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

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IBM, VSAM RLS Development

Session 17835

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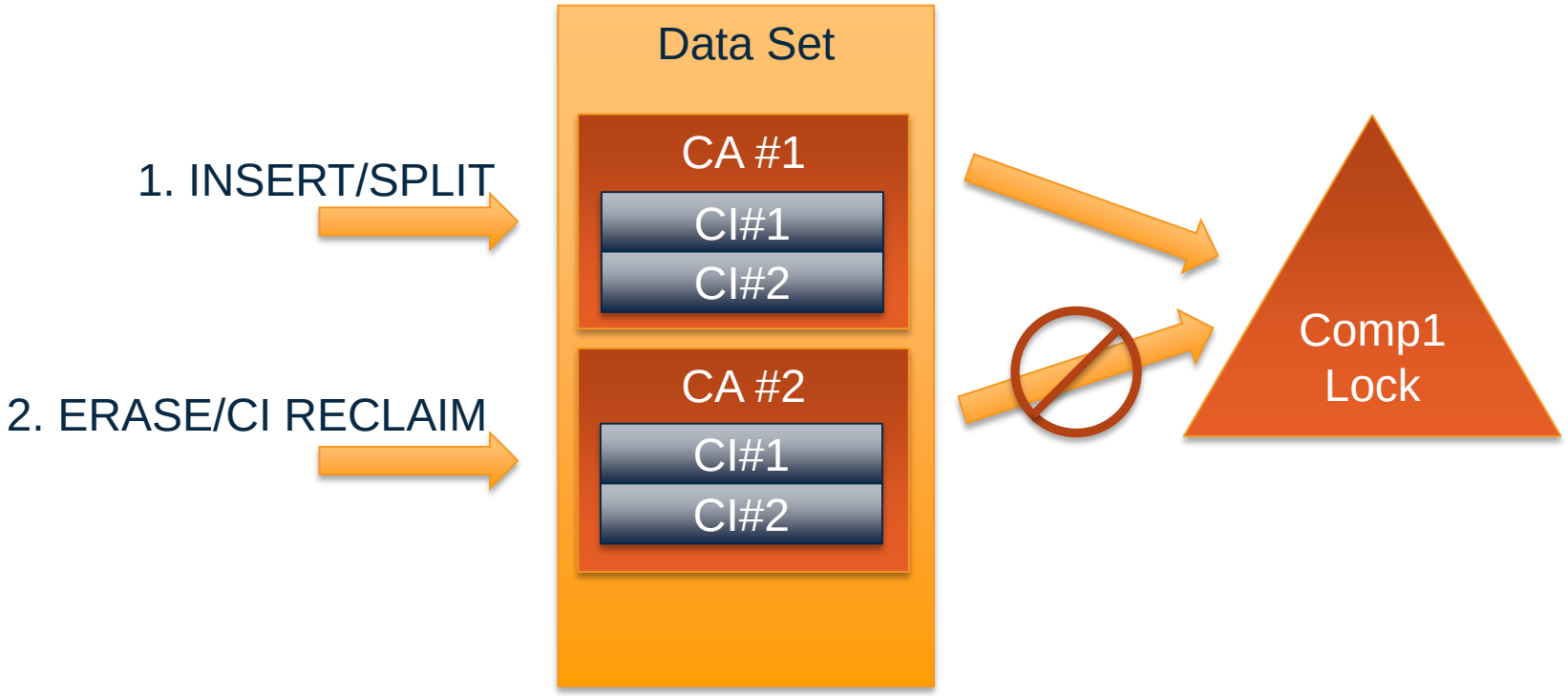
Overview

- **z/OS 2.2 New Features**
  - Index Record Locking (RLS)
  - Space Constraint Relief Enhancement for VSAM (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)

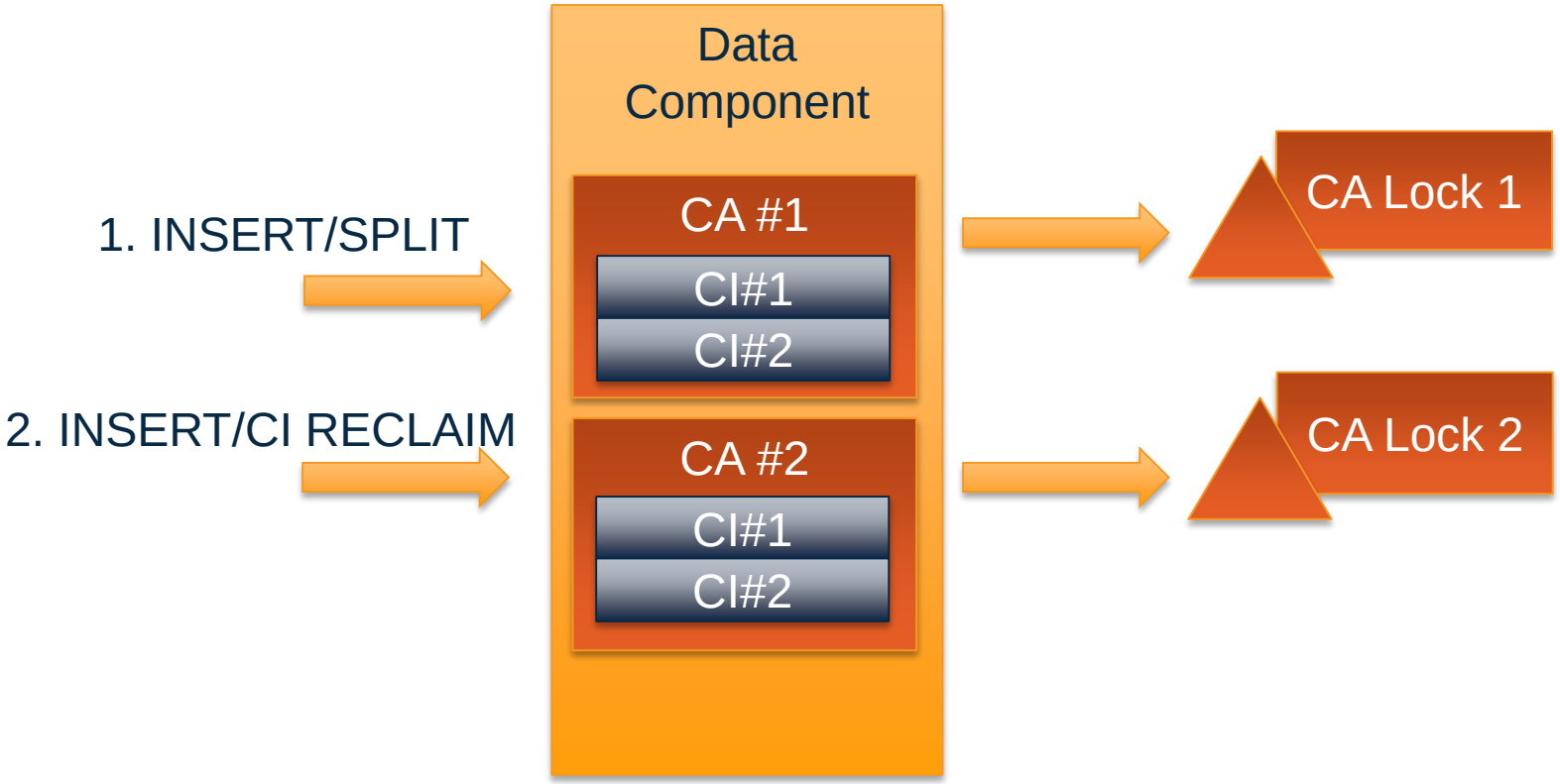
Index Record Locking
(sometimes called CA-level locking)

Current Split Logic



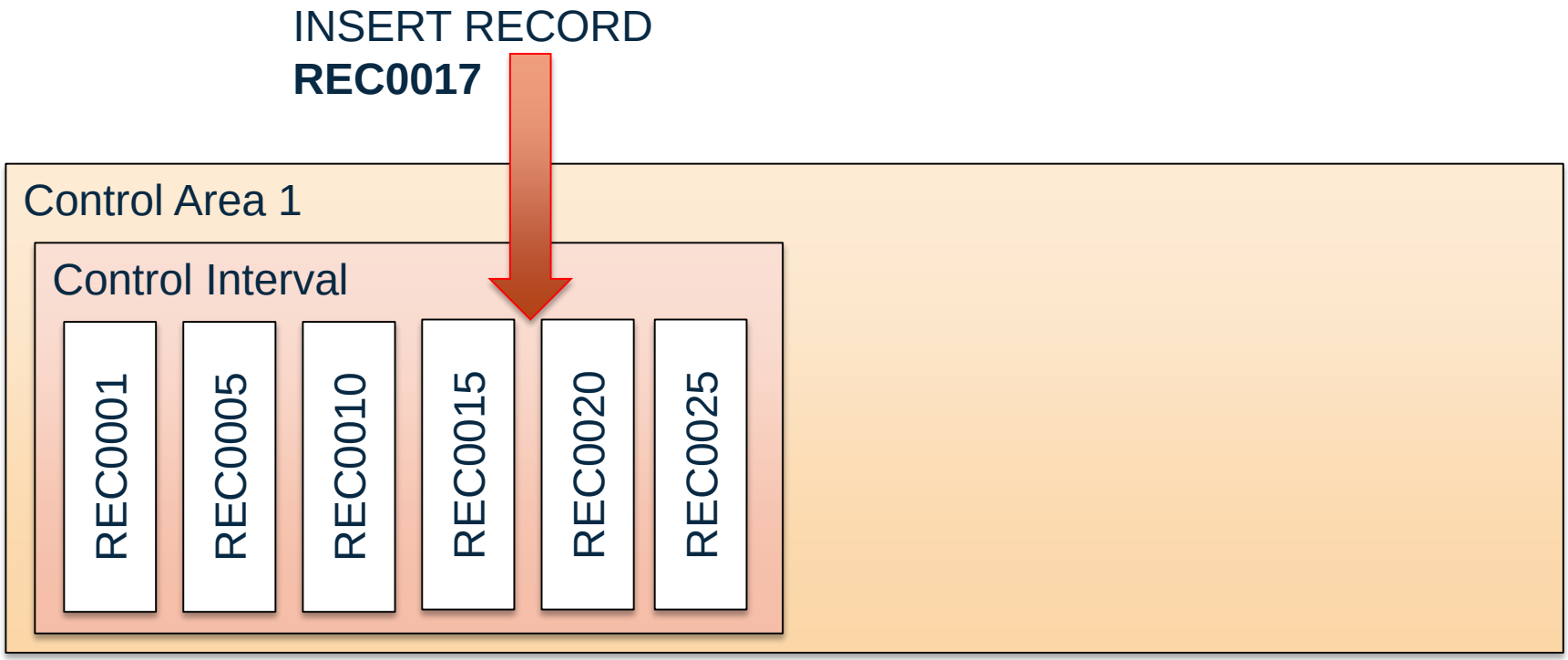
Only one split/erase/reclaim per data set can occur simultaneously

With Index Record Locking



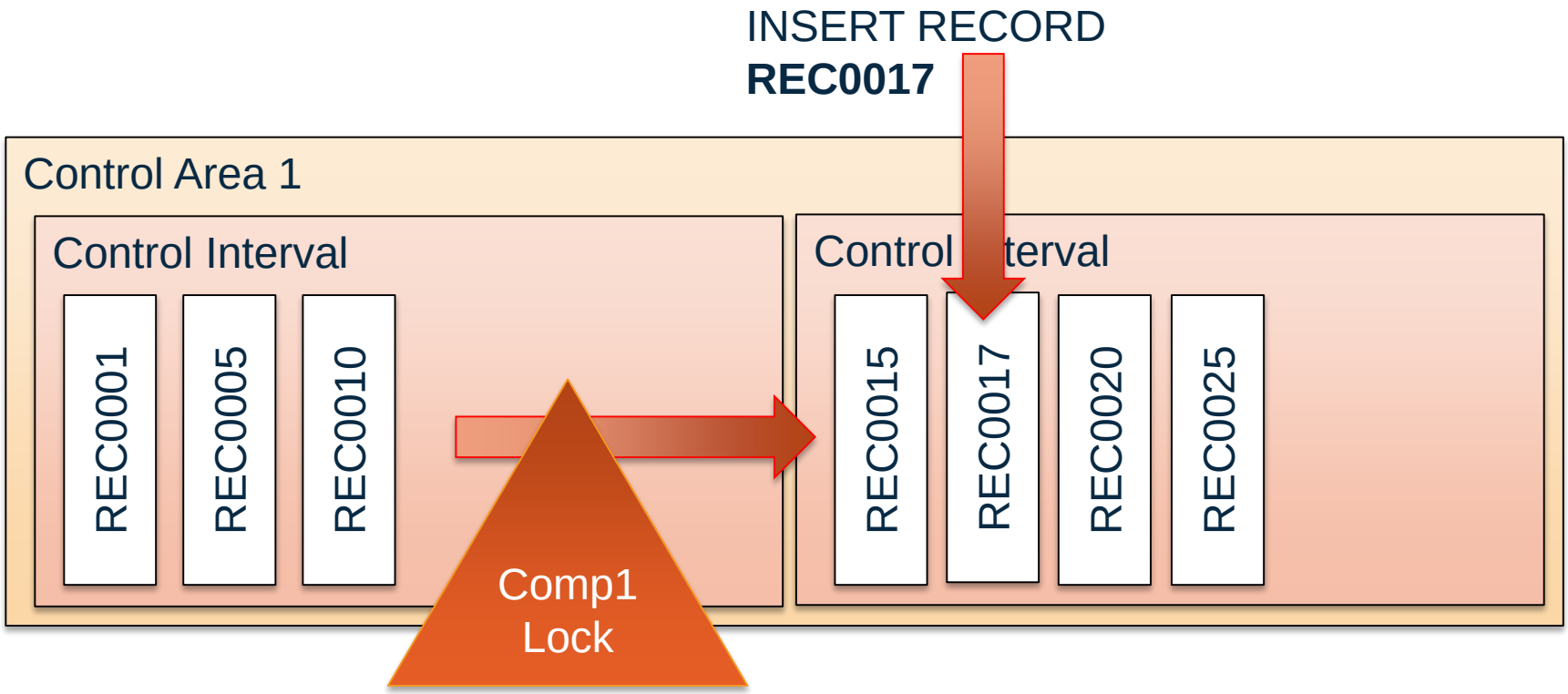
Logically Locks the at the CA level
Lock based on Index sequence set CI

Example of old Component 1 Locking



- No more space in CI, so a SPLIT is needed
- SPLIT gets the Component1 lock (one per data set)
- Any other SPLIT or RECLAIM or spanned record activity must WAIT

Example of old Component 1 Locking



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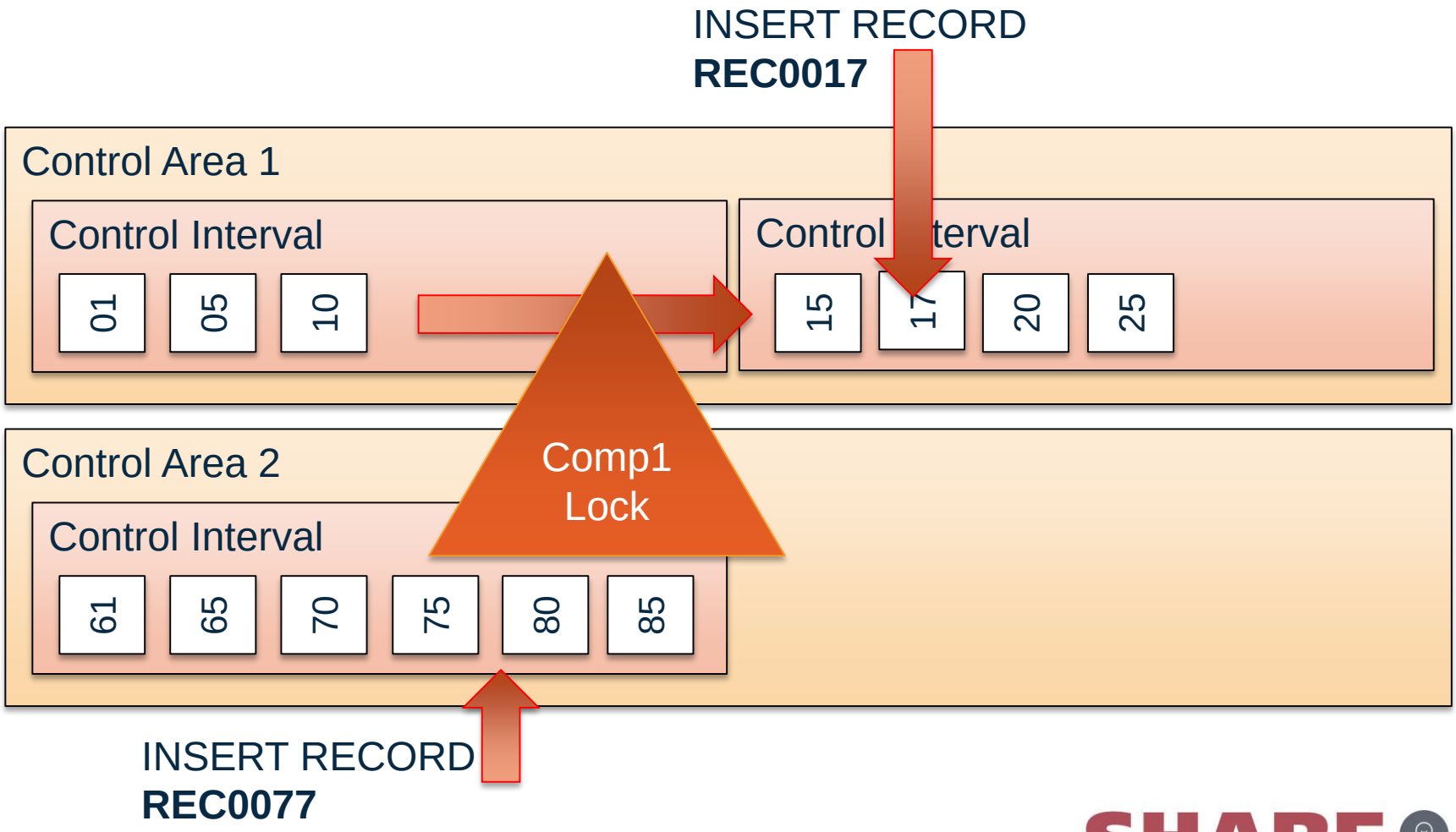
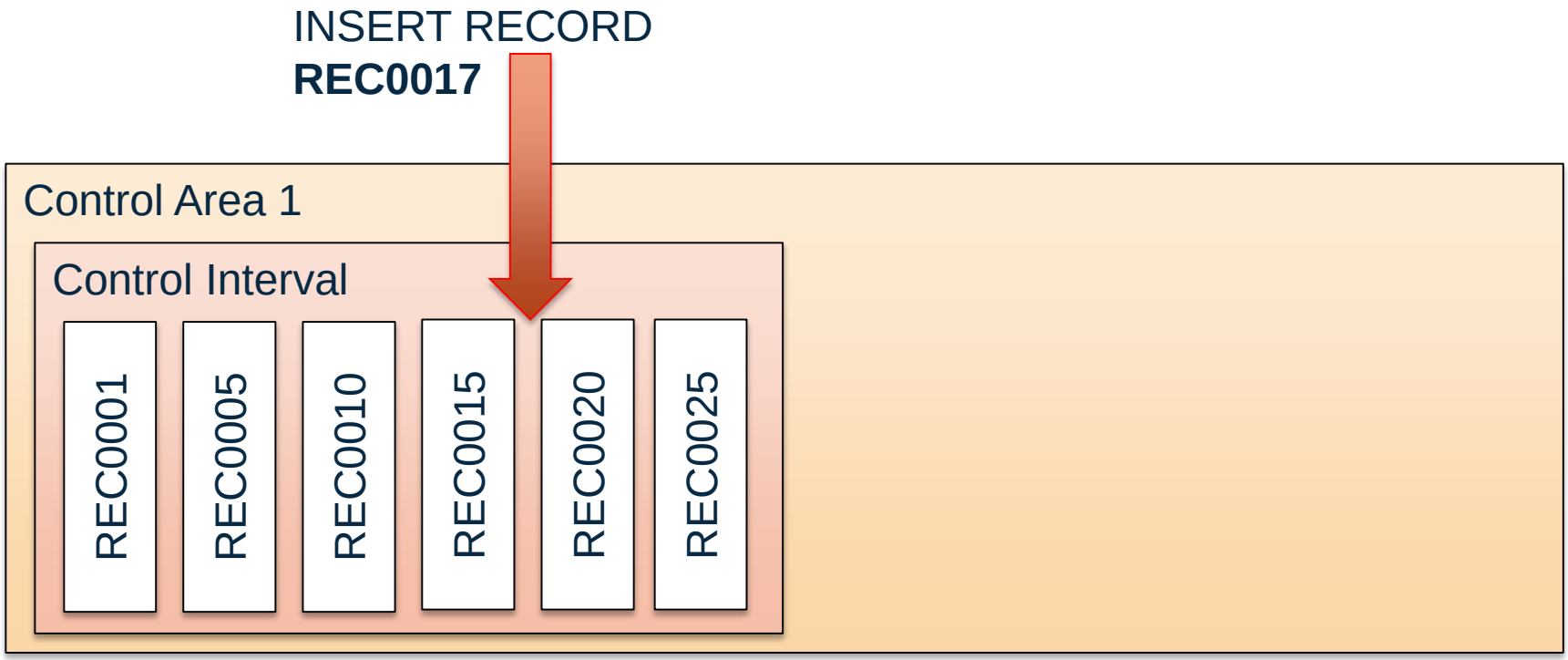
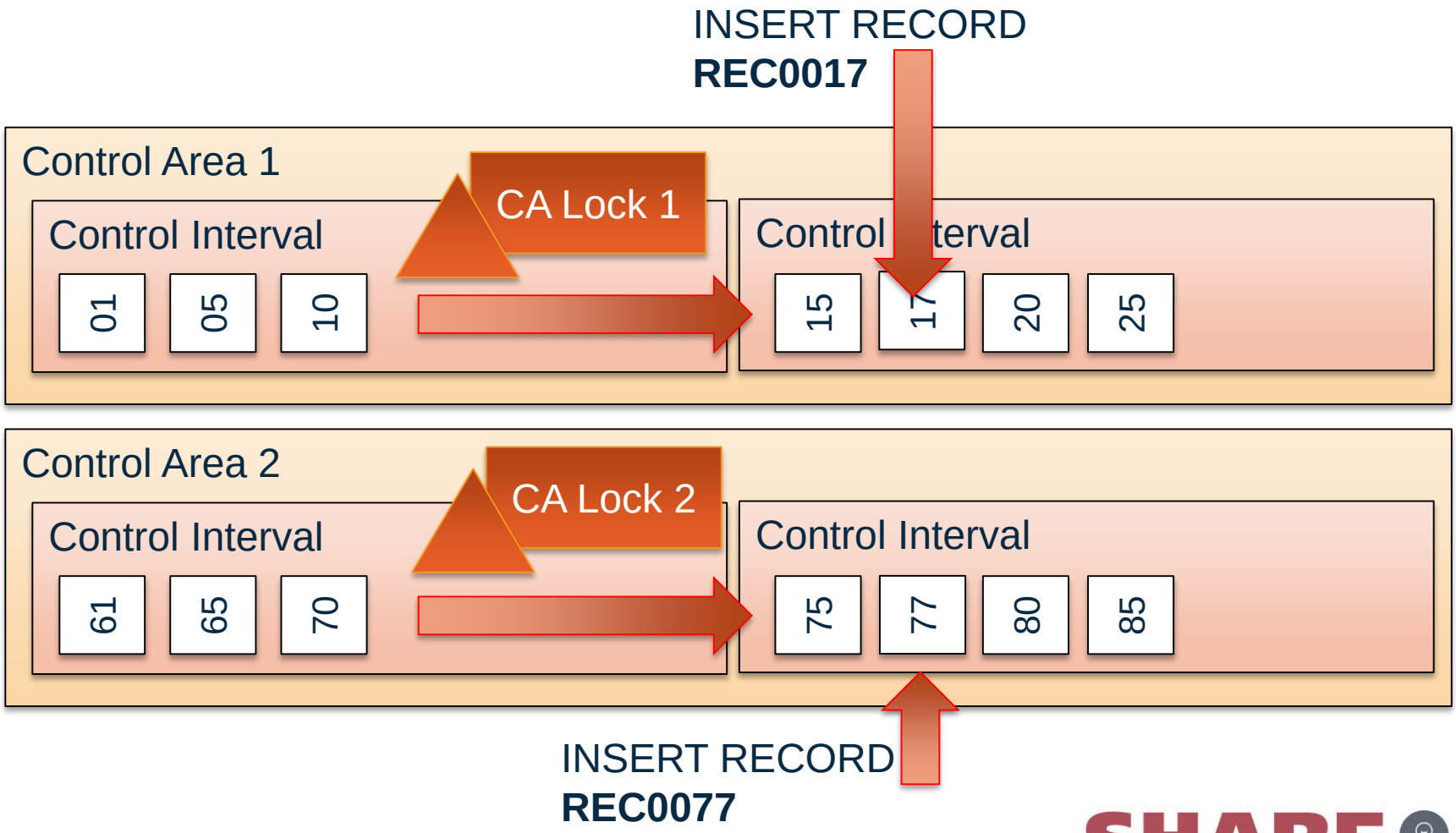


Example of New Method



- No more space in CI, so a SPLIT is needed
- SPLIT gets the Component 1 class 4 lock (one per CA)
- Only other SPLIT / RECLAIM / spanned activity in the same CA must wait.

Example of New Component 1 Locking



Index Record Locking

- Locks at the CA level during:
  - CI SPLIT, CI RECLAIM, Spanned record activity
- CA split / reclaim activity will still use data-set level lock

- **Greatly reduces split pain point**
  - Reduced contention
  - Higher throughput for workloads with heavy INSERT

- New SMF fields (SMF42 subtype 15, 16 :: Component 1 class 4)
  - Obtain (ex. SMF42FPH)
  - True Contention (ex. SMF42FPI)
  - False Contention (ex. SMF42FPJ)
  - Release (ex. SMF42FPK)

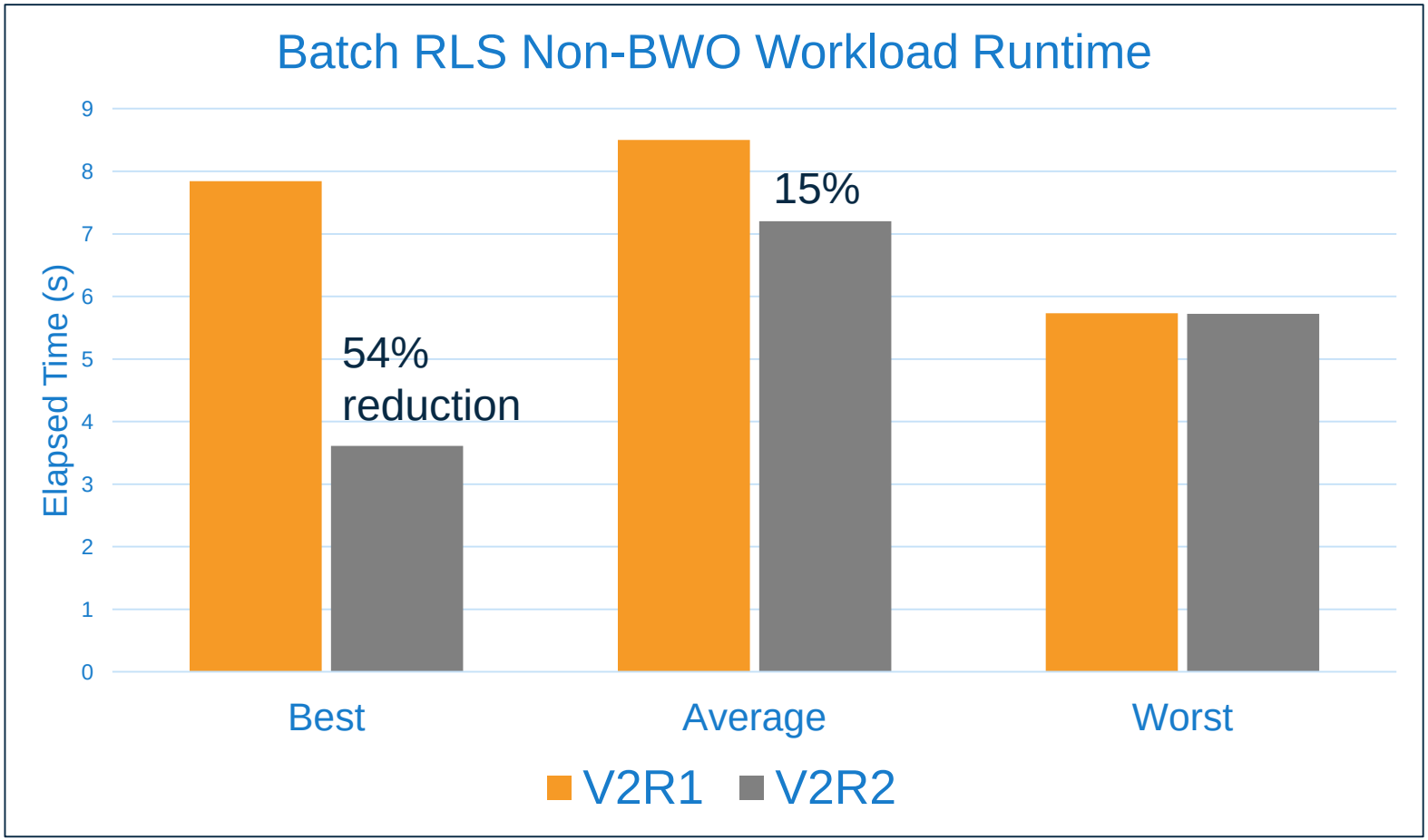
- Lower releases will require toleration OA42676

Performance Measurements

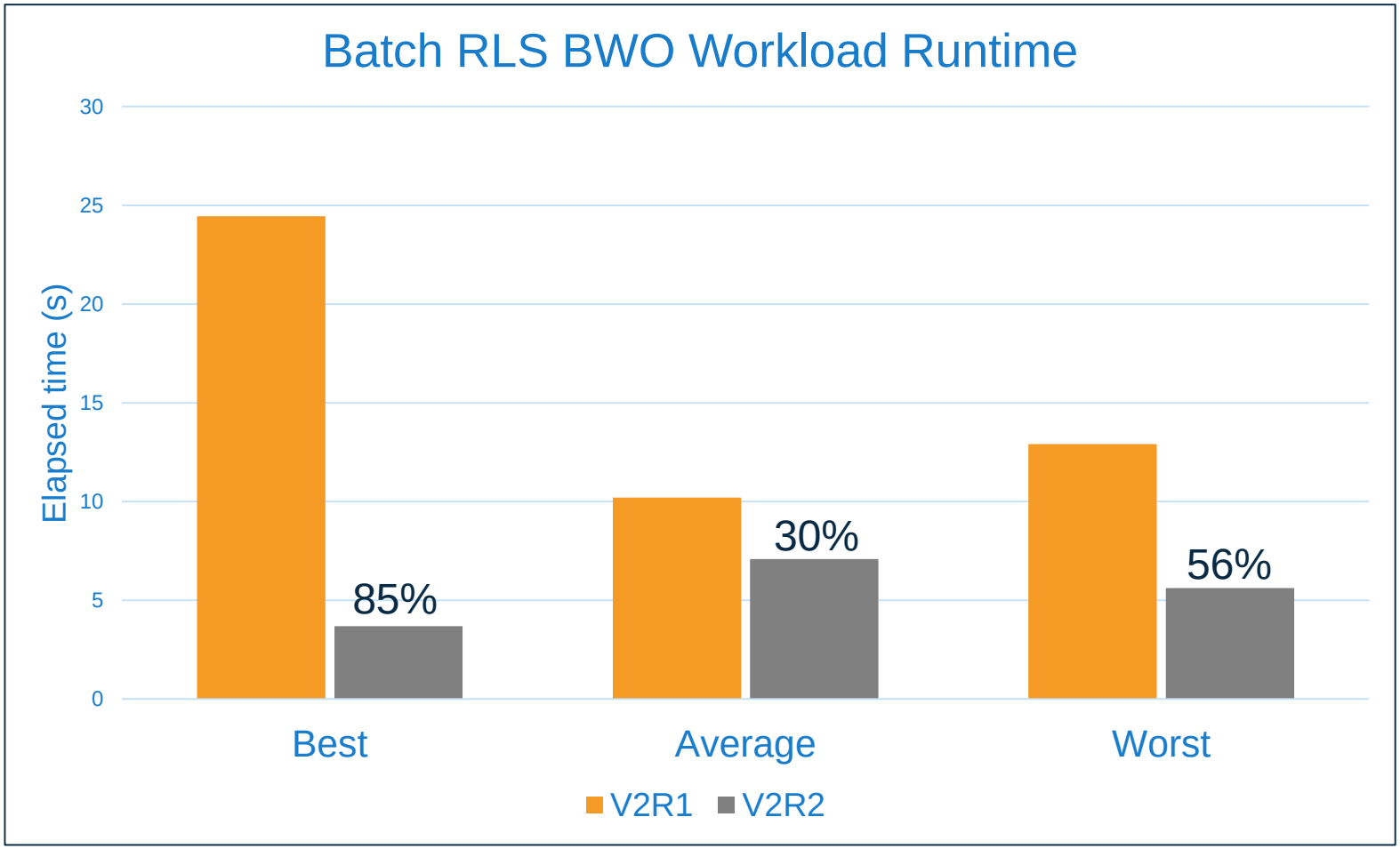
- Three workloads on zEC12 / 8 logical CPs, CF 1 CP

- **Test #1 – Best Case**
  - 30 regions spread across 3 systems
  - Records inserted into different CAs throughout the DS
- **Test #2 – Average Case**
  - 30 regions across 3 systems
  - Random inserts that may include some CA splits
- **Test #3 – Worst Case**
  - Single task on a single system
  - Inserting randomly through the data set

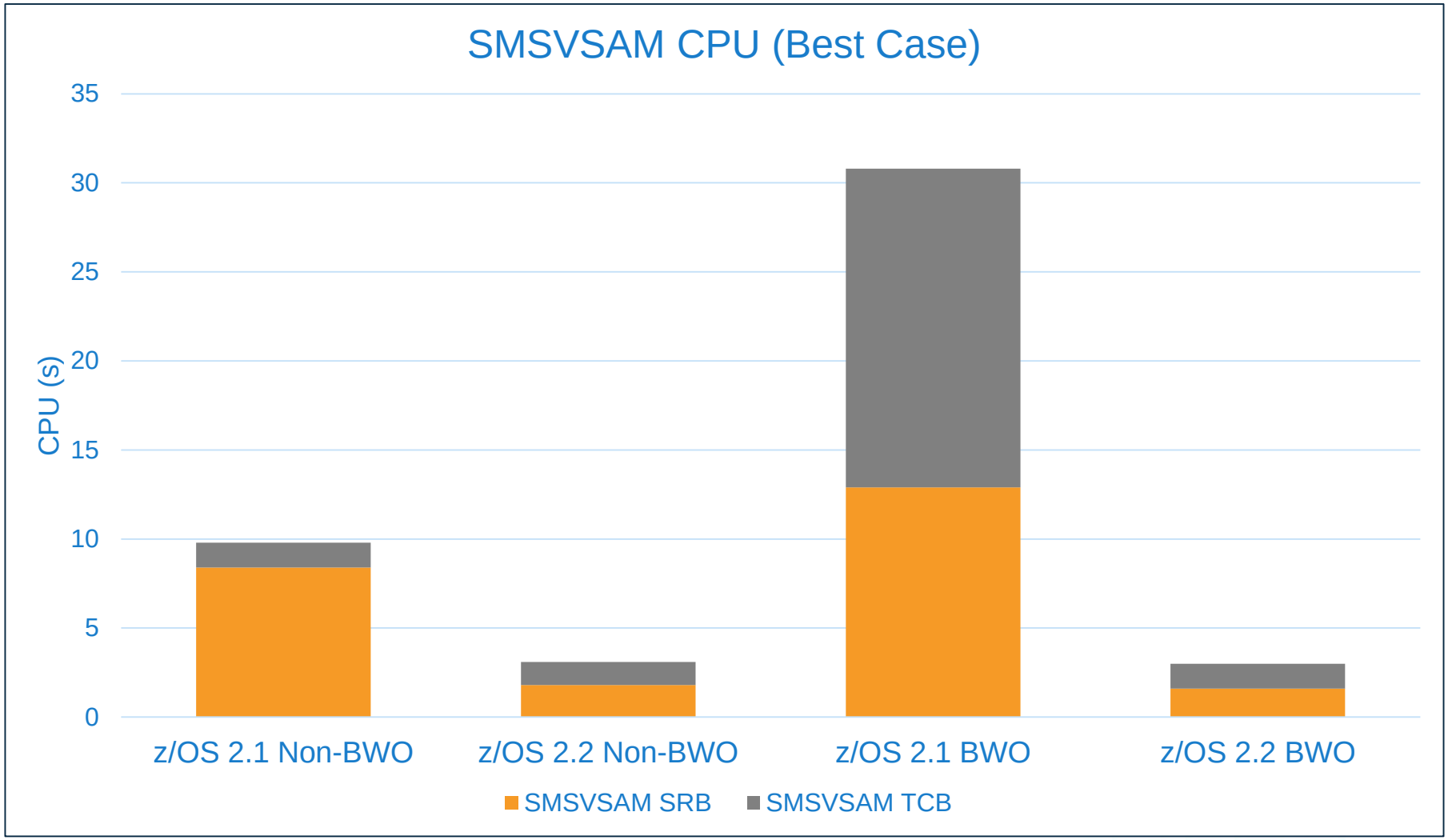
Performance Improvement



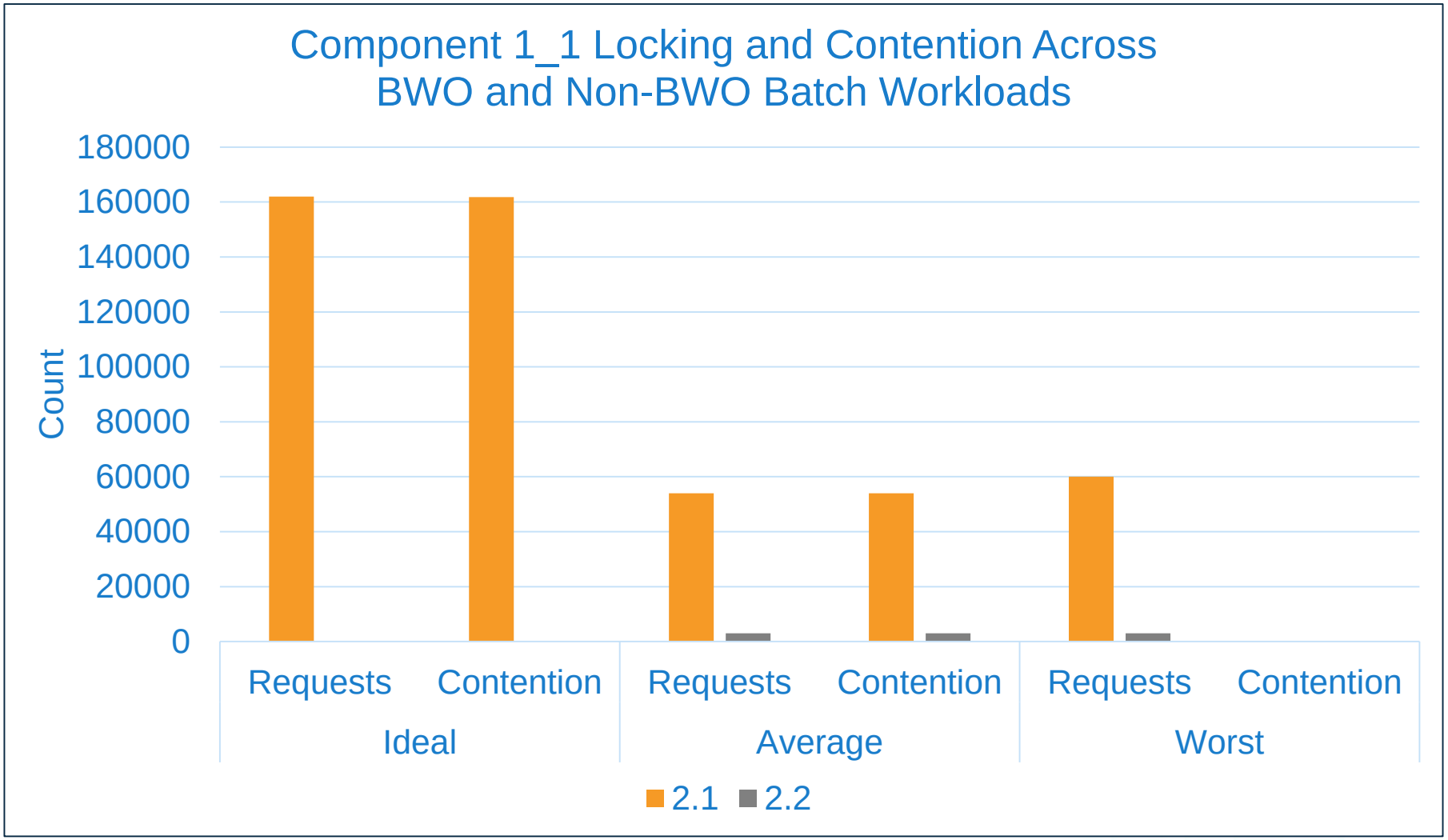
Performance Improvement



Performance Improvement



Locking Performance Improvement



Space Constraint Relief Enhancement

Overview of Change

- **VSAM Secondary Space Allocation** now supports Space Constraint Relief (SCR)

- If SCR enabled, system obtains largest available extent rather than failing

VSAM Space Allocation Processing

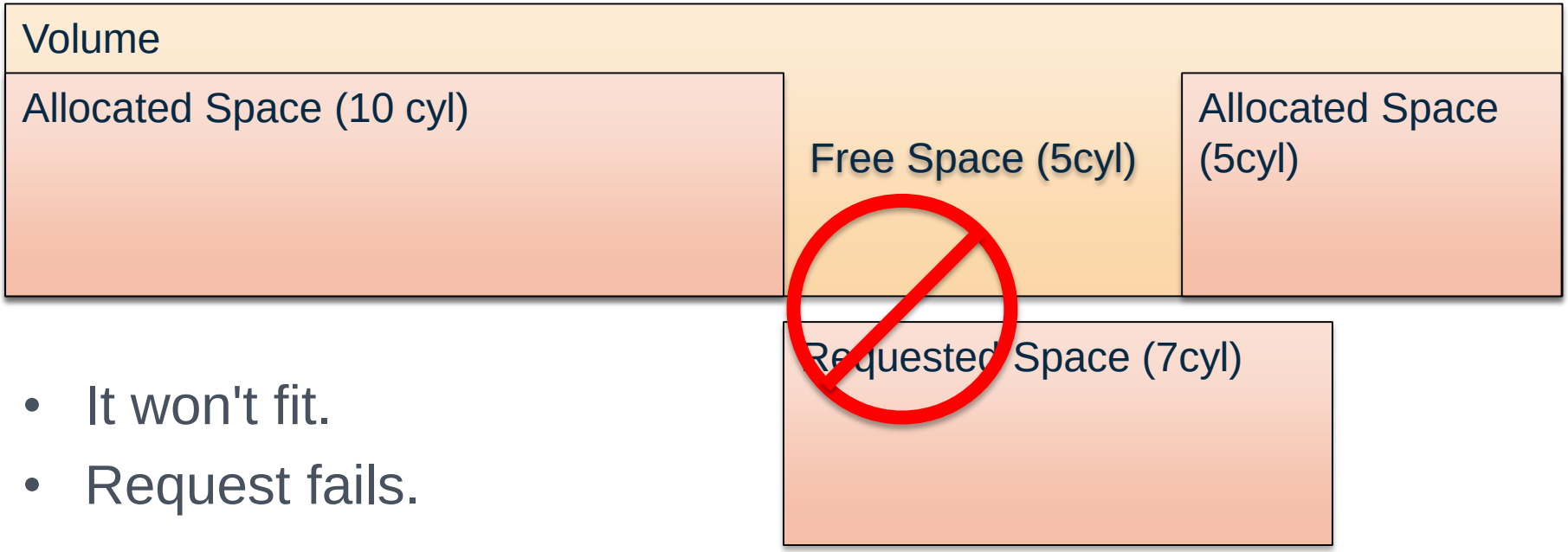
Previous Method:

- Space is obtained in amounts defined by PRI / SEC
- **Primary Allocation:**
  - Tries Best-Fit (if VOLCNT > 1)
  - Tries Space Constraint Relief:
    - Reduces request amount by % specified
    - Removes 5-extent limit

- **Secondary Allocation:**
  - Tries to obtain secondary amount
  - Tries a new volume (EOV)

Current Secondary Space Allocation

- Volume A has 5 CYL free space
- Secondary allocation request comes in for 7 CYL



- It won't fit.
- Request fails.

VSAM Space Allocation Processing

New Method:

- Space is obtained in amounts defined by PRI / SEC
- **Primary Allocation:**
  - Tries Best-Fit (if VOLCNT > 1)
  - Tries SCR:
    - Removes 5-extent limit
    - **Creates minimum size** based on SCR values
    - Requests space in range (MIN – PRI)

- **Secondary Allocation:**
  - Requests largest extent available between minimum size defined by SCR and secondary size
  - Tries a new volume (EOV)

Fields

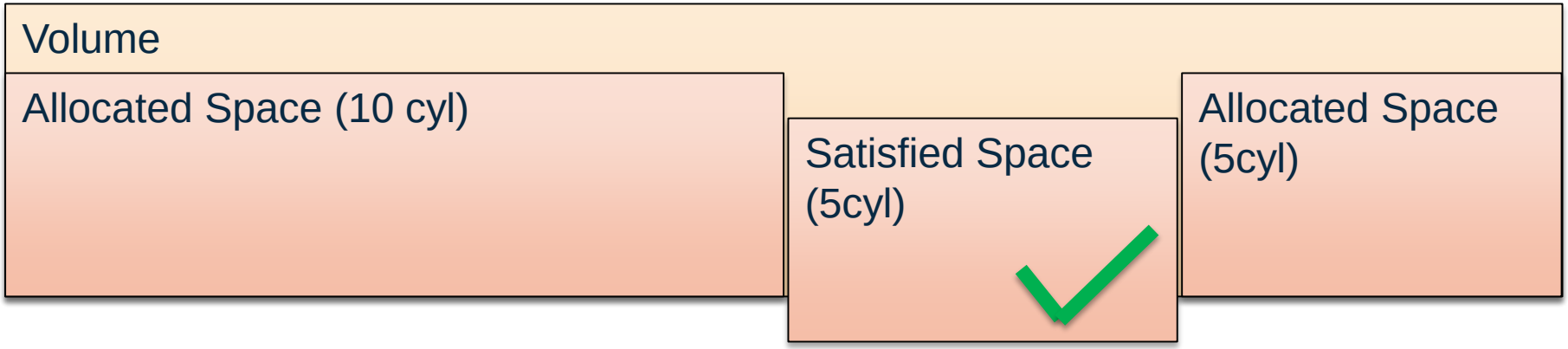
- **Data Class fields:**
  - Space Constraint Relief: **Y**
  - Reduce Space Up to (%): **0-99%**

- **Reduce Space Up To means Remove up to that amount**
- Ex: 100cyl primary, 50cyl secondary, SCR set to 80%
  - For primary: 100cyl * (1-.80) = 20cyl
  - For secondary: 50cyl * (1-.8) = 10cyl

- **Will return largest available extent that fits the range:**
  - Primary: 20cyl – 100cyl
  - Secondary: 10cyl – 50cyl

Current Secondary Space Allocation

- Volume A has 5 CYL free space
- Secondary allocation request comes in for 7 CYL



- SCR set to 50%
  - Range is 3 – 7 CYL
- Request satisfied with 5 CYL extent

Space Reduction Enhancement

- **Non-striped VSAM/RLS/PDSE/BAM/SAM all supported**
- Data set must be SMS-managed
- **For VSAM, resulting extent must be multiple of CA size**

- **To enable, set Data Class fields:**
  - Space Constraint Relief: **Y**
  - Guaranteed Space Reduction. _ (Y or N)
  - Reduce Space Up to (%): **0-99**

- **New SMF fields:**
  - SMF64SSR – if secondary space reduction was used
  - SMF64NTA – size of extent returned in Tracks

- On by default, but can be disabled via DISABLE(SSR) in DEVSUPxx

LISTSTAT – Statistics while VSAM is OPEN (RLS only)

LISTSTAT Command

- *New IDCAMS command*

  IDCAMS SHCDS LISTSTAT('cluster')

- Provides point-in-time statistics:
  - SYSPLEX-wide
  - For currently OPEN VSAM data sets
  - **VSAM RLS only**

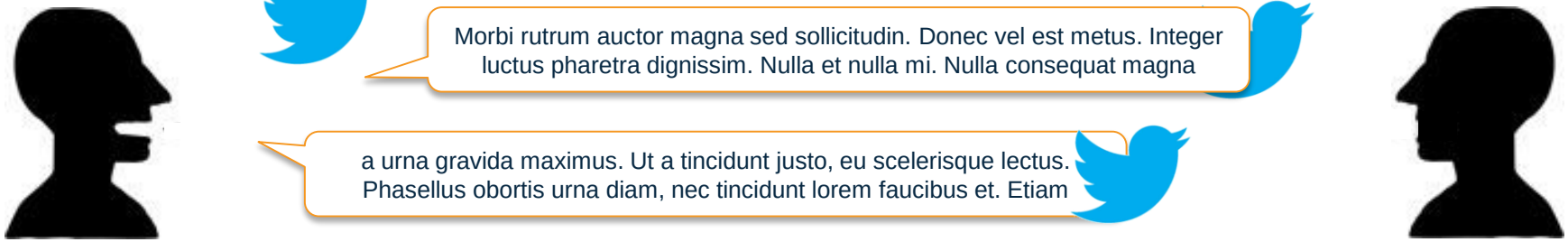
- Subset of LISTCAT and SMF64 information, but **does not require CLOSE**
- Available via OA42435 for 1.13 and 2.1

LISTSTAT Output

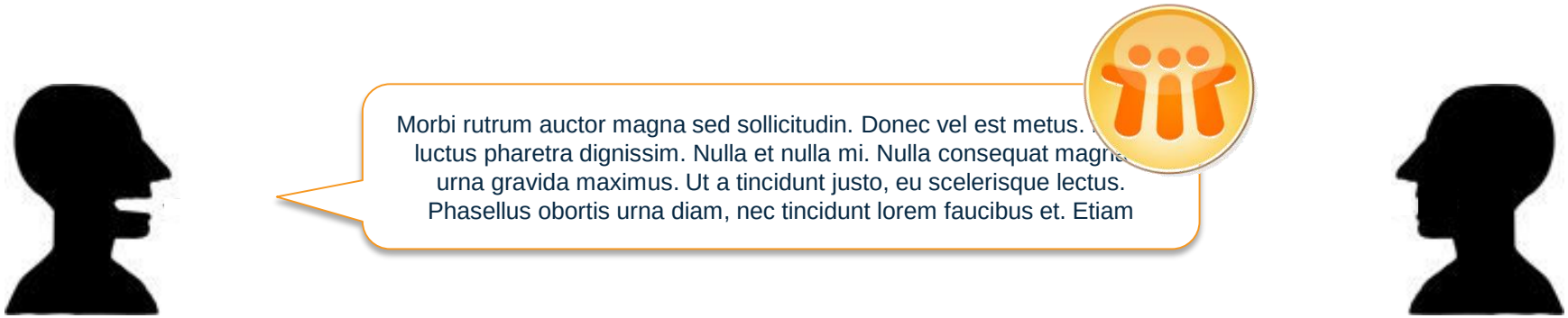
```
SHCDS LISTSTAT('NB.RLS.TEST2')

LIST STATISTICS (LISTSTAT):
CLUSTER---------NB.RLS.TEST2
DATA-------NB.RLS.TEST2.DATA
TOTAL RECORDS---------        101     CI SPLITS-------------          0
RECORDS DELETED-------          0     CA SPLITS-------------          0
RECORDS INSERTED------          1     EXCPS-----------------        207
RECORDS UPDATED-------          0     EXTENTS--------------------     1
RECORDS RETRIEVED-----          0     FREE SPACE----------       774144
HI-A-RBA------------     829440      HI-U-RBA------------       829440
INDEX------NB.RLS.TEST2.INDEX
TOTAL RECORDS---------          1     CI SPLITS-------------          0
CA RECLAIMS-----------          0     CA SPLITS-------------          0
RECLAIMED-CA REUSES---          0     EXCPS-----------------        209
RECORDS UPDATED-------          0     EXTENTS--------------------     1
RECORDS RETRIEVED-----          0     FREE SPACE----------        32768
HI-A-RBA------------      33792      HI-U-RBA------------         1024
HI-LEVEL-RBA----------          0     INDEX LEVELS---------------     1
```

Chained I/O for Spanned Records

Chained I/O Simile

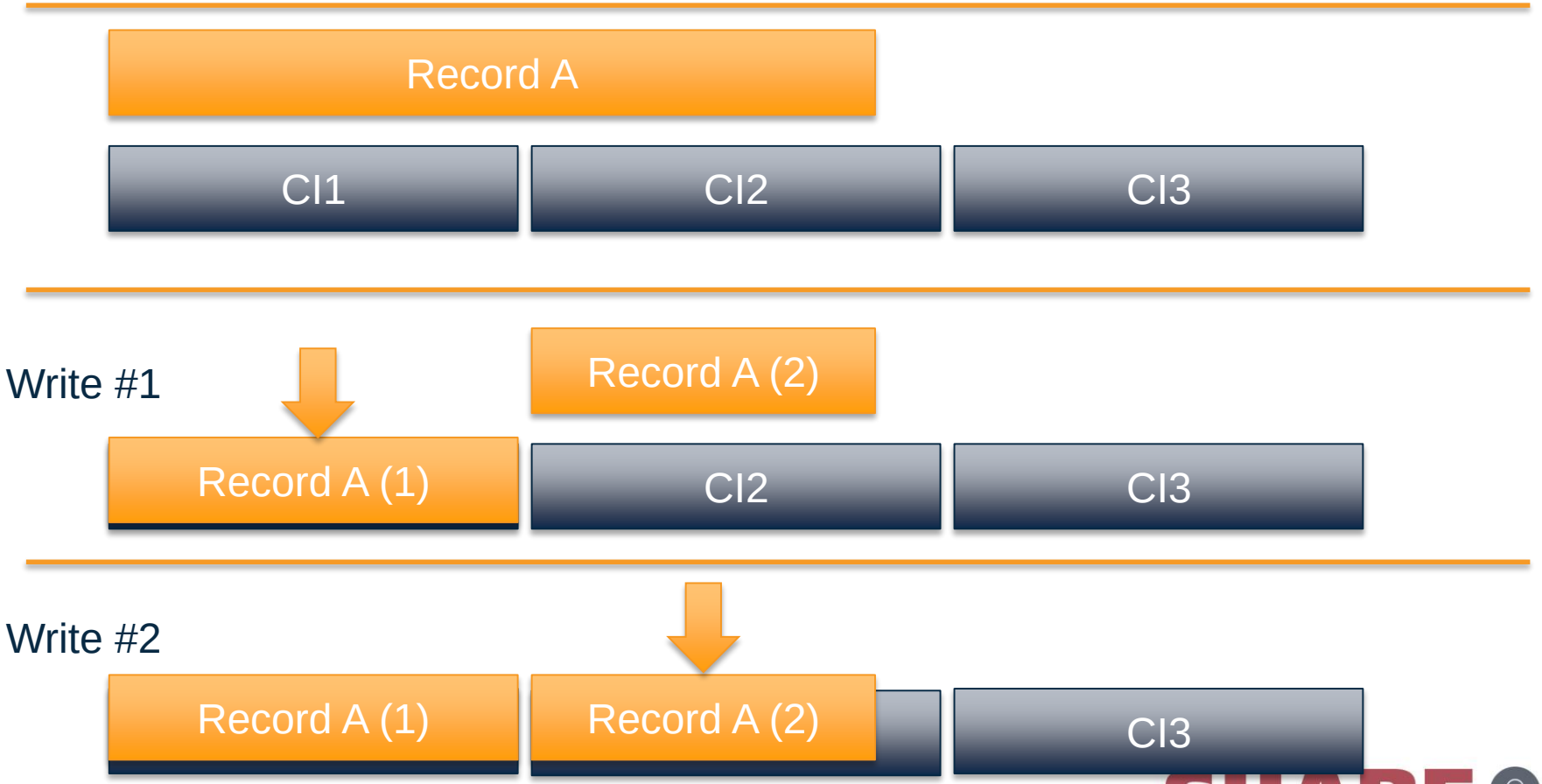


Vs.



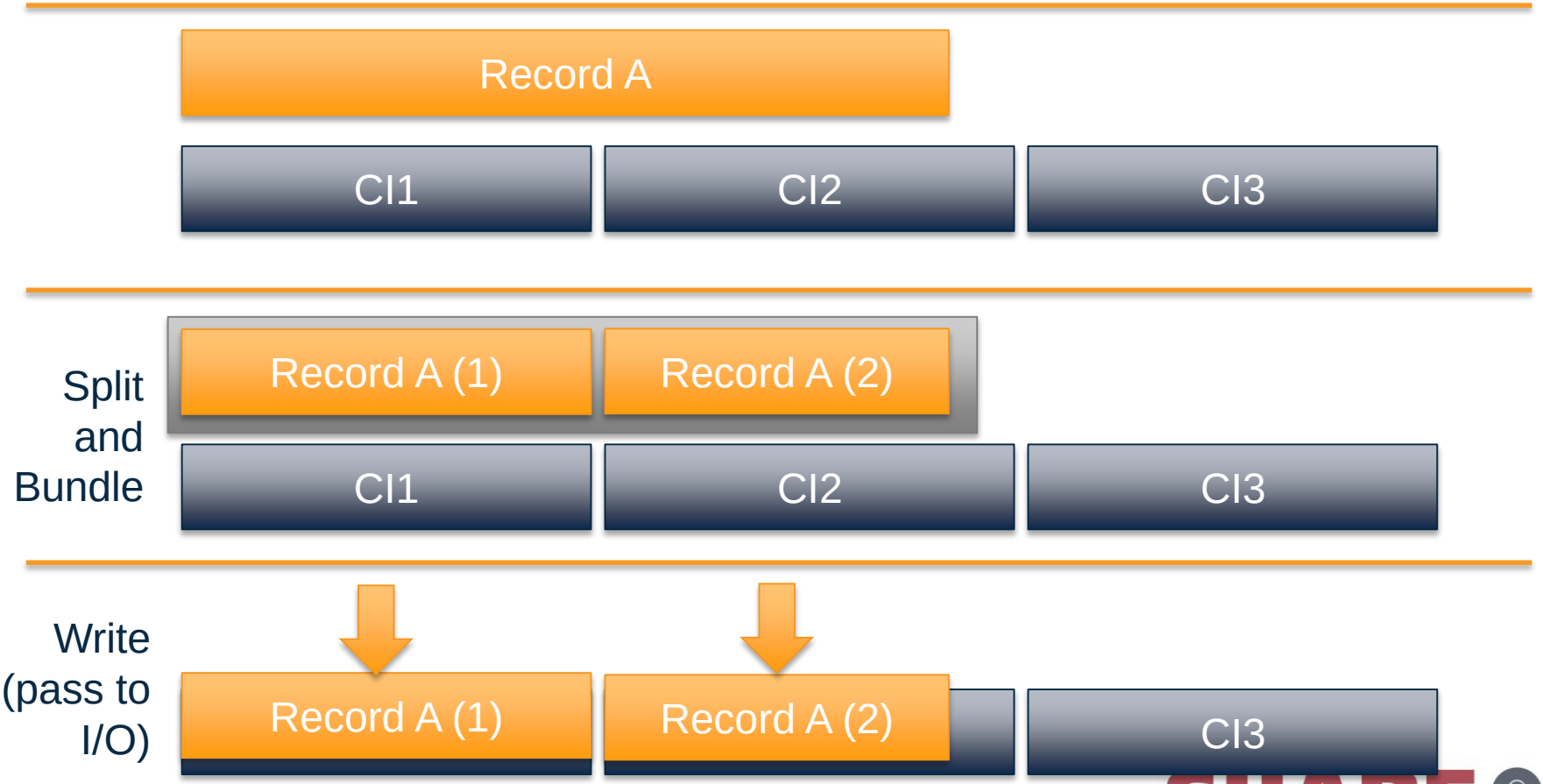
Chained I/O

- Old Way – Segment Spanned Records into parts and loop



Chained I/O

- New Way – Combine segments into one I/O call



Chained I/O

- **NSR and RLS supported**
  - LSR and GSR not currently supported

- VSAM NSR uses Chained IO for READ, PUT, and ERASE
- RLS uses Chained IO for PUT, ERASE (not read)

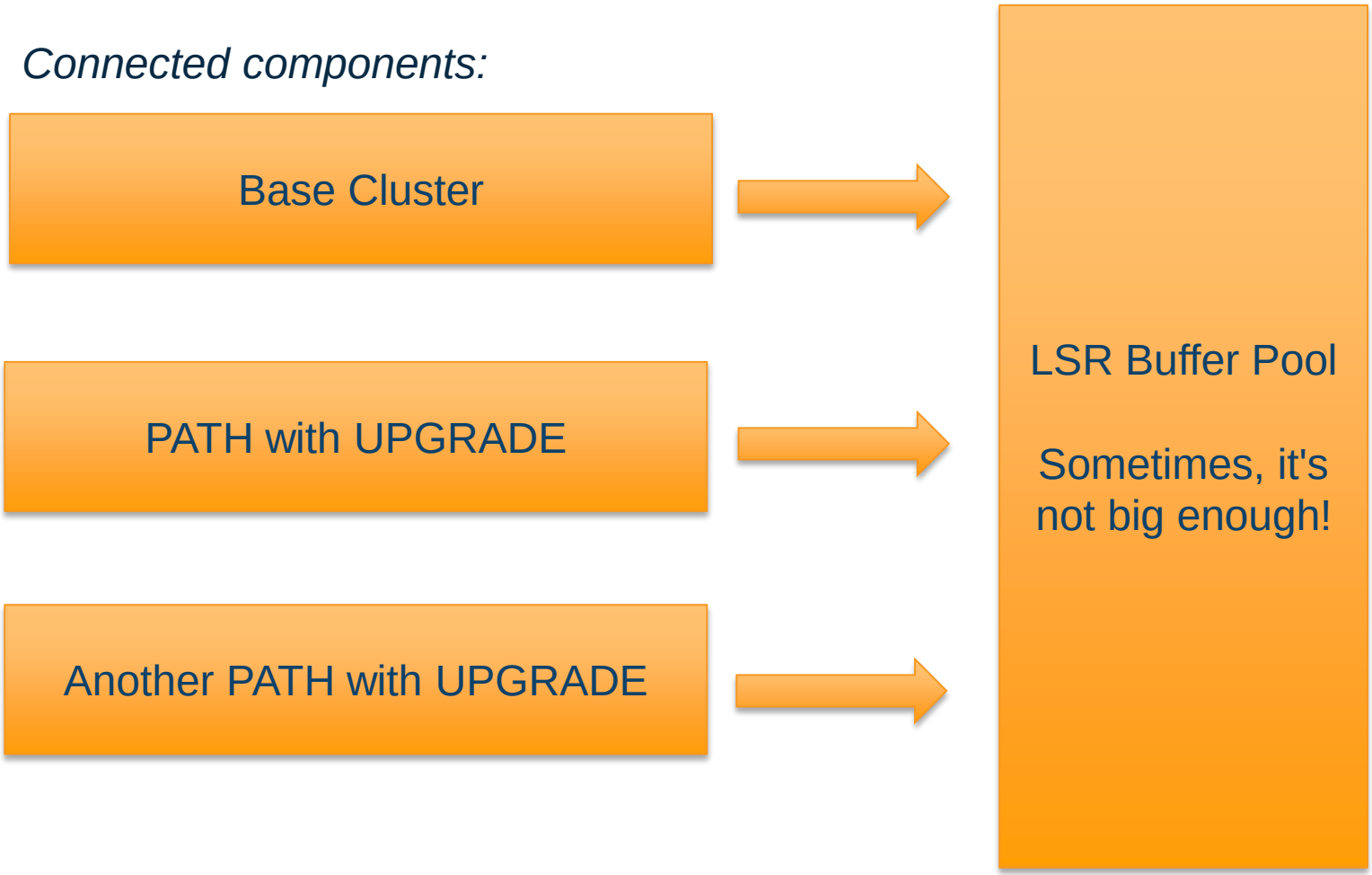
- No co-existence maintenance needed

- Benefits:
  - Reduces I/O overhead when using spanned records
  - Avoids a RC x'8C' that can occur if I/O or system fails, ABEND, or cancel between writes of spanned records

VSAM Dynamic Buffer Addition

LSR Dynamic Buffer Addition

Connected components:



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 xxxx 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.

- Will add buffers indefinitely if you let it!
- Added buffers may affect performance
  - LSR hash built with original pool size
  - Added buffers may cause unnecessary hash conflicts

- Final note:
  - Prevents errors from minor space miscalculations
  - **Not meant to replace well-sized LSR pools**

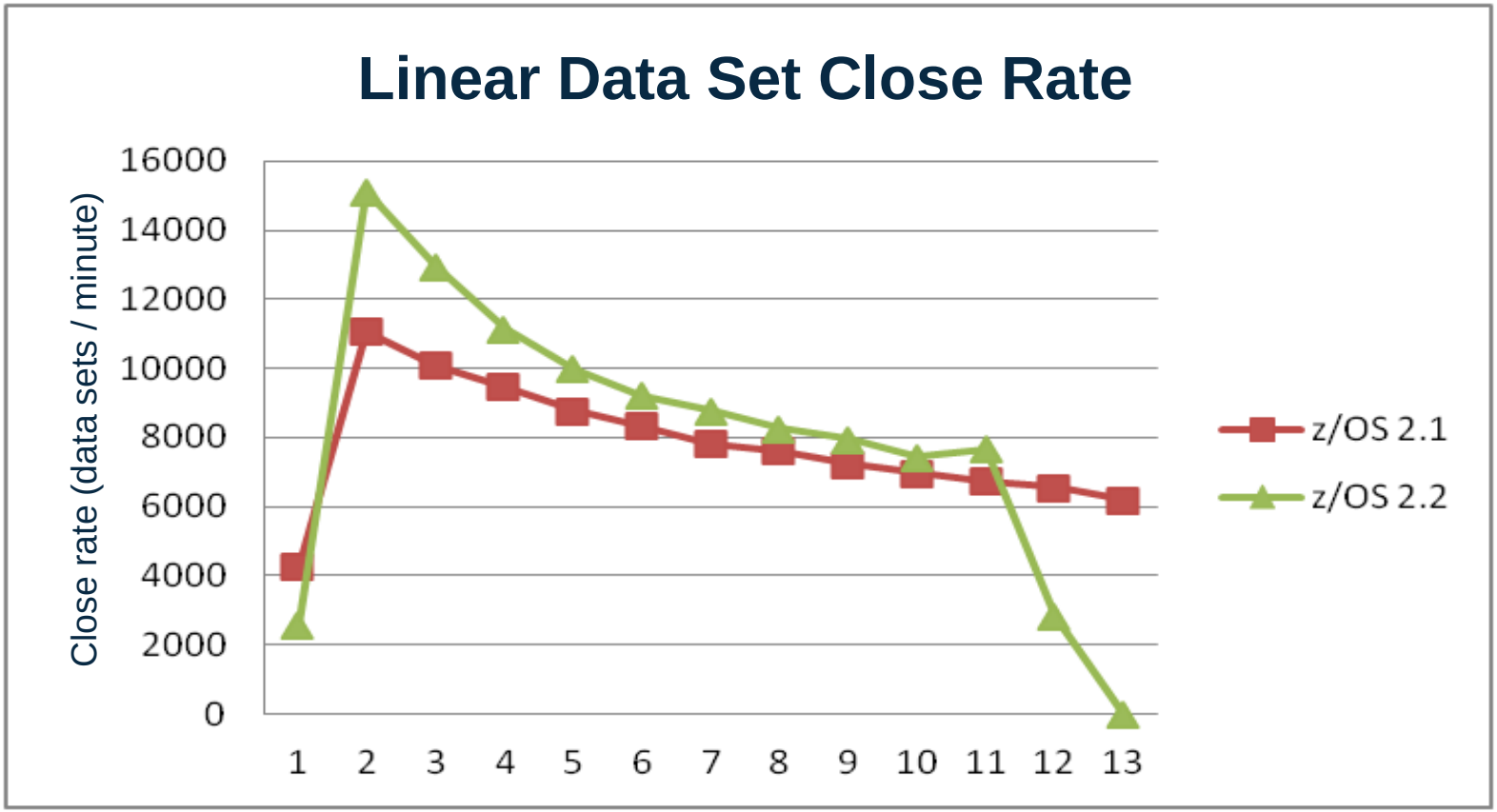
Linear Data Set Constraint Relief

Constraint Relief for Linear VSAM

- **Constraint #1 – Space below the bar**
  - VSAM control blocks are below the bar
  - Limits number of open data sets
- **Solution**:
  - Move some control blocks above the bar
  - Allows for many more open data sets

- **Constraint #2 – Close speed impacted by data set number**
  - Large numbers of data sets create large numbers of AMBL blocks
  - Large numbers of users per data set adds even more 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

IDCAMS Verify Recover Enhancements

Verify Enhancements

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

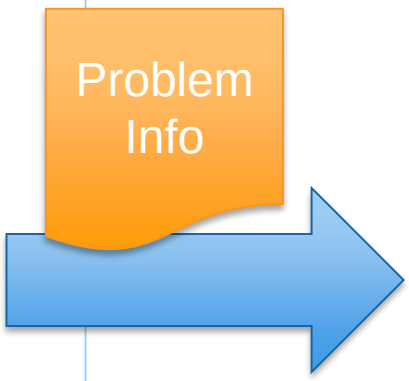
- **z/OS 2.2 enhances EXAMINE and VERIFY RECOVER**
- EXAMINE passes error information to VERIFY RECOVER
- VERIFY RECOVER uses that information to repair

- z/OS 2.2 builds the framework for future enhancement

Verify Enhancements

EXAMINE

- Scans DATA and INDEX
- Finds and reports problems
- Bundles problem information
- Passes to VERIFY RECOVER



VERIFY RECOVER

- Receives problem information
- Parses for errors it knows how to fix
- Fixes errors

Ways to Run Verify

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

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

- **IDCAMS EXAMINE / VERIFY RECOVER in same step (New)**
  - EXAMINE stores information about any problems
  - VERIFY RECOVER parses error information and attempts repair
  - z/OS 2.2 can 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**
  - If VSAM auto dump fails, it currently issues IDA9999I without much helpful information (no RPL/job)
  - 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
- **Additional Cleanup for Non-SMS EOV Failures**
- **Catalog Statistics update** – Permanently records stats in VVR for catalogs

Summary

- **z/OS 2.2 New Features**
  - 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)

Overview

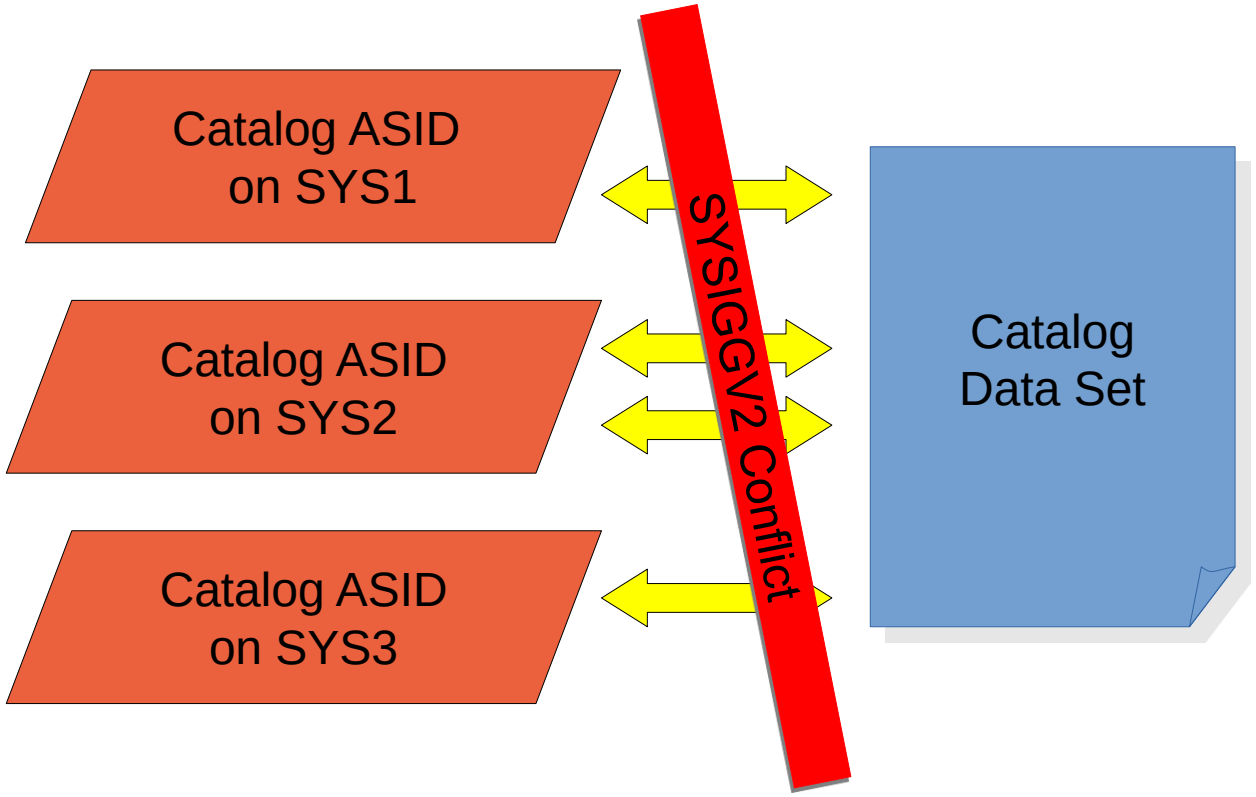
- **z/OS 2.1 New Features**
  - RLS for Catalogs
  - Dynamic Volume Count for RLS
  - Directory Only Caching (RLS)
  - OMEGAMON XE Support (RLS)
  - Data Class ACCBIAS and RMODE31 (VSAM)
  - Other enhancements

RLS User Catalogs

Current Catalog Limitations

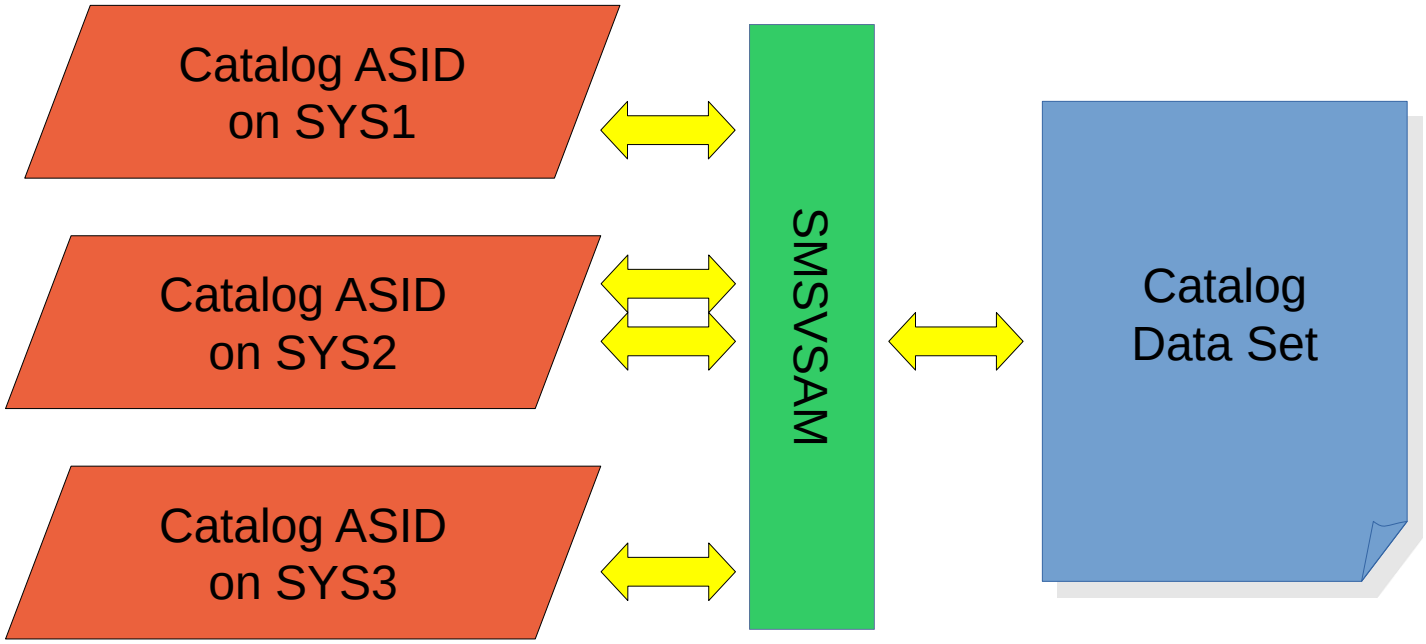
- **Performance**
  - Updates require SYSIGGV2 ENQ – can cause conflict
  - Catalog sharing / caching can be limited
  - Limited VSAM buffers/strings/storage
- **Availability**
  - Catalogs may need to be split to resolve contention
  - Catalogs unavailable during split / recovery
- **Integrity**
  - Catalogs can be damaged by utilities updating while OPEN
  - No central SYSPLEX control and serialization
- **Recovery**
  - Process can be long and tricky

Regular Catalog Access



Potential contention on SYSIGGV2 'ucat' during updates

RLS VSAM Access



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 SYSIGGV2 '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

RLS for Catalogs

- **To ENABLE for a single catalog:**
  - Ensure Catalog has Storage Class with Cache Set
  - IDCAMS ALTER ucat LOG(NONE)
  - **F CATALOG,RLSENABLE(ucat)**
  - **IEC352I MODIFY CATALOG cat.name TO STATE RLSENABLE SUCCESSFUL**
  - F CATALOG,RLSQUIESCE(ucat)

- **Notes:**
  - Requires that SMSVSAM be up and active
  - Only available on z/OS 2.1 and up
  - < 1.13 need toleration maintenance

To Check for RLS Mode

```
F CATALOG,ALLOCATED
IEC348I ALLOCATED CATALOGS 118
*CAS*******************************************************************
* FLAGS -VOLSER-USER-CATALOG NAME                                    % *
* YSU-R- XP0301 0001 BOHLING.RLS.UCAT                                1 *
* Y-I--- USRPAK 0001 SYS1.MVSRES9.MASTCAT                            1 *
*******************************************************************
* Y/N-ALLOCATED TO CAS, S-SMS, V-VLF, I-ISC, C-CLOSED, D-DELETED,     *
* R-SHARED, A-ATL, E-ECS SHARED, K-LOCKED, U-RLS, W-SUSPENDED         *
*CAS*******************************************************************

D GRS,RES=('SYSIGGV2',*)
ISG343I 16.27.56 GRS STATUS 077
S=SYSTEMS SYSIGGV2 BOHLING.RLS.UCAT
SYSNAME        JOBNAME          ASID     TCBADDR    EXC/SHR     STATUS
SYSTEM1    SMSVSAM             0037       008FA680    SHARE       OWN
```


SHARE in Orlando 2015

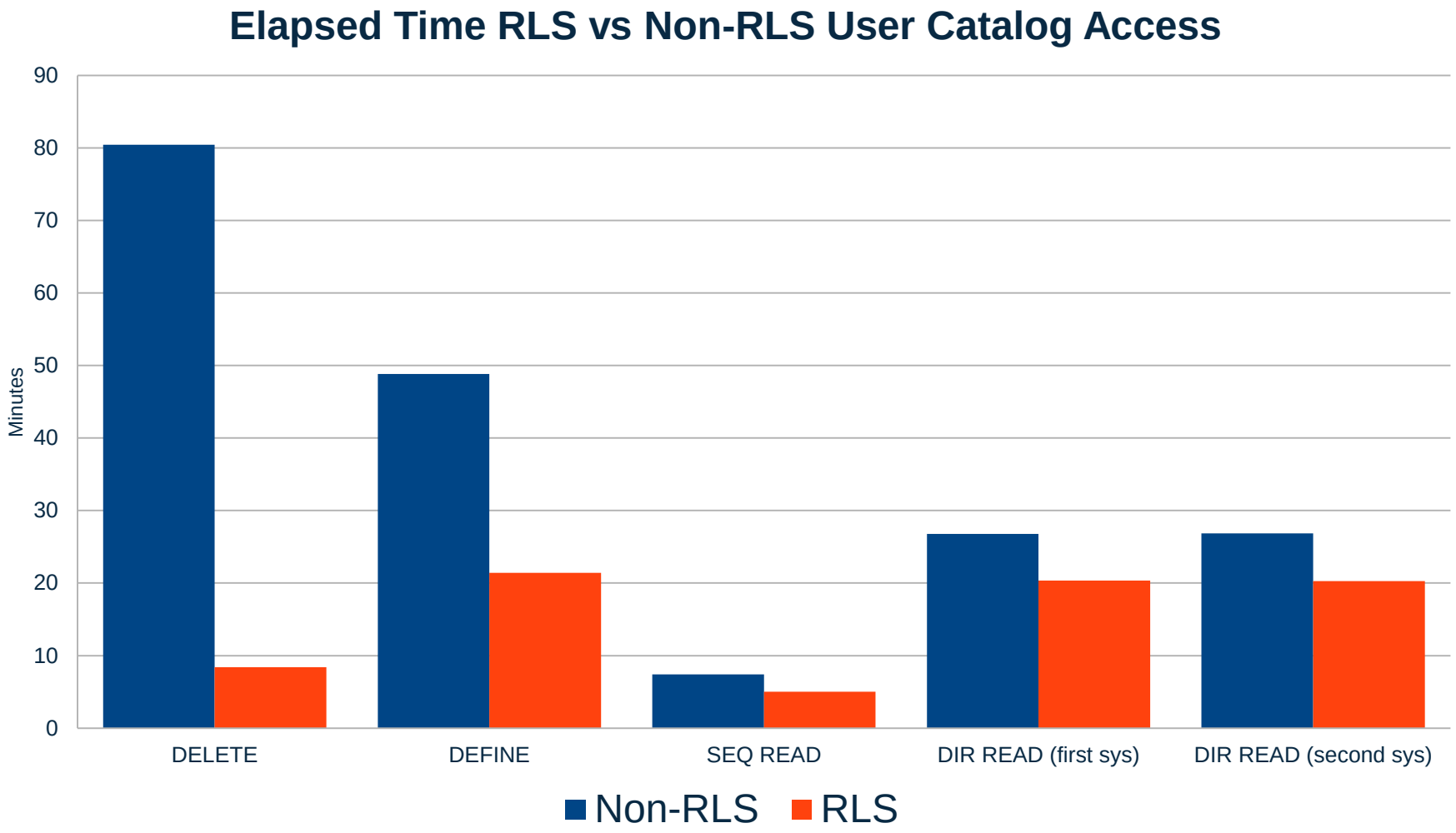
RLS Catalog Performance Benchmark Test

	Elapsed Time (min)		CPU* (sec)		Deltas	
Test	**Non-RLS**	**RLS**	**Non-RLS**	**RLS**	**Elapsed**	**CPU***
DELETE	80.42	8.42	1269.3	298.7	**89.5%**	**77.0%**
DEFINE	48.84	21.42	685.6	130.8	**56.1%**	**80.9%**
SEQ READ	7.40	5.03	65.1	75.2	**32.0%**	**-15.5%**
DIR READ (first sys)	26.77	20.33	94.0	109.6	**24.1%**	**-16.6%**
DIR READ (second sys)	26.86	20.29	95	109.9	**24.5%**	**-15.7%**

***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) RLSCFCACHE(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

Performance Benchmark Test



IDCAMS Tools can use RLS

- **REPRO, PRINT, IMPORT, EXPORT** supported
- To use, specify
  - **RLSSOURCE**(YES | NO | QUIESCE)
  - **RLSTARGET**(YES | NO | QUIESCE)

- Options:
  - YES – use RLS mode to access data set
  - NO – use Non-RLS (regular VSAM) to access data set
  - QUIESCE – Use Non-RLS mode, but QUIESCE first.

RLS for Catalogs Summary

- **Eliminates (most) SYSIGGV2 contention**
- **Allows SYSPLEX-wide serialization at the record level**
- z/OS 2.1 + only
- User catalogs only (no master catalog)

- **AMS (IDCAMS) tools support RLS**
  - REPRO, PRINT, IMPORT, EXPORT

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 • Holds interest information • One per CI • Relatively Small
Data Element	• Holds the stored data • Up to 2k in size • Many per CI (depending on CISIZE) • Ex: 6k CI would require 3 DE

Caching Modes

Mode: ALL or UPDATESONLY

Dir Entries	Data Elements		
Data CI Registered	Data CI Part 1	Data CI Part 2	Data CI Part 3
Index CI Registered	Index CI		

Caching Modes

Mode: NONE

Dir Entries	Data Elements
Data CI Registered	
Index CI Registered	Index CI

Caching Modes

Mode: DIRONLY

Dir Entries	Data Elements
Data CI Registered	
Index CI Registered	

Directory Only Caching

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

- **To Enable:**
  - Data Class definition (page 6)

```
RLS CF Cache Value  . . . . D     (A, N, U or D)
```

- Requires Rls_MaxCFFeatureLevel(A)
- Toleration: OA36443, OA36415

Dynamic Volume Count for RLS

Dynamic Volume Count for RLS

- Dynamic Volume Count added to RLS
- Eliminates the need to CLOSE / ALTER ADDVOL

- If EOV finds no more candidates, and DVC > VolCNT, RLS will add candidates to catalog

- Dynamic Volume Count is set in Data Class

```
Space Constraint Relief . . . Y      (Y or N)
  Reduce Space Up To (%)  . .  __    (0 to 99 or blank)
  Dynamic Volume Count  . . . 10     (1 to 59 or blank)
```

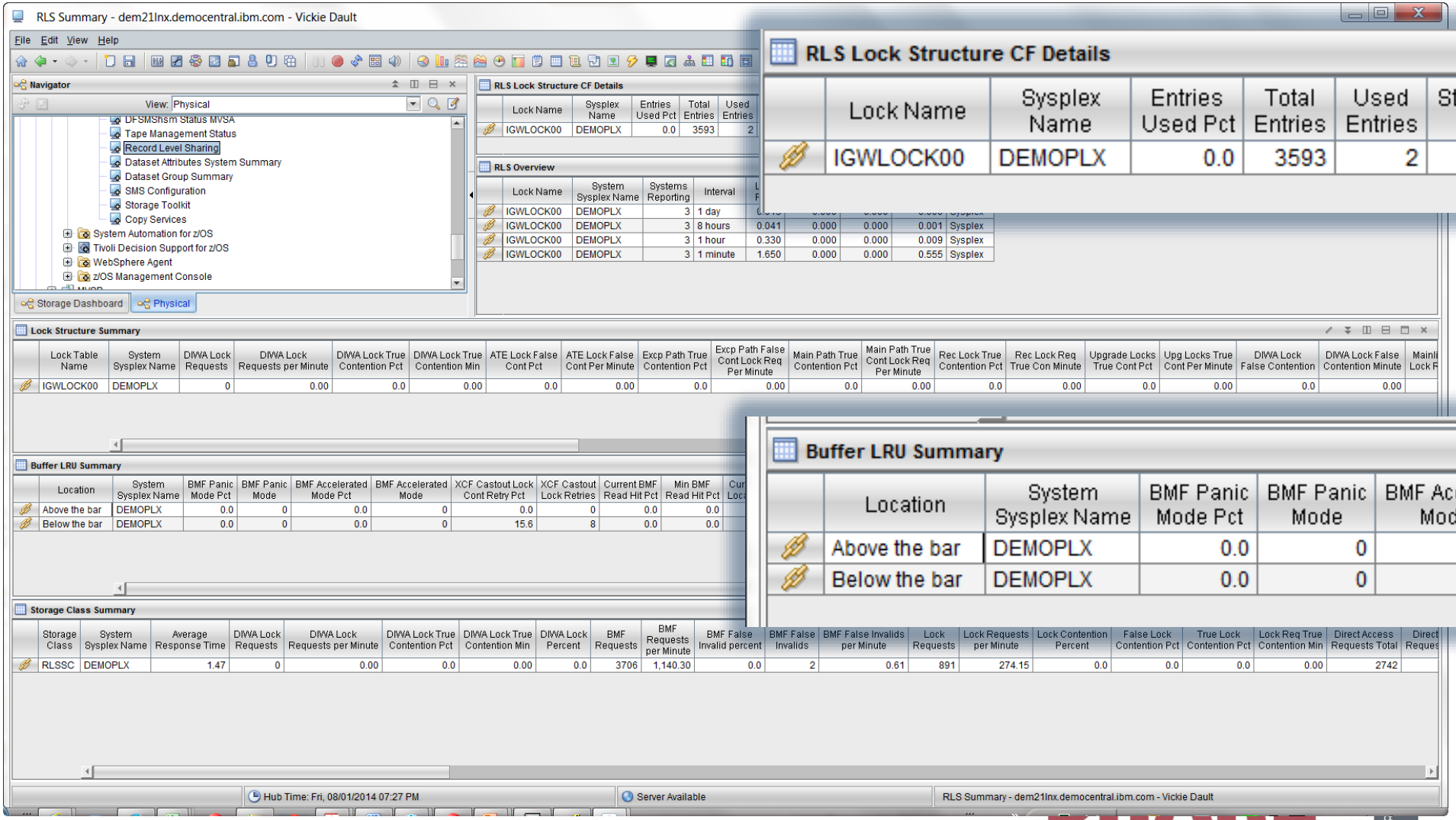
RLS OMEGAMON XE Support

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 / RMF III

- Requirements:
  - Omegamon XE V520 or higher
  - Maintenance: OA41786, OA42288, OA42798, OA43380, OA43381, OA43376, OA45578, OA44589
- For full info, see Share Pittsburg session #15548

Example Display



RMODE31 and ACCBIAS in Data Class

ACCBIAS

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

```
                                DATA CLASS ALTER                Page 2 of 6
Command ===>

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

To ALTER Data Class, Specify:

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

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 data set is eligible for replication
- VSAM RAS Enhancements
- RLS 64-bit buffering enhancement
  - Moved buffer management 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 17835

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