



DFSMS SMStape: Overview

Session: 17811



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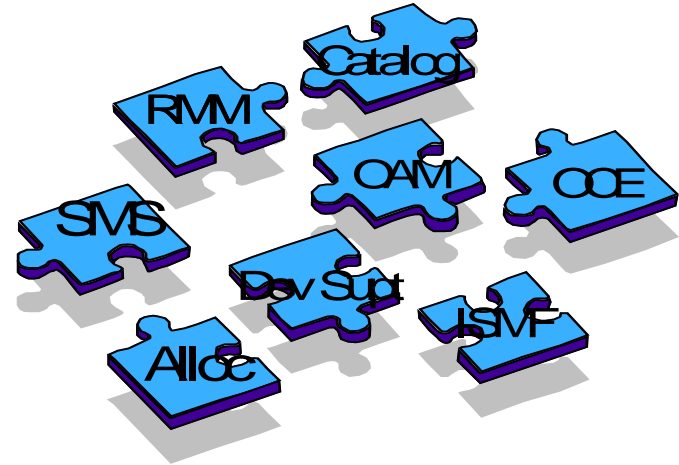
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Agenda

- Background
- Hardware Overview
- Support Overview
- Component Specifics



- **SMStape** was introduced in DFSMS/MVS 1.1.0 (1993) in support of IBM's first automated tape library
 - Multi-site, multi-component development effort
 - OAM, RMM, SMS, ISMF, Catalog, AMS, O/C/EOV, Checkpoint/Restart, AOM, Device Services, HSM, MVS allocation, IOS/DDR, Console Services, Scheduler, JES3, plus ISV support
- **SMStape** support expanded the concepts of SMS management to include tape volumes and tape libraries
 - With outboard policy management enabled at the library, the SMS policy names (**storage class, data class, management class and storage group**) are sent to the library for additional policy actions taken by the library

History ...

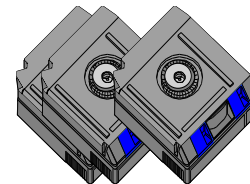
- Tape Libraries Supported
 - 3495 Tape Library Dataserver (1993)
 - <https://www.youtube.com/watch?v=GwMn7YpF8r8>
 - 3494 Tape Library Dataserver (1994)
 - 3494 Virtual Tape Library Dataserver (1997)
 - 3494 Peer-to-Peer VTS (2000)
 - Manual Tape Library (2000)
 - TS3500/3584 Tape Library Dataserver (2005)
 - TS7700/3957 Virtualization Engine (2006) – 3494 VTS replacement (TS7740, TS7720 and TS7720T)

Overview - Library

- Tape library is set of tape volumes and the tape drives where the volumes can be mounted
- Exclusive relationship
 - library-resident volume can only be mounted on the drives defined to that library
- Tape library can be automated (including virtual) or manual
- Each tape library supports multiple device types and media types



TS3500 (3584) Automated Tape Library



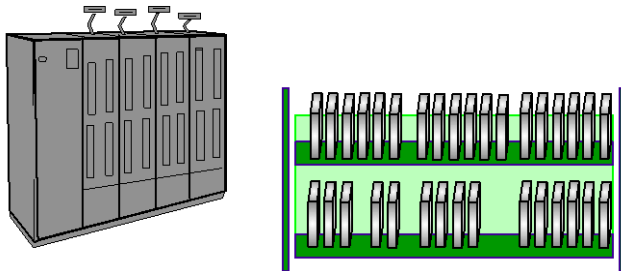
Automated Tape Library (ATL)

- IBM 3494 Tape Library
 - attaches to the host through a library manager interface
 - supports the 3490E, 3590, and 3592 model devices up to the E06
 - supports 3490E media types (MEDIA1 and MEDIA2), the 3590 media types (MEDIA3 and MEDIA4) and the 3592 media types (MEDIA5 – MEDIA10)

- IBM 3584 (TS3500) Tape Library
 - attaches to the host through the 3953 (library manager interface) or through the C07 tape control unit's integrated library manager support
 - supports the 3592 model devices up to the E07 (MEDIA5 – MEDIA13)

Manual Tape Library (MTL)

- System-managed tape without automation
- Enables group of stand-alone drives and volumes to be associated with a library*
- Supports multiple device types and media types per library (3480, 3490/3490E, 3590 and 3592 devices)
- Software-only solution (no library manager interface)
- Operator continues to mount and demount cartridges

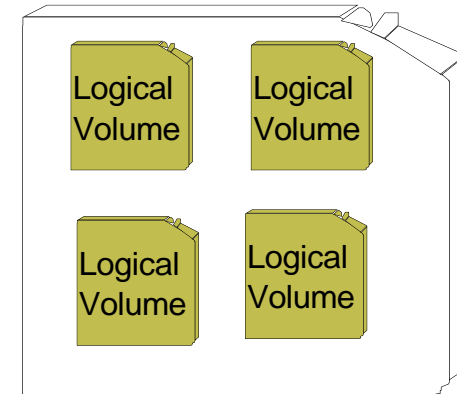


***Note: manual tape library support also used by customers to manage vendors' virtual tape libraries**

IBM Virtual Tape Concepts (VTS)

- Uses virtual tape drives emulating 3490E tape subsystems
- Uses logical tape volumes emulating CST (MEDIA1) or ECCST (MEDIA2) media
- Data written is originally stored in the tape volume cache (disk)
 - Data can be optionally migrated to physical tape
 - referred to as a **stacked volume**
 - each stacked volume can contain multiple logical volumes

Stacked Volume



IBM Virtual Tape Concepts (VTS) ...

- Data is written and read from the host as if it were stored on physical tape media
- Data that is referenced and no longer in cache will be recalled
- Management of data to and from cache is maintained outboard
- Supports exporting of logical volumes for disaster recovery
- Supports advanced policy management using SMS constructs
 - assigned constructs (data class, storage class, management class and storage group) are sent to library on the mount request

TS7700 (3957) Virtualization Engine

- Replacement for the older 3494 VTS
- Configured in a stand-alone or multi-cluster grid configuration for peer-to-peer capabilities across TCP/IP
 - each cluster within the grid has access to all the volumes
 - volumes are accessible from any cluster independent of where a copy exists
 - interconnect up to 6 clusters for high availability and multi-site disaster recovery capabilities
 - **local, metro and remote** distance capabilities

TS7740 – smaller disk cache with back store tape

TS7720 – larger disk cache now with optional back store tape (TS7720T)



→
TCP/IP

TS7700 (3957) Virtualization Engine

TS7700 Grid Configuration

- Policy Managed Replication (uses Management Class)
 - Each volume can have a copy in one or more clusters
 - Replication and copy mode policies (deferred, immediate, or synchronous) based on outboard policy definitions
 - Volume granular replication (unique MC policy can be assigned based on the job/application/workload)
 - Mix of copy mode policies supported (for example, synchronous mode copy for two copies and a third copy that is deferred)
 - Copies made outboard (transparent to host); not all TS7700s have to have a copy of the volume

TS7700 Grid Configuration ...

- Image to host is of a single library
 - referred to as a **composite library** with each physical library (cluster) referred to as a **distributed library**
 - Both composite and distributed libraries are defined in the SCDS
 - drives and volumes are associated with the **composite** library
 - **distributed** libraries mainly used for attention messaging and command routing
 - **recommendation** is to define the composite and all associated distributed libraries to the SCDS regardless of connectivity to the devices

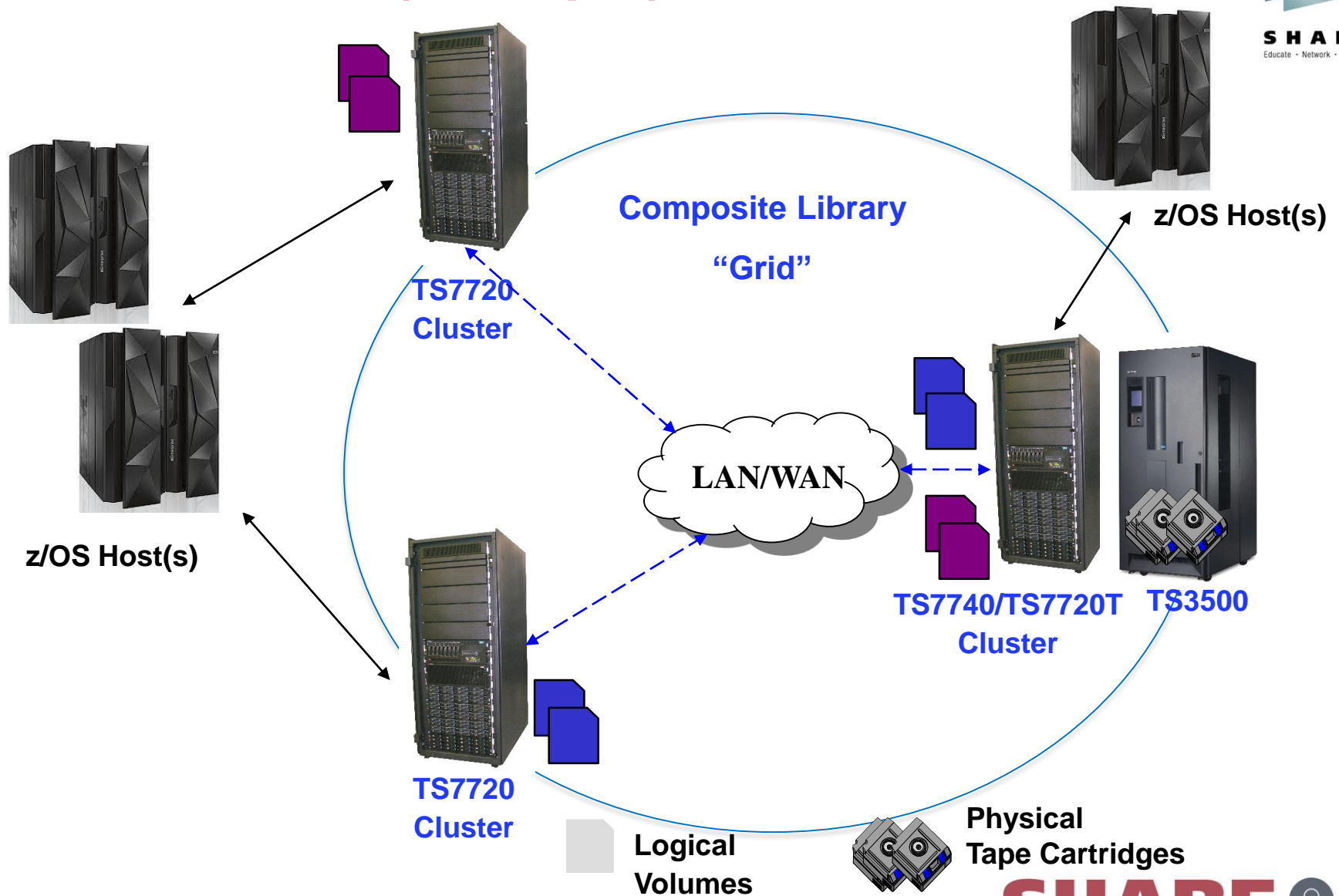
TS7700 Grid Configuration ...

- Allocation Assist Terminology
 - **Device Allocation Assist (DAA)** - for specific mounts, TS7700 returns prioritized list of clusters – for example, clusters with data in cache given higher preference
 - **Scratch Allocation Assist (SAA)** - for scratch mounts, TS7700 returns list of “candidate” clusters; enables customers to direct scratch allocations to specific clusters
 - **JES3 supported added in z/OS V2R1** - new DEVSUPxx enablement keyword and JES3 INISH deck changes for distributed libraries (LDXxxxxx)

TS7700 Grid Configuration ...

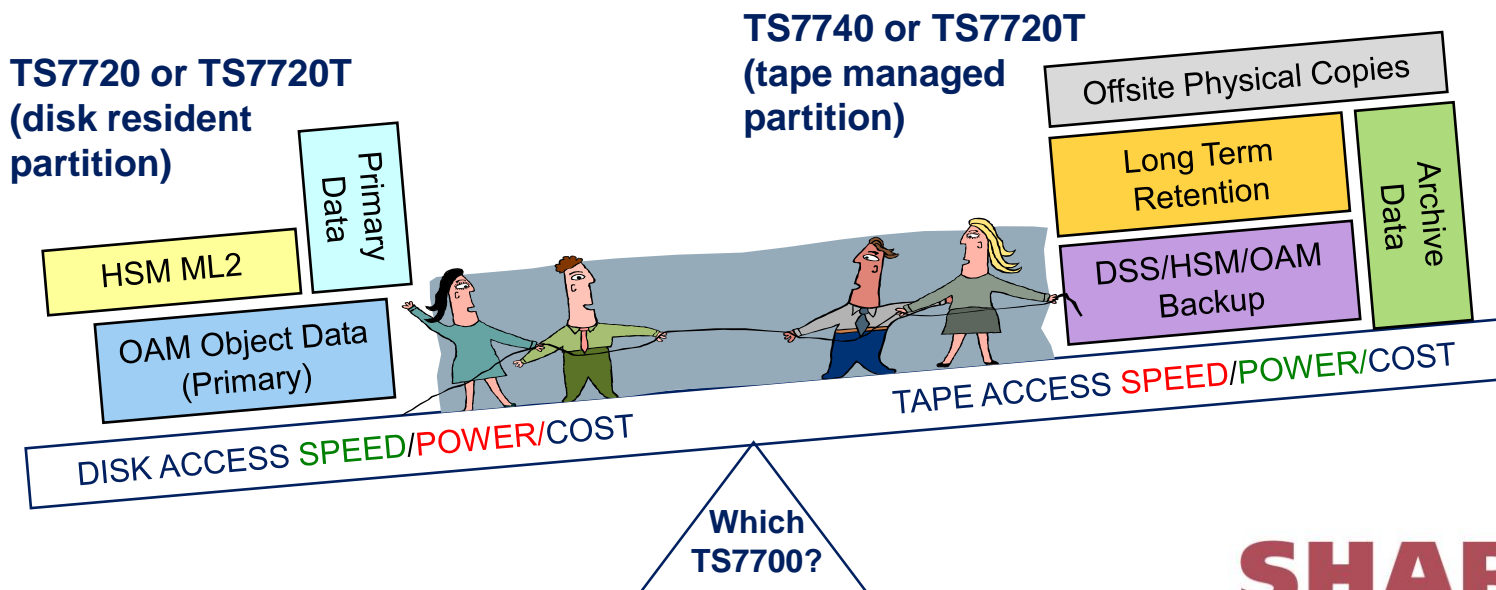
- Load Balancing Considerations
 - Common for each system to have devices in multiple clusters online
 - Common to have more than one grid (composite library)
 - Allocation has no understanding of the underlying clusters; views each composite library (grid) as a single library
 - Two load balancing options supported through **ALLOCxx PARMLIB** member and **SETALLOC operator command**
 - **EQUAL (original/default algorithm)** – randomizes across the composite libraries regardless of the number of clusters and online devices
 - **BYDEVICES** - randomizes across the eligible devices taking into account online devices; tends to randomize better across clusters within a grid

3 Cluster Grid (Example)



TS7700 Considerations

- Leaving data in the disk cache may be optimal for **primary data applications** or applications which require fast access times
- Having the data go to physical tape may be optimal for **archive and backup**
- Clusters in a grid can be intermixed depending on application and workload requirements and directed through policy management



SMStape - Overview

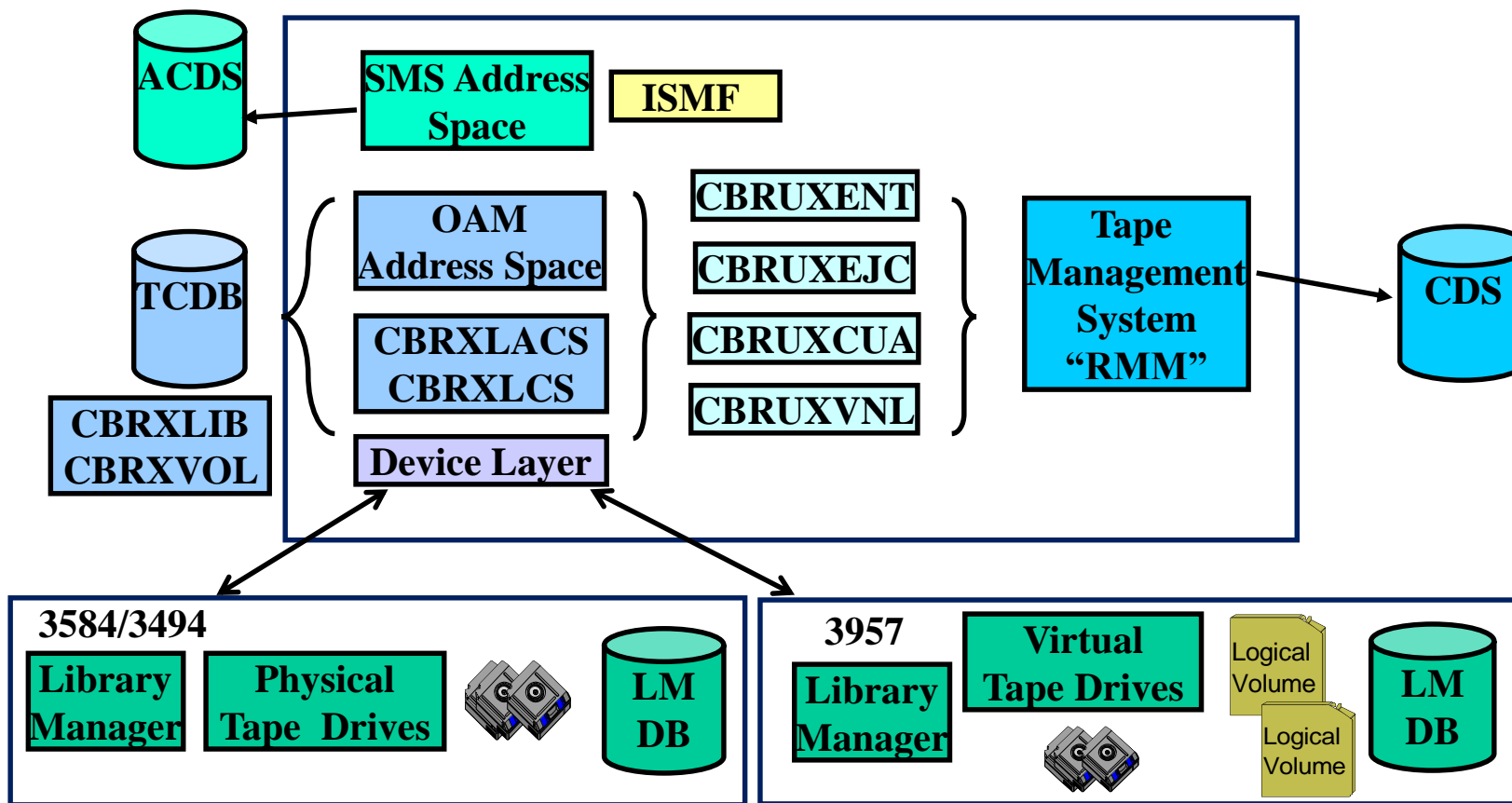
- Manages the tape volumes, the tape devices, and the tape libraries through SMS policy management
- Manages the tape volumes and not the data on the volumes
 - **still the role of the application and the tape management system (such as DFSMSrmm) to manage the data**
- No application or job-related (JCL) changes required to direct tape allocations to SMS-managed tape libraries, devices, and media
 - handled through the policy management layer built into SMS (ACS routines)
 - specified unit information passed to SMS ACS routines as filter criteria

SMStape – Demand Allocation

- JCL keyword **SMSHONOR** supported on the UNIT parameter
 - Enables SMStape to direct an allocation request to a particular device or set of devices (user escoteric)
 - Allocates using intersection of two lists (eligible devices returned from SMS and the devices specified on the UNIT parameter)
 - Useful during problem diagnosis to be able to direct an allocation to a device (i.e. for tracing) or after a microcode load upgrade to verify the device
 - **Recommendation** - continue to allow SMStape and the ACS routines to direct and randomize allocation requests across the eligible devices and consider this capability only in specific use cases



SMStape – Overview ...



Note: CBRUXENT, CBRUXEJC, CBRUXCUA and CBRUXVNL are installation exits at key processing points: cartridge entry, cartridge eject, scratch/private transitions and allocation processing (for shelf resident volumes)

SMStape - Policies

Preferred
Media or
Recording
Technology?

Data Class

Is the request
SMS-managed?

Storage Class

What libraries
should be
eligible?

Storage Group

ACS Routines
Filter Criteria?
Policies to Assign?

Data Class | Storage Class | Management Class | Storage Group(s)

SGATL

LIBATL

SGVTS

LIBVTS

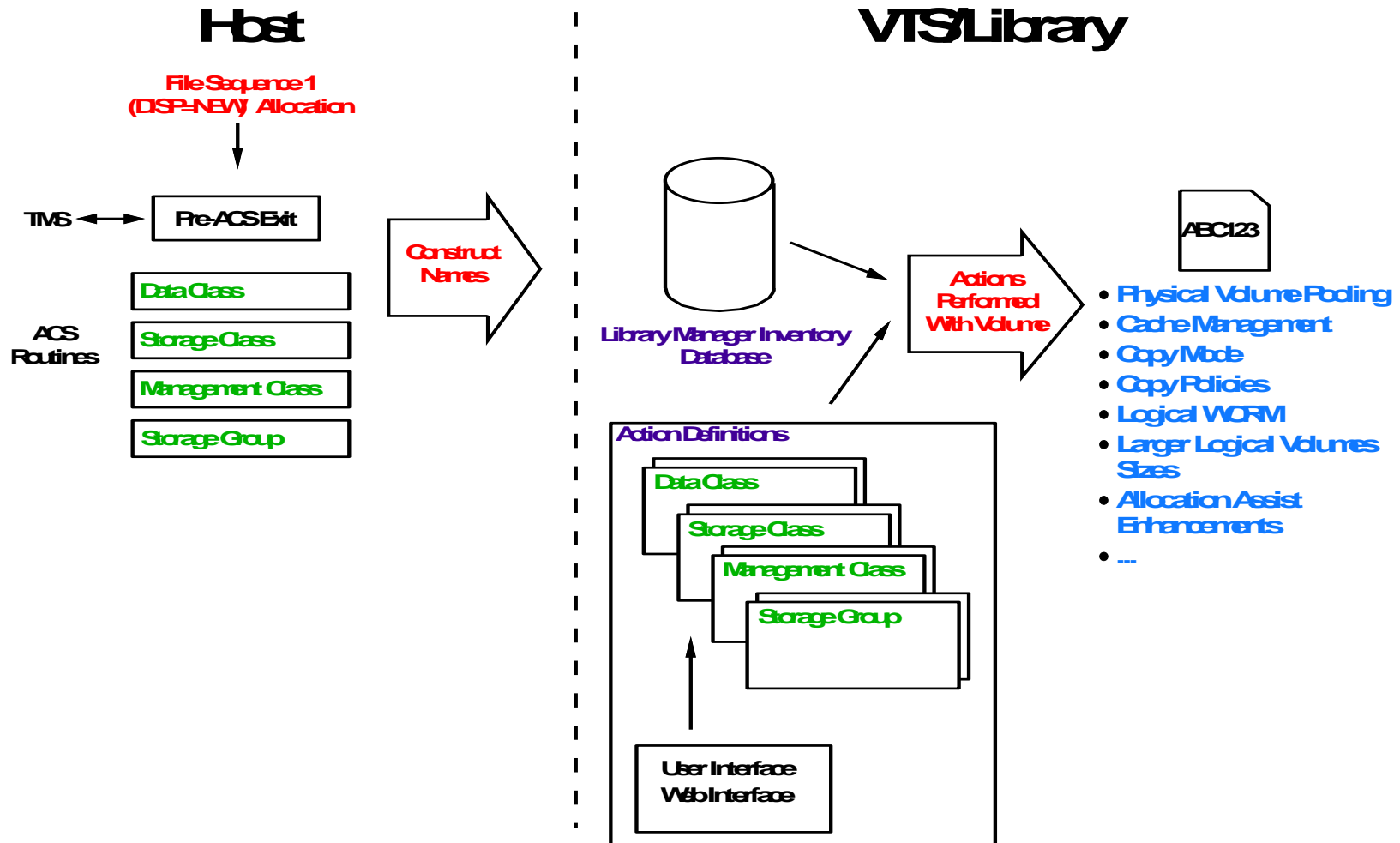


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Advanced “Outboard” Policy Management

- Enables customers to better utilize the resources in their IBM virtual tape library
 - Only applicable to the virtual tape environment
- During Job/Mount processing, the SMS assigned construct names are sent to the library
 - Storage class, management class, data class and storage group
 - Scratch or Private, File Sequence 1, DISP=NEW
- Outboard policy actions for each construct can be defined at the library (through their management interface)
- Enables same construct "policy" names to be used at the host and at the library

Advanced Policy Management ...



Advanced Policy Management ...

■ Storage Class

- **Host** - used to make request SMS managed
- **Outboard** – ex. cache preference, cache partition

■ Data Class

- **Host** - used for media and recording technology preferences
- **Outboard** – ex. larger logical volume sizes (1000, 2000, 4000, 6000 and 25000 MBs), logical WORM

■ Storage Group

- **Host** - used to direct the allocation request to a tape library(s)
- **Outboard** – ex. physical volume pooling of logical volumes

■ Management Class

- **Host** - storage hierarchy, backups
- **Outboard** – ex. copy mode, copy policies, scratch allocation assist (SAA)

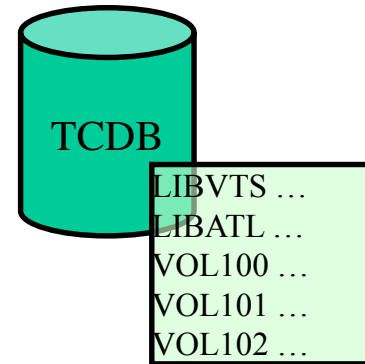
Note: additional policy actions can be supported with little to no software changes

Tape Configuration Database

- User catalog (VOLCAT) houses volume and library records
 - referred to as the tape configuration database (TCDB)
 - ISMF used to create the library records
 - 5-CHAR library ID (defined outboard) is associated with the 8-CHAR host name (ties the host defined library to the actual library)
 - OAM entry processing creates the volume records
 - attention interrupt from the library (attention missed LIBRARY RESET,CBRUXENT can be used to pull the inventory)
- Access Method Services (IDCAMS) create, alter, delete and list support for the volume and library records
 - **primarily a recovery tool** - using IDCAMS to update the volume and library records will not update the library

Tape Configuration Database ...

- General VOLCAT
 - hlq.VOLCAT.VGENERAL
- Optionally, specific VOLCATs
 - hlq.VOLCAT.Vx ('x' being first character of a volser).
- Library records reside in the general VOLCAT.
- Volume records may reside in either the general or specific VOLCAT – specific VOLCAT searched first
- LOADxx PARMLIB member used for *hlq*



ISMF - Overview

- ISMF support to create and manage the SMS definitions
 - base SCDS
 - tape library definitions
 - tape storage groups – maps to library(s)
 - storage classes – indicates system-managed
 - data classes – indicates media/device preference
 - management classes
 - the ACS routines – filter routine logic to assign the SMS constructs
- ISMF support to display and manage the volume inventory (eject, audit and alter)

ISMF (Library Define)

SCDS Name . : EZU33.SCDS01

Library Name : TESTLIB <= host name for the library

To Define Library, Specify:

Description ==> Test Library in Building 9062 Lab 1300

==>

Library ID **BA999** (00001 to FFFFF) <= links the physical library
Console Name with the software definition

Default Data Class

Entry Default Use Attribute . _ (P=PRIVATE or S=SCRATCH)

Eject Default _ (P=PURGE or K=KEEP)

Media Type: Scratch Threshold Media1 0 (0 to 999999)

Media2 ... 0 Media3 0 (0 to 999999)

Media4 ... 0 Media5 0 (0 to 999999)

Media6 ... 0 Media7 0 (0 to 999999)

...

...

...

Command ==>

ISMF (Data Class Define)

SCDS Name . . . : EZU33.SCDS01

Data Class Name : DCTEST

To DEFINE Data Class, Specify:

Media Interchange

Media Type _ (1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13 or blank)
Recording Technology . . . _ (18,36,128,256,384,E1,E2,EE2,E3,EE3,E4,EE4, or blank)
Performance Scaling . . . _ (Y, N or blank)
Performance Segmentation _ (Y, N or blank)
... ..

Note: EE2, EE3, EE4 to request 3592 tape encryption

SMS - Overview

- Provides interfaces to control tape library volume and device selection
- For new allocations
 - ACS routines invoked during allocation processing
 - Storage class ACS routine used to make request SMS-managed.
 - Storage group ACS routine used to direct the allocation to a tape library(s)
 - up to 15 SGs can be selected and each SG can map to 8 libraries
 - Data class ACS routine mainly used for media and recording technology preferences

Device Services/AOM - Overview

- Device services support
 - provides internal interface (LIBSERV) to send I/O to library
 - builds & executes channel programs to the library
 - isolates I/O to library in a single component
 - maps what device pools (tape subsystems) reside in which libraries
- Tape drives defined as library-resident using Hardware Configuration Definition (HCD)
 - LIBRARY-ID and LIBPORT-ID

Device Pool (Subsystem)

- A device pool is a string of tape drives attached to a single control unit
 - up to 16 devices per control unit image
- A device pool name consists of the library ID concatenated with the subsystem number (pool-id) and '*' (for example, F401701*).
- All devices in a device pool have the same characteristics (for example, are all 3592 Model E07's)
 - Support the same media types and recording formats

Hardware Configuration Definition (HCD)

Command ==> _____ Scroll ==> CSR

Specify or revise the values below.

Configuration ID . : SMSTAPE MVSCN,MVSCP ON A2097
Device number . . : 0700 Number of devices : 16
Device type . . . : 3490

Parameter/

Feature	Value +	R Description	
OFFLINE	Yes	Device considered online or offline at IPL	
DYNAMIC	Yes	Device supports dynamic configuration	
LOCANY	Yes	UCB can reside in 31 bit storage	
LIBRARY	Yes	Device supports auto tape library	<==
AUTOSWITCH	Yes	Device is automatically switchable	
LIBRARY-ID	BA999	5 digit library serial number	<==
LIBPORT-ID	01	2 digit library string ID (port number)	<==
MTL	No	Device supports manual tape library	
SHARABLE	No	Device is Sharable between systems	
COMPACT	Yes	Compaction	

OAM - Overview

- Library Automation Communication Services (CBRXLACS) for mount, demount, etc.
- Handles both library and non-library function (internal API)
 - communicates to library (via Device Services) for mounts and demounts
 - issues message to operator for stand-alone requests

OAM - Overview ...

- Library Control Services (CBRXLCS) external API
 - CUA - change use attribute (scratch/private transitions)
 - EJECT - eject a volume
 - QVR - query volume residency/obtain volume information
 - TVE - test volume eligibility
 - MCE - manual cartridge entry
 - IMPORT - initiate 3494 virtual tape import operation
 - EXPORT - initiate 3494 virtual tape export operation/initiate TS7700 copy export operation
 - OLN - obtain library name
 - PTPMC - set 3494 PTP VTS mode control information
 - PTPDATA - obtain 3494 PTP VTS mode control/device data

OAM - Overview ...

- Provides set of internal catalog services
- CBRXLIB - Creates, retrieves, updates library record.
- CBRXVOL - Creates, retrieves, updates, replaces or deletes volume record.
- Builds & invokes the SVC 26 catalog interface

OAM - Overview ...

- Installation exits provided at key processing points
 - CBRUXENT - cartridge entry
 - CBRUXEJC - cartridge eject
 - CBRUXCUA - change use attribute processing (scratch/private transitions)
 - CBRUXVNL - volume not in library (used to direct allocation into a library for shelf resident volumes)
 - also passed critical job related information for more informed decisions
- Installation exits fully supported by DFSMSrmm and other tape management systems

OAM - Overview ...

- OAM address space
 - Cartridge entry and eject processing
 - Operator command processing
 - Audit processing
 - Unsolicited attention message processing (library operator messages, operational state change, device availability, category state change, etc.)
- Job processing (mount/demount activity) **occurs OUTSIDE the OAM address space** (CBRXLACS/CBRXLCS)
 - However, recommendation is to run with the OAM address space active

- New **SETTLIB PARMLIB** option for tape library tuning (z/OS V2R1)
 - Enabled using the SETTLIB statement in the CBROAMxx member of PARMLIB
- Keywords provided to tune several cartridge entry messages
 - direct how the cartridge entry ignore (CBR3620I) and successful (CBR3610I) messages are handled
 - also provides the ability to direct these messages to just the system log
- Provides ability to reduce the frequency of the messages and direct how and where the messages get issued

RMM - Overview

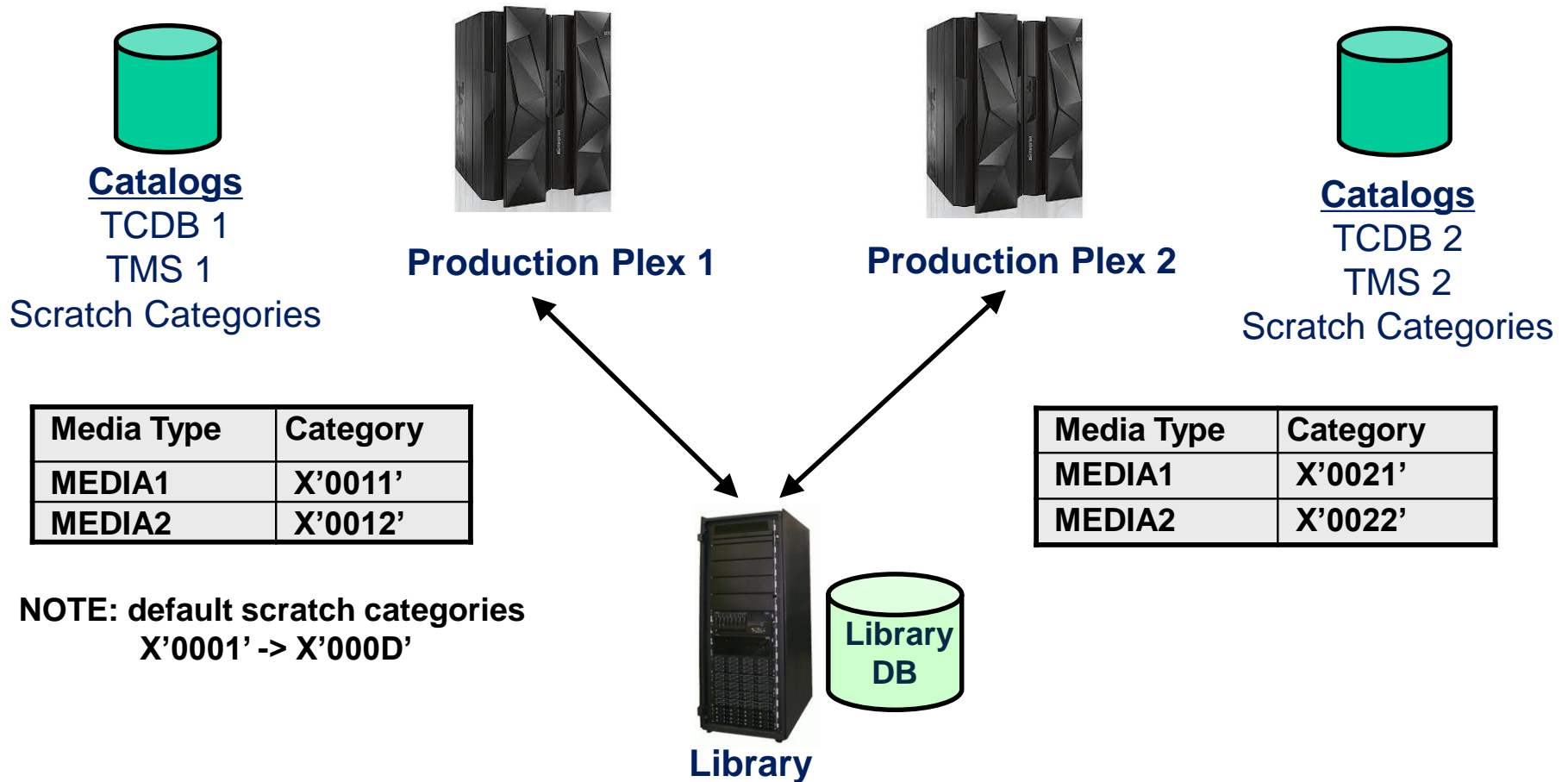
- IBM's tape management product (removable media manager)
 - manages the tape volumes and the datasets on the tape volumes
 - maintains detailed volume and dataset information in its own database
 - tracks the volume's owner and expiration information
 - provides utilities to return volumes to scratch
 - uses the OAM tape library interfaces and exits
 - uses the Open/Close/EOV interfaces and exits
 - tracks the movement and location of the volumes on and off-site
 - tracks the library name, library type, and SMS constructs associated with a volume



Partitioning

- Each tape library can be logically partitioned across multiple systems
 - Set of sharing systems typically having its own tape configuration database (TCDB) and its own tape management system database
 - and its own set of scratch categories
- Scratch categories are defined in **DEVSUPxx PARMLIB** member
 - One scratch category (general scratch pool) per media type

Partitioning ...



Note: non-default categories specified in **DEVSUPxx** PARMLIB member

Volume Categories

- Entered volumes are placed in the insert category
- Host moves the volume to scratch or private (or leaves in insert category for another owning host to process)
 - interacts with tape management system (through cartridge entry exit)
 - one scratch category per media type
 - all private volumes are in same category
- Mount Processing
 - SCRATCH - **mount from category**
 - library selects volume from the requested category
 - SPECIFIC (private) - **mount by VOLSER**

Volume Categories ...

- During a scratch mount OPEN transitions volume to private
 - interacts with the tape management system (through the CUA exit)
- Problem with scratch volume mounted, OPEN places volume in an error category
 - ensures volume isn't repeatedly selected
- After data is expired, the tape management system returns the volume to scratch (through CBRXLCS CUA interface)
- Ejected volumes are placed in an eject category
 - interacts with the tape management system (through the eject exit)

Operator Commands (Common)

- DISPLAY SMS,VOLUME(xxxxxx)
- DISPLAY SMS,LIBRARY(xxxxxxxxx),DETAIL
- DISPLAY SMS,OAM
- LIBRARY DISPDRV,*library-name* (or *device-number*)
- DISPLAY R,L,KEY=OAM (outstanding messages)
- LIBRARY REQUEST,*library-name*,*keyword1*,*keyword2*,*keyword3*,*keyword4*
 - LIBRARY REQUEST,*library-name*,STATUS,GRID
 - LIBRARY REQUEST,*library-name*,LVOL,xxxxxx
 - Many more command options supported, refer to the following TS7700 whitepaper: <http://www-03.ibm.com/support/techdocs/atsmastr.nsf/WebIndex/WP101091>
- DEVSERV QLIB,*library-ID*

Note: refer to OAM Planning, Installation and Storage Administration Guide for Tape Libraries (SC23-6867) for additional commands and further discussion

Publications

- ✓ Object Access Method Planning, Installation and Storage Administration Guide for Tape Libraries (SC23-6867)
- ✓ z/OS DFSMS Software Support for IBM System Storage TS1140, TS1130 and TS1120 Tape Drives (3592) - (SC23-6854)
- ✓ TS7700 Knowledge Center
 - ✓ http://www.ibm.com/support/knowledgecenter/STFS69_3.2.0/ts7700/cust/3.2/hydra_c_ichome.html
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Additional Material Mount Scenarios

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Scratch Mount “JES2”

- MVS allocation calls SMS to invoke ACS routines
- ACS routines assign data class, storage class, management class and tape storage group(s)
- Data class specifies media and recording technology preferences
- SMS invokes OAM with storage groups & assigned data class information
- OAM maps storage groups to list of eligible libraries
- OAM invokes device services to get list of device pools for each library
 - For the TS7700, list returned may include customer selected “candidate” clusters; for cluster steering on the allocation request (scratch allocation assist – SAA)
- OAM eliminates ineligible device pools that don’t satisfy data class specifications

Scratch Mount ...

- OAM returns list of device pools ordered by scratch volume availability (above or below threshold) to SMS
- SMS returns list of eligible device pools to MVS allocation
- MVS allocation builds eligible device list taking into account scratch threshold information & cartridge loader status (as applicable)
- MVS allocates a device*
 - for a non-deferred mount allocation invokes OAM to mount a volume
 - for a deferred mount OPEN invokes OAM to mount a volume
- With advanced policy management, the ACS routine assigned constructs are sent to the library enabling outboard policy actions

* Load balancing options are **“EQUAL”** or **“BYDEVICES”** specified in ALLOCxx PARMLIB member – “equal” (default) randomizes across the libraries and then the devices within the selected library and “bydevices” randomizes across all eligible devices

Scratch Mount ...

- OAM invokes device services to send category mount order to library
- Library selects a scratch volume from the specified category and schedules mount
- MVS allocation completes and job step starts
- Job issues an OPEN for the tape dataset
- OPEN invokes OAM to wait for mount to complete
- Mount completes, library notifies Device Services -> notifies OAM -> notifies OPEN
- OPEN reads volume label and performs label verification
 - Tape management system given opportunity (through exits) to approve the scratch volume

Scratch Mount ...

- If OPEN is successful, OPEN invokes SMS to move the volume to PRIVATE status
- SMS invokes OAM to change the use attribute of the volume
- OAM invokes the change use attribute installation exit (CBRUXCUA), notifying tape management system
- OAM invokes Devices Services to change the volume category to PRIVATE at the library
- OAM moves the volume from Scratch -> Private in the TCDB
- OPEN returns to caller with successful OPEN
- Data can then be written

Recovery Action

- If mount cannot be scheduled or does not complete OAM (CBRXLACS) recovery examines error and attempts recovery
 - Operator given opportunity to retry or cancel the mount

```
CBR4195I LACS retry possible for job ATNCMP: 015
IEE763I NAME= CBRLLACS CODE= 140169
CBR4000I LACS MOUNT permanent error for drive 0BCA.
CBR4105I No MEDIA5 scratch volumes available in library ATL10001.
IEE764I END OF CBR4195I  RELATED MESSAGES
*06 CBR4196D Job ATNCMP, drive 0BCA, volser SCRTCH, error code
140169.
Reply 'R' to retry or 'C' to cancel.
```

- If OPEN fails the mount, it invokes OAM (CBRXLACS) to demount volume, assign it to error category and mounts another scratch volume (up to 5 additional retries)

Specific Mount “JES2”

- MVS allocation invokes SMS to determine if volume resides in a tape library
- SMS invokes OAM to retrieve volume record from TCDB
- If volume is not library resident, OAM invokes the volume not in library exit (CBRUXVNL)
 - Provides an operator the opportunity to enter a shelf resident volume
- With the volume library resident, SMS invokes OAM with list of volser(s)
- OAM ensures all volumes are PRIVATE and in same storage group

Specific Mount ...

- OAM invokes device services to obtain list of devices in library
 - For the TS7700 list is returned in cluster preference order (device allocation assist – DAA)
- OAM uses volume record media and recording technology information to eliminate ineligible devices
- OAM returns device pool list to SMS which passes it back to MVS allocation
- MVS allocation builds eligible device list and allocates a device

Specific Mount ...

- For a non-deferred mount MVS allocation invokes OAM (for a deferred mount OPEN invokes OAM)
- OAM invokes device services to send the mount order to the library
- Library schedules mount
- MVS allocation completes and job step starts
- Job issues an OPEN for the dataset
- OPEN invokes OAM to wait for the mount to complete

Specific Mount ...

- Mount completes, library notifies Device Services -> notifies OAM -> notifies OPEN
- OPEN reads volume label and performs label verification
 - Tape management system given opportunity (through exits) to approve volume
- If OPEN successful, OPEN invokes SMS to update fields in the TCDB volume record
- SMS invokes OAM to update the last mounted date, etc ...
- OPEN returns to caller with successful OPEN
- Data can then be read or written

Recovery Action

- If mount cannot be scheduled or does not complete OAM/LACS recovery examines error and will attempt recovery CBR4195I and CBR4196D
 - Operator given opportunity to retry or cancel the mount

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