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

Neal Bohling

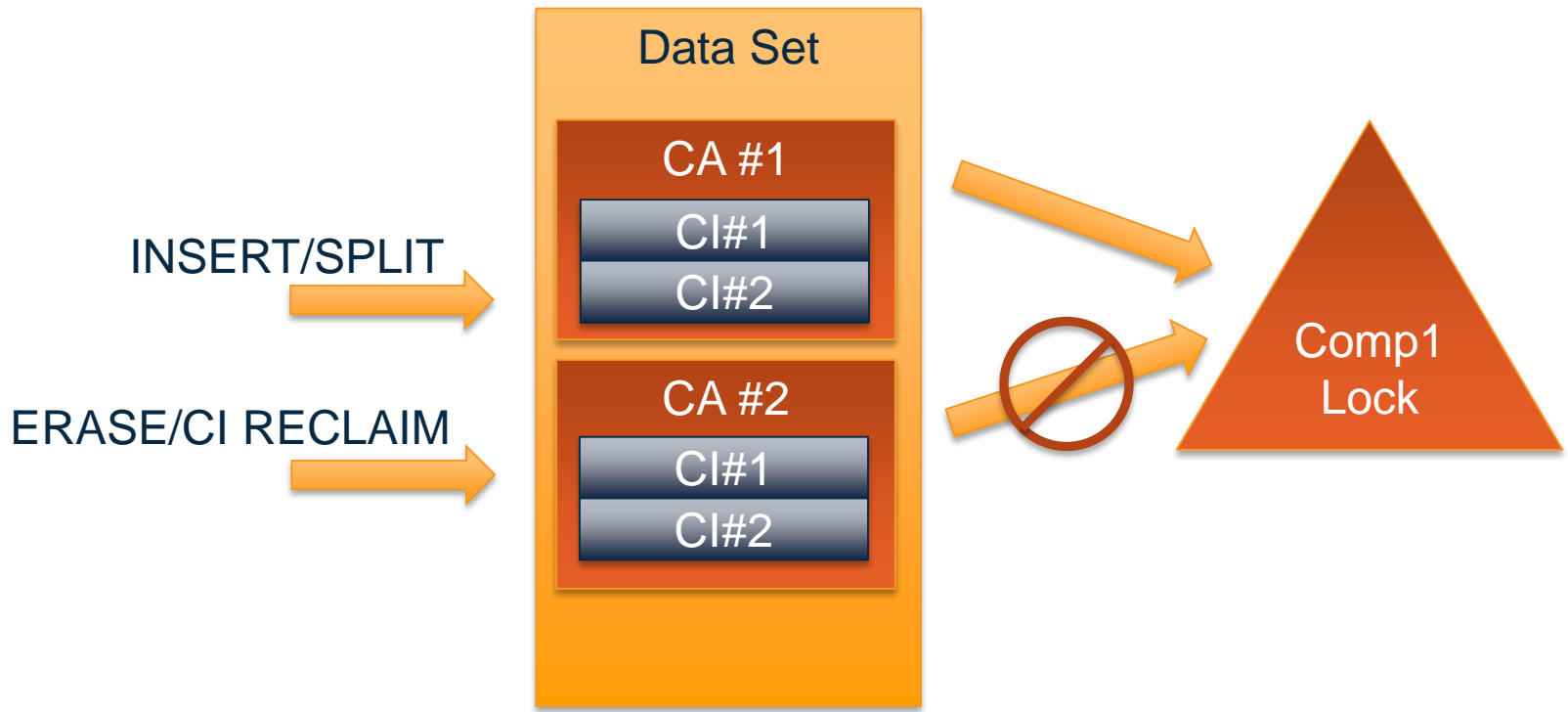*IBM, VSAM RLS Development*

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)
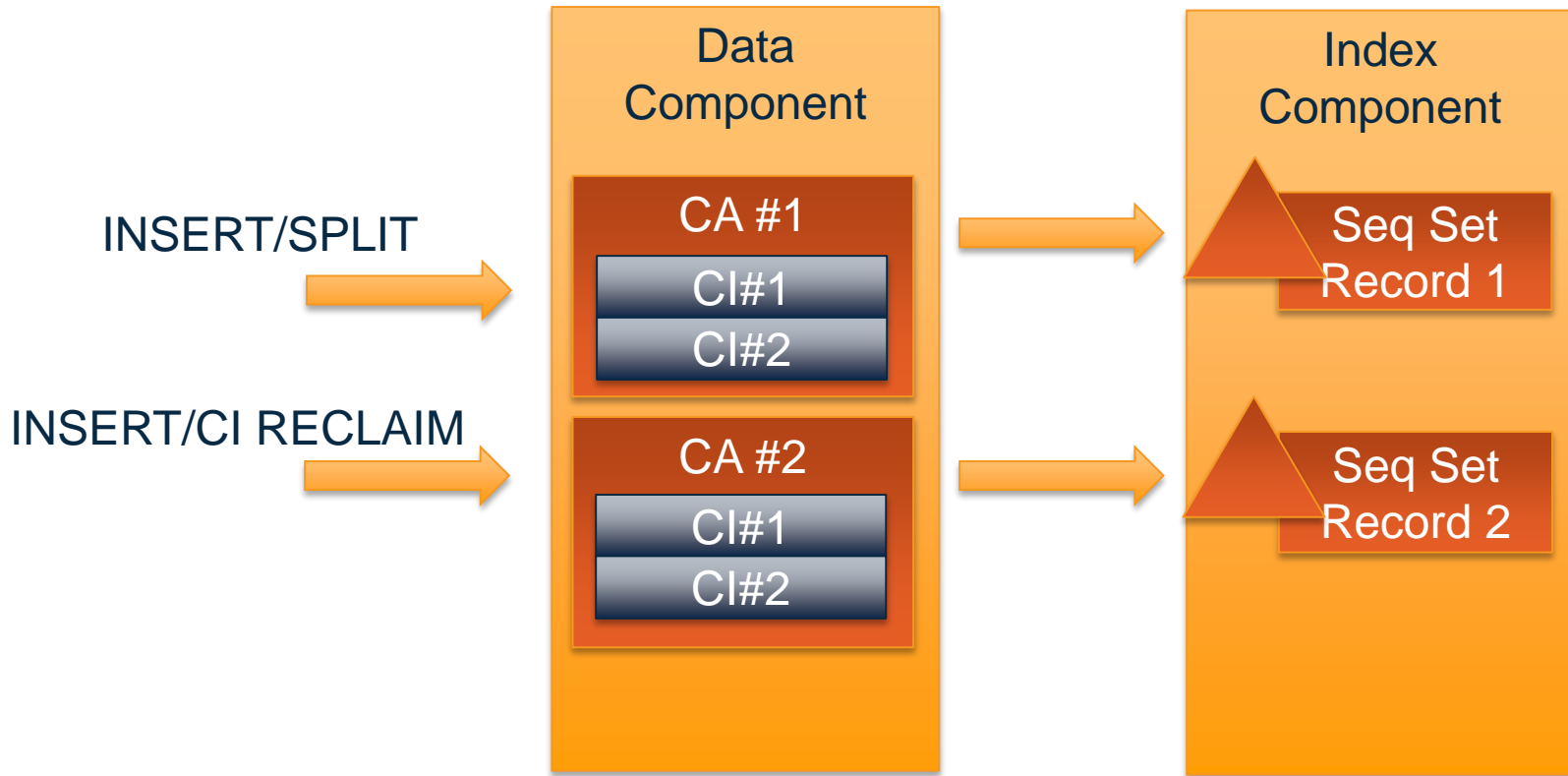 - Verify Enhancements (VSAM)
  - Other RAS Enhancements (all)

Index Record Locking

Current Split Logic

Only one split per data set can occur simultaneously

With Index Record Locking

INSERT/SPLIT

INSERT/CI RECLAIM

Data Component

CA #1
CI#1
CI#2

CA #2
CI#1
CI#2

Index Component

Seq Set Record 1

Seq Set Record 2

Locks the sequence set Index Record corresponding to the CA

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
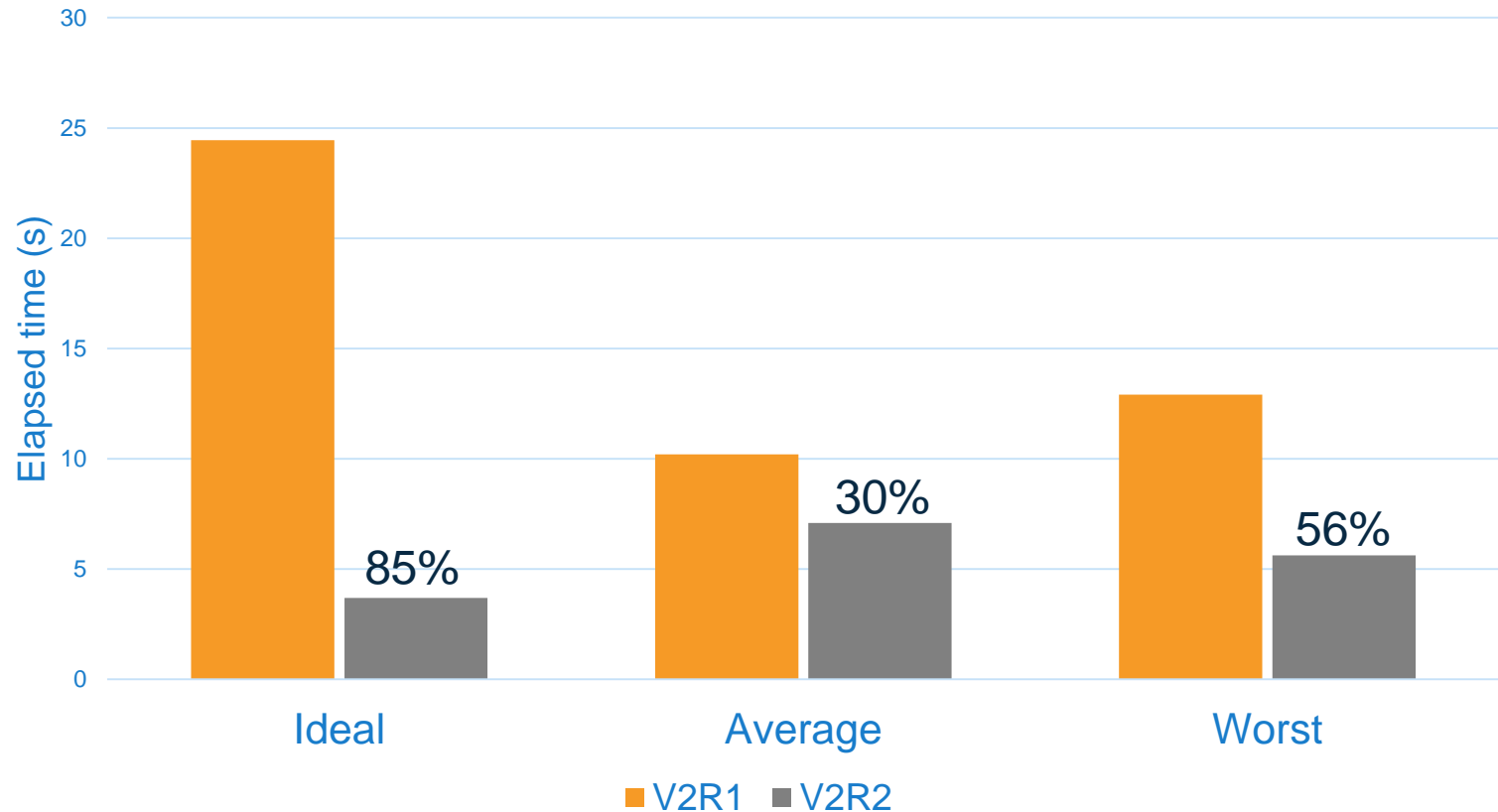 - Inserting randomly through the data set

Performance Improvement

Batch RLS Non-BWO Workload Runtime
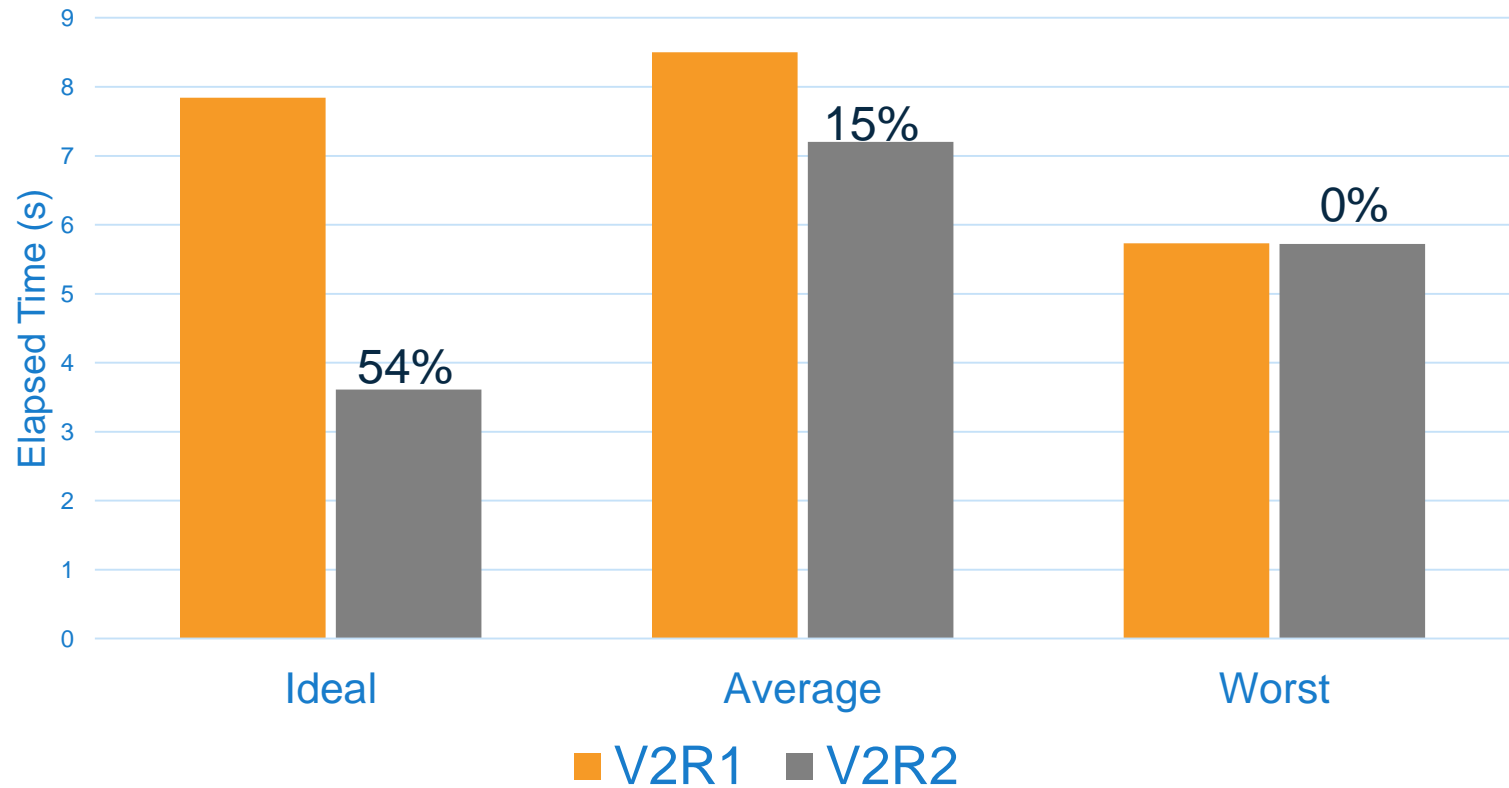
Performance Improvement

Batch RLS BWO Workload Runtime

Performance Improvement

SMSVSAM CPU (Best Case)

Legend: ■ SMSVSAM SRB ■ SMSVSAM TCB

X-axis: CPU (s), from 0 to 35

Categories (top to bottom):
- z/OS 2.1 Non-BWO
- z/OS 2.2 Non-BWO
- z/OS 2.1 BWO
- z/OS 2.2 BWO
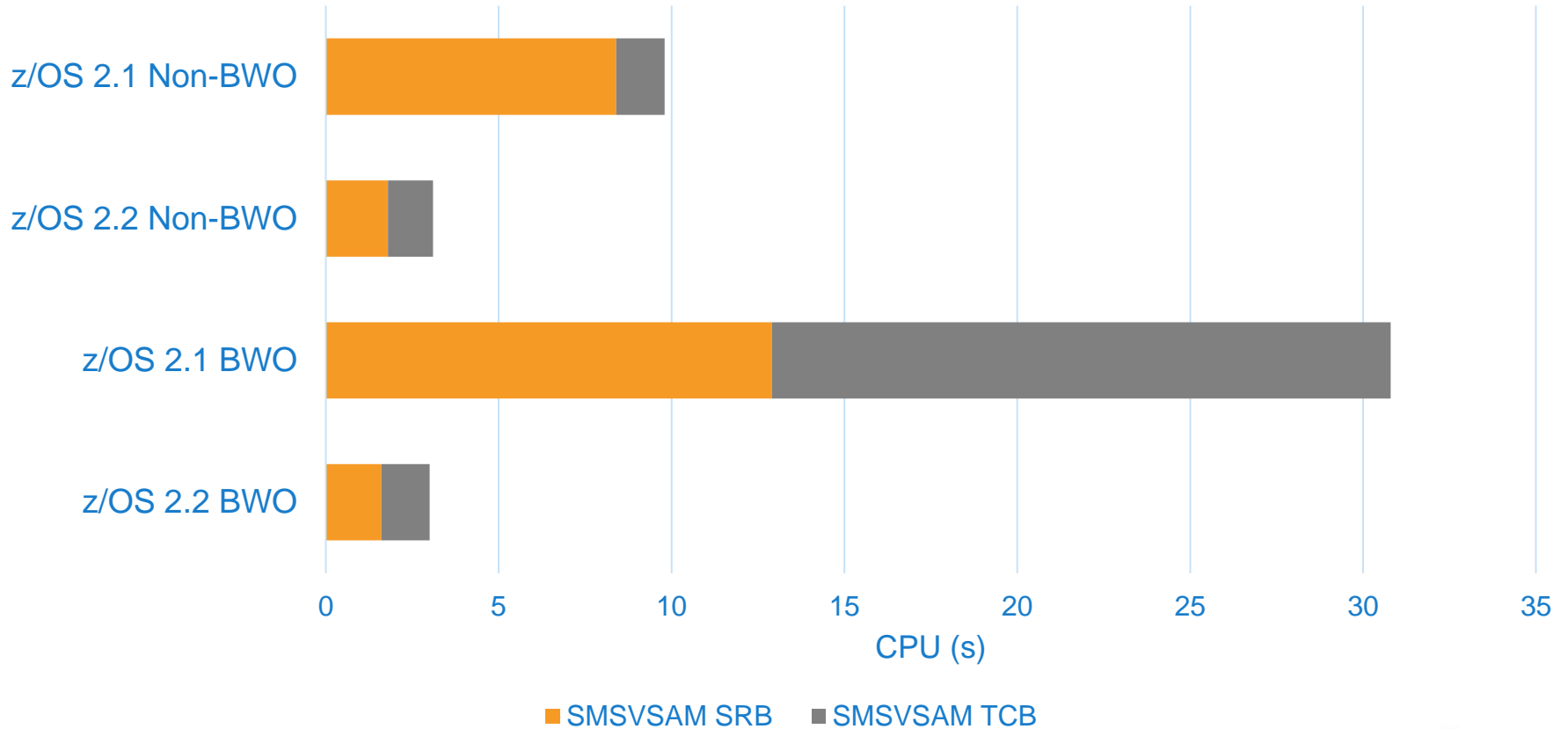
Locking Performance Improvement

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

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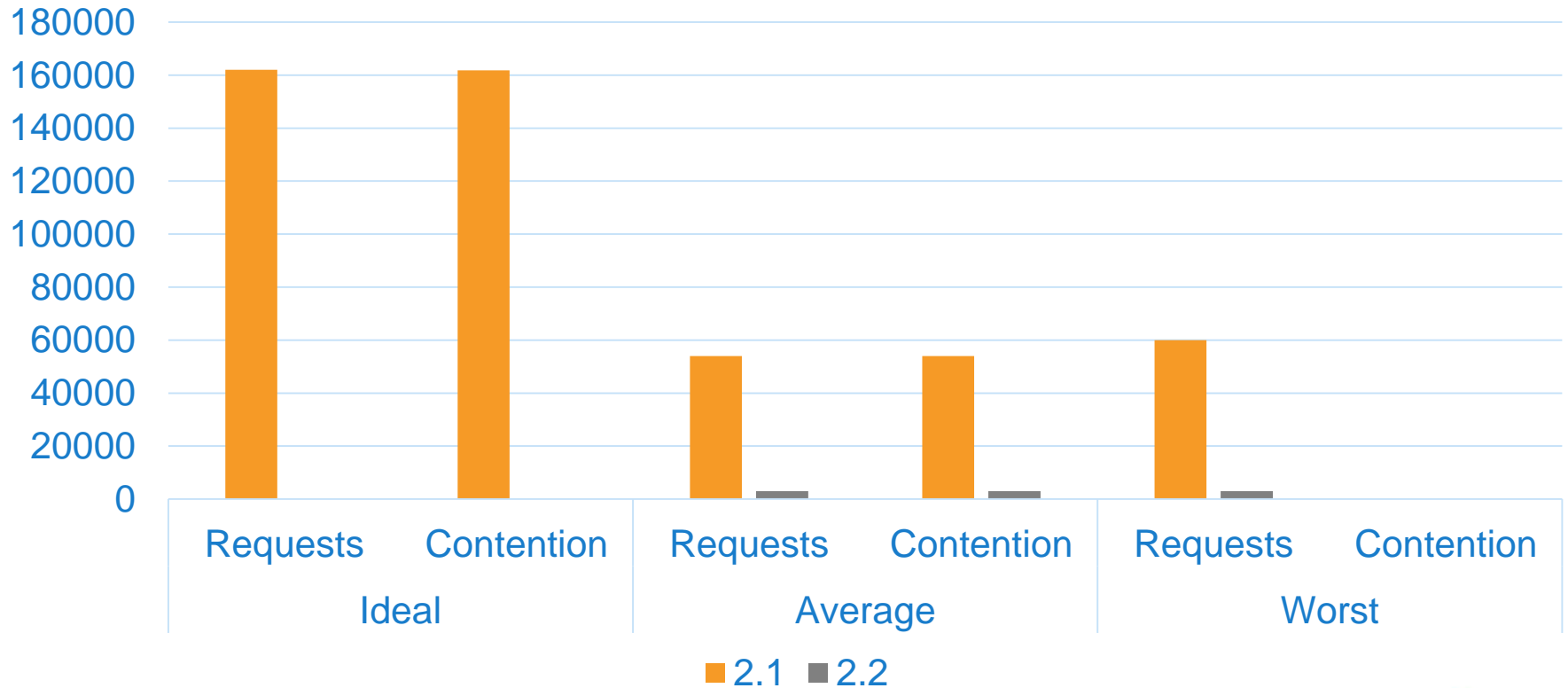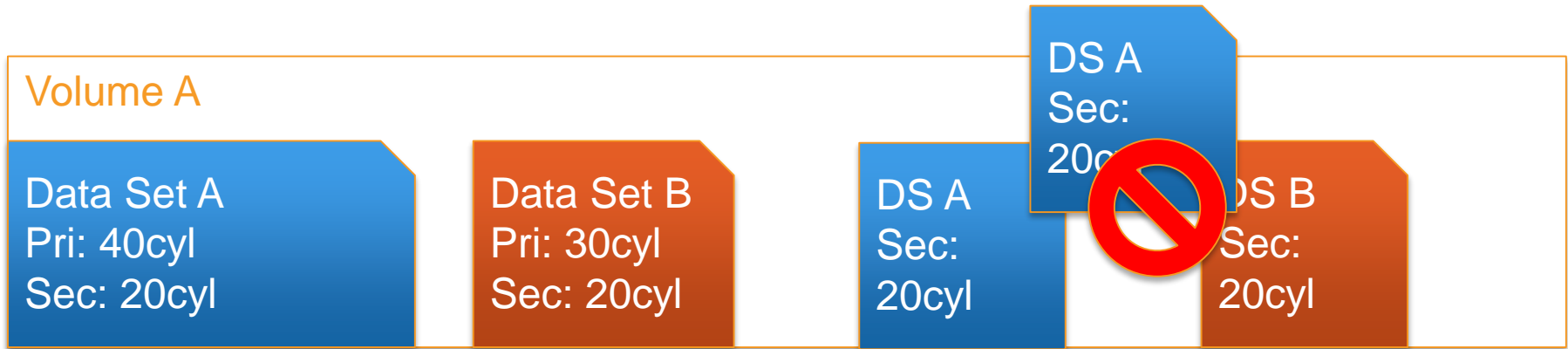
Index Record Locking Other Notes

- **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

Volume A

Data Set A
Pri: 40cyl
Sec: 20cyl

Data Set B
Pri: 30cyl
Sec: 20cyl

DS A
Sec:
20cyl

DS A
Sec:
20c

DS B
Sec:
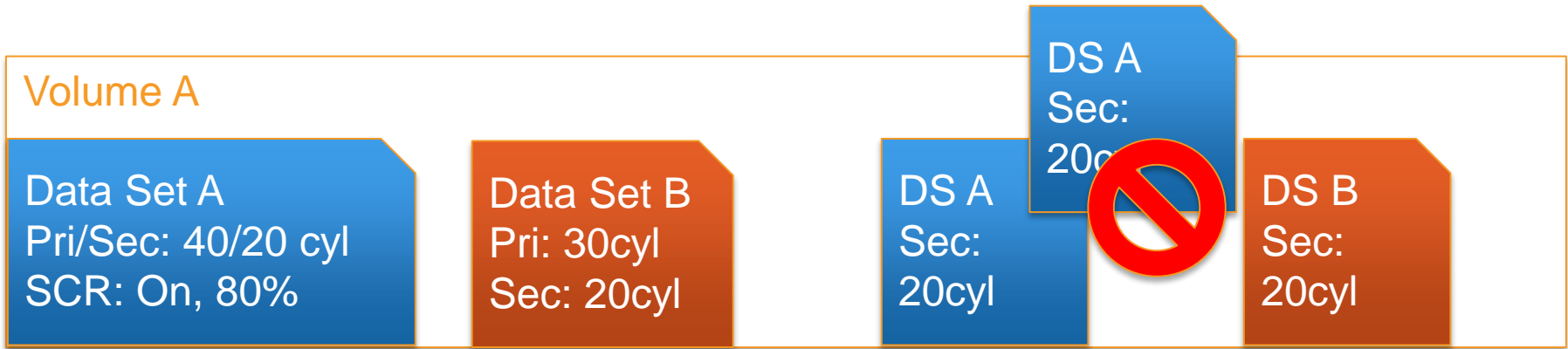20cyl

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 * (1-.80) = 20cyl
  - For secondary: 50cyl * (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 A
Sec:
20c | DS B
Sec:
20cyl |

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 A
Sec:
15cyl | DS B
Sec:
20cyl |

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.

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

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

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)

```
  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

Chained I/O

- Old Way – Segment Spanned Records into parts and loop

Record A

CA1	CA2	CA3

Write #1

Record A (2)

Record A (1)	CA2	CA3

Write #2

Record A (1)	Record A (2)	CA3
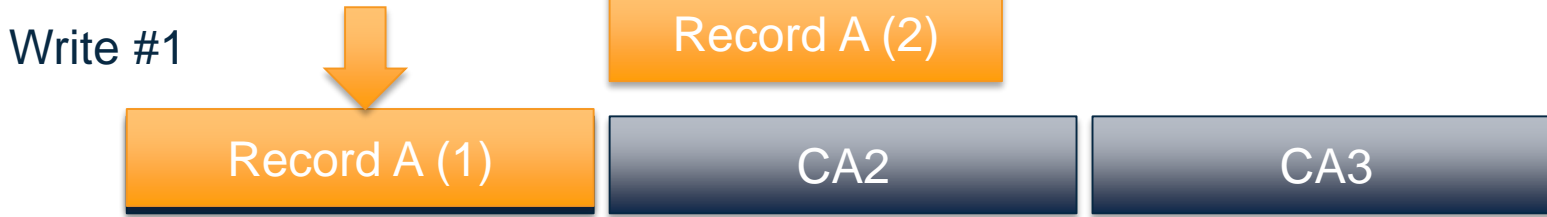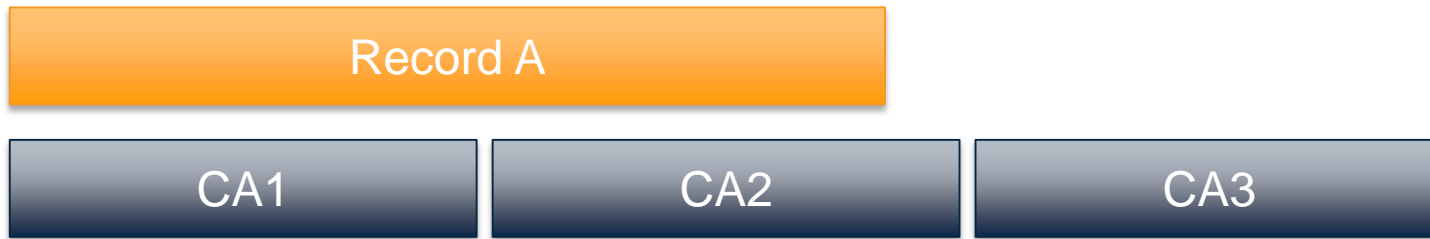
Chained I/O

- New Way – Combine segments into one I/O

Record A		
CA1	CA2	CA3

Split and Bundle

Record A (1)	Record A (2)	
CA1	CA2	CA3

Write (pass to I/O)

| Record A (1)	Record A (2)	CA3
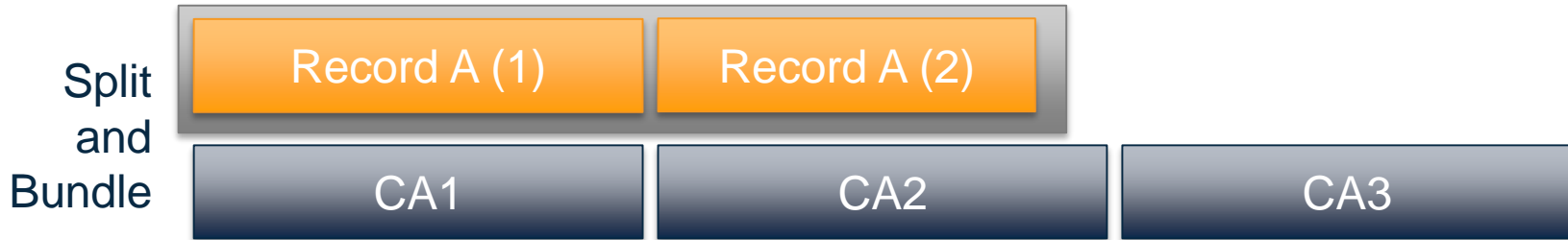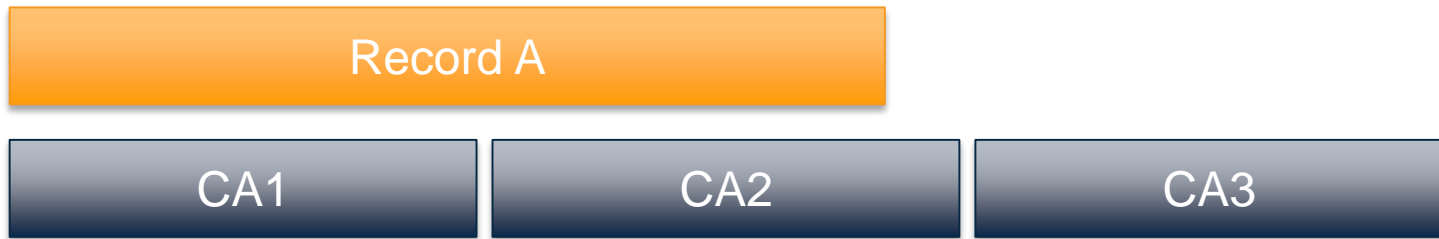
Chained I/O

- 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)]
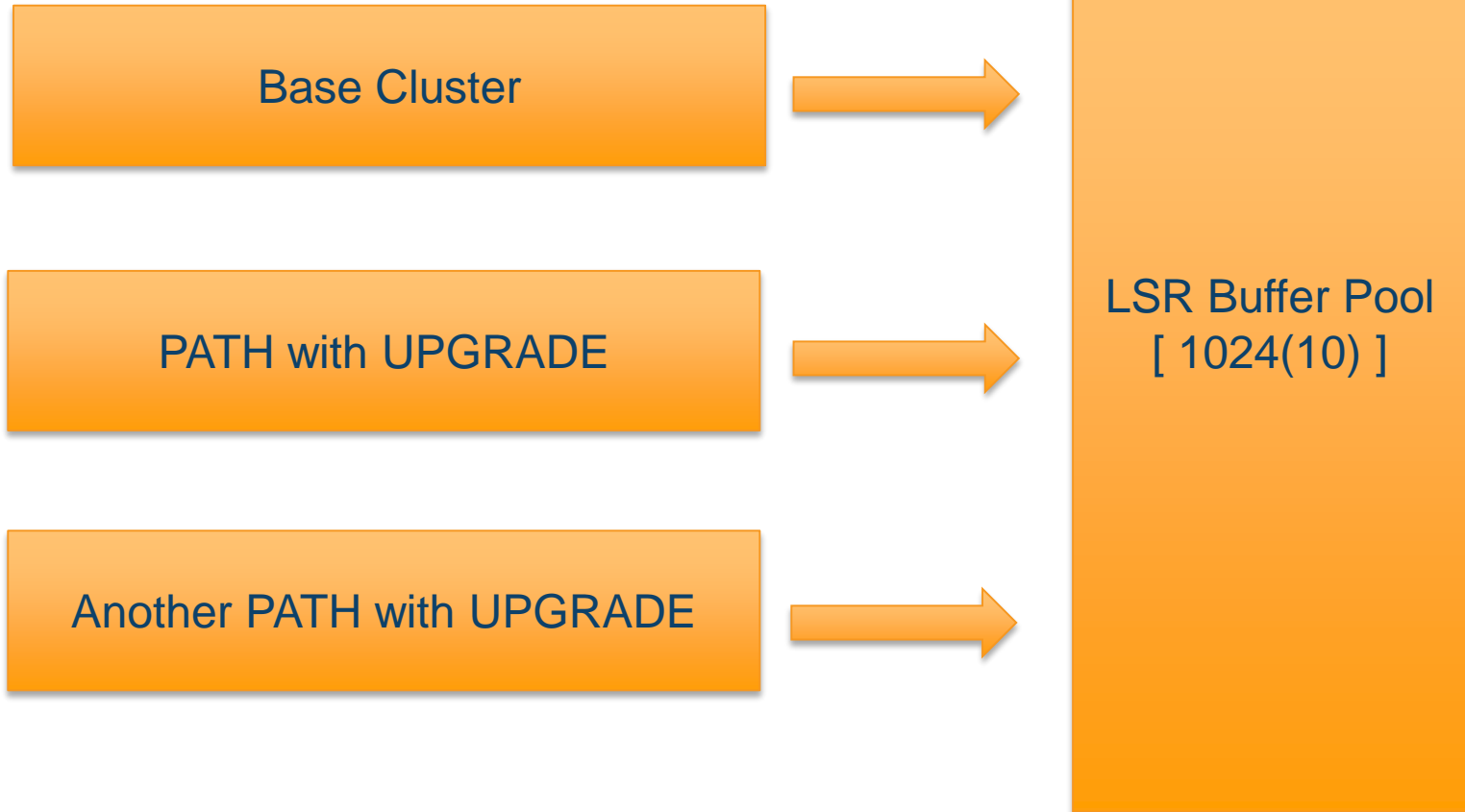
LSR Dynamic Buffer Addition

- **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

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

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.`

- 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**

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

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

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

Close Speed Improvement

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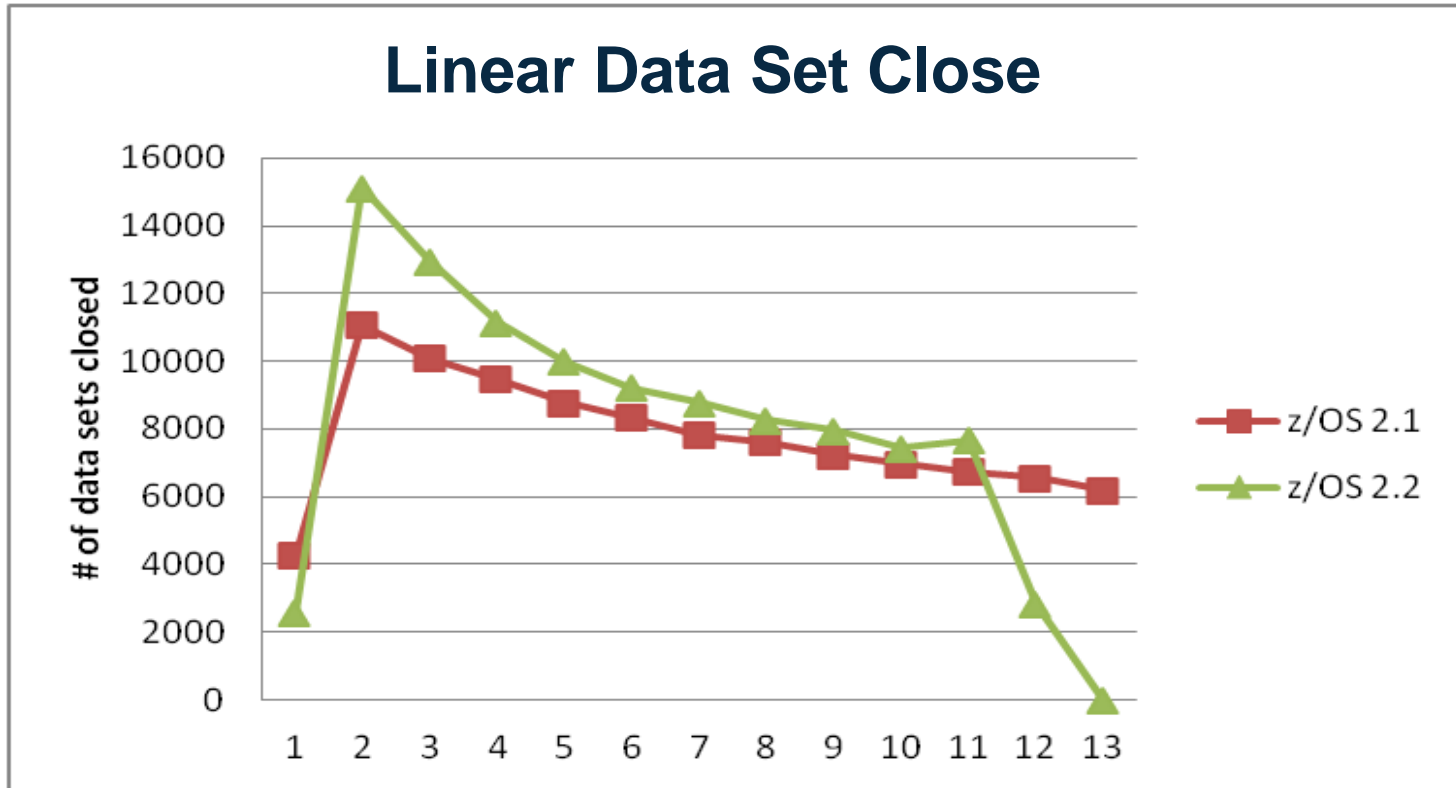
- 13% improvement for 100k data sets (11:20 vs 13m)
- Note – the more data sets, the better the close performance

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

Regular Catalog Access

Catalog on SYS1

Catalog on SYS2

Catalog on SYS3

SYSIGGV2 Conflict

Catalog
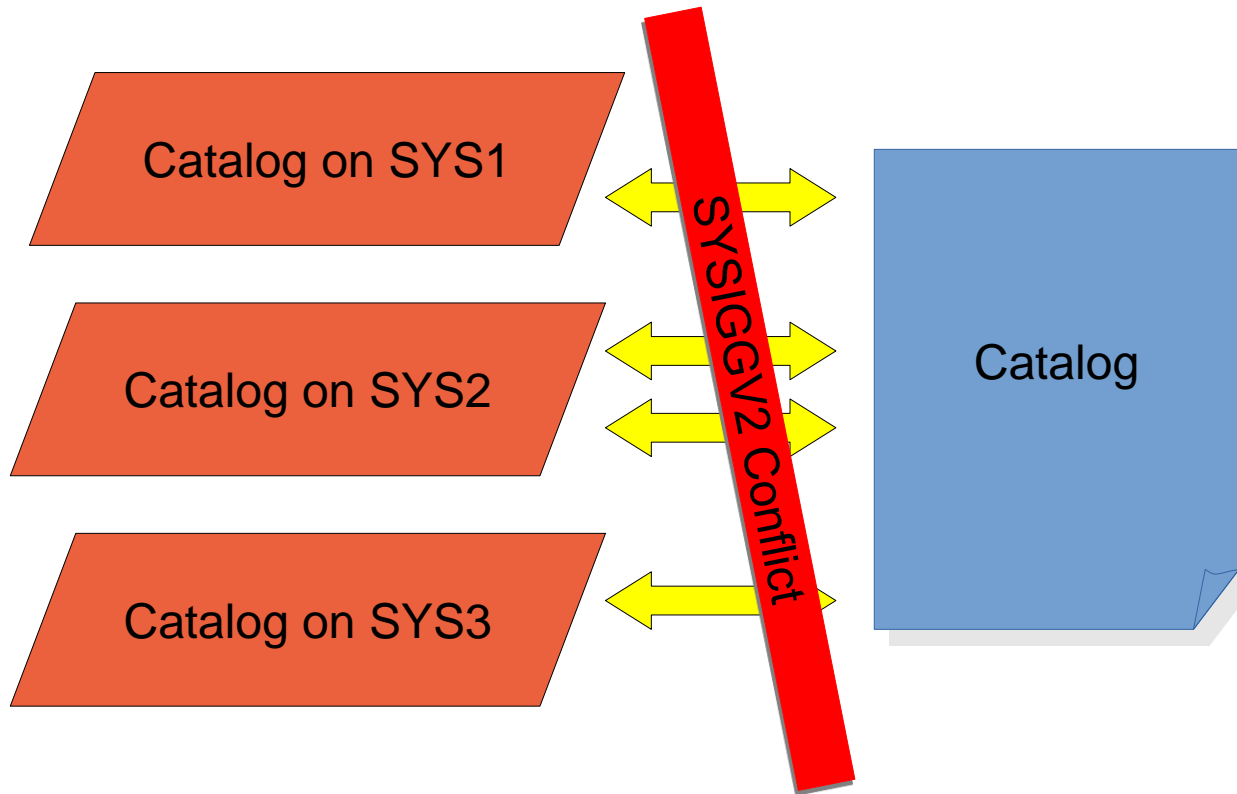
Potential contention on
SYSIGGV2 'ucat' during updates

RLS VSAM Access
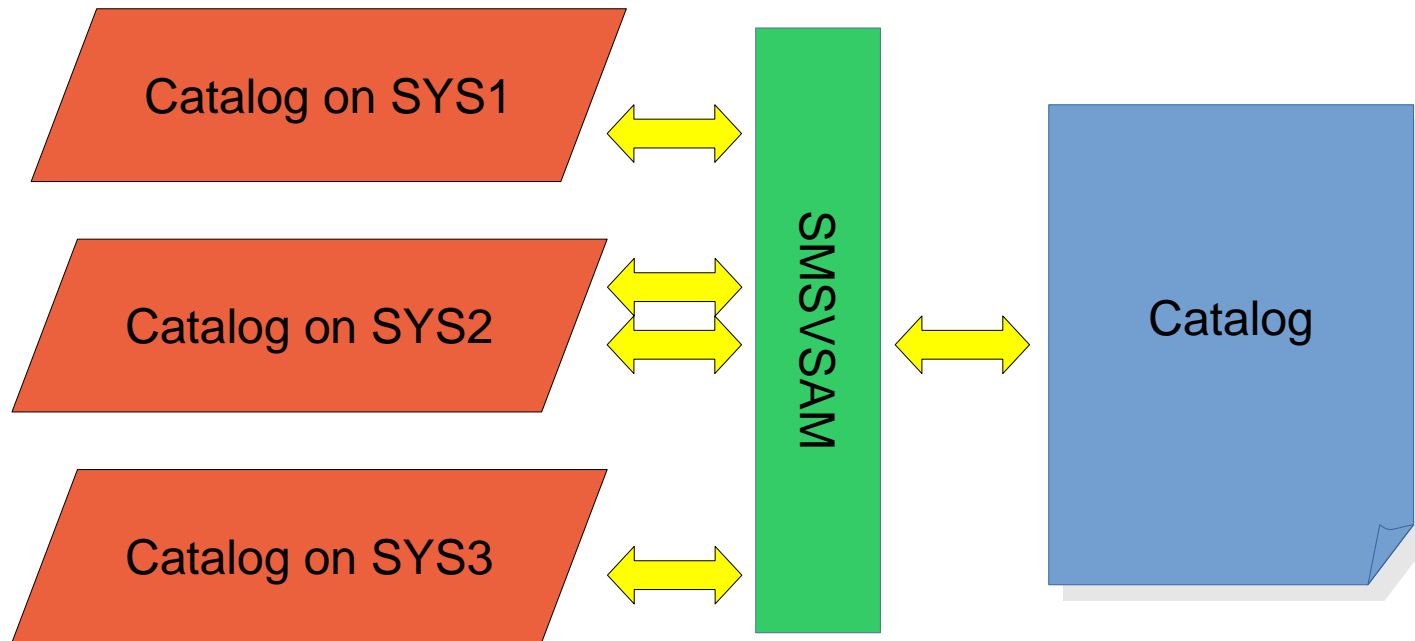
SMSVSAM is responsible for serialization.
Serialization is at the RECORD level instead of DS
No more SYSIGGV2 'ucat' ENQ contention

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:**
  - 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 (RLSSOURCE)

Performance Benchmark Test

Test	Elapsed Time (min)		CPU* (sec)		Deltas	
	Non-RLS	**RLS**	**Non-RLS**	**RLS**	**Elapsed**	**CPU***
DELETE	80.42	8.42	1269.3	298.7	89.51%	76.46%
DEFINE	48.84	21.42	685.6	130.8	56.13%	80.91%
SEQ READ	7.40	5.03	65.1	75.2	32.08%	-15.52%
DIR READ (first sys)	26.77	20.33	94.0	109.6	24.1%	-14.3%
DIR READ (second sys)	26.86	20.29	95	109.9	24.5%	-13.5%

*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

Elapsed Time RLS vs Non-RLS User Catalog Access
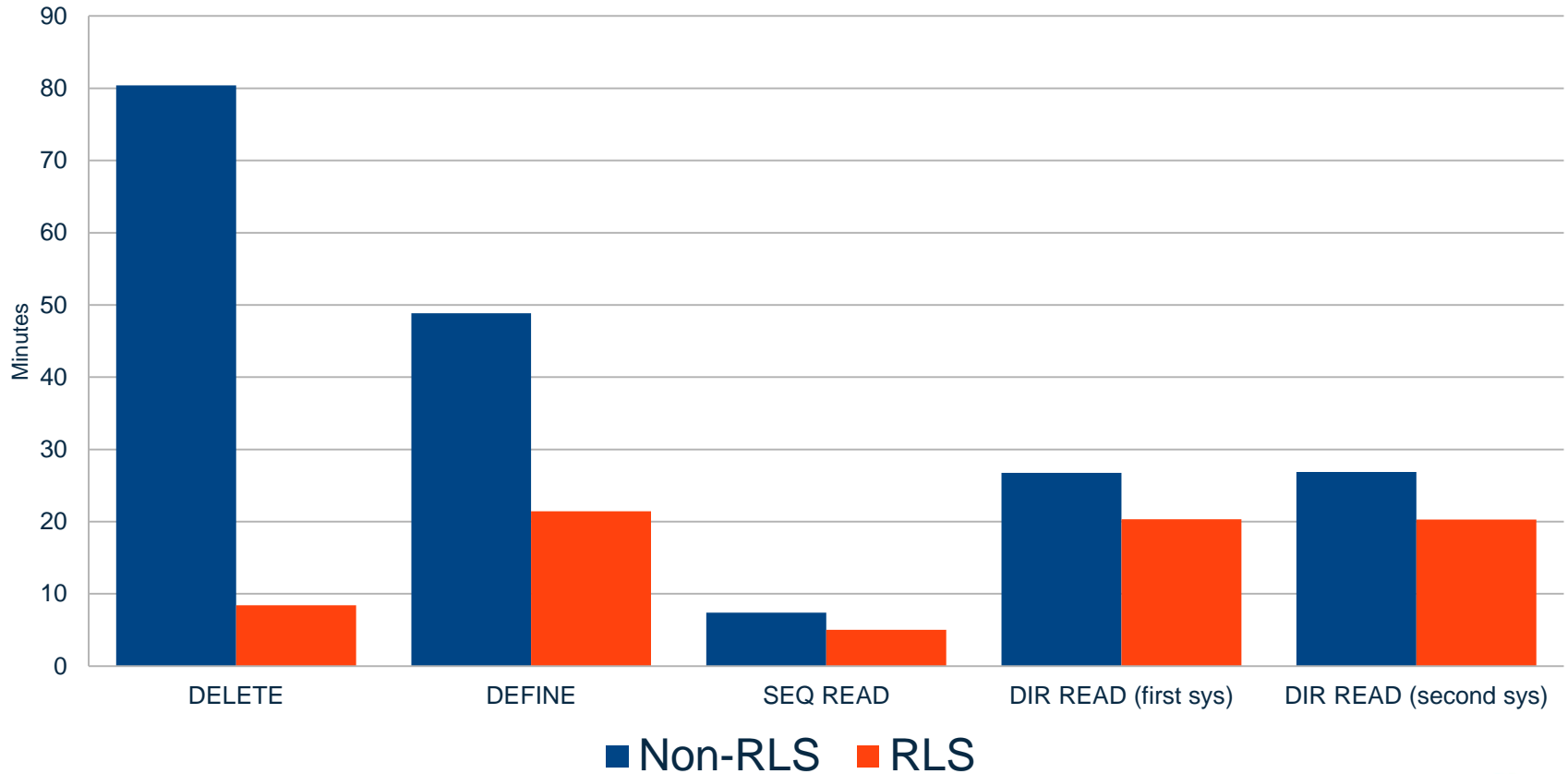
RLS for Catalogs Summary

- **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

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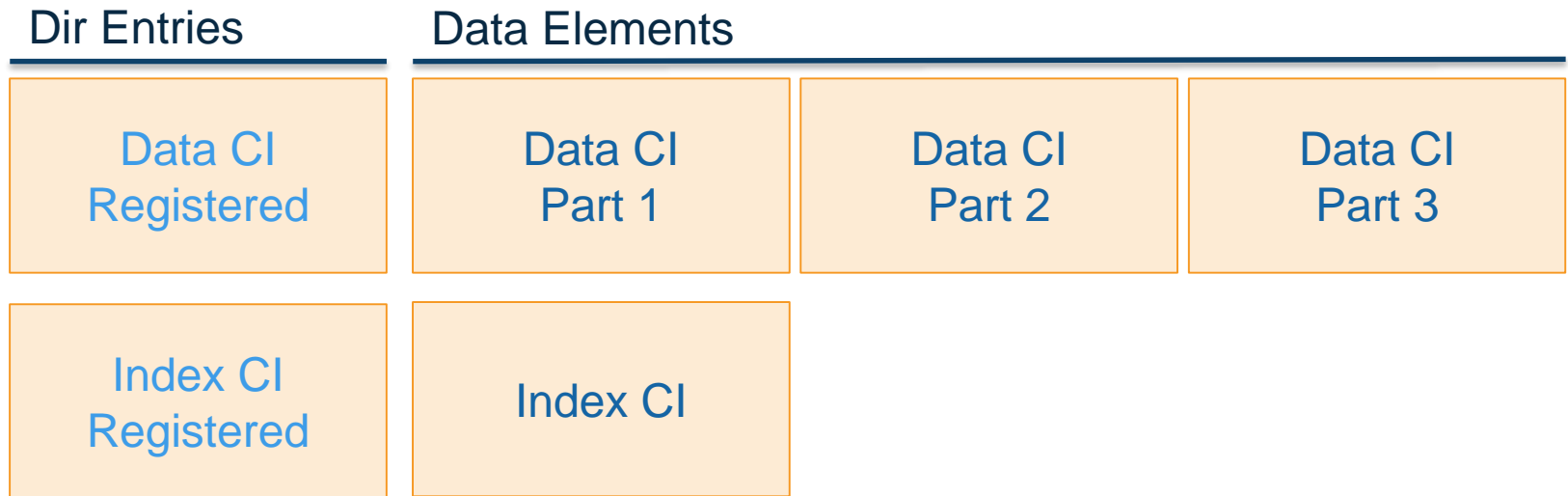
Caching Modes

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

- **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)
- Toleration: 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                    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 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

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