IBM Software Group

IMS Database Reorganization Problems and Solutions

December 2004

e-business on demand software

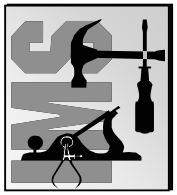
IMS DB Reorganization - The Needs

- **All IMS DB users have a need to reorganize DBs on a regular basis**
  - Pressure for increasing availability
- **The Needs**
  - First Need is to get utilities to perform the DB Reorg
    - Reliable ones
    - Basic support, serial processing
  - Second Need is to get Faster Utilities and Parallel Processing
    - To reduce this process to fit in the ever schrinking Batch Window
    - To get read access to the DB while it is being reorganized
  - Third Need is to get Online Utilities
    - To get Update access to the DB while it is being reorganized
    - Non disruptive process
- **The Answer**
  - Additional IBM Data Management Tools

The process of performing an IMS Database Reorganization is continuing to change as batch windows shrirk and you move closer to 7 X 24 operations.
The evolution of the tools/utilities available from IBM are reflective of this change.

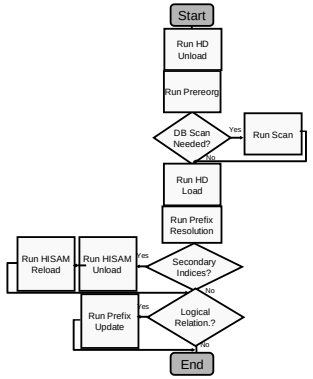
Agenda

- **First Need – IMS Utilities**
- **Second Need – Enhanced solutions with IMS Tools**
- **Third Need - Online Solutions**



IMS DB Reorg. – 1rst Need - IBM Standard IMS Utilities

- **HD Reorganization Unload**
  - (DFSURGU0)
- **HD Reorganization Reload utility**
  - (DFSURGL0)
- **Database Prereorganization Utility**
  - (DFSURPR0)
- **Database Scan Utility**
  - (DFSURGS0)
  - Used to scan DBs that are not reorganized but are involved in LR with DBs that are being reorganized
- **Database Prefix Resolution Utility**
  - (DFSURG10)
- **Database Prefix Update Utility**
  - (DFSURGP0)
- **HISAM Reorganization Unload**
  - (DFSURUL0)
  - For unload of HIDAM primary index database or secondary index database
- **HISAM Reorganization Reload**
  - (DFSURRL0)
  - For reload of HIDAM index database



IMS DB Reorg. – 2nd need – Enhanced Solutions

- **IMS High Performance Unload**
  - Replaces/improves the standard IMS HD Reorg Unload utility
- **IMS High Performance Load V2** *New Version*
  - Replaces/improves the standard IMS HD Reorg Load utility
- **IMS High Performance Prefix Resolution V3** *New Version*
  - Only needed when using logical relationships
  - Not needed with the new type of IMS databases available with IMS V7 (HALDB)
- **IMS Index Builder**
  - Only needed when using secondary indices, or HIDAM primary indices
  - Avoids taking image copies of indices
    For FF and HALDB databases
  - Recovers damaged indices without running the full reorg process
- **IMS Parallel Reorg V3** *New Version*
  - A MUST!
  - Infrastructure to operate IMS Reorganization related tools in parallel, allowing a significant reduction in the reorganization time.

IMS High Performance Unload - 2 Components

- **HP Unload**
  - At the heart of HP Unload is a High Speed Sequential Retrieval (HSSR) Engine
    Can be invoked by appropriate DL/1 applications
    Used by two supplied Reorg Unload Utility Programs (FABHURG1 and FABHFSU)
    High speed buffering technique similar to OSAM SB, different from DL/I Buffering
  - To unload IMS databases
    Supports processing of HDAM, PHDAM, HIDAM, PHIDAM, HISAM, SHISAM and secondary index data bases
  - To accelerate sequential access in IMS batch application
    Transparent to programmer
    Implicit (CALL 'xxxTDLI') or explicit (CALL 'xxxHSSR') support
- **Sequential Subset Randomizer**
  - Creates randomizing module for fast sequential processing of record subset
  - Allows physical clustering of database records in same subset

IMS HP Unload in the Reorganization Process

- **2 Database Unload utilities: FABHURG1 and FABHFSU**
  - Pre-tuned with defaults that should be adequate for most databases
- **Both utility programs provide**
  - unloading of compressed segments without decompression
  - user exit for additional selection &/or editing of unloaded segments
  - production of statistical reports
  - ability to continue after segment sequence errors
  - ability to read corrupted data bases
    bypass corrupted pointers
    force access of HIDAM or PHIDAM roots via index
    - provides diagnostic report about pointer errors
- **Easy to read output reports and statistics**
  - DB statistics report or Randomizing statistics report
- **Full support for HALDB**
  - Unload one, several or all partitions
  - Migration/fallback support
  - New function for user exit FABHEXTR
    Specify that n records are to be unloaded from each HALDB Partition
    - PARTEXTR control statement

IMS HP Unload in the Reorganization Process ...

- **FABHURG1**
  - Provides standard output formats (specified in FRMT SYSIN statement)
    HD Unload Format (default)
    CS (Communications Industry Standard)
    Several formats suitable for application program usage (F1, F2, F3, ...)
  - Allows user exit formatting of output records
    exit name specified on FRMT control card
  - Segments can be selected/skipped by use of record formatting exit or segment edit exit
  - Supports high performance migration to/from HALDB
    But NOT MIGRATX option!
  - Can unload a subset of records
    skip m then unload n records
- **FABHFSU**
  - Provides 4 output formats and can produce three concurrently
    HD Unload Format
    HSAM DB format
    Two formats suitable for application program usage (VB and VN)
  - Can unload a subset of the input DB (without coding a segment selection exit)
    Key range for HISAM/HIDAM
    Range of blocks/CIs for HDAM
  - Alternatively, segments can be selected/skipped by use of record selection exit
  - Provides a Parallel Scan Facility for multi-volume HDAM or HIDAM DBs

IMS HP Unload in the Reorganization Process ...

IBM Recommendations

- **Use FABHURG1 unload utility if you want to**
  - Unload the database in one of the unload formats provided
  - Unload the database in a user-defined unload format using a "Record formatting" user exit
    - A different user exit can also be used to edit segments
    - You can select/skip segments in either exit
  - Extract a part of the database by using the provided FABHEXTR exit routine
    - ie. select DB records m to m+n
  - Migrate to HALDB
    - But consider MIGRATX option in base IMS unload utility
- **Use FABHFSU unload utility if you want to**
  - Use the Parallel Scan facility function
  - Extract a continuous subset of the database using input parameters rather than coding an exit
  - Select/skip segments using a user exit

IMS High Performance Load - 2 Components

- **HP Load Utility**
  - Performance replacement of IMS HD Reorganization Load utility (DFSURGL0)
  - Complement to IMS High Performance Unload Tool
    - compressed/uncompressed input in various formats
    - dynamic allocation of DB datasets
  - Full support for HALDB
  - Self Optimization
    - Except for DATASPACE option where the default is N and use of Y is better
- **HDAM Physical Sequence Sort for Reload (PSSR) Utility**
  - Previously in DBTools SMU
  - Sorts the unloaded database data set before reload
    - Used with HALDB, when changing partition boundaries during reorg
  - Avoids "cascading" on Reload

New in September 2004

IMS HP Load Version 2.1

- Significant upgrades, including majority of customer requirements
- Improved Performance
- One job step execution with IPR V3
- IMS V9 Support

IMS HP Load in the Reorganization Process

- **Support of IMS HDAM, HIDAM, PHDAM and PHIDAM databases**
  - From an HD unloaded data set created by:
    - IMS High Performance Unload product
    - IMS HD Reorganization Unload utility (DFSURGU0)
  - Supports reloading of compressed segments without calling compression routine
  - Initializes empty HDAM and HIDAM databases
- **Support of HISAM and SHISAM**
  - DB Reload and DB Initialization
- **Support of logical relationship or secondary indexes**
  - Creates a DFSURWF1 data set that can be used by:
    - Index Builder (IB) product
    - IMS High Performance Prefix Resolution
    - IMS Prefix Resolution utility (DFSURG10)
- **Support of HALDB partitions**
  - Initializes those that receive no data and preformats PHDAM Root Addressable Area if flagged in DBRC as PINIT
  - Creates ILDS
  - When changing partition boundaries during reorg of HALDB
    - PSSR may be used prior load to sort segments by RAP within partitions for PHDAM.

IMS HP Load in the Reorganization Process ...

- **User Header Conversion Exit for replacement of the header with a header in HD Unload format**
- **User Segment exit facility for additional processing of each segment**
  - Assembler, COBOL or PL/1
  - edit segment
  - delete segment (or this and subsequent segments of DB record)
  - force segment into overflow (HDAM or PHDAM)
  - force segment to start new block (HIDAM or PHIDAM)
- **Statistics reports to aid in tuning the database**
  - Reporting on space use and segment pointer statistics

IMS HP Prefix Resolution

- **Replacement product for the IMS Database Prefix Resolution utility (DFSURG10)**
  - Reduction of elapsed time
  - Reduction in tape handling and DASD allocation
- **Creates a data set containing the data needed (a) to resolve the logical relationship pointers and (b) to create secondary index databases**
  - DFSURWF3 used as input to the IMS Prefix Update utility (DFSURGP0)
  - DFSURIDX used as input to the IMS HISAM Reorganization Unload utility (DFSURUL0)
- **Needs to be run after Reload/Scan of Logically Related databases**
- **Eliminate the intermediate Work File 2 (WF2) data set**
  - Using a cross-memory pipe = HIPPRPIPE Data Transfer Service
- **Creates Statistical Reports**
  - Diagnostics and Summary of Logical Parents Without Logical Children
  - Statistics and Distribution of Logical Parents Based on the Number of Their Logical Children

New in September 2004

IMS HP Prefix Resolution 3.1

·Significant upgrades, including majority of customer requirements
·Improved Performance
·One job step execution with IPR V3
·IMS V9 Support

IMS Index Builder

- **Build or recover one or more secondary indexes by using High Speed Scan of main Data Base**
  - For HALDB, this is the only way to add a new index
- **Build secondary indexes using DFSURWF1 as input**
  - Initial Load of main DB (PROCOPT=L or LS)
  - reorganization Reload of main DB
    High Performance Load or base IMS Reload Utility
  - Optionally separate out logical relationship data into separate file
    enhance performance of Prefix Resolution
- **Build secondary indexes using DFSURIDX as input**
  - for compatibility only, output from Prefix Resolution can be used using Index Builder in place of HISAM Unload/Reload
- **Rebuild HIDAM Primary Index**
  - using High Speed Scan if first root is still accessible via index
  - using direct scan otherwise
- **Initialise empty secondary indexes**

To rebuild indices after reorganization process

To recover damaged secondary indices and avoid full reorganization process

To avoid taking IC of secondary indices

To minimize elapsed time

....

IMS Parallel Reorganization V3

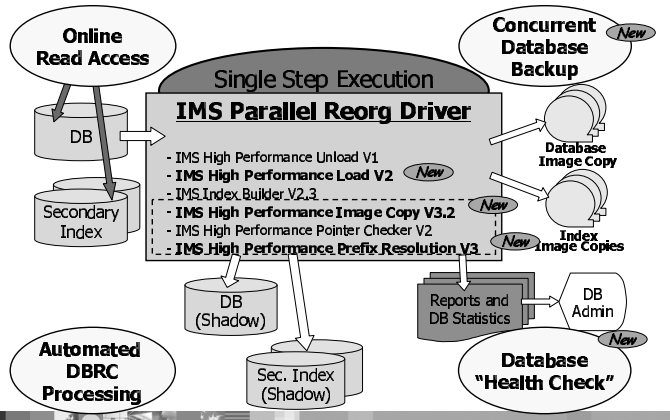
New

- **IPR is an umbrella product or higher level framework for execution of the following tools**
  - IMS High Performance Unload
  - IMS High Performance Load
  - IMS Index Builder
  - IMS High Performance Image Copy
  - IMS High Performance Pointer Checker
- **Functions are**
  - Parallel reorganization
  - High Speed alternative to serial use of HP Unload
  - High Speed alternative to serial use of HP Load
  - Enhanced Data Base Scan (for logical relationships) using HP Unload

Note: IPR is used with the HP tools and IIB
It is NOT an alternative

IMS Parallel Reorganization provides the infrastructure to operate the reorganization utilities in parallel (or independently), allowing a significant reduction in the reorganization time.

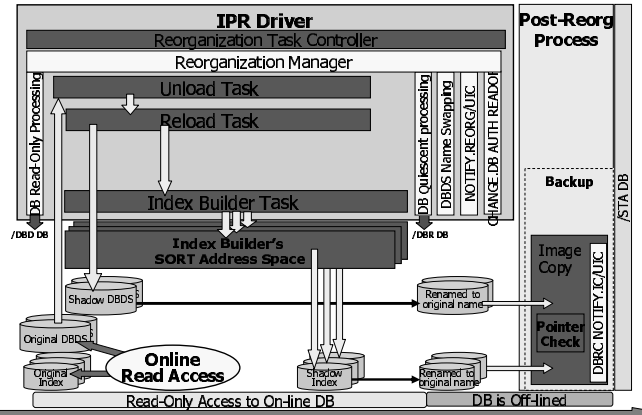
IMS Parallel Reorganization V3 …



IPR Driver Version 2

- **Has implemented the Single Step Execution of the following processes:**
  - Making the Database Read-Only
    - Issuing the IMS /DBD DB command
  - Reorganizing Database Data Sets
    - Running unload, reload, and index-builder concurrently
    - Reorganizing into “shadow” data sets
  - Stopping the Database
    - Issuing the IMS /DBR DB command
  - Performing Post-Reorganization Process
    - Swapping original and “shadow” data sets
    - Notifying DBRC of the reorganization completion

IPR Driver Version 2



IPR V2 Parallel Reorg JCL & Control Parameters

```
//*-------------------------------*
//* IMS HIGH PERFORMANCE UNLOAD   *
//*-------------------------------*
// EXEC FABHULU,MBR=FABHURG1,DBD=DBSAMP01
//SYSPRINT DD SYSOUT=A
//SYSUT2 DD DSN=IMSDB.HDUNLD,DISP=(,CATLG),UNIT=TAPE
//SYSIN DD *
DECN
PROGMON=10000
/*
//*-------------------------------*
//* IMS HIGH PERFORMANCE LOAD     *
//*-------------------------------*
//RELOAD EXEC PGM=DFSRRC00,
//STEPLIB  DD DSN=HPS.SHPSLMDB,DISP=SHR
//         DD DSN=IMSESA.RESLIB,DISP=SHR
//DFSRESLB DD DSN=IMSESA.RESLIB,DISP=SHR
//IMS      DD DSN=IMSESA.DBDLIB,DISP=SHR
//DFSUINPT DD DSN=IMSDB.HDUNLD,DISP=(OLD,PASS)
//DFSURWF1 DD DISP=(NEW,PASS),DSN=IMSDB.DFSURWF1,UNIT=TAPE
//DFS
//SYSPRINT DD SYSOUT=A
//SYSUDUMP DD SYSOUT=A
//DFSVSAMP DD *
512,4
/*
//FRRIN DD *
DATASPACE=YES
PROGMON=10000
/*
//*-------------------------------*
//* IMS INDEX BUILDER             *
//*-------------------------------*
//IMSIB EXEC PGM=IIUSTART
//STEPLIB DD DISP=SHR,DSN=IIU.V3R1M3.SIIULMOD
//         DD DISP=SHR,DSN=IMSESA.RESLIB
//DFSRESLB DD DISP=SHR,DSN=IMSESA.RESLIB
//IMS DD DISP=SHR,DSN=IMSESA.DBDLIB
//DFSURWF1 DD DISP=OLD,DSN=IMSDB.DFSURWF1,BUFNO=99
//IIUIN DD *
PROC BLD_SECONDARY,TSTDATA,ALL
INPUT DFSURWF1
//SYSPRINT DD SYSOUT=*
//SYSOUT DD SYSOUT=*
//IIUSTAT DD SYSOUT=*
//IIUSNAP DD SYSOUT=*
//SYSUDUMP DD SYSOUT=*
```

```
//REORG EXEC PGM=HPSGMAIN,PARM='DBD=DBSAMP01,DBRC=Y'
//STEPLIB         DD DISP=SHR,DSN=HPS.SHPSLMD
//                DD DISP=SHR,DSN=IMSESA.RESLIB
//IMS DD DISP=SHR,DSN=IMSESA.DBDLIB
//HPSOUT DD SYSOUT=*
//IIUPRINT DD SYSOUT=*
//HPSOUT2 DD SYSOUT=*
//IIUSOUT DD SYSOUT=*
//HPSIN DD *
(REORG)
IMSCMD=YES
NAMESWAP=YES
INDEXBLD=YES
(UNLOAD)
PROGMON=10000
DBSTATS=YES
(RELOAD)
DATASPACE=YES
PROGMON=10000
/*
```

reorganization Manager parameters

DECOMPRESS=N is default

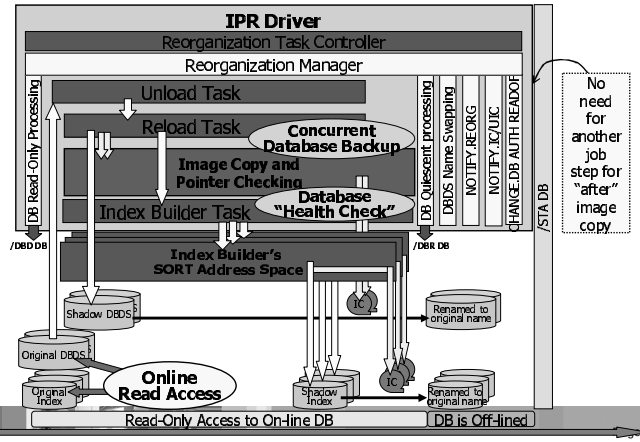
Reload Parameters are same as for HP Load

IPR chooses its own parameters for index builder

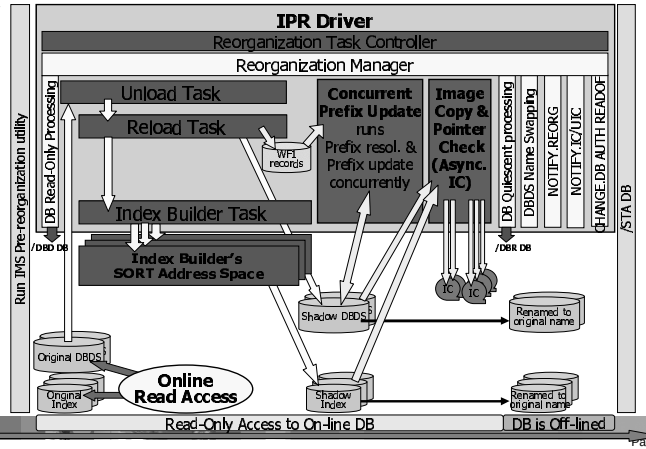
IPR Driver Version 3 – Announced in September 2004

- **Extends IPR Driver V2 functionality to support:**
  - Concurrent execution of image copy with HASH pointer checking while reloading database and building secondary indexes
    - → **Type-A Image Copy**
      (Concurrent Database Backup and “Health Check”)
  - Prefix resolution/update and image copy of a database that has internal logical relationship
    - → **Concurrent Prefix Update**
    - → **Type-B Image Copy**
  - DBRC Notification of the image copies

IPR Driver V3 + Type-A Image Copy



IPR Driver V3 + Concurrent Prefix Update and Type-B Image Copy



IMS DB Reorg. – 3rd need – Online Solutions

- **IMS Version 9 HALDB OnLine Reorg. (OLR)** — *New*
  - Integrated OnLine Reorganization (OLR) of HALDBs
  - HALDB OLR provides 100% availability of the largest databases in the world!
  - OLR provides non-disruptive reorganization of HALDB PHDAM and PHIDAM partitions
    Concurrent IMS updates are allowed while OLR is active
  - Scheduled data outage not required
- **IMS Online Reorganization Tool** — *New*
  - Planned announcement: December 2004
  - For non-HALDB and HALDB
    With restrictions
  - For IMS V7 or above

IMS Online Reorganization Facility for z/OS - Overview

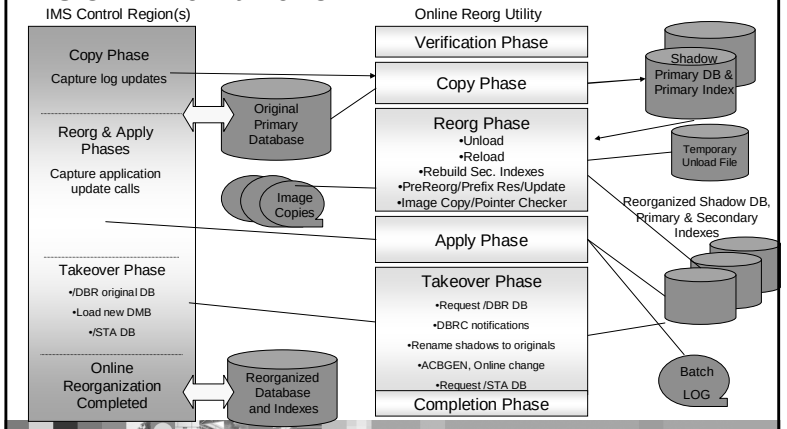
- **Reorganize a Database while still online**
  - Database is reorganized to shadow datasets
  - Index databases are rebuilt to shadow datasets
  - Image copies are taken from the shadow datasets
  - Changes to the original datasets are captured
  - Captured changes are applied to the shadow datasets
  - The original databases are DBR'd
  - The shadow datasets are renamed to originals
  - The databases are started and the reorganized/ renamed databases are available online

Benefits
Increased Data Availability - Outage reduced from hours to seconds
Automation of DBA tasks - Single step Reorg - Single JCL
Improved DBA Efficiency

IMS ORF - Requirements and Restrictions

- **Requirements**
  - IMS 7.1 and above
  - IMS Tools used for the reorganization
    - HP Unload
    - HP Reload
    - HP Image Copy
    - HP Prefix Resolution (if logical relationships)
    - HP Pointer Checker (if requested during IC)
    - IMS Tools Online System Interface (TOI)
  - DBRC is required
    - The database and its indexes must be registered (Indexes can be registered as nonrecov)
- **Restrictions**
  - No support for Fast Path or HSAM databases
  - No external logical relationships
  - HALDBs
    - Single partition at a time
    - No DBD changes supported
    - No logical relationships supported
  - HIDAM root key can not be compressed
  - Primary database must be RECOV
    - No support for CICS or ODBA

IMS ORF - How it Works?



Thanks