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DFSMS Basics: Just How Does DFSMS System Managed Storage (SMS) Select Volumes?

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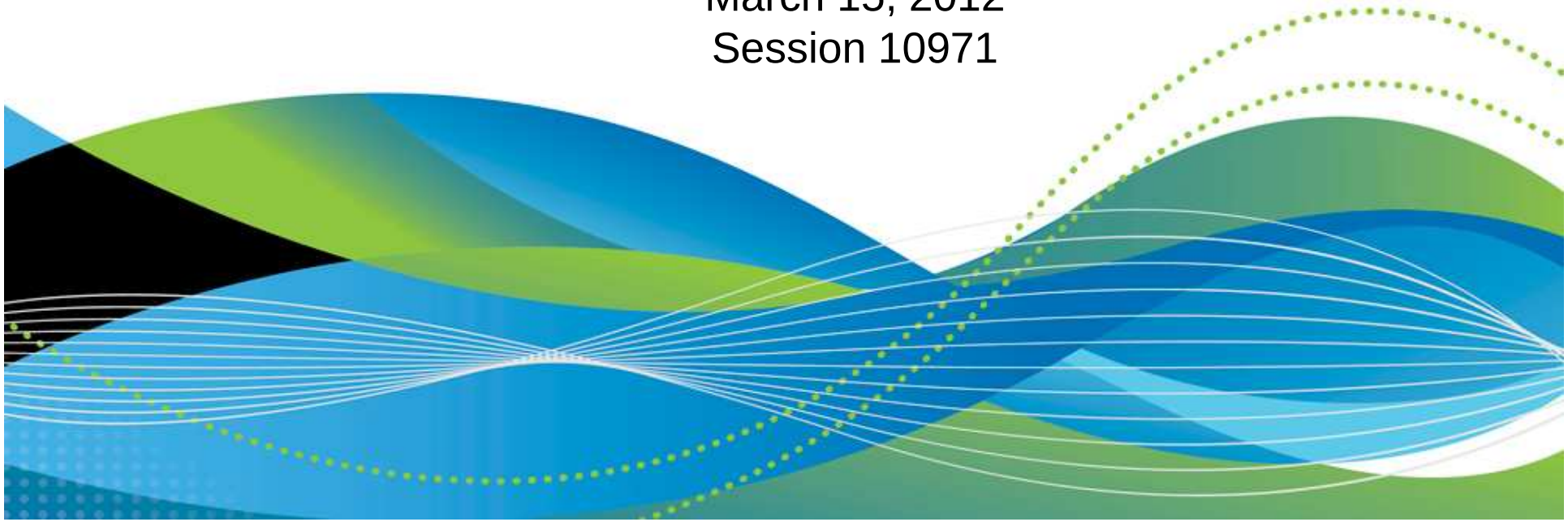
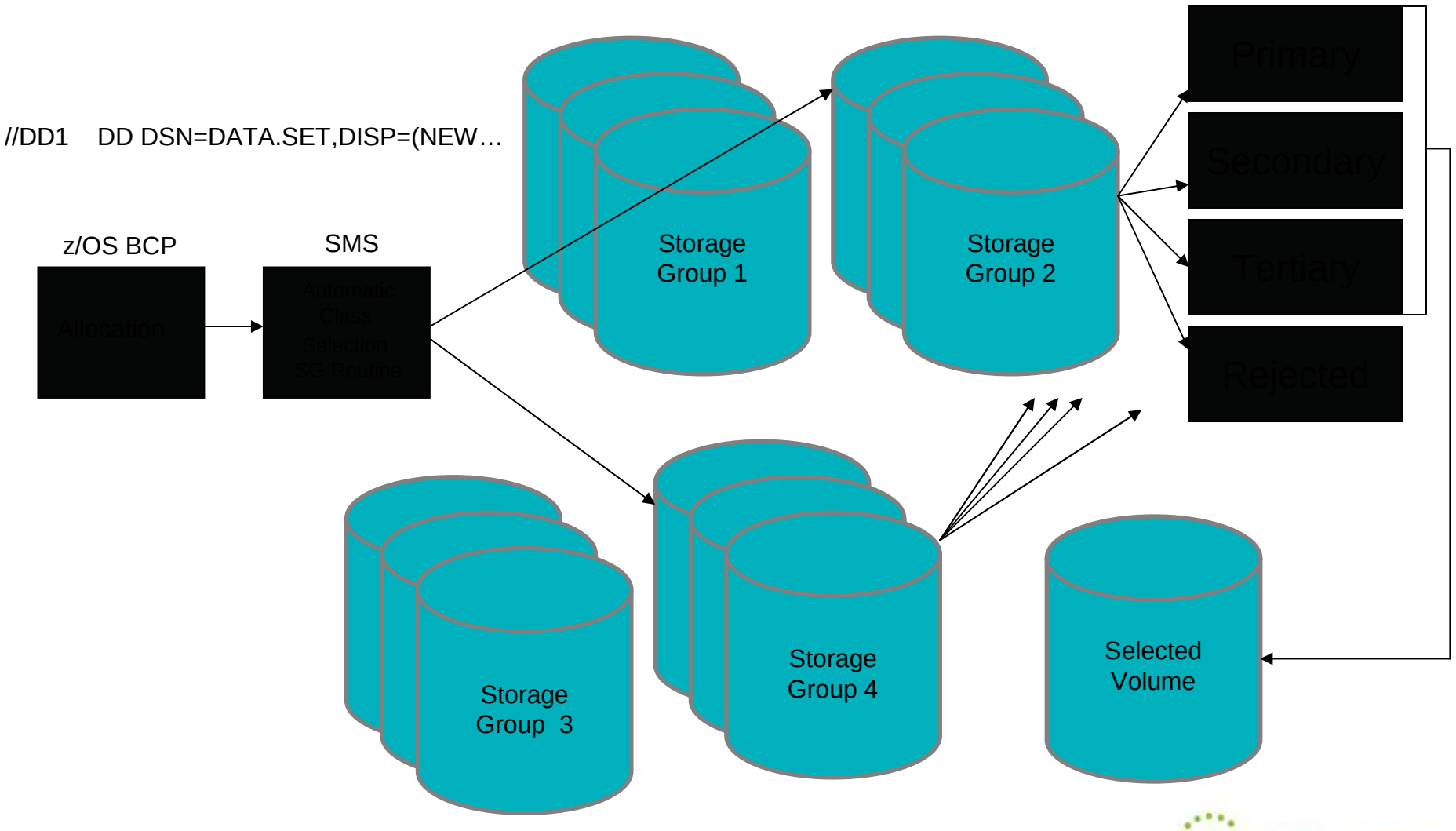


Volume Classification



The Primary List

- Meet data set separation requirement
- SMS storage group and volume statuses are enabled
- MVS status is online
- IART requirement is met
- Number of volumes in storage group >= volume count
- Accessibility requested can be met
- Availability requested can be met
- Meets the guaranteed space requirement
- Can perform the allocation & stay below high threshold
- For MSR=999, volume is non-cached
- Data class extended format request can be met

The Secondary List

- ABEND X37 prevention - the most available space
- Meet data set separation requirement
- Meet volume count requirement
- Can perform the allocation without going more than 20% over high threshold
- SMS storage group and volume status
- Honors tiering of storage groups
- Spill/Overflow volumes
- Volume characteristics
  - Availability
  - Accessibility
  - Extended format
  - Guaranteed space
- Mount time performance

The Tertiary List

- Only used for:
  - Non-guaranteed space requests
  - Non-VSAM data sets
- Consists of volumes in storage groups that do not meet the volume count requested

Conventional Volume Selection

- Used for all non-striped data sets
- Used for all data sets with zero or blank SDR
- Uses a preference sequence to sort volumes in the candidate storage groups into:
  - Primary
  - Secondary
  - Tertiary
  - Rejected

Volume Selection Evaluation Process

Criteria	Preferences
PCU Separation	Volume not on same PCU as data set from which it is separated.
Extent Pool Separation	Volume not in same extent pool as data set from which it is separated.
Volume Separation	Volume does not contain a data set from which this data set should be separated.
Volume Count	Volume is in a storage group that can satisfy the volume count.
Primary Threshold	Volume has sufficient space in target addressing space without exceeding high threshold
Secondary Threshold	Volume has sufficient space without exceeding high threshold

Volume Selection Evaluation Process

Criteria	Preferences
SMS Status	Volume and its storage group are both enabled.
Multi-tiered Storage Group	Volume resides in a storage group that is elected in order of specification
EOV Extend	For EOV Extend, volume does not reside in extend storage group.
Non-Overflow	Volume resides in a non-overflow storage group.
IART	Volume is mountable and IART specified is non-zero.
Fast Replication	Volume is eligible for fast replication request
Extended Attribute	Volume has extended attributes (EAV)

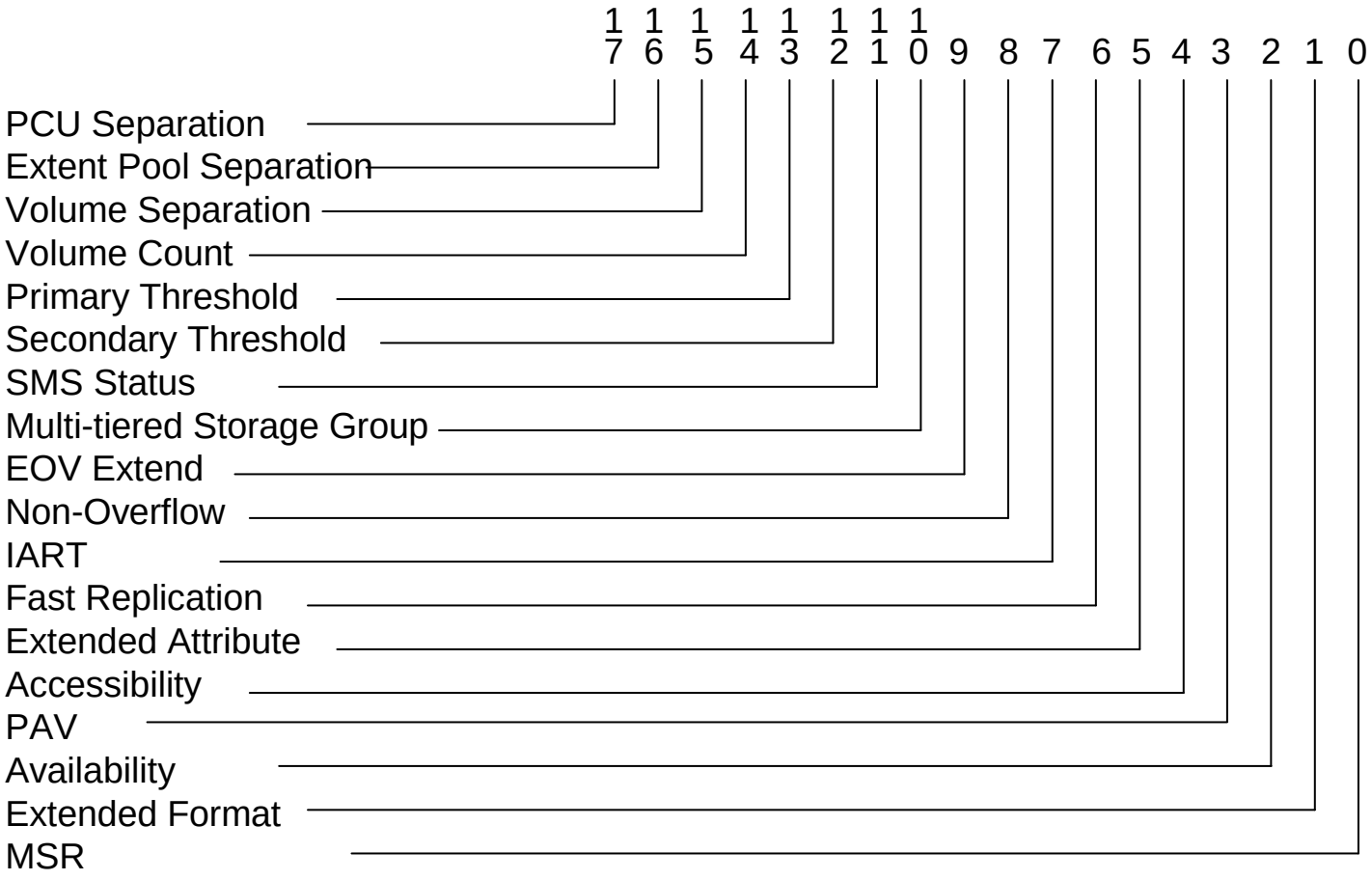
Volume Selection Evaluation Process

Criteria	Preferences
Accessibility	Controller for volume supports accessibility & value is PREF or controller does not support it & value is STANDARD
Parallel Access Volume	Volume supports PAV
Availability	Controller for volume supports availability & value is PREF or controller does not support it & value is STANDARD.

Volume Selection Evaluation Process

Criteria	Preferences
Extended Format	Volume is on a control unit that supports extended format and IF EXT is PREF.
Millisecond Response (MSR)	Volume provides the requested response time specified in direct/sequential MSR or Volume provides a faster response time than requested in the direct or sequential MSR.

Volume Selection Evaluation Process



Example

	Preference	Pos
Volume A	Volume and storage group enabled	11
	Non-overflow	8
	Volume PCU supports accessibility & PREF	4

Total Preference Value = 2320

Volume B	**Volume has sufficient space**	**12**
	Volume and storage group enabled	**11**

Total Preference Value = 6144

Data Set Separation

- Allows you to designate groups of data sets which are to be physically separated by PCU or volume
- SMS attempts to allocate the data sets behind different control units or volumes
- A data set separation profile must be provided
  - Indicates separation by PCU or volume
- The name of the data set containing the profile must be specified in the SMS base configuration
- Can not be used with non-SMS-managed data sets or with full volume copy utilities such as PPRC

Recommended Use of Separation

Use only for a small set of mission-critical data sets

- Volume rejection because of separation may drastically reduce the number of eligible volumes
- Data set separation can affect system performance
  - The number of data sets should be small as SMS must scan them all
  - The use of wildcards characters in separation data set names
  - The number of eligible volumes
- Take care when using separation with striping
- May require constant updating if used with GDSs

Specifying Separation

SEPARATIONGROUP | SEP (PCU | {VOLUME | VOL})
TYPE ({REQUIRED | REQ | R} | {PERFERRED | PREF | P})
DSNLIST | DSNS | DSN (data set name[, data set name,...]);

Examples:

```
SEPARATIONGROUP(VOL) TYPE(PREF)-
      DSNLIST(SMS.PROD.SCDS, SMS.PROD.ACDS, SMS.PROD.COMMDS);

SEP(PCU) TYPE(REQ)-
  DSNS(SYS1.JESCKPT1,-          /*PRIMARY*/
       SYS1.JESCKPT2,-          /*SECONDARY*/
       SYS1.JESCKPT3);          /*TERTIARY*/

SEPARATIONGROUP(VOL) TYPE(PREF)-
      DSNLIST (DB2.DATA.LIB.V%%%%.**)
```

Multiple Separation Profiles

- You can create multiple separation profiles in different data sets or PDS members
- You can only specify one separation profile in the configuration base
- If you have multiple configurations, they can all share the same profile
- Or they can all have separate profiles
- Profile is read when SMS initializes or restarts and whenever a new configuration is activated

When Separation Does Not Work

- The allocation is not SMS-managed.
- The separation profile cannot be accessed.
- The separation profile is invalid.
- The allocation uses a temporary data set name.
- Two data sets are allocated on different systems.
- A volume is varied online during allocation.
- An IODF change occurs during allocation.
- A data set name not in the profile is specified during HSM recover.
- The profile was modified after configuration activation.
- SMS does not perform separation during:
  - Rename.
  - HSM migration to level 1 or 2.
  - Full volume image copy.

MSR and Bias

- MSR (Millisecond Response)
  - Uses only the stored MSR; cached if cache is active, native otherwise
  - Devices close to the requested MSR are placed on the primary list
  - Devices not close to the requested MSR are placed on the secondary list
- Bias
  - Determines which volumes MSR performance numbers (read, write, or both) to consider during volume selection.
- If you leave all MSR and bias fields blank (direct and sequential), SMS ignores device performance during volume selection

Sustained Data Rate (SDR)

- SDR > zero
  - Causes striping volume selection to be used
  - May cause MSR, availability, accessibility, and free space criteria to be ignored
  - Considers controllers over volume attributes

Initial Access Response Time (IART)

- Object access:
  - Specifies the desired response time (in seconds) required for locating, mounting, and preparing a piece of media for data transfer. OAM uses this value to interpret the storage level, that is, to place an object at an appropriate level in the object storage hierarchy. For objects, both the IART and the sustained data rate (SDR) are applicable.
    - OAM uses IART as follows:
      - If the IART value is 0, OAM writes to DASD.
      - If the IART value is 1-9999, OAM selects removable media, either optical or tape.
- DASD Data set access:
  - SMS allows the system resources manager (SRM) to select a DASD volume from the primary volume list if the IART value is 0 or unspecified. SRM volume selection is ideally suited for batch jobs.
- VTS (Virtual Tape Server) cache management:
  - An initial access response time (IART) of 100 or greater means the volume has least preference in the cache. 0-99 means the volume has most preference.

Availability

- Specifies whether data set access should continue in the event of a single device failure.
  - CONTINUOUS
    - Specify an availability of CONTINUOUS if you do not want a device failure to affect processing. Only duplexed and RAID volumes are eligible for this setting. If CONTINUOUS availability is specified, data is placed on a device that can guarantee that it can still access the data in the event of a single device failure. This option can be met by
      - *A dual copy volume*
      - *An array DASD*
  - PREFERRED
    - Array DASD volumes are preferred over nonduplexed volumes.
    - Dual Copy volumes are not candidates for selection.
  - STANDARD
    - If data sets do not require such a high level of availability, specify STANDARD availability, which represents normal storage needs. Specify an availability of STANDARD to cause processing of a data set to stop after a device failure. Simplex volumes are preferred over array DASD. SMS selects only volumes that are not dual copy. This attribute does not apply to objects. Array DASD are acceptable candidates for both STANDARD and CONTINUOUS availability requests.
  - NOPREF
    - Simplex and array DASD are equally considered for volume selection. NOPREF is the default. Dual copy volumes are not candidates for selection.

Accessibility

- Defines the function of the hardware supporting the point-in-time copy using
  - Using either concurrent copy
  - Virtual concurrent copy
  - FlashCopy
- Options are;
  - CONTINUOUS (C)
    - Only point-in-time copy volumes are selected.
  - CONTINUOUS PREFERRED (P)
    - Point-in-time copy volumes are preferred over non-point-in-time copy volumes.
  - STANDARD (S)
    - Non-point-in-time copy volumes are preferred over point-in-time copy volumes.
  - NOPREF (N)
    - Point-in-time copy capability is ignored during volume selection (default)

Multi-Tiered Storage Groups

- Specify Multi-Tiered SG Y in the storage class
- Example:
  - SET &STORGRP = 'SG1', 'SG2', 'SG3'
- Result:
  - SMS selects volumes from SG1 before SG2 or SG3
  - If all enabled volumes in SG1 are over threshold, then SMS selects from SG2
  - If all enabled volumes in SG2 are over threshold, then SMS selects from SG3
  - If all volumes are over threshold, then SMS selects from the quiesced volumes in the same order

Parallel Access Volumes

- Feature of the Enterprise Storage Server (ESS)
- Available only when the PAV option is enabled
- Use the Parallel Access Volume Storage Class attribute:
  - Required: Only volumes with the PAV feature are selected
  - Preferred: Only volumes with the PAV feature are primary
  - Standard: Only volumes without the PAV feature are primary
  - Nopreference: All volumes, PAV and non-PAV are treated equally

Striping Volume Selection

- Used only for:
  - Initial allocation of extended format preferred or required data sets with SDR > 0
  - Recall/Recover of multi-stripe data sets
- Not used for Recall/Recover of single-striped multivolume data sets
- Similar to conventional volume selection
  - Eligible volumes classified as primary and secondary
    - For each controller, primary meets all requested preferences and is selected randomly
    - Secondary is all other volumes on the same controller
  - Assigned a volume preference weight based on preference table

Striping Volume Selection (cont)

- SMS calculates an average preference based on all volumes in an SG
- SMS selects the SG that has enough primary volumes to meet the stripe count and the highest average weight
- If no SGs meet this criteria, the one with the largest amount of primary volumes is selected
- If the largest amount of primary volumes is the same for multiple SGs, the SG with the highest weight is chosen
- If there are multiple SGs that meet the criteria, one is chosen at random

Striping Volume Selection (cont)

- No SGs with mixed device types
- Number of volumes computed from SDR
- Temporary data sets with volume count > 1 treated as non-striped
- Volume must be able to satisfy primary space requested

Striped Data Sets (general information)

- Maximum stripes for non-VSAM = 59
- Maximum stripes for VSAM= 16
- Maximum extents/space alloc = 5
- Non-VSAM max extents/stripe = 123
- For VSAM max extents/stripe:
  - Per volume = 123
  - Per stripe = 255
  - Per data component = 4080
  - VSAM extent constraint removal in data class, if set to Y, 59x123
  - VSAM stripes can extend to new volumes
- Minimum alloc = 1 track/stripe

Extents Per Volume

- Non-VSAM, non-extended format: Up to 16 on the volume
- Non-VSAM, extended format: Up to 123
- PDSE and HFS: Up to 123 on the volume
- VSAM: Up to 255 per component, but only 123 per volume per component
- Striped VSAM: Up to 4080 per data component
- VSAM extent constraint removal in data class, if set to Y, 59x123 or 7257

Extending Striped Data Sets

- All stripes must be able to satisfy secondary space/number of stripes
- Secondary space is divided by number of stripes and rounded up for each volume
- Non-VSAM striped data sets **cannot** extend to additional volumes
- VSAM striped data sets **can** extend to additional volumes
- Volume fragmentation may result in striping volume reselection

Requirements for Striping

- Volumes behind one of the following controllers:
  - ESCON-attached controller that supports concurrent copy
  - 3990-6 controllers
  - 3990-3 controllers with Extended Platform that are ESCON-attached
  - 3990-3 controllers with RAMAC support-level microcode
  - 9394 controllers
  - 9343 controllers with cache
  - IBM RAMAC Virtual Array
  - IBM Enterprise Storage Server
- Volumes must be ENABLED or QUIESCED and varied ONLINE

Why Isn't My Volume Primary?

- Volume was rejected
- Allocation would exceed high threshold
- Volume/SG quiesced
- VTOC IX disabled
- MSR not met
- Non-zero IART
- Controller IML'd while online to MVS
- Accessibility value
- Availability value
- Extended format value
- Insufficient number of volumes in SG

Why Was My Volume Rejected?

- Volume not in selected SG or SGs
- Not online to MVS
- Bad volume of SG status
- Insufficient free space
- Insufficient space in VTOC or IX
- Not init’d as SMS volume
- On exclude list
- Does not support extended format
- Not on include list

Why Was My Volume Rejected (cont)?

- Volume does not meet …
  - Availability
  - Accessibility
  - IART
- UCB type unusable
- Allocation attempted, but failed
- Too fragmented
- SG has insufficient volumes
- Geometry incorrect
- SG contains mixed SDRs
- Does not support Flashcopy

Wrong Volume Selected?

- Check construct assignments
- Check channel path utilization
- Check storage group/volume utilization
- No volumes in primary volume list
- Expected volume was on tertiary list
- Expected volume was rejected
- Products which hook into system code (such as SRM) can create unexpected results

If All Else Fails....

Data Class contains two values which can be used to influence volume selection:

- Space Constraint Relief
- Reduce Space Up To (%)

If you specify the second, the first must be Y

If You Use Space Constraint Relief...

- Very large allocations may succeed with large enough volume count.
- Existing data sets may end up with less space than requested on extents.
- New data sets may be smaller than requested.
- Fewer extents may be available when the data set extends.
- May result in more than 5 primary extents
- X37 abends should occur less frequently.

The Retry Process...

- If the volume count is 1:
  - SMS retries the allocation after reducing the requested space as indicated
  - SMS removes the 5 extent limit
- If the volume count is greater than 1:
  - First, SMS uses best-fit volume selection
  - If this fails, SMS reduces the space quantity and removes the 5 extent limit

Requesting Assistance

- Use VOLSELMSG with JOBNAME, STEPNAME, ASID and/or DSNAME to get detailed volume selection analysis messages
- Turn SMS tracing on:
  - SETSMS TRACE(ON),TYPE(ALL),SIZE(100M),DESELECT(ALL), SELECT(MSG,VTOCC,VTOCA,MSG,MODULE),JOBNAME(jobname)
- Run the job
- Turn SMS tracing off
  - SETSMS TRACE(OFF)
- Make note of the dump data set name
- Take a dump of the SMS address space
  - DUMP COMM=(any dump title you desire)
  - R #,JOBNAME=SMS,CONT
  - R #,SDATA=(LPA,CSA,ALLNUC,GRSQ,LSQA,SWA,PSA,SQA,TRT,RGN,SUM)

Requesting Assistance....

- Activate IPCS from a TSO session.
- Set the defaults (dump data set name) using option 0
- Go to the IPCS COMMAND option (IPCS option 6)
- Issue: VERBX SMSDATA 'TRACE'
- If possible, use IPCS PRINT to create a hard copy of the trace

References: APARs

- II07464 - reasons for volume selection failure
- II08004 - reasons why wrong volume selected
- II08442 - volume selection and DCME settings
- II08618 - striping volume selection information
- II08987 - continuation of II08004

References: Publications

- z/OS DFSMSdfp Storage Administration Reference (SC26-7402)
- z/OS DFSMS: Implementing System-Managed Storage (SC26-7407)
- MVS/ESA SML: Managing Storage Groups (SC26-3125)
- z/OS DFSMShsm Storage Administration Reference (SC35-0422)
- z/OS DFSMShsm Storage Administration Guide (SC35-0421)
- z/OS DFSMSdss Storage Administration Reference (SC35-0424)
- z/OS DFSMSdss Storage Administration Guide (SC35-0423)
- z/OS DFSMS Advanced Copy Services (SC35-0428)

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