z/OS 3.1 IBM Education Assistant

Solution Name: RSM Dedicated Real Memory Pools >4T for specific functions

Solution Element(s): BCP/RSM, BCP/zCX, BCP/SVA

July 2023

Agenda

- Trademarks

- Objectives

- Overview

- Usage & Invocation

- Interactions & Dependencies

- Upgrade & Coexistence Considerations

- Installation & Configuration

- Summary

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Trademarks

- See url http://www.ibm.com/legal/copytrade.shtml for a list of trademarks.
- Additional Trademarks:
  - None

Objectives

- Facilitate the usage of >4T real memory

- Assign memory directly to applications instead of first come first serve
  - Avoid system disruptions due to memory spikes or irregular memory usage patterns

Overview

- Who is interested:
  - Installations that are concerned about applications with irregular or unpredictable memory usage
    - SVC Dump capture
  - Installations that want to preferentially assign memory to certain applications that exploit high virtual storage
    - zCX containers
  - Installations that want to exploit >4T of memory

- What (Solution)
  - Provide the ability for the system administrator to define an amount of real storage that can be used to be directly assigned to job steps
  - Provide the ability to assign Dedicated Memory in 2G units directly to applications and support its use transparently
  - Provide diagnostics aids to determine how effectively the Dedicated Memory is used

- Wow (Benefit / Value, Need Addressed)
  - Utilization of >4T for applications that do not exploit 2G frames
  - Mitigate disruptions from SVC DUMP
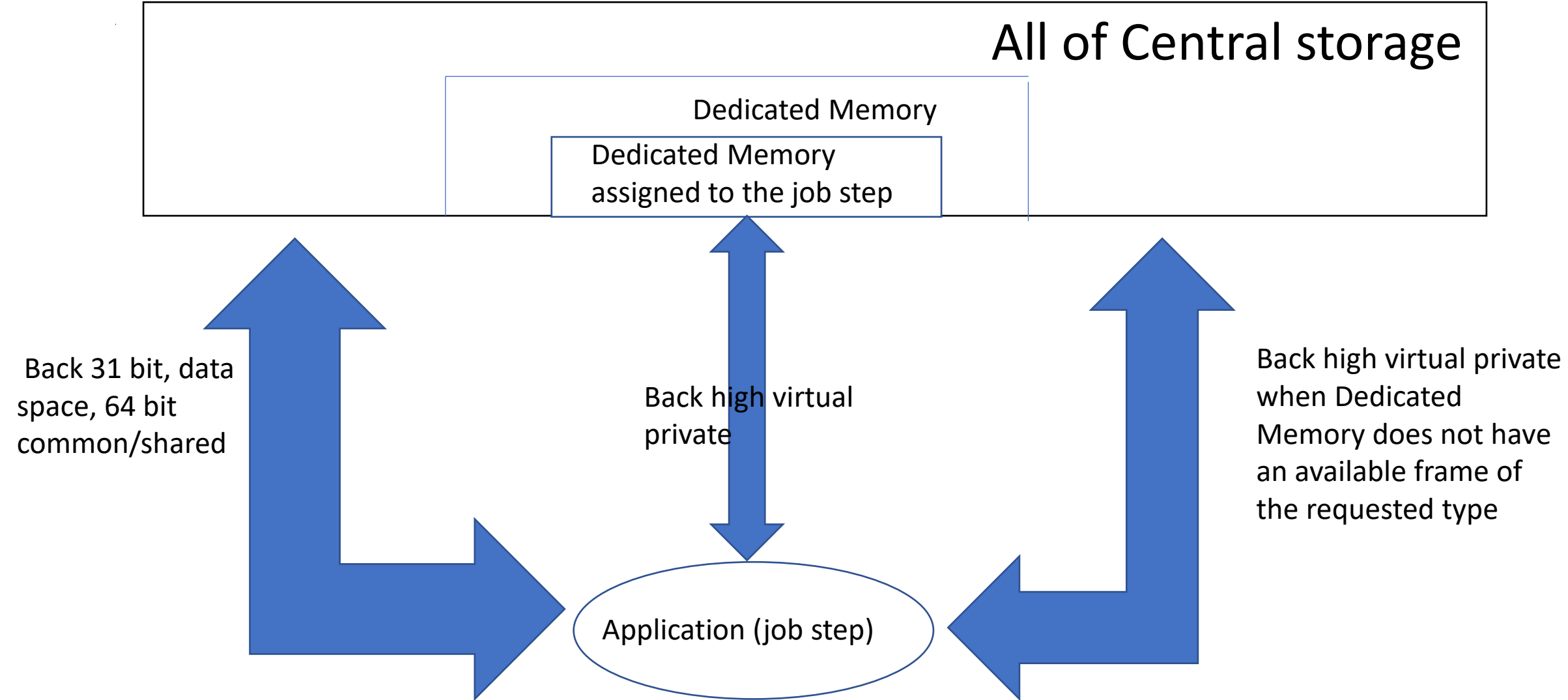 - Better control over memory

Dedicated Memory Usage

- Is used (transparently) back any private memory object as long as the memory object is freed at end of job step i.e. owned by the job step task or a descendent
    - Is used transparently to back page tables of such memory objects
- Is used to back any private memory object if the address space is a single step started task (also any DAT tables)
    - DUMPSRV
    - zCX
- New SMF30 and SMF71 fields for instrumentation (see appendix)
- Never paged/stolen – address space owns the memory until end of job step, regardless of whether it actually uses the memory
- Dedicated Memory assignment not incorporated into SYSEVENT STGTEST result
- Not counted against MEMPOOL

Dedicated Memory Usage

- Not used for 31 bit memory (data spaces, hiperspaces, 31 bit address space)

- Not used for common or shared high virtual

- Not used for paging I/O

- Not included in existing frame counts

- Cannot be used for OMVS

Dedicated Memory Usage

All of Central storage

Dedicated Memory

Dedicated Memory assigned to the job step

Back 31 bit, data space, 64 bit common/shared

Back high virtual private

Back high virtual private when Dedicated Memory does not have an available frame of the requested type

Application (job step)

Interactions & Dependencies

- Software Dependencies
    - None

- Hardware Dependencies
    - None

- Exploiters
    - Exploitation is up to the installation, however, the following applications are recommended
        - zCX container instances
        - DUMPSRV

Upgrade & Coexistence Considerations

- To exploit this solution, all systems in the Plex must be at the new z/OS level: No

- Toleration/coexistence APARs/PTFs.
    - None

Installation and Configuration

- In order to define Dedicated Memory to the system, the new parmlib member IARPRMxx needs to be specified with the new DEDICATEDMEMORY parameter:
  - DEDICATEDMEMORY(xxG|xxT)

- New IEASYSxx parm RSM=
  - RSM=(xx,yy) – where xx and yy correspond to IARPRMxx and IARPRMyy

- The size of the reserved dedicated memory area cannot be dynamically changed after IPL.

- Rules for DEDICATEDMEMORY
  - Must have at least 16G of online NON-Dedicated Memory after the Dedicated Memory area is designated
  - Total system storage must be a multiple of 2G
  - Must be specified as a 2G multiple
    - System will round up or down to a storage increment multiple if necessary

Initialization & IPL Considerations

- How much Dedicated Memory to designate on an image?
  - DUMPSRV – DISPLAY DUMP,INFO can be used to obtain historical sizes of SVC dumps for the current ipl
  - zCX – Already requires knowing how much memory to assign
  - Should not exceed Memlimit

- Some Dedicated Memory is used to manage Dedicated Memory
  - For every 256G of assignable Dedicated Memory, the system needs 2G to manage it
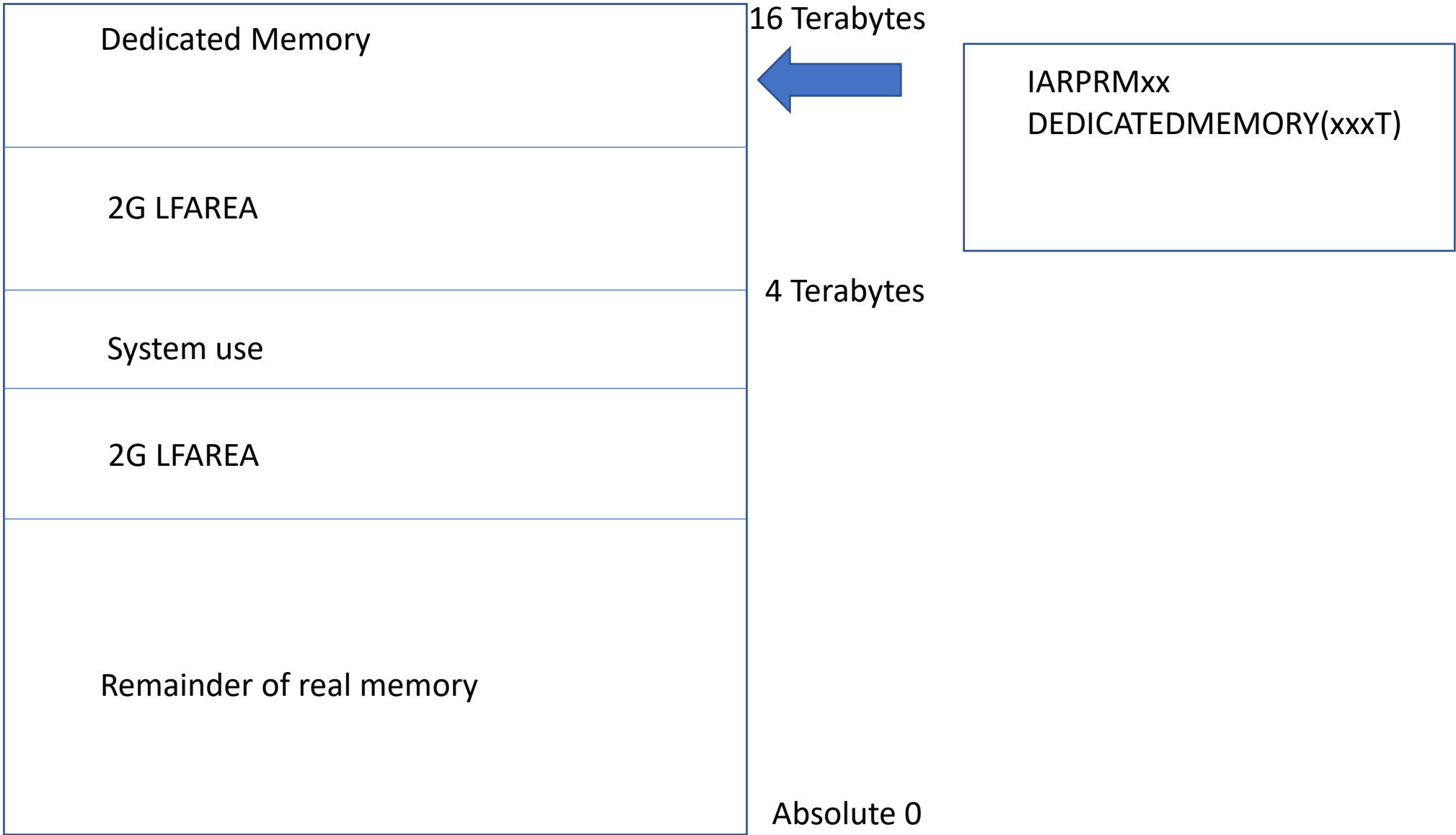   - Define more Dedicated Memory than you plan to assign

Initialization & IPL Considerations

- Historical real memory usage
  - SMF30HVR –High water mark of the number of real storage frames that are used to back 64-bit private storage.
  - SMF30HVA –High water mark of the amount of auxiliary storage that is used to back 64-bit private storage.
  - SMF30_InUseAs2GHWM –High water mark of the number of 2G frames in use by the job step (new in R3.1)
  - SMF30_NUM2GFailed -Number of 2G frames that could not be obtained because none were available at the time of the IARV64 GETSTOR request (new in R3.1)
- Possible estimate (over-estimate)
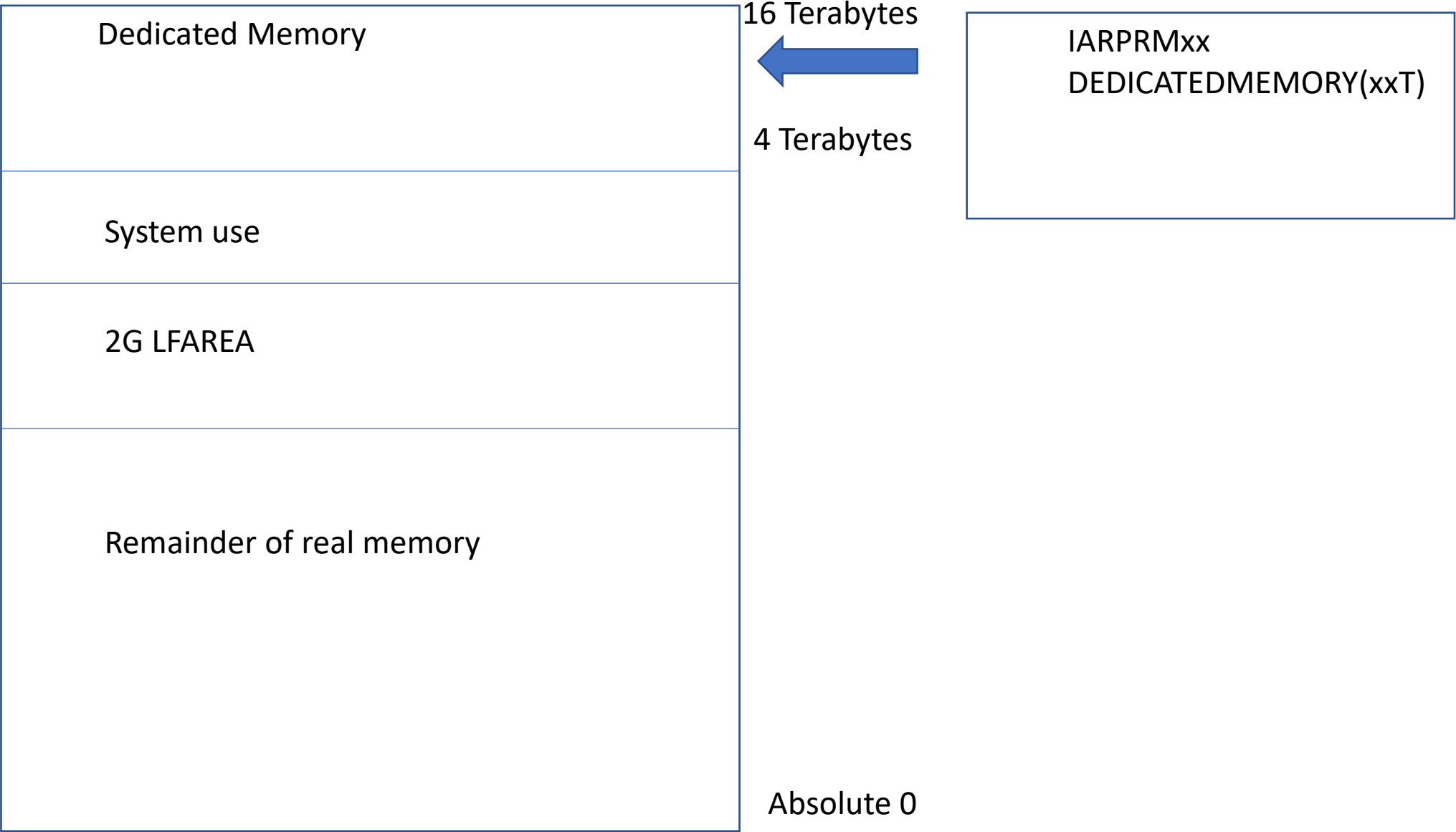 - ((SMF30HVR+SMF30HVA)*4K+SMF30_InUseAs2GHWM*2G)

Initialization & IPL Considerations

- Some Dedicated Memory is used to manage Dedicated Memory and cannot be assigned to any job step
  - Referred to as system-assigned
- Approximately 2G out of every 124G of defined Dedicated Memory is system-assigned
- Example: If you want to define 400G of assignable Dedicated Memory then
  - 400/124 = 4 (rounded up) – 408G should be requested.

Dedicated Memory and 2G LFAREA above 4T

16 Terabytes

Dedicated Memory

IARPRMxx
DEDICATEDMEMORY(xxxT)

2G LFAREA

4 Terabytes

System use

2G LFAREA

Remainder of real memory

Absolute 0

Just Dedicated Memory above 4T

Dedicated Memory

16 Terabytes

4 Terabytes

IARPRMxx
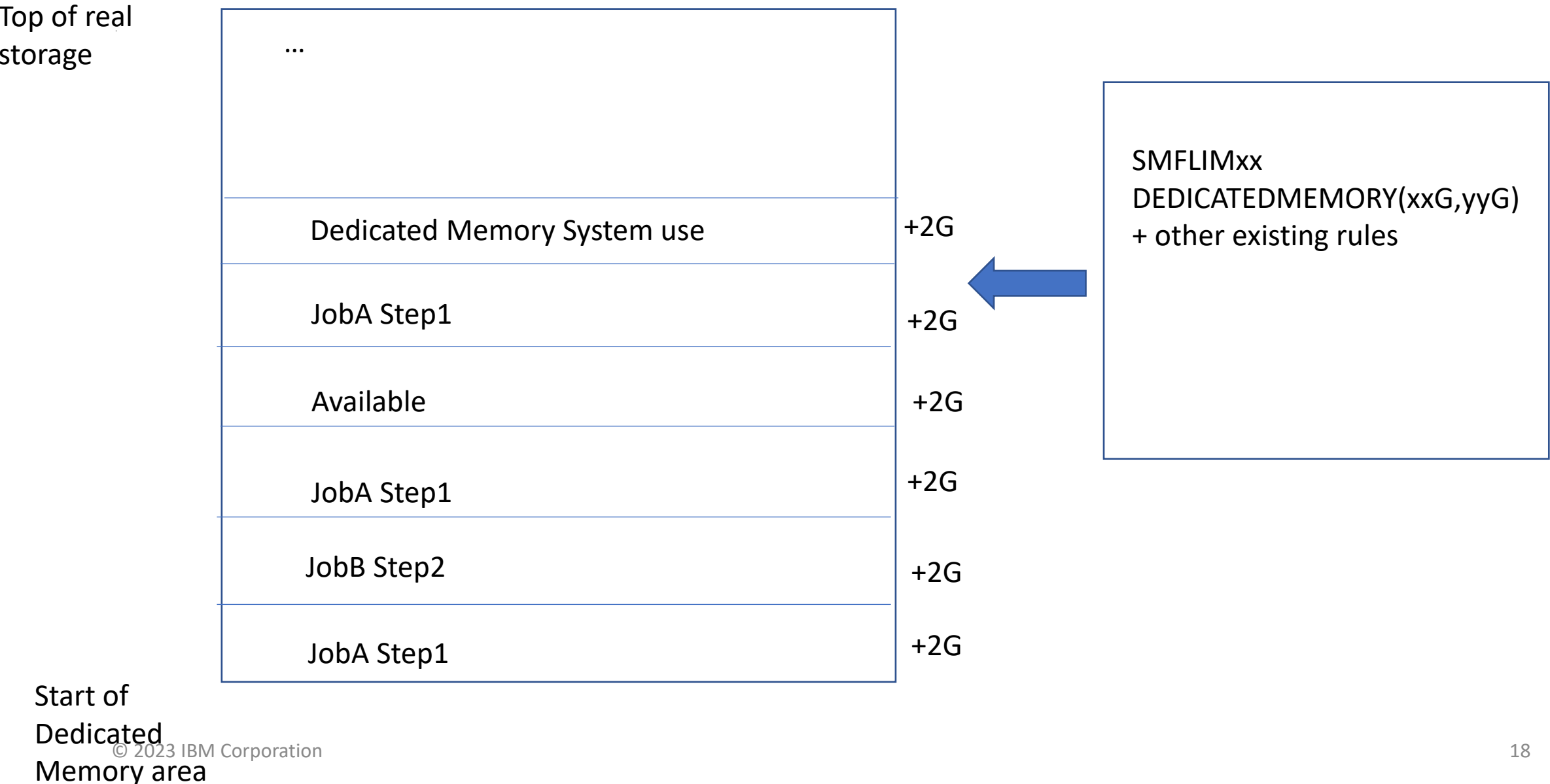DEDICATEDMEMORY(xxT)

System use

2G LFAREA

Remainder of real memory

Absolute 0

Installation and Configuration

- Dedicated Memory is designated at the top of real storage

- A portion of Dedicated Memory is used by the system to manage dedicated memory.

- Dedicated memory is not completely ready for use until all of real storage is initialized as indicated by

  - message IAR060I (new) displayed
  - the new IAXVWAIT service
    - Allows an application to wait for real storage initialization to complete
  - RCERealFramesInitialized set to 1b

- System will "circle back" to those applications that requested Dedicated Memory when memory was still initializing

  - Once memory initialization is complete, assignments that were not completely satisfied during MSI will be satisfied.

- IAR060I REAL STORAGE INITIALIZATION COMPLETE. DEDICATED MEMORY AREA: xxG ONLINE, xxG OFFLINE

Dedicated Memory assignments

Top of real
storage

...

Dedicated Memory System use +2G

JobA Step1 +2G

Available +2G

JobA Step1 +2G

JobB Step2 +2G

JobA Step1 +2G

SMFLIMxx
DEDICATEDMEMORY(xxG,yyG)
+ other existing rules

Start of
Dedicated
Memory area

Initialization & IPL Considerations

- In order to assign Dedicated Memory to applications, parmlib member (SMFLIMxx) needs to be specified with the new DEDICATEDMEMORY parameter:
  - DEDICATEDMEMORY(0G,8G)
    - First value is the minimum amount of dedicated memory to assign
    - Second value is the target amount of dedicated memory to assign
    - If the minimum could not be satisfied, the application will be cancelled unless the application is a system address space
    - See the addendum for syntax rules and example messages.
- The amount of assigned dedicated memory to a job step can be dynamically changed after IPL through the SET SMFLIM command.
  - Note that if the application had started before the SET SMFLIM command, the change in size will not take effect until the application is restarted.

Initialization & IPL Considerations

Example of assigning up to 4G of Dedicated Memory to DUMPSRV:

REGION

JOBNAME(DUMPSRV)

DEDICATEDMEMORY(0G,4G)

Initialization & IPL Considerations

REGION SYSNAME(AQTS) JOBNAME(BIGSORT*) STEPNAME(GREEDY) DEDICATEDMEMORY(100G) MEMLIMIT(100G)

REGION SYSNAME(AQTS) JOBNAME(BIGSORT*) STEPNAME(LEAN)

DEDICATEDMEMORY(0G,10G) MEMLIMIT(10G)

Expected result: Say that step GREEDY goes first. If the system has 100G of dedicated memory it is provided to GREEDY, otherwise the job is cancelled. GREEDY runs to completion.   LEAN job step only requires 10G of dedicated memory.   Job step initialization frees 90G before LEAN runs.

Initialization & IPL Considerations

- zCX initialization has changed to take Dedicated Memory into account when deciding whether the container can start
  - Previously just uses results from SYSEVENT STGTEST to determine the impact to the system
  - SYSEVENT STGTEST just reports on non-Dedicated Memory
- SVC dump processing has changed to capture to high virtual storage in the OPTIMIZE=NO path
  - Already captures to high virtual in the OPTIMIZE=YES path
  - Ensures that Dedicated Memory is used when Dedicated Memory is assigned to DUMPSRV

Installation and Configuration

```
IAR0131 4G STORAGE IS RECONFIGURABLE
IAR073I MEMORY CONFIGURATION
 TOTAL MEMORY: 64G
 ONLINE MEMORY: 64G
--------------- REQUESTED AMOUNTS ----------------
 DEDICATEDMEMORY: 32G--IARPRMH2
 LFAREA: *NOT REQUESTED*
 RSU: 10%
--------------- ACTUAL AMOUNTS ------------------
 DEDICATED MEMORY: 32G
 ONLINE DEDICATED MEMORY: 32G
 ASSIGNABLE DEDICATED MEMORY: 30G
 2G LFAREA: 0M
 2G LFAREA ABOVE 4T: 0M
 1M LFAREA LIMIT: 0M
 RECONFIGURABLE (RSU): 4G
 ONLINE RECONFIGURABLE (RSU): 4G
IAR077A REPLY C TO CONTINUE WITH THE MEMORY CONFIGURATION OR CHANGE IT AND
 RE-IPL.
```

Installation and Configuration

- The Dedicated Memory area is reconfigurable when the storage increment size is at least 2G

- Reconfiguration rules are different than for NON-Dedicated Memory
  - Only Dedicated Memory that is not assigned to a job and not in use by the system is eligible to be configured offline
  - All of Dedicated Memory can be configured offline if no job steps are assigned Dedicated Memory

- NOTE – As in 2.5, all memory reconfiguration is disabled if there is any non-Dedicated Memory above 4T (this has not changed)
  - RSU parameter is accepted if (1) there is no memory defined above 4T or (2) All the memory defined above 4T is Dedicated Memory
  - NOTE: RSU only applies to non-Dedicated Memory

Memory Reconfiguration

- Recall - three different types of memory reconfiguration:
  - By Range: CONFIG STOR(xx-yy),ONLINE/OFFLINE
  - By Amount: CONFIG STOR(xx),ONLINE/OFFLINE
  - By Element: CONFIG STOR(E=1),ONLINE/OFFLINE

- Changes for Dedicated Memory:
  - By Range – Ranges cannot span Dedicated Memory and NON-Dedicated Memory
  - By Amount: New DMEM keyword must be specified
    - CONFIG STOR(xx),DMEM,ONLINE/OFFLINE
  - A storage element with a mixture of Dedicated and NON-Dedicated Memory can be configured online or offline

D M=HIGH,DMEM

IEE174I changed to report on the range of Dedicated Memory

```
 IEE174I 14.19.58 DISPLAY M            FRAME LAST    F      E    SYS=S7E0
 DEDICATED MEMORY SIZE STATUS
 STARTING ADDRESS IS  32G
 ENDING ADDRESS IS   64G




IEE612I CN=RSMCON1   DEVNUM=03E0 SYS=S7E0


IEE163I MODE= RD
```

D M=STOR

- IEE174I changed to report on online ranges of Dedicated Memory

- D M=STOR,DMEM (new)
  - Reports which DMEM ranges are reconfigurable

D M=STOR

```
   IEE174I 16.27.23 DISPLAY M                      FRAME LAST
   REAL STORAGE STATUS
ONLINE-NOT RECONFIGURABLE
     0G-32G
ONLINE-RECONFIGURABLE
     32G-48G
ONLINE-DEDICATED MEMORY
     48G-60G
PENDING OFFLINE
     NONE
  0M IN OFFLINE STORAGE ELEMENT(S)
  4G UNASSIGNED STORAGE
STORAGE INCREMENT SIZE IS 4G



IEE612I CN=RSMCON1   DEVNUM=03E0 SYS=S7E0


IEE163I MODE= R
```

D M=STOR,DMEM

```
00- d m=stor,dmem
 IEE174I 10.37.41 DISPLAY M           FRAME  1    F     E   SYS=S7E0
 DEDICATED MEMORY STATUS
 ONLINE-DEDICATED MEMORY, SOME SYSTEM ASSIGNED - NOT RECONFIGURABLE
     60G-64G
 ONLINE-DEDICATED MEMORY, SOME ASSIGNED TO A JOB - NOT RECONFIGURABLE
     52G-64G
 ONLINE-DEDICATED MEMORY - RECONFIGURABLE
     32G-52G
 PENDING OFFLINE
     NONE
IEE612I CN=RSMCON1   DEVNUM=03E0 SYS=S7E0

―

IEE163I MODE= RD
```

Display Matrix with DMEM option

- ONLINE- DEDICATED MEMORY, SOME ASSIGNED TO SYSTEM – NOT RECONFIGURABLE
  - Some part of the increment is used to manage Dedicated Memory.   Can be reconfigured offline only if the portion that it is used to manage goes offline.
- ONLINE-DEDICATED MEMORY, SOME ASSIGNED TO A JOB – NOT RECONFIGURABLE
  - Some part of the increment is assigned to a job
  - May not actually be used by the job
  - Cannot be configured offline until the job completes or the job step completes and the next jobstep does not require Dedicated Memory (or at least frees the memory associated with the increment being configured)
- ONLINE-DEDICATED MEMORY – RECONFIGURABLE
  - Ranges of Dedicated Memory that can be configured offline without cancelling a job.

D M=STOR,DMEM

```
                      (STETISE EIBRANI ESCHABISE CAIIICAE IAIEONE (ABEND SSES SSS)
     *  REASON=00000401)
00-  $HASP395 BPXAS     ENDED - RC=0000
  -  $HASP250 BPXAS PURGED -- (JOB KEY WAS DC322641)
 IEE174I 15.32.28 DISPLAY M               FRAME LAST   F     E   SYS=S7E0
 DEDICATED MEMORY STATUS
 ONLINE-DEDICATED MEMORY - RECONFIGURATION DISABLED
     32G-64G
  0M IN OFFLINE STORAGE ELEMENT(S)
  0M UNASSIGNED STORAGE
 STORAGE INCREMENT SIZE IS 1G


              _



IEE612I CN=RSMCON1   DEVNUM=03E0 SYS=S7E0



IEE163I MODE= RD
```

D M=STOR,DMEM

```
D M=STOR,DMEM
IEE174I 17.35.19 DISPLAY M 250
DEDICATED MEMORY STATUS
ONLINE-DEDICATED MEMORY, SOME SYSTEM ASSIGNED - NOT RECONFIGURABLE
     NONE
ONLINE-DEDICATED MEMORY, SOME ASSIGNED TO A JOB - NOT RECONFIGURABLE
     NONE
ONLINE-DEDICATED MEMORY - RECONFIGURABLE
     NONE
PENDING OFFLINE
     48G-64G
PENDING STATUS DUE TO:
RANGE                 ASID      JOBNAME
 56G-62G              29        RSJCEX06
 50G-56G              2A        RSJCEY06
 0M IN OFFLINE STORAGE ELEMENT(S)
 0M UNASSIGNED STORAGE
STORAGE INCREMENT SIZE IS 4G
```

D M=STOR(E)

```
 - d m=stor(e)
 IEE174I 10.50.20 DISPLAY M            FRAME LAST    F      E    SYS=S7E0
 ADDITIONAL ELEMENT STATUS
 0:  DMEM=0M
 1:  DMEM=16G




 IEE612I CN=RSMCON1    DEVNUM=03E0 SYS=S7E0

 _

 IEE163I MODE= RD
```

IAXDMEM

- SYSREXX Exec for querying memory information.
  - MODIFY AXR,IAXDMEM <parameters>

- New Parameters
  - DMEM
  - DMEM,JOBLIST
  - DMEM,JOBNAME=jjjjjjjjj
  - DMEM,ASID=nnnn

F AXR,IAXDMEM DMEM


```
* END
00- f axr,iaxdmem dmem
    IAR067I DEDICATED MEMORY V1.0
        36.0GB : TOTAL SIZE
         0.0GB : OFFLINE SIZE
        26.0GB : UNASSIGNED
         2.0GB : SYSTEM USE
IEE612I CN=RSMCON1   DEVNUM=03E0 SYS=S7E0

_

IEE163I MODE= RD
```

F AXR,IAXDMEM DMEM,JOBLIST

```
         2.0GB : SYSTEM USE
00- @iaxdmem dmem,joblist
    IAR068I DEDICATED MEMORY V1.0
    JOBNAME  ASID        ASSIGNED          IN USE
    AS01     0020            8.0GB            8.0GB
IEE612I CN=RSMCON1   DEVNUM=03E0 SYS=S7E0

_

IEE163I MODE= RD
```

F AXR,IAXDMEM DMEM,JOBNAME=xx

```
JOBNAME=AS01      ASID=0020
    8.0GB : ASSIGNED
    8.0GB : IN USE
    8.0GB : MAX IN USE
PAGEABLE 4K STATISTICS
    0.0MB : IN USE FOR PAGEABLE 4K PAGES
    0.0MB : MAX IN USE FOR PAGEABLE 4K PAGES
PAGEABLE 1M STATISTICS
    0.0MB : IN USE FOR PAGEABLE 1M PAGES
    0.0MB : MAX IN USE FOR PAGEABLE 1M PAGES
FIXED 1M STATISTICS
    0.0MB : IN USE FOR FIXED 1M PAGES
    0.0MB : MAX IN USE FOR FIXED 1M PAGES
FIXED 2G STATISTICS
    8.0GB : IN USE FOR FIXED 2G PAGES
    8.0GB : MAX IN USE FOR FIXED 2G PAGES
DAT TABLE STATISTICS
    0.0MB : IN USE FOR DAT TABLES
```

New APIs

- IARQUERY
  - Authorized service to obtain information about real storage usage
- IAXVWAIT
  - Unauthorized service to wait for memory initialization to complete
- IARXNDM
  - Authorized service to obtain system information about Dedicated Memory usage

Summary

- Dedicated Memory is an installation defined area of memory that can be assigned in 2G units at the job step level

- Can be defined above 4T

- Only used for High Virtual Private

- Avoids first come first serve – provides a way to ensure that applications have sufficient memory

Appendix

- z/OS MVS: Initialization and Tuning Guide
- z/OS MVS: Initialization and Tuning Reference
- z/OS MVS: System Commands
- z/OS MVS: Authorized Assembler Services Reference
- z/OS MVS: Assembler Services Reference
- z/OS MVS: Authorized Assembler Services Guide
- z/OS MVS: System Messages
- z/OS MVS: System Management Facilities

Addendum

- Additional material on SMFLIMxx syntax and messages

- Additional material on IARPRMxx syntax

- Additional material on IARQUERY, IAXVWAIT, and IARXNDM

SMFLIMxx syntax

- New REGION attribute DEDICATEDMEMORY(xxxxxu[,yyyyyu]) identifies how much dedicated memory to assign.
    - The first value (xxxxxu) is the minimum amount of dedicated memory to assign.
        - It can be 1-5 digits, followed by the number of units (G=gigabytes, T=terabytes, P=petabytes).
        - Any value from 0G to 16384P is valid, but it must be a multiple of 2G.
    - The second value (yyyyyu) is the target amount of dedicated memory to assign.
        - Like the first value, must be 1-5 digits, G/T/P units, any value from 0G-16384P, must be a multiple of 2G.
        - This value is optional, and if not specified, will be the same as the first value (the minimum amount.)
- The DEDICATEDMEMORY keyword can be combined with any of the existing filters (like JOBNAME) and attributes (like MEMLIMIT.)
    - If you share the SMFLIMxx parmlib member with pre-z/OS 3.1 systems, those systems will not recognize the DEDICATEDMEMORY keyword and will ignore any rule with that specified. In this situation, create separate rules for DEDICATEDMEMORY, or use the SYSNAME filter to only apply the rules specifying DEDICATEDMEMORY to the z/OS 3.1 systems.

SMFLIMxx messages

- Message IEF043I will indicate the steps that SMFLIM processing has performed, if it is not suppressed using the JOBMSG(SUPPRESS) attribute.
  - Example of message when the job applied dedicated memory:

    ```
    IEF043I Actions taken by SMFLIMxx parmlib policy for MYJOB MYSTEP
    Step Dedicated Memory changed to (00002G,00008G) by policy - SMFLIM00 0001
    ```

  - Example of message when the job was cancelled due to insufficient dedicated memory:

    ```
    IEF043I Actions taken by SMFLIMxx parmlib policy for MYJOB MYSTEP2
    Step cancelled due to insufficient Dedicated Memory value (00002G,00002G) by policy – SMFLIM00 0002
    ```

Other RSM messages

- IAR062I JOBNAME <jjjjjjjjj> ASSIGNED ADDITIONAL DEDICATED MEMORY.TOTAL REQUESTED=<rrrrr>G|T|P, TOTAL ASSIGNED=<aaaaa>G|T|P

- IAR063I NO DEDICATED MEMORY WAS ASSIGNED. DEDICATED MEMORY REQUESTED=<nnnnn>G|T, AVAILABLE=<nnnnn>G|T
  - Job is cancelled (unless system address space)

- IAR064I xxxxG|T DEDICATED MEMORY ASSIGNED

- IAR065I JOB IS NOT ELIGIBLE FOR DEDICATED MEMORY
  - OMVS is not eligible

IARPRMxx syntax

- DEDICATEDMEMORY(mmG | nnT)

- DMEM(mmG|nnT)

Specifies the amount of real memory to be designated as Dedicated Memory where the suffixes G represents Gigabytes and T represents Terabytes. The amount must be a multiple of 2G and the total amount of configured memory on the system must equal a multiple of 2G. The system rounds the specified value up or down to a storage increment multiple. Dedicated Memory is designated from the top of Central Storage, regardless of whether the memory is online. At least 16G of online non-Dedicated Memory must exist after the Dedicated Memory designation, otherwise the request is rejected. Some amount of Dedicated Memory must be used by the system to manage Dedicated Memory; at least 4G must be requested.

IARPRMxx syntax

- PROMPT(NO|YES)

Specifies whether the system should prompt the operator to continue with the IPL after message IAR073I is issued. Message IAR073I describes the system's memory configuration, including the amount of Dedicated Memory.

SMF30/RAX fields

SMF Field name	Offset	Size/Format	RAX Field	Description
SMF30_DMEMRequestedt2G	256/ 100x	8/FIXED	RAX64_DMemRequested2G	Requested Dedicated Memory in 2G units at start of job step
SMF30_DMEMMinRequested2G	264/ 108x	8/FIXED	Rax64_DMemMinRequested2G	Requested minimum amount of Dedicated Memory in 2G units at start of Job Step.
SMF30_DMEMAssigned2G	272/ 110x	8/FIXED	RAX64_DmemAssigned2G	Assigned Dedicated Memory in 2G units at start of job step
SMF30_DMEMNumInUseAs2G	280/ 118x	8/FIXED	RAX64_DMEMInUseAs2G	Number of 2G Dedicated Memory frames in use
SMF30_DMEMNumInUseAsFixed1M	288/ 120x	8/FIXED	Rax64_DMemInUseAs1MFixed	Number of Fixed 1M Dedicated Memory frames in use
SMF30_DMEMNumInuseAsPageable1M	296/ 128x	8/FIXED	Rax64_DMemInUseAs1MPageable	Number of pageable 1M Dedicated Memory frames in use

SMF30/RAX fields

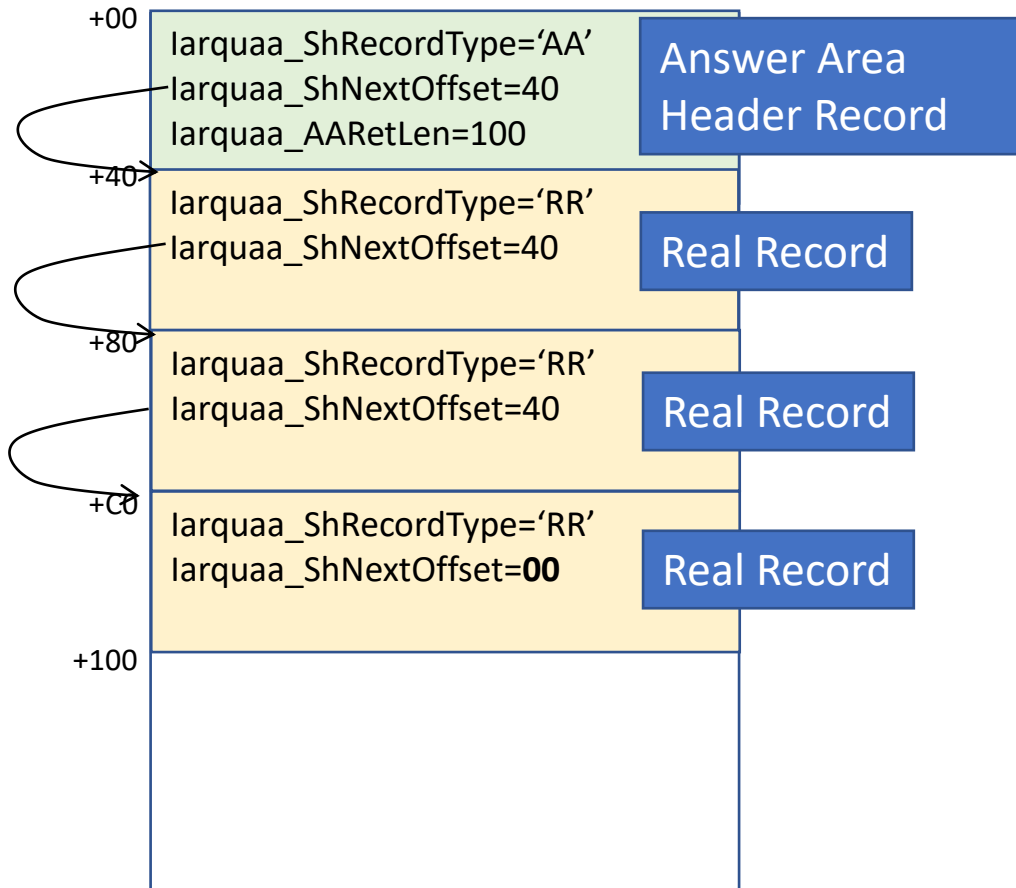| SMF Field name	Offset	Size/Format	RAX Field	Description
SMF30_DMEMNumInUseAs4K	304/ 130x	8/FIXED	Rax64_DMemInUseAs4K	Number of 4K Dedicated Memory frames in use
SMF30_DMEMNumInUseAsDATTables	312/ 138x	8/FIXED	Rax64_DMemQuadGroups*4+Rax64_D MemPGTs	Number of 4K Dedicated Memory frames in use as DAT tables
SMF30_DMEMNumInUseAs4KHWM	320/ 140x	8/FIXED	Rax64_DMemInUseAs4KHWM	High water mark for the number of Dedicated real storage frames (4K units) that is used to back 64-bit private storage.
SMF30_DMEMNumInUseAsPageable1MHWM	328/ 148x	8/FIXED	Rax64_DMemInUseAs1MPageableHWM	High water mark for the number of Dedicated real storage frames (1M units) that is used to back Pageable 1M pages
SMF30_DMEMNumInuseAsFIXED1MHWM	336/ 150x	8/FIXED	Rax64_DMemInUseAs1MFixedHWM	High water mark for the number of Dedicated real storage frames (1M units) that is used to back Fixed 1M pages
SMF30_DMEMNumInUseAs2GHWM	344/ 158x	8/FIXED	RAX64_DMEMInUseAs2GHWM	High water mark for the number of Dedicated real storage frames (4K units) that is used to back 2G pages

SMF30/RAX fields

SMF Field name	Offset	Size/Format	RAX Field	Description
SMF30_DMEMNumInUseAsDATTablesHWM	352/ 160x	8/FIXED	Rax64_DMEMInUseAsDATTablesHWM	High water mark of the number of Dedicated real storage frames (4K units) that is used to back DAT tables
SMF30_DMEMNumInUseHWM	360/ 168x	8/FIXED	Rax64_DMemInUseHWM	High water mark of the number of Dedicated Memory frames in use in 4K units
SMF30_DMEMNum2GFailed	368/ 170x	8/FIXED	Rax64_DMem2GFailedCnt	Count of requested 2G frames eligible to backed by Dedicated Memory frames but were not due to availability
SMF30_DMEMNum1MFailed	376/ 178x	8/FIXED	Rax64_DMem1MFailedCnt	Count of requested 1M frames eligible to backed by Dedicated Memory frames but were not due to availability
SMF30_DMEMNum4KFailed	384 180x	8/FIXED	Rax64_DMem4KFailedCnt	Count of requested 4K frames eligible to backed by Dedicated Memory frames but were not due to availability
SMF30_NumInUseAs2GHWM	392/ 188x	8/FIXED	RAX64_2GPagesBackedInRealHWM	Number of 2G frames in use by the job step high water mark
SMF30_Num2GFailed	400/ 190x	8/FIXED	RAX64_2GFailedCnt	Number of 2G frames that could not be obtained because none were available at the time of the IARV64 request.

IARQUERY Service

- New IARQUERY service to obtain real storage information.
  - **IARQUERY REQINFO=REAL**
    - Return information about specific frames of real storage
  - **INSTARTADDR=,INCOUNT4K=**
    - Start of real storage range and size of range in 4K units
  - **OUTANSAREA=,INANSLEN=**
    - Address and length of output answer area
  - **[STOKEN=, [IncludeDS=YES/NO]]**
    - Filter by address space or data space STOKEN, include data spaces owned by address space
  - **RETCODE=,RSNCODE=**
    - Return and reason codes

- Authorized callers only, must be enabled for interrupts
- Most processing is done unserialized, and runs enabled

Answer Area Format

Iarquaa_ShRecordType='AA' Iarquaa_ShNextOffset=40 Iarquaa_AARetLen=100	Answer Area Header Record
Iarquaa_ShRecordType='RR' Iarquaa_ShNextOffset=40	Real Record
Iarquaa_ShRecordType='RR' Iarquaa_ShNextOffset=40	Real Record
Iarquaa_ShRecordType='RR' Iarquaa_ShNextOffset=**00**	Real Record

+00
+40
+80
+C0
+100

- Mapped by IARQUAA

- Answer Area Header Record
  - Contains overall length, record count, etc.
  - Resume address if output answer area fills

- Real Frame Record
  - Contains attributes of a frame of storage
  - Large frames are compressed into a single record

- Records are chained together by offset
  - Offset from start of current record to start of next record
  - Offset=0 indicates end of chain

- RC=4 with resume address if ANSAREA fills up before range is complete.

IARQUAA – Standard Header Fields

Field Name	Length	Description
Iarquaa_ShRecordType	2	Record Type
Iarquaa_ShVersion	1	Version
Iarquaa_ShLen	2	Length of this record
Iarquaa_ShNextOffset	2	Offset to next record

- Each Record in the answer area begins with a standard mapping.
  - This allows the record to be examined (and possibly skipped) without using the mapping for a specific record type
- PL/X uses ISA to define these fields so the Iarquaa_Shxxxx field names should always be used in PL/X (and ZTT).
- Assembler mapping defines the fields separately due to CBGEN restrictions with ISA fields.

IARQUAA – Answer Area Header Fields

Field Name	Length	Description
Iarquaa_AaRecordType	2	Record Type ("AA")
Iarquaa_AaVersion	1	Version
Iarquaa_AaLen	2	Length of this record
Iarquaa_AaNextOffset	2	Offset to next record
Iarquaa_AaId	8	Eyecatcher "IARQUAA"
Iarquaa_Aa#Rec	8	Number of records returned
Iarquaa_Aa#Rem	8	Number of records not returned due to insufficient space in answer area
Iarquaa_AaRetLen	8	Length of data returned
Iarquaa_AaMaxLen	8	Total space needed to contain all requested data
Iarquaa_AAResumeAddr	8	Resume address if additional calls needed

IARQUAA – Real Record Fields

Field Name	Length	Description
Iarquaa_RrRecordType	2	Record Type ("RR")
Iarquaa_RrVersion	1	Version
Iarquaa_RrLen	2	Length of this record
Iarquaa_RrNextOffset	2	Offset to next record
Iarquaa_RrRSA	8	Real Storage Address
Iarquaa_RrVSA	8	Virtual Storage Address
Iarquaa_RrShareToken	8	Share token for shared storage
Iarquaa_RrRangeSize	4	Number of 4K units represented by this record
Iarquaa_RrOwningAsid	2	Owning ASID
Iarquaa_RrFixCount	4	Fix Count

IARQUAA – Real Record Fields (continued)

Field Name	Length	Description
Iarquaa_RrAged	bit	Frame is aged
Iarquaa_RrDref	bit	Frame is DREF
Iarquaa_RrDataspace	bit	Dataspace Frame
Iarquaa_RrIOInProgress	bit	Paging I/O in progress
Iarquaa_RrTransition	bit	Frame may be in a transitional state
Iarquaa_RrFrameType	2	Frame Type Flags
Iarquaa_RrFrameUsage	2	Frame Usage
Iarquaa_RrFrameSize	1	Frame size (4k, 1M, 2G, quadframe, etc.)
Iarquaa_RrKey	bit(4)	Storage key if available
Iarquaa_RrFP	bit	Fetch protect status if available
Iarquaa_RrKeyFpValid	bit	Storage key and fetch protect status were returned

IARQUAA – IARQUAA_RrFrameType Flags

Field Name	Length	Description
Iarquaa_FtOffline	bit	Frame is offline
Iarquaa_FtPref	bit	Frame is preferred storage
Iarquaa_FtVirtEqReal	bit	V=R frame
Iarquaa_FtReconfigurable	bit	Frame is reconfigurable
Iarquaa_FtPermanent	bit	Permanent storage
Iarquaa_FtDatArea	bit	Frame is in reserved DAT frame area (Quad area)
Iarquaa_Ft2GArea	bit	Frame is in 2G LFAREA
Iarquaa_FtBadFrame	bit	Bad Frame
Iarquaa_FtDmemArea	bit	Frame is in Dedicated Memory area

IARQUAA – IARQUAA_RrFrameUsage Types

Field Name	Field Name	Field Name
Iarquaa_kUsageNotApplicable	Iarquaa_kUsageAvailable	Iarquaa_kUsageSystem
Iarquaa_kUsageNucleus	Iarquaa_kUsageFixedLPA	Iarquaa_kUsageFlawed
Iarquaa_kUsageUninitialized	Iarquaa_kUsageInTransition	Iarquaa_kUsagePftSpace
Iarquaa_kUsagePftDatTable	Iarquaa_kUsage31SQA	Iarquaa_kUsageCommon
Iarquaa_kUsageSharedGroup	Iarquaa_kUsageSharedSegment	Iarquaa_kUsageHVShared
Iarquaa_kUsagePrivate	Iarquaa_kUsage31LSQA	Iarquaa_kUsageDataSpace
Iarquaa_kUsageVioCache	Iarquaa_kUsage2GPage	Iarquaa_kUsageFreemained
Iarquaa_kUsageDatTable	Iarquaa_kUsageDeferDelete	Iarquaa_kUsageAssigned

Frame usage is mainly a translation of the PFTQID and PFTPGTYP fields, although other PFT values may factor in as well.   There is no direct 1-1 correspondence of the values.

IARQUERY Return Codes

- **IARQUAA_kRcOK** (**0**)
  - IARQUERY request completed successfully
- **IARQUAA_kRcWarn** (**4**)
  - IARQUERY request completed successfully, however warning has been issued.
  - RSN=**IARQUAA_kRsnAnsAreaFull** (xx0402xx) indicates that the request was partially satisfied but the provided answer area is full
- **IARQUAA_kRcParmError** (**8**)
  - IARQUERY request has parameters in error.
- **IARQUAA_kRcEnvError** (**12**)
  - IARQUERY request has an environment error.
  - For example, a disabled caller
- **IARQUAA_kRcCompError** (**16**)
  - IARQUERY request has encountered   a component error.

IAXVWAIT Service

- IAXVWAIT – Service to wait for memory to initialize
  - Can be LINK'd to
  - P=H=S, Task mode, unauthorized, AMODE 31, Primary ASC, no FRRs set
  - Register1 = 0 on input

IARXNDM service

- IARXNDM – Service to obtain Dedicated Memory system usage statistics
  - Callable service
  - Caller must include IAXEPVT for the address of the service
  - Key 0 Supervisor state, unlocked
  - Takes parameter mapped by IAXXNDM in Register 1

XNDM input fields and return codes

Field Name	Length	Description
XNDM_Id	8	The id of the control block
XNDM_Version	1	Version of the control block
Reserved space	7	Reserved space – must be 0

Return code (reg 15)	Reason code (reg 0)	Meaning
0	N/A	Successful completion
8	xx0001xx	XNDM_Id incorrect
8	xx0002xx	Incorrect version
8	xx0003xx	Reserved fields not zero
16	N/A	System failure

XNDM output fields

Field Name	Length	Description
XNDM_NumberOfJobsUsing DMEM	8	Total number of jobs using Dedicated Memory
XNDM_Total2G	8	Total amount of Dedicated Memory defined in 2G units
XNDM_TotalOnline2G	8	Total amount of online Dedicated Memory in 2G units
XNDM_Assignable2G	8	Total amount of assignable Dedicated Memory in 2G units
XNDM_Available2G	8	Total available (unassigned) Dedicated Memory in 2G units
XNDM_Requested2G	8	Total amount of requested Dedicated Memory in 2G units
XNDM_MinRequested2G	8	Total minimum requested Dedicated Memory in 2G units
XNDM_Assigned2G	8	Total assigned (to a job step) Dedicated Memory in 2G units
XNDM_InUseAs2G	8	Total amount of Dedicated Memory used as 2G frames
XNDM_InUseAs1MFixed	8	Total amount of Dedicated Memory used as 1M fixed frames
XNDM_InUseAs1MPageable	8	Total amount of Dedicated Memory used as 1M pageable frames (IARV64 GETSTORE PAGEFRAMESIZE=PAGEABLE1MEG)
XNDM_InUseAs4K	8	Total amount of Dedicated Memory used as 4K frames
XNDM_InUseAsDATTables4K	8	Total amount of Dedicated Memory used to back DAT tables (system use)

z/OS 3.1 IBM Education Assistant

Solution Name: z/OS Data Gatherer support for Dedicated Memory

Solution Element(s): z/OS Data Gatherer

Overview – z/OS Data Gatherer support for dedicated memory

Dedicated memory usage data is collected by z/OS Data Gatherer and new metrics are implemented in:

- SMF record type 71, Paging Data Section (system scope)

- Monitor III measurement tables
    - ERBGEIG3 - General information table (system scope)
    - ERBASIG3 - Address space identification table (address space scope

This support is included in the GA shipment of the z/OS 3.1 Data Gatherer (HRG77E0) deliverable.

Usage & Invocation: SMF record type 71 (1)

Monitor I Data Gatherer

- invokes RSM service IARXNDM to retrieve summarized dedicated memory usage data to obtain a system level view

- New metrics are stored in Paging Data Section of SMF71 records

- SMF71 record level (SMF71SRL) is increased to x'8F'

Offsets	Name	Length	Format	Description
1332 534	SMF71RFL	4	binary	Flags: **Bit** **Meaning when set** … 2 Dedicated Memory usage counts are invalid 3-31 Reserved
…				
2440 988	SMF71_DMemAssignable2G	8	floating	Total amount of dedicated memory at system initialization that can be used by address spaces in 2G units. Note: This field does not include dedicated memory used by the system.
2448 990	SMF71_DMemNumberofJobsUsingDmem_M	8	floating	Minimum number of address spaces using dedicated memory.
2456 998	SMF71_DMemNumberofJobsUsingDmem_X	8	floating	Maximum number of address spaces using dedicated memory.
2464 9A0	SMF71_DMemNumberofJobsUsingDmem_A	8	floating	Average number of address spaces using dedicated memory.

Usage & Invocation: SMF record type 71 (2)

Offsets		Name	Length	Format	Description
2472	9A8	SMF71_DMemTotal2G_M	8	floating	Minimum amount of online and offline dedicated memory in 2G units, including dedicated memory used by the system.
2480	9B0	SMF71_DMemTotal2G_X	8	floating	Maximum amount of online and offline dedicated memory in 2G units, including dedicated memory used by the system.
2488	9B8	SMF71_DMemTotal2G_A	8	floating	Average amount of online and offline dedicated memory in 2G units, including dedicated memory used by the system.
2496	9C0	SMF71_DMemTotalOnline2G_M	8	floating	Minimum amount of online dedicated memory in 2G units, including dedicated memory used by the system.
2504	9C8	SMF71_DMemTotalOnline2G_X	8	floating	Maximum amount of online dedicated memory in 2G units, including dedicated memory used by the system.
2512	9D0	SMF71_DMemTotalOnline2G_A	8	floating	Average amount of online dedicated memory in 2G units, including dedicated memory used by the system.
2520	9D8	SMF71_DMemAvailable2G_M	8	floating	Minimum amount of available dedicated memory in 2G units that can be used by address spaces.
2528	9E0	SMF71_DMemAvailable2G_X	8	floating	Maximum amount of available dedicated memory in 2G units that can be used by address spaces.
2536	9E8	SMF71_DMemAvailable2G_A	8	floating	Average amount of available dedicated memory in 2G units that can be used by address spaces.
2544	9F0	SMF71_DMemRequested2G_M	8	floating	Minimum amount of requested dedicated memory in 2G units over all address spaces
2552	9F8	SMF71_DMemRequested2G_X	8	floating	Maximum amount of requested dedicated memory in 2G units over all address spaces
2560	A00	SMF71_DMemRequested2G_A	8	floating	Average amount of requested dedicated memory in 2G units over all address spaces

Usage & Invocation: SMF record type 71 (3)

Offsets	Name	Length	Format	Description
2568 A08	SMF71_DMemMinRequested2G_M	8	floating	Lowest minimum amount of requested dedicated memory in 2G units over all address spaces
2576 A10	SMF71_DMemMinRequested2G_X	8	floating	Highest minimum amount of requested dedicated memory in 2G units over all address spaces
2584 A18	SMF71_DMemMinRequested2G_A	8	floating	Average minimum amount of requested dedicated memory in 2G units over all address spaces
2592 A20	SMF71_DMemAssigned2G_M	8	floating	Minimum amount of assigned dedicated memory over all address spaces
2600 A28	SMF71_DMemAssigned2G_X	8	floating	Maximum amount of assigned dedicated memory over all address spaces
2608 A30	SMF71_DMemAssigned2G_A	8	floating	Average amount of assigned dedicated memory over all address spaces
2616 A38	SMF71_DMemInUseAs2G_M	8	floating	Minimum amount of dedicated memory used as 2G frames over all address spaces
2624 A40	SMF71_DMemInUseAs2G_X	8	floating	Maximum amount of dedicated memory used as 2G frames over all address spaces
2632 A48	SMF71_DMemInUseAs2G_A	8	floating	Average amount of dedicated memory used as 2G frames over all address spaces
2640 A50	SMF71_DMemInUseAs1MFixed_M	8	floating	Minimum amount of dedicated memory used as 1M fixed frames over all address spaces
2648 A58	SMF71_DMemInUseAs1MFixed_X	8	floating	Maximum amount of dedicated memory used as 1M fixed frames over all address spaces
2656 A60	SMF71_DMemInUseAs1MFixed_A	8	floating	Average amount of dedicated memory used as 1M fixed frames over all address spaces

Usage & Invocation: SMF record type 71 (4)

Offsets		Name	Length	Format	Description
2664	A68	SMF71_DMemInUseAs1MPageable_M	8	floating	Minimum amount of dedicated memory used as 1M pageable frames over all address spaces
2672	A70	SMF71_DMemInUseAs1MPageable_X	8	floating	Maximum amount of dedicated memory used as 1M pageable frames over all address spaces
2680	A78	SMF71_DMemInUseAs1MPageable_A	8	floating	Average amount of dedicated memory used as 1M pageable frames over all address spaces
2688	A80	SMF71_DMemInUseAs4K_M	8	floating	Minimum amount of dedicated memory used as 4K frames over all address spaces
2696	A88	SMF71_DMemInUseAs4K_X	8	floating	Maximum amount of dedicated memory used as 4K frames over all address spaces
2704	A90	SMF71_DMemInUseAs4K_A	8	floating	Average amount of dedicated memory used as 4K frames over all address spaces
2712	A98	SMF71_DMemInUseAsDATTables4K_M	8	floating	Minimum number of frames in 4K units backing DAT tables (system use)
2720	AA0	SMF71_DMemInUseAsDATTables4K_X	8	floating	Maximum number of frames in 4K units backing DAT tables (system use)
2728	AA8	SMF71_DMemInUseAsDATTables4K_A	8	floating	Average number of frames in 4K units backing DAT tables (system use)

Usage & Invocation: Monitor III measurement table ERBGEIG3 (1)

Monitor III Data Gatherer collects dedicated memory usage data

- having system scope from RCE / RCE64
  - New metrics are stored in General information table (GEIG3)
  - GEIG3 version number (GEIVERG3) is increased to x'1A'

Offsets	Name	Length	Format	Description
832 340	GEI_DMemAssignable2G	8	floating point	Total amount of dedicated memory at system initialization that can be used by address spaces in 2G units. Note: This field does not include dedicated memory used by the system.
840 348	GEI_DMemTotalOnline2G	8	floating point	Accumulated amount of online dedicated memory in 2G units, including dedicated memory used by the system. [1]
848 350	GEI_DMemTotal2G	8	floating point	Accumulated amount of online and offline dedicated memory in 2G units, including dedicated memory used by the system. [1]
856 358	GEI_DMemAFC2G	8	floating point	Accumulated amount of available dedicated memory in 2G units that can be used by address spaces. [1]
[1] Sum of values obtained at each sample. To obtain average values, divide by the number of valid samples (SSHSMPNR).				

Usage & Invocation: Monitor III measurement table ERBASIG3 (1)

Monitor III Data Gatherer collects dedicated memory usage data

- having address space scope from RAX64
    - Address space identification table (ASIG3) is enhanced to store new metrics
    - ASIG3 version number (ASIVERG3) is increased to x'1F'

Offsets	Name	Length	Format	Description
1248 4E0	ASI_DMemAFC	8	floating point	Amount of dedicated memory assigned to the address space in 4K units that is currently not in use [1]
1256 4E8	ASI_DMemAFC2G	8	floating point	Amount of dedicated memory assigned to the address space in 2G units that is currently not in use [1]
1264 4F0	ASI_DMemAFC1M	8	floating point	Amount of dedicated memory assigned to the address space in 1M units that is currently not in use [1]
1272 4F8	ASI_DMemAssigned2G	8	floating point	Amount of dedicated memory assigned to the address space in 2G units [1]
[1] Sum of values obtained at each sample. To obtain average values, divide by the number of valid samples (SSHSMPNR).				

Usage & Invocation: Monitor III measurement table ERBASIG3 (2)

Offsets	Name	Length	Format	Description
1280 500	ASI_DMemInUseAs1MFixed	8	floating point	Amount of dedicated memory in use as 1M fixed frames [1]
1288 508	ASI_DMemInUseAs1MPageable	8	floating point	Amount of dedicated memory in use as 1M pageable frames [1]
1296 510	ASI_DMemInUseAs2G	8	floating point	Amount of dedicated memory in use as 2G fixed frames [1]
1304 518	ASI_DMemInUseAs4K	8	floating point	Amount of dedicated memory in use as 4K frames [1]
1312 520	ASI_DMemMinRequested2G	8	floating point	Minimum amount of dedicated memory requested by the address space in 2G units [1]
1320 528	ASI_DMemRequested2G	8	floating point	Amount of dedicated memory requested by the address space in 2G units [1]
1328 530	*	16	*	Reserved
[1] Sum of values obtained at each sample. To obtain average values, divide by the number of valid samples (SSHSMPNR).				

Appendix

- Documentation
  - z/OS Data Gatherer Programmer's Guide, GC31-5701
  - MVS System Management Facilities (SMF), SA38-0667