VSAM New Features in z/OS 2.2
(and revisit those from 2.1)

Neal Bohling
IBM, VSAM RLS Development

Session 17137
Overview

• z/OS 2.2
  – Index Record Locking (RLS)
  – Primary and Secondary Space Reduction (all)
  – IDCAMS LISTSTAT support (RLS)
  – Chained I/O for Spanned Records (all)
  – LSR Dynamic Buffer Addition (VSAM)
  – Linear DS Constraint Relief (VSAM)
  – Verify Enhancements (VSAM)
  – Other RAS Enhancements (all)
Index Record Locking
Current Split Logic

Only one split per data set can occur simultaneously
With Index Record Locking

Insert/Split

Insert/CI Reclaim

Locks the sequence set Index Record corresponding to the CA

Complete your session evaluations online at www.SHARE.org/Seattle-Eval
Performance Measurements

• Three workloads on zEC12 / 8 logical CPs, CF 1 CP

• **Ideal:**
  – 30 regions spread across 3 systems
  – Records insert into different CAs throughout the DS

• **Average:**
  – 30 regions across 3 systems
  – Random inserts that may include some CA splits

• **Worst:**
  – Single task on a single system
  – Inserting randomly through the data set
Performance Improvement

Batch RLS Non-BWO Workload Runtime

Elapsed Time (s)

Ideal
Average
Worst

V2R1
V2R2

54%
15%
0%
Performance Improvement

Batch RLS BWO Workload Runtime

<table>
<thead>
<tr>
<th></th>
<th>V2R1</th>
<th>V2R2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ideal</td>
<td>85%</td>
<td></td>
</tr>
<tr>
<td>Average</td>
<td></td>
<td>30%</td>
</tr>
<tr>
<td>Worst</td>
<td></td>
<td>56%</td>
</tr>
</tbody>
</table>

Complete your session evaluations online at www.SHARE.org/Seattle-Eval
Performance Improvement

SMSVSAM CPU (Best Case)

- z/OS 2.1 Non-BWO
- z/OS 2.2 Non-BWO
- z/OS 2.1 BWO
- z/OS 2.2 BWO

CPU (s)

SMSVSAM SRB  SMSVSAM TCB
Locking Performance Improvement

Component 1_1 Locking and Contention Across BWO and Non-BWO Batch Workloads

<table>
<thead>
<tr>
<th></th>
<th>Requests</th>
<th>Contention</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ideal</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Worst</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- Requests: 2.1, 2.2
- Contention: Ideal, Average, Worst

Complete your session evaluations online at www.SHARE.org/Seattle-Eval
Index Record Locking Other Notes

- **Greatly reduces SPLIT pain point**
- Locks at the CA (sequence set index record) level during:
  - CI SPLIT
  - CI RECLAIM
  - Spanned record activity
- CA split / reclaim activity will still use data-set level lock

- New lock, new SMF fields (Component 1 class 4)
  - Obtain (SMF42FPH)
  - True Contention (SMF42FPI) – note, these are cross-plex contention
  - False Contention (SMF42FPJ)
  - Release (SMF42FPK)

- Lower releases will require toleration OA42676
Primary and Secondary Space Reduction Improvement
Current Space Allocation Process

If last volume, extend fails…
Space allocation processing

• **Old Method:**
  – Space is obtained by data-set defined amounts.
  – For primary, retries once with “best fit”, or fails
  – For secondary, fails request or moves to next volume

• **New Method:**
  – Space is obtained by data-set defined amounts
  – DADSM will return the largest extent that meets SCR requirements
  – ONE CALL – values are passed to DADSM
Fields

• **Data Class fields:**
  – Space Constraint Relief: Y
  – Reduce Space Up to (%): 0-99%

• **Note: Reduce Space Up To is a subtraction**

- Ex: 100cyl primary, 50cyl secondary, SCR set to 80%
  - For primary: $100cyl \times (1-.80) = 20cyl$
  - For secondary: $50cyl \times (1-.8) = 10cyl$

• Will return largest available extent that fits SCR threshold
  - For primary, could be 20, 30, 50, or 70 cyl
Updated Space Reduction

Volume A

Data Set A
Pri/Sec: 40/20 cyl
SCR: On, 80%

Data Set B
Pri: 30cyl
Sec: 20cyl

DS A
Sec: 20cyl

DS B
Sec: 20cyl

Complete your session evaluations online at www.SHARE.org/Seattle-Eval
Updated Space Reduction

Space amount is reduced by up to 80% - In this case, it was reduced by 25% to find 15cyl of space.

Returns LARGEST available extent on volume that matches SCR setting.

Complete your session evaluations online at www.SHARE.org/Seattle-Eval
Space Reduction Enhancement

- Works for both Primary and Secondary amounts
- For VSAM, extents must be a multiple of CA size

- VSAM/RLS/PDSE/BAM/SAM all supported
  - Except striped data sets

- Data set must be SMS-managed

- To enable, set Data Class fields:
  - Space Constraint Relief: Y
  - Reduce Space Up to (%): anything > 0

- New SMF fields:
  - SMF64SSR – if secondary space reduction was used
  - SMF64NTA – size of extent returned in Tracks
LISTSTAT – Statistics while VSAM is OPEN
LISTSTAT Command

- New command

**IDCAMS SHCDS LISTSTAT('cluster')**

- Provides point-in-time plex-wide statistics for open VSAM data sets using RLS
- Subset of LISTCAT and SMF64 information, but does not require CLOSE
- Available via OA42435 for 1.13 and 2.1
**LISTSTAT Output**

**SHCDS LISTSTAT(NB.RLS.TEST2)**

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Cluster</strong></td>
<td></td>
</tr>
<tr>
<td>NB.RLS.TEST2</td>
<td></td>
</tr>
<tr>
<td><strong>Data</strong></td>
<td></td>
</tr>
<tr>
<td>NB.RLS.TEST2.DATA</td>
<td></td>
</tr>
<tr>
<td><strong>Total Records</strong></td>
<td>101</td>
</tr>
<tr>
<td>Records Deleted</td>
<td>0</td>
</tr>
<tr>
<td>Records Inserted</td>
<td>1</td>
</tr>
<tr>
<td>Records Updated</td>
<td>0</td>
</tr>
<tr>
<td>Records Retrieved</td>
<td>0</td>
</tr>
<tr>
<td>HI-A-RBA</td>
<td>829440</td>
</tr>
<tr>
<td>HI-U-RBA</td>
<td>829440</td>
</tr>
<tr>
<td><strong>Index</strong></td>
<td></td>
</tr>
<tr>
<td>NB.RLS.TEST2.INDEX</td>
<td></td>
</tr>
<tr>
<td><strong>Total Records</strong></td>
<td>1</td>
</tr>
<tr>
<td>CA Reclains</td>
<td>0</td>
</tr>
<tr>
<td>Reclaimed-Ca Reuses</td>
<td>0</td>
</tr>
<tr>
<td>Records Updated</td>
<td>0</td>
</tr>
<tr>
<td>Records Retrieved</td>
<td>0</td>
</tr>
<tr>
<td>HI-A-RBA</td>
<td>33792</td>
</tr>
<tr>
<td>HI-Level-RBA</td>
<td>0</td>
</tr>
<tr>
<td><strong>Exceeds</strong></td>
<td>207</td>
</tr>
<tr>
<td>Extents</td>
<td>1</td>
</tr>
<tr>
<td>Free Space</td>
<td>774144</td>
</tr>
<tr>
<td>HI-A Level</td>
<td>1024</td>
</tr>
<tr>
<td>HI-U Level</td>
<td>1</td>
</tr>
</tbody>
</table>

Complete your session evaluations online at www.SHARE.org/Seattle-Eval
Chained I/O for Spanned Records
Chained I/O Simile


Vs.


Complete your session evaluations online at www.SHARE.org/Seattle-Eval
Chained I/O

- Old Way – Segment Spanned Records into parts and loop

Write #1:
- Record A (1)
- CA2
- CA3
- Record A (2)

Write #2:
- Record A (1)
- Record A (2)
- CA3
Chained I/O

• New Way – Combine segments into one I/O

Record A

CA1  CA2  CA3

Record A (1)  Record A (2)

Split and Bundle

CA1  CA2  CA3

Write (pass to I/O)

Record A (1)  Record A (2)  CA3

Complete your session evaluations online at www.SHARE.org/Seattle-Eval
Chained I/O

- VSAM uses CIO for READ, PUT, and ERASE
  - Supports NSR
  - LSR and GSR not currently supported

- RLS uses CIO for PUT, ERASE (not read)
  - Stages updates in buffer/cache

- No co-existence maintenance needed for lower releases

- Benefits:
  - Reduces I/O overhead when using spanned records
  - Avoids the x’8C’ that can occur if I/O or system fails, ABEND, or cancel mid-record
Dynamic Buffer Addition
LSR Dynamic Buffer Addition

Base Cluster

PATH with UPGRADE

Another PATH with UPGRADE

LSR Buffer Pool
[ 1024(10) ]
LSR Dynamic Buffer Addition

- **GOAL:** Avoid failing a request due to buffer shortages
- **SOLUTION:** Dynamically add buffers to LSR pool as needed

Invoked when LSR processing receives “no buffers available”
- Expands current pool with same settings
- New message: IDA9990I – indicates addition occurred

- NSR/GSR not supported
- Cross-memory mode, SRB mode, and TCB Key 9 not supported
LSR Dynamic Buffer Addition

• New Message:
  – IDA9990I VSAM DBA ADDED xxx DATA|INDEX BUFFERS of yyyyy BYTES EACH TO SHRPOOL zzz BECAUSE THERE WERE INSUFFICIENT BUFFERS TO PROCESS THE REQUEST.

  RECOMMENDATION: FOR PERFORMANCE, REBUILD THE SHARED POOL WITH AN INCREASE IN SIZE.

• LSR hash built with original pool size, so added buffers may affect performance due to hash conflicts

• Final note:
  – Prevents errors from minor space miscalculations
  – Not meant to replace well-sized LSR pools
Linear Data Set Constraint Relief
Constraint Relief for Linear VSAM

• Constraint #1
  – Below the bar control blocks
  – Limits number of open data sets

• Solution:
  – Move some control blocks above the bar
  – Allows for many more open data sets

• Constraint #2
  – Large numbers of data sets create large numbers of AMBL blocks
  – CLOSE processing takes time to find the right one

• Solution:
  – Use a tree instead of a chain
  – Significant improvements to CLOSE processing time with large numbers of open data sets
Close Speed Improvement

- 13% improvement for 100k data sets (11:20 vs 13m)
- Note – the more data sets, the better the close performance

Complete your session evaluations online at www.SHARE.org/Seattle-Eval
Verify Enhancements
Verify Enhancements

• IDCAMS VERIFY only fixes a small number of problems
• IDCAMS EXAMINE can find many more

• z/OS 2.2 adds functionality to EXAMINE / VERIFY
• Examine can now pass error information to VERIFY
• VERIFY can now identify errors and try to repair

• Only a few added in 2.2, but framework there to add more.
Verify Enhancements

- **IDCAMS VERIFY**
  - Corrects end of file information (HURBA / VVR / catalog)
  - Repairs behind the scenes if previous close failed

- **IDCAMS VERIFY RECOVER**
  - Completes or backs out any interrupted CA reclaim activity

- **IDCAMS EXAMINE / VERIFY RECOVER** (New)
  - EXAMINE stores information about any problems
  - VERIFY can then read that information and attempt to repair
  - z/OS 2.2 will repair:
    - IDC11718I DATA COMPONENT HIGH-USED RBA IS NOT EQUAL TO CA SIZE
    - IDC11728I DATA FOUND IN EMPTY CI
    - IDC11724I DATA COMPONENT CA NOT KNOWN TO SEQUENCE SET
Other RAS Enhancements

• Additional feedback in message IDA9999I
  – VSAM auto dump may sometime fail, and when it does it issues IDA9999I without helpful information
  – IDA9999I updated to output RPL feedback and JOBNAME:
    IDA9999I VSAM AUTO DUMP FAILED TO TAKE A DUMP FOR RPL FEEDBACK CODE rpl_feedback_code DUE TO SDUMPX RSN/RC sdump_reason/return_codes FOR JOB jobname

• Non-SMS EOV Failures – added additional cleanup

• Catalog Statistics update – Permanently records stats in VVR for catalogs
Overview

• z/OS 2.1
  – RLS for Catalogs
  – Dynamic Volume Count for RLS
  – Directory Only Caching (RLS)
  – OMEGAMON XE Support (RLS)
  – ACCBIAS in the Data Class (VSAM)
  – Other enhancements
RLS User Catalogs
Current Catalog Limitations

• **Performance**
  - Contention on SYSIGGV2 when updating
  - Limited catalog buffering and buffer invalidation
  - Limited VSAM buffers/strings/storage

• **Availability**
  - Catalogs need to be split to resolve contention
  - Catalogs unavailable during split / recovery

• **Integrity**
  - Catalogs can be damaged by utilities updating while OPEN
  - Lack of SYSPLEX control and serialization

• **Recovery**
  - Long / error prone forward recovery process

Complete your session evaluations online at www.SHARE.org/Seattle-Eval
Regular Catalog Access

Catalog on SYS1
Catalog on SYS2
Catalog on SYS3

Potential contention on SYSIGGV2 'ucat' during updates
SMSVSAM is responsible for serialization. Serialization is at the RECORD level instead of DS. No more SYSIGGV2 'ucat' ENQ contention.
Improvements RLS Offers

- **Reduced contention**
  - Eliminates SYSIGG2 'UCAT' ENQ contention
  - Plans to remove the SYSIGGV2 'sphere' ENQ
  - No need to split catalogs to lower contention

- **Higher throughput**
  - Significant improvement in elapsed time & CPU
  - Much shorter wait times

- **Improved control**
  - Suspend / resume ALL catalogs, plex-wide
  - Prevents un-serialized updates

Complete your session evaluations online at www.SHARE.org/Seattle-Eval
RLS for Catalogs

- **To enable:**
  - IDCAMS ALTER ucat LOG(NONE)
  - F CATALOG,RLSENABLE(ucat)
  - IEC352I MODIFY CATALOG cat.name TO STATE RLSENABLE SUCCESSFUL
  - F CATALOG,RLSQUIESCE(ucat)

- **Notes:**
  - Only available on z/OS 2.1 and up
  - < 1.13 need toleration maintenance
  - IDCAMS tools are updated to use RLS mode (RLSSSOURCE)
## Performance Benchmark Test

<table>
<thead>
<tr>
<th>Test</th>
<th>Elapsed Time (min)</th>
<th>CPU* (sec)</th>
<th>Deltas</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Non-RLS</td>
<td>RLS</td>
<td>Non-RLS</td>
</tr>
<tr>
<td>DELETE</td>
<td>80.42</td>
<td>8.42</td>
<td>1269.3</td>
</tr>
<tr>
<td>DEFINE</td>
<td>48.84</td>
<td>21.42</td>
<td>685.6</td>
</tr>
<tr>
<td>SEQ READ</td>
<td>7.40</td>
<td>5.03</td>
<td>65.1</td>
</tr>
<tr>
<td>DIR READ (first sys)</td>
<td>26.77</td>
<td>20.33</td>
<td>94.0</td>
</tr>
<tr>
<td>DIR READ (second sys)</td>
<td>26.86</td>
<td>20.29</td>
<td>95</td>
</tr>
</tbody>
</table>

*CPU in GRS, CATALOG may see a small increase – best to compare per request*

Test environment: Z10 2097 E12, 3 LPARs, 7 CPUs, 1 CF, z/OS 2.1
Catalog parms: TASKMAX=180, CISIZE(32768) and CISIZE(4096), STRNO(255)
RLSABOVETHEBAR(NO) RLSFCACHE(ALL) RLSMAXPOOLSIZE(100M) CF Cache size 1G
Catalog RLS vs Catalog VLF at z/OS 2.1
Tests: 300,000 data sets, 100 jobs using 1000 data sets on each LPAR
Source: “Unclog your Systems with z/OS 2.1 – Something New and Exciting for Catalog” by Terri Menendez, IBM
Spring 2013 Session #12977, 12978

Complete your session evaluations online at www.SHARE.org/Seattle-Eval
Performance Benchmark Test

Elapsed Time RLS vs Non-RLS User Catalog Access

Minutes

PERFORMANCE BENCHMARK TEST

Complete your session evaluations online at www.SHARE.org/Seattle-Eval
RLS for Catalogs Summary

- Eliminates bulk of SYSIGGV2 contention
- Allows plex-wide serialization at the record level
- z/OS 2.1 + only
- User catalogs only

- AMS (IDCAMS) tools support RLS
  - REPRO, PRINT, IMPORT, EXPORT
Dynamic Volume Count for RLS
Dynamic Volume Count for RLS

- Dynamic Volume Count added to RLS EOV

- During EOV, if out of candidates, but DVC > VolCNT, RLS will call ALTER ADDVOL to add volume to catalog

- DVC must be set in Data Class
  
  Space Constraint Relief . . . N (Y or N)  
  Reduce Space Up To (%) . . 30 (0 to 99 or blank)  
  Dynamic Volume Count . . . 10 (1 to 59 or blank)
Directory Only Caching
RLS Caching Modes

ALL
- Data CIs and Index CIs stored
- READ or WRITE will add CI to cache

NONE
- Cache on index CIs
- READ or WRITE will add CI to cache

UPDATES ONLY
- Data CIs and Index CIs stored
- Only WRITES will update cache

DIRONLY
- No CI data is stored
- READ or WRITE will update interest
Inside a Cache

Directory Entry
- Holds control information
- One per CI
- Relatively Small

Data Element
- Holds the stored data
- Up to 4k in size
- Many per CI (depending on CISIZE)
- Ex: 16k CI would require 4 DE
Caching Modes

Mode: **ALL** or **UPDATESONLY**

<table>
<thead>
<tr>
<th>Dir Entries</th>
<th>Data Elements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data CI Registered</td>
<td>Data CI Part 1</td>
</tr>
<tr>
<td>Index CI Registered</td>
<td>Data CI Part 2</td>
</tr>
<tr>
<td>Index CI</td>
<td>Data CI Part 3</td>
</tr>
</tbody>
</table>

Complete your session evaluations online at www.SHARE.org/Seattle-Eval
Caching Modes

Mode: NONE

<table>
<thead>
<tr>
<th>Dir Entries</th>
<th>Data Elements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data CI</td>
<td>Index CI</td>
</tr>
<tr>
<td>Registered</td>
<td>Registered</td>
</tr>
<tr>
<td>Index CI</td>
<td>Index CI</td>
</tr>
<tr>
<td>Registered</td>
<td></td>
</tr>
</tbody>
</table>
Caching Modes

**Mode: DIRONLY**

<table>
<thead>
<tr>
<th>Dir Entries</th>
<th>Data Elements</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Data CI</td>
</tr>
<tr>
<td></td>
<td>Registered</td>
</tr>
<tr>
<td></td>
<td>Index CI</td>
</tr>
<tr>
<td></td>
<td>Registered</td>
</tr>
</tbody>
</table>
Directory Only Caching

• **Useful for:**
  – Data sets used by only one system
  – Write-only data sets
  – Reduce cache space requirements

• **To Enable:**
  – Data Class definition (page 6)
    RLS CF Cache Value . . . . A (A, N, U or D)
    RLS Above the 2-GB Bar . . N (Y or N)

• Requires Rls_MaxCFFeatureLevel(A)
• Tolerance: OA36443, OA36415
Directory Only Caching

• New Caching Mode – Directory Only (DIRONLY)

• A true “no caching” option
  – Does not cache any data or index Cis
  – Uses cache to register interest, but stores no data

• Useful for:
  – Data sets that are only used in one system
  – Write-only data sets
OMEGAMON XE Support
OMEGAMON XE Support

- RLS at z/OS 2.1 Provides interfaces for OMEGAMON
- OMEGAMON XE v520 offers RLS Panels
  - 15 new TEP workspaces
  - Many other changes to integrate RLS information
- Monitors all the same info as SMF42

Requirements:
- Omegamon XE V520 or higher
- Maintenance: OA41786, OA42288, OA42798, OA43380, OA43381, OA43376, OA45578, OA44589
- See Share Pittsburg session #15548
Example Display

Complete your session evaluations online at www.SHARE.org/Seattle-Eval
ACCBIAS in Data Class
ACCBIAS

- ACCBIAS and RMODE31 added to data class
- Previously, these were available on JCL, but not SMS

```
DATA CLASS ALTER

Command ===> 

SCDS Name ... : SYS1.SMS.V2R1.SCDS
Data Class Name : DCRLSNC

To ALTER Data Class, Specify:

<table>
<thead>
<tr>
<th>Data Set Name Type</th>
<th>EXT</th>
<th>(EXT, HFS, LIB, PDS, Large or blank)</th>
</tr>
</thead>
<tbody>
<tr>
<td>If Ext</td>
<td>R</td>
<td>(P, R or blank)</td>
</tr>
<tr>
<td>Extended Addressability</td>
<td>N</td>
<td>(Y or N)</td>
</tr>
<tr>
<td>Record Access Bias</td>
<td>S</td>
<td>(S, U, DO, DW, SO, SW or blank)</td>
</tr>
<tr>
<td>RMODE31</td>
<td>ALL</td>
<td>(ALL, BUFF, CB, NONE or blank)</td>
</tr>
<tr>
<td>Space Constraint Relief</td>
<td>Y</td>
<td>(Y or N)</td>
</tr>
<tr>
<td>Reduce Space Up To (%)</td>
<td>0</td>
<td>(0 to 99 or blank)</td>
</tr>
<tr>
<td>Dynamic Volume Count</td>
<td>20</td>
<td>(1 to 59 or blank)</td>
</tr>
<tr>
<td>System Managed Buffering</td>
<td></td>
<td>(1K to 2048M or blank)</td>
</tr>
</tbody>
</table>
```
Other Changes

• SHOWCB macro updated with new keywords:
  – BUFNOL – # of buffers allocated to data set (LSR or SMB)
  – BUFUSE – # of buffers in use
• LOGREPLICATE – keyword added to IDCAMS
  – Specifies whether VSAM is eligible for replication
• VSAM RAS Enhancements
• RLS 64-bit buffering enhancement
  – Moved some control information above the bar
• RLS Serialization change – moving toward GRS latches
VSAM New Features in z/OS 2.2
(and revisit those from 2.1)

Neal Bohling
IBM, VSAM RLS Development

Session 17137