Understanding z/OS Communications Server storage use

Alfred B Christensen – alfredch@us.ibm.com
IBM Raleigh, NC

Thursday 5-Aug-2010 - 3:00 PM to 4:00 PM
### Understanding z/OS Communications Server storage use

<table>
<thead>
<tr>
<th>Session number:</th>
<th>???</th>
</tr>
</thead>
<tbody>
<tr>
<td>Date and time:</td>
<td>Thursday August 5, 2010 - 3:00 PM - 4:00 PM</td>
</tr>
<tr>
<td>Location:</td>
<td>Room 109 (Hynes Convention Center)</td>
</tr>
<tr>
<td>Program:</td>
<td>Communications Infrastructure</td>
</tr>
<tr>
<td>Project:</td>
<td>Communications Server</td>
</tr>
<tr>
<td>Track:</td>
<td>SNA/IP Integration and z/OS Systems Programming</td>
</tr>
<tr>
<td>Classification:</td>
<td>Technical</td>
</tr>
<tr>
<td>Speaker:</td>
<td>Alfred B Christensen, IBM</td>
</tr>
<tr>
<td>Abstract:</td>
<td>If you have ever wondered how the z/OS Communications Server uses storage in your z/OS LPARs, this session is for you. The session will provide an overview and explanation of the z/OS Communications Server storage concepts and model - how TCP/IP and VTAM uses private storage, CSA, ECSA, CSM storage (ECSA, fixed, data spaces), 64-bit common, etc. The session will provide hints and tips about how to monitor Communications Server storage usage using display command and RMF reports.</td>
</tr>
</tbody>
</table>
IBM Software Group – Enterprise Networking Solutions

Trademark, notices, and disclaimers

The following terms are trademarks or registered trademarks of International Business Machines Corporation in the United States or other countries or both:

- Advanced Peer-to-Peer Networking®
- AIX®
- alphaWorks®
- AnyNet®
- AS/400®
- BladeCenter®
- Candle®
- CICS®
- DataPower®
- DB2®
- DRDA®
- e-business on demand®
- e-business (logo)
- e-business(logo)®
- ESCON®
- FICON®
- GDDM®
- GDPS®
- Geographically Dispersed Parallel Sysplex®
- HiperSockets
- HPR Channel Connectivity
- HyperSwap
- i5/OS (logo)
- i5/OS®
- IMS
- InfiniBand®
- iSeries
- LANDP®
- Language Environment®
- MGSeries®
- MVS
- NetView®
- OMEGAMON®
- Open Power
- OpenPower®
- Operating System/2®
- Operating System/400®
- OS/2®
- OS/390®
- OS/400®
- Parallel Sysplex®
- POWER®
- POWER7®
- PowerVM
- PR/SM
- pSeries®
- RACF®
- Rational Suite®
- Rational®
- Redbooks
- Redbooks (logo)
- Sysplex Timer®
- System i5
- System p5
- System x®
- System z®
- System z9®
- System z10
- Tivoli (logo)®
- Tivoli®
- VTAM®
- WebSphere®
- xSeries®
- z8®
- z10 BC
- z10 EC

* All other products may be trademarks or registered trademarks of their respective companies.

The following terms are trademarks or registered trademarks of International Business Machines Corporation in the United States or other countries or both:

- Adobe, the Adobe logo, PostScript, and the PostScript logo are either registered trademarks or trademarks of Adobe Systems Incorporated in the United States, and/or other countries.
- Cell Broadband Engine is a trademark of Sony Computer Entertainment, Inc. in the United States, other countries, or both, and is used under license there from.
- Java and all Java-based trademarks are trademarks of Sun Microsystems, Inc. in the United States, other countries, or both.
- Microsoft, Windows, Windows NT, and the Windows logo are trademarks of Microsoft Corporation in the United States, other countries, or both.
- InfiniBand is a trademark and service mark of the InfiniBand Trade Association.
- Intel, Intel logo, Intel Inside, Intel Inside logo, Intel Centrino, Intel Centrino logo, Celeron, Intel Xeon, Intel SpeedStep, Itanium, and Pentium are trademarks or registered trademarks of Intel Corporation or its subsidiaries in the United States and other countries.
- UNIX is a registered trademark of The Open Group in the United States and other countries.
- Linux is a registered trademark of Linus Torvalds in the United States, other countries, or both.
- ITIL is a registered trademark, and a registered community trademark of the Office of Government Commerce, and is registered in the U.S. Patent and Trademark Office.
- IT Infrastructure Library is a registered trademark of the Central Computer and Telecommunications Agency, which is now part of the Office of Government Commerce.

Notes:
- Performance is in Internal Throughput Rate (ITR) ratio based on measurements and projections using standard IBM benchmarks in a controlled environment. The actual throughput that any user will experience will vary depending upon considerations such as the amount of multithreading in the user's job stream, the I/O configuration, the storage configuration, and the workload processed. Therefore, no assurance can be given that an individual user will achieve throughput improvements equivalent to the performance ratios stated here.
- IBM hardware products are manufactured from new parts, or new and serviceable used parts. Regardless, our warranty terms apply.
- All customer examples cited or described in this presentation are presented as illustrations of the manner in which some customers have used IBM products and the results they may have achieved. Actual environmental costs and performance characteristics will vary depending on individual customer configurations and conditions.
- This publication was produced in the United States. IBM may not offer the products, services or features discussed in this document in other countries, and the information may be subject to change without notice. Consult your local IBM business contact for information on the product or services available in your area.
- All statements regarding IBM’s future direction and intent are subject to change or withdrawal without notice, and represent goals and objectives only.
- Information about non-IBM products is obtained from the manufacturers of those products or their published announcements. IBM has not tested those products and cannot confirm the performance, compatibility, or any other claims related to non-IBM products. Questions on the capabilities of non-IBM products should be addressed to the suppliers of those products.
- Prices subject to change without notice. Contact your IBM representative or Business Partner for the most current pricing in your geography.

Refer to www.ibm.com/legal/us for further legal information.
Agenda

- Background information
- TCP/IP storage use
- Communications Storage Manager (CSM) storage use
- VTAM storage use
- Use of RMF to monitor z/OS CS storage use
- Summary

Disclaimer: All statements regarding IBM future direction or intent, including current product plans, are subject to change or withdrawal without notice and represent goals and objectives only. All information is provided for informational purposes only, on an “as is” basis, without warranty of any kind.
Understanding z/OS Communications Server Storage Usage

Background information
The user region may consist of up to four virtual storage areas:

1. User region
2. Extended user region
3. Low user region
4. High user region

- **Private**
  - High User Region
  - Extended LSAQ/SWA Sub-pools 229,230
  - Extended CSA (ECSA)
  - Extended PLPA/FLPA/MLPA
  - Extended SQA (ESQA)
  - Extended Nucleus

- **Shared**
  - Default Shared Memory Addressing

- **Low User Private**
  - Low User Region
  - Reserved

- **Extended Private**
  - Extended User Region

- **Extended Common**
  - Extended CSA (ECSA)
  - Extended PLPA/FLPA/MLPA
  - Extended SQA (ESQA)
  - Extended Nucleus

- **Common**
  - Nucleus
  - SQA
  - PLPA/FLPA/MLPA
  - CSA
  - LSAQ/SWA Sub-pools 229,230

- **Private**
  - User Region
  - System Region

- **Common**
  - PSA

**The Bar**
- z – 64-bit addressing
- XA – 31-bit addressing
- S/370 – 24-bit addressing
<table>
<thead>
<tr>
<th>Name</th>
<th>Short</th>
<th>Size in bytes</th>
<th>2 to the order of</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 kilobyte</td>
<td>KB</td>
<td>1,024</td>
<td>10</td>
</tr>
<tr>
<td>1 megabyte</td>
<td>MB</td>
<td>1,048,576</td>
<td>20</td>
</tr>
<tr>
<td>1 gigabyte</td>
<td>GB</td>
<td>1,073,741,824</td>
<td>30</td>
</tr>
<tr>
<td>1 terabyte</td>
<td>TB</td>
<td>1,099,511,627,776</td>
<td>40</td>
</tr>
<tr>
<td>1 petabyte</td>
<td>PB</td>
<td>1,125,899,906,842,624</td>
<td>50</td>
</tr>
<tr>
<td>1 exabyte</td>
<td>EB</td>
<td>1,152,921,504,606,846,976</td>
<td>60</td>
</tr>
<tr>
<td>1 zettabyte</td>
<td>ZB</td>
<td>1,180,591,620,717,411,303,424</td>
<td>70</td>
</tr>
<tr>
<td>1 yottabyte</td>
<td>YB</td>
<td>1,208,925,819,614,629,174,706,176</td>
<td>80</td>
</tr>
</tbody>
</table>
A perspective of address space size over time

- A 31-bit XA address space is 128 times larger than a 24-bit S/370 address space
- A 64-bit z/Architecture address space is 8 billion times larger than a 31-bit XA address space and 1024 billion times larger than a S/370 address space

<table>
<thead>
<tr>
<th>Architecture</th>
<th>Size</th>
<th>Relative size</th>
<th>Comparison – metric</th>
<th>Comparison – non-metric</th>
</tr>
</thead>
<tbody>
<tr>
<td>24-bit S/370 address space</td>
<td>16 MB</td>
<td>1</td>
<td>7 cm</td>
<td>2.8 inches</td>
</tr>
<tr>
<td>31-bit XA address space</td>
<td>2 GB</td>
<td>128</td>
<td>9 m</td>
<td>30 feet</td>
</tr>
<tr>
<td>64-bit z/Architecture address</td>
<td>16 EB</td>
<td>1 099 511 627 776</td>
<td>Distance between Earth and Mars 78 341 212 Km</td>
<td>Distance between Earth and Mars 48 678 972 miles</td>
</tr>
</tbody>
</table>

*Note: distance between earth and Mars varies between 66 million Km and 402 million Km. 78 341 212 Km is the average distance.*
Communications Server virtual storage usage overview

System Resolver | TCP/IP | VTAM | TN3270
---|---|---|---
16 EB
High private | High private | High private | High private
64-bit shared (TCP/IP for SCBs)
Low resolver private (cache)
Low private | Low private | Low private
4 GB
Reserved
Extended resolver private
Extended TCP/IP private | Extended VTAM private | Extended TN3270 private
2 GB
ECSA – TCP/IP use
ECSA – VTAM use
ECSA – TN3270 use
ECSA – CSM use
Extended nucleus, ESAQ
LPA, SQA, Nucleus
16 MB
CSA (both VTAM and TCP/IP use a little)
Resolver private | TCP/IP private | VTAM private | TN3270 private
0
PSA

CSM Data Space 31 (backed by 31-bit real storage frames)
CSM Data Space 64 (backed by 64-bit real storage frames)
Limiting the amount of virtual storage in the user region(s)

- **The REGION JCL keyword** limits the amount of space in the user region and the extended user region
  - Includes user region below the line and between the line and the bar, but not above the bar
  - Does not include space in any of the common areas
  - REGION=0M gives all available storage

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

- **Installation defaults can be defined in JES and SMF**
  - To be used as default when no REGION or MEMLIMIT keywords are specified in the JCL
Installation exits may override JCL keywords

- **Installation exits can enforce installation standards – will override any specifications found in JCL**

  - **IEALIMIT**
    - Is no longer a recommended exit routine for this purpose
    - Can only enforce standards for user region below the 16 MB line and is linked into the MVS nucleus

  - **IEFUSI**
    - Is the preferred exit routine to enforce these limits
    - Resides in the LPA
    - Can enforce standards for:
      - The user region below the 16 MB line
      - The extended user region between the 16 MB line and the 2 GB bar
      - The user region above the 2 GB bar (MEMLIMIT JCL keyword)
    - PPT attribute NOHONORIEFUSIREGION can be used for selected programs to ignore IEFUSI standards – defined in the SCHEDxx SYS1.PARMLIB member
Data Spaces and memory objects

- **Data Space**
  - A data space is max 2 GB in size
  - 31-bit addressing is used to access data in a data space
  - A data space may be backed by 64-bit real storage frames (if the system has more than 2 GB of real storage)
  - What CSM means with the term ‘DATA SPACE 64’:
    - This is not 64-bit virtual storage, this is a normal 2 GB data space that is allowed to be backed by 64-bit real storage frames
  - CSM uses so-called common data spaces
    - System-wide number of common data spaces is limited by the MAXCAD keyword in IEASYSxx
      - Default is 50

- **Memory object**
  - Virtual storage above the bar may be allocated and made part of an address space’s virtual storage addressing range
  - Obtained in multiples of 1 MB (a so-called memory object)
  - A memory object may be a common memory object or a shared memory object – residing in the area between 2 TB and 512 TB
  - A memory object may also be part of the private addressing range within an address space – part of the user region
**System wide storage-related definitions**

- **SYS1.PARMLIB – IEASYSn member**
  - **CSA=(a,b)**
    - "a" specifies the size of the CSA, located below 16MB
    - "b" specifies the size of the extended CSA, located above 16MB
      - Make sure this number is big enough to accommodate TCP/IP’s, VTAM’s, and CSM’s ECSA requirements
      - Plus the requirements of whatever else you run on that system
    - **Example:**
      - CSA=(4M,256M)
        - 4MB CSA below the 16 MB line
        - 256MB ECSA above the 16 MB line
  - **HVCOMMON=a**
    - “a” specifies the size of the 64-bit common area (xxG or xxT)
      - The 64-bit common area will be placed below the 4T line.
      - The value you specify will be rounded up to a 2 gigabyte boundary
      - Default is 64 GB, minimum is 2 GB, maximum is 1 TB
Understanding z/OS Communications Server Storage Usage

TCP/IP storage use
TCP/IP storage use overview

- **TCP/IP user region**
  - Primarily extended user region
  - Very little, if any, in the user region below the line
  - Nothing in low and high user regions above the bar
  - TCP/IP refers to this storage as POOL storage

- **Extended Common Service Area (ECSA)**
  - The part of ECSA that is obtained and managed by TCP/IP
    - Not part of CSM storage
    - During TCP/IP initialization, a few modules are loaded into ECSA using dynamic LPA functions
      - Prior to z/OS V1R11 this was done by TCP/IP itself using directed load
      - Main module is EZBTIINI, which in the current z/OS V1R11 distribution is 7,117,424 bytes in size
    - Otherwise ECSA storage is primarily used for common control blocks
    - ECSA storage is obtained in either key 0 or key 6
      - Most workload-related storage is obtained in key 6
    - ECSA storage is obtained with TCP/IP or the “System” as owner
      - Almost all TCP/IP’s ECSA is obtained with the “System” as owner

- **Common 64-bit memory**
  - In z/OS V1R11, TCP/IP uses common 64-bit memory objects for Socket Control Blocks (SCBs)
TCPIP,[stackname],STOR

- This does not include CSM storage
- Limits can optionally be configured in the TCP/IP Profile for POOL and ECSA storage

- **POOL** storage
  - The amount of storage TCP/IP uses in its user regions

- **ECSA** storage
  - In releases prior to z/OS V1R12, ECSA includes the size of load module EZBTIINI, which is loaded into ECSA during initialization (in z/OS V1R11 using dynamic LPA functions).
    - EZBTIINI resides in storage key 0.
    - The total size of this module is roughly 6,950K in z/OS V1R11, which is up about 660K from z/OS V1R10.
  - In z/OS V1R12, ECSA does not include any load modules that have been loaded into common storage
    - The size of load modules in ECSA is reported separately in the output from this command
  - Most of the ECSA storage is from an RMF perspective reported under the MVS master address space (RMF job name of %MVS).
    - The ECSA storage is obtained with OWNER(SYSTEM)
    - You cannot get an RMF Common Storage report to match the number above

- **64-BIT common**
  - This storage is obtained in 1 MB objects, but only backed by real storage or page data set space to the extend TCP/IP uses it

- **CSA Modules**
  - This is common storage used by TCP/IP load modules. Reported in z/OS V1R12.
D TCPIP,[stackname],STOR

z/OS V1R11

13.59.24  d tcpip,tcpcs,stor
13.59.26  EZZ8453I TCPIP STORAGE
EZZ8454I TCPCS STORAGE CURRENT MAXIMUM LIMIT
EZZ8455I TCPCS ECSA  9645K  10087K  NOLIMIT
EZZ8455I TCPCS POOL  14017K  14171K  NOLIMIT
EZZ8455I TCPCS 64-BIT COMMON  1M    1M   NOLIMIT
EZZ8459I DISPLAY TCPIP STOR COMPLETED SUCCESSFULLY

z/OS V1R12

09.19.47  d tcpip,,stor
09.19.47  EZZ8453I TCPIP STORAGE
EZZ8454I TCPCS STORAGE CURRENT MAXIMUM LIMIT
EZZ8455I TCPCS ECSA  2789K  3245K  NOLIMIT
EZZ8455I TCPCS POOL  14212K  14212K  NOLIMIT
EZZ8455I TCPCS 64-BIT COMMON  1M    1M   NOLIMIT
EZZ8455I TCPCS CSA MODULES  7423K  7423K  NOLIMIT
EZZ8459I DISPLAY TCPIP STOR COMPLETED SUCCESSFULLY

ECSA storage is now reported as workload-related storage use only. Load modules in ECSA are reported separately in the CSA Modules line.
D TCPIP,TN-Server-Name,STOR

- Each TN3270 server address space on your system also support the D TCPIP,,STOR command
  - Output will reflect that TN3270 server address space’s use of storage
    - Enter the command for each TN3270 server address space

```
13.30.24  d tcpip,tn3270a,stor
13.30.24  EZZ8453I TELNET STORAGE
EZZ8454I TN3270A STORAGE CURRENT MAXIMUM LIMIT
EZZ8455I TN3270A ECSA 97K 117K NOLIMIT
EZZ8455I TN3270A POOL 6636K 7392K NOLIMIT
EZZ8455I TN3270A 64-BIT COMMON 0M 0M NOLIMIT
EZZ8455I TN3270A CTRACE 262372K 262372K 262372K
EZZ8459I DISPLAY TELNET STOR COMPLETED SUCCESSFULLY
```

- There are no limits that can be configured for a TN3270 server address space
- The storage options include a CTRACE storage type
  - The CTRACE storage is in the TN3270 server’s private area (not common and not data space), but is not included in the POOL storage type line
  - It is currently set to 256 MB
  - The limit here is not configurable
  - The size reflects how much storage is obtained for tracing, not what currently is being used for tracing
How do you limit TCP/IP’s storage use?

- **POOL storage**
  - Via the REGION keyword in TCP/IP’s start up JCL
    - User and extended user region size
    - Can be overridden by installation exits
      - Primarily IEFUSI
    - If used, should be accompanied by limitations in TCP/IP’s profile
  - TCP/IP Profile
    - GLOBALCONFIG POOLLIMIT xxK or xxM
      - 0 means no limit and is the default

- **ECSA storage**
  - TCP/IP Profile
    - GLOBALCONFIG ECSALIMIT xxK or xxM
      - 0 means no limit and is the default

- The GLOBALCONFIG limits will be enforced by TCP/IP itself
  - Warning messages at 80%, 90%, and 98% utilization
    - EZZ4360I, EZZ4361I, and EZZ4362I for ECSA
    - EZZ4364I, EZZ4365I, and EZZ4366I for POOL
  - Storage relieved message issued when under 75% again
    - EZZ4363I for ECSA and EZZ4367I for POOL
Considerations for choosing POOL and ECSA limits

- Monitor TCP/IP storage use during your acceptable peak periods

- Add a reasonable fudge factor to the observed maximum usage values
  - The ECSALIMIT ensures that TCP/IP does not overuse the z/OS system’s common storage.
    - It is intended to improve system reliability by limiting TCP/IP’s common storage usage.
    - Accommodate for temporary application “hang” conditions, where TCP/IP must buffer large amounts of inbound or outbound data.

- If you choose to limit POOL storage, make sure you use a value that is lower than or equal to what your installation exit (IEFUSI) enforces
  - The benefit of specifying POOL limit is that you will receive warning messages before storage obtain calls start failing with not enough storage available to satisfy the requests

- The values can be changed via OBEYFILE command processing
Other considerations for TCP/IP storage controls - UDP

- **UDP applications:**
  - Control queue size of UDP messages
  - UDPCONFIG UDPQUEUELIMIT
    - When UDPQUEUELIMIT is ON then receive queues for UDP ports are limited to 2000 messages or 2800K
  - To further control UDP queue sizes, enable IDS policies with traffic regulation and UDP message queue size limits per UDP application
  - Does not apply to EE UDP traffic!!

*This will also benefit use of CSM storage*
Other considerations for TCP/IP storage controls - TCP

**TCP applications**

- Control number of concurrent connections with TCP Listeners to reduce impacts of flooding attacks:
  - IDS policy with traffic regulation and connection limits

- Monitor “misbehaving” applications that build up large send or receive buffers:
  - Monitor new z/OS V1R11 syslogd messages about applications with long send or receive queues
  - Watch for EZZ8661I to EZZ8664I messages
  - These messages will be logged through TRMD and syslogd even if you have no IDS policy enabled

This will also benefit use of CSM storage
z/OS V1R11 storage improvements for storage shortages situations and slow or stalled TCP applications

- Data in a send buffer is page fixed – awaiting IO operations to be initiated
  - When application is not making progress or fixed storage is constrained
    • All new data added to TCP send queue is marked as page-able
  - When storage becomes constrained, all unsent data on send queues for all non-local TCP connections is marked as page-able
  - Before data is sent to remote stack it is changed back to fixed, as required by the DLC

- It was very difficult to identify which local applications caused excessive amounts of space to be used on the send or receive queues
  - Alerts issued to indicate TCP queue in constrained state
    • Indicate old data on send or receive queue
    • Identify connection (connection id, job name, addresses, ports)
    • Constrained state entry and exit indicated
    • Issued to syslogd using TRMD

Constrained:
- Queue full & data at least 30 sec old
- Any data at least 60 sec old
Entry alert when 90% of constrained threshold reached, exit alert when down at 80%
Understanding z/OS Communications Server Storage Usage

Communications Storage Manager (CSM) storage use
Communications Storage Manager (CSM)

- The communications storage manager (CSM) is a VTAM component that allows authorized host applications to share data with VTAM, TCP/IP and other CSM users without the need to physically copy the data.

- CSM includes a public application programming interface (API) that provides a way to:
  - Obtain and return CSM buffers
  - Change ownership of buffers
  - Copy buffers
  - Manage CSM buffers

- The storage key for CSM buffers is key 6
  - Most CSM storage is obtained with the “System” as owner

It is all about minimizing the number of data copies!
CSM virtual storage overview

- Users of CSM storage use the IVTCSM macro to interact with the CSM storage manager.

- CSM storage is organized into buffer pools of fixed sizes (4K, 16K, 32K, 60K, and 180K).

- CSM storage is either ECSA or data space storage
  - CSM may create up to a total of five data spaces if needed.

- CSM storage may be fixed or pageable
  - CSM storage may be page fixed in order to support an IO operation that requires fixed storage.
CSM buffer pools, source, and residency

**CSM buffer pools**
- 4K
- 16K
- 32K
- 60K
- 180K

**CSM buffer source**
- ECSA
- Data Space 64
- Data Space 31

**CSM buffer residency**
- Page data sets
- 64-bit real storage frame
- 31-bit real storage frame
- Real storage

CSM location of buffer pools
CSM location of buffer pools

MVS backing of virtual storage
MVS backing of virtual storage
How to control CSM storage

- **IVTPRM00 member of SYS1.PARMLIB** – Note: Only the 00 suffix is allowed – IVTPRM00.
  - Read by VTAM during initialization
  - Can be modified and read via a MODIFY CSM without any parameters

- **You can control:**
  - The maximum amount of CSM storage that can be fixed at any point in time
    - Includes both ECSA and data space fixed storage
  - The maximum amount of ECSA storage, CSM can use at any point in time
  - How each of the five buffer pools is to be managed per buffer source
    - The default initial number of buffers to create the first time a user of CSM services request a pool to be created of a given size in one of the three CSM buffer sources
      - If initial number of buffers is set in IVTPRM00, it will always be used – otherwise the initial number of buffers depend on what the first requester asks for
    - The minimum number of free buffers in the pool before expansion must be done
    - The number of buffers the pool is to be expanded by when expansion occurs

- **Each of the data spaces CSM uses is 2 GB in size and no further controls are available for those**

<table>
<thead>
<tr>
<th>Buffer size</th>
<th>4K</th>
<th>16K</th>
<th>32K</th>
<th>60K</th>
<th>180K</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Initial</strong></td>
<td>64</td>
<td>16</td>
<td>16</td>
<td>16</td>
<td>2</td>
</tr>
<tr>
<td><strong>Minimum free</strong></td>
<td>8</td>
<td>4</td>
<td>2</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td><strong>Expansion units</strong></td>
<td>16</td>
<td>8</td>
<td>4</td>
<td>4</td>
<td>2</td>
</tr>
</tbody>
</table>

*Note: A health check suggests these two should be set to 120M as an initial value.*
How to monitor overall CSM storage use

- A “D NET,CSM” command will provide a quick overview of how much storage has been allocated by CSM, and how much of it is in-use or free for use by a CSM user.

- Three main locations:
  - ECSA
  - Data Space 31
  - Data Space 64

- Sample IVTPRM00 for the system used for this D CSM command:
  - FIXED MAX(120M)
  - ECSA MAX(120M)

<table>
<thead>
<tr>
<th>Buffer Type</th>
<th>Source</th>
<th>INUSE</th>
<th>FREE</th>
<th>TOTAL</th>
<th>#buf Exp?</th>
</tr>
</thead>
<tbody>
<tr>
<td>4K</td>
<td>ECSA</td>
<td>200K</td>
<td>312K</td>
<td>512K</td>
<td>128 yes</td>
</tr>
<tr>
<td>16K</td>
<td>ECSA</td>
<td>0M</td>
<td>256K</td>
<td>256K</td>
<td>16 no</td>
</tr>
<tr>
<td>32K</td>
<td>ECSA</td>
<td>0M</td>
<td>512K</td>
<td>512K</td>
<td>16 no</td>
</tr>
<tr>
<td>60K</td>
<td>ECSA</td>
<td>0M</td>
<td>0M</td>
<td>0M</td>
<td>0</td>
</tr>
<tr>
<td>180K</td>
<td>ECSA</td>
<td>0M</td>
<td>360K</td>
<td>360K</td>
<td>2 no</td>
</tr>
<tr>
<td>TOTAL</td>
<td>ECSA</td>
<td>200K</td>
<td>1440K</td>
<td>1640K</td>
<td></td>
</tr>
<tr>
<td>4K</td>
<td>DATA SPACE 31</td>
<td>0M</td>
<td>256K</td>
<td>256K</td>
<td>64 no</td>
</tr>
<tr>
<td>16K</td>
<td>DATA SPACE 31</td>
<td>0M</td>
<td>0M</td>
<td>0M</td>
<td>0</td>
</tr>
<tr>
<td>32K</td>
<td>DATA SPACE 31</td>
<td>0M</td>
<td>0M</td>
<td>0M</td>
<td>0</td>
</tr>
<tr>
<td>60K</td>
<td>DATA SPACE 31</td>
<td>0M</td>
<td>0M</td>
<td>0M</td>
<td>0</td>
</tr>
<tr>
<td>180K</td>
<td>DATA SPACE 31</td>
<td>0M</td>
<td>0M</td>
<td>0M</td>
<td>0</td>
</tr>
<tr>
<td>TOTAL</td>
<td>DATA SPACE 31</td>
<td>0M</td>
<td>256K</td>
<td>256K</td>
<td></td>
</tr>
<tr>
<td>4K</td>
<td>DATA SPACE 64</td>
<td>4372K</td>
<td>236K</td>
<td>4608K</td>
<td>1152 yes</td>
</tr>
<tr>
<td>16K</td>
<td>DATA SPACE 64</td>
<td>0M</td>
<td>256K</td>
<td>256K</td>
<td>16 no</td>
</tr>
<tr>
<td>32K</td>
<td>DATA SPACE 64</td>
<td>64K</td>
<td>448K</td>
<td>512K</td>
<td>16 no</td>
</tr>
<tr>
<td>60K</td>
<td>DATA SPACE 64</td>
<td>0M</td>
<td>0M</td>
<td>0M</td>
<td>0</td>
</tr>
<tr>
<td>180K</td>
<td>DATA SPACE 64</td>
<td>0M</td>
<td>360K</td>
<td>360K</td>
<td>2 no</td>
</tr>
<tr>
<td>TOTAL</td>
<td>DATA SPACE 64</td>
<td>4436K</td>
<td>1300K</td>
<td>5736K</td>
<td></td>
</tr>
<tr>
<td>TOTAL</td>
<td>ALL SOURCES</td>
<td>4636K</td>
<td>2996K</td>
<td>7632K</td>
<td></td>
</tr>
</tbody>
</table>

Comments:
CSM buffer pool usage for user of CSM storage

- To see how much CSM storage each of the CSM ‘users’ currently are using, issue a D NET,CSM,OWNERID=ALL command
  - This command can also be issued with a specific ownerID

- In this example, only VTAM (VTAMCS) and a TCP/IP stack (TCPCS) are using CSM storage
Detailed CSM buffer pool usage overview

- Per each of the 15 CSM buffer pools, a detailed usage display can be used
  - D NET, CSMUSE, POOL=pool-name

- The pool names are:
  - 4KECSA
  - 16KECSA
  - 32KECSA
  - 60KECSA
  - 180KECSA
  - 4KDS
  - 16KDS
  - 32KDS
  - 60KDS
  - 180KDS
  - 4KDS64
  - 16KDS64
  - 32KDS64
  - 60KDS64
  - 180KDS64

F NET, CSM,
- MONITOR=YES
- MONITOR=NO
- MONITOR=DYNAMIC
  - CSM dynamically activates CSM buffer monitoring when CSM storage usage approaches the constrained level

D NET, CSM, MONITOR

Monitor IDs are documented in z/OS Communications Server: IP and SNA Codes Chapter 4
CSM monitor IDs – lots of good hints about where CSM storage is being used

<table>
<thead>
<tr>
<th>Range</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>X’00’ – X’1F’</td>
<td>CSM Monitor IDs</td>
</tr>
<tr>
<td>X’20’ – X’2F’</td>
<td>DLC Monitor IDs</td>
</tr>
<tr>
<td>X’30’ – X’8F’</td>
<td>VTAM Unique Monitor IDs</td>
</tr>
<tr>
<td>X’90’ – X’97’</td>
<td>TCP/IP IF Layer Monitor IDs</td>
</tr>
<tr>
<td>X’98’ – X’9F’</td>
<td>TCP/IP IP Layer Monitor IDs</td>
</tr>
<tr>
<td>X’A0’ – X’AF’</td>
<td>TCP/IP Transport Layer Monitor IDs</td>
</tr>
<tr>
<td>X’B0’ – X’FF’</td>
<td>TCP/IP Misc Monitor IDs</td>
</tr>
</tbody>
</table>

For monitor ID 21 (DLC Read Operation):

- **VTAM**
  - VTAM owns 52K of 4KECSA CSM buffers used for read operations at the DLC layer
  - The read operations are associated with devices 0D00 (CTC), 2E01 (QDIO write), and 2E00 (QDIO read)

- **TCP/IP**
  - TCP/IP owns 80K of 4KECSA CSM buffers used for read operations at the DLC layer
  - TCP/IP’s read operation is associated with device 2E02 (QDIO data path)

- For monitor ID X’21’, the user field will provide the EBCDIC sub-channel read device unit address associated with this device. Some devices can configure how much read storage is used (for example, QDIO devices).
- Other monitor IDs use the user data field for other types of information.
Understanding z/OS Communications Server Storage Usage

VTAM storage use
VTAM storage use overview

- **VTAM user region**
  - Primarily extended user region
  - Some in the user region below the line

- **Common Service Area (CSA) – referred to by VTAM as CSA24**
  - VTAM uses CSA below the line for a few modules and control blocks

- **Extended Common Service Area (ECSA)**
  - The part of ECSA that is obtained and managed by VTAM
    - Not part of CSM storage
  - VTAM has a few modules loaded into ECSA
  - Otherwise ECSA storage is primarily used for common control blocks
  - ECSA storage is obtained in either key 0 or key 6
    - Most of VTAM’s ECSA storage is obtained in key 6
  - ECSA storage is obtained with VTAM or the “System” as owner
    - Workload related ECSA storage is generally obtained in key 6 with VTAM as owner
How do you limit VTAM’s storage use?

- **VTAM’s private storage (VTAM’s POOL storage)**
  - Via the REGION keyword in VTAM’s start up JCL
    - Private and extended private region size
    - Can be overridden by installation exits - primarily by IEFUSI

- **CSA+ECSA storage**
  - Via the CSALIMIT VTAM start option (ATCSTRxx), which covers both CSA and ECSA
    - CSALIMIT=0 - Default, limit set to 90% of system limit (IEASYSnn CSA+ECSA limit)
    - CSALIMIT=nn - Warning when reached, but will continue until only 25% of system limit is available
    - CSALIMIT=(nn,F) - Will not go above the limit specified
  - Can be changed dynamically via a MODIFY VTAMOPTS or MODIFY CSALIMIT command

- **CSA storage below the line**
  - Via the CSA24 start option, which specifically covers 24-bit addressable CSA storage (CSA24 is a subset of the CSALIMIT value)
    - CSA24=a
      - CSA24=0 is the default and means no limit
      - Can be changed dynamically via a MODIFY VTAMOPTS or MODIFY CSALIMIT command
How do you monitor VTAM’s storage use?

- **Via a D NET,BFRUSE command**

  - Towards the end of the output from that command is a breakdown of VTAM’s current storage use (limit, current, high-water mark)
    - CSA
    - CSA24
    - Private

    In this example, this is the default limit: 90% of IEASYSnn CSA+ECSA

<table>
<thead>
<tr>
<th>Message</th>
<th>Contents</th>
</tr>
</thead>
<tbody>
<tr>
<td>IST449I</td>
<td>CSALIMIT = 240012K, CURRENT = 2562K, MAXIMUM = 2578K</td>
</tr>
<tr>
<td>IST790I</td>
<td>MAXIMUM CSA USED = 2578K</td>
</tr>
<tr>
<td>IST1667I</td>
<td>SYSTEM CSA LIMIT = 266680K</td>
</tr>
<tr>
<td>IST1831I</td>
<td>91% OF SYSTEM CSA STORAGE REMAINING = 243320K</td>
</tr>
<tr>
<td>IST449I</td>
<td>CSA24 LIMIT = NOLIMIT, CURRENT = 60K, MAXIMUM = 63K</td>
</tr>
<tr>
<td>IST790I</td>
<td>MAXIMUM CSA24 USED = 63K</td>
</tr>
<tr>
<td>IST595I</td>
<td>IRNLIMIT = NOLIMIT, CURRENT = 0K, MAXIMUM = 0K</td>
</tr>
<tr>
<td>IST981I</td>
<td>VTAM PRIVATE: CURRENT = 1030K, MAXIMUM USED = 1183K</td>
</tr>
<tr>
<td>IST924I</td>
<td>-----------------------------------------------</td>
</tr>
<tr>
<td>IST1565I</td>
<td>CSA MODULES = 1756K</td>
</tr>
<tr>
<td>IST1565I</td>
<td>CSA24 MODULES = 40K</td>
</tr>
<tr>
<td>IST1565I</td>
<td>PRIVATE MODULES = 7497K</td>
</tr>
</tbody>
</table>
Understanding z/OS Communications Server Storage Usage

Use of RMF to monitor z/OS CS storage use
Communications Server storage is in Key 6

- The RMF Monitor II Virtual Storage Activity report reports the amount of Key 6 storage in CSA and ECSA
  - The Communications Server uses key 6 storage

```
<table>
<thead>
<tr>
<th>AREA</th>
<th>ADDRESS</th>
<th>SIZE</th>
<th>MIN</th>
<th>MAX</th>
<th>AVG</th>
<th>MIN</th>
<th>MAX</th>
<th>AVG</th>
</tr>
</thead>
<tbody>
<tr>
<td>EPVT</td>
<td>16E00000</td>
<td>1682M</td>
<td>568K</td>
<td>568K</td>
<td>568K</td>
<td>14.5M</td>
<td>11.13.15</td>
<td>14.7M</td>
</tr>
<tr>
<td>ECSA</td>
<td>6D70000</td>
<td>4K</td>
<td>372K</td>
<td>372K</td>
<td>372K</td>
<td>23.0M</td>
<td>11.05.16</td>
<td>23.2M</td>
</tr>
<tr>
<td>NUCLEUS</td>
<td>FD6000</td>
<td>168K</td>
<td>0K</td>
<td>0K</td>
<td>0K</td>
<td>0K</td>
<td>11.05.16</td>
<td>0K</td>
</tr>
<tr>
<td>PLA</td>
<td>BF30000</td>
<td>2460K</td>
<td>4K</td>
<td>4K</td>
<td>4K</td>
<td>668K</td>
<td>11.05.16</td>
<td>668K</td>
</tr>
<tr>
<td>MLA</td>
<td>BF20000</td>
<td>4K</td>
<td>6</td>
<td>80K</td>
<td>80K</td>
<td>80K</td>
<td>11.05.16</td>
<td>80K</td>
</tr>
<tr>
<td>CSA</td>
<td>8000000</td>
<td>3988K</td>
<td>0K</td>
<td>0K</td>
<td>0K</td>
<td>0K</td>
<td>11.05.16</td>
<td>0K</td>
</tr>
<tr>
<td>PRIVATE</td>
<td>2000</td>
<td>8184K</td>
<td>0K</td>
<td>0K</td>
<td>0K</td>
<td>0K</td>
<td>11.05.16</td>
<td>0K</td>
</tr>
<tr>
<td>PSA</td>
<td>0</td>
<td>8K</td>
<td>0K</td>
<td>0K</td>
<td>0K</td>
<td>0K</td>
<td>11.05.16</td>
<td>0K</td>
</tr>
</tbody>
</table>
```
RMF Monitor III Common Storage report

- Not too useful since most of the common storage that is obtained by the Communications Server components is obtained with the “SYSTEM” as owner (%MVS as jobname).

### RMF V1R11 Common Storage

<table>
<thead>
<tr>
<th>Command ====&gt;</th>
<th>Scroll ====&gt; CSR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Samples: 90</td>
<td>System: 3090</td>
</tr>
<tr>
<td>Date: 07/06/09</td>
<td>Time: 13.05.00</td>
</tr>
<tr>
<td>Range: 90 Sec</td>
<td></td>
</tr>
</tbody>
</table>

#### System Information

<table>
<thead>
<tr>
<th>Percent</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>CSA</td>
<td>ECSA</td>
</tr>
<tr>
<td>SQA</td>
<td>ESQA</td>
</tr>
</tbody>
</table>

#### IPL Definitions

- Peak Allocation Values: 16 9 80 69 639K 23M 1211K 13M
- Average CSA to SQA Conversion: 0 0 0 0
- Average Use Summary: 8 9 35 69 324K 23M 531K 13M
- Available at End of Range: 92 91 65 31 3656K 234M 989K 5903K
- Unalloc Common Area: 4564K

#### Service

<table>
<thead>
<tr>
<th>Service</th>
<th>ELAP</th>
<th>-- Percent Used --</th>
<th>----- Amount Used ----</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jobname</td>
<td>Act</td>
<td>C Class</td>
<td>ASID</td>
</tr>
<tr>
<td>%MVS</td>
<td>3</td>
<td>6 31 38</td>
<td>127K</td>
</tr>
<tr>
<td>%REMAIN</td>
<td>0</td>
<td>0 0 0 0</td>
<td>424</td>
</tr>
<tr>
<td>VTAMCS</td>
<td>S</td>
<td>SYSSTC</td>
<td>0041</td>
</tr>
<tr>
<td>TCPCS</td>
<td>S</td>
<td>SYSSTC</td>
<td>0058</td>
</tr>
<tr>
<td>TN3270A</td>
<td>S</td>
<td>SYSSTC</td>
<td>0061</td>
</tr>
<tr>
<td>ABCRESO</td>
<td>S</td>
<td>SYSSTC</td>
<td>0040</td>
</tr>
<tr>
<td>OMPROUTE</td>
<td>S</td>
<td>SYSSTC</td>
<td>0064</td>
</tr>
</tbody>
</table>

VTAM’s modules in ECSA, CSM’s, and TCP/IP’s ECSA storage is accounted for under %MVS.

VTAM’s workload-related ECSA storage is accounted for under VTAM itself.

TCP/IP components have minor ECSA amounts accounted under their own address spaces.
RMF Monitor III Storage Memory Objects (64-bit storage)

- Both the resolver address space and TCP/IP use 64-bit virtual storage since z/OS V1R11
  - Resolver uses 64-bit user region storage
  - TCP/IP uses 64-bit common storage

### System Summary

<table>
<thead>
<tr>
<th>Memory Objects</th>
<th>Frames</th>
<th>Area Used %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Common</td>
<td>Shared</td>
<td>Large</td>
</tr>
<tr>
<td>Large</td>
<td>Common</td>
<td>Fixed</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1 MB</td>
</tr>
<tr>
<td>6</td>
<td>0</td>
<td>800</td>
</tr>
</tbody>
</table>

### Memory Objects

<table>
<thead>
<tr>
<th>Service</th>
<th>Jobname</th>
<th>C Class</th>
<th>ASID</th>
<th>Total</th>
<th>Comm</th>
<th>Shr</th>
<th>Large</th>
<th>1 MB</th>
<th>Total</th>
<th>Comm</th>
<th>Shr</th>
</tr>
</thead>
<tbody>
<tr>
<td>SMSPDSE</td>
<td>SYSTEM</td>
<td>S</td>
<td>0008</td>
<td>12</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>76.0M</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>TRACE</td>
<td>SYSTEM</td>
<td>S</td>
<td>0004</td>
<td>8</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>8192K</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>GRS</td>
<td>SYSTEM</td>
<td>S</td>
<td>0007</td>
<td>4</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>140G</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>ABCRESO</td>
<td>SYSSTC</td>
<td>S</td>
<td>0040</td>
<td>4</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>4096K</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>JESEAUX</td>
<td>SYSSTC</td>
<td>S</td>
<td>0027</td>
<td>3</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>3072K</td>
<td>3072K</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>ZFS</td>
<td>SYSSTC</td>
<td>S</td>
<td>0049</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>22.0M</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><em>MASTER</em></td>
<td>SYSTEM</td>
<td>S</td>
<td>0001</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1024K</td>
<td>1024K</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>TCPCS</td>
<td>SYSSTC</td>
<td>S</td>
<td>0058</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1024K</td>
<td>1024K</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

*Resolver uses 64-bit private for the DNS cache*

*TCP/IP uses 64-bit common memory for its sockets control blocks*
Understanding z/OS Communications Server Storage Usage

Summary
Summary

- **Limiting CS common storage use should be done to protect other subsystem’s access to common storage**
  - Severe network spikes (normal or the results of an attack) can require large amounts of common storage for a period of time
  - To avoid CS monopolizing all common storage on a system, limits should be enforced
    - There are no general values that will work for everyone
    - Monitor your system for a period of normal and acceptable peak workloads
    - Communications Server components have mechanisms built in to deal with storage constraints where the limits are approached
      - The intended objective of those mechanisms is to keep the system running in a controllable state, reducing the amount of network traffic to/from the system for a brief period of time
  - If other subsystems are unsuccessful in obtaining any more common storage, they may or may not be able to “survive”
Summary

- To get a complete picture of Communications Server common storage use, you need to add up the following items:
  - ECSA use from the D TCPIP,,STOR command for all stacks
  - For z/OS V1R12: Also the CSA modules from D TCPIP,,STOR command
  - ECSA use from the D TCPIP,TN-Server,STOR command for all TN3270 server address spaces
  - CSM total ECSA use from the D NET,CSM command
  - VTAM total ECSA use from the D NET,BFRUSE command

- For all items, you can collect
  - Current use
  - High-water mark
  - Limit (if one has been configured)
And as usual, a little REXX program can do wonders to bringing order into all that data ..
## For more information

<table>
<thead>
<tr>
<th>URL</th>
<th>Content</th>
</tr>
</thead>
<tbody>
<tr>
<td><a href="http://www.twitter.com/IBM_Commsserver">http://www.twitter.com/IBM_Commsserver</a></td>
<td>IBM Communications Server Twitter Feed</td>
</tr>
<tr>
<td><a href="http://www.facebook.com/IBMCommsserver">http://www.facebook.com/IBMCommsserver</a></td>
<td>IBM Communications Server Facebook Fan Page</td>
</tr>
<tr>
<td><a href="http://www.ibm.com/systems/z/">http://www.ibm.com/systems/z/</a></td>
<td>IBM System z in general</td>
</tr>
<tr>
<td><a href="http://www.ibm.com/systems/z/hardware/networking/">http://www.ibm.com/systems/z/hardware/networking/</a></td>
<td>IBM Mainframe System z networking</td>
</tr>
<tr>
<td><a href="http://www.ibm.com/software/network/commsserver/zos/">http://www.ibm.com/software/network/commsserver/zos/</a></td>
<td>IBM z/OS Communications Server</td>
</tr>
<tr>
<td><a href="http://www.ibm.com/software/network/ccl/">http://www.ibm.com/software/network/ccl/</a></td>
<td>IBM Communication Controller for Linux on System z</td>
</tr>
<tr>
<td><a href="http://www.redbooks.ibm.com">http://www.redbooks.ibm.com</a></td>
<td>ITSO Redbooks</td>
</tr>
<tr>
<td><a href="http://www.ibm.com/software/network/commsserver/zos/support/">http://www.ibm.com/software/network/commsserver/zos/support/</a></td>
<td>IBM z/OS Communications Server technical Support – including TechNotes from service</td>
</tr>
<tr>
<td><a href="http://www.ibm.com/support/techdocs/atsmastr.nsf/Web/TechDocs">http://www.ibm.com/support/techdocs/atsmastr.nsf/Web/TechDocs</a></td>
<td>Technical support documentation from Washington Systems Center (techdocs, flashes, presentations, white papers, etc.)</td>
</tr>
<tr>
<td><a href="http://www.rfc-editor.org/rfcsearch.html">http://www.rfc-editor.org/rfcsearch.html</a></td>
<td>Request For Comments (RFC)</td>
</tr>
<tr>
<td><a href="http://www.ibm.com/systems/z/os/zos/bkserv/">http://www.ibm.com/systems/z/os/zos/bkserv/</a></td>
<td>IBM z/OS Internet library – PDF files of all z/OS manuals including Communications Server</td>
</tr>
</tbody>
</table>

*For pleasant reading* ....