Need Space? A How-to on EAV Planning and Best Practices

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Session Objectives

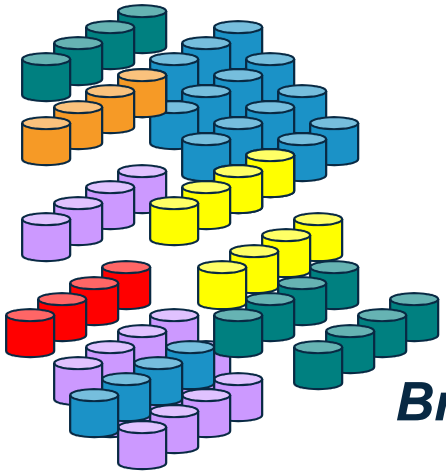
- Why EAV
- EAV Overview
- Planning for Usage
- Best Practices

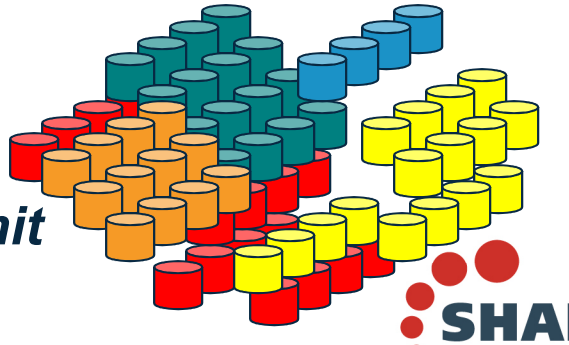
Why are EAVs needed

- **Problem:**
  - Exhaustion of all available z/OS addressable disk storage is a limitation imposed by the four-digit device number. Moreover, rapid data growth is driving the z/OS platform towards this limitation.
    - Business resilience solutions for continuous availability also drives z/OS to this limitation.
- **Solution:**
  - Defining larger volumes by increasing the number of cylinders beyond 65,520
    - Space managed in multi-cylinder units
      - Cylinder-managed space (EAS)
    - New track address format
      - 28 bit cylinder track address (CCCCcccH)
- **Benefit:**
  - Increase z/OS addressable disk storage
    - z/OS R12 completed the major function by supporting additional data set types as EAS eligible.
  - Allows for management of fewer, larger volumes as opposed to many small ones.

What is an EAV

- **What is an Extended Address Volume (EAV)?**
  - A volume with more than 65,520 cylinders
  - Size limited to 1 TB (1,182,006 Max cylinders)*
  - Full support in z/OS V1R12 and higher



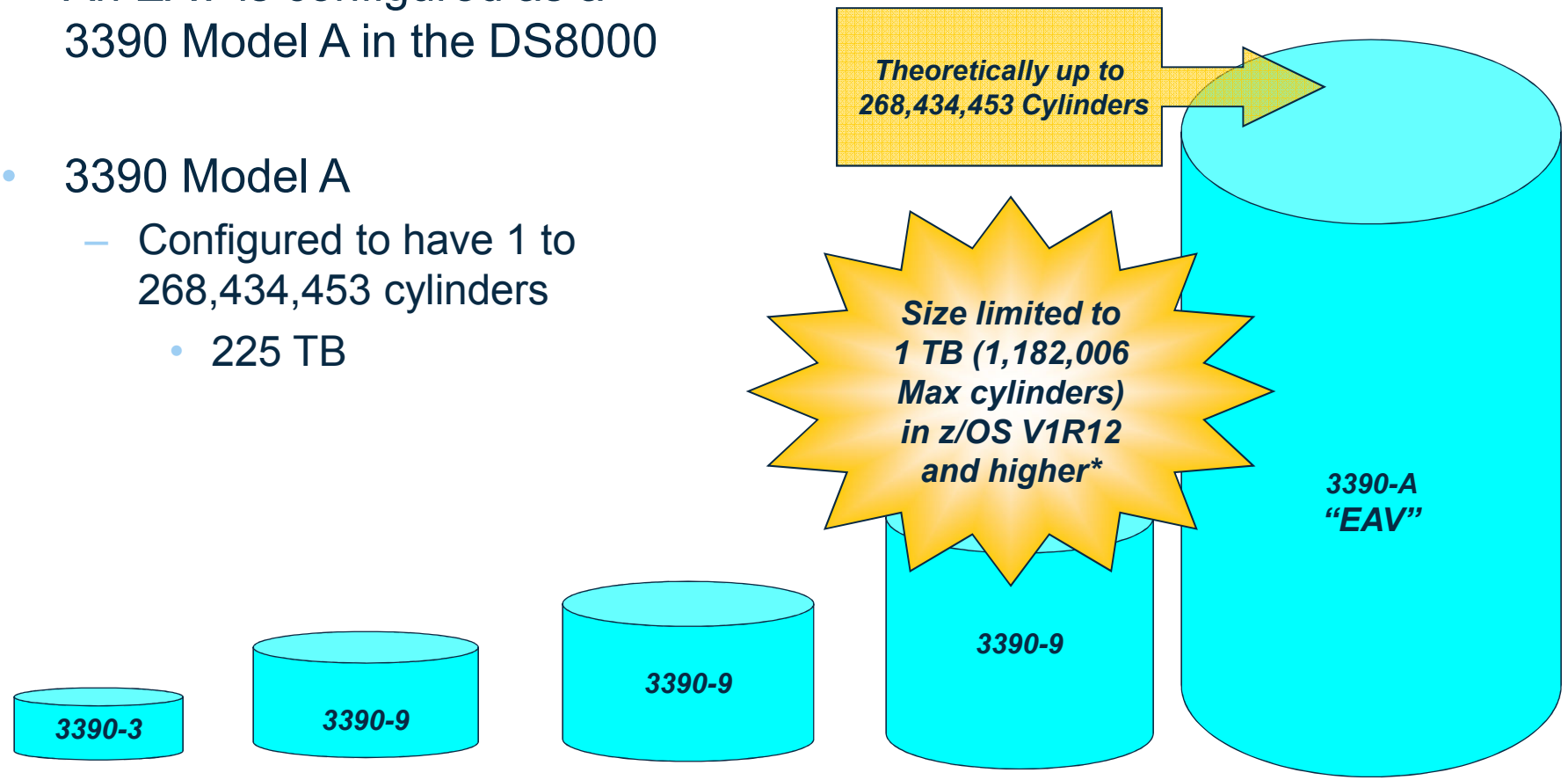


Breaking the 65,520 cylinder limit

**Current maximum size*

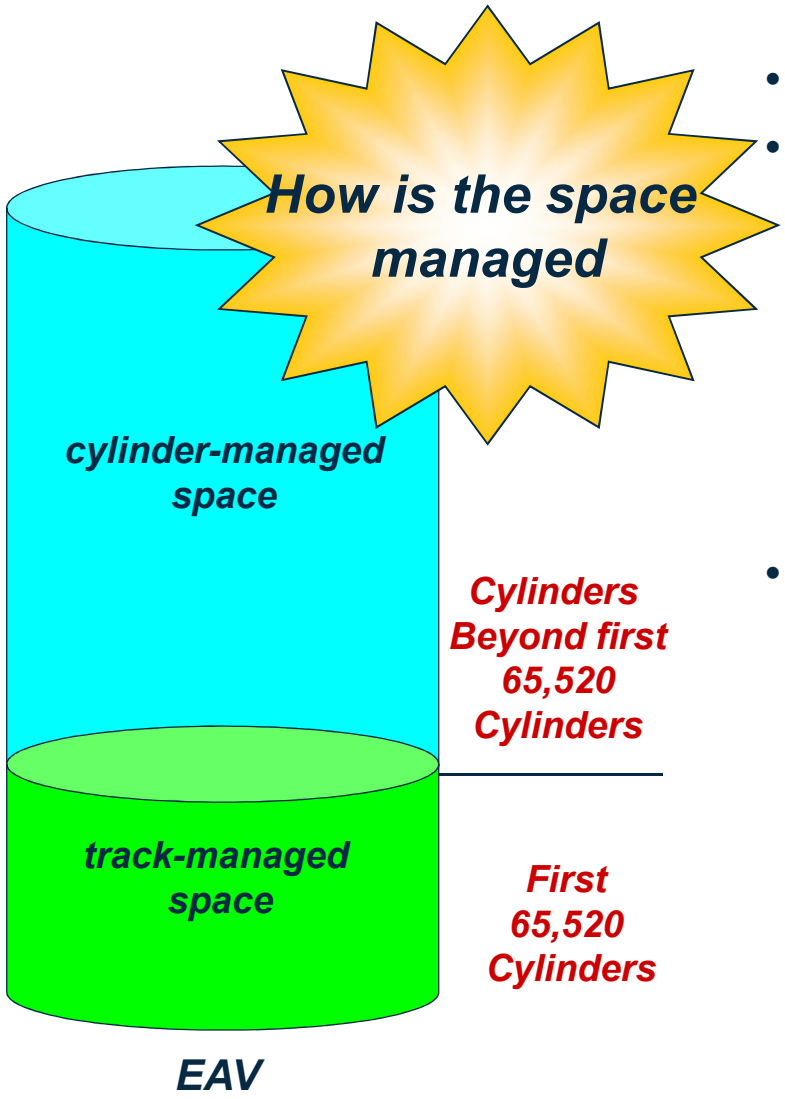
DS8000 Support

- An EAV is configured as a 3390 Model A in the DS8000
- 3390 Model A
  - Configured to have 1 to 268,434,453 cylinders
    - 225 TB



*Current maximum size

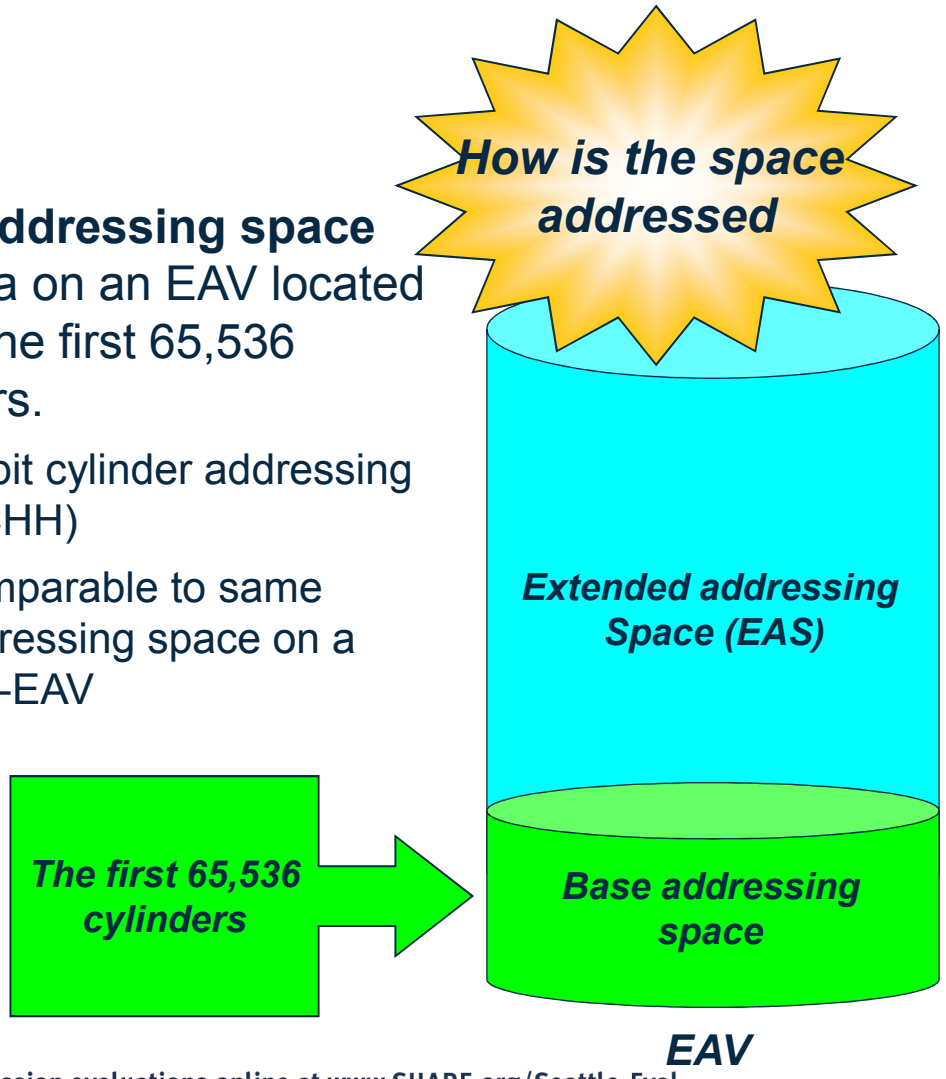
EAV Key Design Points



- Maintains 3390 track format
- **Track-managed space:** the area on an EAV located within the first 65,520 cylinders
  - Space is allocated in track and cylinder units
  - Storage for “small” data sets
  - Track-managed space comparable to same space on non-EAVs
- **Cylinder-managed space:** the area on an EAV located above the first 65,520 cylinders
  - Space is allocated in **multi-cylinder units**
    - A fixed unit of disk space that is larger than a cylinder. An EAV currently uses 21 cylinders.
    - System may round space requests up
  - Storage for “large” data sets

EAV Key Design Points cont.

- **Base addressing space** the area on an EAV located within the first 65,536 cylinders.
  - 16-bit cylinder addressing (CCHH)
  - Comparable to same addressing space on a non-EAV



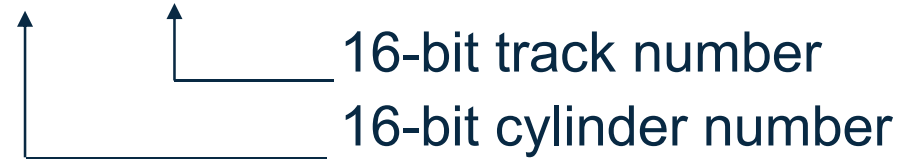
- **Extended addressing space (EAS)** the area on an EAV located above the first 65,536 cylinders.
  - 28-bit cylinder addressing (CCCCcccH)

Cylinders beyond first 65,536 cylinders

New track address format needed to access tracks in EAS

Old track address

- Existing track address format with 16-bit cylinder number (CCHH)



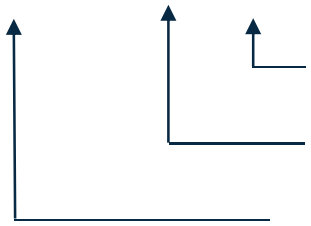
  - Today's supported maximum size volume is 65,520 cylinders, near the 16-bit theoretical limit of 65,535 cylinders

- To handle cylinder numbers greater than 65,520, a new format for the track address is required

New track address

- 28-bit cylinder numbers (Native track address)

CCCCcccH



H is 4-bit track number (0-14)
ccc is high-order 12 bits of 28-bit cylinder number
CCCC is low-order 16 bits of 28-bit cylinder number

- The cylinder number is in a **non-contiguous** form
- This format preserves the 3390 track geometry
- Track addresses for space in ***track-managed space*** will be comparable to today's track addresses
- Track addresses for space in ***cylinder-managed space*** will *NOT* be comparable to today's track addresses
- This is the format used by the access method, extent descriptors, channel programs, and in the DS8000, to access a track

Normalized track addresses

- *Normalized* cylinder-track address (to be used only for printing)

  cccCCCC:H

  H is 4-bit track number (0-14)

  cccCCCC is 28-bit cylinder number in a contiguous (normal) form

  - The colon shows that it is a normalized address

- Not all messages/reports will normalize the track-addresses
  - Reports in the native format (unchanged)
    - LISTCAT (example in backup), LISTDATA PINNED
  - Reports and command responses changed to display larger cylinder numbers
    - IEHLIST LISTVTOC FORMAT (example in backup)
      - Data set and free space extents

Manipulation of track addresses

- Any arithmetic operation other than ‘compare equal’ needs to be changed.
- **New TRKADDR macro**
  - Use new TRKADDR macro for all track address comparisons and calculations. Programs should not need to do their own 28-bit cylinder manipulation.
    - Function types
      - ABSTOREL, COMPARE, EXTRACTCYL, EXTRACTTRK, NEXTTRACK, NORMALIZE, NORMTOABS, RELTOABS, SETCYL
    - Use for all operations
- **New IECTRKAD routine**
  - For programs that are written in a high level language such as C, C++, Cobol or PL/I can call this routine using same TRKADDR functions.

EAS Eligible data set sets in z/OS

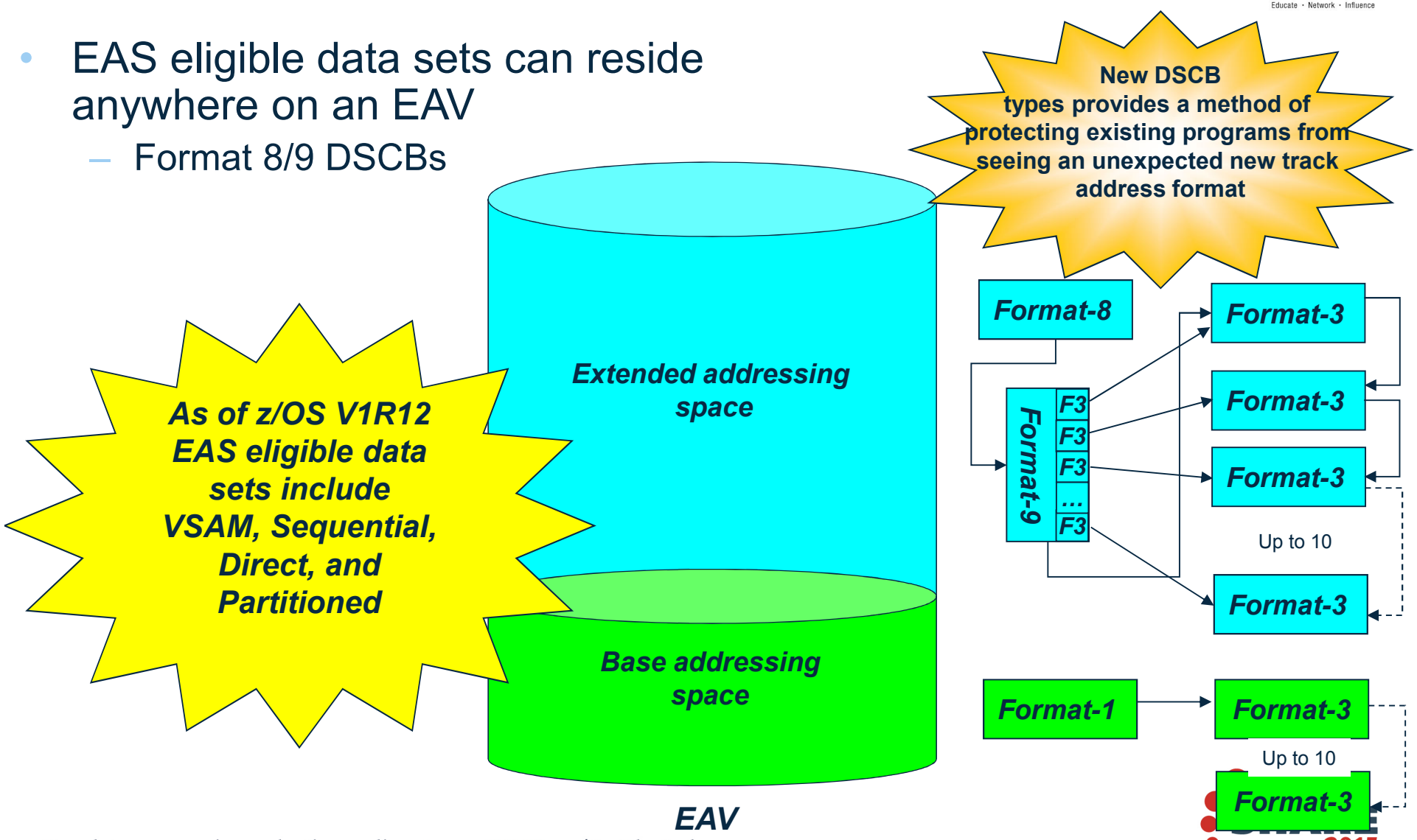
- EAS Eligible: A data set that is eligible to have extents in the extended addressing space and described by extended attribute DSCBs (Format 8/9)
- Can reside in track or cylinder-managed space
- SMS-managed or non-SMS managed
- Any data set type can reside in track-managed space
- Data set types supported
  - VSAM data types (KSDS, RRDS, ESDS and linear)
    - This covers DB2, IMS, CICS, zFS and NFS
    - CA sizes: 1, 3, 5, 7, 9 and 15 tracks
  - Sequential (Extended Format)
  - Sequential (Basic and Large Format)
  - Direct (BDAM)
  - Partitioned (PDS, PDSE)
  - Catalog (VVDS and BCS)

Non-EAS eligible data set list

- A data set that may exist on an EAV but is not eligible to have extents (through create or extend) in the extended addressing space or have extended attribute DSCBs (Format 8/9)
  - The following data sets are not EAS eligible:
    - VSAM data sets with incompatible CA sizes
    - VTOC (continues to be restricted to within first 64K-1 tracks)
    - VTOC index
    - Page data sets
    - VSAM data sets with IMBED or KEYRANGE attributes
    - HFS file system
    - XRC Control, Master or Cluster non-VSAM data sets
      - State data set EAS eligible in z/OS V1R12
      - Journal data set EAS eligible in z/OS V1R11 and V1R12

Access to EAS eligible data sets on EAV

- EAS eligible data sets can reside anywhere on an EAV
  - Format 8/9 DSCBs



How to access extended attribute DSCBs

- Code EADSCB=OK to access extended attribute data set control blocks (DSCBs)
  - EADSCB=OK indicates that program understands 28-bit cylinder numbers and Format 8 and 9 DSCBs.
  - OBTAIN (CAMLST), CVAFDIR, CVAFFILT, CVAFSEQ, DCBE (open for EXCP processing, open VTOC), CVAFDSM
    - Not specifying EADSCB=OK will cause these services to fail
- **Recommendation: code keyword on all invocations**

Allocating Space on EAV

- EAV can be SMS-managed or non-SMS managed
  - Mix of EAV, non-EAV in storage groups supported
  - Specific and non-specific targets
  - With no changes VSAM files allocated to an EAV will be EAS eligible
- USEEAV(YES|NO) controls whether EAV is allowed for data set initial allocations and EOV extends to new volumes.
  - SMS parmlib, change via SETSMS command
  - Can prevent EAV usage for all SMS, non-SMS requests

- Break Point Value (BPV) directs the preferred placement of EAS-eligible data sets on EAV. SMS storage group, SMS parmlib, SETSMS command
  - Value in cylinders
  - Cylinder-managed space is preferred if requested space >= BPV
  - Track-managed space is preferred if requested space < BPV
  - System default is 10 cylinders

Allocating Space on EAV (cont)

- Space is rounded up to next multi-cylinder unit if the extent is allocated in cylinder-managed space
  - Individual extents must always start and end on multi-cylinder unit boundary in cylinder-managed space
- Space released on multi-cylinder unit boundaries
  - Partial release may release a portion or none of unused space
  - VSAM stripes must have a common release point (RBA)
- Exact space will be obtained if any extents are allocated in track-managed space
- An extent can straddle where cylinder-managed space begins
  - Useful for data sets that can only be a single extent
- If requested space is not available from the preferred managed space the system may allocate the space from both cylinder-managed and track-managed space
- To help consolidate extents, for SMS VSAM the current last extent will be enlarged if any of the newly acquired extents are contiguous to it

Planning and Best Practices

Planning Steps - Overview

- Specify **EATTR=OPT|NO** for data sets, as appropriate, to override system default for EAS eligibility
- Review migration considerations
- Utilize the **Generic Tracker Facility**
- Configure EAV volumes and add them to your storage group/pools
- Enable the use of EAV in your system
  - Review Best Practices
- Provide test environment to validate readiness
- Optionally migrate data

Planning: EATTR Data Set Attribute

- **EATTR** is a new data set attribute to specify whether extended attributes can be created for a data set
- Used to override system-determined EAS eligibility
- **NO** - No extended attributes
  - Data set cannot have extended attributes (Format 8 and 9 DSCBs) or optionally reside in EAS.
  - Default behavior for non-VSAM data sets in z/OS V1R11 and higher.
- **OPT** - Extended attributes are optional
  - Data set can have extended attributes and can optionally reside in EAS.
  - Default behavior for VSAM data sets in z/OS V1R11 and higher.

- Specifiable in AMS DEFINE CLUSTER and ALLOCATE, JCL, dynamic allocation, data class and ISPF

Migration Considerations - EATTR

Open ABENDS with EATTR

- **Abend IEC142I 113-44**
  - An attempt was made to open an EAS eligible data set on a volume with more than 65,520 cylinders but the DCBE flag, DCBEEADSCBOK, indicating that the caller understands extended attribute (Format 8/9) DSCBs was not set.
    - Includes OPEN for EXCP and OPEN for BDAM with OPTCD=A. (Note: DCBEEADSCBOK not required with OPEN for BSAM or QSAM)

- **Abend IEC142I 113-48**
  - An attempt was made to open the VTOC on a volume with more than 65,520 cylinders, but the DCBE flag, DCBEEADSCBOK, indicating that the caller understands extended attribute (Format 8/9) DSCBs was not set.

- **Abend IEC023I 237-28**
  - During EOV concatenation, a Format 8 DSCB was read for a data set that was EAS eligible but EADSCB=OK on the DCBE macro was not specified

- In all cases specify EADSCB=OK on DCBE and correct programs to process 28-bit cylinder numbers correctly

Migration to EAV considerations

- Upgrade system service calls that read DSCBs, read free space or attempt to OPEN the VTOC or a VSAM data set with EXCP access
  - OBTAIN, CVAFDIR, CVAFDSM, CVAFVSM, CVAFSEQ, CVAFFILT, OPEN to VTOC, OPEN EXCP
    - Add EADSCB=OK to indicate support for Format 8 DSCBs and 28-bit cylinder numbers that may be present in extent descriptors and free space
- Optionally upgrade system service calls to use new information that describes an EAV
  - LSPACE, DEVTYPE, IDCAMS DCOLLECT
- Upgrade programs that parse formatted output that has changed with EAV
  - IEHLIST LISTVTOC, IDCAMS LISTCAT, IDCAMS LISTDATA PINNED

Migration to EAV considerations (con't)

- Utilize SMF records to identify programs that may need to be changed
- Upgrade programs that utilize changed SMF records or access the VVDS to support 28-bit cylinder
- Upgrade programs that process the VTOC index to support the larger sized space map records

- See reference material for additional information

Utilize the Generic Tracker

- DFSMS EAV code implemented to record ‘instances’ by the Generic Tracker Facility, an optional z/OS started task, GTZ
- GTZ identifies programs making non-compliant system service invocations
- No need for installation or availability of any physical EAVs when run
  - For example, it will report instances for data sets (VSAM, non-VSAM) where EADSCB=OK has not be specified on system services, which would otherwise be failed by z/OS if executed upon an EAV
- Use Generic Tracker externals to collect and report such instances:
  - S GTZ ….. The STC uses member GTZPRMxx of PARMLIB
  - DISPLAY GTZ, TRACKDATA | EXCLUDE | STATUS | **DEBUG (unknown instances)**
  - SETGTZ TRACKING | DEBUG | CLEAR | EXCLUDE
  - GTZPRINT is the batch reporting utility; GTZQUERY is a batch API
  - SET GTZ=xx to change the GTZPRMxx parmlib configuration settings
- On pre-z/OS V2R1 systems use the Console Tracking Facility

DFSMS Generic Tracker Instances

- EAV instances recorded by the Generic Tracker Facility
- Instances recorded by job, program, program offset, ASID, etc...
  - Identify interfaces that access the VTOC and should be upgraded to have EADSCB=OK **(Errors)**
    - OBTAIN, CVAFDIR, CVAFDSM, CVAFVSM, CVAFSEQ, CVAFFILT, OPEN to VTOC, OPEN EXCP
  - Identify the possible improper use of returned information, like parsing 28-bit cylinder numbers in output as 16-bit cylinder numbers **(Warning)**
    - IEHLIST LISTVTOC, IDCAMS LISTCAT, IDCAMS LISTDATA PINNED
  - Identify programs that may want to use new services **(Informational)**
    - LSPACE, DEVTYPE, IDCAMS DCOLLECT

Generic Tracker – EAV instances recorded by DFSMS

EVENTDESC: (in tracker)	Description
SMS-E:1 CVAFDIR STAT082	Error CVAFDIR no EADSCB=OK
SMS-E:1 CVAFDSM STAT082	Error CVAFDSM no EADCSB=OK
SMS-E:1 CVAFFILT STAT086	Error CVAFFILT no EADSCB=OK
SMS-E:1 CVAFSEQ STAT082	Error CVAFSEQ no EADSCB=OK
SMS-E:1 DADSM OBTAIN	Error OBTAIN no EADSCB=OK
SMS-E:1 DCB OPEN EAS 113-44	Error OPEN EAS Eligible no EADSCB=OK
SMS-E:1 DCB OPEN VTOC 113-48	Error OPEN VTOC with no EADSCB=OK
SMS-I:3 DEVTYPE	Informational, new fields available
SMS-I:3 IDCAMS DCOLLECT	Informational, new fields available
SMS-I:3 LSPACE EXPMSG=	Informational, new fields available
SMS-I:3 LSPACE MSG=	Informational, new fields available
SMS-W:2 IDCAMS LISTDATA PINN	Warning, formatted output changed
SMS-W:2 IDCAMS LISTCAT	Warning, formatted output changed
SMS-W:2 IEHLIST LISTVTOC	Warning, formatted output changed

Generic Tracker Usage

- **Starting the Generic Tracker**
  - S GTZ=xx, where xx is the GTZPRMxx PARMLIB member suffix
  - GTZPRMxx member that specifies the SETGTZ TRACKING=ON command (may issue from console or use system automation)
- **Excluding instances**
  - SETGTZ EXCLUDE command
  - EXCLUDE statements in GTZPRMxx in PARMLIB
- **Displaying the GTZ heart beat and tracking data**
  - D GTZ,STATUS (heart beat of the GTZ started task and instance count)
  - D GTZ,TRACKDATA (avoid: possible console buffer exhaustion if recorded instance data are voluminous - D GTZ,STATUS first)
  - GTZPRINT (batch, fast, and writes instance data to disk or spool)

Generic Tracker - Examples

- Excluding instances (sample) – (GTZPRMxx latest version can be found at http://www.ibm.com/systems/z/os/zos/downloads/)

  SETGTZ EXCLUDE command or EXCLUDE statements in GTZPRMxx PARMLIB

```
/* ISPF EXPMSG= */
 EXCLUDE(
  EVENTDESC='SMS-I:3 LSPACE EXPMSG=*'
  HOMEJOB=*
  PROGRAMTYPE=NOPATH PROGRAM=ISRUDA
 )
```

- Can wildcard EVENTDESC='SMS-I*'
  - Excludes all DFSMS informational instances for EAV

- Displaying tracking data (sample) – Warning: Console Buffers Exhaustion

  D GTZ,TRACKDATA

```
-------------------------------------------------------------------------
 INSTANCE:      2                   COUNT:          2
 EVENTDESC:     'SMS-I:3 LSPACE EXPMSG='
 OWNER:         IBMCNZ              SOURCE:         CNZTRKR
 EVENTDATA:     x0000000000000000   x0000000000000803
 PROGRAM:       ISRUDA              PROGRAMOFFSET: x000000000003B69C
 HOMEJOB:       IBMUSER             HOMEASID:      x0034
 EVENTJOB:      IBMUSER             EVENTASID:     x0034
```

Generic Tracker Facility - Abundant Documentation

- GTZQUERY: A Callable Macro Service (API)
  - Can be used to post-process recorded instances data by a user program
- For DFSMS related tracked events see z/OS V2R2.1 *DFSMSdfp Advanced Services,* SC23-6861-01
- See the z/OS Downloads web site for the most current copy of the GTZPRMxx member
- See z/OS Generic Tracker Facility documentation in *z/OS MVS Diagnosis: Tools and Service Aids*, GA32-0905-00
- The GTZCNIDT conversion tool is available to convert pre-V2R1 version CNIDTRxx parmlib records to the newer z/OS 2.1 GTZPRMxx parmlib format
- Generic Tracker instances can be converted into zOS Health Checks with the sample GTZSHCK program

Configure an EAV and Enable

- **Configure Storage Subsystem**
  - Select 3390 Model A
    - Not a new device type
    - From 1 to more than 65,520 cylinders
    - In increments of 1,113 cylinders

- **Enable the use of EAVs in your software environment**
  - IGDSMSxx PARMLIB member
    - USEEAV(YES|**NO**)
      - YES, new allocations on EAVs are permissible
    - BreakPointValue (0-65520)
      - Preferred allocation placement (based on cylinders) in track- vs cylinder-managed space
      - Also, avail at Storage Group level

Best Practices

Best Practice – General

- Run the Generic Tracker for EAV on target workloads
  - Start off with capturing/analyzing ‘error’ instances first
  - Then follow up on ‘informational’ and ‘warning’ instances as applicable
    - For example, With 1-TB EAVs, the LSPACE message response invocation needs the XEXPMSG to return correct values
- Review SMP/E fix category IBM.Function.EAV for support levels
- Consult the software developers support table for EAV support
  - http://www-03.ibm.com/systems/z/os/zos/software/isv113.html
- Use TRKADDR macro for comparison and manipulation of track addresses

Best Practice - Configure an EAV - Existing volume

- Expand an existing volume on DS8000 with dynamic volume expansion (DVE)
  - Use DS8000 Storage Manager or DSCLI to expand existing volume
  - Any existing 3390 volume can be expanded in place
    - Converted to 3390 Model A
    - ***Capacity in same extent pool must be available***
    - Expand to any size
  - Volume remains online and accessible to applications without moving data
  - Reduces complexity of moving data to larger volumes
    - No need for target volume being available
  - Copy services relationships (e.g. FlashCopy) must first be withdrawn
  - Use ICKDSF REFORMAT REFVTOC to update VTOC and VTOC index to access new cylinders since it's non-disruptive

Best Practice - Configure an EAV - Existing volume (cont)

- Consider taking advantage of Dynamic VTOC Refresh
  - Enabled with F DEVMAN,ENABLE(REFVTOC)
  - Queried with F DEVMAN,REPORT
- With DVE, the system will detect the change in size and automatically invoke the reformat command to rebuild/refresh the VTOC/index to take advantage of the newly acquired cylinders.
  - **All systems** in the sysplex will be updated with the new size based on an ENF (Event Notification Facility) signal.
  - DFSMShsm listens for the signal to update its structures!
  - CVAF (Common VTOC Access Facility) calls SMS directly to update its structures!

Best Practice – Setting up to use EAV

- Verify with the Generic Tracker that applications and vendor software will function properly with an EAV
  - Use TRKADDR macro, and IECTRKAD callable service for track calculations
  - Add EADSCB permission keywords on effected system services
- Add EAVs to SMS storage groups, storage pools/esoteric, update ACS routines
- USEEAV(YES|NO) controls whether EAV is allowed for data set initial allocations and EOV (End of Volume) extends to new volumes
  - Can prevent EAS usage for all SMS, non-SMS requests
    - Specified in IGDSMSxx PARMLIB member
    - Changed with SETSMS USEEAV(YES|NO)
    - It's a back out method if needed
      - Existing data would still be accessible

Best Practice – Setting up to use EAV

- Determine the Break Point Value (BPV)
  - Directs the preferred placement of EAS-eligible data sets on EAV.
  - Set by storage group or SMS PARMLIB/SETSMS command to define system default
    - System default of 10 cylinders
    - 0 value says any space amount prefers EAS
    - 65520 says no space amount prefers EAS
  - Set it large enough to minimize your average over allocation percentage
    - Larger value drives % over allocation smaller
  - Set it small enough to have large percentage of allocations prefer EAS
    - Smaller value drives % of allocations larger
  - Application should drive BPV, 21 and 100 used often

Best Practice – Setting up to use EAV

- Standardize volume initialization (ICKDSF) values
  - Initialize volume with an VTOC index
  - Define larger VTOCs to allow for growth
  - Allocate dummy data set adjacent to VTOC to reserve space as an expansion area
    - Allows future non-disruptive ICKDSF EXPAND VTOC
  - Don't specify index size parameters as ICKDSF will determine the needed size based on the VTOC size

Best Practice – Setting up to use EAV

- ***NEW* ICKDSF options (Release 17, GC35-0033-39)**
  - **APAR PM76231**
    - Protect online devices from disruptive commands and provides the ability to query which system(s) have pathing established to a device
  - **VERIFYOFFLINE parameter**
    - Optional parameter on the INIT and REFORMAT commands to verify that the device is offline to all other systems before the command is attempted.
    - Command not allowed to continue if verification fails
  - **HOSTACCESS parameter**
    - Optional parameter on the ANALYZE command to obtain host information for the accessed device
      - UNIT(devnum) or new DEVADDR(lss,cca) parameter

Best Practice – Setting up to use EAV

- ***New*** Use HyperPAV (Parallel Access Volumes - Aliases)
  - So, how many do we need?
  - "How many devices are busy at any one time?" - that is your number of aliases to be defined!
    - I/O arrival rate per second * Average service time = Average number of concurrent UCB accesses per second
  - Use all 256 unit addresses in LSS
    - 3-to-1 base- to-alias ratio is typical (192 base addresses, 64 aliases)
    - Allow for peaks or growth then a lower ratio may be needed (i.e. more aliases)
  - Use RMF HyperPAV Information in 74.1 and 78.3 to monitor

Best Practice – Setting up to use EAV - Performance

- **OBTAIN (SVC 27) and CAMLST (SVC 26)**
  - New option, NUMBERDSCB=n on each macro
    - If n > 0 and the DSCB is a format 1 or 8 DSCB, then you wish to read the logical chain of DSCBs that begins with that DSCB. They are chained with the DS1PTRDS field, which contains the CCHHR type of address of the next DSCB.
    - Consecutive 140-byte areas must be passed
    - SEARCH requests return of additional bytes
      - Possible migration item if program provides 101 bytes of return area

- **CVAFDIR**
  - New parameter MULTIPLEDSCBS=YES|**NO**
    - YES - Process multiple buffers in the first buffer list if there are any for reads and writes. They will contain as many of the whole chain of DSCBs for one data set as possible and must begin with a format 1 or 8 DSCB

Best Practice – Setting up to use EAV – New Data

DEVTYPE (SVC 24) macro

- Obtains device characteristic information about I/O devices
  - DEVTYPE non-INFOLIST calls
    - Returns a 2-byte value for the number of cylinders
      - Not valid for an EAV
  - DEVTYPE INFO=DASD (INFOLIST calls)
    - Existing call
    - Returns a 4-byte value for the number of cylinders
    - In addition it now returns ***new* data**
      - Multi-cylinder unit (MCU) value
      - First cylinder address where cylinder-managed space begins
      - Cylinder-managed space supported indicator
      - Extended attribute DSCBs supported indicator
      - Block size of index data set

Best Practice – Managing Data on EAV - DFSMShsm

- Space management will be performed using both the volume threshold (existing) and the track-managed threshold (new)
  - Track-managed threshold set via:
    - SMS: Storage Group
    - Non-SMS: ADDVOL Command
  - Track-managed threshold was added to ensure that track-managed space gets managed even when overall volume hasn't exceeded the threshold value

Track-Managed Threshold Exceeded	Volume Threshold Exceeded	Data Set Selection
Yes	**Yes**	**All Data Sets**
No	**Yes**	**All Data Sets**
Yes	No	**Only data sets with one or more of the first three extents in track-managed space**
No	No	**None**

Best Practice – Managing Data on EAV - DFSMShsm

- The DFSMShsm owned backup and migration (ML1 / ML2) volumes can be EAV space
  - Manage use with new option
    - SETSYS USECYLINDERMANAGEDSPACE(Y|N)
  - Recommend use of EAVs for ML1 Overflow
    - With larger files the over allocated space in EAS which is static space in these data sets becomes on average a small %un-used.
- DFSMShsm data sets that can be allocated in EAS
  - Journal (basic or large format sequential data sets)
  - Control data sets (CDS) and Journal backup data sets
  - Logging and PDA data sets
- DFSMShsm will support the data set level attribute EATTR for all EAV eligible data sets and process SMS and non-SMS recalls/recovers/arecovers accordingly

Best Practice – Managing Data on EAV - DFSMShsm

- Migration sub-tasking in z/OS V2R1
  - By processing data sets in migration subtasks for a level 0 volume migration task, the aggregate throughput of all the migration tasks is improved.
    - A **MIGRATIONSUBTASKS(YES | NO)** parameter on the SETSYS command allows DFSMShsm to run multiple subtasks concurrently under each migration task for primary space management, on-demand migration, and interval migration on level 0 volumes that migrate data sets to ML1 or ML2 volumes.
    - The **ADDITIONALSUBTASKS(nn)** sub-parameter allows you to dynamically change the number of additional subtasks that the system can use, running under each migration task.
      - These additional subtasks add to the number of subtasks that the system already uses when the MIGRATIONSUBTASKS parameter is specified.

Best Practice – Managing Data on EAV - DFSMShsm

- **DFSMS Storage Tiers Enhancements**
  - Today, Moving data to newly defined disk volumes within a storage environment can be manually intensive and cumbersome.
  - ***New enhancement in V2.2***: Enable the DFSMS Class Transition function to move data laterally to the same tier of storage, in addition to the ability of moving data to different tiers storage.
    - MOVE keyword added to the MIGRATE DSNAME, VOLUME and STORAGEGROUP commands
      - Every data set will be processed, regardless of management class policy or threshold, and ACS routines will be invoked to determine the new storage class and/or storage group.
      - **Use Case:** Move DB2 data from existing smaller volumes to the new larger, newly defined EAVs.

  ? **Why it Matters:** Simplify the task of migrating data to newly defined disk volumes.

- **For more details, see Session 17102: Transitioning to Transitions, Wednesday 3:15PM**

Best Practice – Using EAV – Catalog/IDCAMS

- BCS (basic catalog structure) data sets EAS eligible
- DEFINE UCAT or MODEL – ICFCATALOG and VOLCATALOG objects
  - **EATTR(NO)** – Can not have extended attribute DSCBs or optionally reside in EAS
  - **EATTR(OPT)** – Can have extended attribute DSCBs and optionally reside in EAS
    - Both recorded in the VVDS for the catalog objects and in the DSCBs that get created in the VTOC
    - Catalog object restricted to track-managed space when EATTR is not specified. This is the action taken by the system today for catalog defines.
    - No EATTR option in pre z/OS V1R12 systems
    - EXPORT/IMPORT preserves EATTR value across systems

Best Practice – Using EAV – Catalog/IDCAMS

- VVDS (VSAM volume data sets) data sets EAS eligible
- DEFINE CLUSTER for VVDS object
  - **EATTR(NO)** – Can not have extended attribute DSCBs or optionally reside in EAS
  - **EATTR(OPT)** – Can have extended attribute DSCBs and optionally reside in EAS
    - Both recorded in the DSCBs that get created in the VTOC
    - VVDS objects restricted to track-managed space when EATTR is not specified. This is the action taken when VVDS is allocated by the system.
    - No EATTR option in pre-z/OS V1R12 systems
    - Data Class/Model does not apply to a DEFINE of a VVDS
      - Only way is with the EATTR keyword

Best Practice – Using EAV - DFSORT

- DFSORT data sets that can be allocated in EAS (DFSORT V1R12)
  - SORTIN, SORTOUT, OUTFIL
    - Maximum size of large format sequential supported
  - SORTWK
    - If basic format sequential
      - Limited to 65,534 tracks
    - If large format sequential
      - Limit now up to 16 million blocks (tracks)
      - Larger can be allocated but excess will not be used
      - Less in a resource-constrained environment

Best Practice – Using EAV– New Command

- DFSMSdss Consolidate command
- Performs data set extent consolidation, reducing the number of extents. It allows you to specify which data sets are to be included.
  - Attempts to relocate multiple non-contiguous data set extents into contiguous space within each managed-space
    - Reduces the number of extents of a data set as much as possible even when the entire data set cannot be reduced to one extent
  - Supports the same type of data set filtering as COPY, DUMP, and RESTORE functions.
- No need to DEFRAG volume to consolidate extents

Best Practice – Data Migration

DFSMSdss

- Migrating non-VSAM data sets to EAV and having them eligible to be allocated in the EAS
  - Need to override EATTR=NO or its default
  - Use dynamic patch available in DSS
    - Override source EATTR to OPT for non-VSAM data sets during logical COPY (OA42848)
      - UA70890-V1R12, UA70891-V1R13, UA70892-V2R1

```
//STEPT006 EXEC PGM=ADRDSSU,PARM='UTILMSG=YES'
//SYSPRINT DD SYSOUT=*
//SYSIN    DD *
  SET PATCH 5B=FF                    /* enable source eattr override    */
  COPY                               /* move data set to EAV            */ -
    DS(INCL(PATCHX5B.MIG.EAV))       /* data set to be moved            */ -
    FR(PREF)                         /* prefer fast replication         */ -
    FCTOPPRCPRIMARY(PMR)             /* ensure mirror stays full duplex */ -
    DEBUG(FRMSG(DTL))                /* detailed fast replication msgs  */ -
    STORCLAS(SCMIXTGT)               /* target storage class            */ -
    ADMIN                            /* bypass authorization checking   */ -
    DELETE                           /* delete source when finished     */
  SET PATCH 5B=00                    /* disable source eattr override   */
/*
```

Best Practice - Global Mirror and EAVs

- EAVs transparent to Global Mirror (GM)
- GM not exposed to FlashCopy device MIH timeouts
  - FlashCopy operations outside of GM need SDM APAR OA44461, and AOM APAR OA44843 to mitigate MIH timeout exposures
- Use SSD and enterprise type drives
  - No near line type drives as bit map operations will be reflected back in GM performance
- GM users are rapidly adopting using EAVs
- Larger sized volumes work well with GM

Best Practice - zGlobal Mirror and EAVs

- Good copy services performance depends on volume usage being reasonably well balanced.
  - When using larger volume sizes, it is better to distribute the larger volumes among many LCU's (LSS's) than to concentrate them all on a small number of LCU's.
- Elapsed time for initial copy is directly proportional to volume size.
  - Expect larger volumes to take longer for initial copy.
- Elapsed time for re-sync after a suspend is proportional to the amount of data changed while suspended.
  - If there is good balance between volumes in production, then the impact of large volumes on re-sync duration is minimal.
  - If large amounts of data are updated on few volumes, then those volumes will dominate the resync time regardless of volume size.
- Large volumes may receive a lot of sequential data which modifies large extents of tracks.
  - In that case, using the XRC PARMLIB parameter "SelectionAlgorithm(SIZE)" causes large volumes to be resynchronized first to maximize the ability to use parallelism.

Best Practice – Misc items

- Volume performance scales well with larger volumes
  - Overall EAV support in DFSMS reduces volume contention
  - HyperPAV reduces/eliminates IOSQ
  - However, may lose parallelism of volume functions during ramp down of that function
- Larger volumes
  - Fewer UCBs
  - Fewer volume statistics to manage
  - Less multi-volume data sets
- Allocating in multi-cylinder units
  - Reduces fragmentation
  - May reduce extends as over-allocated space useable

Thank You!

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Backup / Reference Material

Terminology

Note: Two sets of terms are to be used reference an EAV. One to describe how space is managed and the other to describe how the disk is addressed. The context of what is being described will dictate which terminology to use.

- **extended address volume (EAV).** A volume with more than 65,520 cylinders. Only 3390 Model A devices can be an EAV.
- **track address**: A 32 bit number that identifies each track within a volume. It is in the hexadecimal format CCCCcccH, where CCCC is the low order 16 bits of the cylinder number, ccc is the high order 12 bits of the cylinder number, and H is the four-bit track number. For compatibility with older programs, the ccc portion is hexadecimal 000 for tracks in the base addressing space.
- **extended addressing space (EAS**). On an extended address volume, the cylinders whose addresses are equal to or greater than 65,536. These cylinder addresses are represented by 28-bit cylinder numbers.
- **base addressing space**. On an extended address volume, the cylinders whose addresses are below 65,536. These cylinder addresses are represented by 16-bit cylinder numbers or by 28-bit cylinder numbers whose high order 12 bits are zero.
- **multicylinder unit**. A fixed unit of disk space that is larger than a cylinder. Currently, on an EAV, a multi-cylinder unit is 21 cylinders and the number of the first cylinder in each multi-cylinder unit is a multiple of 21.
- **cylinder-managed space**. The space on the volume that is managed only in multi-cylinder units. Cylinder-managed space begins at cylinder address 65,520. Each data set occupies an integral multiple of multi-cylinder units. Space requests targeted for the cylinder-managed space will be rounded up to the next multi-cylinder unit. The cylinder-managed space exists only on EAV volumes.
- **track-managed space**. The space on a volume that is managed in tracks and cylinders. Track-managed space ends at cylinder address 65,519. Each data set occupies an integral multiple of tracks. Track-managed space also exists on all non-EAV volumes.
- **breakpoint value (BPV**). When a disk space request is this size or more, the system prefers to use the cylinder-managed space for that extent. This applies to each request for primary or secondary space for data sets that are eligible for the cylinder-managed space. If not enough cylinder-managed space is available, then the system will use the track-managed space or will use both areas. The breakpoint value is expressed in cylinders. When the size of a disk space request is less than the breakpoint value, the system prefers to use the track-managed area and if enough space is not available there, then the system will use the cylinder-managed space or will use both areas.

Sample external – LISTCAT output

```
 LISTC ALL ENT(VTS5OCJ5.V1P9802.VSAM.D000200)
. . .
. . .
  ALLOCATION
    SPACE-TYPE---------TRACK     HI-A-RBA--------13066240
    SPACE-PRI----------315       HI-U-RBA----------20480
    SPACE-SEC----------1
  VOLUME
    VOLSER-----------1P9802      PHYREC-SIZE--------10240     HI-A-RBA--------13066240     EXTENT-NUMBER----------2
    DEVTYPE------X'3010200F'     PHYRECS/TRK------------5     HI-U-RBA----------20480      EXTENT-TYPE--------X'00'
    VOLFLAG------------PRIME     TRACKS/CA--------------1
     EXTENTS:
     LOW-CCHH-----X'68DB0010'      LOW-RBA----------------0      TRACKS----------------315
     HIGH-CCHH----X'68EF001E'      HIGH-RBA--------12902399
     LOW-CCHH-----X'10FC0001'      LOW-RBA---------12902400      TRACKS------------------4
     HIGH-CCHH----X'10FC0004'      HIGH-RBA--------13066239
```

Sample external - LISTVTOC

```
 CONTENTS OF VTOC ON VOL 1P9802  <THIS IS AN SMS MANAGED VOLUME>
 FORMAT 4 DSCB NO AVAIL/MAX DSCB /MAX DIRECT  NO AVAIL  NEXT ALT   FORMAT 6  LAST FMT 1     VTOC EXTENT        THIS DSCB
           VI   DSCBS    PER TRK  BLK PER TRK  ALT TRK   TRK(C-H)   (C-H-R)   DSCB(C-H-R)/LOW(C-H) HIGH(C-H)    (C-H-R)
           81   65499       50         45         0         0  0          1279  14  50    0   1  1279  14     0   1   1
          NUMBER OF   MULTICYLINDER UNITS
          CYLINDERS   FIRST CYL ADDR  SPACE
             262668          65520      21
---------------DATA SET NAME----------------  SER NO  SEQNO  DATE.CRE  DATE.EXP  DATE.REF  EXT DSORG RECFM OPTCD BLKSIZE
BRS8AM02.HANDLIN.V1P9802.NVSAM.FILL.CB1       1P9802      1  2008.176    00.000    00.000    1  PS   FB     00     6320
SMS.IND   LRECL  KEYLEN  INITIAL ALLOC  2ND ALLOC    EXTEND       LAST BLK(T-R-L)  DIR.REM  F2 OR F3(C-H-R)  DSCB(C-H-R)
S            80           TRKS              1                      0   0 58786                                0   2  29
           EXTENTS  NO  LOW(C-H)    HIGH(C-H)
                     0 50901  9     50901 14
                            ----ON THE ABOVE DATA SET,THERE ARE          6 EMPTY TRACK(S).
---------------DATA SET NAME----------------  SER NO  SEQNO  DATE.CRE  DATE.EXP  DATE.REF  EXT DSORG RECFM OPTCD BLKSIZE
BRS8AM02.HANDLIN.V1P9802.VSAM.FILL.D1.DATA    1P9802      1  2008.176    00.000    00.000    1  VS   U      80     4096
SMS.IND   LRECL  KEYLEN  INITIAL ALLOC  2ND ALLOC    EXTEND       LAST BLK(T-R-L)  DIR.REM  PTR TO F3(C-H-R)  DSCB(C-H-R
S            0           CYLS              0                                                                  2   3  13
                                                      VENDOR
EATTR   JOB         STEP       CREATE TIME       CODE  DATA
OPT     JOB1GALA    STEP0001   01:28:58.673275     1   X'11223344'    2  X'556677'  255  X'88'
EXTENTS  NO       LOW(C-H)       HIGH(C-H)
          0     193704  0      193724 14
                            ----UNABLE TO CALCULATE EMPTY SPACE.
VPSM               A = NUMBER OF TRKS IN ADDITION TO FULL CYLS IN THE EXTENT
           TRK       FULL              TRK       FULL              TRK       FULL              TRK       FULL
          ADDR       CYLS  A          ADDR       CYLS  A          ADDR       CYLS  A          ADDR       CYLS  A
        3784725         42  0       3785670         63  0       3786930         21  0       3787560         42  0
        3788505         63  0       3789765         21  0       3790395         42  0       3791340         63  0

 THERE ARE     52290 EMPTY CYLINDERS PLUS  4590 EMPTY TRACKS ON THIS VOLUME
 THERE ARE 12852 EMPTY CYLINDERS PLUS  4590  EMPTY TRACKS FROM THE TRACK-MANAGED SPACE
 THERE ARE  957221 BLANK DSCBS IN THE VTOC ON THIS VOLUME
```

New fields and extent descriptors for data and free space adjusted to support larger cylinder numbers

Sample external – track address in messages

- ***normalized*** track address - in the x'cccCCCC:H' format
  - ICKDSF and DSS messages (many)

```
ICK01795I TRACK X'cccc hhhh'|X'cccCCCC:H' IS CONTAINED IN DATA SET dataset

ADRY2500I TRACK NOT RESTORED DUE TO I/O ERROR DURING DUMP TRACK C-H =
          X'cccCCCC:H'
```

EAS eligible – Finding Affected Programs

- A product/program might be affected by this project if they do any of these (this list might be incomplete) AND they support processing a data set that is EAS-eligible:
  - Issuing an **OBTAIN** macro to read a DSCB for an EAS-eligible non-VSAM data set or issuing a macro whose name begins with "CVAF" for an EAS-eligible non-VSAM data set.
    - You must code a new EADSCB=OK option. For performance reasons, you might want also to exploit a new option to read all the DSCBs for a specified data set with one call.
  - Almost any channel program issued for an EAS-eligible non-VSAM data set will be affected. This includes both building it and monitoring it.
  - Use a track address for an EAS-eligible non-VSAM data set such as those in IOSEEK in the IOSB, IOBSEEK in the IOB or DS1EXT1 in the DSCB. As in the first release of EAV, these will contain 28-bit cylinder numbers.
    - You can use the TRKADDR macro from z/OS V1R10 to assist with these manipulations.
  - Use the BBCCHHR field in the I/O error text returned by the SYNADAF macro. This is in EBCDIC form. It is similar to text returned by VSAM.
  - The existing **DASDCALC** macro returns information about the space for a data set. It requires new options to return values in larger fields. This now will be relevant for an EAS-eligible non-VSAM data sets.
  - Calculating the size of an EAS-eligible VSAM or non-VSAM data set from the cylinder and track numbers of its extents. These cylinder and track numbers might be from a VTOC, DEB or from an access method internal control block.
    - The TRKADDR macro can assist with this calculation.

EAS eligible – Affected Programs cont.

- More to look for:
  - Examine programs that read VTOCs or DSCBs. On R10, programs designed to read an EAV VTOC expect to see Format 8 DSCBs for only VSAM data sets. On R11 those programs can also see Format 8 DSCBs for extended format sequential data sets. If you share EAVs between R10 and R11, you must avoid opening the non-VSAM data sets that have Format 8 DSCBs or you must prevent those data sets from being on those volumes.
  - Programs can read VTOCs or individual DSCBs with BSAM, QSAM, EXCP, OBTAIN, CVAFDIR and CVAFFILT. If your program opens an EAV VTOC, it must specify EADSCB=OK on the DCBE macro. This is the same as for EAV on R10. The following principles are the same as in R10 but now they apply also to extended format sequential data sets.
  - Examine these VTOC-reading programs to see whether they might be affected by seeing a Format 8 DSCB when they expected a format 1 DSCB or they might be affected by seeing a Format 9 DSCB when they expected a format 3 DSCB.
  - If your program issues the OBTAIN, CVAFDIR or CVAFFILT macro for a data set that has a Format 8 DSCB, then the macro must have EADSCB=OK.
  - If you create a non-VSAM data set on Release 11 on an EAV and you might want to use it on an earlier release, you should avoid EATTR=OPT for that data set. If the non-VSAM data set has a Format 8 DSCB, you cannot open it on a release before 11.
  - Examine programs that calculate the size of a data set on a volume. The value might be larger than the program has ever seen. The TRKADDR macro is available to assist with these calculations.
  - Although there are no intended programming interfaces for channel programs with extended format data sets, any such programs must take the 28-bit cylinder numbers into account as in R10. 28-bit cylinder numbers might be in a DSCB, IOB, or channel program. The TRKADDR macro is available to assist with manipulating track addresses.

Best Practice – Setting up to use EAV – Performance

- VTOC Index block size increased from 2048 bytes to 8192 bytes for devices with cylinder-managed space
  - Contents of index map records increased proportionally (more bits per record, offsets changed)
    - Extended header in VIXM used for keeping point-in-time free space statistics
      - No longer does it need to be calculated each time . . . By LSPACE
    - VPSM
      - Track-managed space: Small (tracks and cylinders) and large (cylinders) unit map. Same but more bits.
      - Cylinder-managed space: Each bit in large unit map represents 21 cylinders (a MCU).
  - Programs that access index maps must use existing self-describing fields in the map records

Best Practice – DSCB Metadata

Format 9 DSCB provide metadata for data set attributes.

Format 9 DSCB is mapped by the IECSDSL1 macro and it contains a 20-byte field DS9ATRV1 that IBM is reserving for vendors.

The format for this field is:

- Subfields that begin with the following two-byte header:

+0	Flags.	
	xxxx	Reserved
	 xxxx	Number of bytes following two-byte header
+1	Vendor code. IBM will maintain a vendor code list	

Vendor code of '1' is for local installation use

Free Space

- EAV free space information is provided for:
  - Total volume statistics (like today)
  - Track-managed statistics (new)
  - Computed and kept in the VTOC index data set
    - Provides quick access to free space information
- Two sets of free space statistics returned/reported by:
  - LSPACE, ISPF, ISMF, IEHLIST, DITTO, FILEMANAGER, OMEGAMON
    - Total Volume and Track Managed
- Total volume and track-managed space size
  - Returned in LSPACE and recorded in SMF type 19
  - Recorded in DCOLLECT records
    - SMS Volume Definition Record (Record type 'VL')
    - VOLUME record field (Record Type 'V')
- If non-EAV, track-managed statistics = total volume statistics

Sample external – Free Space Examples

IEHLIST LISTVTOC FORMAT information for a device with cylinder-managed space

```
FORMAT 4 DSCB NO AVAIL/MAX DSCB /MAX DIRECT  NO AVAIL  NEXT ALT   FORMAT 6 . . . .
          VI    DSCBS    PER TRK  BLK PER TRK  ALT TRK   TRK(C-H)    (C-H-R)
          81    65499       50         45         0         0  0
         NUMBER OF   MULTICYLINDER UNITS
         CYLINDERS   FIRST CYL ADDR  SPACE
            262668          65520      21
. . .
. . .
. . .

THERE ARE     52290 EMPTY CYLINDERS PLUS  4590 EMPTY TRACKS ON THIS VOLUME
THERE ARE 12852 EMPTY CYLINDERS PLUS  4590  EMPTY TRACKS FROM THE TRACK-MANAGED SPACE
```

Sample external – Free Space Examples

ISPF 3.4 VTOC sample display for device with cylinder-managed space . . .

```
                        VTOC Summary Information
Volume . : 1P9802

Unit . . : 3390                 Free Space

 VTOC Data                      Total              Tracks         Cyls
 Tracks  . :     19,199         Size  . . :       788,940        52,290
 %Used . . :          1         Largest . :           950            63
 Free DSCBS:    957,221         Free
                                Extents . :    1,704

 Volume Data                    Track Managed      Tracks         Cyls
 Tracks . :      3,940,020      Size  . . :       197,370        12,852
 %Used  . :             79      Largest . :           950            63
 Trks/Cyls:             15      Free
                                Extents . :      765
```

Best Practice – Setting up to use EAV – Performance/New Data/New keyword

- The LSPACE macro returns information about a DASD volume
  - Returned info can be in character or binary format.
    - New keywords XEXPMSG=*addr* and EXPDATA=*addr*
      - Returns free space information for total volume and for track-managed space
        - For all volumes
    - Total volume size and size of track-managed space is also returned
- New DATATYPE keyword

{ALL }	**Return all of the following information**
{VOLUME }	Return free space for volume
{VTOC }	Return free space for VTOC
{INDEX }	Return free space for index
{FRAGINDEX}	Return the fragmentation index

- New PLISTVER keyword
  - To manage the use of the longer LSPACE parameter list

Sample external – volume size

- Sample external of volume size from DEVSERV PATHS and QDASD operator commands

```
18.09.58 SYSTEM1           IEE459I 18.09.58 DEVSERV PATHS 600
 UNIT DTYPE  M CNT VOLSER  CHPID=PATH STATUS
      RTYPE  SSID CFW TC   DFW PIN DC-STATE CCA DDC       CYL CU-TYPE
 0F4A,3390A ,O,000,EV9LIA,00=+ 04=+
      2107  201F  Y  YY.  YY.  N  SIMPLEX   3A        1177554 2107
 ************************ SYMBOL DEFINITIONS ****************************
 O = ONLINE


09.36.34 SYSTEM1           IEE459I 09.36.34 DEVSERV QDASD 625
 UNIT VOLSER SCUTYPE DEVTYPE       CYL  SSID SCU-SERIAL DEV-SERIAL EFC
00F41 IN7996 2107921 2107900   1177554  2606 0113-03261 0113-03261 *OK
```

Sample external – DISKMAP (Share CBT)

```
 DISKMAP VERSION:20110201

1P9802                ALLOCATION MAP FOR VOLUME "1P9802" ON DEVICE "EB62" MOUNTE
DEVICE DESCRIPTION:  TYPE=3390 DISK PACK  NOCYLS=262668     TRKS/CYL=15   TRKSIZ
VTOC DESCR: R/W=0/0 DSCBS=318700 AVAIL=318696 VTOC EXT=0000.0001-01A8.000E   FMT
TOTAL FREE SPACE:    3927165 TRACKS IN          2 EXTENTS, INCL.    261811  FULL
TRK-MANAGED FREE:     969945 TRACKS IN          1 EXTENTS, INCL.     64663  FULL
 *** THIS PACK CONTAINS AN ACTIVE INDEXED VTOC
     TRACK-MANAGED SPACE (TMS) IS   1.3% FULL
     CYLINDER-MANAGED SPACE (CMS) IS   0.0% FULL
     THIS VOLUME IS   0.3% FULL (CMS+TMS)    ...

1P9802             TRACK ALLOCATION MAP FOR VOLUME "1P9802"
   CYL-TRACK   CYL-TRACK  FIRST TRK  LAST TRK      FIRST       LAST       #TRK  E
   _________   _________ _________ _________   ________   ________   _______ _
       0  0         0  0 0000000:0 0000000:0          0          0         1
       0  1       424 14 0000000:1 00001A8:E          1       6374      6374
     425  0       849 14 00001A9:0 0000351:E       6375      12749      6375
     850  0       856 14 0000352:0 0000358:E      12750      12854       105
     857  0     65519 14 0000359:0 000FFEF:E      12855     982799    969945
   65520  0    262667 14 000FFF0:0 004020B:E     982800    3940019   2957220
```

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QMF
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Rational*
RMF
System i
System z
System z9
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