z/VM 6.3: Changes in Memory Management

Stephen Jones – z/VM Performance Evaluation – stepjone@us.ibm.com

MVMUA January 14, 2014

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Agenda

- Objectives and strategies of the z/VM Large Memory enhancement
- Key features of the z/VM Large Memory enhancement
  - Algorithmic concepts: new, changed, or obsolete
  - Basic flows and data structures
  - Knobs you can twist or set
- Planning for z/VM Large Memory
  - Paging DASD calculations
  - Reminders about best practices with respect to paging I/O
- Workloads
- CP Monitor and z/VM Performance Toolkit
- Summary

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Objectives and Strategies

- Objectives:
  - Support 1024 GB aka 1 TB of central memory in a partition
  - Support large guests in such a context
  - Retain ability to overcommit memory

- Strategies:
  - Repair or replace memory management algorithms that do not scale well
  - Repair or replace memory management algorithms that are grossly unfair

- Specifically:
  - *Page reorder* is a real problem area. Get rid of it.
  - *Demand scan* has scaling problems and frame ordering problems. Repair them.
  - Introduce a new *global aging list* concept to add accuracy to frame reclaim decisions.
  - Improve *fairness* of frame steal to spread the discomfort equitably when memory is constrained.
  - Improve respect of *residency minima* established by SET RESERVED.
  - Extend SET RESERVED to DCSSes such as MONDCSS.

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New Algorithms and Behaviors

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New Approach: Highlights

- Objective: keep the *available lists* populated just right
- New visit heuristic tries to improve occupancy fairness in the face of storage constraint
- The in-use frames are tracked by a new hierarchical data structure:
  - Valid, often-touched frames are at the top
  - Demand scan pushes frames downward as they seem to increase in reclaim appeal
  - Best reclaim candidates are at the bottom
- DASD use for paging is changed to be more friendly to reclaim and to storage subsystems
  - Pages valid on DASD are not rewritten anymore
  - Pages get written back to their same slots
  - Channel program can do fully discontiguous reads or writes
  - We can prewrite pages to DASD if you let us

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New Approach: Management of The Available Lists

Old way

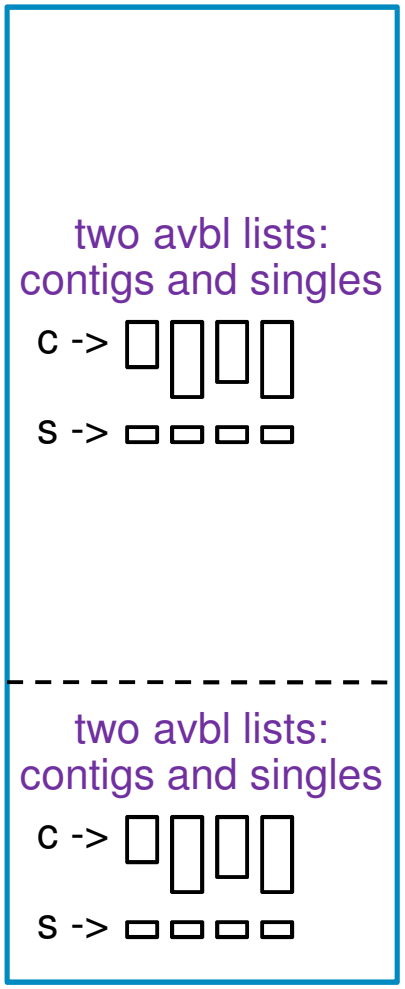
Each **list** had a low threshold and a high threshold

After every free storage request call, demand scan was kicked off if a **list** fell below its low threshold

The <2G lists were repopulated by demand scan

2 GB

<2G Use Policy:
Pre-6.2: *used <2G first*
In 6.2: *used <2G proportionally*
In 6.3: *uses <2G last*



New way

Each **kind of free storage request call** has a low and a high threshold:

- TYPE=ANY contigs
- TYPE=ANY singles
- TYPE=BELOW contigs
- TYPE=BELOW singles

Contig lists are protected from being completely raided by singles requests

After every request, the low threshold for **every type of request** is evaluated

If a TYPE=ANY low threshold is breached, demand scan is kicked off

If the <2G lists are empty, a frame table scan is kicked off

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The Old Demand Scan Visit Policy

- It was a three-pass model:
  - Pass 1: tried to be friendly to dispatched users
    - Unreferenced shared-address-space pages
    - Long-term-dormant users
    - Eligible-list users
    - Dispatch-list users' unreferenced pages down to WSS
  - Pass 2: a little more aggressive… like pass 1 except:
    - Avoided shared address spaces
    - Would take from dispatch-list users down to their SET RESERVED
  - Pass 3: emergency scan
    - Anything we can find

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The Old Demand Scan Problems

- We found a number of problems in it over time, to various degrees, such as:
  - Pass 1 tended to be too soft.
  - Scheduler lists tended not to portray “active” in a way usable by storage management.
  - We tended to steal a lot from the first few users we visited.
  - SET RESERVED was not being observed.

- It used the System z page reference bit R to track page changes
  - Required lots of RRBE instructions to keep track of *recent* reference habits
  - RRBE can have large CPI
  - (Large resident frame list) + (long RRBE instruction) = problems in Reorder

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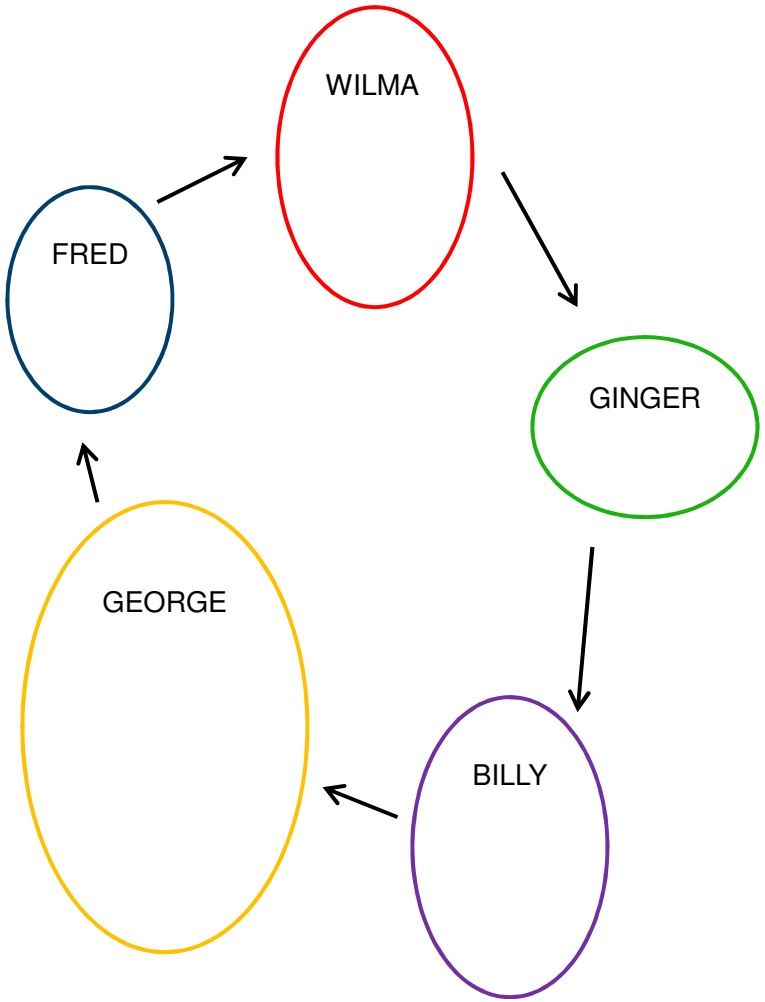
New Approach: The New Demand Scan Visit Policy



- Used to:
  - Visit according to scheduler lists
  - Take heavily at each visited user
  - Start over at list tops every pass
  - Take from private VDISKs nearly last
  - A “take” was truly a *reclaim* of a frame
- Now:
  - Cyclically visits the logged-on users
  - Keeps a visit cursor so it can resume
  - Takes a little and then moves to next
  - Takes from private VDISKs much earlier
  - A “take” is now just a push of in-use frames down toward eventual reclaim
- Effects
  - Better equalizing in the face of storage constraint
  - Better equalizing on the notion of “hot” vs. “cold” pages

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New Approach: Other New Things About Demand Scan

- Gives up control periodically
  - Lets other things happen
  - Avoids long-running “blackouts”

- Tries harder to be “fair” in the face of constraint.

- Aspects of “fairness”:
  - Use a guest’s size and estimation of its page touch rate to decide how much to take
  - Take from large guests who touch their pages less often before taking from small guests who touch their pages a lot
  - Treat identical guests identically
  - Don’t take from a guest’s working set if another guest is not stripped to its working set
  - During startup (when page touch rate data is available) take an amount of pages proportionally to each guest’s size

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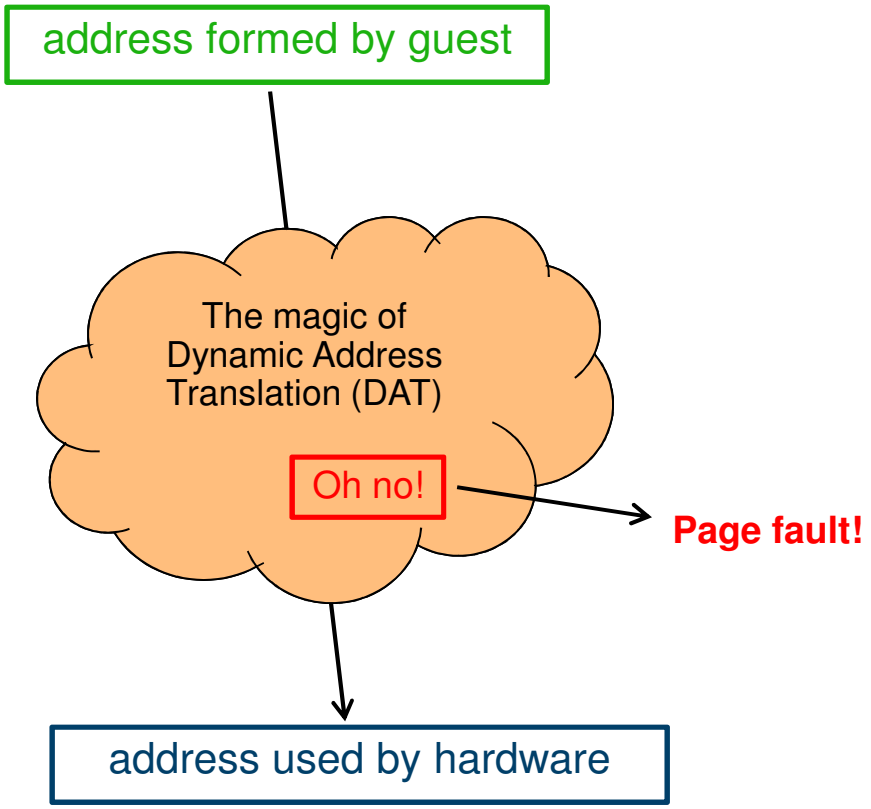
New Approach: Trial Invalidation



- Page table entry (PTE) contains an "invalid" bit
- What if we:
  - Keep the PTE intact but set the "invalid" bit
  - Leave the frame contents intact
  - Wait for the guest to touch the page
- A touch will cause a page fault, but…
- On a fault, there is nothing really to do except:
  - Clear the "invalid" bit
  - Move the frame to the front of the frame list to show that it was recently referenced
- We call this **trial invalidation**.

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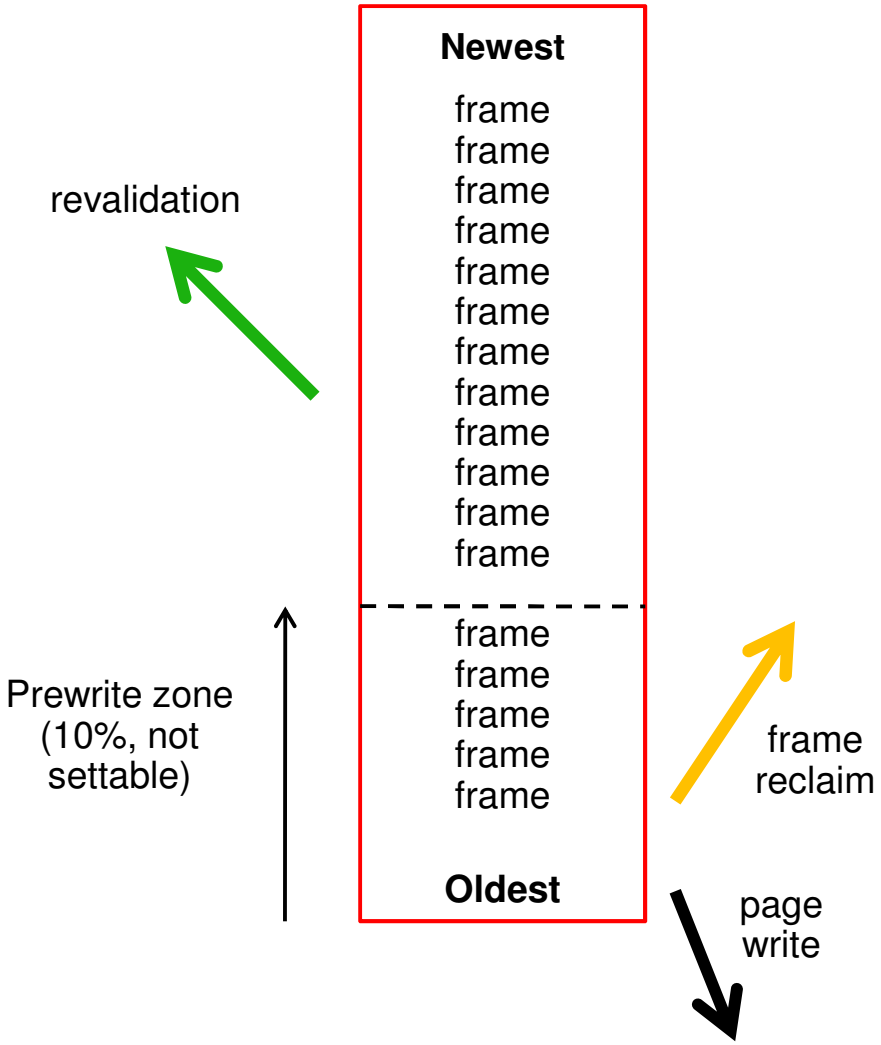
New Approach: Global Aging List



- Size of global aging list can be specified…
  … but is best left to the system to manage

- All of the pages here are IBR

- Demand scan fills it from the top

- Revalidated pages return to their owned-lists

- We prewrite changed pages up from the bottom of the list.

- The global aging list accomplishes the age-filtering process that XSTORE used to accomplish.

- We no longer suggest XSTORE for paging, but we will use it if it's there.

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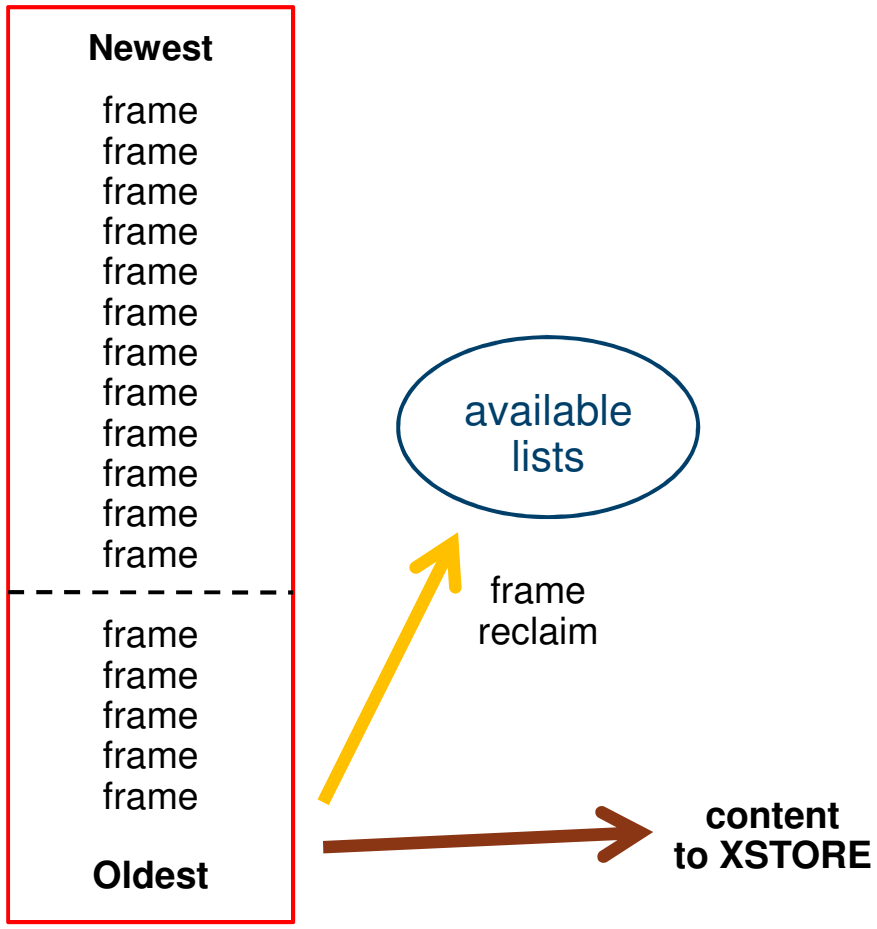
New Approach: What About XSTORE?



- We will use XSTORE if it is there.
- XSTORE is now the *second* line of defense.
- *When frame is reclaimed*, if XSTORE is present, we put a copy of the page there.
  - Even if the frame has already been prewritten
- On fault, if content is still in XSTORE, it comes back from there.
- If you decide to keep XSTORE, do NOT put MDC in XSTORE unless heavy CMS workload.

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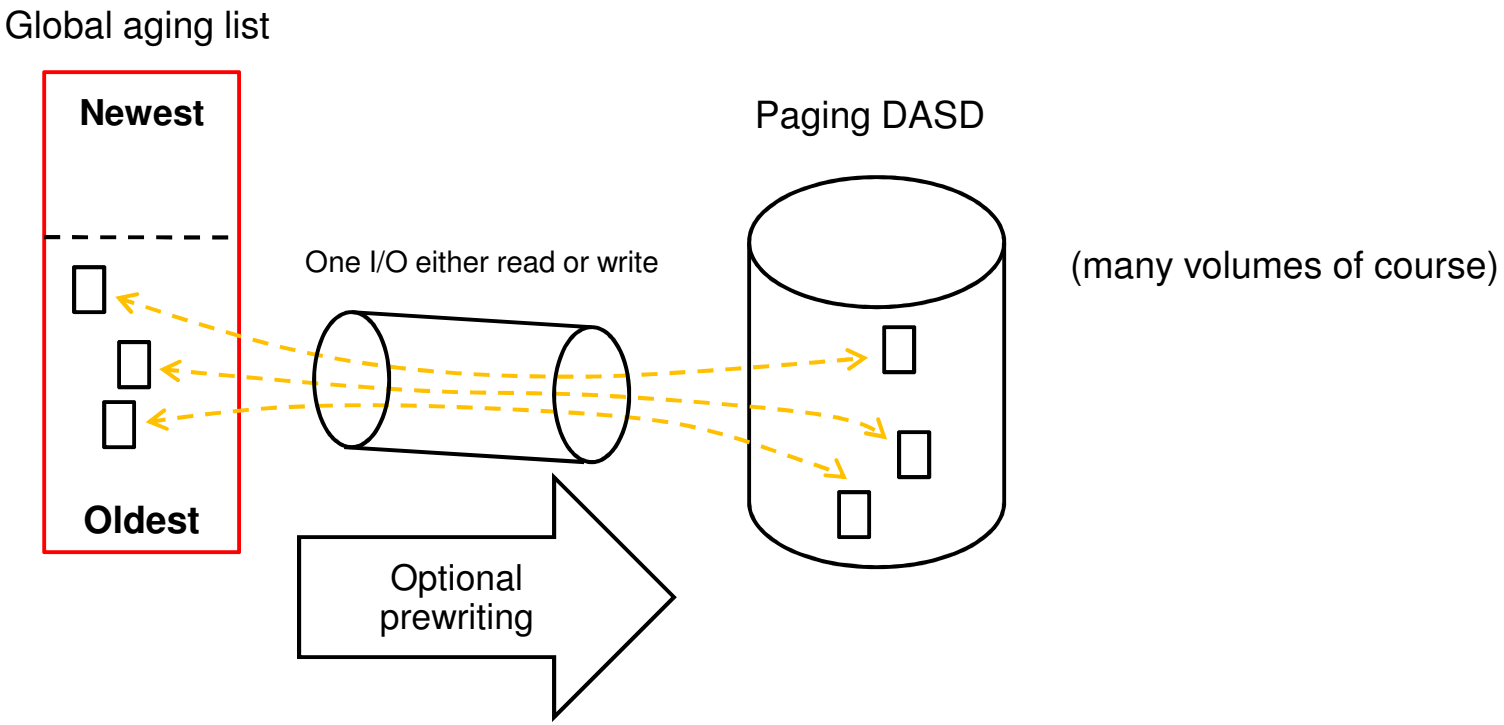
New Approach: How We Now Use Paging DASD



Highlights of new DASD techniques:
- A page almost always goes back to its same DASD slot. (clogged volume or DRAIN)
- A page not changed since last read from DASD is almost never rewritten. (DRAIN)
-The paging channel program can handle discontiguity on both ends, whether read or write.

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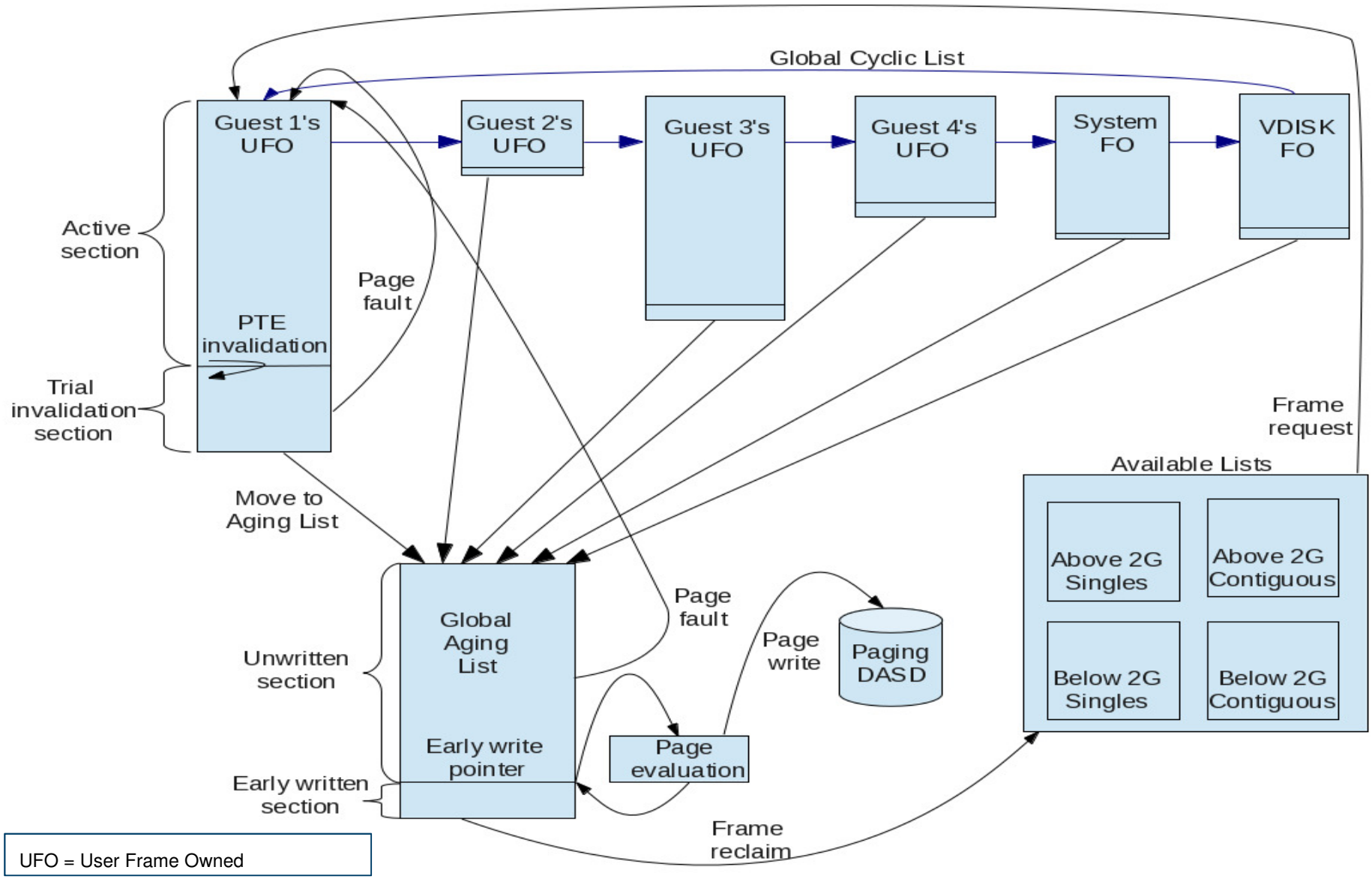
Memory Management Algorithm Visualization



UFO = User Frame Owned

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New Approach: Large Real Implies Large Virtual, So…

- z/VM holds its DAT management structures in CP-owned pageable address spaces
- These *Page Table Resource Manager* address spaces are named PTRM0000, PTRM0001, …
- You will see them in the z/VM Performance Toolkit FCX134 DSPACESH report
- The number and size of these address spaces control how much logged-on guest real (aka virtual memory) the system can support
- In z/VM 6.2:
  - There were 16 of them: …, PTRM000F
  - We created them as we needed them
  - With 16 of these, we could address 8 TB of virtual
- In z/VM 6.3:
  - There are now 128 of them: …, PTRM007F
  - We create them all at system initialization
  - With 128 of these, we can now address 64 TB of virtual

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New Behavior: CP SET RESERVED command

- We now do much better at honoring the setting
  - Revisit your uses to see whether you were trying to compensate
- You can now reserve pages for:
  - A user
  - An NSS or DCSS
- About the NSS or DCSS use:
  - A new instance of an NSS or DCSS *does not* inherit a pending-purge instance's RESERVED setting
  - Set an NSS' or DCSS' RESERVED setting *after* CP SAVESYS or SAVESEG
  - No need for anyone to have loaded the segment in order to set a RESERVE for it
  - We certainly intended this for MONDCSS
- You can set a system-wide maximum (SYSMAX) on the number of reserved pages
- RESERVED settings do not survive IPL
  - Consider CP command in the CP directory? (not for NSS or DCSS though)

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Removed Behavior: Reorder

- We just don't do this anymore.
- The CP SET REORDER and CP QUERY REORDER commands are still there, but they act differently now. More later.
- You will no longer see reorder information in Monitor.
- No longer a trade-off with larger virtual machines

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New or Changed Commands

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Commands: Knobs You Can Twist

Concept	Knob	Comments
Size of the global aging list Whether early writes are allowed	Command: CP SET AGELIST … Config file: STORAGE AGELIST … Lookup: CP QUERY AGELIST	Sets the size of the global aging list, in terms of: - A fixed amount (e.g., GB) - A percent of DPA (preferred) The default is 2% of DPA. Seems OK. Sets whether early writes are allowed. (If storage-rich, say NO.)
Amount of storage reserved for a user or for a DCSS	Command: CP SET RESERVED … Config file: STORAGE RESERVED … Lookup: CP QUERY RESERVED …	You can set RESERVED for: - A user - An NSS or DCSS You can also set a SYSMAX on total RESERVED storage. Config file can set only SYSMAX.

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Commands: Other Interesting "Queries"

Query or Lookup	Comments
CP INDICATE LOAD	The STEAL-nnn% field no longer appears in the output.
CP INDICATE NSS	Includes a new "instantiated" count. Number of pages that exist. Sum of locus counts might add to more than "instantiated".
CP INDICATE USER	Includes a new "instantiated" count. Sum of locus counts might add to more than "instantiated".
CP INDICATE SPACES	Includes a new "instantiated" count.

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Commands: What Happened to My Reorder Commands?

- The notion of reorder is gone.
- The CP SET REORDER command gives RC=6005, “not supported”.
- The CP QUERY REORDER command says it’s OFF.
- You will no longer see reorder counts in Monitor.
- Be aware of Reorder setting implications when using LGR between z/VM 6.2 and z/VM 6.3

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You Must Make a Plan

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Planning for Large Memory

- Normal best practices for migrating from an earlier release certainly apply.
- Change your paging XSTORE into central
  - XSTORE gave us an aging function. It let us catch LRU mistakes.
  - The new IBR concept and global aging list provide the same function but do so more efficiently in central.
- Plan enough DASD paging space
  - The system now prewrites pages to DASD.
  - See space calculation on a later slide
- Plan a robust paging DASD configuration
  - Use plenty of paging volumes
  - Make the volumes all the same size
  - Put only paging space on the volumes you use for paging
  - Spread the paging volumes through your LCUs
  - Avoid LCUs that you know are hot on application I/O
  - Use plenty of chpids
  - Do not use ESCON chpids
  - Do not mix ECKD paging and SCSI paging
  - Leave reserved slots in the CP-owned list

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Planning for Large Memory

- Look at your CP SET RESERVED settings to make sure they're right.
  - Revisit scenarios where you looked at this capability and it wasn't effective
- Add CP SET RESERVED settings for DCSSes or NSSes if you like
  - MONDCSS is a good one to consider
- If you increase central, make sure you also increase dump space
  - More guidance will be available on www.vm.ibm.com/techinfo/

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Planning DASD Paging Space

- Calculate sum of:
  - Logged-on virtual machines' primary address spaces, plus…
  - Any data spaces they create, plus…
  - Any VDISKs they use, plus…
  - Total number of shared NSS or DCSS pages, … and then …
  - Multiply this sum by 1.01 to allow for PGMBKs and friends

- Add to that sum:
  - Total number of CP directory pages (reported by DIRECTXA), plus…
  - Min (10% of central, 4 GB) to allow for system-owned virtual pages

- Then multiply by some safety factor (1.25?) to allow for growth or uncertainty

- Remember that your system will take a PGT004 if you run out of paging space

- Consider using something that alerts on page space, such as Operations Manager for z/VM

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Planning to Learn About Your System's Performance

- While you are still on the earlier release, collect measurement data:
  - Know what your key success metrics are and what their success thresholds are
  - Transaction rates – *only you* know where these are on your workloads
  - MONWRITE files – some tips:
    - When: Daily peaks? Month-end processing? Quarter-end processing?
    - Collection tips: http://www.vm.ibm.com/devpages/bkw/monwrite.html

- Then go ahead and try z/VM 6.3

- When you start running on z/VM 6.3, collect the very same measurement data

- Compare z/VM 6.3 back to z/VM 6.2 to see what the effect is on your workload

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Planning to Keep Your System Maintained

- Additional service has shipped, current install media includes second RSU (6302)

- Keep listening:
  - www.vm.ibm.com
  - The IBMVM mailing list

- See also the PSP bucket for z/VM 6.3

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Comments on Workloads

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z/VM Large Memory: Amenable Workloads

- Best benefit: workloads highly affected by reorder or old demand scan
  - Large guests affected by reorder delays
  - Long demand scans looking for <2G frames

- Less benefit: workloads that were doing fine before
  - Storage-rich workloads
  - Running fine paging to only XSTORE
  - No problems with long demand scans
  - Small guests not affected by reorder

- Let's look at some examples

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The "Sweet Spot" Workload

Our synthetic workload called *Sweet Spot* imitates behaviors we have seen in customer-supplied MONWRITE data.

	z/VM 6.2	z/VM 6.3	Delta	Pct. Delta
Cstore	256	384	128	
Xstore	128	0	-128	
External Throughput (ETR)	0.0746	0.0968	0.0222	29.8%
Internal Throughput (ITR)	77.77	105.60	27.83	35.8%
System Util/Proc	31.4	4.7	-26.7	-85.0%
T/V Ratio	1.51	1.08	-0.43	-28.5

By getting rid of both reorders and spin lock contention, we achieved huge drops in %CPU and T/V.

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The "Sweet Spot" Workload

- Closer look at how the fairness and workloads may result in different results.
- Sweet Spot workload has four groups of virtual machines. Some benefit more than others.

	z/VM 6.2	z/VM 6.3	Delta	Pct. Delta
System External Throughput	0.0746	0.0968	0.0222	29.8%
User Group 1 ETR	0.0065	0.0128	0.0063	96.9%
User Group 2 ETR	0.0138	0.0236	0.0098	71.0%
User Group 3 ETR	0.0268	0.0264	-0.0004	-1.5%
User Group 4 ETR	0.0275	0.0341	0.0066	24.0%

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Workload: The Apache Paging Workload

Our Linux-based workload called *Apache Paging* is built to page heavily to DASD almost no matter how much central or XSTORE we give it.

	z/VM 6.2	z/VM 6.3
Cstore (GB)	256	384
Xstore (GB)	128	0
External Throughput (ETR)	1.000	1.024
Internal Throughput (ITR)	1.000	1.017
Xstore paging / second	82489	0
DASD paging / second	33574	31376

This is an example of a workload where the limit comes from something large memory will not fix.

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Large Memory Scaling Measurements

- VIRSTOR – Test case system started with CMS boot strap with controls over memory reference patterns and processor usage.
  - Create workload similar to resource usage from customer Monwrite data
- Linux Apache Static Web serving
- Measure and test levels of servers at peak usage for 256 GB in an overcommitted environment
- Scale up from there to 1 TB
  - All resources scaled up, though note that while additional DASD space was provided, it was on the same storage server.

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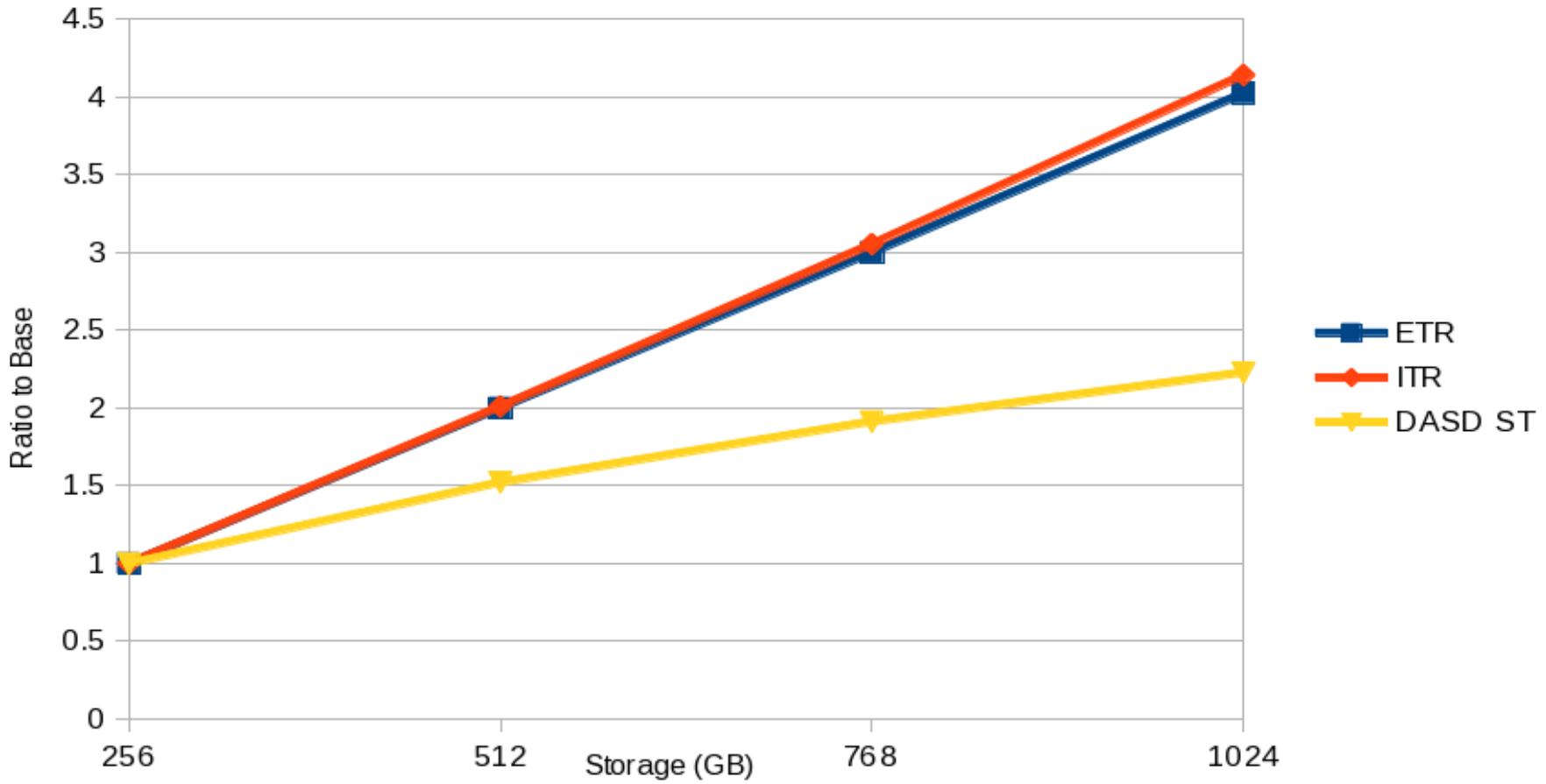
VIRSTOR Workload in Overcommitted Environment



ETR = External Throughput; ITR = Internal Throughput; DASD ST = DASD Service Time

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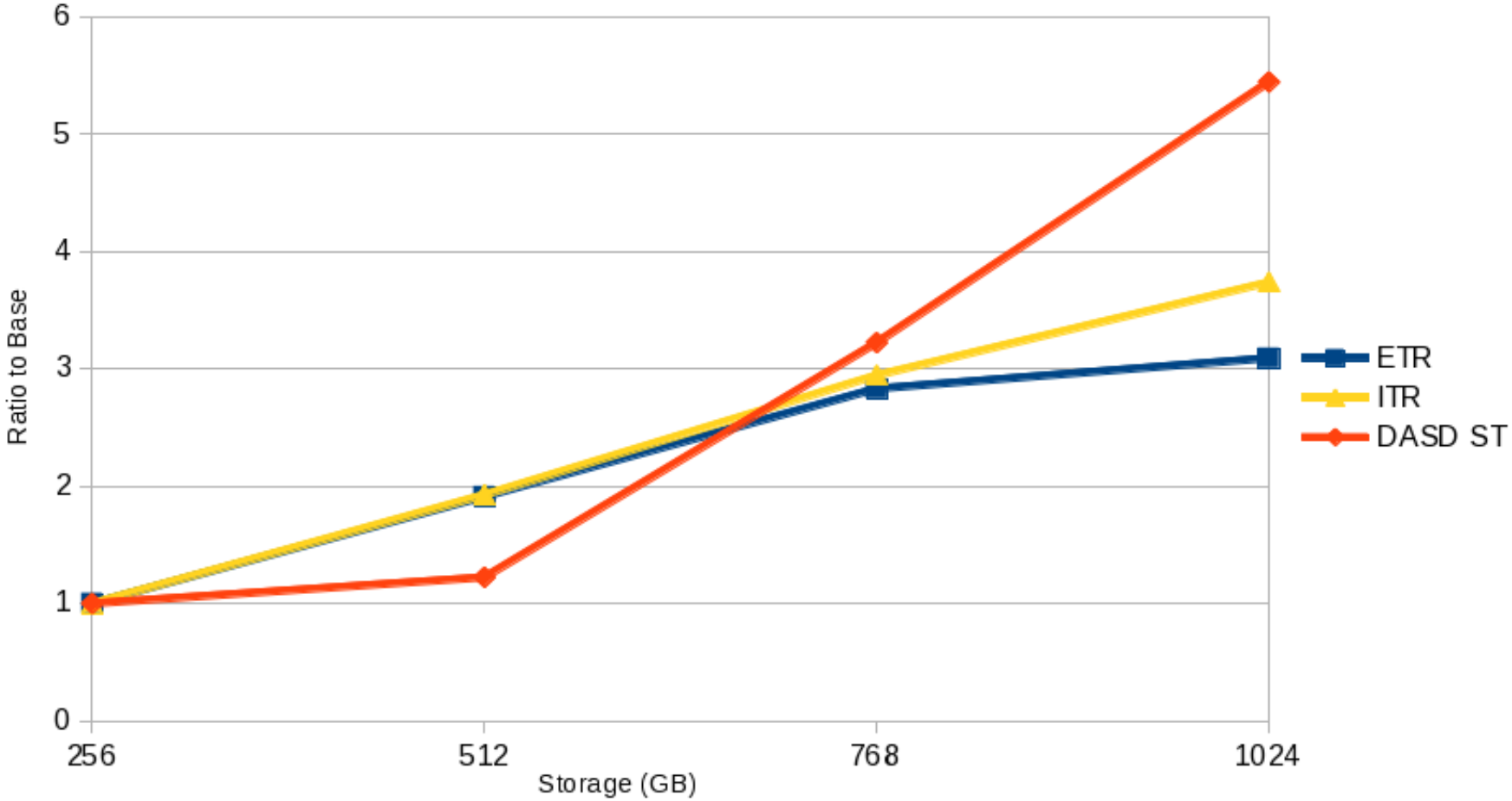
Apache Workload in Overcommitted Environment



ETR = External Throughput; ITR = Internal Throughput; DASD ST = DASD Service Time

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Summary

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z/VM Large Memory: Summary

- Objective was to get rid of algorithmic constraints that stopped growth
- Things we got rid of:
  - Reorder
  - Using the scheduler lists to visit users
  - Taking a large amount when we visit a user
  - Excessively favoring VDISKs as regards memory residency
  - Problems in evaluating depletion of available lists
  - Excessive or unnecessary rewriting of DASD
  - Dependency on long-running System z instructions
- Things we added:
  - Visiting all users round-robin
  - Taking only a little when we visit
  - Visiting VDISKs sooner
  - Detecting available list depletion a little more smartly
  - Scatter-to-scatter paging channel program
  - Using trial invalidation
- Effect: workloads constrained by z/VM 6.2 should go better on z/VM 6.3

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CP Monitor and z/VM Performance Toolkit

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CP Monitor Records

No new Monitor records, only big changes….

Domain	Record	Name	Type	Title	Fields, N / D / C
D0	R3	MRSYTRSG	sample	Real Storage Data (Global)	D C
D0	R4	MRSYTRSP	sample	Real Storage Data (Per Processor)	D
D0	R6	MRSYTASG	sample	Auxiliary Storage (Global)	N C
D0	R7	MRSYTSHS	sample	Shared Storage Data	D
D0	R23	MRSYTLCK	sample	Formal Spin Lock Data	N C
D1	R7	MRMTRMEM	config	Memory Configuration Data	N
D1	R15	MRMTRUSR	config	Logged on User	C
D2	R4	MRSCLADL	event	Add User to Dispatch List	D C
D2	R5	MRSCLDDL	event	Drop User from Dispatch List	D C
D2	R6	MRSCLAEL	event	Add User to Eligible List	C
D2	R8	MRSCLSTP	event	System Timer Pop	D
D3	R1	MRSTORSG	sample	Real Storage Management (Global)	N D C
D3	R2	MRSTORSP	sample	Real Storage Activity (Per Processor)	D
D3	R3	MRSTOSHR	sample	Shared Storage Management	N C
D3	R14	MRSTOASI	sample	Address Space Information Record	N C
D3	R15	MRSTOSHL	event	NSS/DCSS/SSP Loaded into Storage	N
D3	R16	MRSTOSHD	event	NSS/DCSS/SSP Removed From Storage	N C
D4	R2	MRUSELOF	event	User Logoff Data	N D C
D4	R3	MRUSEACT	sample	User Activity Data	N D C
D4	R9	MRUSEATE	event	User Activity Data at Transaction End	D C

As usual, the Monitor records will be on www.vm.ibm.com at GA.

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z/VM Performance Toolkit: Highlights

- Changed screens:
  - FCX102 SYSTEM, Some Internal System Counters
  - FCX103 STORAGE, General Storage Utilization
  - FCX133 NSS, NSS and DCSS Utilization and Paging Activity
  - FCX146 AUXLOG, Auxiliary Storage Utilization, by Time
  - FCX147 VDISKS, Virtual Disks in Storage
  - FCX265 LOCKLOG, Spin Lock Log, by Time
- Deleted screens:
  - FCX254 AVAILLOG, Available List Management, by Time
  - FCX259 DEMNDLOG, Demand Scan Details, by Time
- New screens:
  - FCX290 UPGACT, User Page Activity — *page state transition rates*
  - FCX291 UPGACTLG, User Page Activity (benchmarks a user)
  - FCX292 UPGUTL, User Page Utilization Data — *page residency counts*
  - FCX293 UPGUTLLG, User Page Utilization Data (benchmarks a user)
  - FCX294 AVLB2GLG, Available List Data Below 2G, by Time — *available list counts*
  - FCX295 AVLA2GLG, Available List Data Above 2G, by Time
  - FCX296 STEALLOG, Steal Statistics, by Time — *steal algorithm activity*
  - FCX297 AGELLOG, Age List Log, by Time — *global aging list activity*

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z/VM Performance Toolkit: New Columns and Concepts

New Field	What this means
Inst	*Instantiations:* the rate at which valid memory is being created *Instantiated:* the amount of valid memory
Relse	*Releases:* the rate at which memory is being released
Inval	*Invalidations:* the rate at which demand scan is marking memory invalid as a way to determine whether it is being touched
Reval	*Revalidations*: the rate at which invalid pages are being made valid because somebody touched them
Ready	*Ready reclaims* or *ready steals:* the frame was found and selected for reclaim and had already been prewritten to auxiliary storage
Not Ready	*Notready reclaims* or *notready steals:* the frame was selected for reclaim but we had to wait for the auxiliary write (DASD) to finish before we could take it

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z/VM Performance Toolkit: New Columns and Concepts

New Field	What this means
PNR	*Private, not referenced*: the page was read from aux as part of a block read, but it is still marked invalid because nobody has touched it yet
x<2G or *x*>2G	*Below 2 GB* or *Above 2 GB*: tells where the real backing frames are in real central
Sing	*Singles:* free frames surrounded by in-use frames (cannot coalesce)
Cont	*Contigs*: free frames in strings of two or more
Prot	*Protect threshold:* number of frames a singles-obtain must leave on a contigs-list

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z/VM Performance Toolkit: New Report FCX292 UPGUTL

```
FCX292  Run 2013/04/10 07:38:36          UPGUTL                                                          Page  103
                                         User Page Utilization Data
From 2013/04/09 16:02:10                                                                  SYSTEMID
To   2013/04/09 16:13:10                                                                  CPU 2817-744   SN A6D85
For    660 Secs 00:11:00                 "This is a performance report for SYSTEM XYZ"                  z/VM   V.6.3.0 SLU 0000
```

Userid	Data Spaces Owned	WSS	Inst	Resvd	Storage: Resident: Total T_All	Total T<2G	Total T>2G	Locked L<2G	Locked L>2G	Invalid But Resident: UFO U<2G	UFO U>2G	PNR P<2G	PNR P>2G	AgeList A<2G	AgeList A>2G	XSTOR	AUX	Base Space Size	Nr of Users
>>Mean>>	.0	5284M	6765M	5611	5286M	27M	5259M	1010	232K	6565	2238K	59588	26M	53080	107M	.0	1815M	7108M	73
User Class Data:																			
CMS1_USE	.0	3320K	19M	.0	484K	.0	484K	.0	4096	.0	69632	.0	244K	.0	344K	.0	19M	2047M	1
LCC_CLIE	.0	364M	485M	.0	365M	11264	365M	.0	208K	.0	325K	.0	2686K	.0	8177K	.0	164M	1024M	8
LXA_SERV	.0	7974M	10G	.0	7978M	41M	7937M	.0	206K	9984	3327K	90624	39M	80725	161M	.0	2719M	10240M	48
User Data:																			
DISKACNT	.0	4976K	5156K	0	4K	0	4K	0	0	0	4K	0	0	0	0	0	5152K	32M	
DTCVSW1	.0	184K	11M	0	196K	8K	188K	8K	4K	0	4K	0	0	0	168K	0	11M	32M	
DTCVSW2	.0	180K	11M	0	184K	0	184K	0	4K	0	4K	0	0	0	164K	0	10M	32M	
EREP	.0	4912K	4944K	0	4K	0	4K	0	0	0	4K	0	0	0	0	0	4940K	32M	
FTPSERVE	.0	84K	5764K	0	88K	0	88K	0	4K	0	4K	0	0	0	76K	0	5760K	32M	
GCSXA	.0	204K	208K	0	8K	0	8K	0	4K	0	4K	0	0	0	0	0	200K	16M	
LCC00001	.0	364M	488M	0	365M	0	365M	0	204K	0	228K	0	2884K	0	8660K	0	192M	1024M	
LCC00002	.0	369M	492M	0	371M	20K	371M	0	204K	0	224K	0	2312K	0	7736K	0	159M	1024M	
LCC00003	.0	363M	484M	0	364M	0	364M	0	204K	0	252K	0	2852K	0	8372K	0	215M	1024M	
LCC00004	.0	363M	483M	0	363M	16K	363M	0	204K	0	228K	0	2724K	0	8512K	0	185M	1024M	

Look for the new concepts: Inst IBR UFO PNR AgeList

Amounts are in bytes, suffixed. Not page counts!

FCX113 UPAGE is still produced.

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z/VM Performance Toolkit: New Report FCX292 UPGUTL

```
<------------------------- Resident ------------------------------>
                                    <------ Invalid But Resident ------>
<---- Total ----> <-Locked--> <-- UFO --> <-- PNR --> <-AgeList->
T_All  T<2G  T>2G  L<2G  L>2G  U<2G  U>2G  P<2G  P>2G  A<2G  A>2G XSTOR  AUX
 365M     0  365M     0  204K     0  228K     0 2884K     0 8660K     0 192M
```

- Look for the new concepts: Inst IBR UFO PNR AgeList
- Amounts are in bytes, suffixed. Not page counts!
- FCX113 UPAGE is still produced.

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z/VM Performance Toolkit: New Report FCX290 UPGACT

```
FCX290  Run 2013/04/10 07:38:36          UPGACT                                                    Page  102
                                         User Page Activity
From 2013/04/09 16:02:10                                                                  SYSTEMID
To   2013/04/09 16:13:10                                                                  CPU 2817-744   SN A6D85
For    660 Secs 00:11:00                 "This is a performance report for SYSTEM XYZ"        z/VM   V.6.3.0 SLU 0000
```

Userid	Stl Wt	Transition/s Inst	Relse	Inval	Reval	Steal/s Ready	NoRdy	Movement/s PGIN	PGOUT	Reads	Write	Migrate/s MWrit	Xrel	Nr of Users
>>Mean>>	1.0	143K	5142	849K	718K	999K	.0	.0	.0	958K	761K	.0	.0	73
User Class Data:														
CMS1_USE	1.0	15515	15801	2377	1632	5145	.0	.0	.0	.0	1980	.0	.0	1
LCC_CLIE	1.0	658K	20875	488K	486K	60875	.0	.0	.0	54212	22869	.0	.0	8
LXA_SERV	1.0	108K	1095	1191K	994K	1506K	.0	.0	.0	1447K	1153K	.0	.0	48
User Data:														
DISKACNT	1.0	0	0	0	0	0	0	0	0	0	0	0	0	
DTCVSW1	1.0	0	0	3072	2855	0	0	0	0	0	0	0	0	
DTCVSW2	1.0	0	0	3004	2780	0	0	0	0	0	0	0	0	
EREP	1.0	0	0	0	0	0	0	0	0	0	0	0	0	
FTPSERVE	1.0	0	0	1434	1434	0	0	0	0	0	0	0	0	
GCSXA	1.0	0	0	0	0	0	0	0	0	0	0	0	0	
LCC00001	1.0	601K	18686	501K	498K	65139	0	0	0	49866	23670	0	0	
LCC00002	1.0	657K	24955	487K	486K	54725	0	0	0	44522	18991	0	0	
LCC00003	1.0	565K	23012	485K	481K	64065	0	0	0	44783	19859	0	0	
LCC00004	1.0	602K	24104	499K	495K	63178	0	0	0	48811	24588	0	0	
LCC00005	1.0	717K	25675	500K	499K	65865	0	0	0	66002	28753	0	0	

Look for the new concepts: Inst Relse Inval Reval Ready NoRdy

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z/VM Performance Toolkit: New Report FCX290 UPGACT

```
FCX290   Run 2013/04/10 07:38:36          UPGACT                                                    Page  102
                                          User Page Activity
From 2013/04/09 16:02:10                                                                  SYSTEMID
To   2013/04/09 16:13:10                                                                  CPU 2817-744    SN A6D85
For     660 Secs 00:11:00                 "This is a performance report for SYSTEM XYZ"  z/VM   V.6.3.0 SLU 0000

                 <------------------------------- Storage ------------------------------->
                                                  <-------- Movement/s -------->
             Stl <--- Transition/s ----> <-Steal/s->                      <Migrate/s> Nr of
```

	Stl	<--- Transition/s		---->		<-Steal/s->	
Userid	Wt	Inst	Relse	Inval	Reval	Ready	NoRdy
>>Mean>>	1.0	143K	5142	849K	718K	999K	.0
User Class Data:							
CMS1_USE	1.0	15515	15801	2377	1632	5145	.0
LCC_CLIE	1.0	658K	20875	488K	486K	60875	.0
LXA_SERV	1.0	108K	1095	1191K	994K	1506K	.0

- Look for the new concepts: Inst Relse Inval Reval Ready NoRdy

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z/VM Performance Toolkit: New Report FCX295 AVLA2GLG

```
FCX295  Run 2013/04/10 07:38:36          AVLA2GLG                                                    Page   25
                                         Available List Data Above 2G, by Time
From 2013/04/09 16:02:10                                                                  SYSTEMID
To   2013/04/09 16:13:10                                                                  CPU 2817-744   SN A6D85
For    660 Secs 00:11:00                 "This is a performance report for SYSTEM XYZ"    z/VM   V.6.3.0 SLU 0000
```

	<---------- Storage ---------->				<--Times-->		<-Frame Thresh-->		
Interval	<Available>		<Requests/s>		<Returns/s>		<-Empty/s->		Sing	<-Contigs->	
End Time	Sing	Cont	Sing	Cont	Sing	Cont	Sing	Cont	Low	Low	Prot
>>Mean>>	23M	267M	47M	59M	47M	51M	.0	.0	1310	15	15
16:02:40	0	938M	32M	126M	502K	30310	.0	.0	1332	15	15
16:03:10	152K	4556K	50M	89M	49M	59M	.0	.0	1168	15	15
16:03:40	400K	4824K	68M	82M	71M	79M	.0	.0	1321	15	15
16:04:10	0	5896K	49M	72M	52M	70M	.0	.0	2409	15	15
16:04:40	0	2124K	40M	60M	41M	59M	.0	.0	1308	15	15
16:05:10	876K	3488K	54M	52M	55M	51M	.0	.0	1118	15	15
16:05:40	0	3624K	53M	58M	54M	57M	.0	.0	1409	15	15
16:06:10	2016K	4464K	49M	57M	51M	56M	.0	.0	1273	15	15

Look for the new concepts: Singles Contigs Prot

Amounts are in bytes, suffixed. Not page counts!

FCX254 AVAILLOG is no longer produced.

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z/VM Performance Toolkit: New Report FCX295 AVLA2GLG

```
FCX295  Run 2013/04/10 07:38:36          AVLA2GLG
                                         Available List Data Above 2G, by Time
From 2013/04/09 16:02:10
To   2013/04/09 16:13:10
For    660 Secs 00:11:00                 "This is a performance report for SYS
```

```
           <------------ Storage ------------> <--Times--> <-Frame Thresh-->
 Interval  <Available> <Requests/s> <Returns/s> <-Empty/s->  Sing <-Contigs->
 End Time    Sing  Cont  Sing   Cont  Sing  Cont  Sing  Cont   Low   Low  Prot
 >>Mean>>     23M  267M   47M    59M   47M   51M    .0    .0  1310    15    15
 16:02:40       0  938M   32M   126M  502K 30310    .0    .0  1332    15    15
 16:03:10    152K 4556K   50M    89M   49M   59M    .0    .0  1168    15    15
```

- Look for the new concepts: Singles Contigs Prot
- Amounts are in bytes, suffixed. Not page counts!
- FCX254 AVAILLOG is no longer produced.

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z/VM Performance Toolkit: New Report FCX296 STEALLOG

```
FCX296  Run 2013/04/10 07:38:36          STEALLOG                                                    Page   62
                                         Frame Steal Statistics, by Time
From 2013/04/09 16:02:10                                                                 SYSTEMID
To   2013/04/09 16:13:10                                                                 CPU 2817-744   SN A6D85
For    660 Secs 00:11:00                 "This is a performance report for SYSTEM XYZ"   z/VM   V.6.3.0 SLU 0000
```

	Pct	<---------- Storage/s ---------->					<-Completions/s->						<- Age List --->		
Interval	Time	Total	Write	<--User--->	<-Shared-->		<Pvt Vdisk>		AgeL	Need	Time	Sys	Travs	<-Users/s->		<-Stor	Skip/s-->	
End Time	Actv	Stoln	OnDmd	Inval	Reval	Inval	Reval	Inval	Reval	Reval	Met	Limit	Req	/s	Visit	Skip	Pin	Ser	Resv
>>Mean>>	2.6	71M	.0	61M	36M	16099	1589	.0	.0	15M	115.1	.0	.0	5.8	283.1	5.8	.0	.0	.0
16:02:40	.0	.0	.0	.0	123K	.0	136.5	.0	.0	4639K	.0	.0	.0	.0	.0	.0	.0	.0	.0
16:03:10	2.4	82M	.0	3085K	45M	69632	4506	.0	.0	5301K	111.5	.1	.0	2.3	25.4	2.2	.0	.0	.0
16:03:40	3.4	102M	.0	36M	70M	39595	.0	.0	.0	11M	236.1	.0	.0	6.7	203.2	6.7	.0	.0	.0
16:04:10	3.5	94M	.0	75M	37M	13926	1092	.0	.0	18M	124.4	.0	.0	7.5	363.9	7.5	.0	.0	.0
16:04:40	3.2	84M	.0	68M	37M	9148	1092	.0	.0	15M	39.2	.0	.0	5.7	303.4	5.7	.0	.0	.0
16:05:10	3.0	80M	.0	70M	36M	16521	2867	.0	.0	16M	122.1	.0	.0	6.9	345.1	6.9	.0	.0	.0
16:05:40	2.9	80M	.0	71M	41M	11332	1092	.0	.0	17M	135.5	.0	.0	7.0	340.7	6.9	.0	.0	.0
16:06:10	2.8	78M	.0	70M	40M	11742	1092	.0	.0	16M	131.7	.0	.0	6.7	330.8	6.7	.0	.0	.0
16:06:40	2.7	74M	.0	71M	35M	10240	2731	.0	.0	17M	134.8	.0	.0	6.8	341.8	6.8	.0	.0	.0

- Look for the new concepts: Stoln Inval Reval etc.
- Amounts are in bytes, suffixed. Not page counts!

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z/VM Performance Toolkit: New Report FCX297 AGELLOG

```
FCX297  Run 2013/04/10 07:38:36          AGELLOG                                                    Page   63
                                         Age List Log, by Time
From 2013/04/09 16:02:10                                                          SYSTEMID
To   2013/04/09 16:13:10                                                              CPU 2817-744   SN
A6D85
For    660 Secs 00:11:00                 "This is a performance report for SYSTEM XYZ"   z/VM   V.6.3.0 SLU
0000
```

```
                  <---------------------- Storage ------------------------>       <----- Revalidation ------>
                                        <-- Steal Ready ---> <--- Not Ready ---->   %Of <------- Storage/s ------->
 Interval  Size S E <-List Size--> <--RefOnly--> <--Changed--> <Evaluating-> Pages <--RefOnly--> <--Changed-->
 End Time  %DPA Z W Target Current  NoWrt  Write  Write PndWrt   Refd Change  Eval  NoWrt  Write  NoWrt  Write
 >>Mean>>   2.0 V Y  7800M   7793M   177M     2K   602M  5481M   951K    98K    10  8595K     .0  6154K 359300
 16:02:40   2.0 V Y  7800M   7653M 51816K      0   725M  6620M      0      0    10 657954     .0  3919K  79736
 16:03:10   2.0 V Y  7800M   7800M 27972K      0   747M  4243M  4812K   548K    10  1079K     .0  3697K 537395
 16:03:40   2.0 V Y  7800M   7800M 21472K      0   756M  2173M  2596K      0    10  7429K     .0  3532K  36045
 16:04:10   2.0 V Y  7800M   7799M   770M    36K 10452K  3069M      0      0    10 13340K     .0  4293K 427622
 16:04:40   2.0 V Y  7800M   7799M   660M      0   120M  4756M      0      0    10 11392K     .0  3982K 3140.3
 16:05:10   2.0 V Y  7800M   7800M   218M      0   559M  5175M  2900K   276K    10 10095K     .0  5406K 534528
 16:05:40   2.0 V Y  7800M   7799M   229M      0   551M  5398M      0      0    10 10542K     .0  6067K 428851
 16:06:10   2.0 V Y  7800M   7800M   205M      0   570M  5548M  3824K   368K    10 10395K     .0  5503K 326861
 16:06:40   2.0 V Y  7800M   7800M   157M      0   623M  5648M   760K    24K    10  9115K     .0  7718K 305562
```

- Look for the new concepts: Write PndWrt etc.
- Amounts are in bytes, suffixed. Not page counts!

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References

- z/VM CP Planning and Administration
- z/VM CP Commands and Utilities
- z/VM Performance Report: www.vm.ibm.com/perf/

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