

Reclaim Those Empty CAs!

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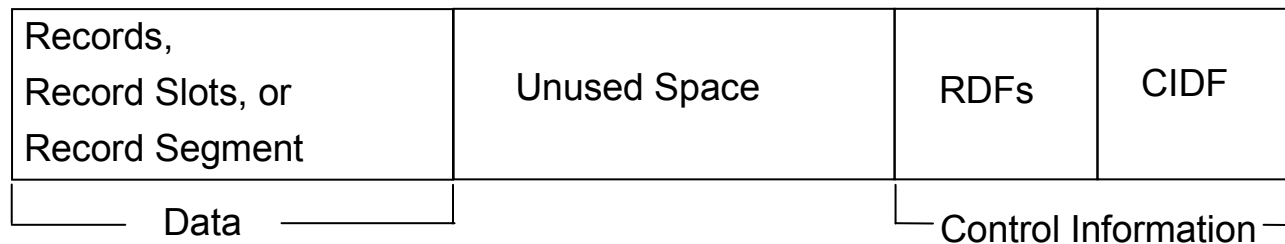
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Control intervals

- **Control Intervals**
 - Segments of information
 - Fixed in length - multiple of 512 bytes up to 8KB, multiple of 2KB from 8KB to 32KB
 - Used to transfer data to and from virtual storage and DASD
- **Can span tracks, but not Control Areas (explained later)**
- **Format**



Control Areas

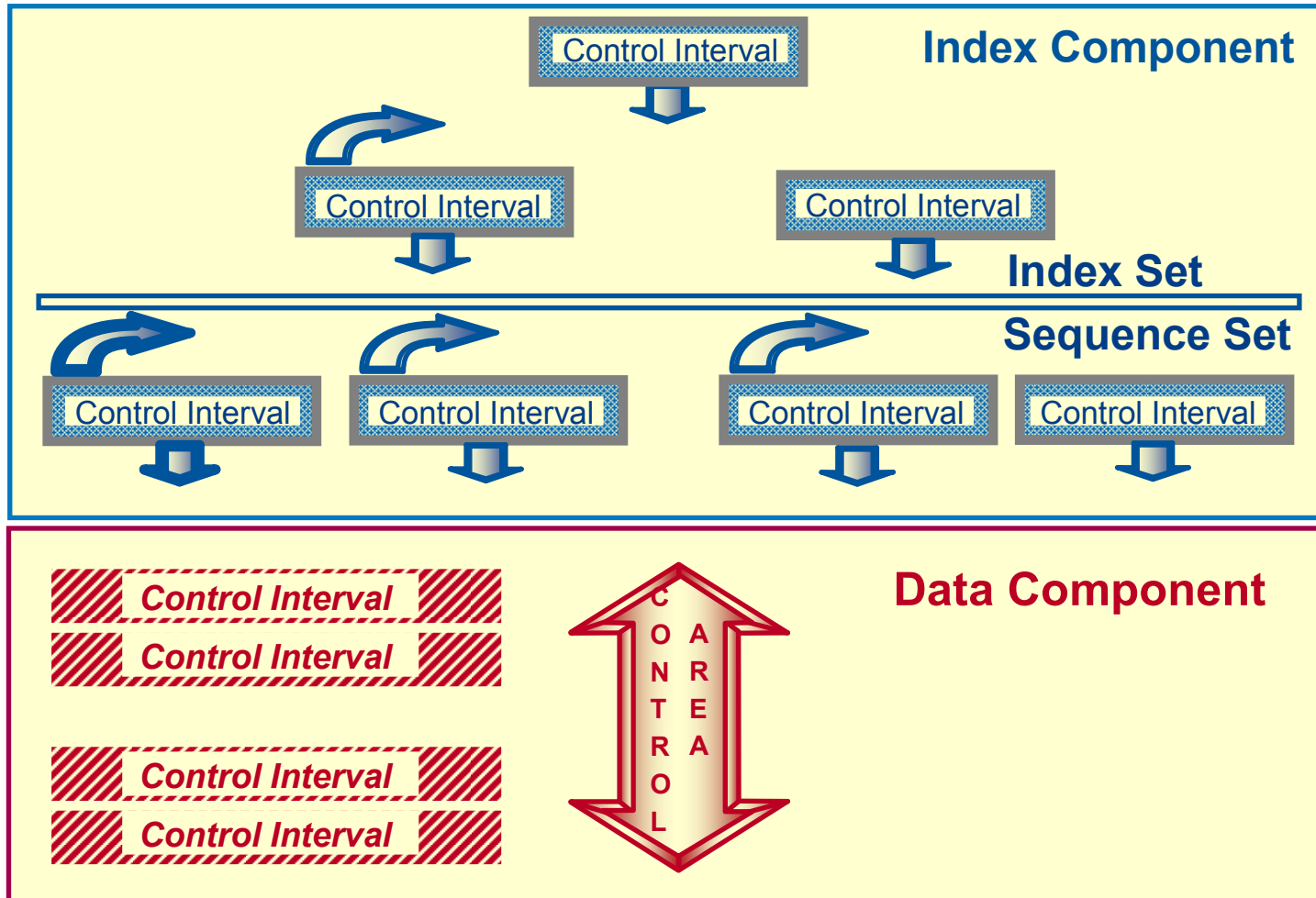
Control Intervals are grouped into fixed-length contiguous areas of direct access storage called Control Areas (CA).

- **CAs can be a minimum of one track, and a maximum of one cylinder or the maximum number of stripes (16).**

VSAM KSDS Index Structure

- **A KSDS has two components, a data and an index, each is a separate data set.**
- **An index data set contains key values and pointers.**
- **Most VSAM indexes consist of 2-3 index levels.**
- **The lowest level is called the sequence set. All levels above this are called the index set.**
- **The sequence set pointers point into the data component by RBA.**
- **In the sequence set, there is one index record per data component CA.**
- **Each sequence set index record contains a number of index entries equal to the number of data component CIs which fit into the CA.**
- **An index entry consists of the highest key associated with that CI.**

Index Structure (KSDS)



CI split, CA split and Extend

- **CI splits occur when there is not enough free space to add a new record to the data CI or no room to add an index entry in the index CI.**
 - For PUT DIR, the split is half of the CI, but the user can specify that the split is to occur at the insertion point.
 - For PUT SEQ, the split is at the insert point.
- **CA splits occur when there are no empty CIs in the CA during CI split processing.**
- **Extend occurs when a CA split occurs and there are no more empty CAs in the data set.**

VSAM Key Usage

- **VSAM assumes that all keys are uniformly, randomly distributed.**
- **Therefore, it is expected that all CAs will be evenly filled.**
- **The real world does not always work like this**

Creeping Key

- **Empty CAs are commonly caused by creeping keys**
- **A creeping key is one that continues to grow**
- **Keys containing date and time stamps are an example of these. Also keys generated using an increasing number such as a generation can also exhibit this behavior**
- **Catalog entries with generations or time stamps exhibit this behavior**

Creeping Key

- **Quite often the earlier dates, time stamps or generations are deleted.**
- **Since the keys never gets smaller, the CAs eventually empty and are never used again.**
- **Empty CAs appear to be orphaned**
- **If a record with a lower key was inserted, which it will not, the empty CA would be used.**

Performance Implications Empty CAs

- **Performance problem**
 - **Fragmented Space on volumes as data set grows**
 - **Multiple volumes from extend (EOV)**
 - **Sequential processing because sequence set must be read to determine the CA is empty**
- **The only recourse is a VSAM REORG**
 - **The KSDS is closed and taken "offline" to the application.**
 - **The KSDS, if not DEFINEd as REUSE, is backed up to sequential data set using REPRO, EXPORT or some other method.**
 - **The data set is deleted and redefined**
 - **The data set is reloaded from the sequential copy using REPRO, IMPORT, or some other method**
 - **detrimental to a customer's 24x7 available**

CA Reclaim – The Solution

- **Adds empty CAs to a free CA list**
- **List Anchor is in CI 2 of the index**
- **When a CA split occurs, CAs from free CA list are used first – rather than empty CAs beyond the high used RBA**
- **While not a true online reorg, it lessens the need for reorg**
- **Helps achieve 24x7 availability**
- **Available in DFSMS V1R12 or higher**

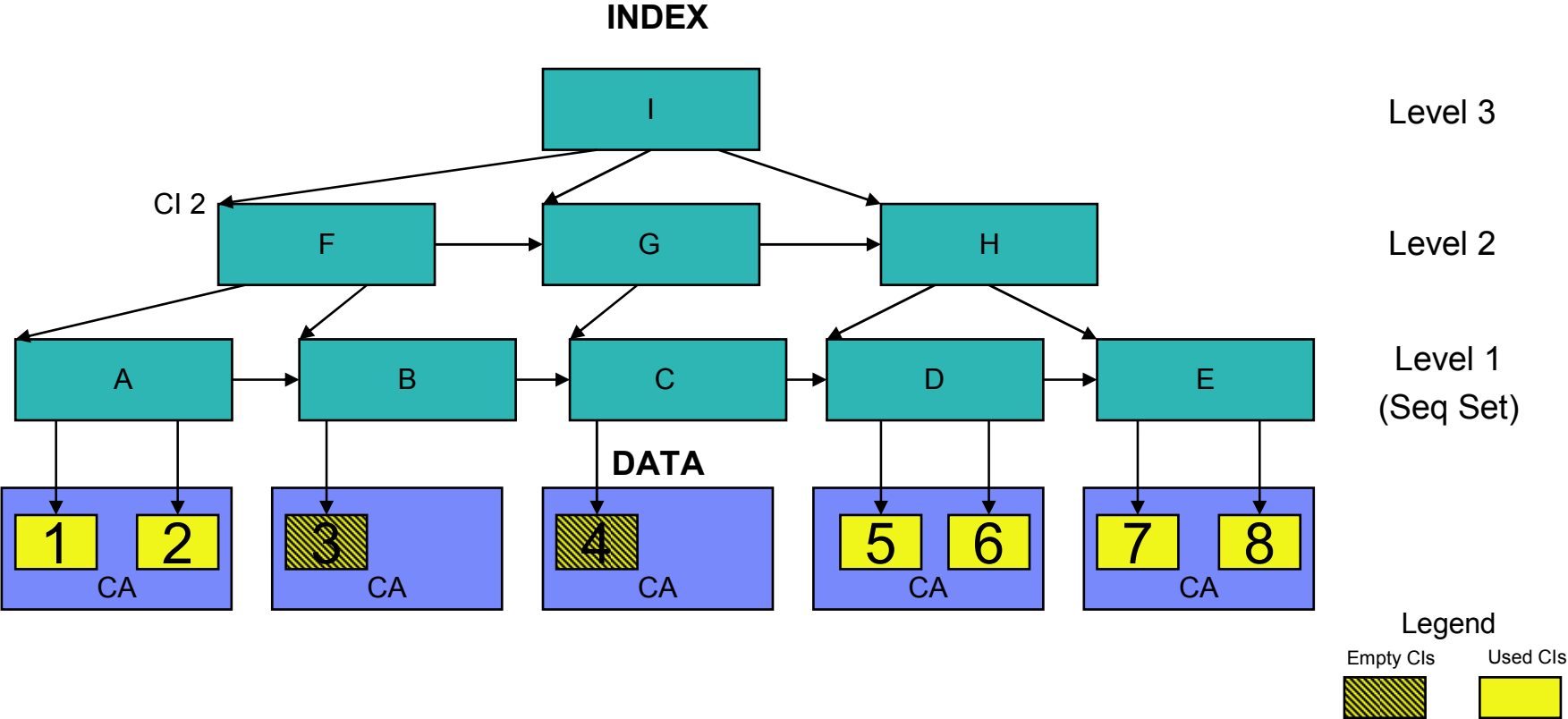
CA Reclaim – What is Supported

- **When CA Reclaim is used**
 - **VSAM KSDSs using batch**
 - **VSAM KSDSs using RLS**
 - **ICF Catalogs (KSDSs)**
 - **Both SMS and nonSMS**

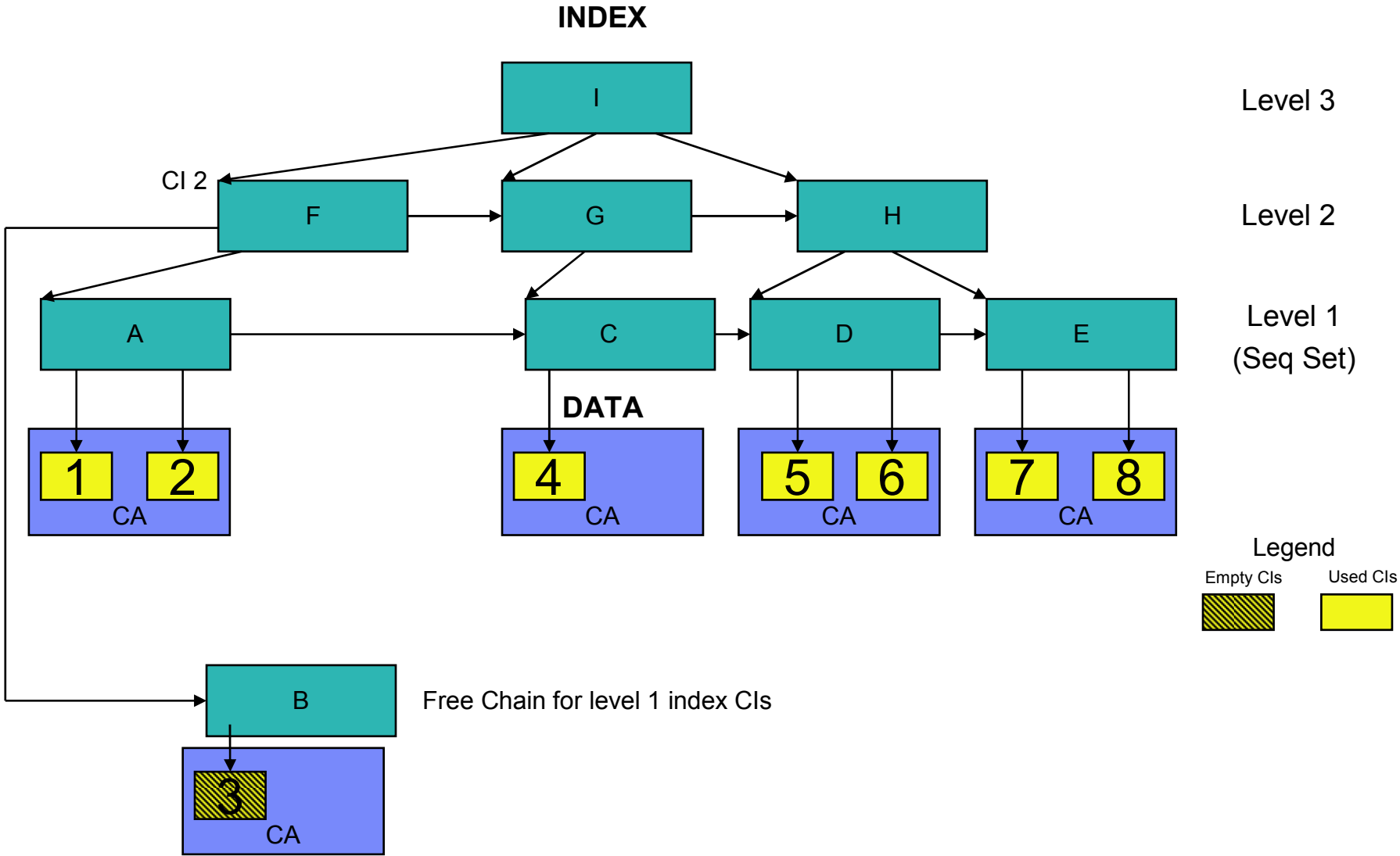
What Is Not Reclaimed

- **CA reclaim will not reclaim the following data CAs for a KSDS:**
 - **Partially empty CAs**
 - **CAs already empty before CA reclaim is enabled**
 - **CA with RBA 0 and the CA with the highest key of the KSDS**
 - **CAs in KSDSs with IMBED**
 - **Application opening a data set with Global Shared Resources (GSR)**

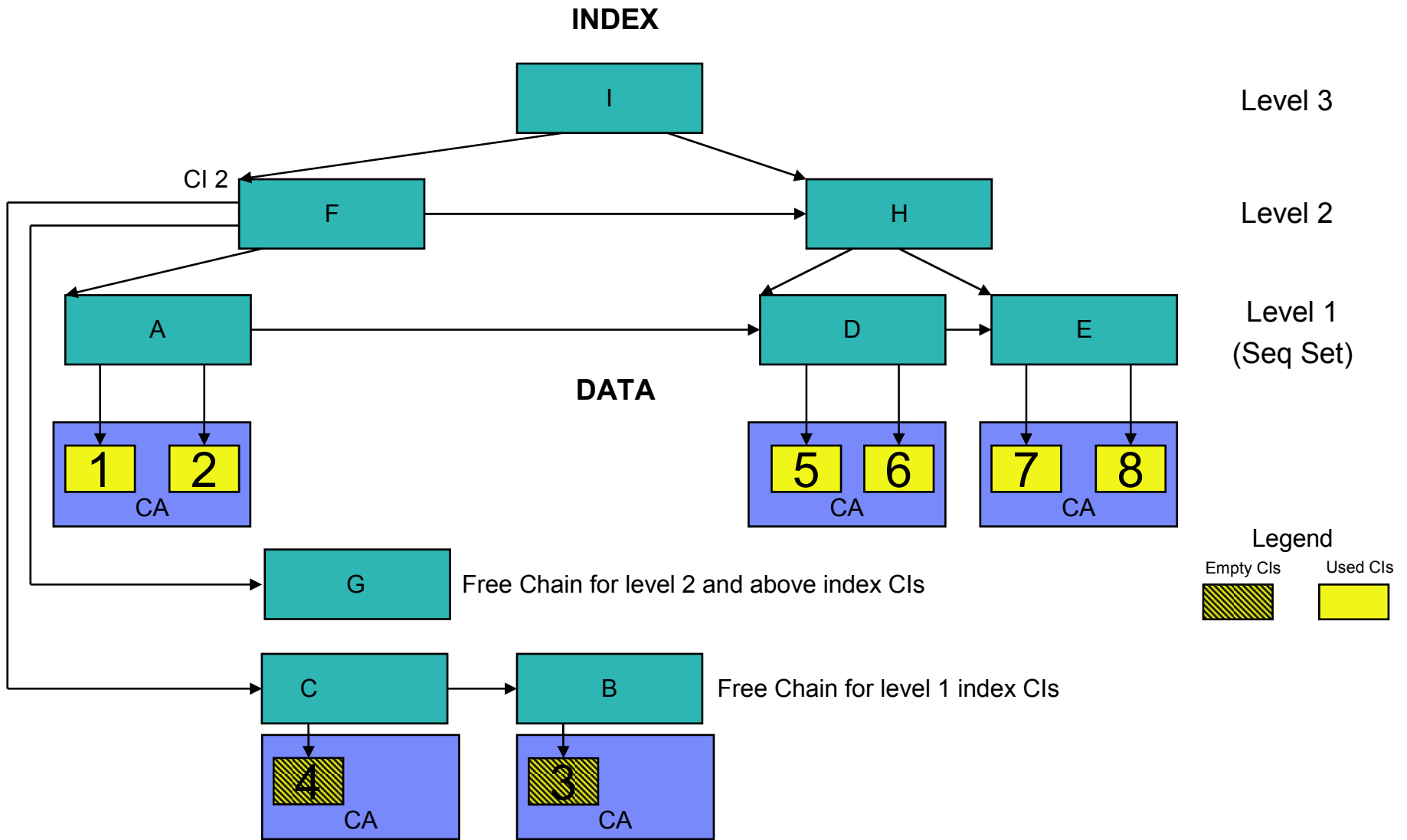
Without CA Reclaim



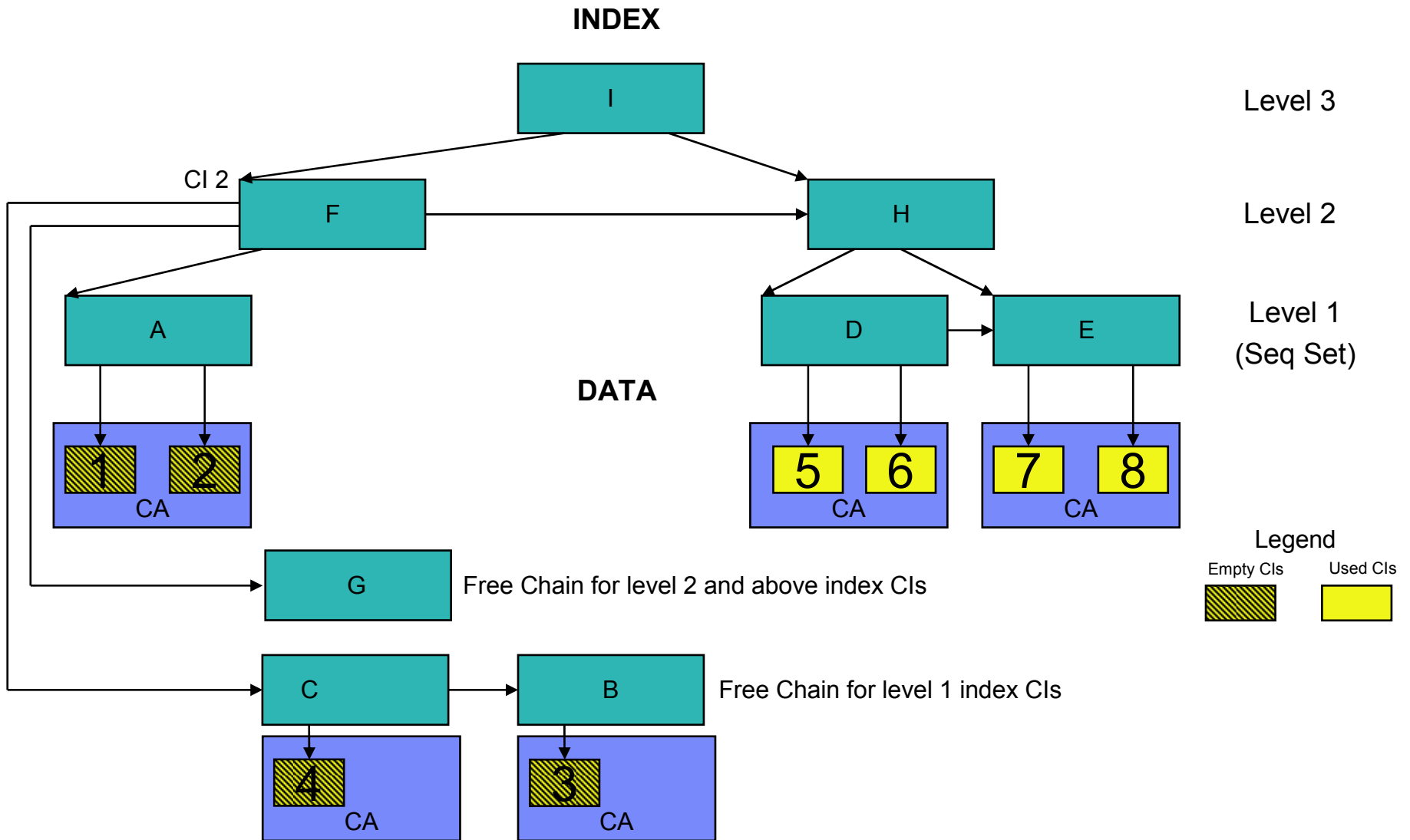
With CA Reclaim: 1 Free CA



With CA Reclaim: 2 Free CAs



With CA Reclaim: 3 Free CAs



CA Reclaim Invocation

- **System Level**
 - **SYS1.PARMLIB(IGDSMSxx) specifies CA_RECLAIM(DATACLAS|DATACLASS)**
 - Default: None
 - **Or SETSMS command is issued which explicitly specifies CA_RECLAIM(DATACLAS|DATACLASS)**
 - overrides 'SYS1.PARMLIB(IGDSMSxx)
 - CA_RECLAIM(NONE) to stop CA Reclaim
 - SYSPLEX – must route using RO *ALL, SETSMS

CA Reclaim Invocation

- **Data Set Level**
 - The **DATACLAS** for the **KSDS** specifies or defaults to **CA Reclaim=Y** during **IDCAMS DEFINE** or **DD define**
 - **CA Reclaim=N** set to not do CA Reclaim
 - Or a subsequent **IDCAMS ALTER** command is issued which explicitly specifies **RECLAIMCA**
- **BOTH System Level and Data Set Level must be set to get CA Reclaim**

CA Reclaim Abend/Cancel Processing

- **If an ABEND or Cancel occurs when CA reclaim is in progress, VSAM and RLS will try to complete the CA reclaim.**
 - **The philosophy is to complete the interrupted process as soon as feasible to minimize any possible complications.**
 - **The recovery will complete the interrupted CA reclaim even after the user has issued the SETSMS command to disable CA reclaim.**
 - **The CA reclaim algorithm is such that when it is interrupted, the worst case will be wasted DASD space, no worse than without CA reclaim.**
 - **There are no data integrity problems caused by interrupted CA reclaim.**

ISMF Data Class Define/Alter Panel Changes

```

Panel  Utilities  Scroll  Help
-----
DGTDCDC6                DATA CLASS DEFINE/ALTER                Page 5 of 5
Command ===>

SCDS Name . . . : USER6.MYSCDS
Data Class Name : DC1

To DEFINE/ALTER Data Class, Specify:
Shareoptions Xregion . . . (1 to 4 or blank)
                Xsystem . . . (3, 4 or blank)
Reuse . . . . . N (Y or N)
Initial Load . . . . . R (S, R or blank)
BWO . . . . . (TC, TI, NO or blank)
Log . . . . . (N, U, A or blank)
Logstream Id . . . . .
FRlog . . . . . (A, N, R, U or blank)
RLS CF Cache Value . . . . A (A, N or U)
RLS Above the 2-GB Bar . . N (Y or N)
Extent Constraint Removal N (Y or N)
CA Reclaim . . . . . Y (Y or N)

```

Use ENTER to perform Verification; Use UP Command to View previous Panel;
 Use HELP Command for Help; Use END Command to Save and Exit; CANCEL to Exit.

New field description:

CA Reclaim - specifies whether the DASD space for empty CAs will be reclaimed on z/OS 1.12 or later systems.

Valid values: - Y yes, reclaim free CA s - Default

- N no, do not reclaim free CA s

ISMF Data Class Display Panel Changes

```
Panel Utilities Scroll Help
-----
DGTICDC4                                DATA CLASS DISPLAY                Page 5 of 5
Command ===>

CDS Name . . . : Y421252.MYSCDS
Data Class Name: DC1
Reuse . . . . . : NO
Initial Load . . . . . : RECOVERY
BWO . . . . . :
Log . . . . . :
Logstream Id . . . . . :
FRlog . . . . . :
RLS CF Cache Value . . . . . : ALL
RLS Above the 2-GB Bar . . . . . : NO
Extent Constraint Removal . . . . . : NO
CA Reclaim . . . . . : YES
```

Use UP Command to View previous Panel;
Use HELP Command for Help; Use END Command to Exit.

ISMF Data Class List Panel Changes

Panel List Utilities Scroll Help

DATA CLASS LIST

Command ==>

Scroll ==> CSR
 Entries 1-9 of 16
 Data Columns 44-49 of 49

CDS Name : Y421252.MYSCDS

Enter Line Operators below:

| LINE OPERATOR | DATACLAS NAME | EXT CON REMOVAL | RLS ABOVE THE BAR | OVERVERRIDE SPACE | SDB | EATTR | CA RECLAIM |
|------------------|------------------|--------------------|----------------------|----------------------|----------|--------|---------------|
| --- (1) ---- | -- (2) ---- | - (44) -- | -- (45) --- | -- (46) -- | - (47) - | (48) - | - (49) -- |
| | DC1 | NO | NO | NO | NO | --- | NO |
| | DCA11 | NO | NO | YES | NO | NO | NO |
| | DCC1 | YES | NO | NO | NO | --- | NO |
| | DC1 | NO | YES | NO | NO | --- | NO |
| | DC3 | NO | NO | NO | NO | --- | YES |
| | DC5 | YES | NO | NO | NO | --- | NO |
| | DC7 | NO | YES | NO | NO | --- | YES |
| | DC7A | YES | NO | NO | NO | --- | NO |
| | DC9 | NO | YES | NO | NO | --- | NO |

ISMF Data Class List Print Panel Changes

```

Panel Utilities Scroll Help
-----
DGTDP41          DATA CLASS PRINT ENTRY PANEL          Page 1 of 3
Command ==>

Select Format Type . . . . . 1  (1 - Standard, 2 - Roster)
Report Data Set Name . . . . .
Replace Report Contents . . . N  (Y or N)  Lines/Page . . . 55  (12 to 99)
Specify Tags to be Printed:
==> *

          Line Operator          (26)  Data Set Name Type
          Data Class Name        (16)  Dynamic Volume Count
(15) Additional Volume Amt      (48)  EATTR
(8)  Avgrec                     (27)  Extended Addressability
(9)  Avg Value                  (44)  Extent Constraint Removal
(35) BWO                        (42)  FRlog
(41) Block Size Limit          (33)  Initial Load
(49) CA Reclaim                (6)   Key Length
(28) Compaction                (7)   Key Offset
(18) Control Interval Size Data (24)  Last Date Modified

Use ENTER to Perform Print; Use DOWN Command for next Panel;
Use HELP Command for Help; Use END Command to Exit.

```

ISMF Data Class List Sort Panel Changes

```

Panel Utilities Scroll Help
-----
DGTDCDC3          DATA CLASS SORT ENTRY PANEL          Page 1 of 3
Command ===>

Specify one or more Attribute Numbers for Sort Sequence:
Major Field . . . 2      Minor Field 1 . . .          Minor Field 2 . . .

Specify A for Ascending or D for Descending Sort Order:
Major Field . . . A      Minor Field 1 . . .          Minor Field 2 . . .

(1) Line Operator          (26) Data Set Name Type
(2) Data Class Name       (16) Dynamic Volume Count
(15) Additional Volume Amt (48) EATTR
(8) Avgrec                (27) Extended Addressability
(9) Avg Value             (44) Extent Constraint Removal
(35) BWO                  (42) FRlog
(41) Block Size Limit     (33) Initial Load
(49) CA Reclaim           (6) Key Length
(28) Compaction           (7) Key Offset
(18) Control Interval Size data (24) Last Date Modified

Use ENTER to Perform SORT; Use DOWN Command to view next Panel;
Use HELP Command for Help; Use END Command to Exit.

```

ISMF Data Class List View Panel Changes

```

Panel  Utilities  Scroll  Help
-----
DGTDVW41          DATA CLASS VIEW ENTRY PANEL          Page 1 of 3
Command ===>

If desired, Select option . . . (1 - SELECT, 2 - SAVE, 3 - DELETE)
          View Name . . . (1 to 8 characters, * to Delete all,
                          or blank for List of Saved Views)

Specify tags in Sequence Desired:
===> *

          Line Operator          (26)  Data Set Name Type
          Data Class Name        (16)  Dynamic Volume Count
(15) Additional Volume Amt      (48)  EATTR
(8)  Avgrec                     (27)  Extended Addressability
(9)  Avg Value                  (44)  Extent Constraint Removal
(35) BWO                        (42)  FRlog
(41) Block Size Limit          (33)  Initial Load
(49) CA Reclaim                (6)  Key Length
(28) Compaction                (7)  Key Offset
(18) Control Interval Size data (24)  Last Date Modified

Use ENTER to Perform Selection or Display List in VIEW Sequence;
Use DOWN for next Panel; Use HELP Command for Help; Use END Command to Exit.

```

ISMF Data Class Messages

```
DGTMDC91 -----ISMF MESSAGE-----
HELP
COMMAND ===>
  MESSAGE NUMBER:  DGTDC091

  SHORT MESSAGE:   Inv CA Reclaim Value

  LONG MESSAGE:    CA Reclaim must be Y (Yes) or N (No)

  EXPLANATION:
    You have entered an invalid CA Reclaim value.

  SUGGESTED ACTION:
    Correct and reenter a valid value for CA Reclaim.
    CA Reclaim must be Y (YES), or N (NO).
  Use ENTER to continue with ISMF HELP; Use END to return to ISMF.
```

Navquest Changes

```

//IBUSERA JOB (ACCT),'IBUSER',MSGCLASS=H,
//      NOTIFY=IBUSER,CLASS=A,MSGLEVEL=(1,1),TIME=(0,10)
//MYLIB JCLLIB ORDER=SYS1.SACBCNTL
//*****
//*$MAC(ACBJBAD1) COMP(5695DF123): BATCH - DC DEFINE/ALTER/DISPLAY */
//*
//*****
//STEP1 EXEC ACBJBAOB,
//      TABL2=userid.TEST.ISPTABL
//SYSUDUMP DD SYSOUT=*
//SYSTSIN DD *
PROFILE PREFIX(IBMUSER)
ISPSTART CMD(ACQBAD1 +
DEFNE/ALTER +
SCDS(TEST.CDS) +
DCNAME() +
DESCR() +
RECOG() +
RECFM() +
LRECL() +
...
...
...
FRLOG() +
RLSCF() +
MAXVOL() +
EXTCONS() +
RLSABOVE() +
SMBVSP() +
KEYLABL1() +
KEYENCD1() +
KEYLABL2() +
KEYENCD2() +
RECLAIMCA(Y) +
UPDHLVLSCHS() +
) +
BATSCRW(132) BATSCRD(27) BREDIMAX(3) BDISPMAX(999999)
/*

```

IDCAMS EXAMINE

- **Existing EXAMINE DATATEST or DATATEST INDEXTEST message IDC11724I**
 - **IDC11724I DATA COMPONENT CA NOT KNOWN TO SEQUENCE SET** continues to display orphan CAs, but RC changed from 8 to 4
 - **NOINDEXTEST** continues to return RC = 8
 - **EXAMINE** will not distinguish whether the orphan CAs were created by interrupted CA splits or CA reclaim.

IDCAMS EXAMINE

- **IDC01728I FOUND *nnnnnn* EMPTY CONTROL AREAS THAT HAVE NOT BEEN RECLAIMED.**
 - Can be used to determine if data set is good candidate for CA Reclaim
 - Number will not change if CA Reclaim enabled
 - Old Empty CAs remain
 - Only new empty CAs are reclaimed

IDCAMS EXAMINE

- **IDC11768I [CI SPLIT | CA RECLAIM] IN PROGRESS**
 - **Caused by ABEND, CANCEL, or a system failure**
 - **Informational, not a data integrity issue**
 - **Does not leave orphan CA**
 - **Corrected in subsequent access**
 - **Different from IDC11778I**

IDCAMS EXAMINE

- **IDC11778I CA RECLAIM IN PROGRESS**
 - Caused by ABEND, CANCEL, or a system failure
 - Informational, not a data integrity issue
 - Temporary condition
 - Index CI 2 is dumped. Processing continues

IDCAMS VERIFY RECOVER

- **IDCAMS VERIFY RECOVER**
 - **RECOVER** is new parameter
 - **Completes an interrupted CA reclaim, in addition to what IDCAMS VERIFY currently does**
 - **May cause index update, so no other applications should have the data set OPEN**
 - **Default is NORECOVER**

IDCAMS ALTER

- **ALTER RECLAIMCA|NORECLAIMCA**
 - Turns CA Reclaim indicator in Catalog ON or OFF for a given KSDS entry
 - IDC3180I CA RECLAIM ALTER IS NOT VALID FOR THE DATA SET TYPE – non KSDS or IMBED
 - ERASE requests will not do CA reclaim for the KSDS if ALTER NORECLAIMCA or SETSMS CA_RECLAIM(NONE)

IDCAMS LISTCAT

- **New entry in LISTCAT output**

SMSDATA

```
STORAGECLASS ---SXPXXS04  MANAGEMENTCLASS--BKDAILY
DATACLASS -----ABCD    LBACKUP ---0000.000.0000
CA RECLAIM -----(YES)
BWO STATUS-----00000000  BWO TIMESTAMP---00000 00:00:00.0
BWO-----NO
```

'YES' (default) means CA reclaim is enabled.

Changes to SMF Record Type 64

- **VSAM Cluster Component status**
 - Written at Close and EOVS

- **Added field:**

| Offset | Name | Length | Description |
|------------|-----------------|----------|---|
| 121 | SMF64FD1 | 1 | EOV DIAGNOSTIC FIELD 1 |
| 122 | SMF64FD2 | 1 | EOV DIAGNOSTIC FIELD 2 |
| 123 | | 1 | RESERVED |
| 124 | SMF64DAU | 4 | Change in the number of CA-reclaimed control areas reused in the KSDS since the last EOVS or CLOSE |
| 128 | | 4 | RESERVED |

Changes to RLS Sysplex Cache Manager (SCM)

- There are three new SCM messages issued for

SETSMS CA_RECLAIM(NONE | {DATACLAS|DATACLASS}) :

- **IGW467I DFSMS CA_RECLAIM PARMLIB VALUE SET DURING SMSVSAM ADDRESS SPACE INITIALIZATION ON SYSTEM: system-name CURRENT VALUE: parm-value**
 - System-name System on which the SMSVSAM address space was initialized
 - Parm-value Current value of the CA_Reclaim parameter
- **IGW467I DFSMS CA_RECLAIM PARMLIB VALUE CHANGED ON SYSTEM:**
 - System-name**
 - OLD VALUE: old-value**
 - NEW VALUE: new-value**
- **IGW467I DFSMS CA_RECLAIM PARMLIB VALUE ON SYSTEM: System-name CURRENT VALUE: parm-value**
 - The value did not change

Migration/Coexistence

- **DFSMS Components require toleration APARs for earlier releases to coexist with CA Reclaim**
 - **May cause data integrity problems if not on**
 - **VSAM OA26466**
 - **VSAM RLS OA25108, OA32711, OA33397**
 - **SMS OA27557 (V1R10 only)**
 - **Catalog OA32713**
 - **HSM OA29142**
 - **DSS OA29022**
 - **AMS OA26256**

Performance

- **Performance depends on a number of factors**
 - Severely fragmented KSDSs
 - KSDS with many empty CAs
- **Pros**
 - In general, sequential performance is improved
 - Direct requests may improve due to fewer index CIs to traverse
 - Lessens need for extends
 - Reduces and may eliminate the need for Reorgs
- **Con**
 - Completely emptying a KSDS causes performance degradation – consider REUSE if possible

Publications

- **z/OS V1R12.0 DFSMS: Using Data Sets (SC26-7410-10)**
- **z/OS V1R12.0 DFSMS Access Method Services for Catalogs (SC26-7394-11)**
- **z/OS V1R12.0 DFSMS Using the Interactive Storage Management Facility (SC26-7411-07)**
- **z/OS V1R12 DFSMS: Implementing System Managed Storage (SC26-7407-07)**
- **z/OS V1R12.0 DFSMS Storage Administration Reference (for DFSMSdfp, DFSMSdss, DFSMSHsm) (SC26-7402-13)**
- **z/OS V1R12.0 DFSMS Using the New Functions (SC26-7473-07)**
- **z/OS V1R12.0 MVS System Commands (SA22-7627-23)**
- **z/OS V1R12.0 MVS System Messages, Vol 7 (IEB-IEE) (SA22-7637-20)**
- **z/OS V1R12.0 MVS Initialization and Tuning Reference (SA22-7592-21)**
- **z/OS V1R12.0 DFSMSdfp Diagnosis Reference (GY27-7618-11)**

Summary

- **CA Reclaim**
 - **Detects Empty CAs**
 - **The empty CAs are removed from the active index structure and moved to free chains**
 - **Uses the empty CAs when needed before using new CAs**
 - **Reduces or eliminates reorgs in support of 24x7 operations**
 - **Performance improvement for sequential searches**

The End

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