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# CICS TS V4.2 Virtual Storage and Tuning

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# Agenda

- Background information
  - z/OS Virtual Storage – Overview
  - Limiting the amount of virtual storage in a CICS Address Space
- CICS Storage Management
  - System Initialization Parameters – DSALIM, EDSALIM, ...
  - Dynamic Storage Areas – DSAs
  - CICS Storage Categories – CICS-key, User-key, ...
  - Short-on-Storage, Storage Fragmentation, Storage Violations, ...
  - Storage Manager Statistics, Monitoring, ...
  - Program Loader, Program Compression, ...
- Summary

# Notes

This session will present an overview of the CICS Storage Management basics. The DSAs (24-bit, 31-bit, and 64-bit), the settings for storage protection, transaction isolation, command protection, program protection, and trace table sizes will all be discussed.

Also presented will be information on performance and tuning. This will cover the CICS storage manager and Loader statistics and monitoring data, using the CICS supplied reporting tools, along with how to look at specific issues such as short-on-storage, storage fragmentation, storage violations, and program compression.

# z/OS Virtual Storage – Overview

- Each address space consists of ...
  - **common area** below 16 megabytes
  - **private area** below 16 megabytes
  - **extended common area** above 16 megabytes
  - **extended private area** above 16 megabytes
- Information about 24-bit and 31-bit storage in an address space
  - *z/OS MVS Programming: Assembler Services Guide*
  - *z/OS MVS Initialization and Tuning Guide*
- Information about 64-bit storage in an address space
  - *z/OS MVS Programming: Assembler Services Guide*

# Limiting the amount of virtual ... ... storage in the user region(s)

Private	High User Region
Shared	Default Shared Memory Addressing
Low User Private	Low User Region
	Reserved
Extended Private	Extended LSQA/SWA/Subpools 229,230
	Extended User Region
Extended Common	Extended CSA (ECSA)
	Extended LPLA/FLPA/MLPA
	Extended SQA (ESQA)
	Extended Nucleus
Common	Nucleus
	SQA
	PLPA/FLPA/MLPA
	CSA
Private	LSQA/SWA/Subpools 229,230
	User Region
6	System Region
Common	PSA

The **MEMLIMIT** JCL keyword limits the amount of space in the low and high user regions

- Above the bar

The **REGION** JCL keyword limits amount of space in the user region and extended user region

- Includes user region below the line and between the line and the bar, but not above the bar
- REGION=0M gives all available storage

**Installation defaults can be defined in JES and SMF**

- Used as default when no REGION or MEMLIMIT keywords are specified in the JCL

# z/OS Installation Exits may ... ... override JCL keywords



- z/OS Installation exits can enforce installation standards
  - Will override any specifications found in JCL
- IEFUSI
  - Can enforce standards for ...
    - The user region below the 16 MB line
    - The extended user region between the 16MB line and the 2 GB bar
    - The user region above the 2 GB bar (MEMLIMIT JCL keyword)
- IEALIMIT
  - Can only enforce standards for user region below the 16 MB line and is linked into the MVS nucleus
- *z/OS MVS Installation Exits*

# CICS Storage Management

- z/OS MEMLIMIT parameter
  - Specifies the amount of virtual storage above the bar
  - Minimum requirement of 4G – CICS will not start with less
- z/OS REGION parameter
  - Specifies the amount of virtual storage that the job requires
  - Sufficient for your CICS peak workload requirements ...
    - Peak concurrent tasks, transaction storage requirements, ...
    - CICS application resources and application program storage, ...
- *CICS Performance Guide*
  - Virtual and real storage: performance and tuning
- Auxiliary Storage Management
  - *z/OS MVS Initialization and Tuning Guide*



# CICS Storage Management ...

- CICS Storage Management – User region
  - System Initialization Parameters – DSALIM, EDSALIM, ...
  - CICS Dynamic Storage Areas – DSAs
  - CICS Storage Categories – CICS-key, User-key ...
  - System Initialization Parameters – STGPROT, TRANISO, ...
  - Short-on-Storage, Storage Fragmentation, Storage Violations, ...
  - CICS Storage Manager Statistics ...
    - Dynamic Storage Areas – DSAs
    - Domain Subpools
    - Task Subpools
  - CICS Storage Manager Monitoring ...
    - Task Storage, Shared Storage, Program Storage, ...
  - CICS Storage Management – Program Loader
    - Program Load, Which DSA are Programs loaded into?
    - Program Compression, Statistics, Monitoring, ...

# CICS System Initialization Parameters

- DSALIM={5M|number}
  - Specifies the upper limit of the total amount of storage within which CICS can allocate the individual dynamic storage areas (DSAs) that reside in 24-bit storage (below 16 MB, also known as below the line)
- EDSALIM={48M|number}
  - Specifies the upper limit of the total amount of storage within which CICS can allocate the individual extended dynamic storage areas (EDSAs) that reside in 31-bit storage (above 16 MB but below 2 GB, also known as above the line)
- TRTABSZ={4096|number-of-kilobytes}
  - Specifies the size, in kilobytes, of the internal trace table
- TRTRANSZ={16|number-of-kilobytes}
  - Specifies the size, in kilobytes, of the transaction dump trace table

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# CICS Dynamic Storage Areas – DSAs

- DSALIM and EDSALIM are allocated during CICS initialization
  - GxDSAs in 64-bit storage allocated as/when required
- CICS Dynamic Storage Areas ...
  - DSAs
    - CDSA, UDSA, SDSA, RDSA
    - ECDSA, EUDSA, ESDSA, ERDSA, ETDSA
    - GCDSA
  - DSA Extent Management ...
    - xDSA → 256K
    - ExDSA → 1M
    - GxDSA → 2G
  - Storage Cushions
    - DSAs → 64K
    - ExDSA → 128K (EUDSA=0K,ERDSA=256K)
    - GxDSA → 64M

## Dynamic Storage Areas – DSAs ...

- CICS DSA – Storage area for ...
  - non-reentrant CICS-key programs
  - all CICS-key task-lifetime storage
  - CICS control blocks
- User DSA – Storage area for ...
  - all user-key task-lifetime storage
- Shared DSA – Storage area for ...
  - non-reentrant user-key programs
  - storage obtained using CICS GETMAIN commands with SHARED
- Read-only DSA – Storage area for ...
  - reentrant programs and tables

# CICS System Initialization Parameters ...

- TSMAINLIMIT={64M|nnnnnM|nnG}
  - Specifies a storage limit for Main Temporary Storage Queues to use
  - Min, Max, Default → 1M, 32G, 64M
  - But must not be greater than 25% of z/OS MEMLIMIT for the CICS region else CICS will not start – message DFHTS1608

```

Applid IYK2Z1V2  Sysid CJB2  Jobname CI07CJB2  Date 03/07/2012  Time 12:52:11  CICS 6.7.0  PAGE 3
Temporary Storage
Put/Putq main storage requests . . . . . :      84
Get/Getq main storage requests . . . . . :       0
Current TSMAINLIMIT Setting. . . . . :    65,536K
Times at TSMAINLIMIT . . . . . :           0
Current storage used for TSMAINLIMIT . . . :    111K
Peak storage used for TSMAINLIMIT. . . . . :    111K
Number of TS queues auto deleted . . . . . :       0
Number of times cleanup task has run . . . :       1
Put/Putq auxiliary storage requests. . . :       3
Get/Getq auxiliary storage requests. . . :       1
. . . . .
. . . . .

```

# CICS System Initialization Parameters ...

- Recommendations ...
  - z/OS REGION and z/OS MEMLIMIT parameters ...
    - REGION → Sufficient for your CICS Peak workload requirements
    - MEMLIMIT → Minimum MEMLIMIT requirement of 4G
  - DSALIM and EDSALIM → z/OS REGION
    - Consider z/OS storage requirements outside the DSAs
    - Peak concurrent tasks, transaction storage requirements, ...
    - CICS application resources and application program storage, ...
  - CICS Trace Table Sizes ...
    - TRTABSZ={4096|number-of-kilobytes}
    - TRTRANSZ={16|number-of-kilobytes}
    - When in 64-bit storage recommend something other than the minimum!
  - In CICS TS V4.2 ...
    - CICS Internal Trace Table in 64-bit storage only if Transaction isolation inactive (TRANISO=NO) *or* APAR OA34311 applied on z/OS 1.12
    - Transaction Dump Trace Table is always in 64-bit storage

# CICS Storage Management ...

- System Initialization Parameters – continued ...
  - STGPROT, TRANISO, CMDPROT, RENTPGM, ...
- CICS Storage Categories
  - CICS-key, User-key, ...
- Short-on-Storage Conditions
  - Storage stress situation, ...
  - Short-on-storage condition, ...
  - Avoiding short-on-storage, ...
  - Analyzing short-on-storage conditions

# CICS System Initialization Parameters ...

- STGPROT={NO|YES}
  - Specifies whether you want storage protection to operate in the CICS region.
- TRANISO={NO|YES}
  - Specifies, together with the STGPROT system initialization parameter, whether you want transaction isolation in the CICS region.
- CMDPROT={YES|NO}
  - Specifies that you want to allow, or inhibit, CICS validation of start addresses of storage referenced as output parameters on EXEC CICS commands.
- RENTPGM={PROTECT|NOPROTECT}
  - Specifies whether you want CICS to allocate the read-only DSAs, RDSA and ERDSA, from read-only key-0 protected storage

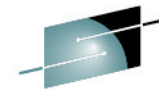


# CICS System Initialization Parameters ...

- STGRCVY={NO|YES}
  - Specifies whether CICS should try to recover from a storage violation.
- CWAKEY={USER|CICS}
  - Specifies the storage key for the common work area (CWA) if you are operating CICS with storage protection (STGPROT=YES).
- TCTUAKEY={USER|CICS}
  - Specifies the storage key for the terminal control table user areas (TCTUAs) if you are operating CICS with storage protection (STGPROT=YES).
- Program Definition ...
  - EXECKEY={USER|CICS}
    - Specifies the key in which CICS gives control to the program, and determines whether the program can modify CICS-key storage.

# CICS Storage Categories

- CICS Storage Categories – CICS-key, User-key, ...
  - CICS-key storage
    - Used for most CICS system code and control blocks and, at the discretion of the installation, other code, and data areas that require protection from overwriting.
    - In a CICS region with transaction isolation active, a CICS-key program has read/write access to CICS-key and user-key storage.
  - User-key storage
    - Used for most application programs and their data areas.
- CICS functions that help detection of / avoid Storage Violations
  - Subsystem Storage Protection and Transaction Isolation
  - Command Protection
    - Prevents CICS, when processing an EXEC CICS command, from overwriting storage that the issuing transaction could not itself directly overwrite

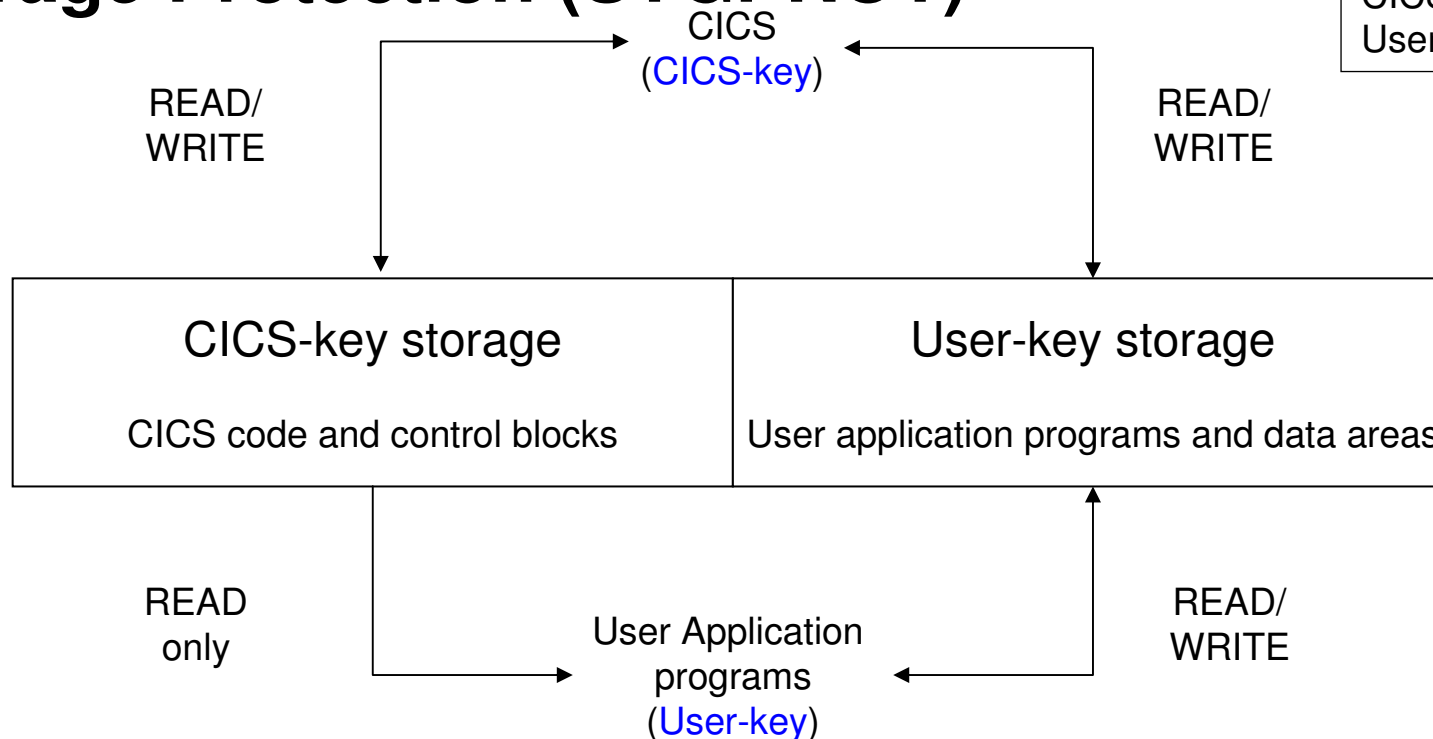


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CICS-key = 8  
User-key = 9

# Storage Protection (STGPROT)



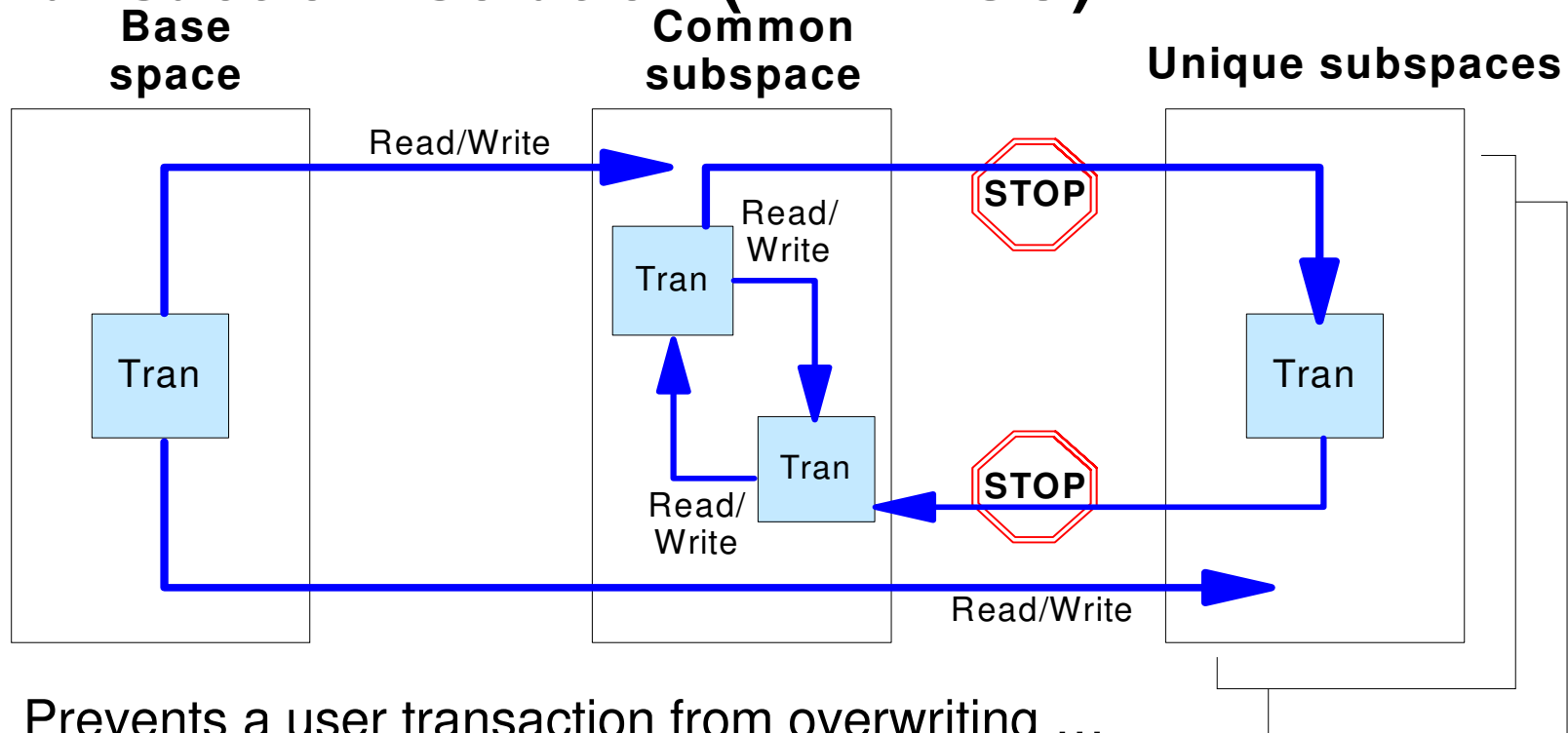
*Prevents user application programs from directly overwriting CICS code and control blocks.*

**CICS-key storage** – is used for CICS system code and control blocks. A CICS-key program has read-write access to CICS-key and user-key storage.

**User-key storage** – is where application programs and their data areas normally reside. A user-key program has read-write access to user-key storage, but only read access to CICS-key storage.

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# Transaction Isolation (TRANISO)



- Prevents a user transaction from overwriting ...  
... user application storage of other transactions ...
  - Builds on z/OS subspace group facility
  - User-key programs run in separate subspaces
  - Common subspace for transactions that share storage
  - CICS-key programs run in the base space

# Transaction Isolation (TRANISO) ...

- Required base space execution
  - All CICS key programs, ...
  - User replaceable modules, PLT programs, ...
  - Global user exits and task related user exits
- Unique subspace execution
  - All user key programs with ISOLATE(YES)
- Common subspace execution
  - All user key programs with ISOLATE(NO)
- Storage Manager Global Statistics
  - Unique and Common subspace usage
- Transaction Usage – Transaction Definition and Statistics
  - Isolate(Yes|No), Taskdataloc(Below|Any), Taskdatakey(User|CICS)

# Transaction Isolation (TRANISO) ...

- Transaction Definition and Transaction Resource Statistics
  - Analysis by ...
    - Isolate(Yes|No), Taskdataloc(Below|Any), Taskdatakey(User|CICS)
- Storage Manager Global Statistics → DFH0STAT ...

```

Applid IYK2Z1V2  Sysid CJB2  Jobname CI07CJB2  Date 03/05/2012  Time 14:58:56  CICS 6.7.0  PAGE 35
  
```

Transaction Totals

Isolate	Task Data Location/Key	Subspace Usage	Transaction Count	Attach Count
Yes	Below/CICS	None	10	18
Yes	Any/CICS	None	159	45
Yes	Below/USER	Unique	80	0
Yes	Any/USER	Unique	51	0
No	Below/CICS	Common	0	0
No	Any/CICS	Common	16	5
No	Below/USER	Common	0	0
No	Any/USER	Common	4	0
Totals			320	68

Subspace Statistics

```

Current Unique Subspace Users (Isolate=Yes) . . . : 0
Peak Unique Subspace Users (Isolate=Yes) . . . . : 0
Total Unique Subspace Users (Isolate=Yes) . . . . : 0

Current Common Subspace Users (Isolate=No) . . . : 0
Peak Common Subspace Users (Isolate=No) . . . . : 0
Total Common Subspace Users (Isolate=No) . . . . : 0
  
```

# CICS Storage Management ...

- Short-on-Storage in the Dynamic Storage Areas
  - CICS attempts to resolve pressures on storage before entering a short-on-storage condition
  - When CICS starts to become short on space in a DSA ...
    - Situation is known as a storage stress condition
  - CICS attempts to alleviate the storage stress situation by ...
    - Deleting programs that are not being used – program compression
    - Searching for free extents in other DSAs
    - Using the storage cushion in the affected DSA
  - If these actions fail to alleviate the situation then ...
    - A short-on-storage condition is declared for the DSA
    - CICS takes steps to limit work so that there is enough storage to process work that is already in progress
      - *defers all transaction attach requests*
    - Message issued – DFHSM0131, DFHSM0133, or DFHSM0606
      - *Additional messages when condition is resolved*

# CICS Storage Management ...

- Storage stress situation ...
  - Can be a symptom of other resource constraints that cause CICS tasks to occupy storage for longer than usual
  - Sudden large number of tasks that overwhelm available free storage
  - Applications requiring unexpectedly large amounts of storage
- Short-on-Storage in the Dynamic Storage Areas ...
  - Program compression might be triggered when the DSALIM or EDSALIM is approached and there are few free or empty extents
  - CICS considers a short-on-storage condition for a DSA when ...
    - No further extents can be allocated or relocated from other DSAs
    - Program compression has been attempted
    - All nonresident programs that are not in use have been deleted
    - Storage from the storage cushion is in use or at least one request is suspended because there is no contiguous area large enough for it



# CICS Storage Management ...

- Avoiding short-on-storage conditions ...
  - Lower the number of concurrent tasks in the region → MXT
  - Avoid making large GETMAIN requests in your application programs
  - Define programs as resident only where necessary
    - CICS cannot delete resident programs – even if they are not in use
  - Use the CICS Storage Manager statistics to monitor key metrics ...
    - Storage cushion releases, Storage request suspends, ...
  - Try to define a reasonable number of transactions with ...
    - SPURGE(YES) and with a DTIMEOUT value
    - Only transactions defined in this way can be purged during an SOS condition, if they have been waiting for storage longer than DTIMEOUT

# CICS Storage Management ...

- Analyzing short-on-storage conditions ...
  - Obtain a CICS SDUMP when system is Short-on-Storage ...  
CEMT SET SYDUMPCODE(SM0131) SYSDUMP MAXIMUM(1) ADD
  - Use the IPCS command VERBX CICS670 'SM=3,LD=3'
    - Storage Manager and Loader control blocks
  - Examine the DSA summaries ...
    - Noting which DSAs are short-on-storage and free space in other DSAs
  - Run DFH0STAT or collect the statistics interval and use DFHSTUP
- What to do next ...
  - Review the storage limits for your CICS region ...
    - Is the DSALIM or EDSALIM parameter set as large as possible?
    - Is the z/OS MEMLIMIT parameter set to an appropriate value?
  - Review options such as MXT and use of resident programs
  - May have to consider dividing your CICS region

# CICS Storage Management – Statistics

- CICS Storage Manager Statistics
  - Dynamic Storage Areas – DSAs
  - Domain Subpools
  - Task Subpools
- CICS Program Loader Statistics
  - Loader Global
  - Program Resource
  - Library Resource
- CICS Program Statistics
  - Program Definition Resource
- CICS Transaction Manager Statistics
  - Transaction Manager Global and Transaction Class Resource

# Storage Manager Statistics ... ... Storage BELOW 16MB ...



```

Applid IYK2Z1V2  Sysid CJB2  Jobname CI07CJB2  Date 01/25/2012  Time 13:16:55  CICS 6.7.0  PAGE 3
  
```

Region size established from REGION= parameter. . . . : 10,216K

Storage BELOW 16MB

Private Area Region size below 16Mb . . . . . :	10,216K	MVS PVT Size. . . . . :	10,240K	
Max LSQA/SWA storage allocated below 16Mb (SYS) . . :	500K	MVS CSA Size / Allocated. . . . :	3,204K /	872K
Max User storage allocated below 16Mb (VIRT). . . . :	6,496K	MVS SQA Size / Allocated. . . . :	1,028K /	499K
System Use. . . . . :	20K			
RTM . . . . . :	250K			

---

Private Area storage available below 16Mb . . . . . :	2,950K	Current DSA Limit . . . . . :	6,144K
VIRT minus Current DSA Limit. . . . . :	352K	Current Allocation for DSAs . . . :	1,024K
		Peak Allocation for DSAs. . . . :	1,024K

	CDSA	UDSA	SDSA	RDSA	Totals
Current DSA Size. . . . . :	512K	256K	0K	256K	1,024K
Current DSA Used. . . . . :	440K	0K	0K	212K	652K
Current DSA Used as % of DSA. . . . . :	85%	0%	0%	82%	
* Peak DSA Used . . . . . :	440K	4K	0K	212K	
Peak DSA Size . . . . . :	512K	256K	0K	256K	
Cushion Size. . . . . :	64K	64K	0K	64K	
Free Storage (inc. Cushion) . . . . . :	72K	256K	0K	44K	
* Peak Free Storage . . . . . :	264K	256K	0K	256K	
* Lowest Free Storage . . . . . :	72K	252K	0K	44K	
Largest Free Area . . . . . :	72K	256K	0K	44K	
Largest Free Area as % of DSA : . . . . . :	14%	100%	0%	17%	
Largest Free/Free Storage . . . . . :	1.00	1.00	0.00	1.00	

# Storage Manager Statistics ... ... Storage ABOVE 16MB



Applid IYK2Z1V2 Sysid CJB2 Jobname CI07CJB2 Date 01/25/2011 Time 13:16:55 CICS 6.7.0 PAGE 4

Storage ABOVE 16MB

Private Area Region size above 16Mb . . . . . :	1,417,216K	MVS EPVT Size . . . . . :	1,417,216K
Max LSQA/SWA storage allocated above 16Mb (SYS) . . :	18,000K	MVS ECSA Size / Allocated . . :	350,524K / 130,177K
Max User storage allocated above 16Mb (EXT) . . . :	354,984K	MVS ESQA Size / Allocated . . :	223,876K / 36,332K

---

Private Area storage available above 16Mb . . . . . :	1,044,232K	Requests for MVS storage causing waits . . :	0
		Total time waiting for MVS storage . . . :	00:00:00.00000

CICS Trace table size . . . . . :	8,192K	Current EDSA Limit . . . . . :	327,680K
EXT minus Current EDSA Limit . . . . . :	27,304K	Current Allocation for EDSAs . . :	41,984K
		Peak Allocation for EDSAs . . . :	41,984K

	ECDSA	EUDSA	ESDSA	ERDSA	ETDSA	Totals
Current DSA Size . . . . . :	12,288K	1,024K	1,024K	26,624K	1,024K	41,984K
Current DSA Used . . . . . :	11,568K	192K	64K	26,084K	32K	37,940K
Current DSA Used as % of DSA . . :	94%	18%	6%	97%	3%	
* Peak DSA Used . . . . . :	11,912K	512K	64K	26,084K	44K	
Peak DSA Size . . . . . :	12,288K	1,024K	1,024K	26,624K	1,024K	
Cushion Size . . . . . :	128K	0K	128K	256K	128K	
Free Storage (inc. Cushion) . . :	720K	832K	960K	540K	992K	
* Peak Free Storage . . . . . :	1,044K	1,024K	1,024K	3,536K	1,024K	
* Lowest Free Storage . . . . . :	376K	512K	960K	540K	980K	
Largest Free Area . . . . . :	460K	832K	960K	284K	992K	
Largest Free Area as % of DSA . :	3%	81%	93%	1%	96%	
Largest Free/Free Storage . . . :	0.63	1.00	1.00	0.52	1.00	

# Storage Manager Statistics ...



Applid IYK2Z1V2 Sysid CJB2 Jobname CI07CJB2 Date 01/25/2011 Time 13:16:55 CICS 6.7.0 PAGE 4

... Storage ABOVE 16MB ...

	ECDSA	EUDSA	ESDSA	ERDSA	ETDSA	Totals
Current DSA Size . . . . .	12,288K	1,024K	1,024K	26,624K	1,024K	41,984K
Current DSA Used . . . . .	11,568K	192K	64K	26,084K	32K	37,940K
Current DSA Used as % of DSA . . . . .	94%	18%	6%	97%	3%	
* Peak DSA Used . . . . .	11,912K	512K	64K	26,084K	44K	
Peak DSA Size . . . . .	12,288K	1,024K	1,024K	26,624K	1,024K	
Cushion Size . . . . .	128K	0K	128K	256K	128K	
Free Storage (inc. Cushion) . . . . .	720K	832K	960K	540K	992K	
* Peak Free Storage . . . . .	1,044K	1,024K	1,024K	3,536K	1,024K	
* Lowest Free Storage . . . . .	376K	512K	960K	540K	980K	
Largest Free Area . . . . .	460K	832K	960K	284K	992K	
Largest Free Area as % of DSA . . . . .	3%	81%	93%	1%	96%	
Largest Free/Free Storage . . . . .	0.63	1.00	1.00	0.52	1.00	
Current number of extents . . . . .	12	1	1	16	1	31
Number of extents added . . . . .	12	1	1	16	1	
Number of extents released . . . . .	0	0	0	0	0	
Getmain Requests . . . . .	21,586	47	2	461	44	
Freemain Requests . . . . .	8,524	41	0	7	29	
Current number of Subpools . . . . .	394	20	13	4	6	437
Add Subpool Requests . . . . .	448	74	13	4	6	
Delete Subpool Requests . . . . .	54	54	0	0	0	
Times no storage returned . . . . .	0	0	0	0	0	
Times request suspended . . . . .	0	0	0	0	0	
Current requests suspended . . . . .	0	0	0	0	0	
Peak requests suspended . . . . .	0	0	0	0	0	
Requests purged while waiting . . . . .	0	0	0	0	0	
Times Cushion released . . . . .	0	0	0	0	0	0
Times Short-On-Storage . . . . .	0	0	0	0	0	0
Total time Short-On-Storage . . . . .	00:00:00.00000	00:00:00.00000	00:00:00.00000	00:00:00.00000	00:00:00.00000	
Average Short-On-Storage time . . . . .	00:00:00.00000	00:00:00.00000	00:00:00.00000	00:00:00.00000	00:00:00.00000	
Storage Violations . . . . .	0	0	0	0	0	
Access . . . . .	CICS	USER	USER	READONLY	TRUSTED	

\*30 indicates values reset on last DSA Size change

Complete your sessions evaluation online at [SHARE.org/AnaheimEval](http://SHARE.org/AnaheimEval)

## Storage Manager Statistics ...

- Key Storage Manager DSA metrics ...
  - Current and Peak DSA Size → DSALIM and EDSALIM
  - Largest Free Area → Low value may indicate fragmentation
  - Lowest Free Storage → Relative to DSA Size and DSALIM
  - Times Short-On-Storage, Times Cushion released, ...
  - Times no storage returned, Times request suspended, ...
- Use the following to assess whether there is sufficient storage
  - Times Short-On-Storage, Times Cushion released, ...
  - Times no storage returned, Times request suspended, ...
- Indicators that storage stress situations have occurred
  - *May not have produced a short-on-storage condition*
  - Times Cushion released, ...
  - Times request suspended, Times no storage returned, ...

# Storage Manager Statistics ... ... Storage ABOVE 16MB ...



- Domain Subpools ...

Applid IYK2Z1V2 Sysid CJB2 Jobname CI07CJB2 Date 02/28/2012 Time 11:23:00 CICS 6.7.0 PAGE 3										
Storage - Domain Subpools										
Subpool Name	Location	Access	Element Type	Element Length	Initial Free	Current Elements	Current Element Stg	Current Page Stg	% of DSA	Peak Page Stg
KESTK24	CDSA	CICS	VARIABLE	0	OK	0	0	OK	0.00%	OK
KESTK24E	CDSA	CICS	VARIABLE	0	OK	26	106,496	104K	20.31%	104K
KESTK31	ECDSA	CICS	VARIABLE	0	OK	101	2,895,872	2,828K	30.69%	2,940K
KESTK31E	ECDSA	CICS	VARIABLE	0	OK	7	57,344	56K	0.61%	56K
LDENRSRO	ERDSA	READONLY	VARIABLE	0	OK	357	10,070,272	9,856K	35.65%	9,856K
LDENUC	ECDSA	CICS	VARIABLE	0	OK	12	28,416	32K	0.35%	32K
LDENUCRO	ERDSA	READONLY	VARIABLE	0	OK	93	6,888,448	6,776K	24.51%	6,776K
LDEPGM	ESDSA	USER	VARIABLE	0	OK	0	0	OK	0.00%	OK
LDEPGMRO	ERDSA	READONLY	VARIABLE	0	OK	9	10,584,544	10,356K	37.46%	10,356K
LDERES	ESDSA	USER	VARIABLE	0	OK	0	0	OK	0.00%	OK
LDERESRO	ERDSA	READONLY	VARIABLE	0	OK	0	0	OK	0.00%	OK
LDNRS	CDSA	CICS	VARIABLE	0	OK	4	27,136	32K	6.25%	32K
LDNRSRO	RDSA	READONLY	VARIABLE	0	OK	11	141,312	148K	57.81%	148K
LDNUC	CDSA	CICS	VARIABLE	0	OK	0	0	OK	0.00%	OK
LDNUCRO	RDSA	READONLY	VARIABLE	0	OK	2	9,984	12K	4.69%	12K
LDPGM	SDSA	USER	VARIABLE	0	OK	0	0	OK	4.69%	OK
LDPGMRO	RDSA	READONLY	VARIABLE	0	OK	4	49,280	52K	20.31%	52K
LDRES	SDSA	USER	VARIABLE	0	OK	0	0	OK	20.31%	OK
LDRESRO	RDSA	READONLY	VARIABLE	0	OK	0	0	OK	0.00%	OK
SMSHARED	CDSA	CICS	VARIABLE	0	OK	3	1,024	4K	0.78%	4K
SMSHRC24	CDSA	CICS	VARIABLE	0	OK	8	219,184	228K	44.53%	228K
SMSHRC31	ECDSA	CICS	VARIABLE	0	OK	3	416	4K	0.04%	4K
SMSHRU24	SDSA	USER	VARIABLE	0	OK	0	0	OK	0.04%	OK
SMSHRU31	ESDSA	USER	VARIABLE	0	OK	0	0	OK	0.00%	OK



# Storage Manager Statistics ...

- Task Subpools ...

Applid IYK2Z1V2 Sysid CJB2 Jobname CI07CJB2 Date 03/05/2012 Time 14:58:56 CICS 6.7.0 PAGE 27									
Storage - Task Subpools									
Subpool Name	Access	Getmain Requests	Freemain Requests	Current Elements	Current Element Stg	Average Element Size	Current Page Stg	% of DSA	Peak Page Stg
CDSA	CICS	102	102	0	0	0	16K	03.13%	60K
UDSA	USER	1	1	0	0	0	0K	00.00%	4K
ECDSA	CICS	7,399	7,399	0	0	0	228K	02.47%	340K
EUDSA	USER	31	31	0	0	0	0K	00.00%	512K

- Improved 64-bit Storage Manager Statistics in CICS TS V4.2 ...
  - Additional 64-bit Storage Usage Metrics from z/OS
    - Number of Private Memory Objects, ...
    - Allocated Private Memory Object storage, high-water-mark, ...
    - Real and Auxiliary storage usage, ...
  - Metrics also useful to measure the impact of 64-bit JVMs
    - Storage for the 64-bit JVMs is outside of the CICS GxDSAs

# Storage Manager Statistics ... ... Storage ABOVE 2GB



Applid	IYK2Z1V2	Sysid	CJB2	Jobname	CI07CJB2	Date	01/25/2011	Time	13:16:55	CICS	6.7.0	PAGE	5
<u>Storage ABOVE 2GB</u>													
MEMLIMIT Size	:					8,192M	CICS Internal Trace table size	:					8,388,608
MEMLIMIT Set By	:					JCL		:					
IARV64 GETSTOR request size	:					2,048M	Number of IARV64 FROMGUARD failures	:					0
	:						Largest IARV64 FROMGUARD failure size	:					0
Current Address Space active (bytes)	:					24,117,248	Number of Private Memory Objects	:					12
Current Address Space active	:					23M	Bytes allocated to Private Memory Objects	:					3,231,711,232
Peak Address Space active	:					26M	...minus Current GDSA allocated	:					1,084,227,584
	:						Bytes hidden within Private Memory Objects	:					3,207,593,984
Current GDSA Allocated (bytes)	:					2,147,483,648	...minus Current GDSA hidden	:					1,065,353,216
Current GDSA Allocated	:					2,048M	Bytes usable within Private Memory Objects	:					24,117,248
Peak GDSA Allocated	:					2,048M	Peak bytes usable within Private Memory Objects	:					27,262,976
Current GDSA Active (bytes)	:					5,242,880	Number of Shared Memory Objects	:					0
Current GDSA Active	:					5M	Bytes allocated to Shared Memory Objects	:					0
Peak GDSA Active	:					8M	Peak bytes usable within Shared Memory Objects	:					0
	:						Auxiliary Slots backing Private Memory Objects	:					0
	:						HWM Auxiliary Slots backing Private Memory Object	:					0
	:						Real Frames backing Private Memory Objects	:					3,311
	:						HWM Real Frames backing Private Memory Objects	:					3,315
	:						Number of Large Memory Objects Allocated	:					0
	:						Number of Large Pages backed in Real Storage	:					0

# Storage Manager Statistics ...

Storage ABOVE 2GB

## Storage ABOVE 2GB ...

SHARE

8,388,608

MEMLIMIT Size . . . . . 8,192M CICS Internal Trace table size . . . . .

MEMLIMIT Set By . . . . . JCL

Current Address Space active . . . . . 23M  
 Peak Address Space active . . . . . 26M

Number of Private Memory Objects . . . . . 12  
 Bytes allocated to Private Memory Objects . . . . . 3,231,711,232  
 Bytes hidden within Private Memory Objects . . . . . 3,207,593,984  
 Peak bytes usable within Private Memory Objects . . . . . 27,262,976

Current GDSA Allocated . . . . . 2,048M  
 Peak GDSA Allocated . . . . . 2,048M

Current GDSA Active . . . . . 5M  
 Peak GDSA Active . . . . . 8M

GCDSA

Current DSA Size . . . . . 5M  
 Peak DSA Size . . . . . 8M  
 Cushion Size . . . . . 64M  
 Free Storage (inc. Cushion) . . . . . 2,043M  
 \* Peak Free Storage . . . . . 2,048M  
 \* Lowest Free Storage . . . . . 2,040M  
 Largest Free Area . . . . . 2,042M  
 Largest Free/Free Storage . . . . . 0.99

Current number of extents . . . . . 1  
 Number of extents added . . . . . 1  
 Number of extents released . . . . . 0

Getmain Requests . . . . . 71  
 Freemain Requests . . . . . 62

Current number of Subpools . . . . . 10  
 Add Subpool Requests . . . . . 84  
 Delete Subpool Requests . . . . . 54

Times no storage returned . . . . . 0  
 Times request suspended . . . . . 0  
 Current requests suspended . . . . . 0  
 Peak requests suspended . . . . . 0  
 Requests purged while waiting . . . . . 0

Times Cushion released . . . . . 0  
 Times Short-On-Storage . . . . . 0

Total time Short-On-Storage . . . . . 00:00:00.00000  
 Average Short-On-Storage time . . . . . 00:00:00.00000

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# CICS Storage Management – Monitoring

- Performance Class
  - Task Storage – CICS-key, User-key, below 16MB, above 16MB, ...
    - GETMAIN request count, Storage High Water Mark, Storage occupancy, ...
  - Shared Storage – below 16MB, above 16MB, ...
    - GETMAIN request count, Bytes GETMAINed, Bytes FREEMAINed, ...
  - Program Storage ...
    - Program Storage High Water Mark
    - Program Storage High Water Mark below 16MB, above 16MB, ...
    - Program Storage High Water Mark by DSA
    - Use CICS Statistics to analyse region's program storage usage!
      - *Loader Global and Loader's Storage Domain Subpools*
- Exception Class
  - Identifies which task(s) were affected when a GETMAIN request was suspended due to insufficient storage and SUSPEND(YES) was specified

## CICS Storage Management – Loader ...

- Loader Domain
  - Program Storage Management, Program LOAD, ...
  - DFHRPL and LIBRARY dataset – Allocation, Open, Close, ...
- Which DSA does a program get loaded into?
  - Program definition attributes – EXECKey(User|CICS) Resident(No|Yes)
  - Program attributes – RMODE(24|ANY) and RENT|NORENT
- Program Compression, ...
  - Might be triggered when the DSALIM or EDSALIM is approached and there are no free or empty extents available
  - Each DSA that contains programs is evaluated individually
  - Programs are deleted on a least-recently-used (LRU) basis
- Programs defined as resident – use sparingly, if at all!
  - A heavily used nonresident program is likely to remain resident
- 37 • During light usage, a resident program might be wasting virtual storage

# CICS Storage Management – Loader

- Loader Global Statistics
  - Program Load activity ...
    - Load requests, Load time, Load request waits, wait time, ...
  - DFHRPL and LIBRARY update activity, ...
  - By Dynamic Storage Area (DSA) ...
    - Program Compression Activity
    - Not-in-use queue membership information
  - Program Load and Dataset management occur on the RO TCB
    - See the CICS Dispatcher TCB mode statistics for RO TCB usage
- Program Storage Domain Subpools
  - Analyse a CICS region's overall program storage usage
  - Set of Storage Domain Subpools in 6 DSAs ...
    - Usage dependant on the Program Definition and Program Attributes

# CICS Storage Management – Loader ...

Applid IYK2Z1V2 Sysid CJB2 Jobname CI07CJB2 Date 02/28/2012 Time 10:47:38 CICS 6.7.0 PAGE 3

## Loader

```

LIBRARY Load requests . . . . . :          513  LIBRARY Load Rate per second . . . . . :          4.23
Total LIBRARY Load time. . . . . : 00:00:01.90348
Average LIBRARY Load time. . . . . : 00:00:00.00369  Total Program Uses . . . . . :          7,498
                                         Program Use to Load Ratio. . . . . :          14.61

LIBRARY Load requests that waited. . . . . :          4
Total LIBRARY Load request wait time . . . . . : 00:00:00.02323  Times LIBRARY secondary extents detected . . . . . :          0
Average LIBRARY Load request wait time . . . . . : 00:00:00.00580
Current Waiting LIBRARY Load requests. . . . . :          0
Peak Waiting LIBRARY Load requests . . . . . :          1
Times at Peak. . . . . :          4  Average Not-In-Use program size. . . . . :          11K

LIBRARY search order updates . . . . . :          1  Load requests waited - search order update . . . . . :          0
Total LIBRARY search order update time . . . . . : 00:00:00.00000
Average LIBRARY search order update time . . . . . : 00:00:00.00000
  
```

## CDSA

```

Programs Removed by compression. . . . . :          0
Time on the Not-In-Use Queue . . . . . : 00:00:00.00000
Average Time on the Not-In-Use Queue . . . . . : 00:00:00.00000
Programs Reclaimed from the Not-In-Use Queue . . . . . :          0
Programs Loaded - now on the Not-In-Use Queue. :          0
  
```

## SDSA

```

Programs Removed by compression. . . . . :          0
Time on the Not-In-Use Queue . . . . . : 00:00:00.00000
Average Time on the Not-In-Use Queue . . . . . : 00:00:00.00000
Programs Reclaimed from the Not-In-Use Queue . . . . . :          0
Programs Loaded - now on the Not-In-Use Queue. :          0
  
```

## RDSA

```

Programs Removed by compression. . . . . :          0
Time on the Not-In-Use Queue . . . . . : 00:00:00.00000
Average Time on the Not-In-Use Queue . . . . . : 00:00:00.00000
Programs Reclaimed from the Not-In-Use Queue . . . . . :          0
Programs Loaded - now on the Not-In-Use Queue. :          2
  
```

## ECDSA

```

Programs Removed by compression. . . . . :          0
Time on the Not-In-Use Queue . . . . . : 00:00:00.00000
Average Time on the Not-In-Use Queue . . . . . : 00:00:00.00000
Programs Reclaimed from the Not-In-Use Queue . . . . . :          3
Programs Loaded - now on the Not-In-Use Queue. :          10
  
```

## ESDSA

```

Programs Removed by compression. . . . . :          0
Time on the Not-In-Use Queue . . . . . : 00:00:00.00000
Average Time on the Not-In-Use Queue . . . . . : 00:00:00.00000
Programs Reclaimed from the Not-In-Use Queue . . . . . :          0
Programs Loaded - now on the Not-In-Use Queue. :          0
  
```

## ERDSA

```

Programs Removed by compression. . . . . :          0
Time on the Not-In-Use Queue . . . . . : 00:00:00.00000
Average Time on the Not-In-Use Queue . . . . . : 00:00:00.00000
Programs Reclaimed from the Not-In-Use Queue . . . . . :          6,597
Programs Loaded - now on the Not-In-Use Queue. :          34
  
```

# CICS Storage Management – Loader ...

Applid IYK2Z1V2 Sysid CJB2 Jobname CI07CJB2 Date 02/28/2012 Time 10:47:38 CICS 6.7.0 PAGE 3

Loader

Program Storage

Nucleus Program Storage (CDSA) . . . . . :	32K	Nucleus Program Storage (ECDSA) . . . . . :	100K
Program Storage (SDSA) . . . . . :	0K	Program Storage (ESDSA) . . . . . :	0K
Resident Program Storage (SDSA) . . . . . :	0K	Resident Program Storage (ESDSA) . . . . . :	0K
Read-Only Nucleus Program Storage (RDSA) . . . . :	160K	Read-Only Nucleus Program Storage (ERDSA) . . . . :	16,244K
Read-Only Program Storage (RDSA) . . . . . :	52K	Read-Only Program Storage (ERDSA) . . . . . :	10,356K
Read-Only Resident Program Storage (RDSA) . . . . :	0K	Read-Only Resident Program Storage (ERDSA) . . . . :	0K
CDSA used by Not-In-Use programs . . . . . :	0K	0.00% of CDSA	ECDSA used by Not-In-Use programs : 22K 0.00% of ECDSA
SDSA used by Not-In-Use programs . . . . . :	0K	0.00% of SDSA	ESDSA used by Not-In-Use programs : 0K 0.00% of ESDSA
RDSA used by Not-In-Use programs . . . . . :	4K	0.00% of RDSA	ERDSA used by Not-In-Use programs : 494K 0.00% of ERDSA

Applid IYK2Z1V2 Sysid CJB2 Jobname CI07CJB2 Date 02/28/2012 Time 10:47:38 CICS 6.7.0 PAGE 4

Storage - Program Subpools

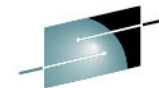
Subpool Name	Subpool Location	Current Storage	Peak Storage
LDNRS	CDSA	32K	32K
LDNUC	CDSA	0K	12K
LDPGM	SDSA	0K	0K
LDRES	SDSA	0K	0K
LDNRSRO	RDSA	148K	148K
LDNUCRO	RDSA	12K	12K
LDPGMRO	RDSA	52K	52K
LDRESRO	RDSA	0K	0K
LDENRS	ECDSA	68K	68K
LDENUC	ECDSA	32K	32K
LDEPGM	ESDSA	0K	0K
LDERES	ESDSA	0K	0K
LDENRSRO	ERDSA	9,856K	9,856K
LDENUCRO	ERDSA	6,388K	6,388K
LDEPGMRO	ERDSA	10,356K	10,356K
LDERESRO	ERDSA	0K	0K

Program Storage Subpool that a program is loaded into ...

- Program definition attributes ...  
EXECKey(User|CICS) Resident(No|Yes)
- Program attributes ....  
RMODE(24|ANY) and RENT|NORENT

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# CICS Storage Management – Transaction Mgr

```
Applid IYK2Z1V2 Sysid CJB2 Jobname CI07CJB2 Date 03/09/2012 Time 14:24:38 CICS 6.7.0 PAGE 3
```

Transaction Manager

Total Accumulated transactions so far . . :	62		
Accumulated transactions (since reset) . . :	62	Transaction Rate per second . . :	1.55
Maximum transactions allowed (MXT) . . . . :	75		
Times at MXT . . . . . :	0		
Current Active User transactions . . . . . :	3		
Peak Active User transactions . . . . . :	6		
Total Active User transactions . . . . . :	17		
Current Running transactions . . . . . :	2		
Current Dispatchable transactions . . . . . :	0		
Current Suspended transactions . . . . . :	1		
Current System transactions . . . . . :	0		
Transactions Delayed by MXT . . . . . :	0		
Total MXT queueing time . . . . . :	00:00:00.00000		
Average MXT queueing time . . . . . :	00:00:00.00000		
Current Queued User transactions . . . . . :	0		
Peak Queued User transactions . . . . . :	0		
Total Queueing time for current queued . . :	00:00:00.00000		
Average Queueing time for current queued . :	00:00:00.00000		

## Recommendations – Recap

- z/OS REGION and z/OS MEMLIMIT parameters
  - REGION → Sufficient for your CICS Peak workload requirements
  - MEMLIMIT → Minimum MEMLIMIT requirement of 4G
- DSALIM and EDSALIM → z/OS REGION
  - Consider z/OS storage requirements outside the DSAs
- *CICS Performance Guide*
  - For guidance on estimating and setting ...
    - z/OS REGION and z/OS MEMLIMIT
    - DSALIM and EDSALIM
- CICS Storage Protection Facilities
  - STGPROT=YES
  - TRANISO=NO|YES
  - CMDPROT=YES and RENTPGM=PROTECT

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## Recommendations – Recap ...

- TRTABSZ=nnnnK and TRTRANSZ=nnnnK
  - When in 64-bit storage recommend setting other than the minimum!
- MXT (and TRANCLASS) Limits
  - “Generally” ...
    - It is better to hit the MXT limit rather than going “Short-on-Storage”
    - But, do “Not” over allocate MXT!
  - Appropriate use of MXT and Transaction Class limits can be used to avoid unconstrained virtual storage demand
- Try to define a reasonable number of transactions with ...
  - SPURGE(YES) and a DTIMEOUT value

## Recommendations – Recap ...

- Remember ...
  - Terminal user areas (TCTUA) ...
    - TCTUALOC={BELOW|ANY} → TCTUALOC=ANY
  - Transaction definition ...
    - Taskdataloc(Below|Any) → Taskdataloc(Any)
  - Program definition ...
    - Datalocation(Below|Any) → Datalocation(Any)
- CICS Storage Manager Statistics
  - Dynamic Storage Areas – DSAs
- CICS Program Loader Statistics
  - Loader Global – Program Load activity, Not-in-use queue usage, ...
- CICS Transaction Manager Statistics
  - Transaction Manager Global – MXT, Current and Peak Tasks, ...
- 44 • Transaction Class Resource – Class Limits, ...

# Summary

- z/OS Virtual Storage Map
  - Limiting the amount of virtual storage in an Address Space
- CICS Storage Management
  - System Initialization Parameters – DSALIM, EDSALIM, ...
  - Dynamic Storage Areas – DSAs
  - CICS Storage Categories – CICS-key, User-key, ...
  - Short-on-Storage, Storage Fragmentation, Storage Violations, ...
  - Storage Manager Statistics, Monitoring, ...
  - Program Loader, Program Compression, ...



- SHARE Session ...

- *11365: Analyzing/Measuring/Monitoring Memory Usage and Understanding z/OS Memory Management: Performance View*

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Complete your sessions evaluation online at [SHARE.org/AnaheimEval](http://SHARE.org/AnaheimEval)

# References

*CICS Performance Guide, SC34-7177*  
*CICS Problem Determination Guide, GC34-7178*  
*CICS Resource Definition Guide, SC34-7181*  
*CICS Operations and Utilities Guide, SC34-7213*

*CICS Performance Analyzer for z/OS User's Guide, SC34-7153*  
*CICS Performance Analyzer for z/OS Report Reference, SC34-7154*  
*CICS Performance Analyzer for z/OS Getting Started Guide, SC34-7155*

*z/OS MVS Initialization and Tuning Guide, SA22-7591*  
*z/OS MVS Installation Exits, SA22-7593*  
*z/OS MVS JCL Reference, SA22-7597*  
*z/OS MVS JCL User's Guide, SA22-7598*  
*z/OS MVS Programming: Extended Addressability Guide, SA22-7614*  
*z/OS MVS System Management Facilities (SMF), SA22-7630*  
*z/OS JCL User's Guide, SA22-7598*

*z/OS RMF Users' Guide, SC33-7990*  
*z/OS RMF Performance Management Guide, SC33-7992*

## **Redbooks:**

*Threadsafe Considerations for CICS, SG24-6351-04*  
*ABCs of z/OS System Programming Volume 11, SG24-6327-01*

