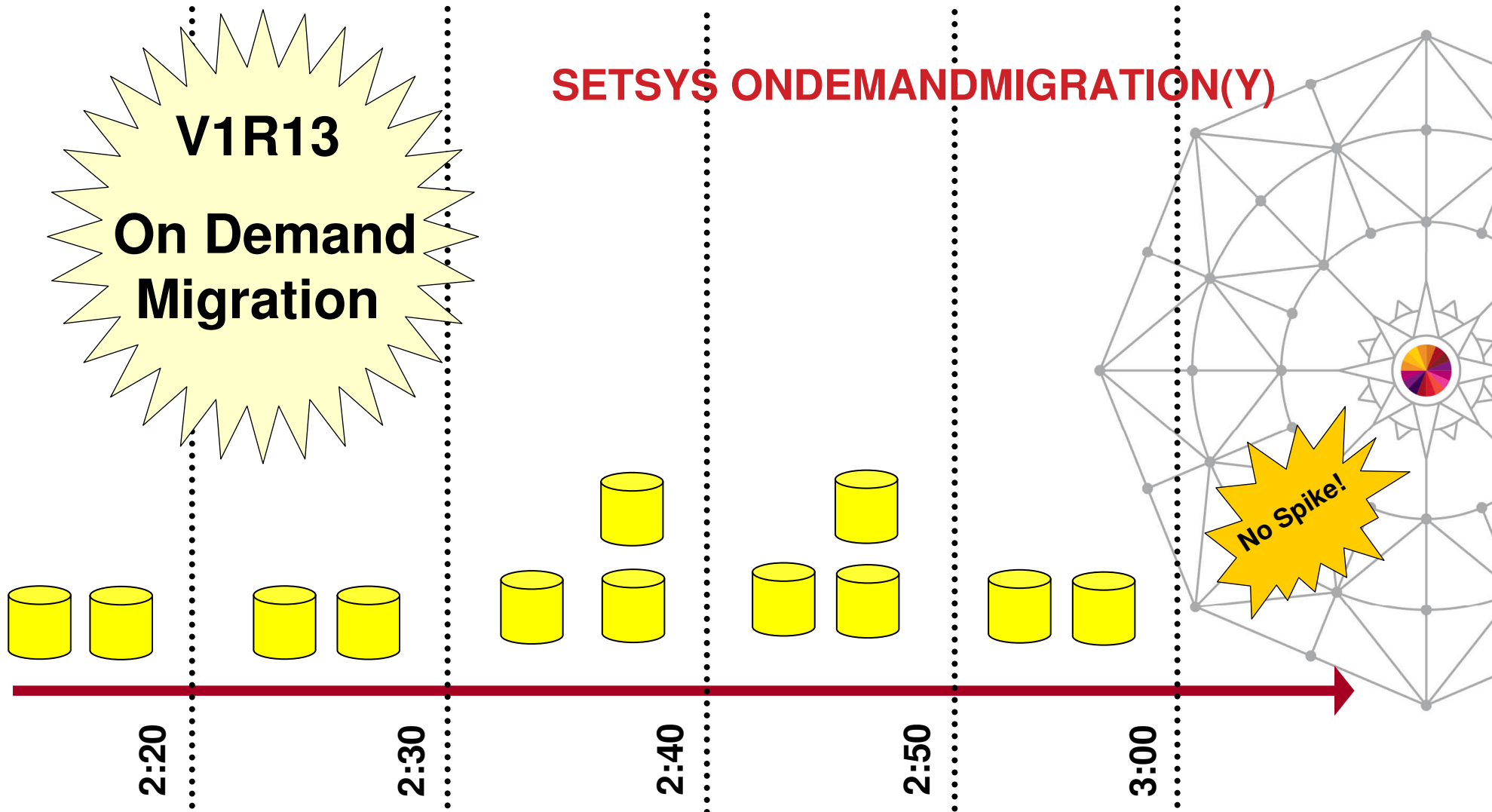
Migration

V1R13 On Demand Migration



Migration

V1R13 On Demand Migration



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



Migration

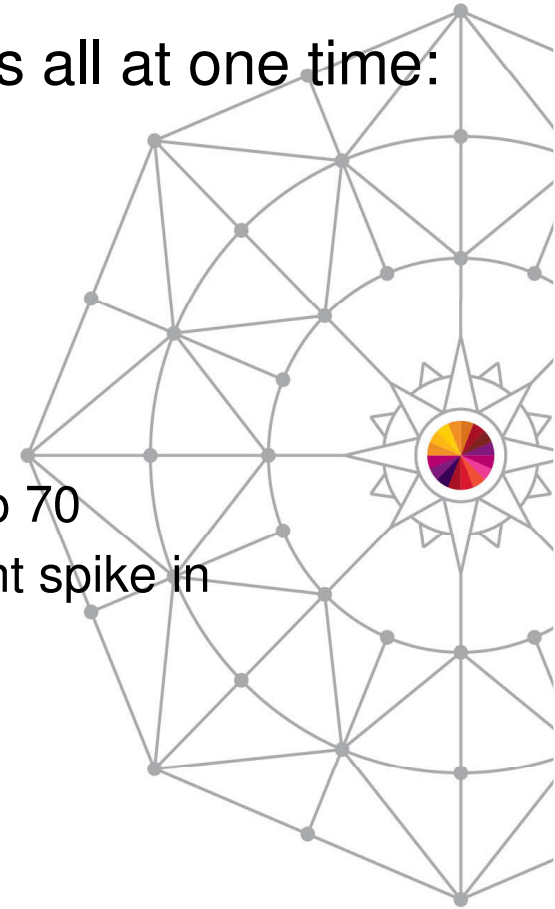
Small Data Set Packing

- 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



Migration General

- 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



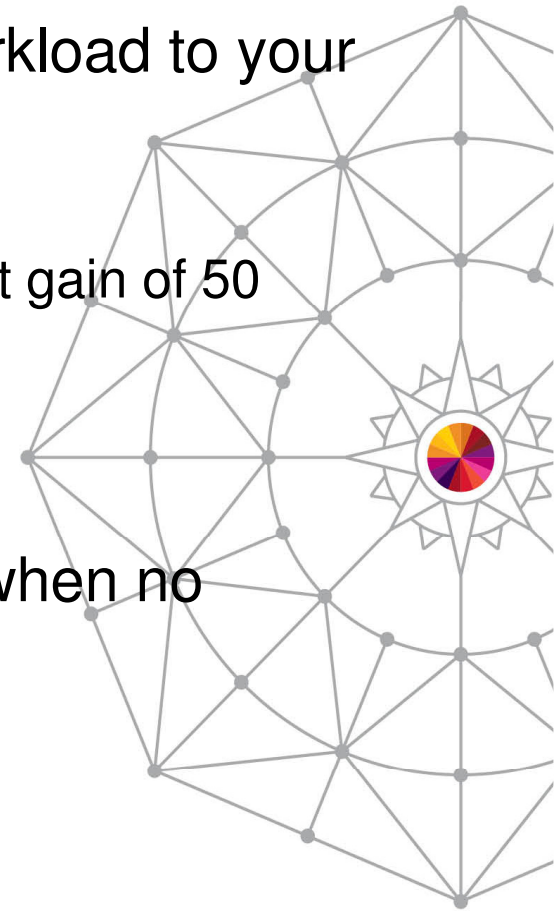
Audit Mediacontrols

- 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')

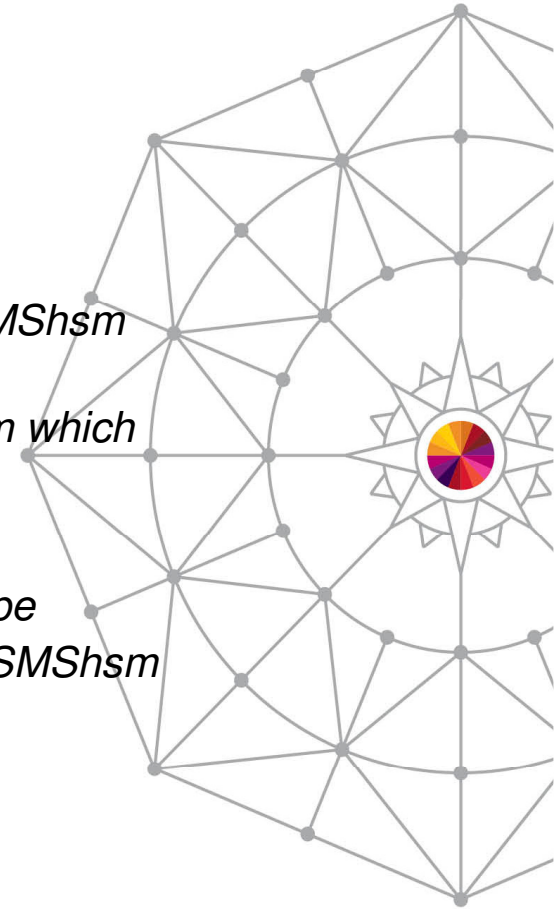
Recycle Limiting Workload

- 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



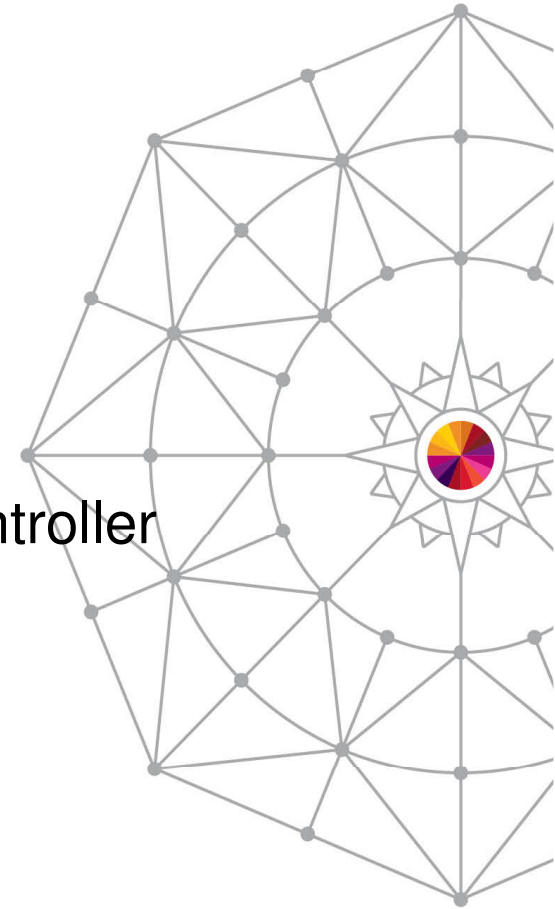
Tape VTS

- In a VTS environment
 - Disk backed by Tape:
 - **SETSYS PARTIALTAPE** should be **MARKFULL**
 - **REUSE**
 - *Causes the complete virtual volume to be staged when DFSMSHsm reuses it*
 - *Perhaps worse yet, it causes a 'hole' in the physical tape from which the virtual tape came*
 - **MARKFULL**
 - *Only used portion of virtual volume de-staged to back-end tape*
 - *Does increase the number of virtual volumes required by DFSMSHsm*
 - Disk only:
 - **SETSYS PARTIALTAPE** should be **REUSE**
 - *Above issues do not exist*



Tape VTS *(cont)*

- Other benefits of a Disk-Only environment
 - Significantly faster Recalls (no tape mounts)
 - Eliminate ML1
 - Eliminates HSM Compaction CPU overhead
 - Eliminates Secondary Space Management
 - Data Deduplication for Backup Data
 - Multiple copies created / managed by storage controller reduces DFSMShsm processing
 - Storage Controller features of Replication, etc

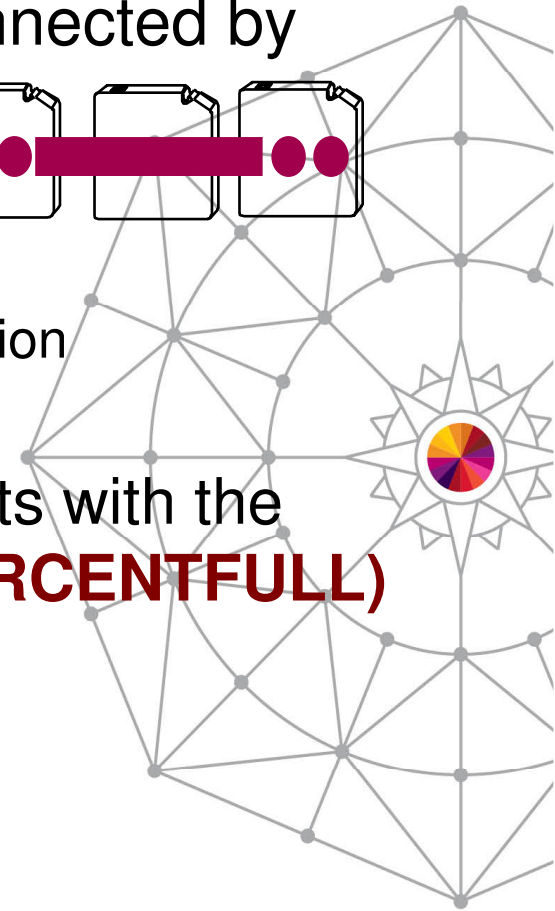
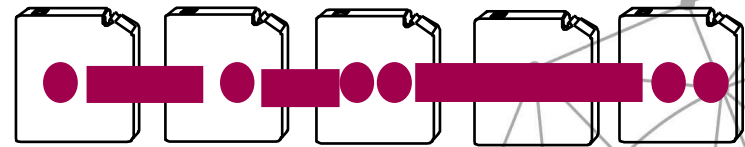


Tape VTS (cont)

- Results from *Customer A* after migrating from tape to disk-only VTL
 - Reduced HSM's Total CPU Time by 19 hours, 45 minutes
 - 13.44% REDUCTION in Total CPU Time used for HSM Migration to L2 even though the number of Megabytes transferred increased by over 6TB or 680,000 data sets
 - 64.39% REDUCTION in Average CPU Time used for HSM L2 RECALLS
 - 91.71% REDUCTION in Average ELAPSE Time for L2 RECALL
 - 53.09% REDUCTION in Total CPU Time used to RECYCLE HSM BACKUP
 - 26.73% REDUCTION in Total CPU Time used for DAILY BACKUP
 - 55.19% REDUCTION in Total ELAPSE Time used for DAILY BACKUP even though the backup workload increased
 - REDUCTION in duplicate recall requests (RC2 errors) from 2,431 to 264
 - REDUCED all errors in HSM for this period by 74,741

Tape Connected Sets

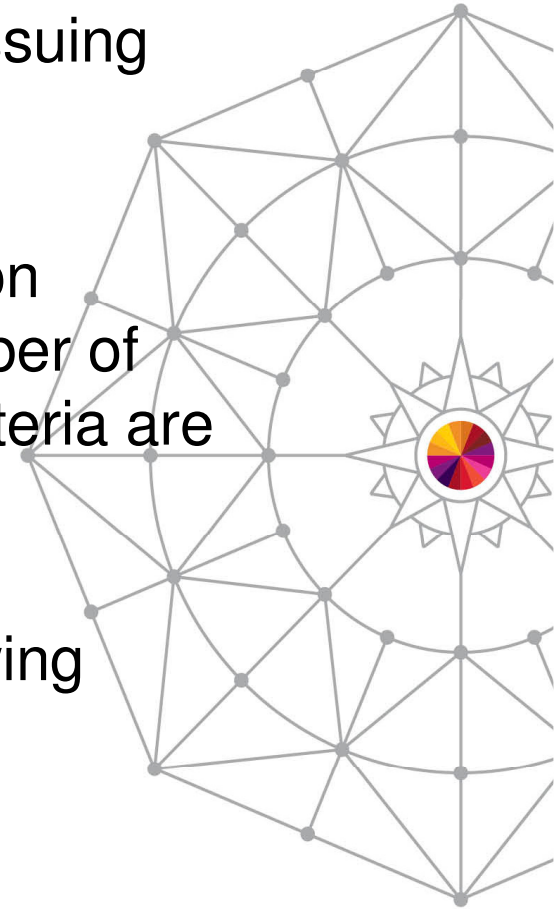
- **Connected Set** - sequence of tape volumes connected by valid spanning data
 - Slows down recall and recycle activity
 - More difficult for tape library ejections
 - Spanning data sets cannot be reconnected during migration
- You can minimize the occurrence of connected sets with the judicious use of **SETSYS TAPEUTILIZATION(PERCENTFULL)** and **TAPESPANSIZE** parameters
 - **Never** use TAPEUTILIZATION(NOLIMIT)



Tape

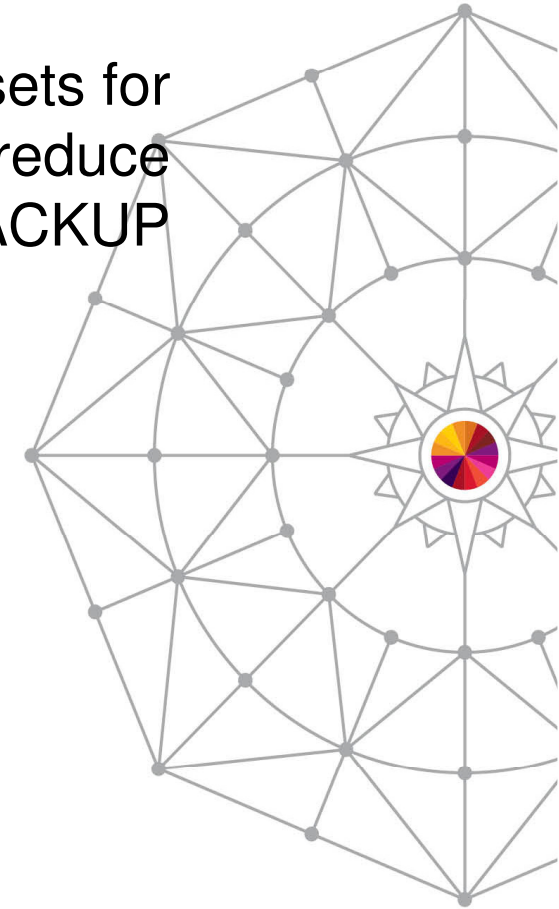
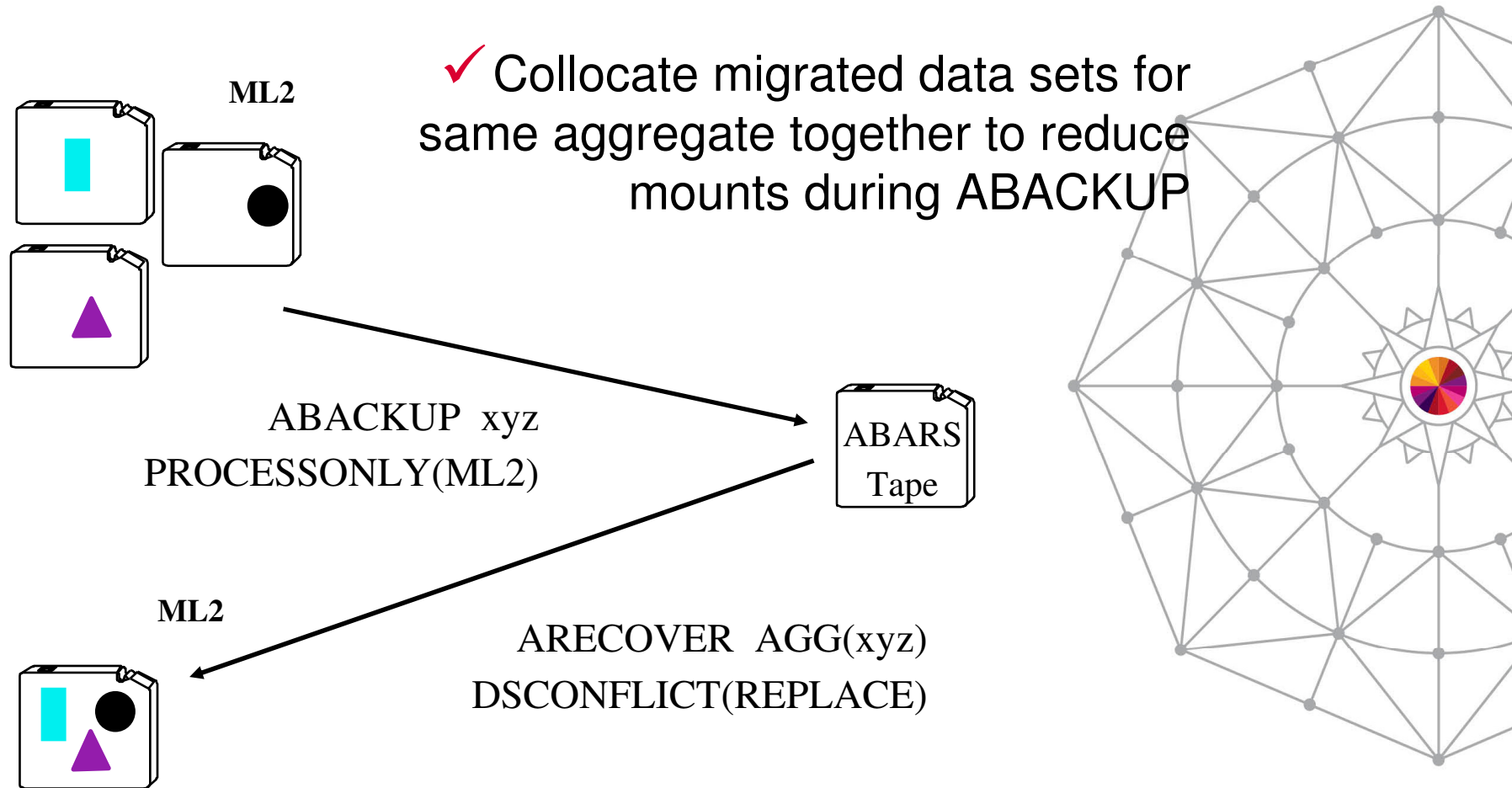
Connected Sets *(cont)*

- 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



Tape

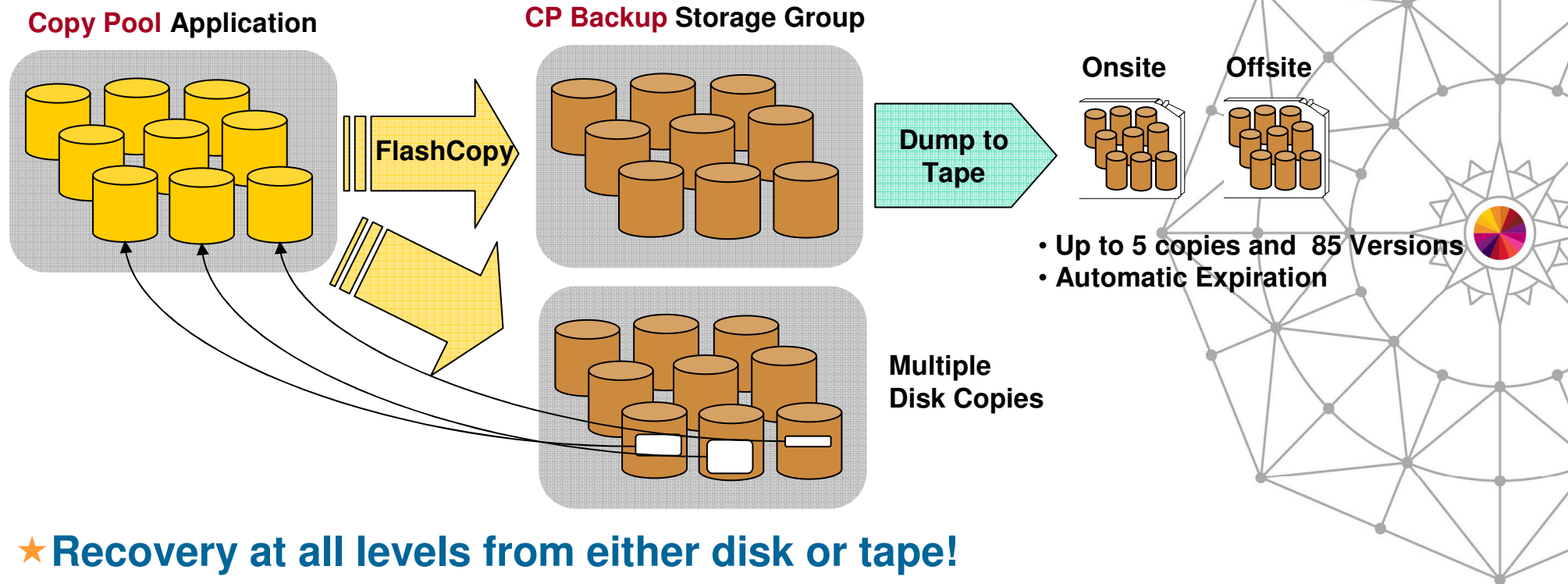
Collocate ML2 Data for ABARS



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

DFSMSHsm Advantages

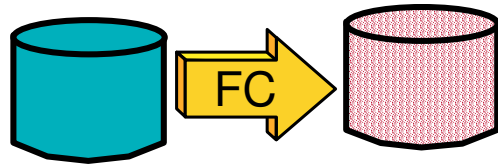
- ★ New Source Volumes always included in backup
- ★ Copy Pool Backup Storage Group disallows allocations on target volumes
- ★ Managed creation/expiration of tape copies
- ★ DFSMSHsm ensures valid tape copies
- ★ Data set level recovery from physical backup copies
- ★ Catalog capture during FlashCopy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



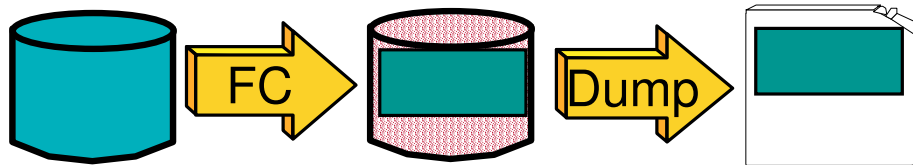
Fast Replication Data Integrity

- Scenario: FlashCopy Relationship is Withdrawn

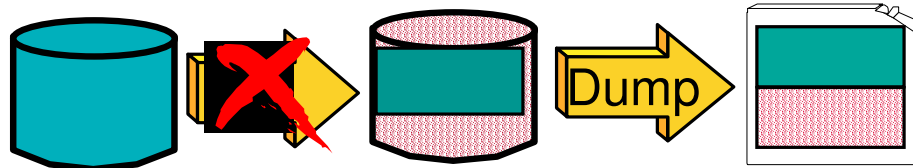
Time 1
Initiate FC



Time 2
Start Dump



Time 3
Withdraw
Relationship



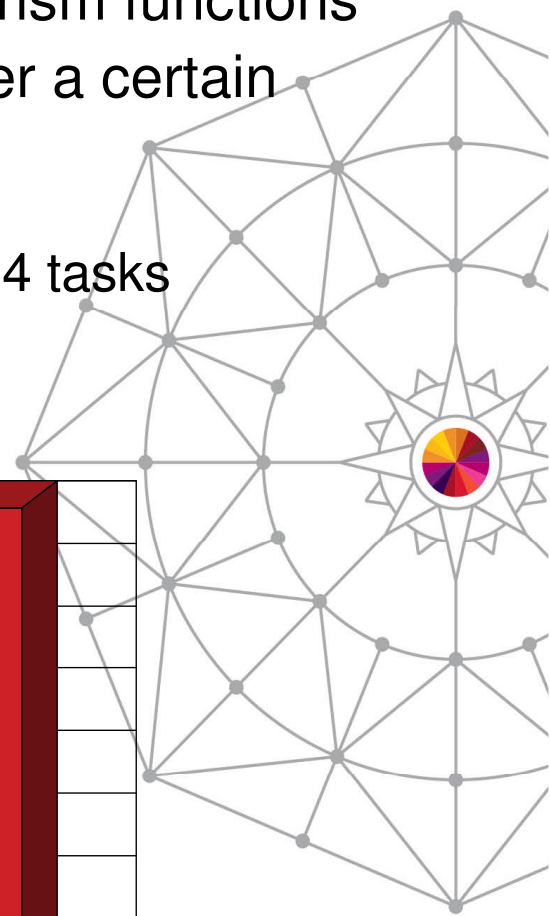
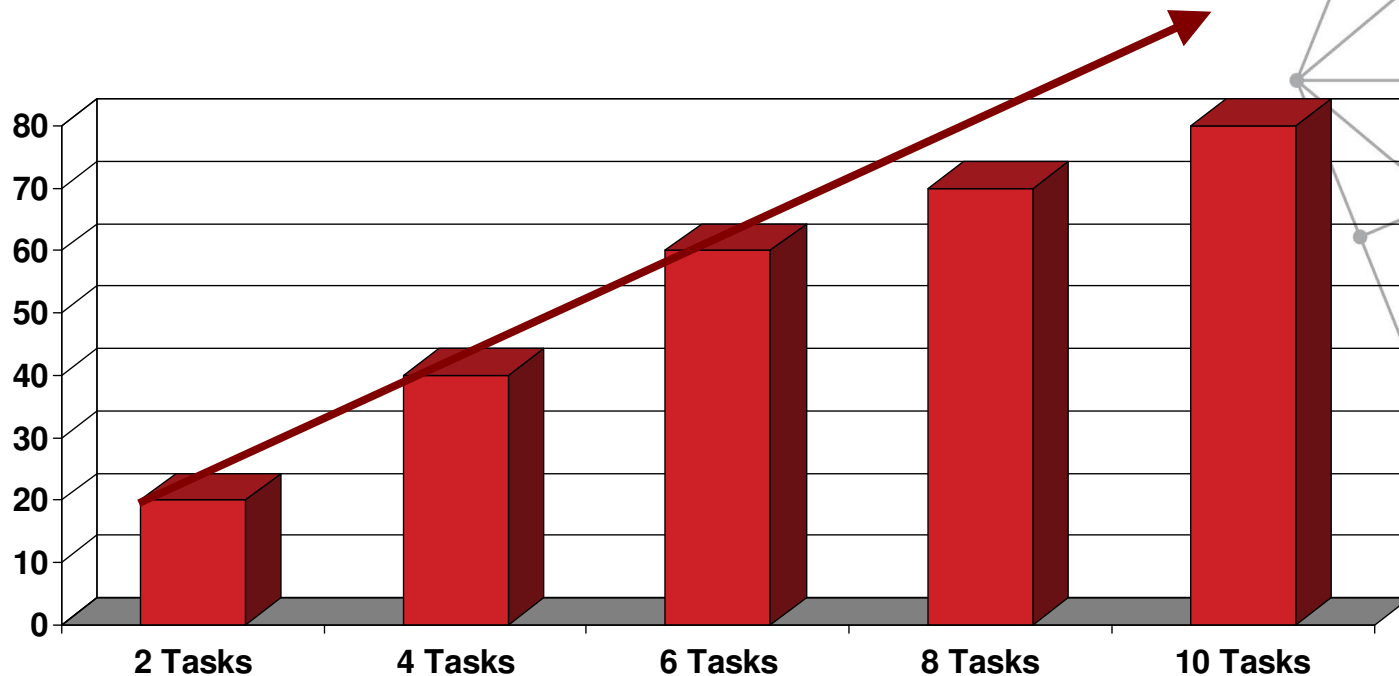
Tape is corrupt.
Data copied after the
withdraw is residual.

DFSMSHsm prevents this!

(When Withdraw done with DFSMSHsm)

Throughput MASH

- 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



Throughput

MASH *(cont)*

- **Multiple Address Space HSM (MASH)**
 - Each LPAR can have multiple active DFSMSHsm address spaces
 - Up to 39 active DFSMSHsms in an HSMplex
 - HSMplex – All DFSMSHsm'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)

Single
Address
Space



Single
HSM
Address
Space

Backup
PSM
SSM
Recycle
Recall
Recovery



Single
HSM
Address
Space

Backup
PSM
IM
Recovery
Autodump



Multiple
Address
Spaces



Recall
Recovery
Main
HSM
Address
Space

Backup
Recycle
Auxiliary
HSM
Address
Space

Backup
IM
Auxiliary
HSM
Address
Space

Autodump
PSM
Auxiliary
HSM
Address
Space



Recall
Recovery
Main
HSM
Address
Space

Backup
Auxiliary
HSM
Address
Space

Backup
Autodump
Auxiliary
HSM
Address
Space

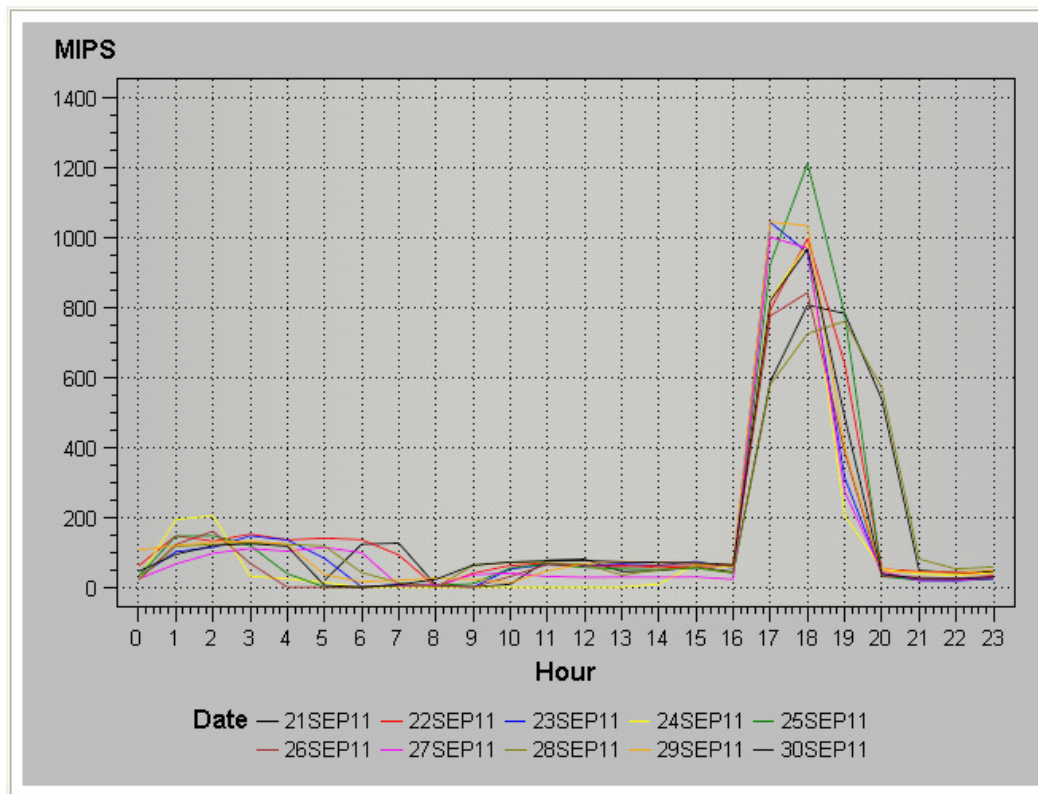
SSM
Recycle
Auxiliary
HSM
Address
Space



Throughput

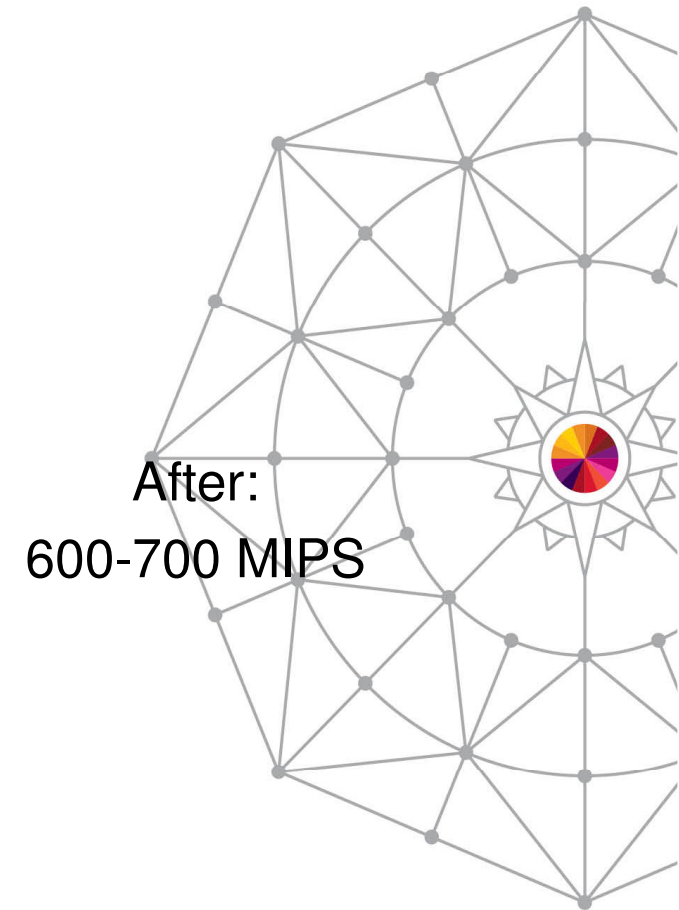
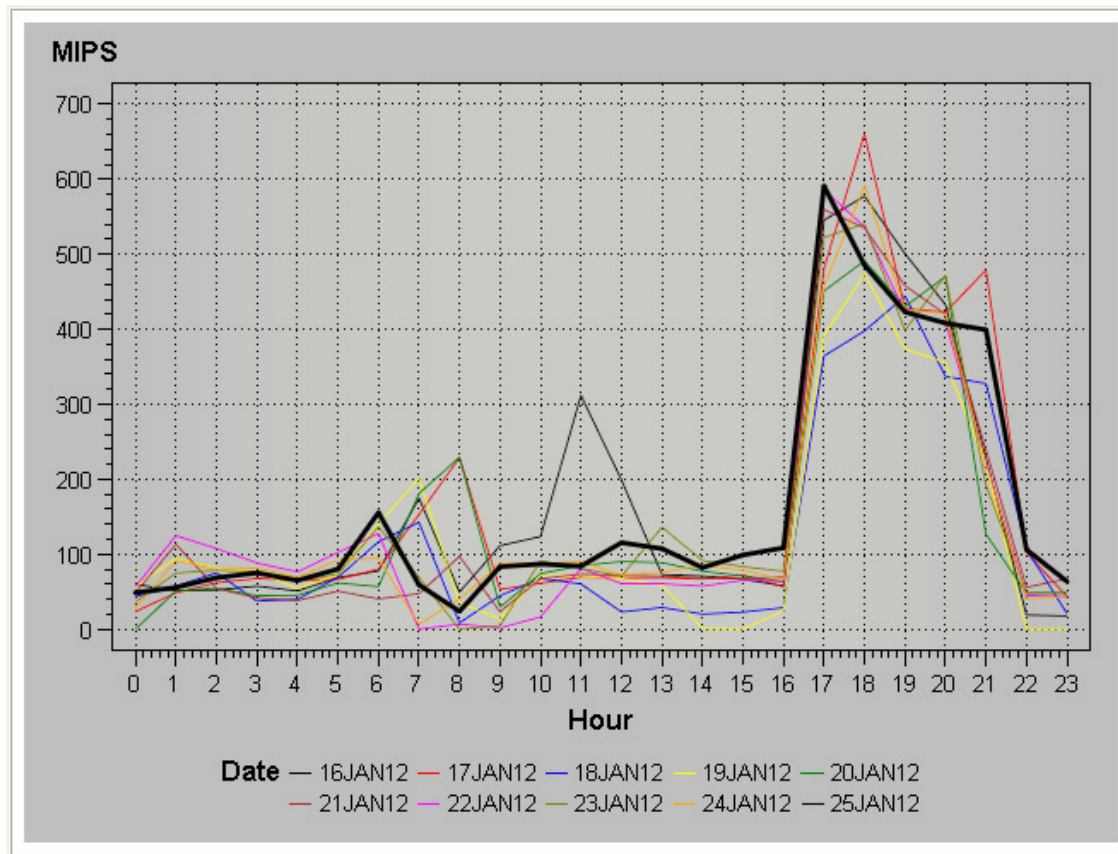
Tune Maximum Tasking Levels

- Tune the maximum number of concurrent DFSMSHsm tasks to minimize DFSMSHsm's peak CPU consumption
 - Charts from *Customer C* showing peak DFSMSHsm CPU before and after they minimized the number of DFSMSHsm concurrent tasks to complete the workload within the allotted timeframe



Before:
1200 MIPS

Throughput Tune Maximum Tasking Levels



Availability

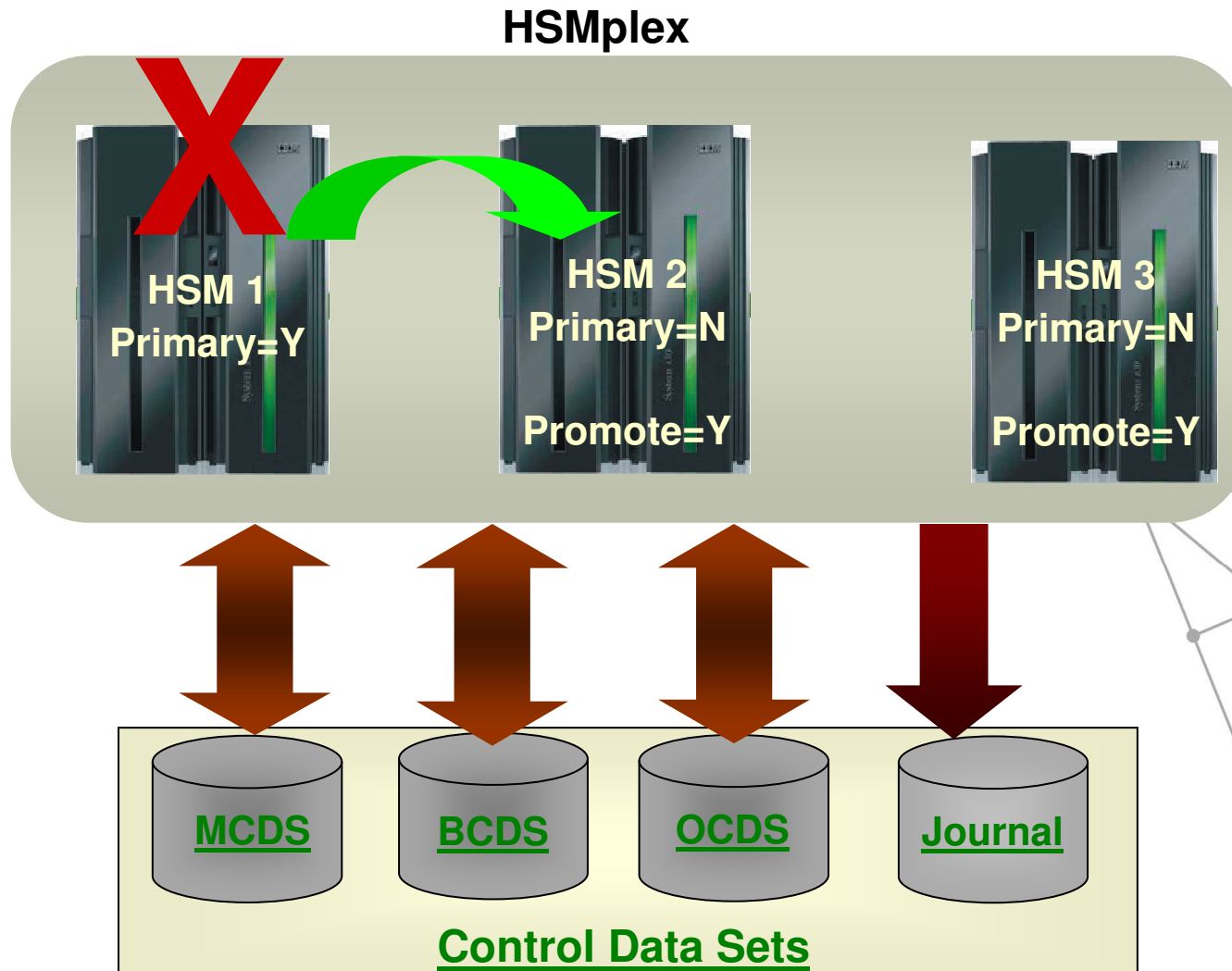
Secondary Host Promotion

- 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)



Availability

Secondary Host Promotion *(cont)*

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

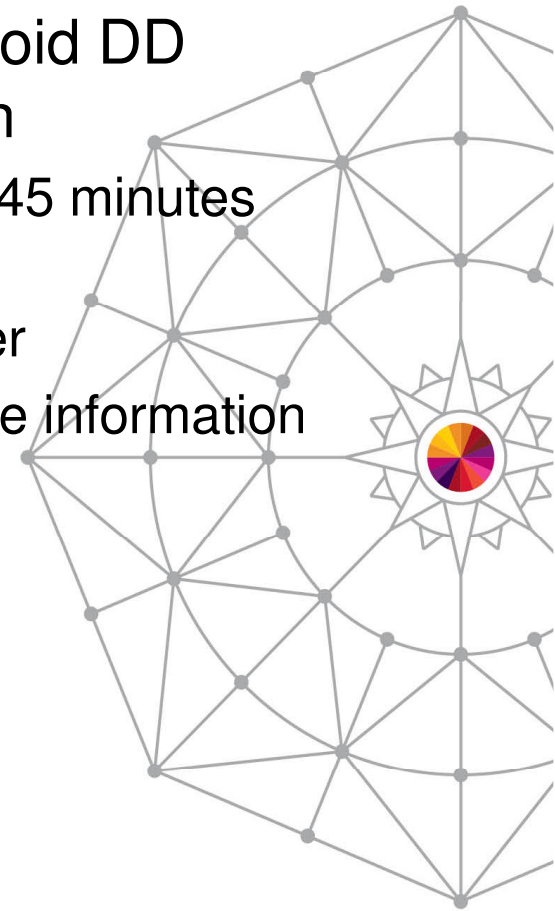
- SETSYS PLEXNAME(HSMplex_name_suffix)
 - Default: ARCPLEX0
 - Must be specified if more than one HSMplex within a sysplex. Must be specified on all hosts in that HSMplex.
 - Must be specified in ARCCMDxx member
- SETSYS PROMOTE(PRIMARYHOST(Y|N) SSM(Y|N))
 - Default: No
 - PRIMARYHOST(Y) is ignored for 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

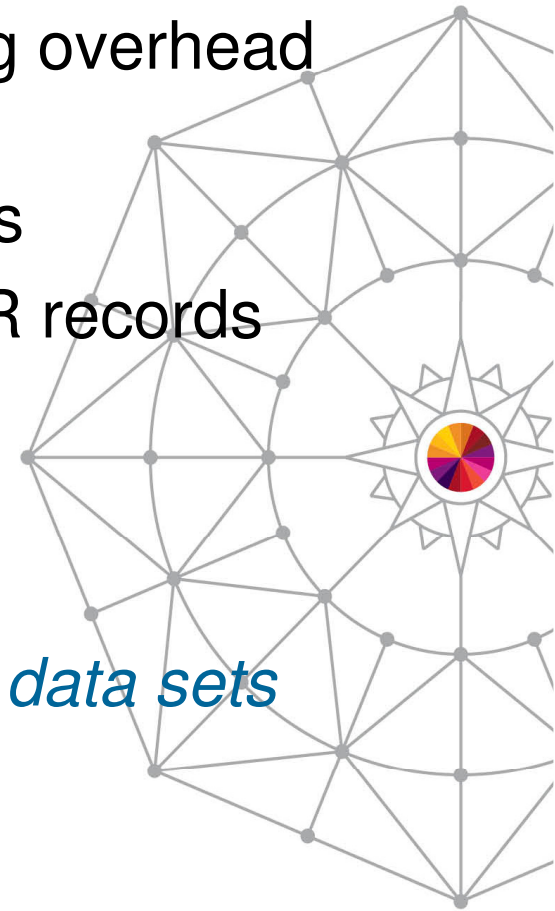
- Specify **DDCONS(NO)** on SMF parameters to avoid DD name consolidation during DFSMSHsm shutdown
 - DFSMSHsm shutdown has been reported to take up 45 minutes due to DD consolidation
 - DDCONS is specified in SMFPRMnn parmlib member
 - See *MVS Initialization and Tuning Reference* for more information
- **Pros of DDCONS(NO):**
 - Faster HSM shutdown
 - Less likelihood 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*



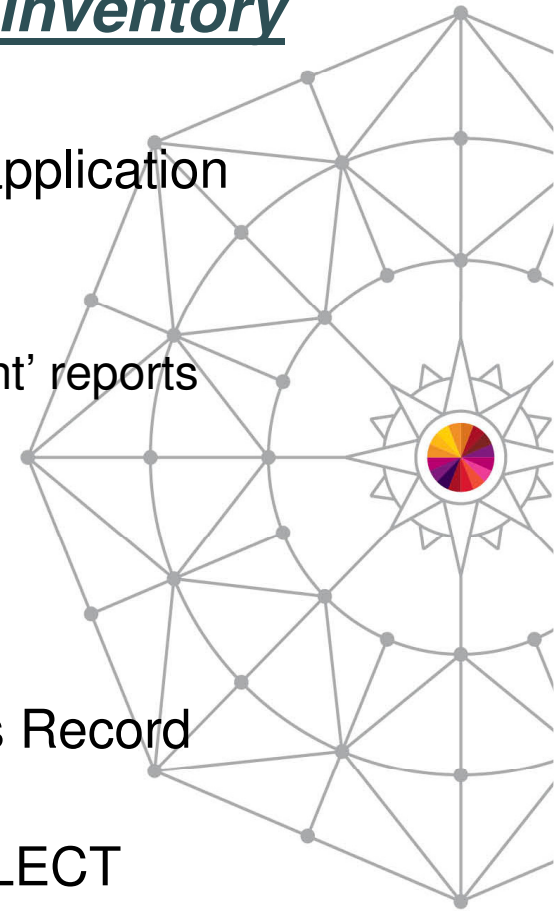
DFSMSHsm Reporting Report Generator

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

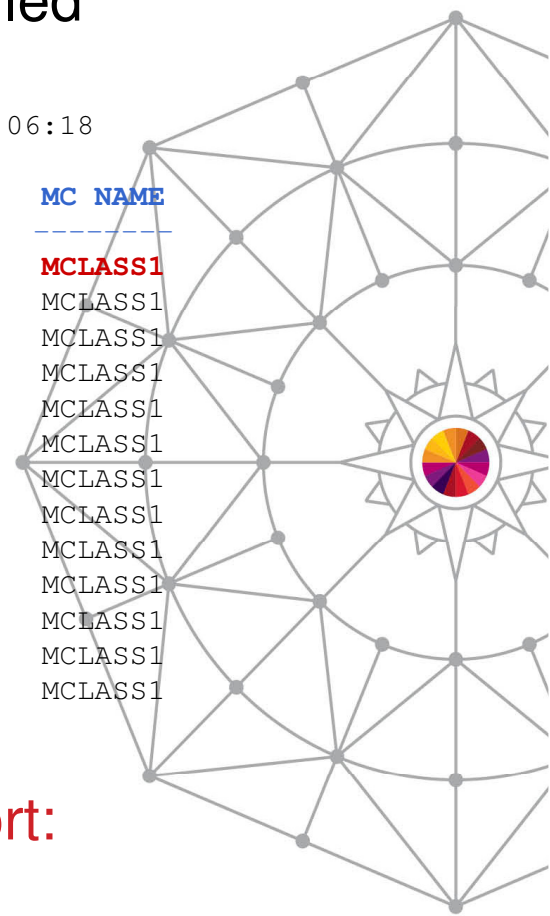


DFSMShsm Reporting Report Generator

Migration Age of zero when data set is recalled

DFSMShsm Thrashing Report - 1 - 2008/02/04 15:06:18

DSN	AGE	SIZE KB	MC NAME
HSMATH0.SMS.VBGPS1	0000	36830	MCLASS1
HSMATH0.SMS.VSMALNA	0000	159	MCLASS1
HSMATH0.SMS.VSMALNB	0000	159	MCLASS1
HSMATH0.SMS.VSMALNC	0000	159	MCLASS1
HSMATH0.SMS.VSMALND	0000	159	MCLASS1
HSMATH0.SMS.VSMALNE	0000	159	MCLASS1
HSMATH0.SMS.VSMALNF	0000	159	MCLASS1
HSMATH0.SMS.VSMALNG	0000	159	MCLASS1
HSMATH0.SMS.VSMALNH	0000	159	MCLASS1
HSMATH0.SMS.VSMALNI	0000	159	MCLASS1
HSMATH0.SMS1.PS.TEST0	0000	3	MCLASS1
HSMATH0.SMS1.PS.TEST1	0000	3	MCLASS1
HSMATH0.SMS2.PS.TEST2	0000	3	MCLASS1



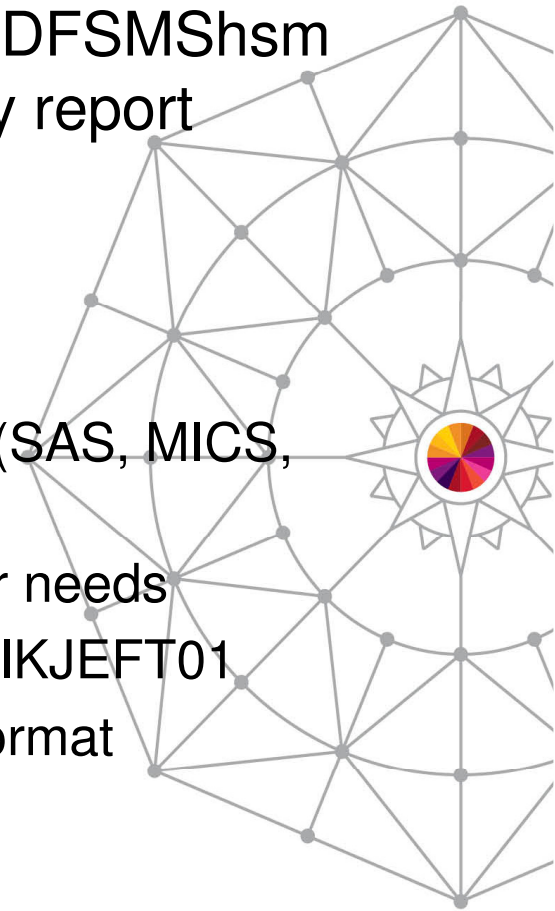
Other fields included in the sample report:

- Date; Elapsed time
- Target volume
- Return Code / Reason Code

DFSMSHsm Reporting

FSRSTAT

- **FSRSTAT** is a REXX sample program that reads DFSMSHsm FSR records, and generates a statistical summary report
- Shipped with DFSMSHsm
 - 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)

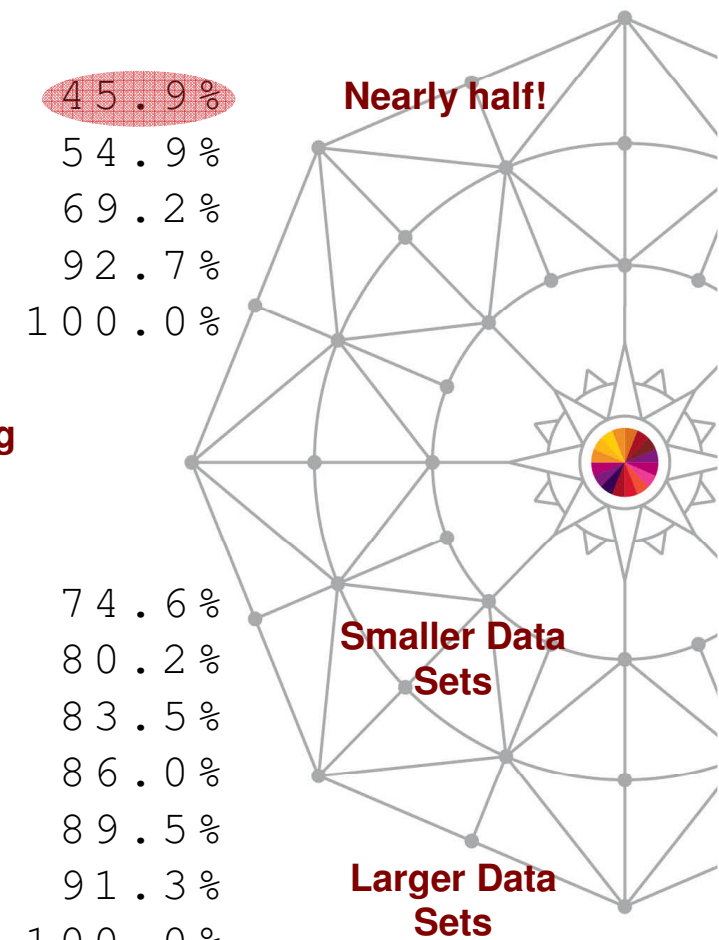
0 ->	49	84320	45.9%	45.9%
50 ->	149	16568	9.0%	54.9%
150 ->	749	26290	14.3%	69.2%
750 ->	29MB	43066	23.4%	92.7%
30MB ->	7GB	13464	7.3%	100.0%

Average 12343.72 KB ← **Misleading**

By rate (KB/sec)

0 ->	499	137052	74.6%	74.6%
500 ->	999	10318	5.6%	80.2%
1000 ->	1499	6073	3.3%	83.5%
1500 ->	1999	4550	2.5%	86.0%
2000 ->	2499	6443	3.5%	89.5%
2500 ->	2999	3219	1.8%	91.3%
3000 ->	9999	16053	8.7%	100.0%

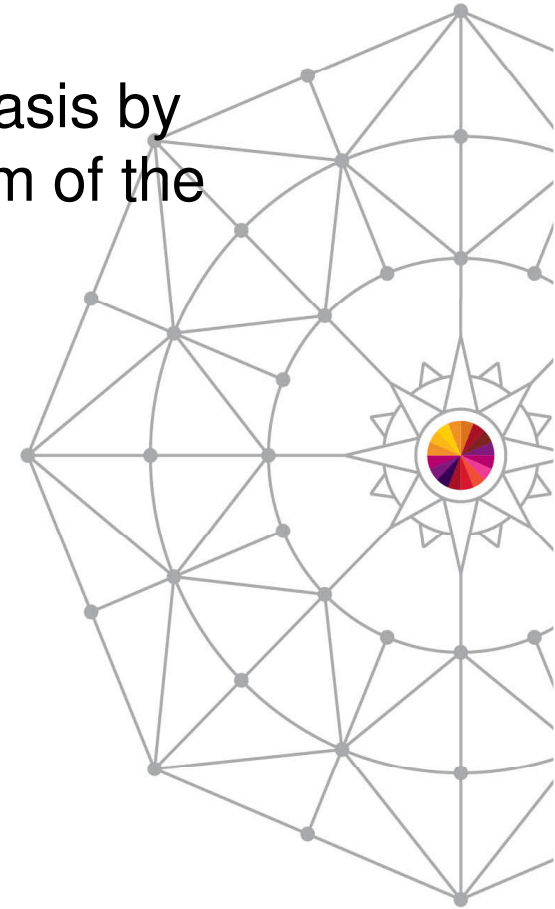
Average 808.55 KB/sec



Just For Fun

- 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:

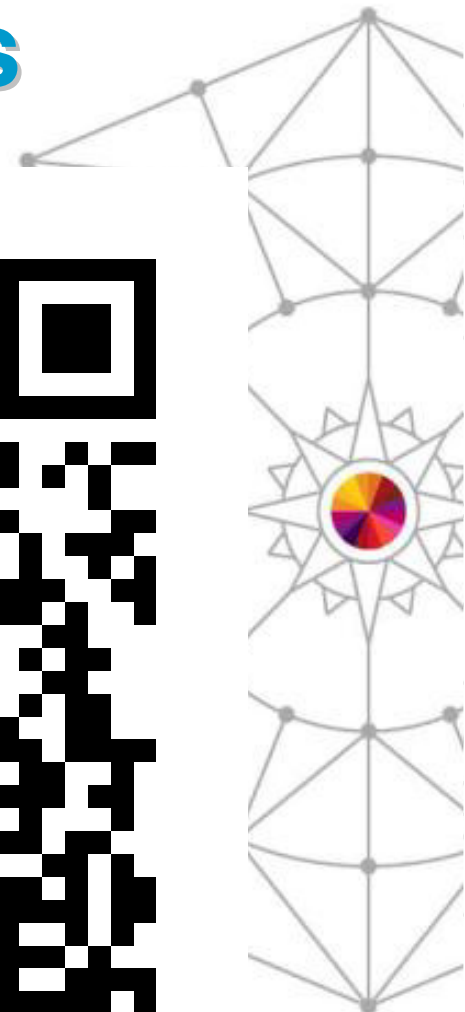
ALTERPRI USERID(*anyuser*) LOW



DFSMSHsm Best Practices

Glenn Wilcock
IBM

March 12, 2014
Session 15075



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