

IAM: Back to the Future

Turning back the clock
on VSAM run times.

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Shaping the Future of Enterprise Technology





Improving Performance for VSAM Applications

- What is IAM
- IAM Version 9.2 Enhancements
- IAM Performance Strategies
- IAM Performance Results
- IAM Performance Summary
- IAM Best Practices
- IAM Advanced Functions
- How to IAM a VSAM Data Set
- Finding VSAM Data Sets



What is IAM?

- **Reliable High Performance Indexed Access Method**
 - Well established for over 40 years
 - Continuously evolving utilizing new technology to be responsive to customer needs
- **An Alternative to VSAM**
 - VSAM API (Application Programming Interface)
 - Supports KSDS, ESDS, RRDS and Alternate Index
 - Provides CPU time, I/O, and Response time savings
 - Hardware or Software data compression techniques
 - Minimizing manual tuning
 - Selected for use at the dataset level



IAM Version 9.2 Enhancements

- z/HPF I/O Architecture Support
- 64-bit Virtual I/O Buffers
- Enhanced I/O Error Information
 - Includes full 32-byte sense data when available
- IAM WTO Message Enhancements
 - Use of Multi-Line WTO messages for automated operations
 - Split IAMW22 reasons into separate message numbers
- IAM/RLS & IAM/PLEX Support of CICS VSAM RLS Functions
- Enhanced IAMSMFVS Report
- GA: February 2015



IAM Future Enhancements

- Support for IBM GDPS Active-Active
- File reorganization process with minimal data unavailability
- PE Block reuse



IAM Performance Strategies

- **Index in Virtual Storage**
 - Read into virtual storage during open
 - Eliminates index buffers and index I/O
 - Compressed Format to Reduce Storage Requirements
 - Use 64-bit virtual or z/OS Data Space storage
 - Eliminates impact on job region requirements
 - Prime Related Overflow (PRO)
 - Reduces Overflow index storage requirements



IAM Performance Strategies

- **Real Time Tuning**

- Dynamic buffer management based on application processing
 - Adjustments made in real time based on current I/O profile
 - Increase or decrease buffers to meet current requirements
 - Revise buffer management techniques based on I/O activity
 - Read and write multiple blocks per physical I/O
- Uses 31-bit or 64-bit virtual storage for all buffers
 - Not dependent on application program addressing requirements
- Does not connect buffers to place holders (strings)
 - Eliminates VSAM CI lockout/exclusive control problems
- Simplified Manual Tuning
 - IAMINFO message if more buffers are beneficial



IAM Performance Strategies

User Reported Benefit:

User Experience Feb. 2015

*"We have a native VSAM file with about 2 million records and 1700 index records. Reading the entire file consumes over **2 hours** elapsed time and 2 million EXCPs each to both the DATA and INDEX components of the VSAM file. We converted the file to IAM and ran the same program using the same inputs and the job completed in **13 minutes**."*



- IAM Reduced Elapsed Time by 89%
- IAM Reduced EXCP's by 96%



IAM Performance Strategies

- **File Load Buffering**

- Sequential output process
- Defaults to obtaining enough buffers for 2 cylinders of data
- Uses 31-bit or 64-bit virtual storage for buffers
- Controlled by CRBUFOPT Override or Global Option
- When 1/2 buffers are filled, issues EXCP to write that set of buffers
- Application can concurrently fill up rest of buffers
- Uses Data Space to hold index while writing data

Note: For SMS Extended Format datasets BSAM is used, so IAM does not have direct control on number blocks written per physical I/O



IAM Performance Strategies

- **High Performance FICON: z/HPF**
 - An alternative internal I/O architecture
 - Reduces channel connect time
 - A single TCW structure vs multiple CCW structure
 - Recently enhanced by IBM to support EXCP
- **Benefits**
 - Improved I/O efficiency and capacity
 - IAM: Averages 26% reduction in connect time
 - May provide some elapsed time savings



IAM Performance Strategies

- **Insert Strategy: Record Based Overflow**
 - Record placement based on space, not on key
 - Indexed by record key in virtual storage
- **Benefits**
 - Less I/O overhead than VSAM CI/CA splits
 - More efficient use of DASD space
 - Unused Overflow space has no restrictions on use
 - Works exceptionally well for the vast majority of files



IAM Performance Strategies

- **Insert Strategy: Prime Related Overflow (PRO)**
 - Record placement based on key by a block split technique
 - All records in block related to same Prime Data Block
 - Indexed by block
- **Benefits**
 - Reduces Overflow Index Size and Reorg Frequency
 - Improved Sequential Processing over Record based overflow
 - Works well on files with hundreds of thousands of inserts
 - No restrictions on reuse of empty overflow blocks



IAM Performance Strategies

- **Data Compression**
 - Increases effective amount of data transfer per I/O
 - Reduces EXCP counts
 - Reduces data set size
 - **IAM Software Compression**
 - High performance, proprietary run length encoding algorithm
 - No dictionary required
 - Typical results are 20% to 50% compression
 - **IAM System z Hardware Compression**
 - Dictionary dynamically built during file load
 - Optional user provided customized dictionaries
 - Typical results are similar to Software Compression
 - Customized dictionaries may achieve > 90% compression



IAM Performance Strategies

- **IAM's Dynamic Data Space**
 - Record based cache in a z/OS Data Space
 - Used for randomly read records
 - May significantly reduce I/O and buffer needs
 - Records stored in segments, less unused storage for variable length records
 - Dynamic LRU management of records in table
 - Statistics provided in IAMINFO reports



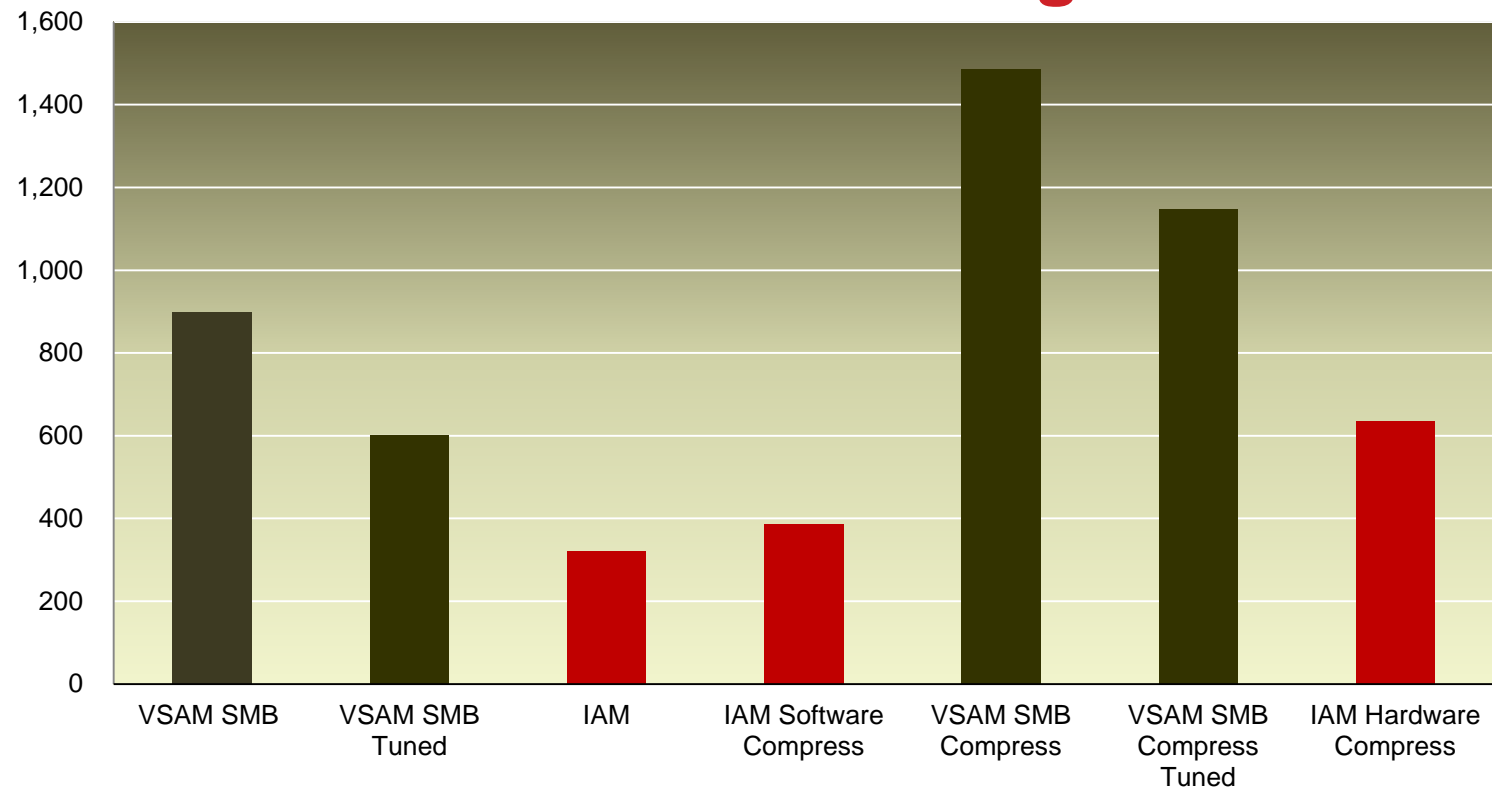
IAM Performance Results

- **IAM vs VSAM Performance Benchmark**

- Set of five batch jobs executed consecutively
 - Each job had 15 steps performing a variety of VSAM I/O
 - Used different length records from 125 byte to 1000 byte records
- VSAM: SMS Extended Format with SMB ACCBIAS=SYSTEM
- IAM: DSNTYPE=LARGE with Real Time Tuning
- Configuration:
 - CPU: Z114-2818M05 M02 in LPAR with 2 gigabytes
 - OS: z/OS 2.1
 - DASD: IBM DS8700-941 with z/HPF support
 - www.fdr.com/IAMtnews for more details

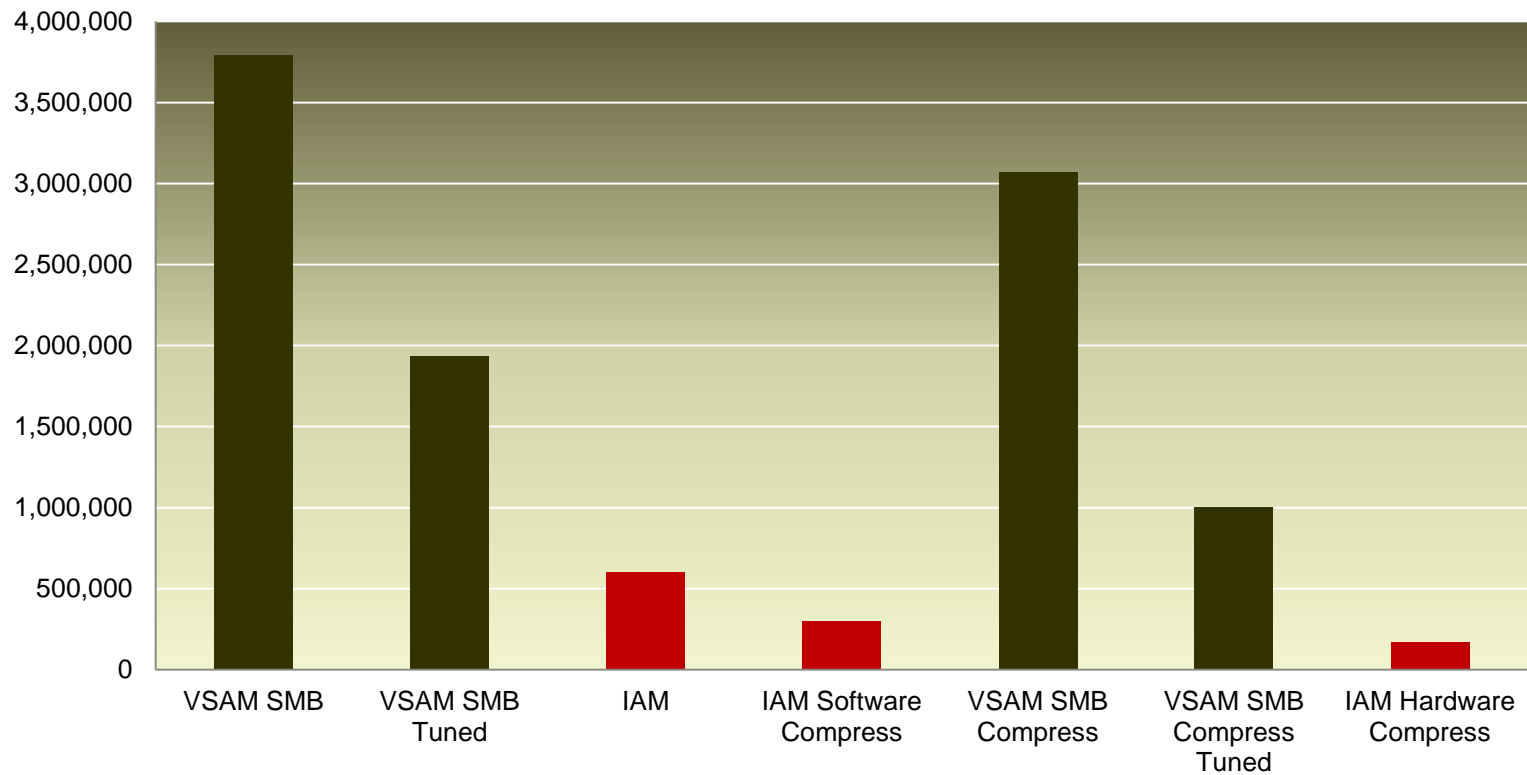


IAM vs VSAM CPU TIME 36% to 64% Savings



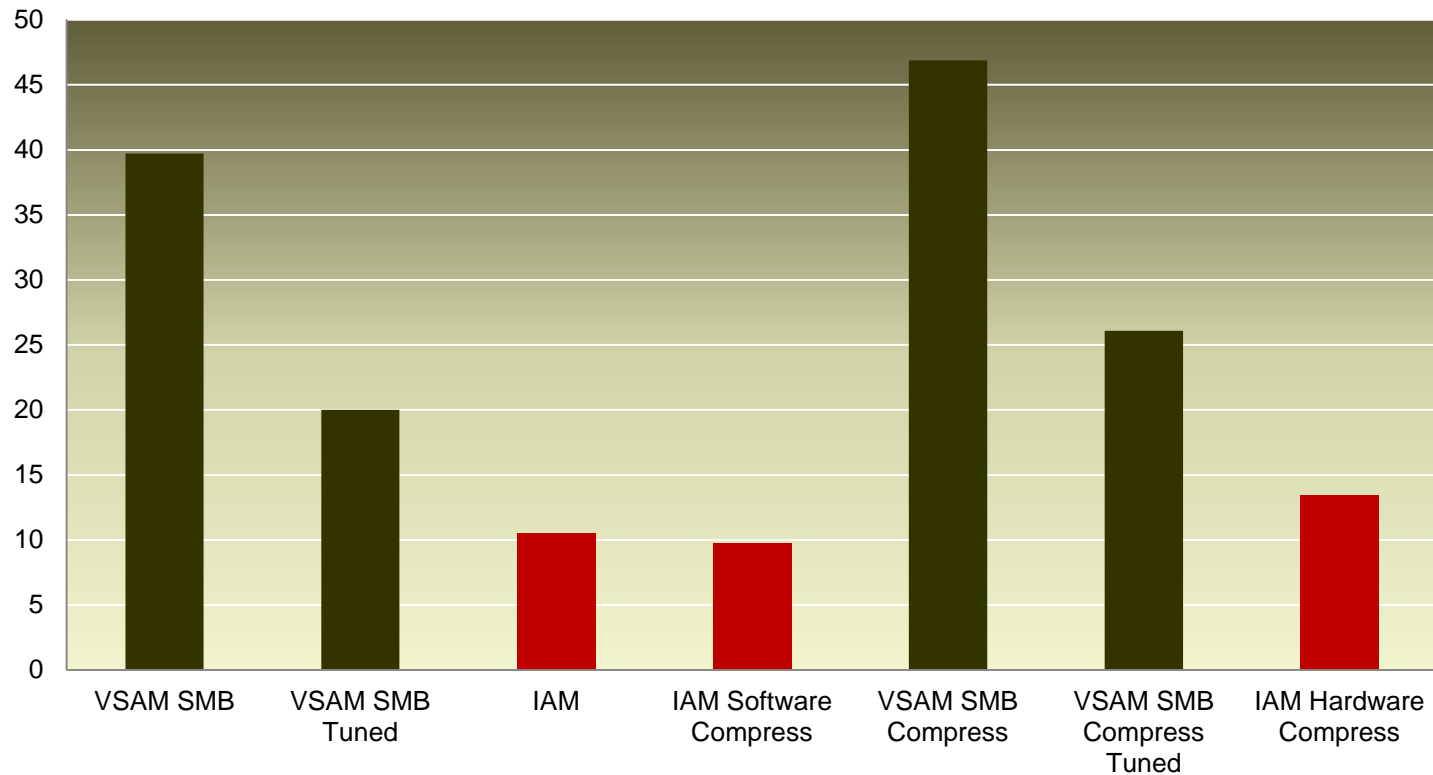


IAM vs VSAM EXCP'S 69% to 94% Savings





IAM vs VSAM RUN TIME 48% to 75% Savings





Performance Summary

- Reduces Batch Processing Time by 20% to 60%
- Reduces Physical I/O (EXCP's) by 40% to 80%
- Reduces CPU Time by 20% to 40%
 - CPU savings may be reduced by Data Compression
- Data Compression Reduces DASD Space by 20% to 50%



IAM: Best Practices

1. Have current version IAM load library in Link List
2. Run IAMSTART automatically with each IPL
3. Activate collection of the IAM SMF records
4. Use DSNTYPE=LARGE for IAM Data Sets
 - SMS Extended Format not recommended for IAM
5. Always delete / define multi-volume IAM data sets prior to reorgs, reload, or as target of data set copy functions
6. Do a LISTCAT ALL after defining an IAM data set
7. Add an IAMINFO DD to SYSOUT on job steps that use IAM
8. Set Global Options to minimize need for IAM Overrides



IAM: Best Practices – Global Options

1. Keep DSORG=PS set
2. Keep BELOWPOOL=YES set
3. Keep ENHANCED Enabled
4. Set SMF=YES and RECTYPE=nnn to an unused SMF user record type to collect IAM SMF records
5. Set ENABLE=LARGE
To avoid use of SMS Extended Format
6. Set ESDSINTEGRATED=5 if using IAM ESDS files and
7. Set ENABLE=XESDS or ENABLE=PSEUDO if using ESDS
8. Set ENABLE=EAV if IAM files will be on EAV volumes



IAM: Best Practices – Global Options

9. Set COMPRESSTYPE=HW For Hardware Instruction
 - If preferred over software compression
10. DATACOMPRESS=999999999 turns off data compression
 - Use when CPU time savings are high priority
11. INDEXSPACE=64BIT or ALL
 - Avoids using job region for index storage
12. ENABLE=BUF64 and CRBUFOPT=64BIT for 64-bit buffers
 - Remove buffers from job region but can increase CPU time
13. Keep DATASPACE=2048 setting
14. Avoid use of RLS=(REQUIRED, TABLE) option



IAM Advanced Functions: Alternate Index

- IAM Performance to Alternate Index Processing
- Defined and Functions like VSAM Alternate Index, only faster
 - Define Base Cluster as IAM (OWNER(\$IAM))
 - Define Alternate Index – Automatically becomes IAM AIX
 - Unique or Non-Unique Keys
 - Upgrade or NoUpgrade
 - Define Path – Automatically becomes IAM Path
 - Update or NoUpdate
- No Application Program or CICS Changes
- Additional Cost Option to IAM Product
- Includes Support for VSAM RRDS type data sets



IAM Advanced Functions: Record Sharing

- Enables shared access to IAM files with data integrity
- IAM/RLS
 - Sharing with multiple address spaces on single LPAR
 - Supports CICS, Batch, TSO, other address spaces
 - Included with base IAM product
 - All I/O for shared data set handled by IAMRLS address space
- IAM/PLEX
 - Sharing with Multiple Systems in a SYSPLEX
 - Supports CICS, Batch, TSO, other address spaces
 - All I/O to each shared data set routed to owning IAMPLEX
 - Additional Cost Option to base IAM product



How to IAM a VSAM Data Set: IDCAMS DEFINE

```
DEFINE CLUSTER(NAME(my.vsam.ksds)           -  
              VOLUME(*) CYL(10 1)          -  
ADD → OWNER($IAM) )                       -  
              DATA(NAME(my.vsam.ksds.data) -  
                    RECORDSIZE(200 256) KEYS(16 0) -  
                    CISIZE(4096) FREESPACE(10 10)) -  
              INDEX(NAME(my.vsam.ksds.index) -  
                    CISIZE(1024))           -
```



How to IAM a VSAM Data Set: IAMINFO Report

- IAM Run Time Reports: IAMINFO
 - One page statistical report on IAM file activity
 - Produced whenever an IAM file is closed
 - Requires IAMINFO DD card: //IAMINFO DD SYSOUT=*
 - Optionally can be written as SMF record
 - IAMINFO Report from provided IAMSMF program
 - Can be produced in CSV format for spread sheet use
 - Provides detailed information to assist with tuning
 - IAM368 Message if more buffers would have reduced I/O
 - IAM373 Message will tell you if file should be reorganized



Example IAMINFO Report – Top Portion

```

IAM400  IAMINFO DATASET STATISTICS REPORT -- VERSION 9.2/00 SPIN 00 -- INNOVATION DATA PROCESSING  DATE-2015.069
IAM360  STEP - BNC1KF      DDNAME - VSAMCRT1  DATA SET MONITORED - IAMV.BNC1KI.CLUSTER
IAM361  INFO REQUESTED BY PROGRAM RANUPD  FOR UPDATE PROCESSING  OPENED-2015.069.15:06:36  CLOSED-015.069.15:06:59
IAM362  IAM DATA CHARACTERISTICS -
        IAM FILE FORMAT-----= ENHANCED - IAM FILE STATUS-----= LOADED
        LOGICAL RECORD LENGTH-----= 1000 - CI SIZE-----= 8192
        KEY SIZE-----= 8 - KEY OFFSET-----= 0
        TOTAL RECORDS-----= 2000000 - TOTAL RECORDS DELETED-----= 0
        TOTAL RECORDS UPDATED-----= 100000 - TOTAL RECORDS INSERTED-----= 0
IAM363  IAM FILE CHARACTERISTICS -
        BLOCKING FACTOR-----= 4 - BLOCK SIZE-----= 13682
        TRACKS IN USE-----= 38492 - VARIABLE LENGTH OVERFLOW--= YES
        NUMBER OF EXTENTS-----= 13 - NUMBER OF VOLUMES-----= 2
        DATASET TYPE-----= KSDS - SHARE OPTIONS-----= 2
        NUMBER OF IAM DATA BLOCKS--= 153849 - HIGH ALLOCATED RBN-----= 0
        INTEGRATED OVERFLOW (CI%)--= 0 - DASD RESERVE (CA%)-----= 0
        FILE DEFINED DATE-----= 2015.069 - FILE DEFINED TIME-----= 15:04:32
        FILE LOADED DATE-----= 2015.069 - FILE LOADED TIME-----= 15:04:50
        FILE UPDATE DATE-----= 2015.069 - FILE UPDATE TIME-----= 15:06:59
IAM372  IAM EXTENDED AREA CHARACTERISTICS -
        EXT. OVERFLOW RECORDS-----= 0 - EXT. OVERFLOW BLOCKS-----= 0
        EXTENDED BLOCKS ALLOCATED--= 0 - EXTENDED PE BLOCKS-----= 0
        EXTENDED BLOCKS USED-----= 0 - EXTENDED BLOCKS AVAILABLE--= 0
  
```



Example IAMINFO Report – Bottom Portion

```

IAM365  IAM EXECUTION STATISTICS -
TOTAL STORAGE REQUIRED----= 23650304 - PRIME INDEX(COMPRESSED)----= 360203
STORAGE ABOVE THE LINE----= 23642112 - COMPRESSED DATA STRUCTURE-= NO
64-BIT BUFFER STORAGE (K)-= 0 - TURBO BUFFERING-----= YES
64-BIT INDEX STORAGE (K)--= 704 - TOTAL JOB 64-BIT INDEX (K)= 704
REQUESTS PROCESSED-----= 2200004 - REQUESTS FAILED-----= 1
DISK BLOCKS READ-----= 3935 - DISK BLOCKS WRITTEN-----= 1389
DYNAMIC BUFFER RETRIEVALS-= 249942 - MAXIMUM BUFFERS USED-----= 1388
MINIMUM BUFFERS USED-----= 64 - MAXIMUM BUFFERS AVAILABLE-= 9809
DYNAMIC TABLE RETRIEVALS--= 0 - DYNAMIC TABLE RECORDS-----= 0
Z/HPF I/O REQUESTS-----= 0 - ECKD I/O REQUESTS-----= 5324

IAM366  IAM COMMAND EXECUTION SUMMARY -
GET RANDOM-----= 100000 - PUT UPDATE-----= 100000
GET SEQUENTIAL-----= 2000001 - PUT ADD-----= 0
GET PREVIOUS-----= 0 - POINT (START BROWSE)-----= 0
GET KGE/GENERIC-----= 0 - POINT KGE/GENERIC-----= 1
GET (SKIP SEQUENTIAL)-----= 0 - ERASE-----= 0
ENDREQ-----= 0 - WRTBFR-----= 0
IAM STATISTICS-----= 0 - IAM FLUSH BUFFER-----= 0
CLOSE-----= 1 - OPEN-----= 1
CLOSE TYPE=T-----= 0 - VERIFY-----= 0
INVALID REQUESTS-----= 0 - RECORD LENGTH CHANGES-----= 0
SEQ CHAINED BLOCKS READ---= 149945 - SEQ CHAINED BLOCKS WRITTEN= 0
  
```



Finding VSAM Data Sets to IAM

- **SMF Analysis Program**

- Determine how much VSAM I/O activity a system has
 - Do we have high enough VSAM I/O activity to justify IAM?
- Identify Datasets that are Candidates for Conversion to IAM
 - Report on VSAM datasets with most I/O activity
 - Report on largest VSAM datasets
 - What datasets will yield the most savings from IAM?

- **Available for Free Trial**

- Includes Review and Analysis of Results from your installation



Example of SMF Analysis Program Output

DEVICE TYPE. 3390 VSAM CYLINDERS. 1737106
 TOTAL DISK EXCPS. 10809424107 VSAM EXCPS. 3092629292

VSAM EXCP REPORT

DATA SET NAME	% CLUSTER EXCPS	TOTAL EXCPS	RECORDS	READS	INSERTS	UPDATES	DELETES	SPLITS		ALLOC
								CI	CA	TRKS
I DP1. ABCD. EFGHI. YW16AEAO	100	155676980								
I DP1. ABCD. EFGHI. YW16AEAO. INDEX	99	154214328	32006	0	0	0	0	0	0	517
I DP1. ABCD. EFGHI. YW16AEAO. DATA	1	1462652	321755940	22174275	0	0	0	0	0	7485
I DP1. ABCD. EFGHJ. YW45AEAO	100	136947086								
I DP1. ABCD. EFGHJ. YW45AEAO. INDEX	99	35728377	12366	0	0	0	0	0	0	328
I DP1. ABCD. EFGHJ. YW45AEAO. DATA	1	1218709	136605426	26716724	0	0	0	0	0	6750
I DP1. RAM PROD. XYZ	100	125142131								
I DP1. RAM PROD. XYZ. DATA	93	116776692	32182274	2633724141	290541	1182304	0	9104	1581	7500
I DP1. RAM PROD. XYZ. INDEX	7	8365439	15899	0	0	25501	0	1581	0	1125
I DP1. ABCD. EFGHK. YW31AEAO	100	64290464								
I DP1. ABCD. EFGHK. YW31AEAO. INDEX	99	63572195	8400	0	0	0	0	0	0	112
I DP1. ABCD. EFGHK. YW31AEAO. DATA	1	718269	90589959	11401885	0	0	0	0	0	104625



Vendor Products that Use IAM

VENDOR	PRODUCT
Accero (CYBORG)	Payroll
American Software	DRP
ASG (Mobius)	View Direct
CGI	CGI Advantage
CSC	Hogan, Cyberlife, Capsil
Fidelity National	Systematics Banking Appl, BASE2000, CSF
First Data	Vision Plus
Fiserv	GL, AR, MSA, Millenium, Walker, Infopoint Deposits,
Infor (GEAC)	Lawson
JDA	Compass Contract
LRS	Page Center
LSI	Popims
MacKinney Software	Jes Q Print

VENDOR	PRODUCT
McKesson (HBO)	HealthQuest
Pitney Bowes (Group 1)	Finalist, Code1 MailStream Plus
Retalix (NCR)	Biceps, ABS
SEA	TRMS, SAVRS
Serena	Changeman ZMF
Shaw Systems	Collections
Siemens Medical Systems	Invision, Signature
Sigma	SAM (Student Aid Management)
SunGuard (SCT)	SIS+, HRS, FRS
Empower Software (Tesseract)	Payroll, HR, Benefits
Trizetto	Claim Facts, Group Facts
VIPS	Medicare Part B, SuperOP



Vendor Products that Work with IAM

DASD MANAGEMENT SOFTWARE:

FDR/ABR (INNOVATION DATA PROCESSING)

FDREPORT (INNOVATION DATA PROCESSING)

FDRREORG (INNOVATION DATA PROCESSING)

DF/SMS (IBM)

DF/HSM (IBM)

DF/DSS (IBM)

CA ALLOCATE (formerly VAM) (CA)

CA DISK (CA)

POOLDASD (BOOLE & BABBAGE)

MAINVIEW SRM STOPX37/II (BMC)

JOURNALING AND RECOVERY:

FILE SAVE (CA)

DRS (BMC)

AR/CTL (BMC)

CICS/VR (IBM)

RRDF - Remote Recovery Data Facility (E-Net)

PERFORMANCE MONITORS:

OMEGAMON (TIVOLI)

THE MONITOR TMON (ASG)

STROBE (COMPUWARE)



Vendor Products that Work with IAM

MISCELLANEOUS PRODUCTS:

FILE-AID (COMPUWARE)

File Manager (IBM)

ABEND-AID (COMPUWARE)

CICS (IBM)

CONNECT: DIRECT (IBM-Sterling)

ISPF (IBM)

NETWORK DATA MOVER (CA)

(NDM)

SELCOPY and SELCOPY/i (CBL Compute (Bridgend) Ltd)

SHRINK (CA)

SECURITY PRODUCTS:

RACF (IBM)

ACF/2 (CA)

TOPSECRET (CA)

PROGRAMMING LANGUAGES:

VS/COBOL (IBM)

COBOL II (IBM)

FORTRAN (IBM)

PL/1 (IBM)

BAL (IBM)

CA/OPTIMIZER (CA)

SAS (SAS INSTITUTE)

SHARING PACKAGES:

IAM/PLEX (IDP)

SHARE OPTION 5 (CA)

SYSB (H & W)

SORT PRODUCTS:

SYNCSORT (SYNCSORT)

DF/SORT (IBM)

CA/SORT (CA)



Additional Resources

- Innovation Web Site: www.fdr.com
- IAM Product Page: www.fdr.com/iam
- FTP Login for Manual: www.fdr.com/ftp/ftp.cfm
- Support Email: support@fdrinnovation.com



Summary

- IAM transparently improves VSAM application performance
- Dynamic buffer management
- Index in storage
- Reduces physical I/O (EXCP's) by 40% to 80%
- Cuts CPU time by 20% to 40%
- Reduces elapsed processing times 20% to 60%
- Data Compression can save DASD space by 20% to 50%
- Provide Record Level Data Sharing Capabilities

IAM

It's all about Time!

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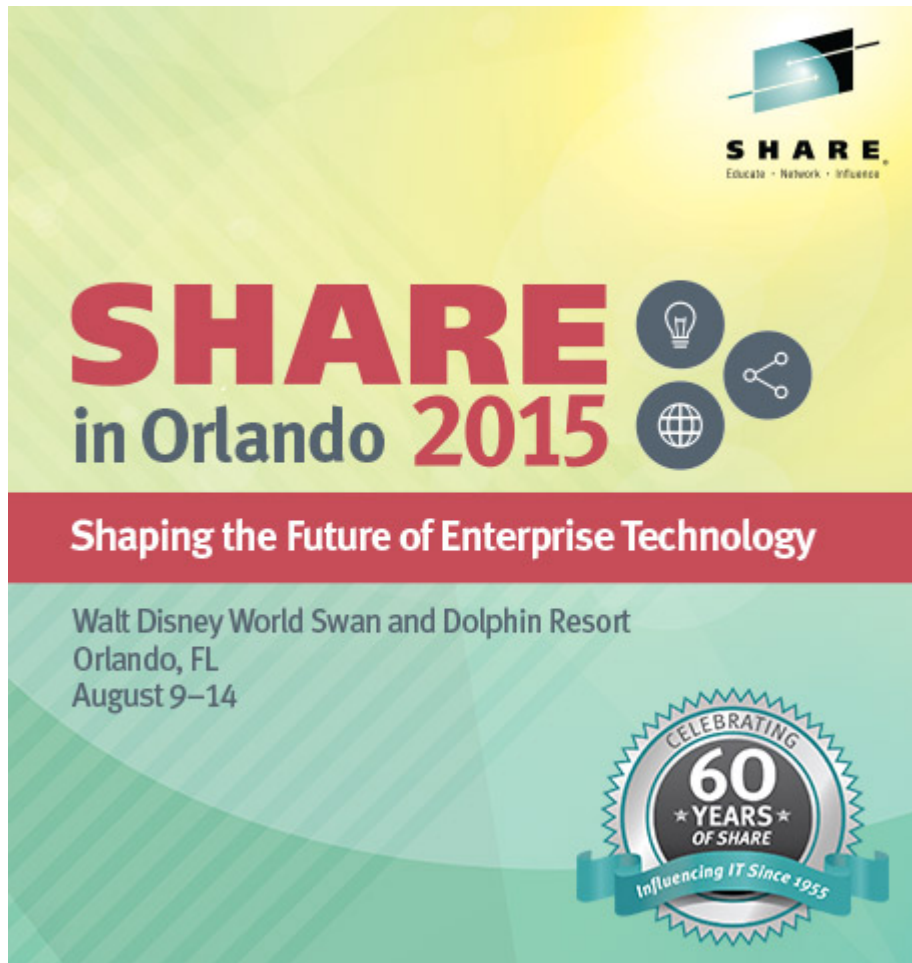
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