# Understanding DFSMS
# Intelligent - But Not Artificial

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# Storage Management History

## Manual Storage Management

- JCL or IDCAMS supplies all required dataset attributes
- Volume selection via mount attributes (PRIVATE, STORAGE, PUBLIC)
- Manual movement of datasets, volumes

**1970s-1980s**

## Storage Usage Explodes

- Prices per byte drop / Capacities increase / RAID devices appear
- Manual storage management becomes impossible

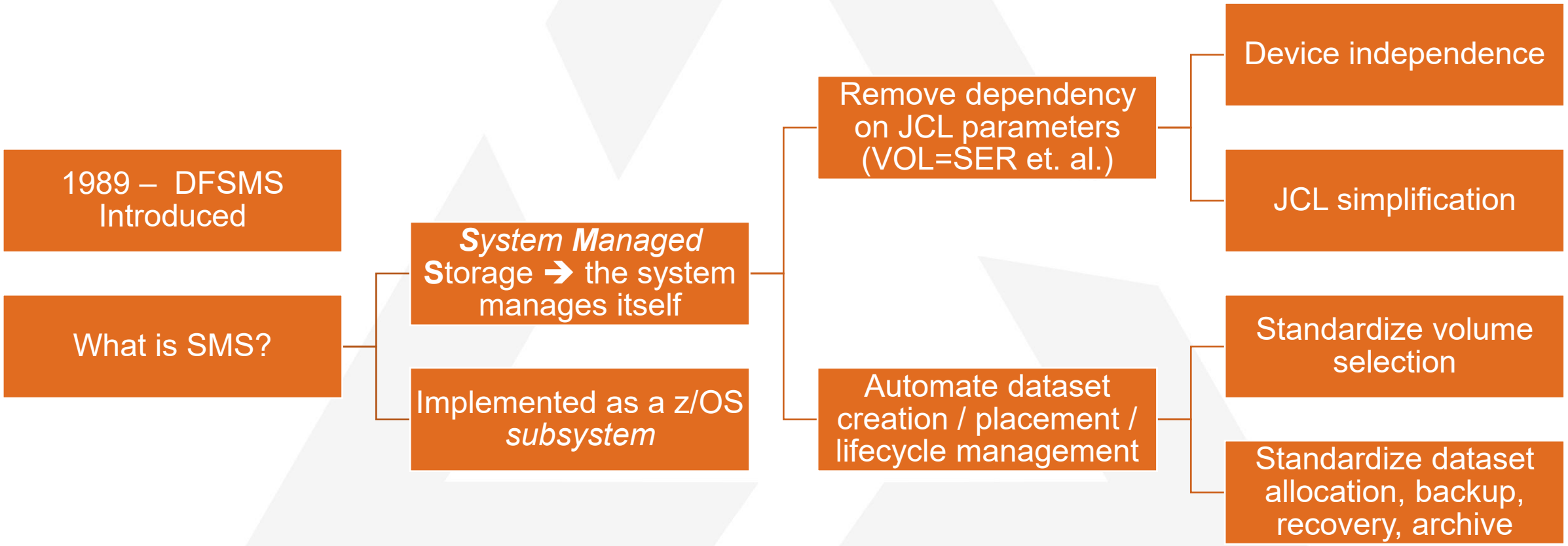
**Late 1980s**

**1970s-1980s**

## Life Cycle Management

- Volser or datasets explicitly specified
- By JCL/control statement (FDRABR, DFHSM, DFDSS, CA-Disk)

# Storage Management Automation



# System Managed Storage

- Establish and Implement Systemwide Policies for:
  - **Space Availability**
    - Dataset policies – expiration, scratch, migration/recall,…
    - Volume policies – defrag, extent reduction,…
    - Equalize volume utilization level
  - **Data Availability**
    - Allocation characteristics – SPACE, DSNTYPE, DCB
    - Backup/archive selection, retention, restore

# The Storage Administrator

- Manages the DFSMS Environment
  - ISMF – Interactive Storage Management Facility
  - SMS Constructs
    - Classify datasets & volumes according to type, usage, and resource requirements
  - ACS Routines
    - Assign constructs to implement storage management policies

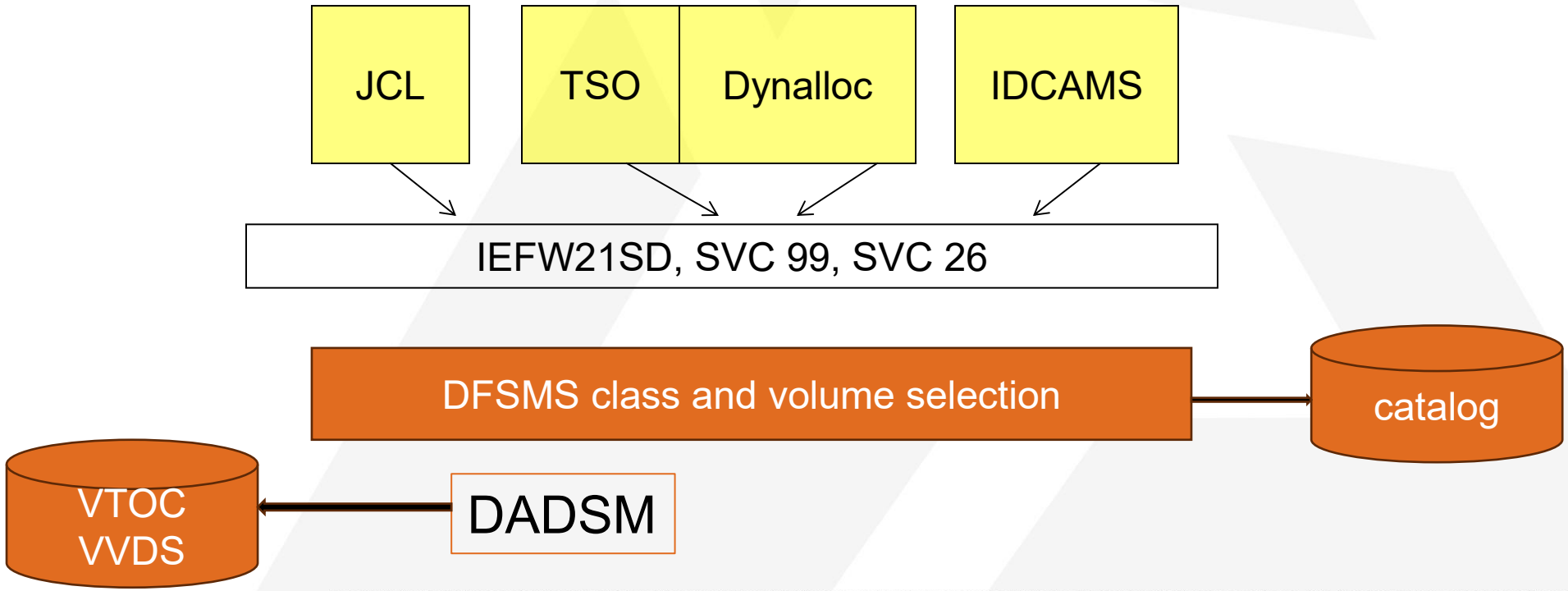
# z/OS System and DFSMS Components

- **z/OS System Components**
  - Catalog / VSAM / IOS / Security / DADSM / others
  - System Data Mover (SDM)

- **DFSMS Components and Products**
  - DFSMSdfp – ‘data facility product’ – base SMS
  - DFSMShsm / DFSMSdss – data **manager**/data **mover**
    - FDRABR, CA-Disk, or other
  - DFSMSrmm – tape management
    - CA1, TLMS, Control-T, et al
  - DFSort
    - Syncsort
  - DFSMStvs, DFSMSnfs

# SMS – Intelligent Data Set Allocation

```
//DD1 DD DSN=MY.DATA.SET,
// DISP=(,CATLG),UNIT=SYSALLDA,
// SPACE=(CYL,(1000,1000),RLSE),KEYLABEL=MY.KEY,
// DCB=(LRECL=4000,BLKSIZE=20000,RECFM=FB),
// VOL=SER=SMS002,EATTR=OPT,DSNTYPE=(EXTREQ,2),...
```



# SMS Constructs *Classify* Data Sets (and volumes)

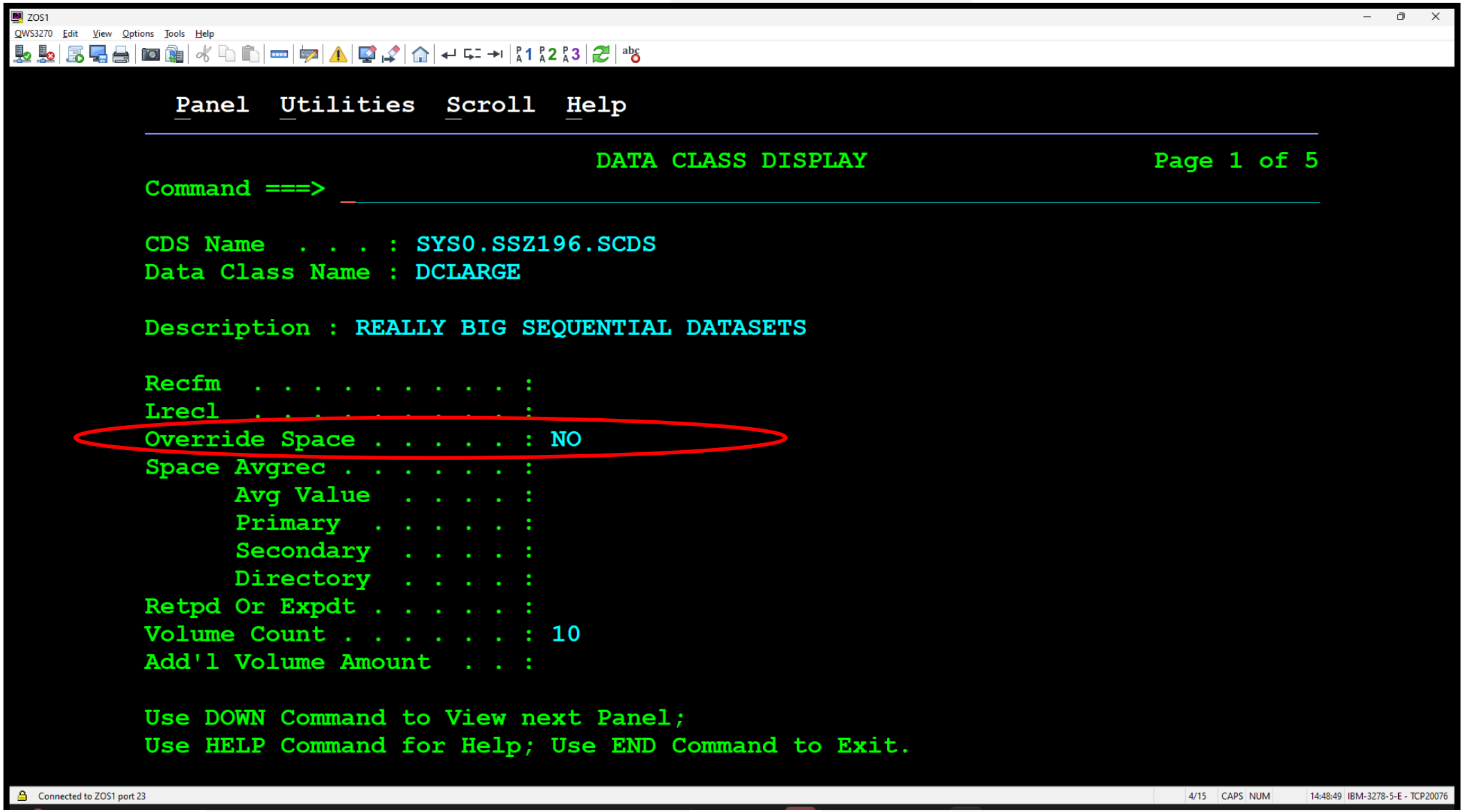
DC, SC, MC class names are recorded in *catalog entry* for dataset

| | |
|---|---|
| Data Class | • Physical and logical attributes<br>  • SPACE, RETPD, DSNTYPE, volcount, encryption, EATTR |
| Storage Class | • Performance / resource requirements<br>  • Guaranteed space, PAV, zHyperlink, SDR (striping) |
| Management Class | • Life cycle attributes<br>  • Backup frequence/retention/location, expiration, class transition |
| Storage Group | • Volume pool<br>• Space thresholds/alerts, migration/backup |

# Data Class – What Does the Data Set Look Like?

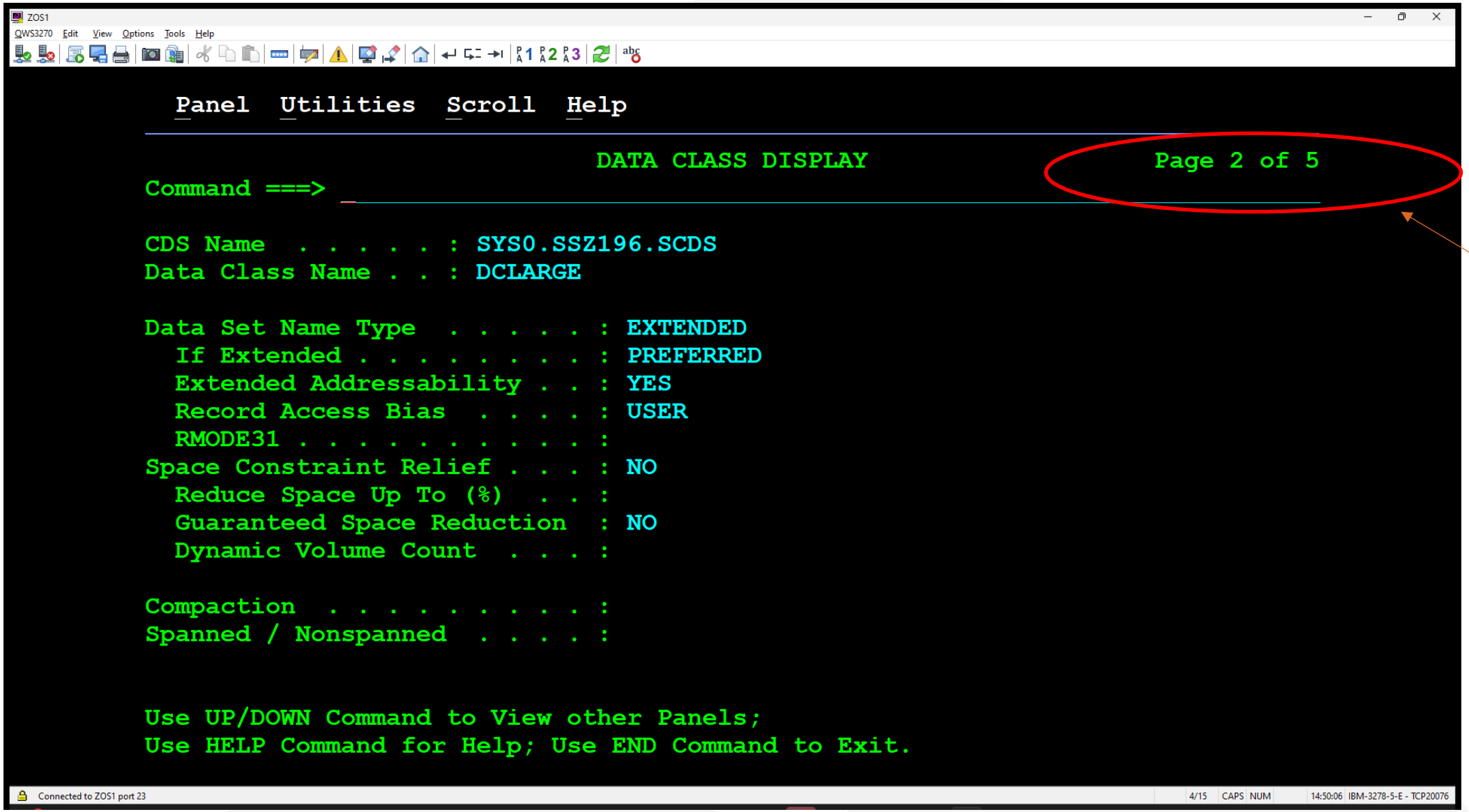
- Assigned when dataset is created
- SMS-managed or non-SMS
  - Data class name not placed in catalog entry for non-SMS
- *Many* data set attributes – VSAM, non-VSAM, tape
  - Physical Characteristics
  - Logical / Organizational Characteristics
  - Values overridden by JCL (unless OVERRIDE SPACE=YES)
  - Some values can ***only*** be specified in data class
    - SCR, compaction, ECR, Mediatype …

# ISMF Data Class Definition




JCL parms and many other attributes

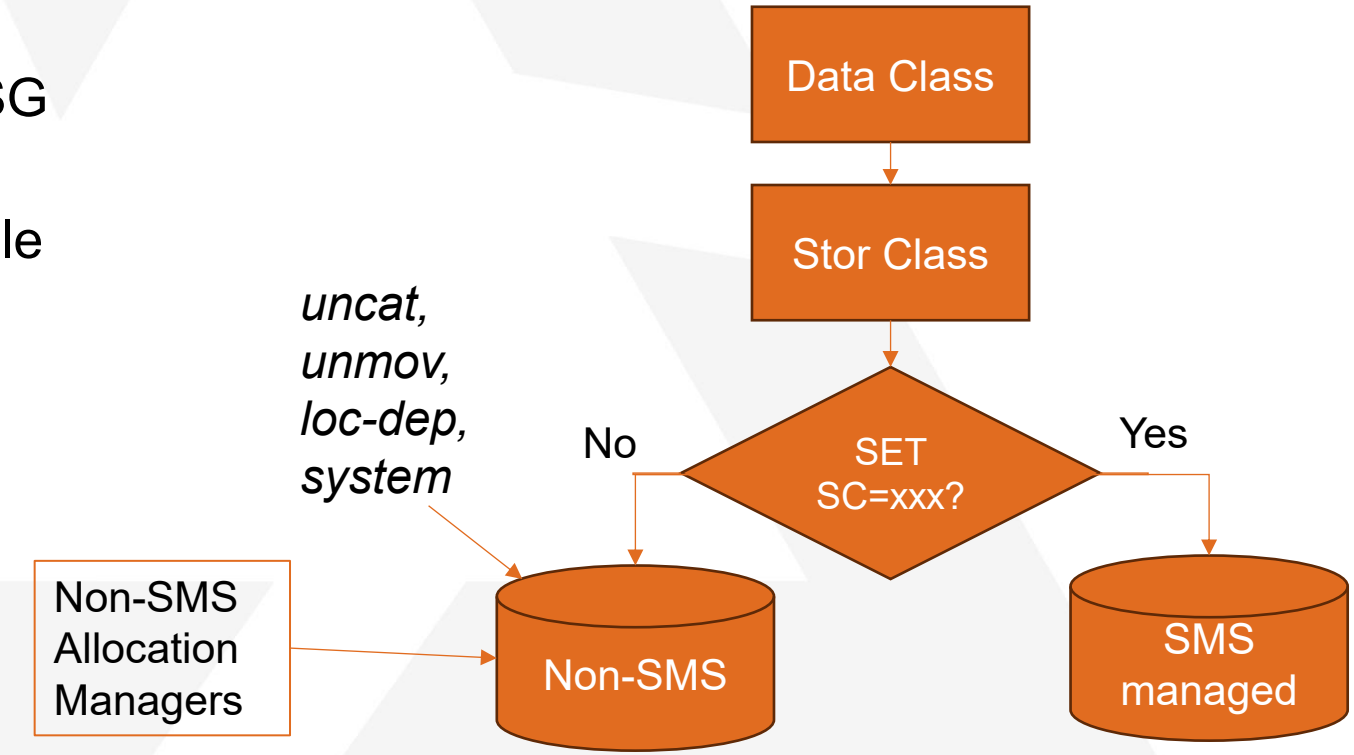
# ISMF Data Class Definition



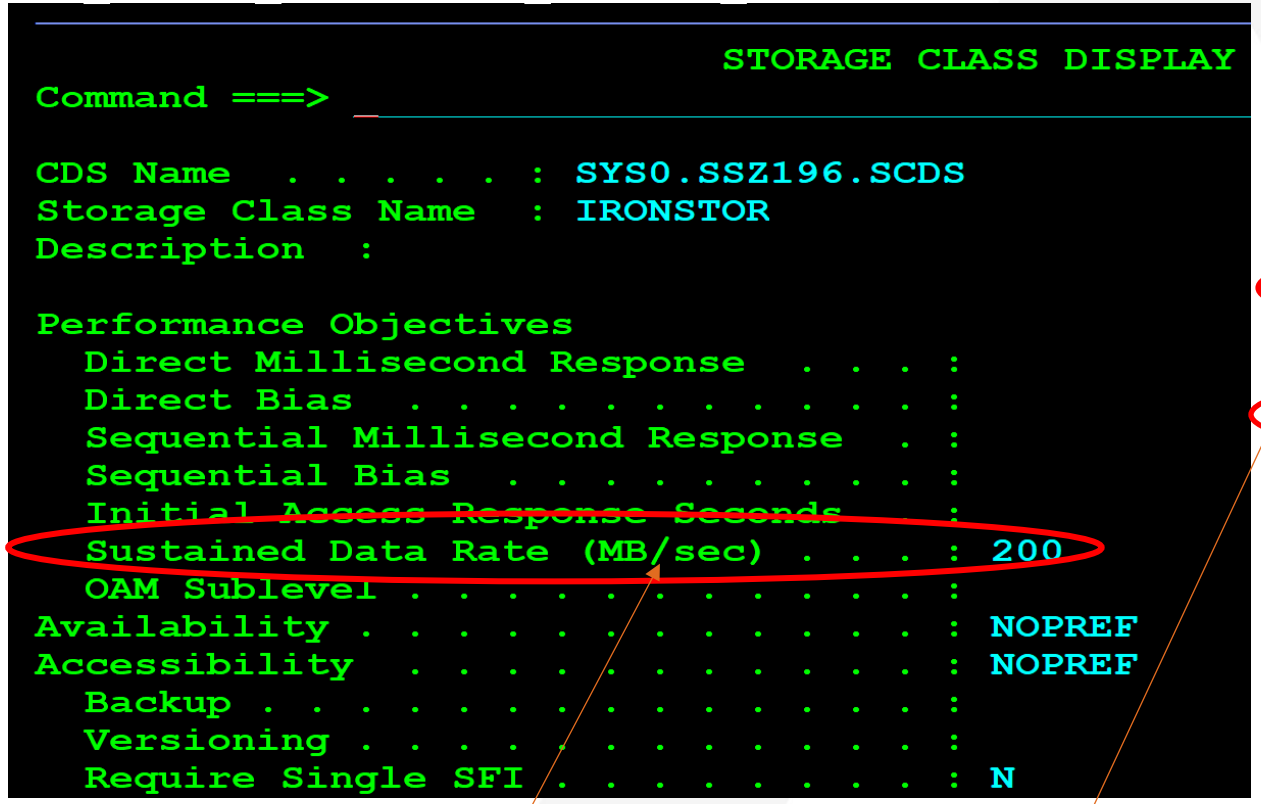

Many attributes

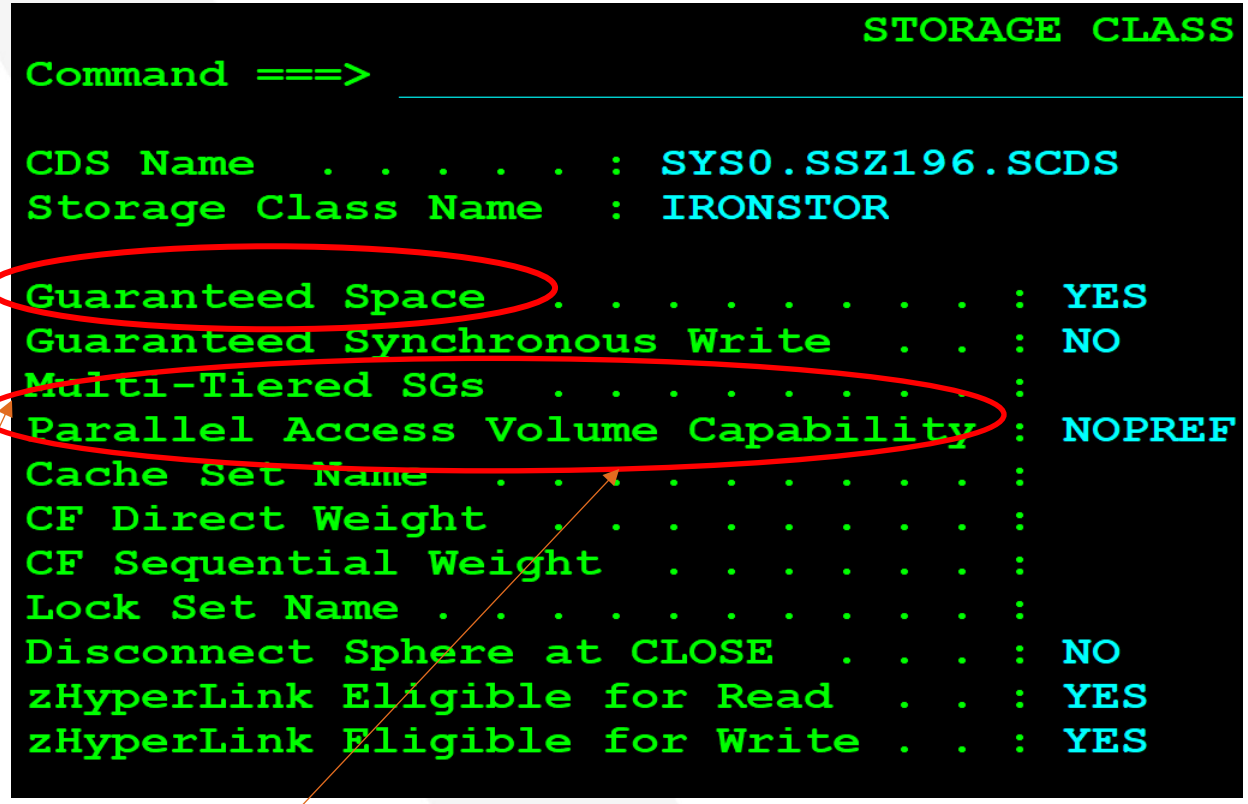
# Storage Class – What Service Level is Needed?

- Storage Class determines:
  - SMS-managed or unmanaged (non-SMS)
  - Service requirements (PAV, striping, zHyperlink, more)
  - *Guaranteed space*
    - Characteristic of SC, *not* SG
    - VOLSER= honored
    - Alloc fails if vol not available



# Storage Class Definition




Striping

try1st SG first

PAV

# Generation Data Sets

# Management Class – Life Cycle Requirements

How often should backup occur?

How many copies to keep?

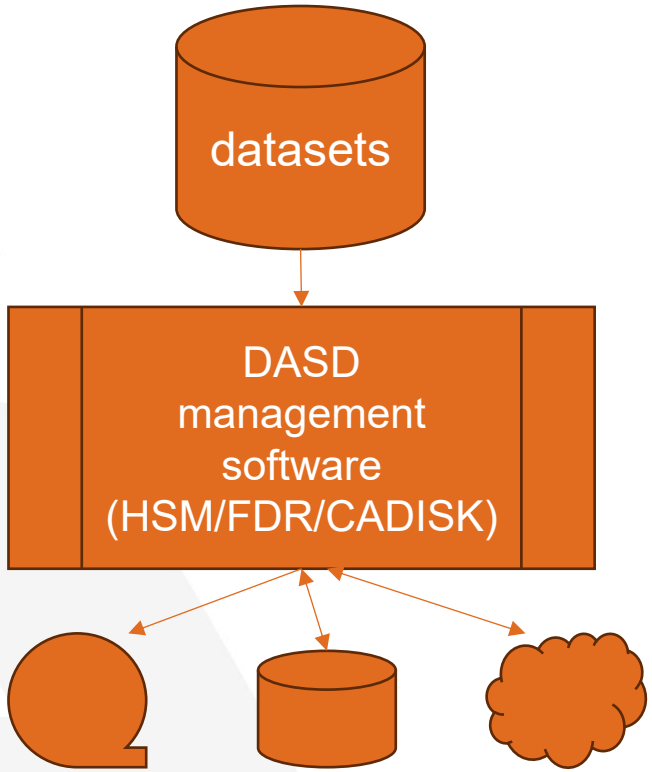
How long to retain?

When to expire?

When to delete?

Attributes:

- Backup / Migration / Class Transition / Expiration
- Partial Release
- GDG Management
- OAM
- ABARS
- Cloud PSM/migration
- RMM Tape retention



# Management Class Definition

```
Expiration Attributes

  Expire after Days Non-usage  . : 1
  Expire after Date/Days . . . . : 0
  Retention Limit  . . . . . . . : 0
```

```
Partial Release . . . . . . : NO
Migration Attributes
  Primary Days Non-usage  . : 0
  Level 1 Days Date/Days  . : 0
  Level 2 Days Non-usage  . : NOLIMIT
  Command or Auto Migrate . : NONE
  Size Less Than or Equal to:
   Action . . . . . . . . . :
  Size Greater than . . . . :
   Action . . . . . . . . . :
GDG Management Attributes
  # GDG Elements on Primary :
  Rolled-off GDS Action . . :
```

```
Cloud Network Connection Name :
```

```
Backup Attributes
  Backup frequency  . . . . . . . . . . : 0
  Number of backup versions . . . . . . :
     (Data Set Exists)
  Number of backup versions . . . . . . : 0
     (Data Set Deleted)
  Retain days only backup version . . . :
     (Data Set Deleted)
  Retain days extra backup versions . . :

  Admin or User Command Backup  . . . . : NONE
  Auto Backup . . . . . . . . . . . . . : NO
  Backup copy technique . . . . . . . . : STANDARD
```

DASD Manager

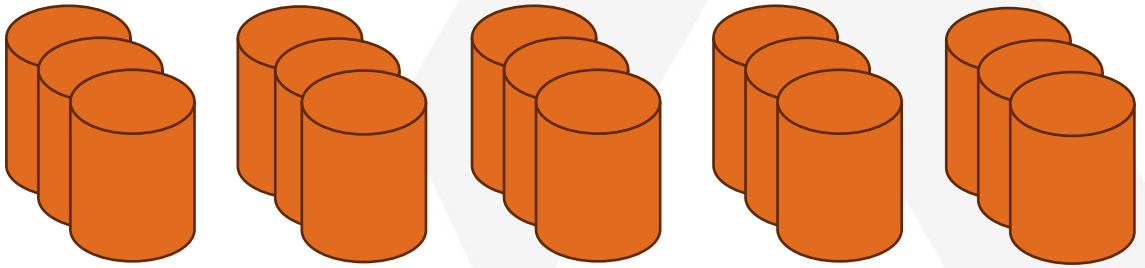
```
Class Transition Criteria
  Time Since Creation Years  :
                      Months :
                      Days . :

  Time Since Last use Years  :
                      Months :
                      Days . :
  Periodic
    Monthly   on Day . . . . :
    Quarterly on Day . . . . :
              in Month . . . :
    Yearly    on Day . . . . :
              in Month . . . :
```

```
Transition Copy Technique . . . : STANDARD
Serialization Error Exit  . . . : NONE
```

```
Tape Volume Attributes
  Retention Method  . . . . . . . :
  Volume Set Management Level . . :


Tape Data Set Attributes
  Exclude from VRSEL  . . . . . . :
  Retain While Cataloged  . . . . :
```

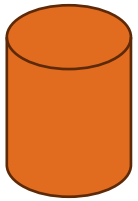
# Storage Groups – Collections of Volumes

**POOL** Storage Groups



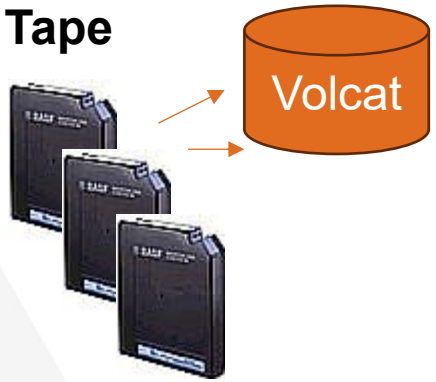

Enabled / disabled / quiesced

**VIO** Storage Group

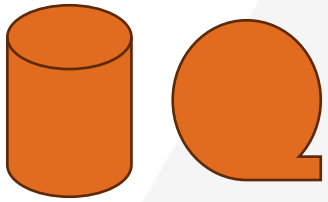


Storage Groups define *volumes*, not *datasets*

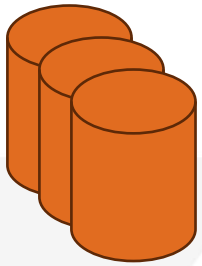
**Tape**




**Object/Object Backup**

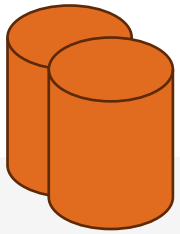


**DUMMY** (non-SMS)



Public/Private/Storage

**Copypool Backup**



# POOL Storage Group

DASD Manager attributes

```
                        POOL STORAGE GROUP DISPLAY
Command ===>

CDS Name  . . . . . : SYS0.SSZ196.SCDS
Storage Group Name  : DB2BSG

Description  :

Auto Migrate . . . . . : YES
Auto Backup  . . . . . : NO
Auto Dump  . . . . . : NO
Overflow . . . . . : NO
Migrate Sys/Sys Group Name . :
Backup Sys/Sys Group Name  . :
Dump Sys/Sys Group Name  . . :
Extend SG Name . . . . . :
Copy Pool Backup SG Name . . :
Dump Class . . . . . :
Dump Class . . . . . :
```

Thresholds

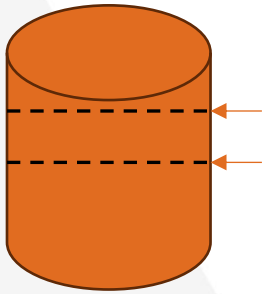
```
                        POOL STORAGE GROUP DISPLAY
Command ===>

CDS Name  . . . . . : SYS0.SSZ196.SCDS
Storage Group Name  : DB2BSG

Dump Class . . . . . :
Dump Class . . . . . :
Dump Class . . . . . :
Allocation/Migration Threshold - High  . : 85
                                 Low . . : 10
Alloc/Migr Threshold Track-Managed - High: 85
                                     Low : 10
Total Space Alert Threshold %  . . . . . : 80
Track-Managed Space Alert Threshold %  . : 80
Guaranteed Backup Frequency  . . . . . :
BreakPointValue  . . . . . :
Processing Priority  . . . . . : 50
```

Additional pool SG

EAV threshold

# Storage Group Volume Selection

- SMS attempts to select ‘best’ volume
  - Primary list
    - Under SG threshold
    - Meet SC criteria
      - Avail, Accessib, PAV, IART, et al
    - Not quiesced
  - Secondary list
    - Over threshold
    - In SG tier
  - Tertiary list
    - Doesn’t meet volume count
    - others



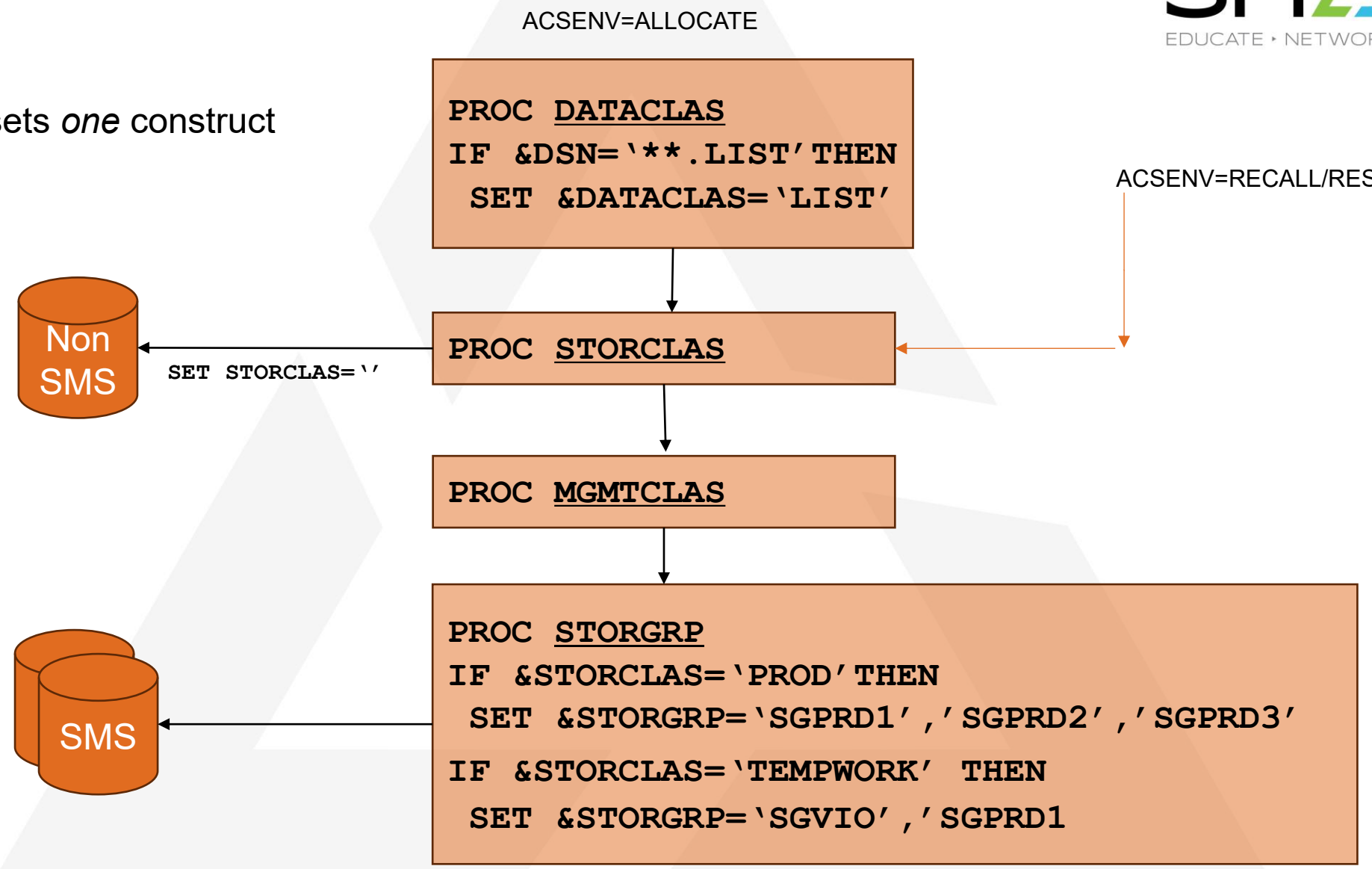
Alloc / migr thresholds

Over hi thresh, allocate elsewhere

Under lo thresh, stop migrating

# ACS Routines Assign Constructs

Each routine sets *one* construct



# ACS Routines Use *Variables*

## **Read-Only** Variables

| | | | |
|---|---|---|---|
| &ACCT_STEP | &DSKEYLBL | &LIBNAME | &PGM |
| &ACSENVIR | &DSN | &LLQ | &RECORG |
| &ACSENVR2 | &DSNTYPE | &MAXGENS | &RETPD |
| &ALLVOL | &DSN_VERSION | &MAXSIZE | &SECLABL |
| &ANYVOL | &DSORG | &MEMHLQ | &SECOND_QTY |
| &APPLIC | &DSOWNER | &MEMLLQ | &SIZE |
| &BLKSIZE | &DSTYPE | &MEMN | &SPACE_TYPE |
| &DATE | &EATTR | &MEMNQUAL | &STEP |
| &DAYOFWEEK | &EXPDT | &MSPDEST | &SYSNAME |
| &DB2SSID | &FILENUM | &MSPARM | &SYSPLEX |
| &DD | &GROUP | &MSPOLICY | &TIME |
| &DEF_DATACLAS | &HLQ | &MSPOOL | &UNIT |
| &DEF_MGMTCLAS | &JOB | &NQUAL | &USER |
| &DEF_STORCLAS | &LABEL | &NVOL | &USER_ACSVAR |
| | | | &XMODE |

## **Read-Write** Variables

- DATACLAS
- STORCLAS
- MGMTCLAS
- STORGRP

# ACS Routine Language Statements

- Statements
  - PROC – names/begins routine
  - FILTLIST – definition list
  - SET – set one R/O variable
  - DO-END
  - IF-THEN
  - SELECT-WHEN-OTHERWISE
  - EXIT – exit with or without error
  - WRITE
  - LOGWRITES –job/step/userid to logrec

```
FILTLIST PRDVOLS
   INCLUDE(PRD*,PROD*)
   EXCLUDE(PRD999)
```

```
IF &VOLSER NE &PRDVOLS
  THEN SET &STORCLAS = 'TEST'
```

```
SELECT &USER
 WHEN ('IBMUSER')SET &MGMTCLAS='M1'
 WHEN (&ORDUSER) SET &MGMTCLAS='M5'
 OTHERWISE SET &MGMTCLAS='M6'
END
```

```
PROC STORCLAS
IF &STORCLAS = 'NULLSC'
 THEN SET &STORCLA = ''
```

```
PROC STORGRP
IF &STORCLAS = 'FAST'
 THEN SET &STORGRP = 'SGPRD1'
```

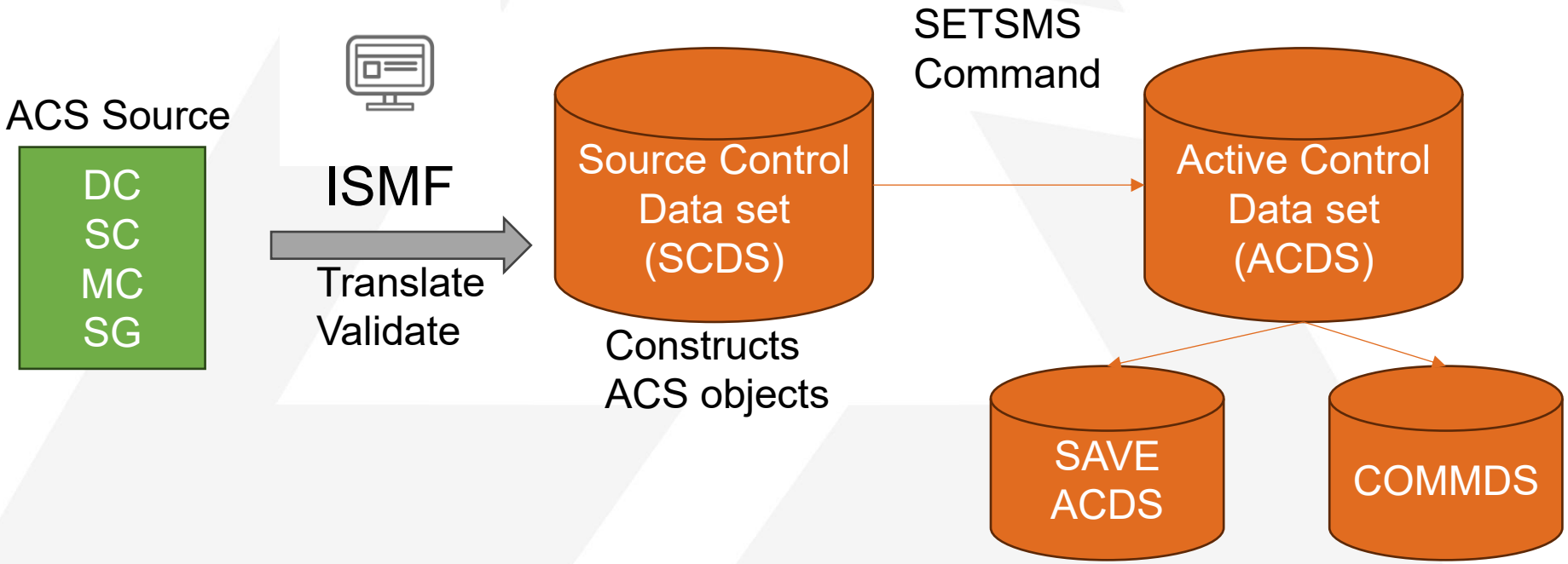
```
IF (&DSN(3) = 'DEPT56') &&
   (&HLQ NE 'PROD')
THEN DO
     WRITE 'BAD DSN'
     EXIT CODE(16)
     END
```

alloc fails

# SMS Configuration

***Configuration***

- Set of Storage Management Policies
- Embodied in SMS Constructs and ACS Routines



# Useful SMS Console Commands

```
DISPLAY SMS
      VOL(volser)
      SG(storgrp),<LISTVOL>
      LIBRARY
      others
VARY  SMS  -  quiesce/enable/online/offline
      SG
      VOLSER
      LIBRARY
DEVSERV QDASD / QTAPE
```

# Recommended Reading

z/OS DFSMS Introduction SC23-6851

https://www.ibm.com/docs/en/SSLTBW_3.2.0/pdf/idag200_v3r2.pdf

z/OS DFSMS Implementing System Managed Storage SC23-6849

https://www.ibm.com/docs/en/SSLTBW_3.2.0/pdf/idai600_v3r2.pdf

z/OS DFSMS Using the Interactive Storage Management Facility SC23-6856

https://www.ibm.com/docs/en/SSLTBW_3.2.0/pdf/idai500_v3r2.pdf

z/OS DFSMSdfp Storage Administration SC23-6860

https://www.ibm.com/docs/en/SSLTBW_3.2.0/pdf/idas200_v3r2.pdf

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