

# IBM Education Assistance for z/OS V2R2

Item: RSM Scalability

Element/Component: Real Storage Manager



## Agenda

- Trademarks
- Presentation Objectives
- Overview
- Usage & Invocation
- Interactions & Dependencies
- Migration & Coexistence Considerations
- Installation
- Presentation Summary
- Appendix



## Trademarks

- See url <http://www.ibm.com/legal/copytrade.shtml> for a list of trademarks.



## Presentation Objectives

- Large memory benefits
- Dumping large memory
- Change in default of LFAREA INCLUDE1MAFC



## Overview

- Problem Statement / Need Addressed
  - Changing business landscapes increase demand for memory usage and parallelism in z/OS. In-transaction analytics, sub-second response times, and greater demand due to mobile all increase the need for more data and better performance.
- Solution
  - Real Storage Management (RSM) has made extensive internal changes to frame management and serialization.
- Benefit / Value
  - These changes enable large memory usage (up to 4TB on z13), better performance and increased parallelism.



## RSM Scalability Changes

- RSM was modified to support large amounts of real storage:
  - Initialization of real storage is more efficient
  - Management of 1MB frames is improved
  - Improvements to configuring storage online and offline
  - Steal processing can find eligible frames more efficiently
- RSM was modified to increase concurrency both at the system and application levels
  - Multiple page faults can be dealt with concurrently within an address space or with common storage
  - Page fixing and unfixing can occur concurrently within an address space or with common storage
  - Getmain/Freemain of storage can occur concurrently with page fixing/freeing and page faults
  - Less contention on available frame queues



## Memory-Related Performance Gains

- The changes to RSM enable the use of more memory on each system which can in turn improve performance
- Substantial latency reduction for OLTP workloads
  - Significant response time reductions and increased transaction rates
- In-memory databases dramatic gains in response time by avoiding IO wait
- Batch window reduction
  - More concurrent workloads and shorter elapsed times for jobs
- Reduced time to insight for analytic workloads
  - Processes data more efficiently helping organizations keep pace with influx of data
  - Reduces time it takes to get from raw data to business insight





## Large Memory Study

- Significant performance improvements were seen when more memory was used for larger DB2 buffer pools while running the SAP Banking Services (SBS) Day Posting workload on an IBM zEnterprise EC12 (zEC12). Improvements were seen when running in single system and data sharing environments.
- See backup slides for details plus benefits for IMS, Java, Batch, and CF.





## Dumping Large Memory

- As applications use more memory dumps become larger
- We recommend as systems grow leaving more memory available for dumping
- New option REAL= parameter for stand-alone dump
  - Default of REAL=ALL dumps all real storage
  - REAL=USED dumps only used real storage skipping any unused (that is, available) real frames
  - Can be set with REAL=USED at generation of ADSADMP or at runtime with SET REAL(USED)
- Additionally some performance improvements were made to stand-alone dump but your mileage may vary depending on your configuration



## Usage & Invocation

- No action is needed to take advantages of the RSM Scalability improvements



## Interactions & Dependencies

- Software Dependencies
  - None
- Hardware Dependencies
  - None for base support
  - z13 for more than 1TB of memory
- Exploiters
  - All users of z/OS



## Migration & Coexistence Considerations

- Change in default for LFAREA INCLUDE1MAFC
  - With APAR OA41968, a new keyword, INCLUDE1MAFC, was added to the LFAREA parameter in the IEASYSxx parmlib member
    - When specified 1MB large frames (as defined in the LFAREA system parameter) are included in the available frame count (RCEAFC) and also included in results of SYSEVENT STGTEST
    - Therefore RSM performs less paging when there is an abundance of available fixed 1MB pages in the system
    - The default at V2R1 is not to include 1MB frames in the available frame count
  - At V2R2 the default changes to include 1MB frames. This is equivalent to specifying LFAREA=(INCLUDE1MAFC,...)
  - To retain the previous behavior specify LFAREA=(INCLUDE1MAFC(NO),...)
  - See *MVS V2R2 Initialization and Tuning Reference* for details



## Installation

- Related support rolled down to V2R1 via OA44207 and OA44436.
  - This support is included in V2R2 base.



## Presentation Summary

- Use of large memory can have dramatic improvement in performance
- Prepare for large dumps
- Note the default change of LFAREA INCLUDE1MAFC



## Appendix

### ▪ Publications:

- *MVS V2R2 Initialization and Tuning Reference*, SA23-1380-03
- IBM zEnterprise System®: Performance Report on Exploiting Large Memory for DB2 Buffer Pools with SAP®





## Appendix – Additional notes: Large Memory Client Value

- Superb Large Memory and N-Way scaling on z enable the wide-scale deployment that allows system z to host Business Analytics, IT Analytics, Cloud, and Big Data applications as well as serve as the back end for Mobile applications.
- Continued exploitation of system z Large Page Support in system components, middleware, and customer applications, provides improved transactional response times and greater throughput. This can translate to better performance and overall CPU savings for DB2, JAVA, and analytic workloads.



## Appendix – Additional notes: Large Memory Exploitation

- Substantial Latency Reduction for interactive workloads
  - Google, Amazon studies show substantial business value for faster response times, even sub-second
- Batch Window Reduction
  - More Concurrent Workload
  - Shorter Elapsed times for Jobs
- Measurable 'tech-dividend' CPU benefit
  - Ability to run more work at the same HW and SW MSU rating
  - Or ability to run the same workload with lower HW and SW MSU rating
- Rollout
  - Dump Transfer Tool for large dumps
  - SVC and SAD Dump performance
  - 1MB pages
  - 2GB pages
  - IO adapters with >1 TB memory addressability
  - Flash Memory
  - DB2, Java & IMS Large Memory Scale
  - z/OS Large Memory Scale
  - CFCC Large Memory Scale



## Appendix – Additional notes: DB2 Large Memory Benefits

- Conversion to DB2 Page Fix Buffers
  - Exploit 1MB and 2GB pages
  - Paging Spike / Storm Concerns mitigation with Flash and Large Memory
  - Pagefix CPU 'tech-dividend' 0-6%
  - Large Page CPU 'tech-dividend' 1-4%
- Increase Buffer Pool size in z/OS
  - Response times up to 2X and CPU 'tech-dividend' up to 5%
- Increased Global Buffer Pool Size in CF
  - 4K page hit in CF is 10X faster transfer than a 4K page hit in disk control unit cache.
- Nov. 2011 Information on Demand white paper titled “Save CPU Using Memory” by Akiko Hoshikawa showed that the IBM Relational Warehouse Workload (IRWW) had a 40% response-time reduction and 5% CPU performance improvement by exploiting increased buffer pool sizes.



## Appendix – Additional notes: IMS Large Memory Exploitation

- Page fixing blocks and buffers.
- Exploit IMS 12 ability to dynamically resize database buffer pools
- Use IMS Buffer Pool Analyzer to view buffers by total buffer life.
- IMS program specification block (PSB) pool with large, infrequently used PSBs.
- IMS V12 large memory for IMS log buffers to improve online logging throughput.
- Dynamic database backout. Larger real memory allows the read process to be successful more frequently reducing the need for batch back-out.



## Appendix – Additional notes: Java Large Memory Exploitation

- Shift in application and middleware programming models, persistency systems, and application development frameworks
- Evolution of in-memory data-bases and analytics, large scale distributed caching systems like Websphere Extreme Scale, and object-relational mapping libraries for persistency such as JPA all drive increased memory usage.
- Incremental garbage collection technology like the Balanced GC policy to address increasing heap storage to thread performance ratios.
- Exploitation of 1MB and 2GB pages for up to 5% or more CPU benefit



## Appendix – Additional notes: Batch Memory Exploitation

- Potentially increase parallelism of batch workloads (e.g. more parallel sorts)
- Potentially improve single thread performance for complex queries
- Not much help for pure sequential processing



## Appendix – Additional notes: Large Memory Deployment: Steps 1-2

- These are very rough “rule of thumb” performance expectations
  - Steps 1-3 total around 5% improvement
  - Step 4 is an additional 5%
- Step 1: Convert pageable DB2 buffer to page fixed buffers at current BP size
  - Gain 0-6%, most clients see 2-3% CPU benefit for BPs with IO activity
  - Use Flash and/or additional real memory to mitigate any real memory concerns that are currently preventing you from page fixing DB2 buffers.
  - IBM performance testing for very large memory will assume Page Fixed buffers
- Step 2: Deploy 1MB or 2GB large pages for page fixed DB2 buffers
  - Gain up to another 1-2% CPU benefit





## Appendix – Additional notes: Large Memory Deployment: Steps 3-4

- Step 3: Deploy pageable 1MB pages (requires Flash Express, skip this step if no Flash)
  - Gain up to 1% with 1MB pages for DB2 11 executable code with z/OS 2.1
  - Expect to gain additional CPU benefit when z/OS 2.2 delivers shared 64bit 1MB pageable pages exploited by DB2
- Step 4: Increase size of DB2 local buffer pools to up to 100GB, in data sharing increase size of Global Buffers Pools enough to support local buffer pool size.
  - Gain up to 5% depending workload profile and tuning
  - Note 100GB per DB2 means up to 1TB or more per z/OS



## Appendix – Additional notes: Large Memory Study -- Introduction

- The first phase of our Large Memory Study with SAP is complete.
  - The IBM SAP on System z Performance Team in Poughkeepsie studied the performance effects of using large amounts of memory for DB2 buffer pools in both single system and data sharing environments. We documented the results of this study in a techdoc, [IBM zEnterprise System: Performance Report on Exploiting Large Memory for DB2 Buffer Pools with SAP](#).
- There is still more work to do in this area, but this document shows the performance benefits of using larger amounts of memory for DB2 buffer pools.
- Note that this study was run on z/OS 1.13 and 2.1.
  - Similar performance numbers for v2.2 are not available at this time



## Appendix – Additional notes: Large Memory Study -- Summary

- Executive Summary

- Significant performance improvements were seen when more memory was used for larger DB2 buffer pools while running the SAP Banking Services (SBS) Day Posting workload on an IBM zEnterprise EC12 (zEC12). Improvements were seen when running in single system and data sharing environments.

- Our measurements showed

- reductions in response time of up to 70%,
- increases in transaction rates of up to 37%,
- and savings in CPU time per transaction of up to 25%.
- These performance improvements were a result of up to a 97% reduction in synchronous I/O.



## Appendix – Additional notes: Large Memory Study: Overview

- A customer representative financial services workload
  - Memory intensive, large number of tables, and random I/O behavior
  - An example of a financial services DB2 workload with variable memory sizes
- Test Scenarios:
  - DB2 11 Single System
  - 256 GB / 512 GB / 1024 GB real storage
  - DB2 11 Single System – minimal #of BPs
  - Start with 256 GB real storage



## Appendix – Additional notes: Large Memory Study -- Environment


### System z Database Server IBM zEC12 2827-HA1



### IBM System Storage



  
FICON  
Express8S

 10 GbE Network



## Appendix – Additional notes: Large Memory Study -- Environment Details

- IBM System Storage - Dual Frame DS8870
  - 8 GB adapters and LMC 6.2 for 60M Account Banking Database
  - DS8700 for DB2 logs
- System z Database Server - IBM zEC12 2827-HA1
  - 12 CPs
  - DB2 11 for z/OS on z/OS V1R13
  - Up to 1024 GB of real storage with up to 675 GB LFAREA
  - PAGESCM=NONE
- Application Servers - 24 IBM PS701 8406-71Y Blade Servers
  - Each with 8 3.0 GHz processors and 128 GB memory
  - DB2 Connect 10.1 FP2 on AIX 7.1.0
- Presentation Server
  - IBM 9133-55A with 4 2.1 GHz processors and 32 GB memory
- FICON Express8S and 10 GbE Network



## Appendix – Additional notes: Large Memory Study -- Results

- With zEC12-12w; CPU 70 – 80%
- 256 GB to 512 GB real storage
  - 13% improvement in ITR
  - 16% improvement in ETR
  - 40% improvement in response time
- 256 GB to 1024 GB real storage
  - 25% improvement in ITR
  - 38% improvement in ETR
  - 83% improvement in response time
- Largest buffer pool: 144 GB





## Appendix – Additional notes: Large Memory Study -- Throughput and Transaction Response Times for Various BP Sizes

