VSAM Exploitation

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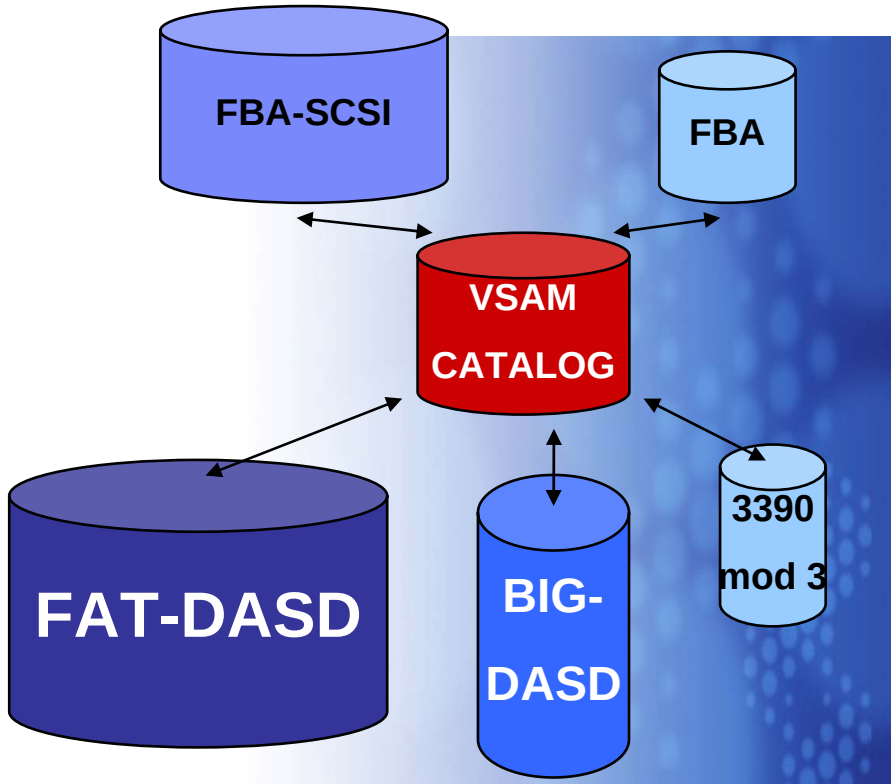
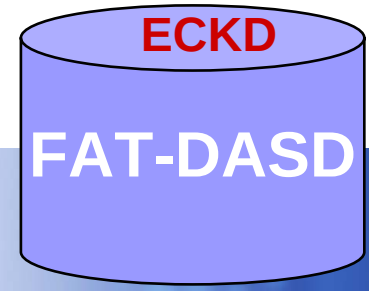
AGENDA

- **VSAM restrictions overview**
- Space utilization
- Reorganization - how and when
- CATALOG Reorganization
- Backup/Restore
- Don’ts
- VSAM & DL/I Service update

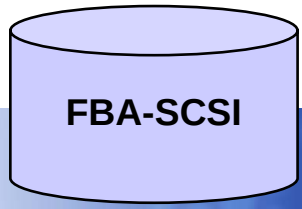


VSAM limits overview



- 123 Extents per data component & 123 Extents per Index component
- 123 Volumes per data component & 123 Volumes per Index component
- UNIQUE, REUSEable files & catalogs only 16 Extents & 16 Volumes
- 4.3 Gig (X'FFFFFFFF') RBA for ESDS, SAMESDS, RRDS, VRDS and AIX
- 289 Gig for XXL Datasets but only KSDS data component !!
- 32K max CISIZE for data component = max Recordsize without SPANNED
- 8K max CISIZE for index component
- 16 million records per EXTENT & allocation in RECORDS (important for Backup/Restore)
- data+index = max 16 million records
- 4999 Cylinders or 8.388.096 blocks prim/sec allocation for CATALOGs (V4.1)

VSAM limits overview



- 16 Volumes used from DEFAULT-MODEL
- NO IMBED, NO RECOVERABLE CATALOGs since V3.1

FAT-DASD/BIG-DASD limitations

- Key length between 7-35 require min data CISIZE of 1024
- Key length between 36-55 require min data CISIZE of 2048
- Key length greater then 55 require min data CISIZE of 4096
- Define Catalog DEDICATE on a BIG- or FAT-DASD only on empty disk with VTOC at first or last Cylinder
- MIN allocation = 1 Cylinder
- MIN & MAX CA Size = 1 Cylinder -> SPANNED recordsize limit

DASD Overview

ECKD

MODEL	VSAM Capacity	Bytes/Cylinder	VSAM Classification
3380	max 2655 cylinders	712140	Small DASD
3390 mod 3	max 3339 cylinders	849960	Small DASD
3390 mod 9	max 10017 cylinders	849960	BIG- or FAT-DASD
3390 mod 27 / DS8000	max 65520 cylinders	849960	BIG- or FAT-DASD

SCSI-FBA

MODEL	Capacity in Blocks	Capacity in Bytes	VSAM Classification
Generic FBA	491.520 FBA blocks	2 Gigabyte	FBA
FBA-SCSI	33.553.920 FBA blocks	16 Gigabyte	FBA-SCSI

Space utilization

18K

- **18K data CISIZE provides best space utilization**
  - Its NOT about how much bytes are wasted inside a CI its about tracks and cylinders !!

SAMPLE: (Any KSDS, ESDS or AIX with nearly 4 gigabyte of data)

A) CISIZE of 512 bytes → space utilization of 24K per track

4.294.967.295 / 25088 bytes per track(CI 512) = 171196 tracks =11413 cylinders

B) CISIZE of 18432(18k) → space utilization of 54K per track

4.294.967.295 / 55296 bytes per track(CI 18K) = 77672 tracks = 5178 cylinders

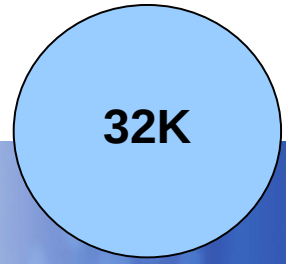
- same amount of VSAM data in both cases
- NO effect on the 4 gig limit
- 115% better space utilization starting with very first track allocated

512

Note: max 289 gig = 767963 cyl(512) and 348427 cyl(18k)

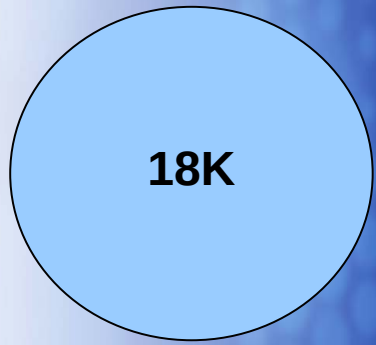
= (over 6 FATDASDs difference)

18K is bigger then 32K



- **18K provides max size for SPANNED RECORDsize**
  - Max recordsize = 1 CA = 1 Cylinder(ECKD)

    or 30720 Blocks(SCSI)
  - AVG/MAX recordsize, CISIZE, DEVICE Type together determine the max recordsize possible



18K CISIZE <<->> (54k*1024) * 15 tracks per cylinder = **829440 bytes max rec**

32K CISIZE <<->> (48k*1024) * 15 tracks per cylinder = **737280 bytes max rec**

Reorganization of KSDS and AIX

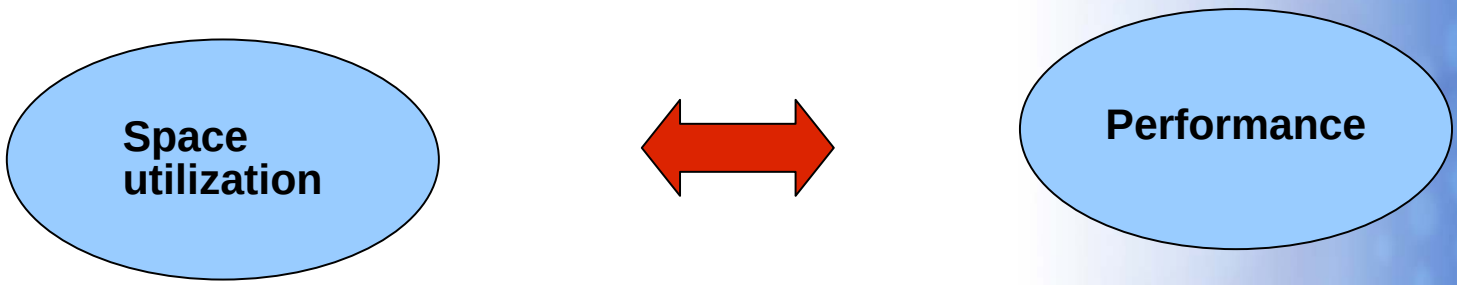
How to identify when it's time to reorganize ?

Values to look for:

- CI Splits / CA Splits, CI-Size <---> Recordsize
- High-Used-RBA, High-Allocated-RBA,
- Number of Records, Number of Deleted Records

Things to keep in mind:

- clusters index components NEVER shrink (even during delete records)
- bigger CI-Size causes less CI Splits, but more CA-Splits if direct processing
- High-Allocated-RBA = Freespace(Listcat) + High-Used-RBA
- Whats good for performance is sometimes bad for space utilization and vice versa



Reorganization AIX Sample

AIX DATA COMPONENT ATTRIBUTES

```
        KEYLEN----------------40     AVGLRECL-------------61  ..  CISIZE--------------2048
        RKP-------------------8      MAXLRECL----------641900  ..  CI/CA----------------315
        AXRKP-----------------19
      STATISTICS
        REC-TOTAL-------26165863     SPLITS-CI----------67612     EXCPS------------7857278
        REC-DELETED---------4277     SPLITS-CA----------2648      EXTENTS----------------11
        REC-INSERTED-----2193570     FREESPACE-%CI---------10     SYSTEM-TIMESTAMP:
        REC-UPDATED---------5957     FREESPACE-%CA----------5          1975.105   08:01:48
        REC-RETRIEVED---63576470     FREESPACE------142571520
      ALLOCATION
        SPACE-TYPE------CYLINDER
        SPACE-PRI------------907     USECLASS-PRI-----------0     HALRBA-OR-CI--3971358720
        SPACE-SEC------------451     USECLASS-SEC-----------0     HUSRBA-OR-CI—-3828787200
```

Base-Cluster DATA COMPONENT ATTRIBUTES

```
STATISTICS
        REC-TOTAL-------33916753     SPLITS-CI---------227960     EXCPS----------167777760
        REC-DELETED---------4155     SPLITS-CA-----------3576     EXTENTS----------------23
        REC-RETRIEVED--378842242     FREESPACE---------150570
```

AIX calculations

SPLITS-CI----------67612 & SPLITS-CA----------2648

suggest a lot of freespace inside of already allocated CI's and CA'

HOW MUCH is it ??

5 bytes of control info + length of alternate key + length of prime key

5 + 40 + 19 **= 64 bytes per record in base-cluster**

64 * REC-TOTAL-------3916753 (BC) **= 0,2 gig used**

HUSRBA of 3.8 gig – 0.2 gig used space ***= 3.6 gig unused space = ratio of 0.95%***

(with so many splits, the initial freespace can be ignored)

lets check from the other side (how much space would be covered by all splits ?

SPLITS-CI----------67612 * CISIZE--------------2048 **= 138.469.376 bytes**

SPLITS-CA----------2648 * CI/CA--315 * CISIZE----2048 **= 1.7 gig**

= 1.8 gig split space

0,2 gig used space / 1.8 gig split space = 11% split space ratio

only about 11% of the space reserved by Splits has been reused at best!!

Reorganization Check-List

- **AM I WASTING SPACE ?**
  - IF NO → DON'T REORG !!
  - IF YES, go to next question
- **ARE THERE MANY CI/CA SPLITS ?**
  - IF NO → then the splits are not the reason,→ look for other explanations
  - IF YES, go to next question
- **IS THE SPACE ALLOCATED BY SPLITS REUSED?**
  - If NO, WHY is the space not reused ? → look for other explanations
    - 0 ~ 40% → splits not really reused → REORG
  - If YES → DO you want to get rid of all the SPLITS ??
    - 40 ~ 80% → splits are reused

      leave splits for better performance **OR** REORG to free some space
    - 80 ~ 100% → splits cannot be the reason for wasting space !!

      → look for other explanations

Explanations

- **EMPTY INDEX because of steadily increasing key**
  - date/time in key → Index CIs for older keys will never be reused after record deleted and steadily increasing key value
- **many deletes and INDEX will never shrink**
  - INDEX HUSRBA is always the all-time high
- **Wasted space within Data CIs**
  - CISIZE does not match RECSIZE multiple
- **Very High Freespace values during initial DEFINE**
- **HUSRBA value in error**
  - Check with MILA4VSAM or IKQVCHK (Catalog Checker) for errors
  - Use IDCAMS VERIFY

Reorganization KSDS Sample

Base-Cluster DATA COMPONENT ATTRIBUTES

```
ATTRIBUTES
    KEYLEN----------------19     AVGLRECL-------------330   ...  CISIZE--------------2048
    RKP-------------------0      MAXLRECL-------------330   ...  CI/CA----------------315
    SHROPTNS(2,3)   RECOVERY     SUBALLOC          NOERASE      EXTRALARGE        INDEXED
    NOWRITECHK       NOIMBED     NOREPLICAT     UNORDERED       NOREUSE       NONSPANNED
  STATISTICS
    REC-TOTAL--------3916753     SPLITS-CI-----------7960       EXCPS----------163738140
    REC-DELETED---------4155     SPLITS-CA-----------1576       EXTENTS---------------19
    REC-INSERTED-----1622557     FREESPACE-%CI----------0       SYSTEM-TIMESTAMP:
    REC-UPDATED--------32262     FREESPACE-%CA----------0            2007.183   02:01:48
    REC-RETRIEVED--378842242     FREESPACE--------150570            X'C0D47CA4D42B836A'
  ALLOCATION
    SPACE-TYPE------CYLINDER
    SPACE-PRI------------800     USECLASS-PRI-----------0       HALRBA-OR-CI--2000370500
    SPACE-SEC------------500     USECLASS-SEC-----------0       HUSRBA-OR-CI--2000219930
```

KSDS (data portion) calculations

SPLITS-CI---------227960 & SPLITS-CA----------3576
suggest a lot of freespace inside of already allocated CI's and CA's

HOW MUCH is it ??

MAXLRECL--330 * REC-TOTAL------3916753 **= 1.3 gig of used space**
HUSRBA or CI# * CIZISE *(2.000.219.930)* ***= 2 gig occupied***
(EXTRALARGE datasets show CI# instead of RBA) ***= 0.7 gig unused space***

lets check from the other side (how much space would be covered by splits?):

SPLITS-CI----------7960 * CISIZE-------------2048 **= 0,016 gig**
SPLITS-CA----------1576 * CI/CA--315 * CISIZE----2048 **= 1,016 gig**
= 1,032 gig split space

1,3 gig used space / 1 gig split space = *100% split byte ratio*

No Valid assumption can be made for reused SPLITS in case of 100%!!

- if first priority is FreeSpace, then REORG
- if first priority is Performance, then you cannot tell

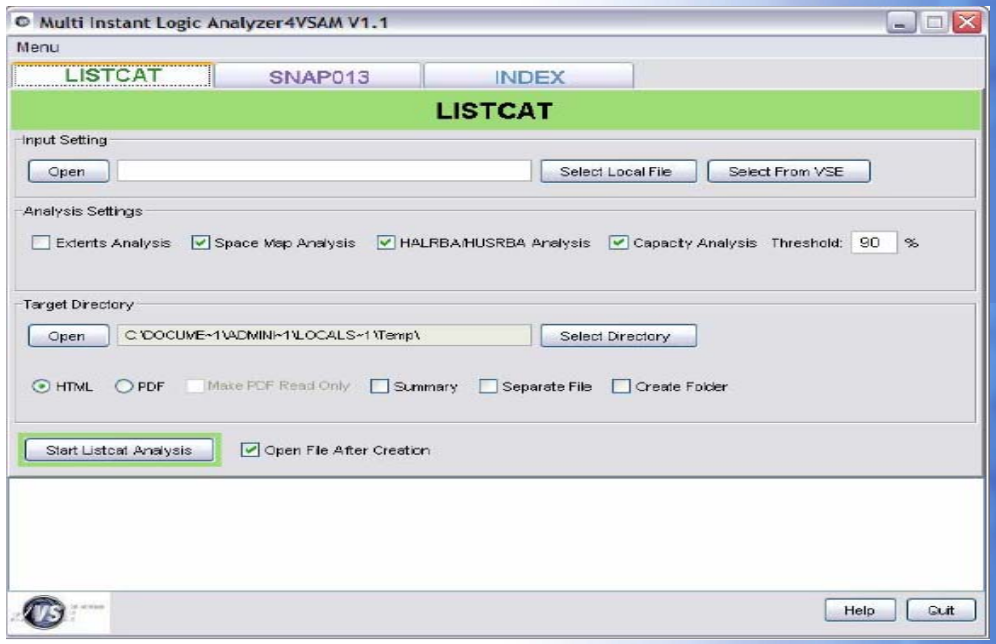
ONLY if used space < split space < total space occupied you can make a performance relevant assumption !!

Hints

- **FREESPACE is NO indication for free space inside of allocated CI's/CA's**

  HALRBA-OR CI—3.971.358.720 – HUSRBA-OR-CI—3.828.787.200 = FREESPACE--142.571.520
- **Ratio between** REC-TOTAL-------26165863 **and** REC-DELETED---------4277
- **If records total is smaller then records delete ->> check INDEX portion**

- **The Multi Instant Logic Analyzer4VSAM can help !!**



Reorganization - How

REPRO is faster then BUILDINDEX !!

- BUILDINDEX requires sort of records and that can for large files require a multiple amount of time to reorganize instead of using REPRO
- BUILDINDEX requires either GETVIS or 2 workfiles for the sort

GETVIS required for internal sort by BUILDINDEX:

1. Sort record length	*= alternate key length + prime key length (for KSDS) or alternate key length + 4 (for an ESDS).*
2. Sort area size	*= Sort record length x number of records in the base cluster, rounded up to 32,768 or to the next multiple of 2,048, whichever is greater.*
3. Sort table size	*= (sort area size ÷ sort record length) x 4.*
2.+3.	*= amount of GETVIS necessary for internal sort*

Reorganization - How

The amount of space that IDCAMS requests when defining an external sort work file:

1. Sort records per block	*= 2041 (fixed-length record size)*	*÷ sort record length*
2. Primary allocation in records	*= (number of rec in base cluster*	*÷ sort rec per block) + 10*
3. Secondary allocation in records	*= 10% of primary allocation*	*+ 10*

Both primary and secondary space allocations are requested in records with a fixed-length record size of 2041 bytes and a CI size of 2048 bytes.

- **Define your own workfiles before BUILDINDEX with the required amount of space**
- **Define workfiles on Virtual FBA if possible**

USE REPRO to reorganize AIX !!

Reorganize UserCatalog

1. Use the following jobstream to copy catalog records to tape.

```
// JOB REORGCAT
// ASSGN SYS005,cuu  <<----- backup tape
// MTC REW,SYS005
// DLBL IJSYSUC,'usercatalog filename',,VSAM
// TLBL UCAT,'UCATON.TAPE1',,TAPE01,1
// EXEC IDCAMS,SIZE=AUTO
     REPRO INFILE(IJSYSUC/UCATMRPW) -
                OUTFILE (UCAT -
                ENVIRONMENT (PDEV(2400) RECFM(VARBLK) REW -
                BLKSZ(5164) RECSZ(516)))
/*
/&
```

2. Remove all files with allocations on the catalog volume.

This can be done by backing them up, or moving them to another volume.

Reorganize UserCatalog

3. Scratch the VSAM spaces belonging to the user catalog from the catalog volume. Do not modify any of the other volumes belonging to this catalog.

4. Define a new, larger, user catalog on the original volume.

5. Restore the old user catalog from tape using the following:

```
// JOB REORGCAT
// ASSGN SYS004,cuu <<----- Tape containing previous backup
// MTC REW,SYS004
// DLBL IJSYSUC,'usercatalog filename',,VSAM
// TLBL CATIN,'UCATON.TAPE1',,TAPE01,1
// EXEC IDCAMS,SIZE=AUTO
      REPRO INFILE (CATIN -
                  ENVIRONMENT (PDEV(2400) RECFM(VARBLK) -
                  BLKSZ(5164) RECSZ(516))) -
                  OUTFILE(IJSYSUC/UCATMRPW)
/*
/&
```

BACKUP/RESTORE

- **Migration from 3390 mod3 to Large-/BIG-/FAT-DASD using BACKUP/RESTORE can cause problems, because keylength-CISIZE dependencies on the larger ECKD devices**.
  - e.g. A cluster with CISIZE of 512 and a keylength of 15 cannot be RESTORED to any BIG-/FAT-DASD
  - Solution : restore to 3390 mod3 and use EXPORT/IMPORT for migration

- **Restore to a different device type will always be slower then if BACKUP and RESTORE Volume are of the same device characteristics. (this is because remapping will operate on a CI instead of a CA basis)**

- **Don't use Fastcopy or DDR or any similar product to migrate your CATALOGS** ***--> this will cause Catalog corruptions !!***

Don'ts !

- **Never define a SAM-ESDS,UNIQUE or REUSable file with a big primary and a very small secondary allocation and having a long list of candidate volumes.**
  - This will lead to EXTENTs wasted and those Cluster only have 16 Ext.max
- **Don’t try to save space with small Catalog secondary allocations**
  - Catalog’s can only allocate on one volume, so a big primary allocation will be used only once and never again
- **Not to many AIX with UPGRADE over one BaseCluster**
  - Upgrade-set is bottleneck for processing

Latest VSAM Service for z/VSE 3.1

- DY46855/UD53326 Restrict SDUMPS in Some Invalid RBA Cases
- DY46860/UD53314 Progchk in IKQVRM Accessing AIX Cluster
- DY46784/UD53245 Performance Degradation, Storage Overlays, ABENDS under CICS
- DY46776/UD53243 Invalid FREEVIS After Unsuccessful GETVIS
- DY46808/UD53267 SHOWCB Macro Returns Negative Value in RKP Field for Compressed ESDS Files
- DY46773/UD53230 SDUMP From IKQBFE +x'834' Exclusive Control
- DY46725/UD53213 Behaviour of POINT MACRO at END OF FILE for RRDS Files Changed

---------- E313 ----------

- DY46813/UD53266 Program Check with LE/VSE COBOL Program
- DY46752 MSG0S03I PROGCK in IKQIOE
- DY46817 MSGDFHFC0304 MSGDFHFC0959 ERROR during CLOSE Under CICS
- DY46807/UD53264 SDUMPs from IKQIXS w/ 5-Level Index
- DY46810 SDUMPs from IKQIOD w/ Real 3380 Vols
- DY46724/UD53193 VSAM DELETE ERASE of Files with Records Larger Than 32512 Results in MSG4224I RC 08 EC 104
- DY46723/UD53192 RECORD NOT FOUND Condition with ESDS File & DSN
- DY46718/UD53189 ENDREQ Does Not Help Alleviate RECORD NOT FOUND

Latest VSAM Service for z/VSE 4.1

DY46835/UD53319	RECMAP Error Message Does Not Set Correct MAXCC
DY46852/UD53305	ProgCk (Protection Exception) During VSE/VSAM OPEN
DY46878/UD53332	Restrict SDUMPS in Some Invalid RBA Cases
DY46786/UD53251	Progchk in IKQVRM Accessing AIX Cluster
DY46854/UD53308	Performance Degradation, Storage Overlays, ABENDS Under CICS
DY46861/UD53311	Invalid FREEVIS After Unsuccessful GETVIS
DY46853/UD53307	SHOWCB Macro Returns Negative Value in RKP Field for Compressed ESDS Files
DY46775/UD53238	SDUMP From IKQBFE +x'834' Exclusive Control
DY46816/UD53276	MSG0S03I PROGCK in IKQIOE
	SDUMPs from IKQIXS w/ 5-Level Index
	SDUMPs from IKQIOD w/ Real 3380 Vols
	Program Check with LE/VSE COBOL Program
	MSGDFHFC0304 MSGDFHFC0959 ERROR During CLOSE
DY46795/UD53274	Behavior of POINT MACRO at End of File Changed for RRDS Files

---------- E411 ----------

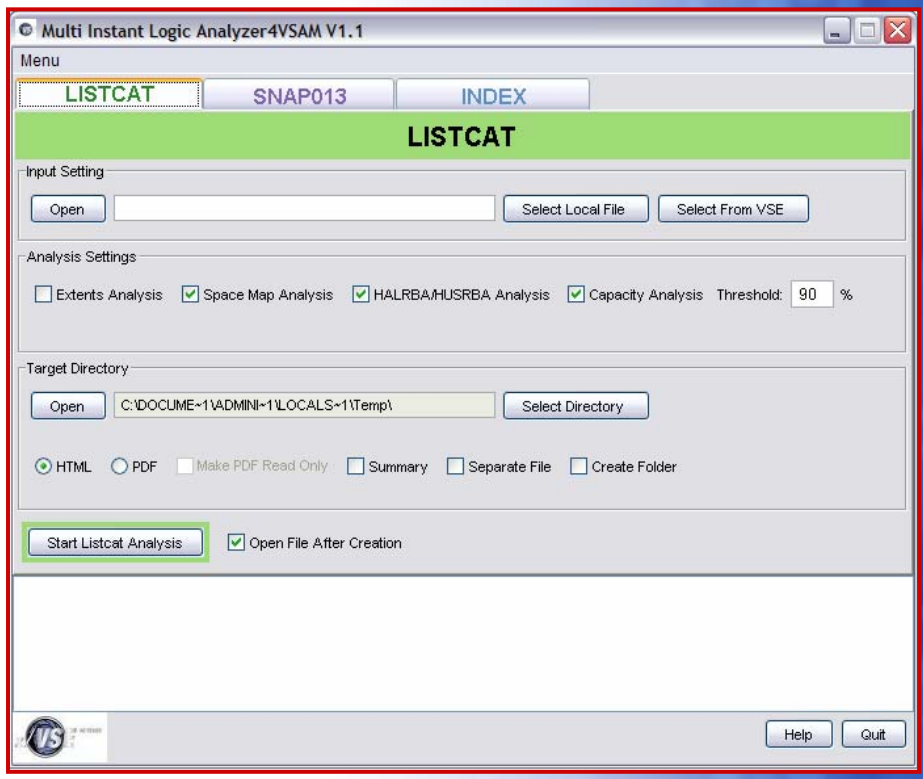
DY46726/UD53194	Multiple OPEN/CLOSE Lead to Partition GETVIS Storage Fragmentation
DY46793/UD53250	VSAM DELETE ERASE of Files with Records Larger Than 32512 Results in MSG4224I RC 08 EC 104
DY46792/UD53248	RECORD NOT FOUND (RNF) Condition with ESDS File and DSN
DY46791/UD53246	ENDREQ Does Not Help Alleviate RECORD NOT FOUND Situation

Latest DL/I Service

- PK37263: ABEND AT DELETE CALL WITH MULTIPLE DATASETS
  PTF DL/I 1.10: UK21158 PTF DL/I 1.11: UK21160
- PK44598: ALLOW DUPLICATE SECONDARY INDEXES DURING PREFIX UPDATE
  PTF DL/I 1.10: --- PTF DL/I 1.11: UK25033
- PK48347: SUPPORT UP TO 10 DATASETS PER DL/I HD DATABASE
  PTF DL/I 1.10: --- PTF DL/I 1.11: UK26815
- PK49053: DL/I RELOAD WITH EMPTY DATABASE
  PTF DL/I 1.10: UK27125 PTF DL/I 1.11: UK27124

Multi Instant Logic Analyzer4VSAM v1.2+

- **What is the Multi Instant Logic Analyzer4VSAM ?**
  - A collection of multiple tools to analyze VSAM data instantly
  - LISTCAT, SNAP013, INDEX and Capacity analysis included
  - VSE Connector integration
  - Helps identifying & solving potential problems early
  - HTML / PDF output



VSAM Exploitation

QUESTIONS ?

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