VSAM Record Level Sharing (RLS Overview) Part 1 and 2

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- IBM Products Exploiting RLS.
- Record Level Sharing - Design direction.
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- Review of RLS
  - Share Options
  - Buffering
  - locking
  - RAS
  - Performance Measurement

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Agenda
(continued)

Transactional VSAM (TVS)

- Hardware/Software Requirements
- Application Requirements

- Multiple Lock Structure (future enhancement)
- Recommended APARs
- Summary

RLS z/OS Release Enhancements

RLS z/OS Release Enhancements

- OS/390 2.1 - VSAM RLS general availability (1996)
- z/OS 1.4 - Transactional VSAM (priced feature)
- All z/OS Releases -   RAS support shipped via APARs
- z/OS 1.7 - VSAM RLS 64 Buffering
- z/OS 1.8 - RMF support for 64 bit buffering. RAS support. RSM changes.
- z/OS 1.9 – RAS support, sysplex wide dumping.
- z/OS x.x - Multiple Lock Structure support
- z/OS x.x - CA Reclaim

IBM Products Exploiting VSAM RLS

IBM Products Exploiting RLS/TVS:

- CICS
- HSM
- INFOMAN
- SCLM
- IMS (RLS and TVS)

Record Level Sharing (RLS) – Design Direction

Record Level Sharing (RLS) - Design

- VSAM RLS is another method of access, to your existing VSAM files, which provides full read and write integrity at the record level, to any number of users in your parallel sysplex.

Review of Base VSAM

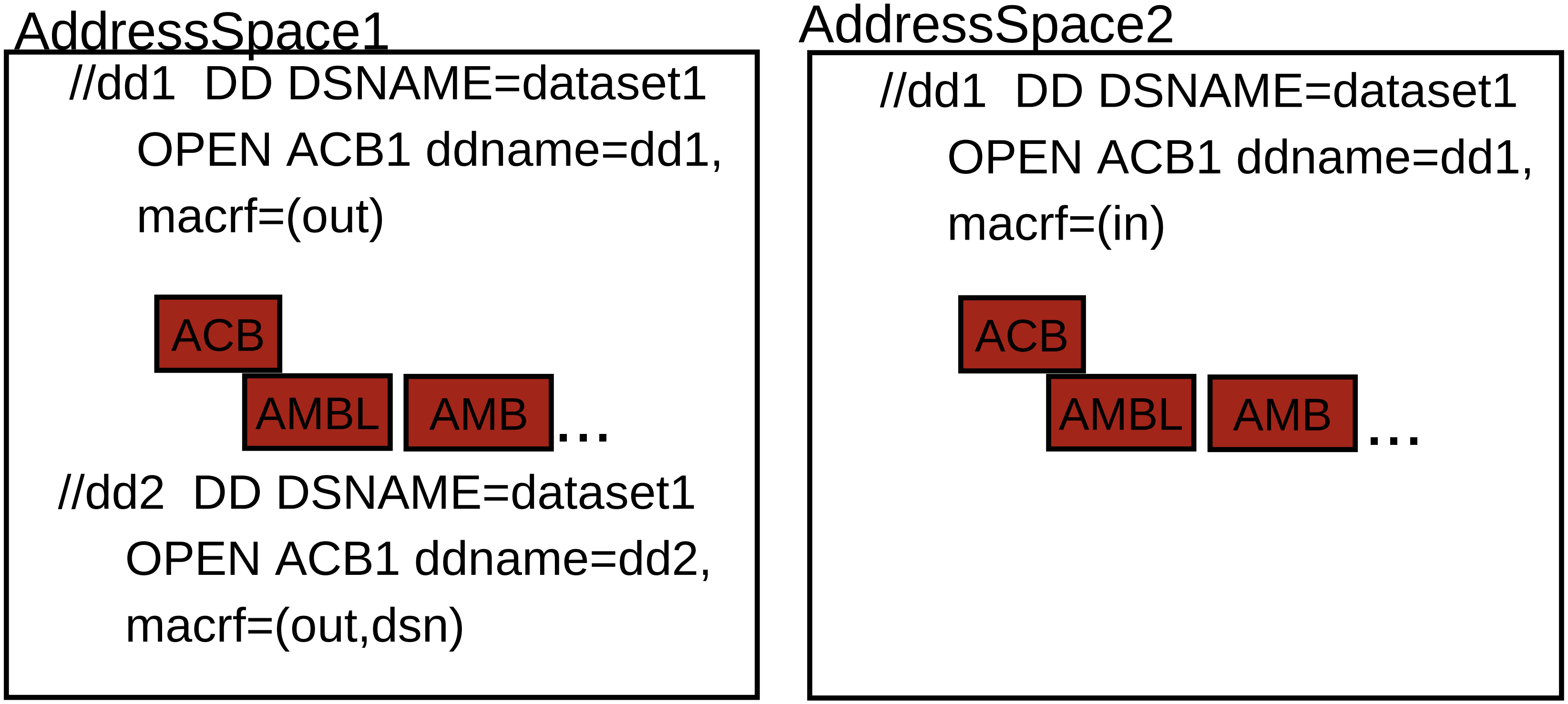
Review of Base VSAM

- Share options
- Buffering
- Locking
- RAS
- Performance Measurements

Review of Base VSAM

- Share options.
  - attribute of the data set.
  - SHAREOPTIONS(crossregion,crosssystem)
    - SHAREOPTIONS(1,x) - Defined as one user opened to the data set for read/write or any number of users for input only. VSAM provides full read/write integrity.
    - SHAREOPTIONS(2,x) - Defined as one user opened to the data set for read/write and any number of users for input VSAM provides full read/write integrity for the read/write user, however, the readers do not receive read integrity.
    - SHAREOPTIONS(3,x) - Defined as any number of users opened to the data set for read/write. VSAM does not provide any read/write integrity.
    - SHAREOPTIONS(4,x) – VSAM will flush buffers after each request.
  - ACB MACRF=(DDN/DSN) is the only real mechanism for sharing VSAM files.

Example of ShareOptions (2,x)



AddressSpace1

```
//dd1  DD DSNAME=dataset1
      OPEN ACB1 ddname=dd1,
      macrf=(out)
```

```
//dd2  DD DSNAME=dataset1
      OPEN ACB1 ddname=dd2,
      macrf=(out,dsn)
```

(read/write integrity)

AddressSpace2

```
//dd1  DD DSNAME=dataset1
      OPEN ACB1 ddname=dd1,
      macrf=(in)
```

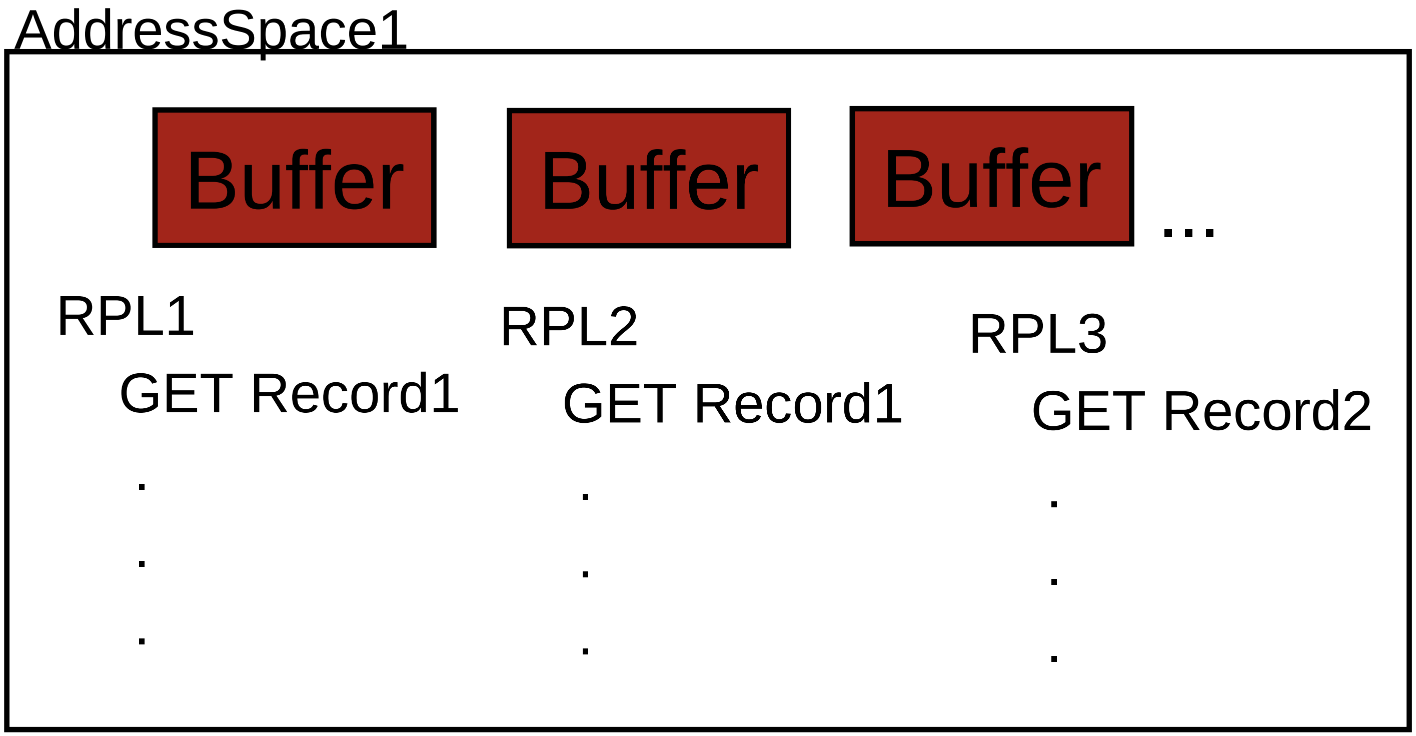
(no read integrity)

Base VSAM - Buffering

- Base VSAM provides 3 types of buffering: ACB macrf=(NSR/LSR/GSR).
  - NSR - Non-Shared Resources
  - LSR - Local Shared Resources
  - GSR - Global Shared Resources
- For LSR/GSR, user defined the buffer pool:

```
POOL1  BLDVRP  BUFFERS=(1024(5)),
               STRNO=4,
               TYPE=LSR,
               MODE=31,
               RMODE31=ALL
```

Example of LSR Buffering



AddressSpace1

Buffer

Buffer

Buffer

...

RPL1

GET Record1

.

.

.

RPL2

GET Record1

.

.

.

RPL3

GET Record2

.

.

.

(read/write integrity)

Base VSAM - Locking

- Base VSAM serializes on a CI level.
- Multiple users attempting to access the same CI for read and write either defer on the CI or are returned an exclusive control conflict error by VSAM.
- CIs with many records per CI, or applications that repeatedly access the same CI can have a performance impact due to retrying of exclusive control conflict errors.

Example of Base VSAM LSR Serialization

Scope = Single LSR Buffer Pool
Granularity = Control Interval
Ownership = RPL

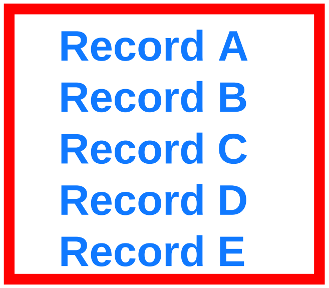
GET UPD RPL_1

(Record B)

GET UPD RPL_2

(Record E)

- fails - Exclusive Control Conflict



Record A
Record B
Record C
Record D
Record E

Control Interval

Base VSAM - RAS

- Base VSAM has little to no first time data capture, and internal recovery, for logic errors.
  - All resources are obtained in a single address space.
  - EOT acted as cleanup routine (plus estae stacked by open/close).
  - Performance highly valued over RAS.
  - RAS in general was not a major requirement when VSAM was developed.
- End result:
  - Difficult problems to debug.
  - Broken data sets and data integrity problems.

Base VSAM – Performance Measurements

- Base VSAM provides SMF 62 and 64 records.
  - SMF 62 – Created by OPEN for each ACB.
  - SMF 64 - Created by EOV and CLOSE for each ACB, however, the stats represent the sum of all ACBs connected to the control block structure.

Review of RLS

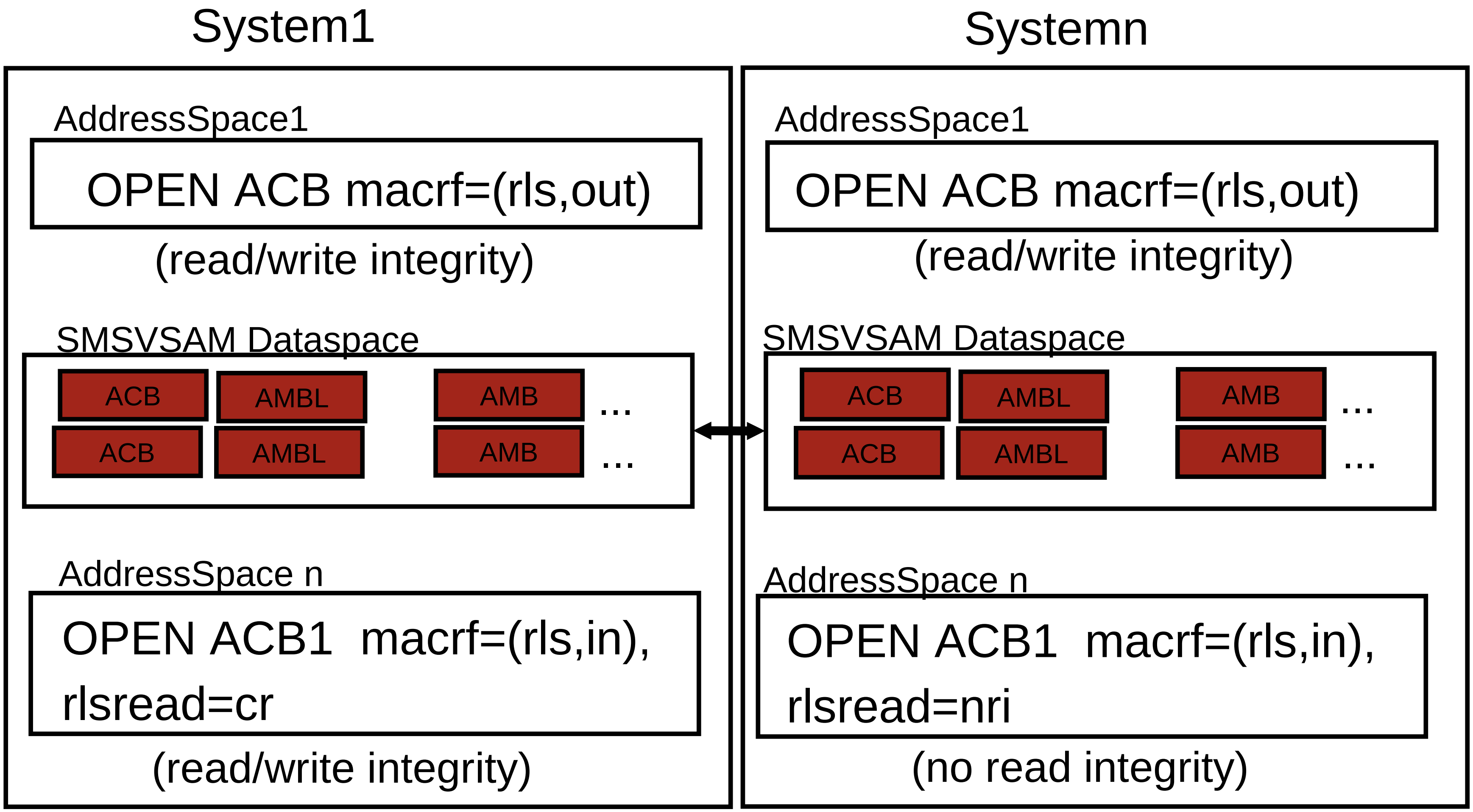
Review of RLS

- Share options
  - Example of RLS Readers/Writers
  - Example of Shareoption (2,x) with RLS and base VSAM
- Buffering
- Locking
- RAS
- Performance Measurements

Review of RLS

- Share options.
  - largely ignored by RLS.
  - Exception is SHAREOPTIONS(2,x) -
    - Now defined as one user opened to the data set for non-RLS read/write and any number of users for non-RLS read. VSAM provides full read/write integrity for the non-RLS read/write user, however, the readers do not receive read integrity.
    - Or, any number of users opened for RLS read/write and any number of users for non-RLS read. VSAM provides full read/write integrity for the RLS users and no read integrity for the non-RLS readers.

Example of RLS Readers/Writers



System1

AddressSpace1

OPEN ACB macrf=(rls,out)

(read/write integrity)

SMSVSAM Dataspace

AddressSpace n

OPEN ACB1 macrf=(rls,in),
rlsread=cr

(read/write integrity)

Systemn

AddressSpace1

OPEN ACB macrf=(rls,out)

(read/write integrity)

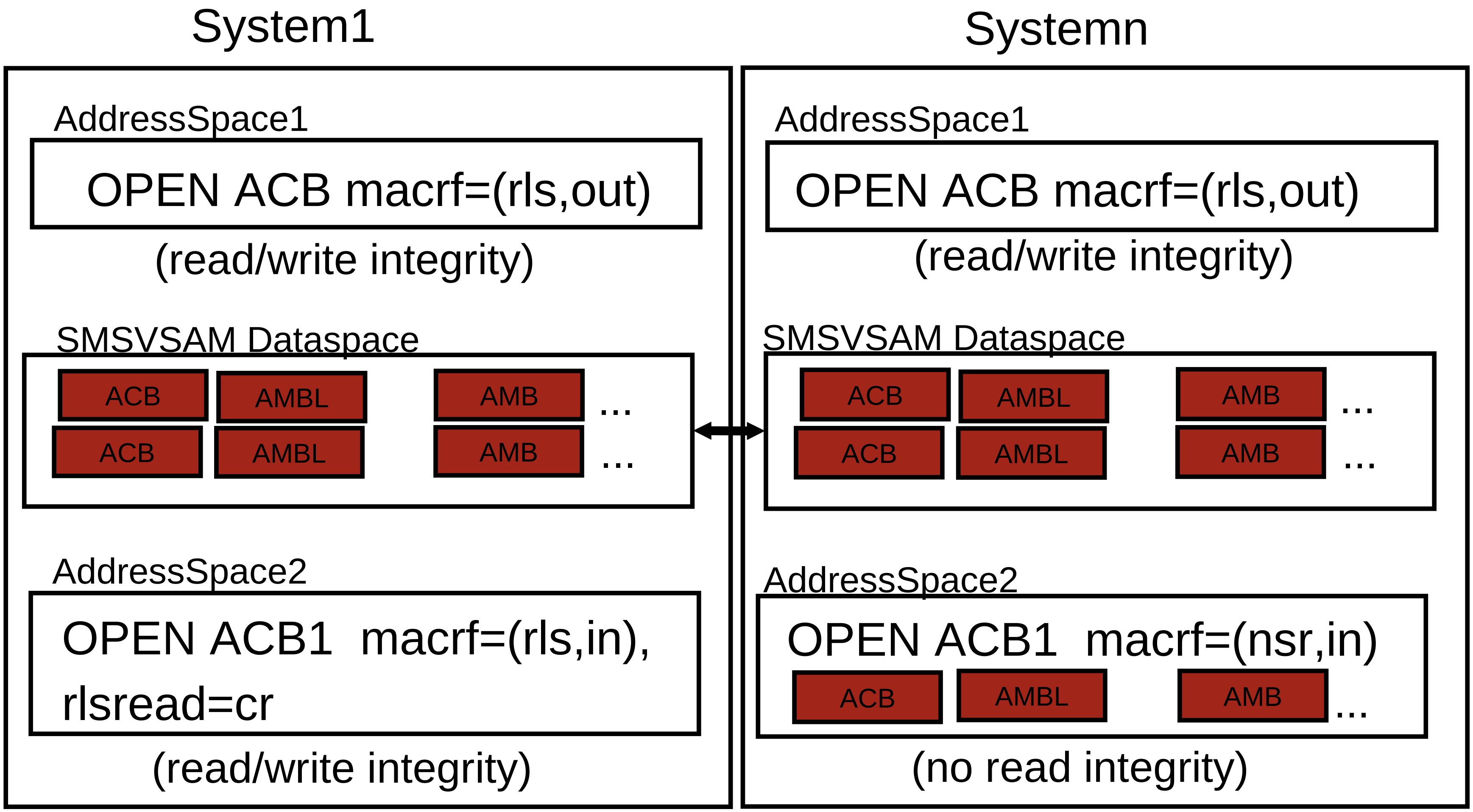
SMSVSAM Dataspace

AddressSpace n

OPEN ACB1 macrf=(rls,in),
rlsread=nri

(no read integrity)

Example of Shareoption (2,x) with RLS and base VSAM



System1

AddressSpace1

OPEN ACB macrf=(rls,out)

(read/write integrity)

SMSVSAM Dataspace

AddressSpace2

OPEN ACB1 macrf=(rls,in), rlsread=cr

(read/write integrity)

Systemn

AddressSpace1

OPEN ACB macrf=(rls,out)

(read/write integrity)

SMSVSAM Dataspace

AddressSpace2

OPEN ACB1 macrf=(nsr,in)

(no read integrity)

RLS - Buffering

- VSAM now provides 4 types of buffering: ACB macrf=(NSR/LSR/GSR/RLS).
  - NSR - Non-Shared Resources
  - LSR - Local Shared Resources
  - GSR - Global Shared Resources
  - RLS - Record Level Sharing
- Each image in the sysplex has one 31 bit local buffer pool, (located in a dataspace) with a current maximum size of 1.7 gig and one 64 bit pool located in the SMSVSAM address space. Both buffer pools are managed by LRU.
- Pool sizes controlled by PARMLIB parameters: RLS_Max_Pool_Size (31 bit pool) and RLSAboveTheBarMaxPoolSize (64 bit pool).
- Buffer coherency is maintained through the use of CF cache structures and the XCF cross-invalidation function.

LRU

- The LRU for the 31 bit pool operates in the following 4 modes:
  - **Normal Mode** - Total pool size is less than 80% of RLS_Max_Pool_Size.
  - **Maintenance Mode** - Total pool size is greater than 80% and less than 120% of RLS_Max_Pool_Size.
  - **Accelerated Mode** - Total pool size is greater than 120% and less than 2* RLS_Max_Pool_Size.
  - **Panic Mode** - Total pool size is greater than 2* RLS_Max_Pool_Size or greater than 1728M.

LRU

- The LRU will release 31 bit buffers as follows:
  - **Normal Mode** - IGWBLCRU will release invalid and paged out buffers.
    - Initial_Free_UIC = 240.
    - Buffer_UIC + 1.
    - Maximum age of buffers is 60 minutes.
  - **Maintenance Mode** - Reduce Initial_Free_UIC by 1. If Buffer_UIC > Intial_Free_UIC_Count then buffer is released (22.5 minutes max).
  - **Accelerated Mode** - Reduce Initial_Free_UIC by 4. If Buffer_UIC > Initial_Free_UIC then buffer is released. Requests for new buffers will first be stolen. If there are no buffers to steal a new get block will be done (7.5 minutes max).
  - **Panic Mode** - Reduce Initial_Free_UIC by 8. If Buffer_UIC > Initial_Free_UIC then buffer is released. Requests for new buffers will first be stolen (3.75 minutes max). If no buffers to steal, the request will be put to sleep until the LRU runs.

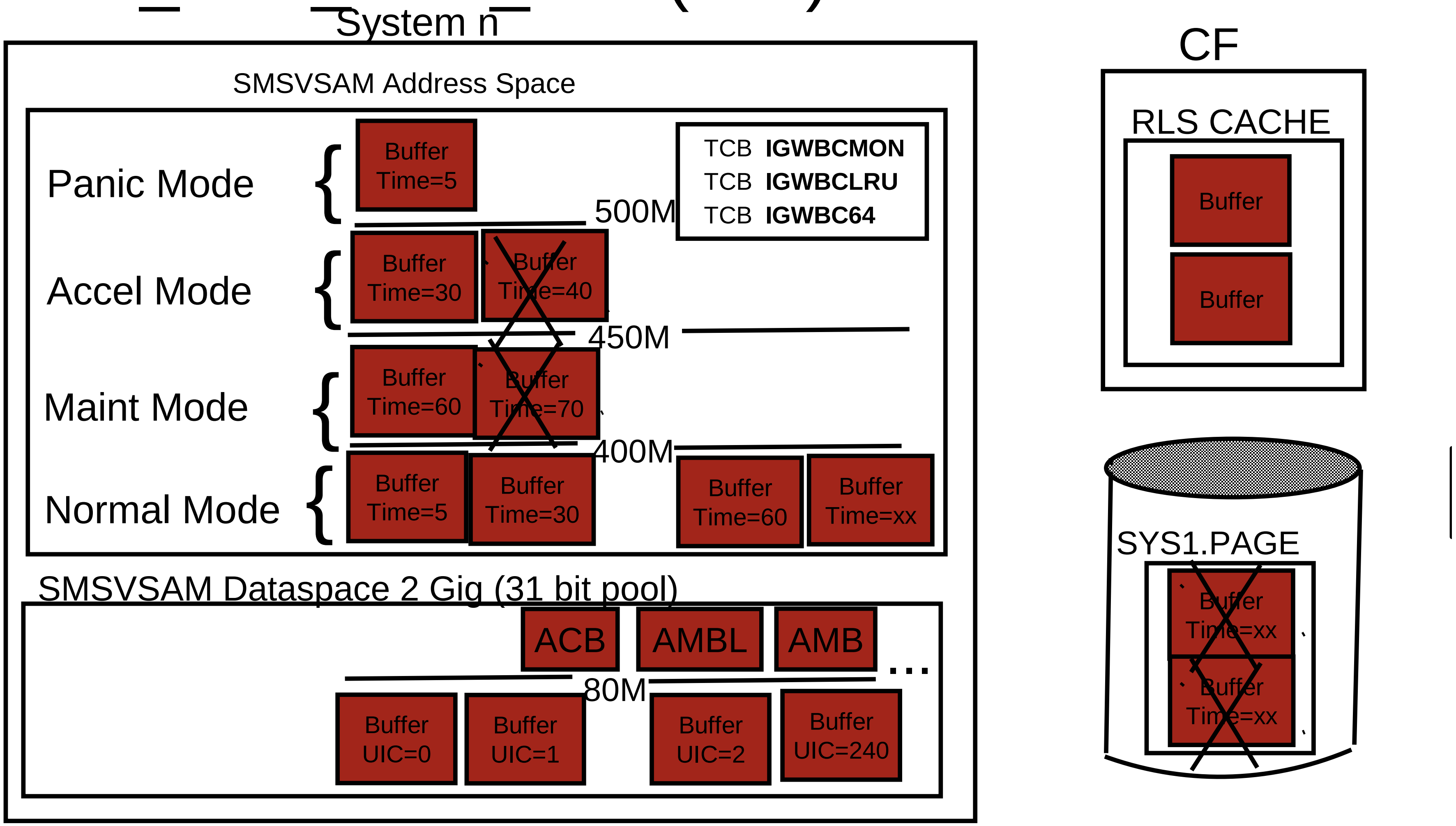
LRU

- Setting the Local Buffer Pool Size – Considerations (cont):
  - The LRU for the 64 bit buffer pool operates in four modes:
    - **Normal Mode** - Total 64 bit pool size is less than 80% of RLSAboveTheBarMaxPoolSize.
    - **Maintenance Mode** - Total 64 bit pool size is greater than 80% and less than 90% of RLSAboveTheBarMaxPoolSize.
    - **Accelerated Mode** - Total 64 bit pool size is greater than 90% and less than 100% of RLSAboveTheBarMaxPoolSize.
    - **Panic Mode** - Total 64 bit pool size is greater than 100% of RLSAboveTheBarMaxPoolSize

LRU

- The LRU will release 64 bit buffers as follows:
  - **Normal Mode** - Buffers 60 minutes or older will be released.
  - **Maintenance Mode** - Buffers 60 minutes or older will be released.
  - **Accelerated Mode** - Buffers 30 minutes are older will be released. Requests for new buffers will first be stolen. If there are no buffers to steal a new get block will be done.
  - **Panic Mode** - Buffers 5 minutes are older will be released. Requests for new buffers will first be stolen. If there are no buffers to steal, the request will sleep until LRU runs.

RLSAboveTheBarMaxPoolSize(500)
RLS_Max_Pool_Size(100)



System n

SMSVSAM Address Space

Panic Mode

Buffer Time=5

500M

Accel Mode

Buffer Time=30

Buffer Time=40

450M

Maint Mode

Buffer Time=60

Buffer Time=70

400M

Normal Mode

Buffer Time=5

Buffer Time=30

Buffer Time=60

Buffer Time=xx

TCB **IGWBCMON**

TCB **IGWBCLRU**

TCB **IGWBC64**

SMSVSAM Dataspace 2 Gig (31 bit pool)

ACB

AMBL

AMB

...

80M

Buffer UIC=0

Buffer UIC=1

Buffer UIC=2

Buffer UIC=240

CF

RLS CACHE

Buffer

Buffer

SYS1.PAGE

Buffer Time=xx

Buffer Time=xx

Setting up Parameters/Structures sizes

- Local Buffer Pool Sizes:
  - RLS_MAX_POOL_SIZE(nnnn)   Where nnnn = (10 to 9999), anything over 1500 is treated as a maximum of 1728M.
  - RLSAboveTheBarMaxPoolSize(sysname1,nnnn) Where nnnn is either 0, or 500M to 2,000,000M
  - RLS_MaxCFFeatureLevel(Z/A)
- Pool Size values are a goal for which the LRU tries to maintain. If more buffers are required at any given time, the pool may temporarily exceed the values set.
- Real Storage   - Total amount of buffer pools should not exceed amount of real storage. A paged out buffer is immediately freed by the LRU.

Sizing the RLS Cache Structures

- The “ideal” cache structure size:
  - Total_Cache_Sturcture_sizes = ((RLS_Max_Pool_Size) * Number_of_SMSVSAMs_in_Sysplex) + (RLSAboveTheBarMaxPoolSize(system1) + … +RLSAboveTheBarMaxPoolSize(systemn))
  - Assumes the following:
    - RLS_MaxCFFeaturelevel(A) - caching all data
    - No sharing of data across the sysplex.
    - If more than one cache structure to be allocated, Data sets are “evenly” distributed (size, number, amount of data accessed) between the individual cache structures.

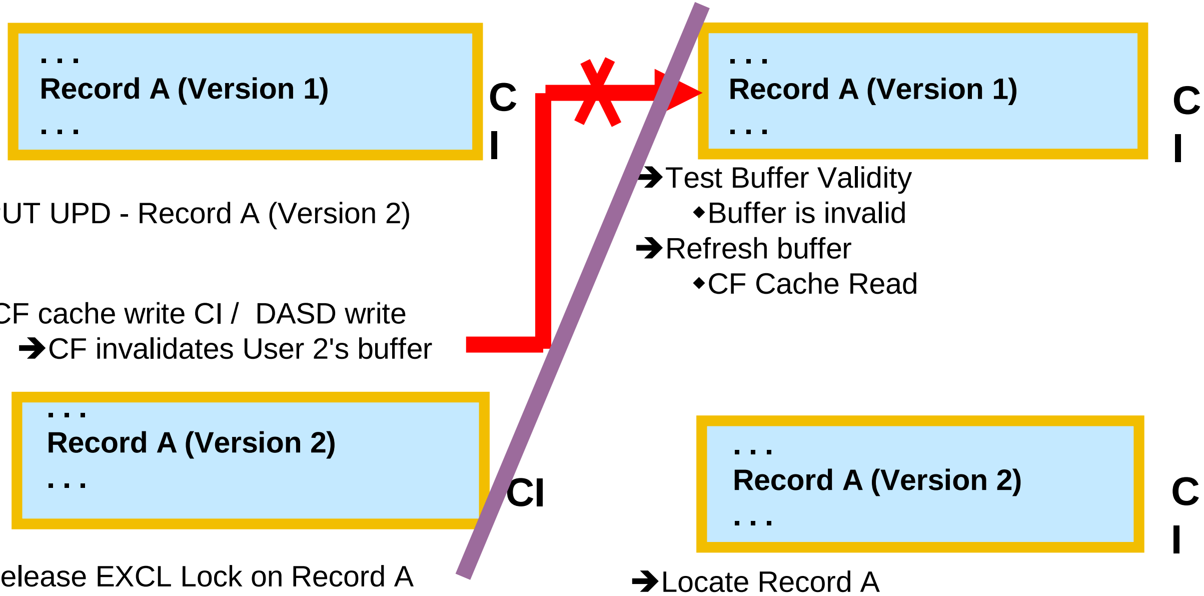
Example CPU Time for GET Request

- Get request in which all CIs were found in the local buffer pool: .0001xx - .0002xx seconds
- Get Request in which at least the one CI is read from DASD: .001x - .02xxxx Seconds

Example CPU Time for GET Request

- Get request in which all CIs were found in the local buffer pool: .0001xx - .0002xx seconds
- Get Request in which at least the one CI is read from DASD: .001x - .02xxxx Seconds

RLS Buffer Invalidate Example



System1

USER 1 (WRITER)

■GET UPD - Record A
- ➔Locate Record A
- ➔EXCL Lock on Record A
- ➔Test Buffer Validity
  - ⬩Buffer is valid
- ➔Return record to caller

. . .
Record A (Version 1)
. . .

CI

■PUT UPD - Record A (Version 2)

■ CF cache write CI / DASD write
- ➔CF invalidates User 2's buffer

. . .
Record A (Version 2)
. . .

CI

■Release EXCL Lock on Record A

System2

USER 2 (READER)

■GET NUP,CR - Record A
- ➔Locate Record A
- ➔SHR Lock on Record A
  - ⬩WAIT for Lock

. . .
Record A (Version 1)
. . .

CI

- ➔Test Buffer Validity
  - ⬩Buffer is invalid
- ➔Refresh buffer
  - ⬩CF Cache Read

. . .
Record A (Version 2)
. . .

CI

- ➔Locate Record A
- ➔Return record to caller
- ➔Release SHR Lock on Record A

RLS - Locking

- RLS serializes on a record level.
- Users updating or inserting a record will hold the lock exclusive for the duration of the write request or transaction.
- Users reading a record will hold the lock share when consistent read (CR) is specified. Lock is released at end of request
  - ACB RLSREAD=CR
  - //dd1 DD dsn=datasetname,RLS=CR

RLS - Locking (cont.)

- Users reading a record will not obtain any locks when no read intergrity (NRI) is specified.
  - ACB RLSREAD=NRI
  - //dd1 DD dsn=datasetname,RLS=NRI
- Users reading a record will hold the lock share when consistent read extended (CRE) is specified. The lock is released at the end of the transaction:
  - ACB RLSREAD=CRE
  - //dd1 DD dsn=datasetname,RLS=CRE
- RLS locking is performed through the use of a CF lock structure and the XES locking services.

Example of VSAM RLS Serialization

Scope = Sysplex
Granularity = Record
Ownership = CICS Transaction or Batch Job

CICS1.Tran1

GET UPD RPL_1
(Record B)

CICS2.Tran2

GET UPD RPL_2
(Record E)

CICS3.Tran3

GET CR RPL_3
(Record B)
–Waits for record lock

Record A
Record B
Record C
Record D
Record E

Control Interval

Record B

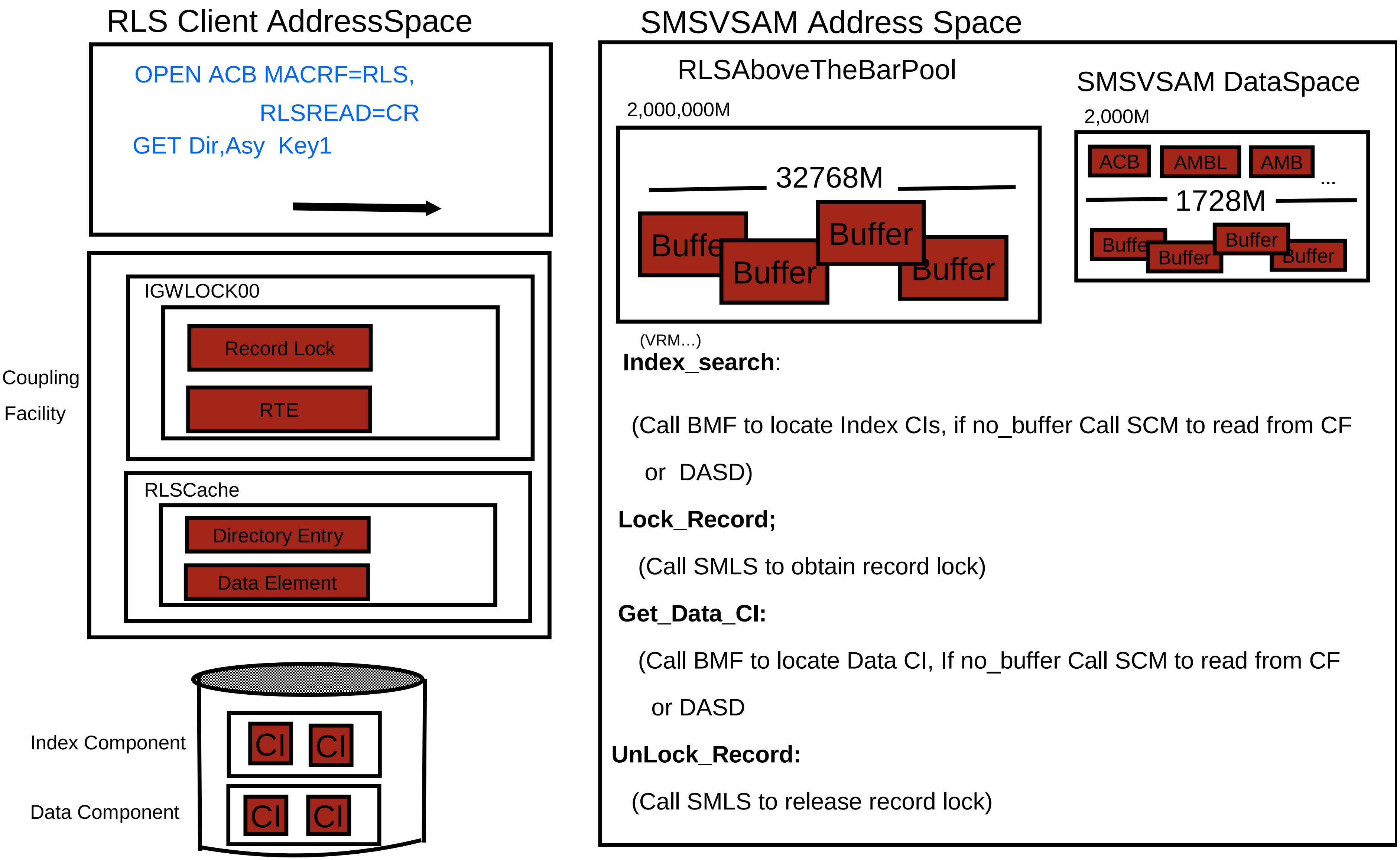
- Holder (EXCL)
  - CICS1.Tran1
- Waiter (SHARE)
  - CICS3.Tran3

Record E

- Holder (EXCL)
  - CICS2.Tran2

VSAM RLS Locks

Overview of Get Path



Index_search:

(Call BMF to locate Index CIs, if no_buffer Call SCM to read from CF or DASD)

Lock_Record;

(Call SMLS to obtain record lock)

Get_Data_CI:

(Call BMF to locate Data CI, If no_buffer Call SCM to read from CF or DASD

UnLock_Record:

(Call SMLS to release record lock)

RLS - RAS

- RLS provides extensive first time data capture for logic errors.
  - Many "health checks" in the code which produce ABEND0F4 dumps to capture the problem at the earliest possible point.
  - All mainline paths protected by recovery routines which force the data set to be closed in order to prevent damage to the data set.
    - Initial recovery design terminated SMSVSAM.
    - New recovery design marks data set as unusable.
  - Extensive logging and tracing facilities.
  - RAS is considered a high priority element of RLS design..
- End result:
  - Problems easier to debug..
  - Much less likely for broken data sets or data integrity problems.

RLS Performance Measurements

- SMF 62 and 64
  - SMF 62 – Created by RLS OPEN for each ACB.
  - SMF 64 – Created by RLS EOV and CLOSE for each ACB. Stats are on an ACB level.
- SMF 42 Subtypes 15, 16, 17, 18, 19
  - **Subtype 15** - RLS statistics by Storage Class
  - **Subtype 16** - RLS statistics by Data set
    - Must use V SMS,MONDS(spherename),ON to collect subtype 16 statistics.
  - **Subtype 17** - RLS locking Statistics for IGWLOCK00
  - **Subtype 18** - RLS caching Statistics
  - **Subtype 19** - BMF statistics
- SMF formatter soon to be available as part of our IPCS VERBX SMSXDATA
- Note: Only one system in the sysplex collects the SMF 42 records. The system collecting the records is displayed in the D SMS,SMSVSAM operator command.

RLS/TVS Configuration Change

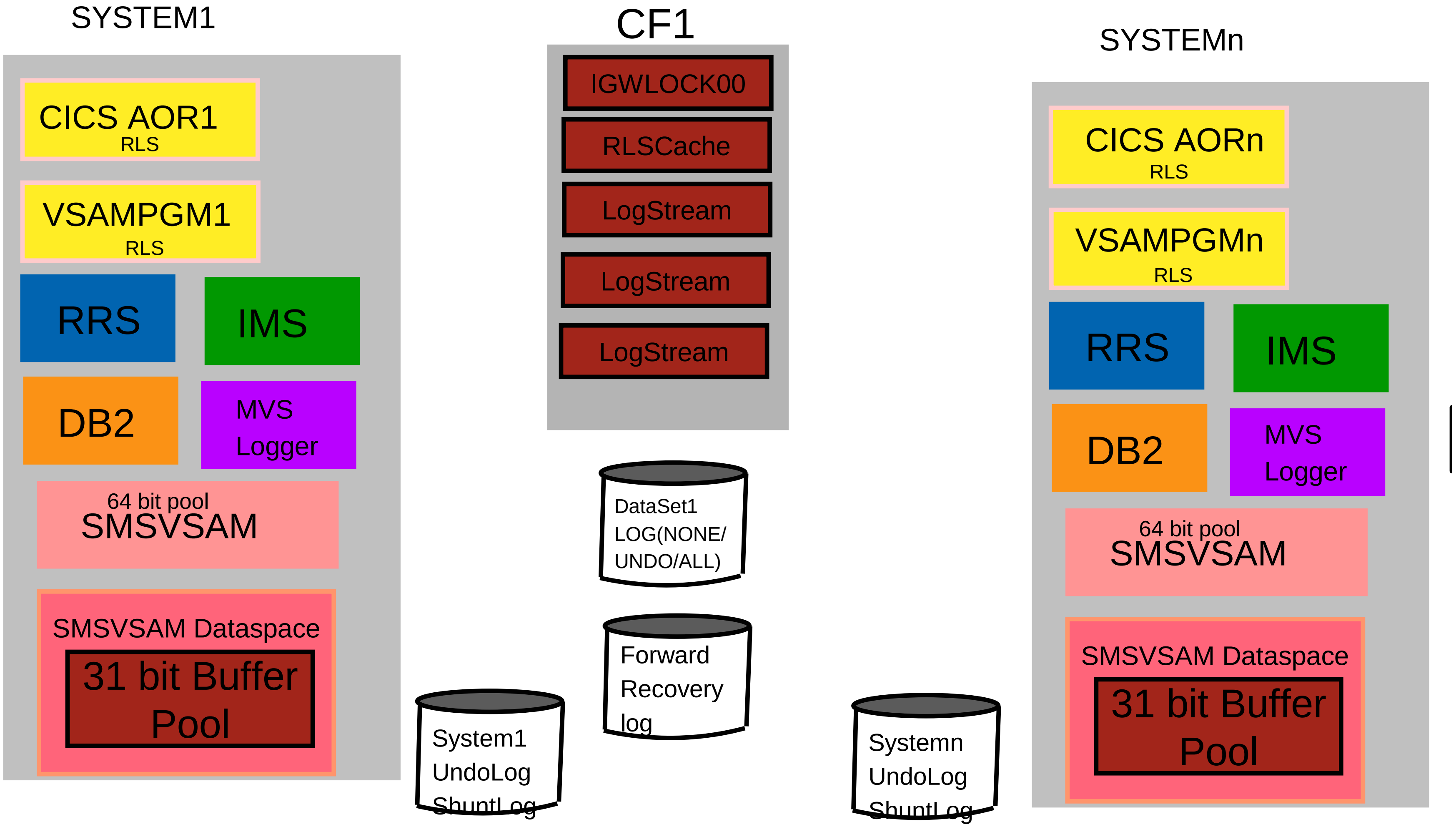
Configuration Changes

- Update CFRM policy to define lock, cache, list, log structures.
  - See DFSMSdfp Storage Administration Reference for sizing info.
- Update SYS1.PARMLIB(IGDSMSxx) with RLS/TVS parameters.
  - See MVS Initialization and Tuning.
- Define new SHCDSs (Share Control Data Sets).
  - See DFSMSdfp Storage Administration Reference.
- Update SMS configuration for Cache Sets.
  - See DFSMSdfp Storage Administration Reference.
- Update data sets with LOG(NONE/UNDO/ALL) and LOGSTREAMID.
  - See Access Methods Services for ICF.

System Requirements - PARMLIB Changes

```
SYS1.PARMLIB(IGDSMSxx)
SMS ACDS(acds)                                 COMMDS(commds)
     INTERVAL(nnn|15)                          DINTERVAL(nnn|150)
     REVERIFY(YES|NO)                          ACSDEFAULTS(YES|NO)
     SYSTEMS(8|32)                            TRACE(OFF|ON)
     SIZE(nnnnnK|M)                           TYPE(ALL|ERROR)
      JOBNAME(jobname|*)                      ASID(asid|*)
     SELECT(event,event....)                  DESELECT(event,event....)
     DSNTYPE(LIBRARY|PDS)                     DSSTIMEOUT(nnn|0)
     RLSMAXCFFEATURELEVEL(A|Z)                RLS_MAX_POOL_SIZE(nnn|100)
     RLSINIT(NO|YES)                          SMF_TIME(NO|YES)
     CF_TIME(nnn|3600)                        BMF_TIME(nnn|3600)
     CACHETIME(nnn|3600)                      DEADLOCK_DETECTION(iii|15,kkk|4)
     RLSTMOUT(nnn|0)                          RLSAboveTheBarMaxPoolSIze(system,size)
     RLSFixedPoolSize(system.size)             SYSNAME(sys1,sys2,...)
     TVSNAME(nnn1,nnn2....)                   MAXLOCKS(max|0,incr|0)
      TV_START_TYPE(WARM|COLD,WARM|COLD...)   AKP(nnn|1000,nnn|1000)
      LOG_OF_LOGS(logstream)                 QTIMEOUT(nnn|300)
```

SYSPLEX with SMSVSAM (and TVS) - Example



SMSVSAM Initialization

SMSVSAM Initialization

```
IGW619I ACTIVE SHARE CONTROL DATA SET 209
SYS1.DFPSHCDS.ACTIVE2.VSPLXPK ADDED.
 IGW619I SPARE SHARE CONTROL DATA SET 283
 SYS1.DFPSHCDS.SPARE.VSPLXPK ADDED.
IGW321I Running Protocol 4
IXL014I IXLCONN REQUEST FOR STRUCTURE IGWLOCK00 313
WAS SUCCESSFUL.  JOBNAME: SMSVSAM ASID: 0009
CONNECTOR NAME: SYSTEM1 CFNAME: FACIL01
IGW321I System Ordinal is 1
IGW453I SMSVSAM ADDRESS SPACE HAS SUCCESSFULLY 316
CONNECTED TO DFSMS LOCK STRUCTURE IGWLOCK00
IGW321I No retained locks
IGW321I 0 RLS Sphere Record Table Entries read
IGW321I 0 RLS Sphere Record Table Entries deleted
IGW321I No Spheres in lost locks
```

SMSVSAM Initialization (cont.)

```
IGW414I SMSVSAM SERVER ADDRESS SPACE IS NOW ACTIVE.
IGW467I DFSMS RLS_MAX_POOL_SIZE PARMLIB VALUE SET DURING 354
SMSVSAM ADDRESS SPACE INITIALIZATION ON SYSTEM: SYSTEM1
CURRENT VALUE: 100
IGW467I DFSMS DEADLOCK_DETECTION PARMLIB VALUE SET DURING 355
SMSVSAM ADDRESS SPACE INITIALIZATION ON SYSTEM: SYSTEM1
THIS SYSTEM IS OPERATING AS THE GLOBAL DEADLOCK PROCESSOR.
CURRENT VALUE: 15  4
.
.
IGW467I DFSMS RLS_MAXCFFEATURELEVEL PARMLIB VALUE SET DURING
SMSVSAM ADDRESS SPACE INITIALIZATION ON SYSTEM: SYSTEM1
CURRENT VALUE: Z
```

SMSMVSAM Initialization (with TVS) - (cont.)

SYSTEM1

```
SYSTEM1  05008 11:34:01.17  IGW467I DFSMS TVSNAME PARMLIB VALUE SET DURING 578
                                    SMSVSAM ADDRESS SPACE INITIALIZATION ON SYSTEM:
                                    SYSTEM1 TVSNAME: IGWTV001
SYSTEM1  05008 11:34:01.18  IGW467I DFSMS TRANSACTIONAL VSAM UNDO LOG PARMLIB VALUE SET
                                    DURING SMSVSAM ADDRESS SPACE INITIALIZATION ON SYSTEM:
                                   SYSTEM1  UNDO LOGSTREAM NAME:
                                    IGWTV001.IGWLOG.SYSLOG
 SYSTEM1  05008 11:34:01.18 IGW467I DFSMS TRANSACTIONAL VSAM SHUNT LOG PARMLIB VALUE SET
                                    DURING SMSVSAM ADDRESS SPACE INITIALIZATION ON SYSTEM:
                                    SYSTEM1 SHUNT LOGSTREAM NAME:
                                    IGWTV001.IGWSHUNT.SHUNTLOG
                                    .
                                    .
```

System Requirements - SMSVSAM Initialization - Example

SYSTEM1

```
SYSTEM1  05008 11:34:01.18 IGW467I DFSMS TRANSACTIONAL VSAM TVS_START_TYPE PARMLIB
                                   VALUE SET DURING SMSVSAM ADDRESS SPACE INITIALIZATION
                                   ON SYSTEM:  SYSTEM1  TVSNAME VALUE:  IGWTV001
                                   CURRENT VALUE: WARM  1
 SYSTEM1  05008 11:34:06.29 IGW860I TRANSACTIONAL VSAM HAS SUCCESSFULLY REGISTERED
                                   WITH RLS
SYSTEM1  05008 11:35:36.63 IGW865I TRANSACTIONAL VSAM INITIALIZATION IS COMPLETE.
SYSTEM1  05008 11:35:36.65 IGW886I 0 RESTART TASKS WILL BE PROCESSED DURING
                                   TRANSACTIONAL RESTART PROCESSING
SYSTEM1  05008 11:35:36.65 IGW866I TRANSACTIONAL VSAM RESTART PROCESSING IS COMPLETE.
                                   .
                                   .
                                   .
```

SMSVSAM Commands

SMSVSAM Display Commands

```
D SMS[,
    [,CFCACHE(structurename|*)                    ]
    [,CFLS                                        ]
    [,CFVOL(volid)                                ]
    [,DSNAME(dsn){,WTOR}                          ]
    [,JOB(jobname){,WTOR}                         ]
    [,LOG({logstreamid|ALL}{,WTOR}                ]
    [,MONDS(specmask|*)                           ]
    [,SHCDS                                       ]
    [,SHUNTED,{SPHERE(sphere)|UR({urid|ALL}}{,WTOR}]
    [,SMSVSAM[,ALL]                               ]
```

SMSVSAM Display Commands (cont)

```
 D SMS[,
      [,TRANVSAM[,ALL][,ALLLOGS][,WTOR]              ]
      [,URID({urid|ALL}){,WTOR}                      ]
D SMS,SMSVSAM,DIAG(CONTENTION)
```

D SMS,SMSVSAM (example)

```
D SMS,SMSVSAM
DISPLAY SMS,SMSVSAM - SERVER STATUS
  SYSNAME:  SYSTEM1    AVAILABLE ASID: 0033 STEP: SmsVsamInitComplete

DISPLAY SMS,SMSVSAM - JOB STATUS
  SUBSYSTEMS CONNECTED:       1 BATCH:       1

DISPLAY SMS,SMSVSAM - LOCK TABLE STATUS (IGWLOCK00)
  CONNECT STATUS:
    SYSNAME:  SYSTEM1  ACTIVE          RSN: 02010407 RbldNotActive

  COMPOSITE STATUS:
    ORIGINAL STRUCTURE: NOT VOLATILE          FAILURE ISOLATED
    NEW      STRUCTURE: NOT VOLATILE          FAILURE ISOLATED

  STRUCTURE STATUS:
  SYSNAME: SYSTEM1   Duplex
.
.
```

System Requirements - SMSVSAM Displays

SYSTEM1

```
- 13.19.03 SYSTEM1        d sms,tranvsam
  13.19.04 SYSTEM1        IEE932I 023
  IGW800I 13.19.04 DISPLAY SMS,TRANSACTIONAL VSAM
  DISPLAY SMS,TRANSACTIONAL VSAM - SERVER STATUS
   System     TVSNAME  State    Rrs      #Urs    Start              AKP     QtimeOut
   --------    --------   ------    -----    --------  ---------          --------  --------
   SYSTEM1  IGWTV001 ACTIVE REG        0      WARM/WARM     200      400

  DISPLAY SMS,TRANSACTIONAL VSAM - LOGSTREAM STATUS
   LogStreamName                        State      Type        Connect Status
   --------------------------           ----------    ----------    --------------
   IGWTV001.IGWLOG.SYSLOG           Enabled   UnDoLog     Connected
   IGWTV001.IGWSHUNT.SHUNTLOG  Enabled   ShuntLog    Connected
```

SMSVSAM Vary Commands

```
V SMS,{CFCACHE(cachename),{ENABLE|E }       }
 {                {QUIESCE|Q}       }
 {CFVOL(volid),{ENABLE|E }            }
 {           {QUIESCE|Q}            }
 {MONDS(dsname[,dsname...]),{ON|OFF}   }
 {SHCDS(shcdsname),{NEW     }          }
 {              {NEWSPARE}          }
 {              {DELETE  }          }
 {SMSVSAM,{ACTIVE                    }
 {       {FALLBACK                  }
 {       {TERMINATESERVER            }
 {       {FORCEDELETELOCKSTRUCTURE    }
```

SMSVSAM Vary Commands

```
V SMS,{TRANVSAM({tvsname|ALL}){,{QUIESCE|Q}}     }
 {             {,{ENABLE|E }}     }
 {             {,{DISABLE|D}}     }
 {                           }
 {LOG(logstreamid){{,QUIESCE|Q}}         }
 {         {,{ENABLE|E }}         }
 {         {,{DISABLE|D}}         }
 {                           }
 {SMSVSAM,SPHERE(sphere){,{QUIESCE|Q}}     }
 {            {,{ENABLE|E }}     }
 {                           }
 {TRANVSAM(tvsname),PEERRECOVERY{,{ACTIVE|A  }}}
 {                 {,ACTIVEFORCE }}
 {                 {,{INACTIVE|I}}}
```

RLS/CICS Environment

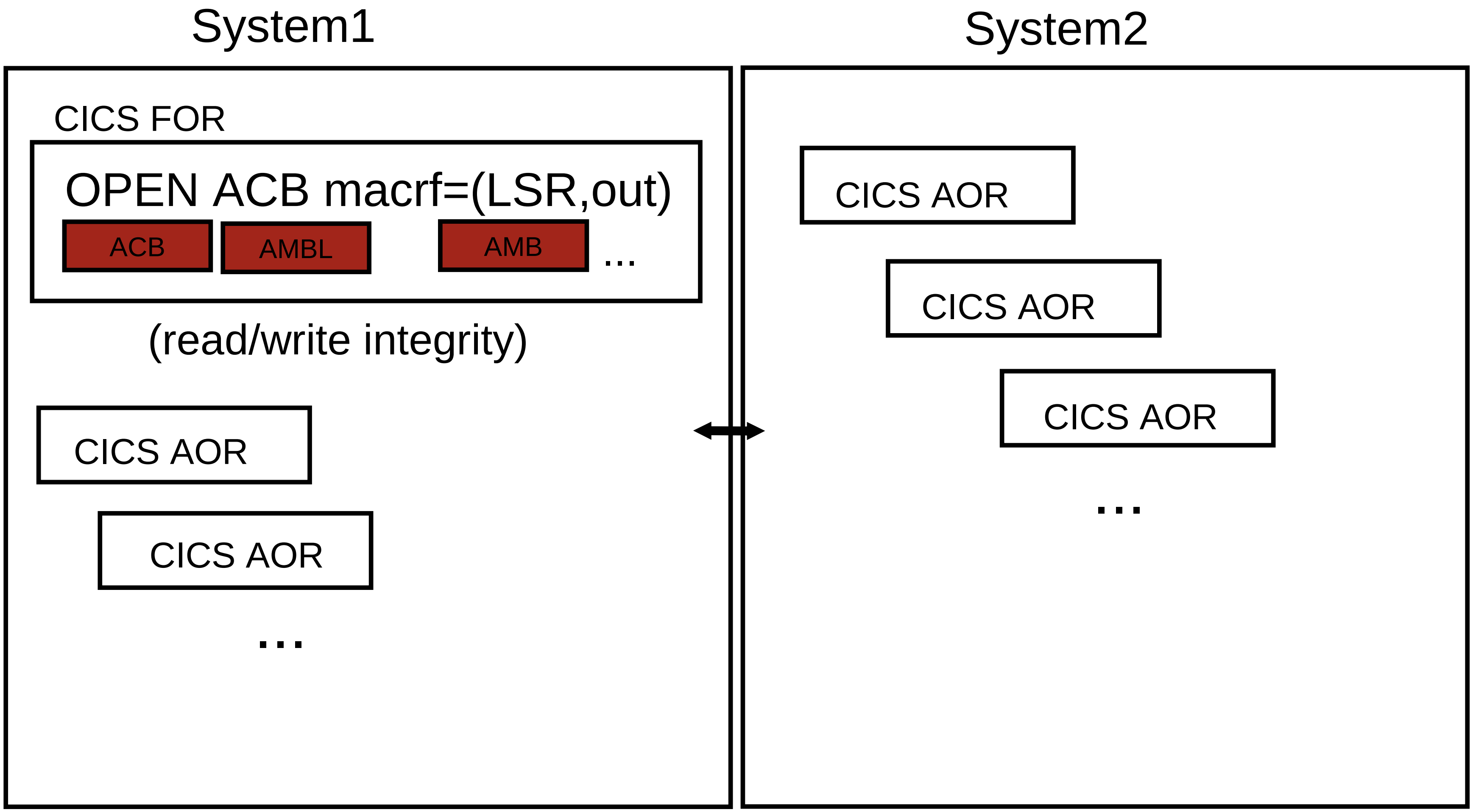
RLS/CICS Environment

- CICS and base VSAM FOR configuration.
  - Advantages and disadvantages of the FOR/AOR configuration.
- CICS and RLS configuration.
  - Advantages and disadvantages of the CICS/RLS configuration.
- RLS/CICS data recovery.
  - Recoverable data sets.
  - Recoverable subsystems.
  - Retained locks.
  - Lost locks.
  - IDCAMS SHCDS commands
  - QUICOPY/QUIBWO interface.

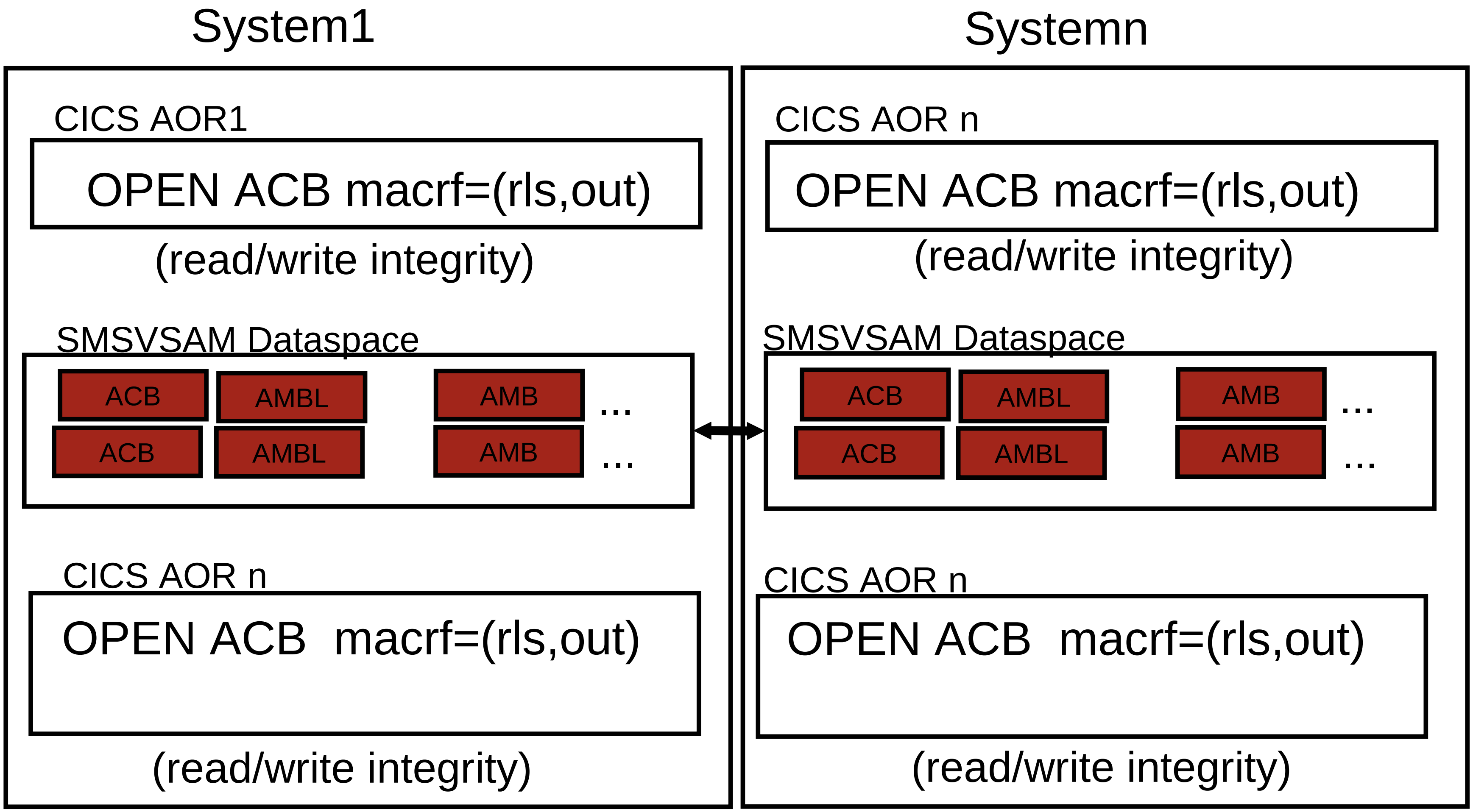
RLS/CICS Environment

- RLS/CICS automation enhancements.
  - QUIOPEN/QUICLOSE interface.

CICS FOR/AOR Configuration



RLS/CICS Configuration



System1

CICS AOR1

OPEN ACB macrf=(rls,out)

(read/write integrity)

SMSVSAM Dataspace

ACB AMBL AMB …

ACB AMBL AMB …

CICS AOR n

OPEN ACB macrf=(rls,out)

(read/write integrity)

Systemn

CICS AOR n

OPEN ACB macrf=(rls,out)

(read/write integrity)

SMSVSAM Dataspace

ACB AMBL AMB …

ACB AMBL AMB …

CICS AOR n

OPEN ACB macrf=(rls,out)

(read/write integrity)

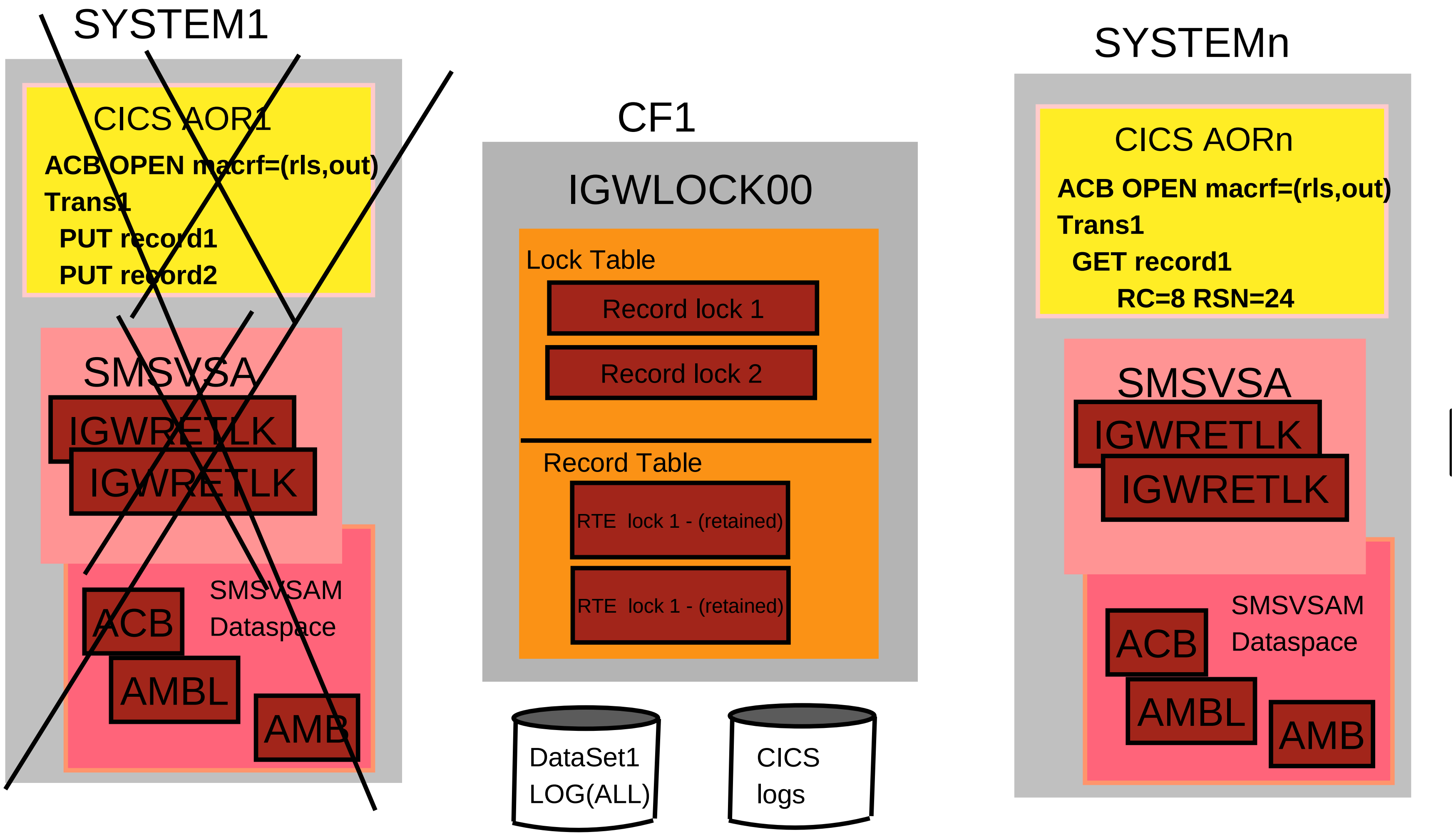
RLS/CICS Data Recovery

- Recoverable data sets
  - defined as LOG(UNDO/ALL) in the catalog.
    - UNDO - backout logging performed by CICS (or TVS).
    - ALL - both backout and forward recovery logging (or TVS).
  - LOG(ALL) data sets must have a LOGSTREAMID(forwardecoverylog) also defined in the catalog.
- Non-Recoverable data sets
  - defined as LOG(NONE) in the catalog.
    - No logging performed by CICS (or TVS).
- Recoverable Subsystems.
  - CICS (and TVS) must register with the SMSVSAM address space with a "subsystemname" so that locks obtained by that subsystem can be tracked.

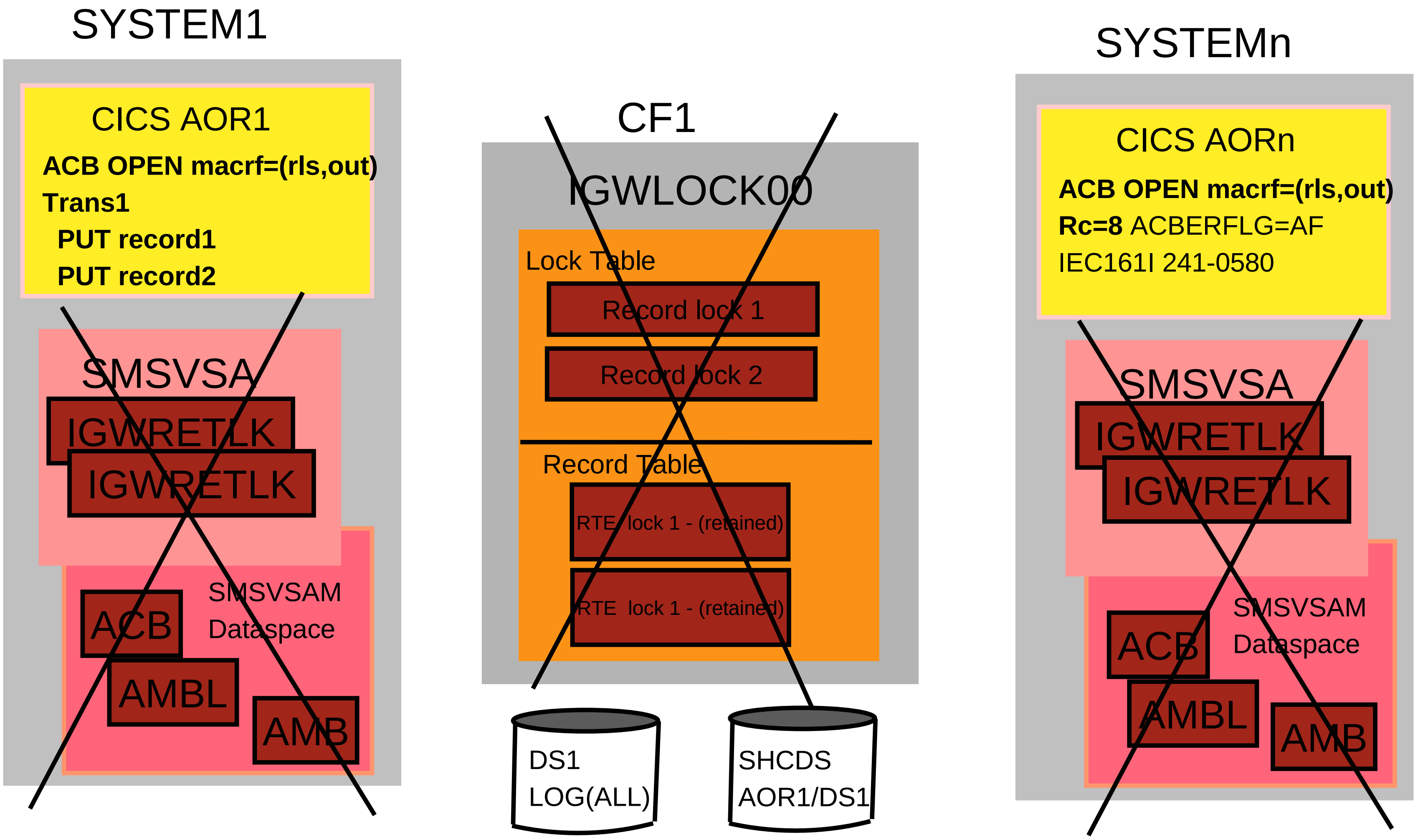
RLS/CICS Data Recovery

- Retained locks
  - Record locks are converted to "retained" in the event of a failure. The "owning" subsystem is the only subsystem that may access the record locks during recovery. All other subsystems or VSAM RLS applications will received a retained lock error in the RPL
  - SMSVSAM automatically notifies CICS when SMSVSAM restarts. CICS will automatically perform backouts when the file is reopened.
- Lost Locks
  - A data set which had actively held locks and a system failure occurs resulting in the loss of the RLS lock structure and at least one of the RLS address spaces at the exact same time.
  - Only the owning subsystem of the active locks may open the file and recovery the record locks. All other RLS opens will be failed until the data set has been fully recovered.

Retained Lock Example



Lost Lock Example



SYSTEM1

CICS AOR1

ACB OPEN macrf=(rls,out)

Trans1

PUT record1

PUT record2

SYSTEMn

CICS AORn

ACB OPEN macrf=(rls,out)

Rc=8 ACBERFLG=AF

IEC161I 241-0580

RLS/CICS Data Recovery

- IDCAMS SHCDS commands
  - Used to list information about data set, clients, subsystems, etc. using RLS.
- QUICOPY/QUIBWO interface.
  - Called by DSS to communicate with CICS (via the SMSVSAM) address space to inform CICS when a DSS copy/backup begins and ends.
  - Allows DSS to either take a "sharp" copy (via the QUICOPY interface) or a "fuzzy" copy (via the QUIBWO interface).
  - CICS will halt new transactions when a QUICOPY is under way. New opens will not be allowed during a QUICOPY.
  - CICS will log the start and end of the copy/backup operation. The data set can then be fully recovered from the last backup.

SHCDS Commands

```
SHCDS    {{LISTDS(base_cluster_name) {JOBS}} |
          {LISTSUBSYS(subsystem_name|ALL)} |
          {LISTSUBSYSDS(subsystem_name)} |
          {LISTRECOVERY(base_cluster_name|ALL)} |
          {LISTALL} |
          {FRSETRR(base_cluster_name)} |
          {FRUNBIND(base_cluster_name)} |
          {FRBIND(base_cluster_name)} |
            {FRRESETRR(base_cluster_name)} |
 {FRDELETEUNBOUNDLOCKS(base_cluster_name)} |
 {PERMITNONRLSUPDATE(base_cluster_name)} |
 {DENYNONRLSUPDATE(base_cluster_name)} |
 {REMOVESUBSYS(subsystem_name)} |
 {CFREPAIR({INFILE(ddname) |
            INDATASET(datasetname)}
```

SHCDS Commands *(continued)*

```
         {LIST|NOLIST})}
{CFRESET({INFILE(ddname) |
         INDATASET(datasetname)}
         {LIST|NOLIST})}
{CFREPAIRDS({base_cluster_name |
          {partially_qualified_base_cluster_name)
{CFRESETDS({base_cluster_name |
          {partially_qualified_base_cluster_name)
{LISTSHUNTED {SPHERE(base_cluster_name) |
            URID(urid)             |
            DATA(urid)}}
{RETRY {SPHERE(base_cluster_name) |
       URID(urid)}}
{PURGE {SPHERE(base_cluster_name) |
       URID(urid)}}
```

SHCDS Example

ISPF Command Shell

Enter TSO or Workstation commands below:

```
===>   SHCDS LISTSUBSYS(aor1)

----- LISTING FROM SHCDS ----- IDCSH03 -----------------------------------------------------------------------------------------------------------

                                            RECOVERY     LOCKS      LOCKS        LOCKS
 SUBSYSTEM NAME      STATUS                NEEDED        HELD       WAITING     RETAINED

  _______________   ______________       _______       _____      _______    _________

  AOR1                   ONLINE--FAILED        YES              0              0            1

  DATA SETS IN LOST LOCKS------------         0

   DATA SETS IN NON-RLS UPDATE STATE--         0

   TRANSACTION COUNT------------------         1

 ***
```

SHCDS Example

ISPF Command Shell

Enter TSO or Workstation commands below:

```
===>   SHCDS LISTDS('dataset1*')
----- LISTING FROM SHCDS ----- IDCSH02 ------------------------------------------------------------------------------------------------------
 DATA SET NAME----dataset1
   CACHE STRUCTURE----CACHE01
   RETAINED LOCKS---------YES   NON-RLS UPDATE PERMITTED---------NO
   LOST LOCKS--------------NO   PERMIT FIRST TIME----------------NO
   LOCKS NOT BOUND---------NO   FORWARD RECOVERY REQUIRED--------NO
   RECOVERABLE------------YES
```

SHCDS Example (cont.)

```
                      SHARING SUBSYSTEM STATUS
  SUBSYSTEM   SUBSYSTEM        RETAINED       LOST       NON-RLS UPDATE
  NAME          STATUS              LOCKS            LOCKS     PERMITTED
  ---------       --------------          ----------------       ----------       --------------------------
  AOR1            ONLINE--FAILED    YES                 NO             NO
***
```

RLS/CICS Automation Enhancements

- QUIOPEN/QUICLOSE Interface
  - QUICLOSE interface is used by CICS to fully close a data set around the sysplex.
    - SMSVSAM drives CICS quiesce exit which issues closes for all regions open to the data set.
    - SMSVSAM updates the catalog and marks the data set as quiesced.
    - RLS opens against a quiesced data set will be failed.
  - QUIOPEN interface is used by CICS to enable a data set to be reopened for RLS use.
    - SMSVSAM drives CICS quiesce exit to ALL CICS regions registered with RLS.
    - SMSVSAM updates the catalog and marks the data set as unquiesced.
  - Invoked with the following commands:
    - V SMS,SMSVSAM,SPHERE(spherename),Q
    - V SMS,SMSVSAM,SPHERE(spherename),E
    - F cicsname,CEMT SET DSN(RLSADSW.VFA1D.*),QUI
    - F cicsname,CEMT SET DSN(RLSADSW.VFA1D.*),UNQ

Transactional VSAM (TVS)

Transactional VSAM (TVS)

- Enhance VSAM Record Level Sharing (RLS) to provide data recovery capabilities for any application exploiting VSAM RLS.
- VSAM RLS data recovery capabilities include:
  - transactional recovery
  - data set recovery
- VSAM RLS becomes a "transactionalized" access method, or is now referred to as "Transactional VSAM" (TVS).

System Requirements - Hardware/Software Requirements

- Parallel sysplex running z/OS 1.4 or higher with VSAM RLS implemented.
- z/OS Transactional VSAM (separately priced feature).
- z/OS RRMS implemented.
- z/OS System Logger implemented.
- CICS VSAM Recovery (CICVR) Utility (optional)

Application Requirements - Data Set Changes

- Data sets accessed by RLS must have a LOG parm specifed in the catalog. Valid values are:
  - LOG(NONE) - Non-recoverable data set. Can be opened for input/output by any RLS application.
  - LOG(UNDO) - Recoverable data set requiring backout (UNDO) logging. Can be opened for input/output by RLS recoverable subsystems (i.e. CICS) and/or RLS applications running on a z/OS system with the TVS feature installed.
  - LOG(ALL) - Recoverable data set requiring both backout (undo) and forward recovery logging. Can be opened for input/output by RLS recoverable subsystems (i.e. CICS) and/or RLS applications running on a z/OS system with the TVS feature installed.

Application Requirements - Data Set Changes (cont)

- Data sets defined as LOG(ALL) must also have a LOGSTREAMID(fowardrecoverylogname) specified in the catalog.

Application Requirements - Data Set Define/Alter Example

```
DEFINE CLUSTER (NAME(recoverabledataset)            -
        RECORDSIZE(100 100)             -
        STORCLAS(storclasname)            -
        FSPC(20 20)               -
        LOG (ALL)              -
        SHAREOPTIONS(2 3)             -
        LOGSTREAMID(forwardrecoverylog)     -
        CISZ(512)        -
        KEYS(06 8) INDEXED             -
       )                      -
    DATA(NAME(recoverabledataset.DATA) -
        VOLUME(volser)               -
        TRACKS (1,1))  -
    INDEX(NAME(recoverabledataset.INDEX) -
        VOLUME(volser)               -
        TRACKS (1,1))
```

Application Requirements – RLS/TVS Access Options

- Transactional VSAM support occurs when:
  - ACB MACRF=(RLS,OUT) for recoverable data set (LOG(UNDO|ALL))
  - ACB MACRF=(RLS,IN), RLSREAD=CRE .
  - //ddname DD DSN=recoverabledatasetname,DISP=shr,RLS=(CR|NRI) and ACB MACRF=(OUT)
  - //ddname DD DSN=datasetname,DISP=shr,RLS=CRE and ACB MACRF=(IN)

Application Requirements - Transactional Recovery

- RLS applications opening recoverable data sets on z/OS with the TVS feature installed, should be modified to add SRRCMIT and SRRBACK interfaces.

- SRRCMIT and SRRBACK will either commit or backout the unit of recovery (UR) provided by SMSVSAM on behalf of the VSAM RLS application.

- Explicitly committing or backing out the UR will release record level locks in a timely fashion. Failure to do so may impact other sharers of the data set.

- SMSVSAM will implicitly issue a commit or backout at EOT, if the VSAM application fails to do so.

Application Requirements - Supported Languages

- High level language support for RLS and RRS interfaces:
  - PLI
  - C & C++
  - COBOL
  - Assembler

Application Requirements - Explicit Commit Example

```
//ddname  DD  DSN=Recoverabledatasetname,DISP=SHR

//step1   EXEC  PGM=vsamrlspgm

Begin JOB Step   ------------------------------------- No locks held

OPEN  ACB MACRF=(RLS,OUT)

(UR1)

GET UPD record 1------------------------------------ Obtain an exclusive lock on record 1

PUT UPD  record 1 ----------------------------------  Lock on record 1 remains held

GET repeatable read record n--------------------  Obtain a shared lock on record n

PUT ADD record n+1-------------------------------- Obtain an exclusive lock on record n+1

GET UPD record 2 ---------------------------------- Obtain an exclusive lock on record 2

PUT UPD record 2 ----------------------------------- Lock on record 2 remains held

Call SRRCMIT ----------------------------------------- Commit changes, all locks released .

CLOSE

End of JOB Step
```

Application Requirements - Implicit Commit Example

//ddname DD DSN=Recoverabledatasetname,DISP=SHR

//step1   EXEC PGM=vsamrlspgm

Begin JOB Step ------------------------------------- No locks held

OPEN ACB MACRF=(RLS,OUT)

(UR1)

GET UPD record 1---------------------------------- Obtain an exclusive lock on record 1

PUT UPD record 1 -------------------------------- Lock on record 1 remains held

GET repeatable read record n------------------- Obtain a shared lock on record n

PUT ADD record n+1------------------------------ Obtain an exclusive lock on record n+1

GET UPD record 2 -------------------------------- Obtain an exclusive lock on record 2

PUT UPD record 2 --------------------------------- Lock on record 2 remains held

CLOSE -- All Locks are retained

End of JOB Step (normal)------------------------- Commit changes release all locks

Application Requirements - Explicit Backout Example

```
//ddname  DD  DSN=Recoverabledatasetname,DISP=SHR
//step1   EXEC  PGM=vsamrlspgm
Begin JOB Step ----------------------------------------- No locks held
OPEN  ACB MACRF=(RLS,OUT)
(UR1)
GET UPD record 1-------------------------------------- Obtain an exclusive lock on record 1
PUT UPD  record 1 -----------------------------------  Lock on record 1 remains held
GET repeatable read record n--------------------  Obtain a shared lock on record n
PUT ADD record n+1--------------------------------- Obtain an exclusive lock on record n+1
GET UPD record 2 ----------------------------------- Obtain an exclusive lock on record 2
PUT UPD record 2 ------------------------------------ Lock on record 2 remains held
Call SRRBACK ----------------------------------------- Undo changes, all locks released .
CLOSE
End of JOB Step
```

Application Requirements - Implicit Backout Example

//ddname DD DSN=Recoverabledatasetname,DISP=SHR

//step1   EXEC PGM=vsamrlspgm

Begin JOB Step --------------------------------------- No locks held

OPEN ACB MACRF=(RLS,OUT)

(UR1)

GET UPD record 1------------------------------------ Obtain an exclusive lock on record 1

PUT UPD record 1 ---------------------------------- Lock on record 1 remains held

GET repeatable read record n-------------------- Obtain a shared lock on record n

PUT ADD record n+1-------------------------------- Obtain an exclusive lock on record n+1

GET UPD record 2 ---------------------------------- Obtain an exclusive lock on record 2

PUT UPD record 2 ----------------------------------- Lock on record 2 remains held

--------------------------------------- Cancel --

End of JOB Step (abnormal) ----------------------- Undo changes release all locks

Information about TVS

Information about DFSMS and TVS

- www.storage.ibm.com/software/sms/index.html
- www.storage.ibm.com/software/sms/tvs/index.html

Additional Information

- www.redbooks.ibm.com

• Transactional VSAM Presentation Guide	SG24-6973
• Transactional VSAM Overview and Planning Guide	SG24-6971
• Transactional VSAM Application Migration Guide	SG24-6972
• VSAM Demystified	SG24-6105

Multiple Lock Structure (MLS)

Multiple Lock Structure

- ❑ **Multiple Lock Structures (MLS), goal of this function is to remove the single point of failure of one lock structure in the current VSAM RLS design**
  - – **Current Locking Design**
  - – **Current Locking Design - Issues**
  - – **Multiple lock Structure Design**

Current Locking Design

- ❑ The current design of locking uses one coupling facility (CF) lock structure, IGWLOCK00, which contains:
  - – Record locks and record data (retained locks)
  - – System "Special" locks:
    - Sphere, component, subsystem locks and data set related record data

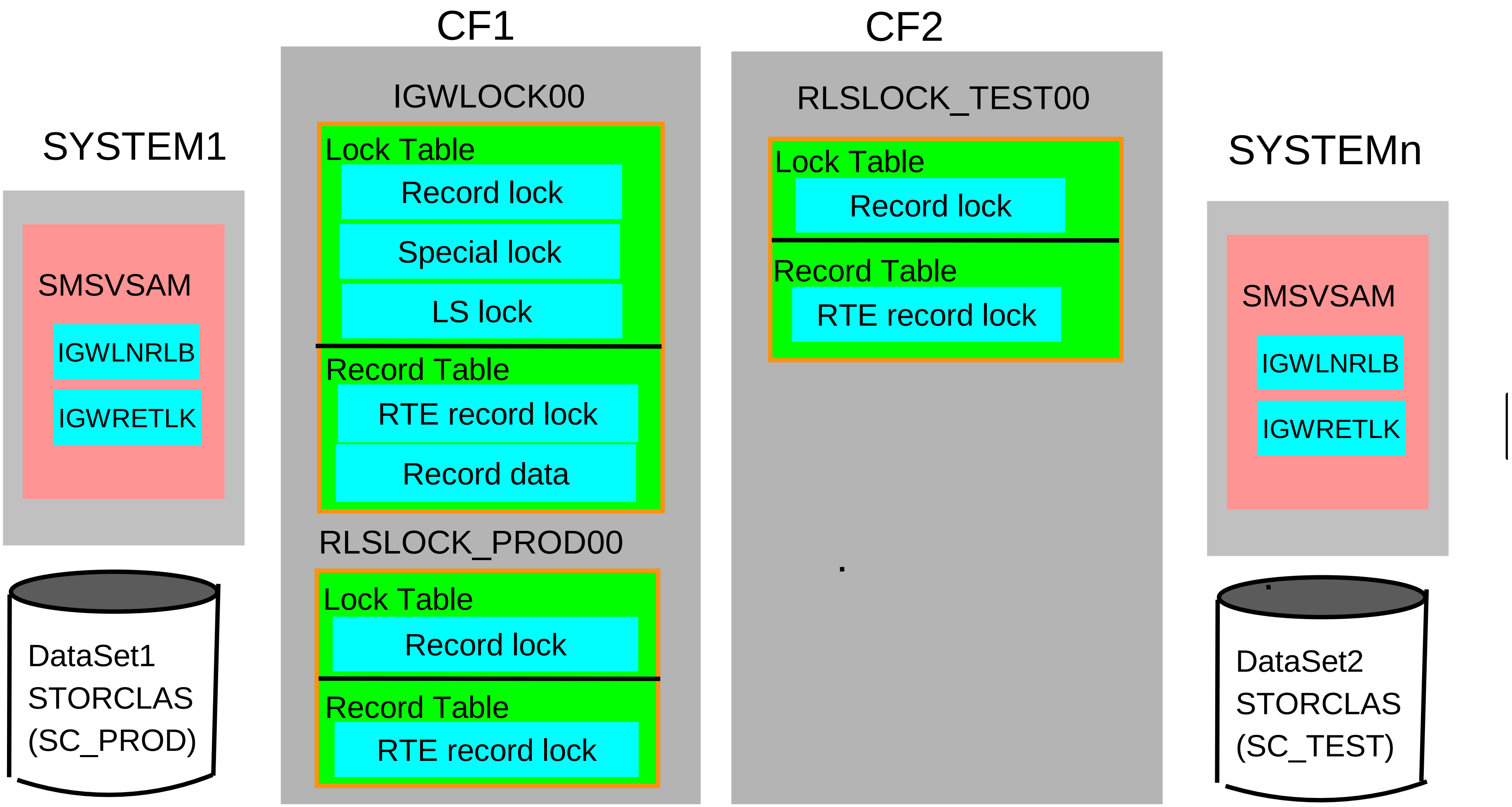
Current Locking Design - Issues

- **The current locking design has two issues:**
  - **IGWLOCK00 represents a single point of failure in the sysplex:**
    - **A "run away" application could fill IGWLOCK00 with record locks, causing all RLS application's lock requests in the sysplex to fail.**
  - **IGWLOCK00 could cause performance issues:**
    - **All RLS locking activity against a single lock structure in a single CF**

Proposed Design - Multiple Lock Structure

- ❑ **Continue to support IGWLOCK00 as the "primary" lock structure, which will contain:**
  - – Record locks and record data for data sets not using the new MLS support
  - – System "special" locks:
    - Sphere, component, subsystem locks and data set record data.
  - – "Lock structure" lock (associates data sets to lock structures)
- ❑ **Add new "secondary" lock structures, which will contain:**
  - – Record locks and record data for data sets using the new MLS support
- ❑ **Assign data sets to "secondary" lock structures via a new "lock set" parameter on the SMS STORCLAS construct**
  - – A "secondary" lock structure will be assigned from the list of lock structures specified in the lock set parameter
  - – If the lock set parameter is blank, IGWLOCK00 will be assigned as the default

Mulitple Lock Structure Example



SYSTEM1

SMSVSAM

IGWLNRLB

IGWRETLK

DataSet1
STORCLAS
(SC_PROD)

CF1

IGWLOCK00

Lock Table

Record lock

Special lock

LS lock

Record Table

RTE record lock

Record data

RLSLOCK_PROD00

Lock Table

Record lock

Record Table

RTE record lock

CF2

RLSLOCK_TEST00

Lock Table

Record lock

Record Table

RTE record lock

SYSTEMn

SMSVSAM

IGWLNRLB

IGWRETLK

DataSet2
STORCLAS
(SC_TEST)

Recommended APARs

Recommended APARs

- OA21101
  - D SMS,SMSVSAM,QUIESCE
- OA19421
  - Move index buffer above the bar for release 1.7 and above
- OA19975
  - Change the wait time for the castout lock in the RLS read path from 0.03second/0.000026 seconds to 0.0015 seconds.
- OA16676, OA16870, OA17643
  - Remove Assignedspheres ENQ hang

Recommended APARs

- OA17644, OA18070, OA18541, OA18285, OA18688, OA18902
  - SCM RAS APARs
- OA20367
  - RLS/Catalog hang in Open/Delete
- OA21705
  - Fix the storage leaks in MMFSTUFF dataspace
- OA18933
  - SSF compress/expand pool failure

Recommended APARs

- OA17556
  - D SMS,SMSVSAM,DIAG(CONTENTION)
    - Display TCBs in latches contention
- OA12045, OA12851, OA16982
  - VERBX IGWFPMAN ‘F(IPCS)’ From IPCS Panel
    - Q - Analyze current Failure
    - AS - Analyze current Address Space Threads
    - POOLS - Analyze SSF Pools

Recommended APARs

D SMS,SMSVSAM,DIAG(CONTENTION) - example #1

```
SYSTEM1        d sms,smsvsam,diag(contention)
SYSTEM1        IGW343I VSAM RLS DIAG STATUS (V.01)
|---RESOURCE----|                |------ WAITER ------|  |--HOLDER---|    ELAPSED
    TYPE       ID      JOB NAME       ASID   TASK          ASID   TASK        TIME
    --------    --------      --------        ----     --------        ----    --------     --------
LATCH    7F158C70 SMSVSAM       003A  008DA250     003A  008D7218  00:00:06
   DESCRIPTION: IGWLYSPH - SHM OBJECT POOL
LATCH    7F151E78 SMSVSAM       003A   008D7218     003A  008DC1C8 00:00:21
   DESCRIPTION: IGWLYDTS - SHM OBJECT POOL
LATCH    7BAD43B8 SMSVSAM       003A   008DC1C8     002D  007F3000  00:19:09
LATCH    7BAD43B8 SMSVSAM       003A   008D5A48     002D  007F3000  00:22:09
LATCH    7BAD43B8 SMSVSAM       003A   008D6938     002D  007F3000  00:33:23
LATCH    07F1B1D0 SMSVSAM      003A    008D64F8     003A  008D6CF0  01:47:20
LATCH    07F1D3B8 SMSVSAM      003A    008D6CF0     0000  00000000   11:23:30
```

Recommended APARs

D SMS,SMSVSAM,DIAG(CONTENTION) - example #2

```
SYSTEM1         d sms,smsvsam,diag(contention)
SYSTEM1         IGW343I VSAM RLS DIAG STATUS (V.01)
|---RESOURCE----|                 |------ WAITER ------|  |--HOLDER---|    ELAPSED
    TYPE       ID      JOB NAME      ASID   TASK         ASID   TASK        TIME
    --------   --------    --------      ----    --------       ----    --------     --------
LATCH    7BAD43B8 SMSVSAM      003A   008D5A48     003A  007F3000  00:22:09
LATCH    07F1B1D0  SMSVSAM     003A   007F3000     003A  008D5A48  00:22:09
LATCH    07F1B1D0 SMSVSAM      003A    008D64F8    003A  008D5A48  00:22:24
LATCH    07F1B1D0 SMSVSAM      003A    008D6CF0    003A  008D5A48  00:23:30
```

Recommended APARs

IP VERBX IGWFPMAN ‘F(IPCS)’ - example

```
Function(F)   Component    AddressSpace   Analysis  IPCSPrint         Help
---------------------SMS PDSE IPCS MAIN----------------------------------------

 COMMAND===>

 Function(         )  Component(           )  CB@( 00000000        )

 JOB( SMSVSAM  ) or ASID( 000A  )

 VERB===> IGWFPMAN

 Primary( 000A : SMSVSAM  ) Secondary( 000A : SMSVSAM  )

 Dump: Dump Name
 Title: Dump Title
```

Summary

- RLS provides full read/write integrity to your existing VSAM files.
- RLS can improve both performance and availability in your CICS and non-CICS VSAM environments.
- RLS provides data protection after a system failure.
- RLS provides automation for data recovery.
- Improved RAS
- Minimal application/configuration changes required.

Summary

- RLS has been enhanced to perform data recovery in the form of:
  - transactional recovery
  - data set recovery.
- VSAM RLS Applications can take advantage of RLS's new data recovery by using the RRS commit and backout protocols.
- VSAM RLS Applications should reconsider restart procedures in a shared environment.

Trademarks

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