

Understanding z/VM 6.3 Through New Performance Toolkit Reports

Version 2.1

Session 16480

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z/VM Development Client Focus and Care

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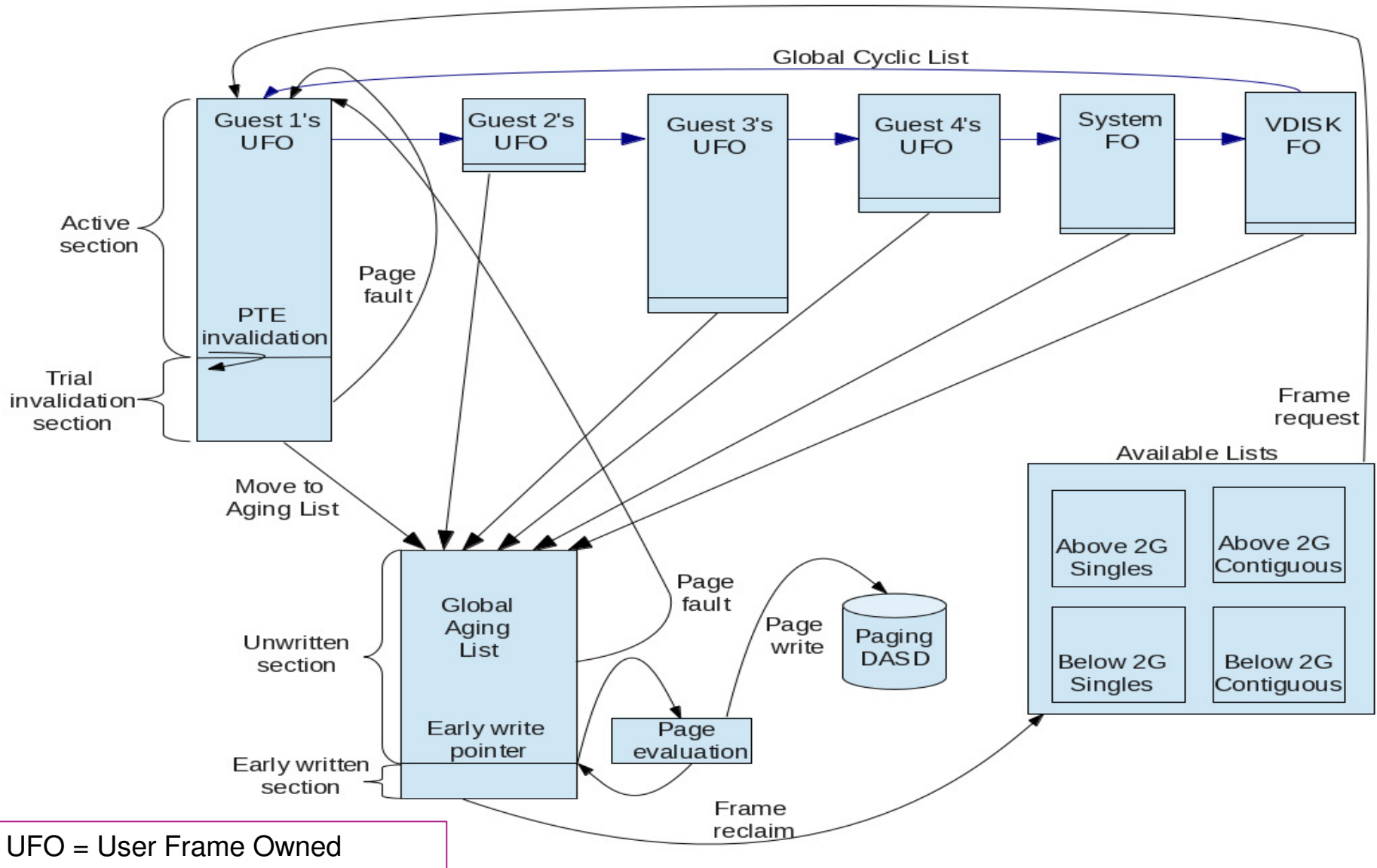
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Agenda

- Focus on two main areas changed during z/VM 6.3
 - HiperDispatch
 - Memory Management

- For each area:
 - Review the technology
 - Reference monitor records changed
 - Look at the key metrics
 - Discuss the new relevant Performance Toolkit Reports

Large Memory



Large Memory CP Monitor 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

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*

Key Considerations

- Do I have enough page space?
- Should Early Write be ON (default) or OFF?
- Do I have eligible lists forming?
- How much memory are virtual machines really using?
- How is SET RESERVE working?
- How effective is the local Invalid But Resident section?
- How effective is the global Age List?

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

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

Page Utilization – FCX109 – DEV CPOWN

FCX109 Data for 2014/02/03 Interval 07:28:00 – 07:29:00 Monitor Scan

Page / SPOOL Allocation Summary

PAGE slots available	235865k	SPOOL slots available	4808160
PAGE slot utilization	17%	SPOOL slot utilization	59%
T-Disk space avail. (MB)	.....	DUMP slots available	0
T-Disk space utilization	...%	DUMP slot utilization	..%

< Device Descr. ->						<----- Rate/s ----->					
Addr	Devtyp	Volume Serial	Area Type	Area Extent	Used %	<---Page--->		<---Spool--->		Total	SSCH +RSCH
						P-Rds	P-Wrt	S-Rds	S-Wrt		
1020	3390-9	H2PG00	PAGE	5896620	17	23.4	13.2	...	...	36.6	5.7
1021	3390-9	H2PG01	PAGE	5896620	17	20.3	14.0	...	...	34.3	5.2
1022	3390-9	H2PG02	PAGE	5896620	17	20.5	13.1	...	...	33.6	5.2
1023	3390-9	H2PG03	PAGE	5896620	17	25.7	11.3	...	...	37.0	6.0
1024	3390-9	H2PG04	PAGE	5896620	17	26.2	11.7	...	...	37.9	6.5
1025	3390-9	H2PG05	PAGE	5896620	17	24.8	13.2	...	...	38.0	6.8
1027	3390-9	H2PG07	PAGE	5896620	17	22.7	12.0	...	...	34.7	5.8
1028	3390-9	H2PG08	PAGE	5896620	17	22.3	12.6	...	...	35.0	6.5

Page Utilization History – FCX146 - AUXLOG

FCX146 Data for 2014/02/03 Interval 07:28:00 - 07:33:00 Monitor Scan										
Interval End Time	<Page Slots>		<Spool Slots>		<Dump Slots>		<----- Spool Files ----->			
	Total Slots	Used %	Total Slots	Used %	Total Slots	Used %	<--Created-->		<--Purged-->	
							Total	/s	Total	/s
>>Mean>>	235865k	17	4808160	59	0	..	0	.00	0	.00
07:29:00	235865k	17	4808160	59	0	..	0	.00	0	.00
07:30:00	235865k	17	4808160	59	0	..	0	.00	0	.00
07:31:00	235865k	17	4808160	59	0	..	0	.00	0	.00
07:32:00	235865k	17	4808160	59	0	..	0	.00	0	.00
07:33:00	235865k	17	4808160	59	0	..	0	.00	0	.00

Early Writes? – FCX297 – AGELLOG (Age List Log)

```

FCX297      Data for 2013/10/15  Interval 09:28:00 - 09:29:00  Monitor Scan

                <----- Storage ----->
                        <-- Steal Ready ----> <--- Not Ready ---->
Interval  Size S E <-List Size--> <---RefOnly--> <---Changed--> <Evaluating->
End Time  %DPA Z W Target Current  NoWrt  Write  Write PndWrt  Refd Change
>>Mean>>  2.0 V Y  7787M  7787M  299M   0    480M  3884M   24K    0
09:29:00  2.0 V Y  7787M  7787M  300M   0    479M  3874M   48K    0

```

- Running with default 2% of DPA
- Early Writes is ON (“Y”)

Early Writes? – Write vs. Read – FCX143 - PAGELOG

FCX143 Data for 2013/10/15 Interval 09:28:00 - 09:29:00

```
<----- Paging to DASD ----->
                          <-Single Reads-->
Reads Write Total  Shrd Guest System Total
  /s   /s   /s     /s   /s     /s     /s
981.3 603.3 1585   46.9 302.2   1.1 303.3
```

- Compare Writes/Second to Reads/Second
 - Reads can be > Writes if pages aren't being changed
 - Writes can be > Reads if the pages aren't being re-referenced and sit idle on DASD
 - Writes can be >> Reads if written during early write, but revalidated before actually stolen

Early Writes Revalidated – FCX297 - AGELLOG

```

FCX297      Data for 2013/10/15  Interval 09:28:00 - 09:29:00      Monitor Scan
<----- Storage ----->          <----- Revalidation ----->
<-- Steal Ready ----> <--- Not Ready ---->    %Of <----- Storage/s ----->
<--RefOnly--> <--Changed--> <Evaluating-> Pages <--RefOnly--> <--Changed-->
NoWrt  Write  Write PndWrt   Refd Change  Eval  NoWrt  Write  NoWrt  Write
 299M   0    480M 3884M   24K    0    10 560742   .0 2303K 21026

```

- You see above that most of the revalidated pages are pages that were not written yet. Though the majority of those were ones that would have been written.

Eligible Lists Forming? – FCX145 - SCHEDLOG

```
FCX145          Data for 2013/10/15   Interval 09:28:00 - 10:05:00
<- In Eligible List -->
                <Loading->
  E1  E2  E3  E1  E2  E3
  .0  .0  .0  .0  .0  .0
  .0  .0  .0  .0  .0  .0
```

- Subtle changes in “Loading Users” in z/VM 6.3 can cause inadvertent eligible lists.
- Keep an eye on SCHEDLOG and the subset of users in eligible list that are “Loading Users”

Eligible Lists Forming? – FCX154 - SYSSET

FCX154	Data for 2013/10/15	System	Settings	Monitor Scan
Initial Scheduler Settings: 2013/10/15 at 09:27:50				
DSPSLICE (minor)	5.000 msec.	IABIAS	Intensity	90 Percent
Hotshot T-slice	1.999 msec.	IABIAS	Duration	2 Minor T-slices
DSPBUF Q1	32767 Openings	STORBUF	Q1 Q2 Q3	300 % Main storage
DSPBUF Q1 Q2	32767 Openings	STORBUF	Q2 Q3	300 % Main storage
DSPBUF Q1 Q2 Q3	32767 Openings	STORBUF	Q3	300 % Main storage
LDUBUF Q1 Q2 Q3	100 % Paging exp.	Max. working set	9999	% Main storage
LDUBUF Q2 Q3	95 % Paging exp.	Loading user	5	Pgrd / T-slice
LDUBUF Q3	85 % Paging exp.	Loading capacity	47	Paging expos.

- Review LDUBUF settings and Loading capacity
- From above example, 40 loading users in Q3 would cause an eligible list to form.
 - $.85 \times 47 = 39.95$

Virtual Machine Memory Usage – FCX292 - UPGUTL

```

FCX292      Data for 2013/10/15  Interval 10:04:00 - 10:05:00  Monitor Scan
-----
              <----- Storage ----->
              <----- Resident ----->
              <----- Invalid But Resident ----->
Data
Spaces
Userid  Owned  WSS  Inst  Resvd  T_All  T<2G  T>2G  L<2G  L>2G  U<2G  U>2G  P<2G  P>2G  A<2G  A>2G  XSTOR  AUX  Base
>>Mean>> .9 1807M 2669M 86780 1529M 7588K 1522M 7567 504K 2378 550K 76557 11M 168K 33M .0 2222M 3315M
DJSLA101  0 5120M 5113M  0 4404M  19M 4384M  0 208K  0 960K  16K 11M 280K 55M  0 3434M 5120M
    
```

```

Data
Spaces
Userid  Owned  WSS  Inst  Resvd
>>Mean>> .9 1807M 2669M 86780
DJSLA305  0 3100M 6728M  0
    
```

- “Inst” = pages guest has interacted with in some way which requires z/VM to back the page.
 - Up to the size of the virtual machine
 - Often less than sum of (Resident+XSTOR+AUX) because of pages kept on DASD and in real memory

Reserved? – FCX292 - UPGUTL

```

FCX292      Data for 2013/10/15  Interval 10:04:00 - 10:05:00  Monitor Scan
-----
          <----- Storage ----->
          <----- Resident ----->
          <----- Invalid But Resident ----->
          <----- Total -----> <--Locked--> <-- UFO --> <-- PNR --> <--AgeList-->
Data
Spaces
Userid  Owned  WSS  Inst  Resvd  T_All  T<2G  T>2G  L<2G  L>2G  U<2G  U>2G  P<2G  P>2G  A<2G  A>2G  XSTOR  AUX  Base
WJBLA101  0 5120M 5113M 20M 4404M 19M 4384M 0 208K 0 960K 16K 11M 280K 55M 0 3434M 5120M
    
```

```

          Data
          Spaces
Userid  Owned  WSS  Inst  Resvd
>>Mean>>  .9 1807M 2669M 86780
WJBLA101  0 5120M 5113M 20M
    
```

- “Resvd” = Amount of pages reserved. May be larger than number of resident pages if virtual machine has not instantiated that memory yet.
- Note that memory is now in bytes (suffixed) not pages.

Virtual Machine Activity – FCX292 - UPGUTL

```
FCX292      Data for 2013/10/15  Interval 10:04:00 - 10:05:00  Monitor Scan
-----
          <----- Storage ----->
                <----- Resident ----->
          Data          <----- Invalid But Resident ----->          Base
          Spaces          <----- Total -----> <--Locked--> <-- UFO --> <-- PNR --> <--AgeList-->          Space
Userid   Owned   WSS  Inst Resvd T_All  T<2G  T>2G  L<2G  L>2G  U<2G  U>2G  P<2G  P>2G  A<2G  A>2G  XSTOR  AUX  Size
WJBLA101    0 5120M 5113M   20M 4404M   19M 4384M    0 208K    0 960K   16K   11M  280K   55M    0 3434M 5120M
```

```

          <----- Resident ----->
                <----- Invalid But Resident ----->
          <----- Total -----> <--Locked--> <-- UFO --> <-- PNR --> <--AgeList-->
Userid   T_All  T<2G  T>2G  L<2G  L>2G  U<2G  U>2G  P<2G  P>2G  A<2G  A>2G
WJBLA101 4404M   19M 4384M    0 208K    0 960K   16K   11M  280K   55M
```

- Get an understanding of where in the lists pages reside:
 - IBR = Invalid But Resident
 - UFO = User Framed Owned section
 - PNR = Private Not Referenced
 - AgeList = part of global age list, but still associated with virtual machine.

Reserved? – FCX290 - UPGACT

```

FCX290      Data for 2013/10/15   Interval 10:04:00 - 10:05:00   Monitor Scan
.
.  _____  . . . . .
.  <----- Storage ----->
.                                     <----- Movement/s ----->
.
Stl <--- Transition/s ---> <-Steal/s->                                     <Migrate/s>
Userid      Wt  Inst Relse Inval Reval Ready NoRdy  PGIN PGOUT Reads Write MWrit  Xrel
DJS LA329   1  64853 74069 38571 18978 15292    0     0     0  4506    0    0     0

```

- PGIN/PGOUT – zero due to not using expanded storage
- Reads would be what would be most important in relationship to Reserved.
- Also note rate of Invaliding and Revalidating
 - $\text{Reval} / \text{Inval} = \text{percentage of times trial invalidation leads to page moving back to top of user frame owned list.}$
- Note: FCX113 UPAGE still produced, but UPGACT is improved

New Toolkit Report FCX295 AVLA2GLG

```

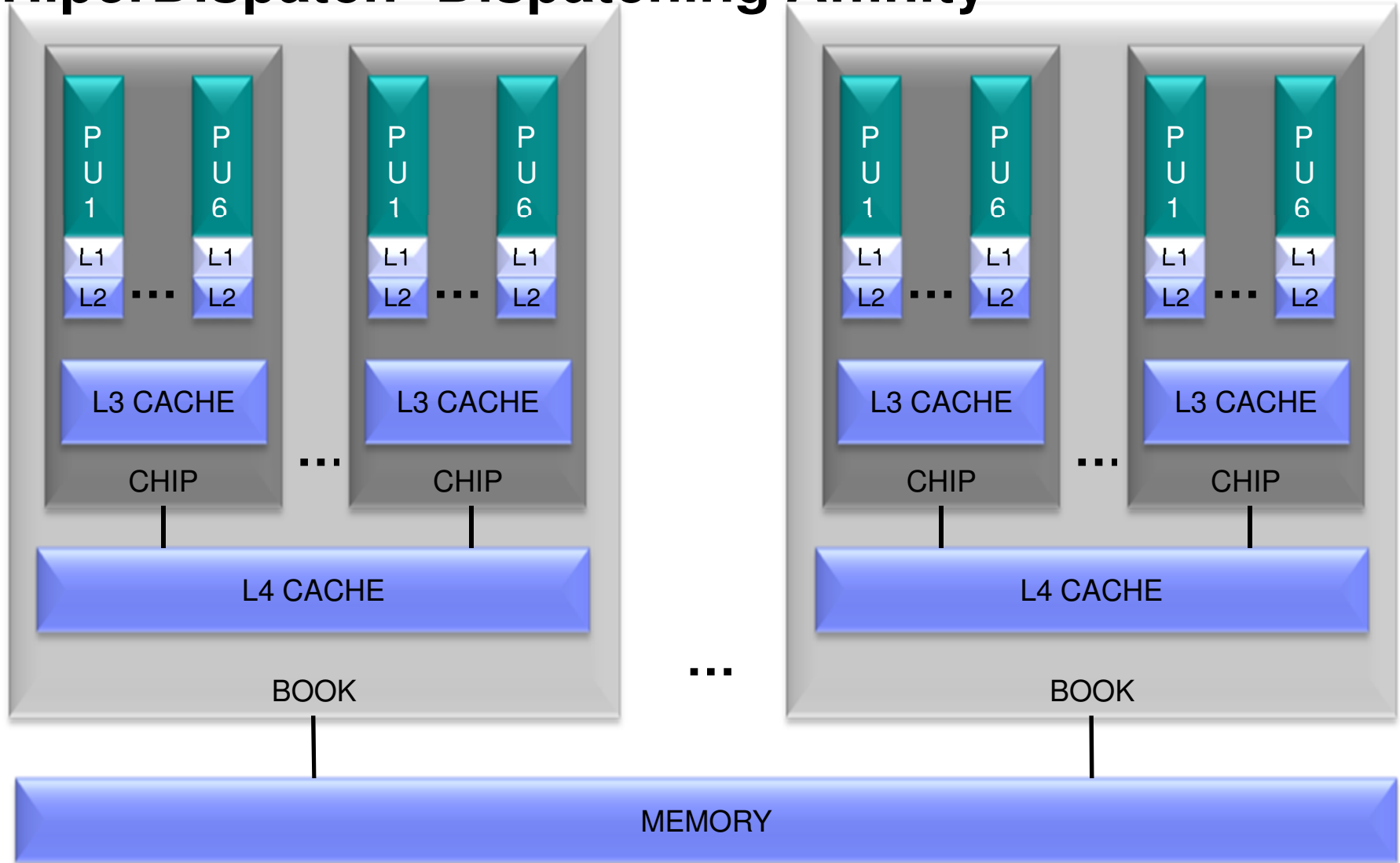
FCX295  Run 2013/04/10 07:38:36          AVLA2GLG          Page 25
                                     Available List Data Above 2G, by Time
From 2013/04/09 16:02:10
To   2013/04/09 16:13:10
For   660 Secs 00:11:00
                                     SYSTEMID
                                     CPU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

Interval	<----- Storage ----->				<--Times-->		<-Frame Thresh-->				
	<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.

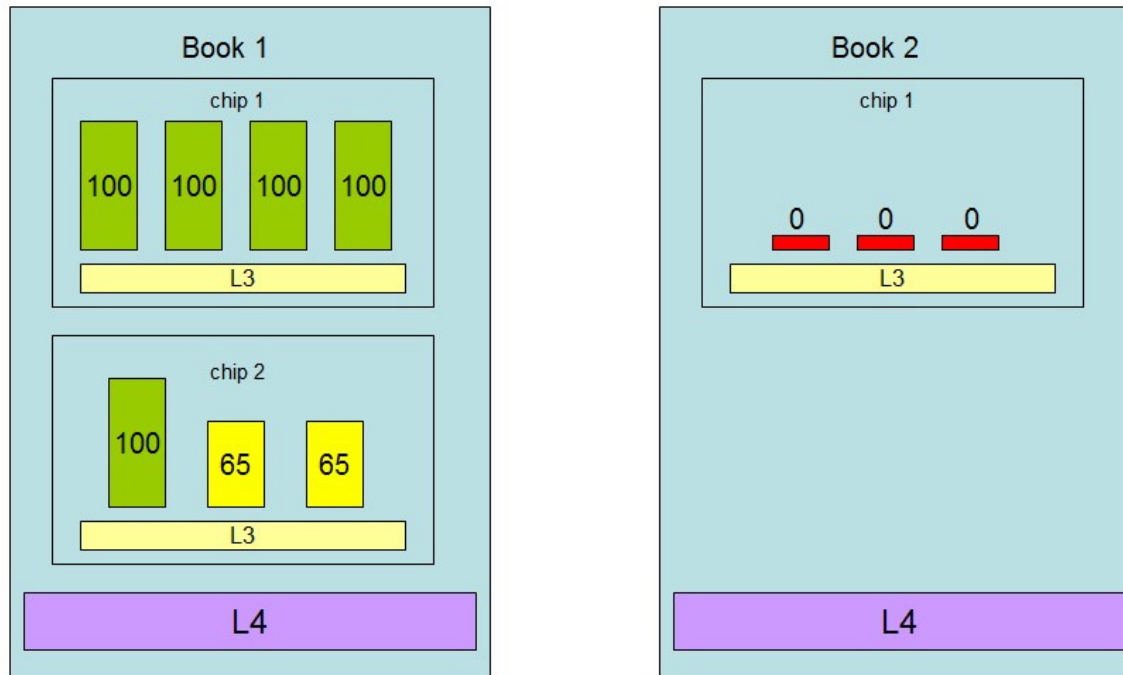
HiperDispatch

HiperDispatch- Dispatching Affinity



IBM z Systems: The Partition Knows Its Placement

Partition Topology



In vertical partitions:

- Sense your placement
- Run work smartly in light of your placement
- Sense unentitled power
- Use LPUs smartly in light of unentitled power

Notice PR/SM has given this partition a “quiet place” to do its work, provided the partition runs its work on its Vh LPUs.

Key Considerations

- Running Horizontal or Vertical? Other related SRM Settings?

- Is Global Performance Data enabled?

- What's my Topology?

- What's my entitlement?

- Are processors being parked?

HiperDispatch Monitor Records

Domain	Record	Name	Type	Description of Change
D0	R2	MRSYTPRP	sample	Added polarity, entitlement, and park-time accumulator
D0	R16	MRSYTCUP	sample	Added partition current weight
D0	R23	MRSYTLCK	sample	Added the HCPDSVTL topology lock
D1	R4	MRMTRSYS	config	Added bit indicating whether system is horizontal or vertical
D1	R5	MRMTRPRP	config	Added park state, polarization, entitlement, and topological location
D1	R16	MRMTRSCH	config	Added h/v bit, CPUPAD settings, and EXCESSUSE settings
D2	R7	MRSCLSRM	event	Added h/v bit, CPUPAD settings, and EXCESSUSE settings
D4	R2	MRUSELOF	event	Added rebalance results and steal results
D4	R3	MRUSEACT	sample	Added rebalance results and steal results
D5	R2	MRPRCVOF	event	Added park/unpark failure as reason varied off
D5	R3	MRPRCVON	event	Added parked as a state; use if neither D5 R17 nor D5 R18 are seen
D5	R15 (new)	MRPRCDSV	event	Records assignment of processors to dispatch vectors
D5	R16 (new)	MRPRCPUP	event	Records park/unpark decision
D5	R17 (new)	MRPRCRCD	sample	Records processor's VMDBK steal behavior
D5	R18 (new)	MRPRCDHF	sample	Records PLDV population trends

z/VM HiperDispatch: z/VM Performance Toolkit

- Themes in the changes in existing Perfkit screens
 - CPU entitlement appears in sensible places, e.g. FCX100 CPU
 - Percent-parked appears in sensible places, e.g. FCX100 CPU
 - Parked time is correctly accounted for, e.g. FCX126 LPAR %Susp
 - SRM settings are reported where they ought to be, e.g. FCX154 SYSSET
 - Interesting events are reported in FCX180 SYSCONF as they should
 - Number of unparked CPUs appears in sensible places, e.g. FCX225 SYSSUMLG
 - Counts of new monitor records appear in FCX155 MONDATA as they should
 - Obsolete data is compatibly deleted in certain places, e.g. FCX144 PROCLOG

- New reports sure to attract interest:
 - FCX287 TOPOLOG shows a log of partition topology, container-major
 - FCX298 PUORGLOG shows a log of partition topology, CPU-major
 - FCX299 PUCFGLOG shows a log of the park/unpark state
 - FCX301 DSVBKACT replaces the PLDV emptiness columns on FCX144 PROCLOG
 - FCX302 PHYSLOG shows a physical CPU utilization log of the CEC by type pool
 - FCX303 DSVSLOG replaces the PLDV steal columns on FCX144 PROCLOG
 - FCX304 PRCLOG is where you should now look instead of FCX144 PROCLOG
 - FCX306 LSHARACT reports the partitions' entitlements vs. logical CPU counts

- Obsolete reports
 - FCX144 PROCLOG is still there for now, but start using FCX304 PRCLOG instead

Vertical? SRM Settings? – FCX154 - SYSSET

```

FCX154          Data for 2013/10/15          System  Settings          Monitor Scan

Initial Scheduler Settings: 2013/10/15 at 09:27:50
DSPSLICE (minor) 5.000 msec.          IABIAS Intensity          90 Percent
Hotshot T-slice  1.999 msec.          IABIAS Duration           2 Minor T-slices
DSPBUF Q1        32767 Openings        STORBUF Q1 Q2 Q3         300 % Main storage
DSPBUF Q1 Q2     32767 Openings        STORBUF Q2 Q3           300 % Main storage
DSPBUF Q1 Q2 Q3  32767 Openings        STORBUF Q3              300 % Main storage
LDUBUF Q1 Q2 Q3   100 % Paging exp.     Max. working set        9999 % Main storage
LDUBUF Q2 Q3     100 % Paging exp.     Loading user             5 Pgrd / T-slice
LDUBUF Q3        100 % Paging exp.     Loading capacity         47 Paging expos.
LIMITHARD algorithm Consumption
DSPWD method     Reshuffle
Polarization     Vertical
Global Perf. Data ON
EXCESSUSE: CP    MEDIUM  CPUPAD: CP    100%
              ZAAP MEDIUM  ZAAP      100%
              IFL  MEDIUM  IFL      1000%
              ICF  MEDIUM  ICF      100%
              ZIIP MEDIUM  ZIIP     100%

```

- Default Vertical Polarization
- Global Performance Data is On
- Using default values for EXCESSUSE and CPUPAD

Topology? – FCX298 - PUORGLOG

1FCX298 Run 2013/05/20 10:39:48

PUORGLOG

Processor Unit organization log

From 2013/05/19 03:39:31

To 2013/05/19 03:41:31

For 120 Secs 00:02:00

Result of GF003855 Run

Logical PU organization for Partition PPRF1 (GDLBOFVM)

Date	Time	CPU	Type	PPD	Ent.	Location
05/19	03:39:31	0	CP	VhD	100	1:6
05/19	03:39:31	1	CP	VhD	100	1:6
05/19	03:39:31	2	CP	VhD	100	1:5
05/19	03:39:31	3	CP	VhD	100	1:5
05/19	03:39:31	4	CP	VhD	100	1:5
05/19	03:39:31	5	CP	VhD	100	1:5
05/19	03:39:31	6	CP	VhD	100	1:5
05/19	03:39:31	7	CP	VhD	100	1:4
05/19	03:39:31	8	CP	VhD	100	1:4
05/19	03:39:31	9	CP	VhD	100	1:4
05/19	03:39:31	10	CP	VhD	100	1:4
05/19	03:39:31	11	CP	VhD	100	1:2
05/19	03:39:31	12	CP	VhD	100	1:2
05/19	03:39:31	13	CP	VhD	100	1:2
05/19	03:39:31	14	CP	VhD	100	1:2
... truncated ...						

Notes:

Vh: vertical high

Vm: vertical medium

VI: vertical low

VhD: vertical high, dedicated partition

Ent: entitlement with respect to a physical CPU

Location: book:chip (z10: book)

Is there Parking? – FCX304 - PRCLOG

```

FCX304          Data for 2013/10/15  Interval 09:28:00 - 10:05:
                                     <--- Percent Busy ---->
Interval      C          Pct
End Time     U Type  PPD  Ent.  DVID  Park
>>Mean>>    0 IFL  vh   100  0000   0  24.9  21.4  3.5  20.6
>>Mean>>    1 IFL  vh   100  0001   0  36.8  34.7  2.1  33.7
>>Mean>>    2 IFL  vh   100  0002   0  37.6  36.0  1.6  35.1
>>Mean>>    3 IFL  vh   100  0003   0  38.4  36.9  1.4  36.1
>>Mean>>    4 IFL  vh   100  0004   0  43.7  42.4  1.3  41.6
>>Mean>>    5 IFL  vh   100  0005   0  39.1  37.4  1.8  36.3
>>Mean>>    6 IFL  vh   100  0006   0  37.9  36.4  1.4  35.5
>>Mean>>    7 IFL  vh   100  0007   0  40.5  39.3  1.3  38.4
>>Mean>>    8 IFL  vh   100  0008   0  40.6  39.4  1.2  38.5
>>Mean>>    9 IFL  vh   100  0009   0  42.0  40.7  1.3  39.9
>>Total>   10 IFL  vh  1000  MIX   0 381.5 364.6 16.9 355.6

```

- PRCLOG replaces PROCLOG
- Pct Park Time – remember processors may be parked and unparked multiple times in an interval.

Is there Parking? - FCX299 - PUCFGLOG

FCX299 Run 2013/06/24 09:36:54

PUCFGLOG
Processor Unit Configuration log

Page 6

From 2013/02/19 11:49:52
To 2013/02/19 11:56:10
For 378 Secs 00:06:18

Result of GFCM0107 Run

GFCM0107
CPU 2817-744 SN B6D85
z/VM V.6.3.0 SLU 0000

Date	Time	Type	OnL	Entitl	Type	Cap	CPUPAD	EX	Load	XP	XPF	T/V	LCEI	XPF	T/V	N	NotVh	UpCap	LPU	Unparked	mask
02/19	11:49:54	CP	24	1985.2	...	100.0	70	2.2	1159.4	892.8	3.519	3.9	885.9	200.5	2	.0	200.0	00300000	00000000		
02/19	11:49:56	CP	24	1985.2	...	100.0	70	.5	1153.3	888.1	256.0	1.7	883.4	201.3	2	.0	200.0	00300000	00000000		
02/19	11:49:58	CP	24	1985.2	...	100.0	70	.5	1159.7	893.1	122.3	1.7	885.2	204.2	2	.0	200.0	00300000	00000000		
02/19	11:50:00	CP	24	1985.2	...	100.0	70	.7	1136.7	875.4	53.45	1.7	857.7	172.5	2	.0	200.0	00300000	00000000		
02/19	11:50:02	CP	24	1985.2	...	100.0	70	.9	1128.6	869.2	4.531	1.7	863.0	172.5	2	.0	200.0	00300000	00000000		
02/19	11:50:04	CP	24	1985.2	...	100.0	70	1.3	1034.5	778.8	1.822	1.8	688.3	172.4	2	.0	200.0	00300000	00000000		
02/19	11:50:06	CP	24	1985.2	...	100.0	70	.6	1157.1	891.1	38.57	1.8	856.4	168.5	2	.0	200.0	00300000	00000000		
02/19	11:50:08	CP	24	1985.2	...	100.0	70	.5	1162.9	895.5	250.8	1.7	856.9	211.1	2	.0	200.0	00300000	00000000		
02/19	11:50:10	CP	24	1985.2	...	100.0	70	44.8	1161.8	894.7	2.214	89.1	858.9	211.1	2	.0	200.0	00300000	00000000		
02/19	11:50:12	* CPU	Park/Unpark	State	changed																
02/19	11:50:12	CP	24	1985.2	...	100.0	70	199.7	1145.1	881.9	1.517	354.6	858.5	197.6	5	.0	500.0	00300000	00000000		
02/19	11:50:14	* CPU	Park/Unpark	State	changed																
02/19	11:50:14	CP	24	1985.2	...	100.0	70	501.6	1155.6	890.0	1.009	803.5	858.3	197.5	10	.0	1000.0	013C0000	00000000		
02/19	11:50:16	* CPU	Park/Unpark	State	changed																
02/19	11:50:16	CP	24	1985.2	...	100.0	70	999.6	1147.4	883.6	1.001	1497.6	857.9	146.5	16	.0	1600.0	0FFC0000	00000000		
02/19	11:50:18	* CPU	Park/Unpark	State	changed																
02/19	11:50:18	CP	24	1985.2	...	100.0	70	1599.3	1155.1	889.6	1.001	2199.1	857.7	130.3	23	100.0	2300.0	FFFFF000	00000000		
02/19	11:50:20	* CPU	Park/Unpark	State	changed																
02/19	11:50:20	CP	24	1985.2	...	100.0	70	2297.6	1179.7	908.5	1.001	2995.8	860.2	125.6	24	100.0	2400.0	FFFFFFE0	00000000		
02/19	11:50:22	* CPU	Park/Unpark	State	changed																
02/19	11:50:22	CP	24	1985.2	...	100.0	70	2397.1	1144.5	881.4	1.005	2496.6	854.3	125.4	24	100.0	2400.0	FFFFFFF0	00000000		
02/19	11:50:24	CP	24	1985.2	...	100.0	70	2080.5	1181.8	910.1	1.002	2569.2	887.6	125.3	24	100.0	2400.0	FFFFFFF0	00000000		
02/19	11:50:26	CP	24	1985.2	...	100.0	70	1681.3	1140.0	878.0	1.002	2660.9	845.8	122.1	24	100.0	2400.0	FFFFFFF0	00000000		
02/19	11:50:28	CP	24	1985.2	...	100.0	70	1632.4	1169.6	900.7	1.002	2684.7	886.2	1.660	24	100.0	2400.0	FFFFFFF0	00000000		
02/19	11:50:30	CP	24	1985.2	...	100.0	70	1587.7	1149.4	885.2	1.002	2635.4	869.6	1.252	24	100.0	2400.0	FFFFFFF0	00000000		
02/19	11:50:32	CP	24	1985.2	...	100.0	70	1878.3	1129.6	869.9	1.011	2560.8	854.7	1.008	24	100.0	2400.0	FFFFFFF0	00000000		
02/19	11:50:34	CP	24	1985.2	...	100.0	70	1824.3	1176.2	905.8	1.002	2425.8	884.3	1.007	24	100.0	2400.0	FFFFFFF0	00000000		

- Shows what can happen to T/V when utilization is really low
- Shows parking because of high projected T/V
- Shows unpark when workload ramps up
- Shows how a varying U produces a high U'
- Shows XPF and XPF' in action
- Shows that the T/V projections level right out once the guest workload is well underway
- Shows what a non-Vh LPU will be "truly worth" during the next interval

Entitlement? – FCX306 - LSHARACT

1FCX306 Run 2013/02/19 12:10:57

LSHARACT

LPAR Data, Collected in Partition RPRF2

Physical PUs, Shared: CP- 40 ZAAP- 2 IFL- 16 ICF- 1 ZIIP- 3
 Dedicated: CP- 4 ZAAP- 0 IFL- 0 ICF- 0 ZIIP- 0

Proc Type	Partition Name	LPU Num	LPAR Weight	Entlment	<LPU Total,%>		LPU Conf
					Busy	Excess	
CP	RCPX4	10	10	59.3	3.0	.0	o
CP	RCTS1	5	10	59.3	311.9	252.6	o
CP	RCTS2	5	30	177.8	1.0	.0	o
CP	RCT1	20	30	177.8	111.3	.0	o
CP	RCT2	10	10	59.3	11.2	.0	o
CP	REXT1	5	10	59.3	.0	.0	o
CP	REXT2	4	10	59.3	.0	.0	o
CP	RINS	10	10	59.3	.0	.0	o
CP	RPRF1	4	DED				
CP	RPRF2	24	335	1985.2	1548.4	.0	o
CP	RSPX1	6	40	237.0	481.3	244.3	o
CP	RSPX2	6	40	237.0	499.7	262.7	o
CP	RSPX5	6	40	237.0	126.5	.0	o
CP	RST1	10	10	59.3	16.2	.0	o
CP	RST1X	6	10	59.3	102.5	43.2	o
CP	RST2	6	50	296.3	.9	.0	o
CP	RST3	3	30	177.8	1.2	.0	o
ICF	RCTS2	1	10	25.0	.0	.0	-
ICF	RCT1	1	30	75.0	.0	.0	-
IFL	RCTS2	2	10	188.2	.0	.0	-
IFL	RCT1	2	30	564.7	.0	.0	u
IFL	RSTL1	16	45	847.1	449.2	.0	o
ZAAP	RCPX4	1	10	40.0	.1	.0	-
ZIIP	RCPX4	1	10	60.0	.3	.0	-
ZIIP	RCTS2	1	10	60.0	.0	.0	-
ZIIP	RCT1	1	30	180.0	.0	.0	u

- Reports by partition & CPU type
- Reports entitlement in percent
- Reports percent-busy of the partition's CPUs of that type
- Reports whether the partition is consuming beyond its entitlement ("Excess")
- Reports LPU configuration with respect to entitlement:
 - "o" – overconfigured
 - "u" – underconfigured
 - "-" – apparently just right

Total CEC? – FCX302 - PHYSLOG

FCX302 Run 2013/06/24 09:36:54

PHYSLOG
Real CPU Utilization Log

From 2013/02/19 11:49:58
To 2013/02/19 11:56:10
For 372 Secs 00:06:12

Result of GFCM0107 Run

Interval	<PU Num>	Total									
End Time	Type	Conf	Ded	Weight	%Lgc1P	%Ovrhd	LpuT/L	%LPmgt	%Total	TypeT/L	
>>Mean>>	CP	44	4	675	3387.1	27.947	1.008	31.870	3446.9	1.018	
>>Mean>>	ZAAP	2	0	50	.093	.042	1.451	.424	.559	6.015	
>>Mean>>	IFL	16	0	85	448.16	1.017	1.002	2.108	451.28	1.007	
>>Mean>>	ICF	1	0	40	.004	.003	1.624	2.257	2.263	563.66	
>>Mean>>	ZIIP	3	0	50	.193	.090	1.465	1.204	1.487	7.694	
>>Mean>>	>Sum	66	4	900	3835.5	29.099	1.008	37.864	3902.5	1.017	
11:50:04	CP	44	4	675	1963.9	33.262	1.017	36.226	2033.4	1.035	
11:50:04	ZAAP	2	0	50	.004	.001	1.306	.037	.042	10.107	
11:50:04	IFL	16	0	85	501.44	1.087	1.002	2.372	504.90	1.007	
11:50:04	ICF	1	0	40	.007	.004	1.566	2.277	2.289	312.13	
11:50:04	ZIIP	3	0	50	.005	.002	1.334	.093	.100	19.003	

You now have an easy way to see how busy your CEC is.

Features:

- Talled by CPU type (CP, IFL, ...)
- One group of rows every sample interval

Reports all three ways CPU gets used:

- By logical CPUs
- By PR/SM, chargeable
- By PR/SM, unchargeable

New concepts:

- LPU T/L: like "guest T/V"
- Type T/L: like "system T/V"

Dispatch Vector Activity? – FCX303 - DSVSLOG

1FCX303 Run 2013/05/20 10:32:38

DSVSLOG

DSVBK Steals per logical CPU Log, by Time

From 2013/05/19 02:03:25

To 2013/05/19 02:05:19

For 114 Secs 00:01:54

Result of GF003820 Run

Interval	C	P	Type	PPD	Ent.	DVID	Pct Park Time	DSVBK Steal /s					
End Time	U							Lvl-00	Lvl-01	Lvl-02	Lvl-03	Lvl-04	Lvl-05
>>Mean>>	0	CP	vh	100	0000	0	0	4.404	4.088	.000	....	....	....
>>Mean>>	1	CP	vh	100	0001	0	0	2.456	2.561	.000	....	....	....
>>Mean>>	2	CP	vh	100	0002	0	0	6.877	.921	.000	....	....	....
>>Mean>>	3	CP	vh	100	0003	0	0	7.596	.930	.000	....	....	....
>>Mean>>	4	CP	vh	100	0004	0	0	4.500	.482	.000	....	....	....
>>Mean>>	5	CP	vh	100	0005	0	0	3.614	.228	.000	....	....	....
>>Mean>>	6	CP	vh	100	0006	0	0	4.518	.482	.000	....	....	....
>>Mean>>	7	CP	vh	100	0007	0	0	2.912	.386	.000	....	....	....
>>Mean>>	8	CP	vh	100	0008	0	0	1.412	.421	.000	....	....	....
>>Mean>>	9	CP	vh	100	0009	0	0	1.386	.184	.000	....	....	....
>>Mean>>	10	CP	vh	100	000A	0	0	2.070	.544	.000	....	....	....
>>Mean>>	11	CP	vh	100	000B	0	0	2.114	.149	.000	....	....	....
>>Mean>>	12	CP	vh	100	000C	0	0	5.886	1.623	.000	....	....	....
>>Mean>>	13	CP	vh	100	000D	0	0	3.772	.702	.000	....	....	....
>>Mean>>	14	CP	vh	100	000E	0	0	3.026	.675	.000	....	....	....
>>Mean>>	15	CP	vh	100	000F	0	0	2.658	.360	.000	....	....	....
>>Total>	16	CP	vh	1600	MIX	0	0	59.202	14.737	.000	....	....	....

Reports VCPU steal behavior by the distance the steal dragged the VCPU.

- Lvl-00: you stole it from a CPU in your chip (z10: ... in your book)
- Lvl-01: you stole it from a CPU in your book (z10: ... in another book)
- Lvl-02: you stole it from a CPU on another book (z10: ... not applicable)

IBM z13 SMT Changes

Simultaneous Multithreading (SMT)

- Objective is to improve capacity, not performance.
- Allows z/VM to dispatch work on up to two threads of a z13 IFL
- VM65586 for z/VM 6.3 **only**
 - PTFs planned to be available March 13, 2015
- Transparent to virtual machine
 - Guest does not need to be SMT aware
 - SMT is not virtualized to the guest
- z13 SMT support limited to IFLs and zIIPs
 - z/VM support is only for IFLs
- SMT is disabled by default
 - Requires a System Configuration setting and re-IPL
 - When enabled, applies to the entire system
- Potential to increase the overall capacity of the system
 - Workload dependent

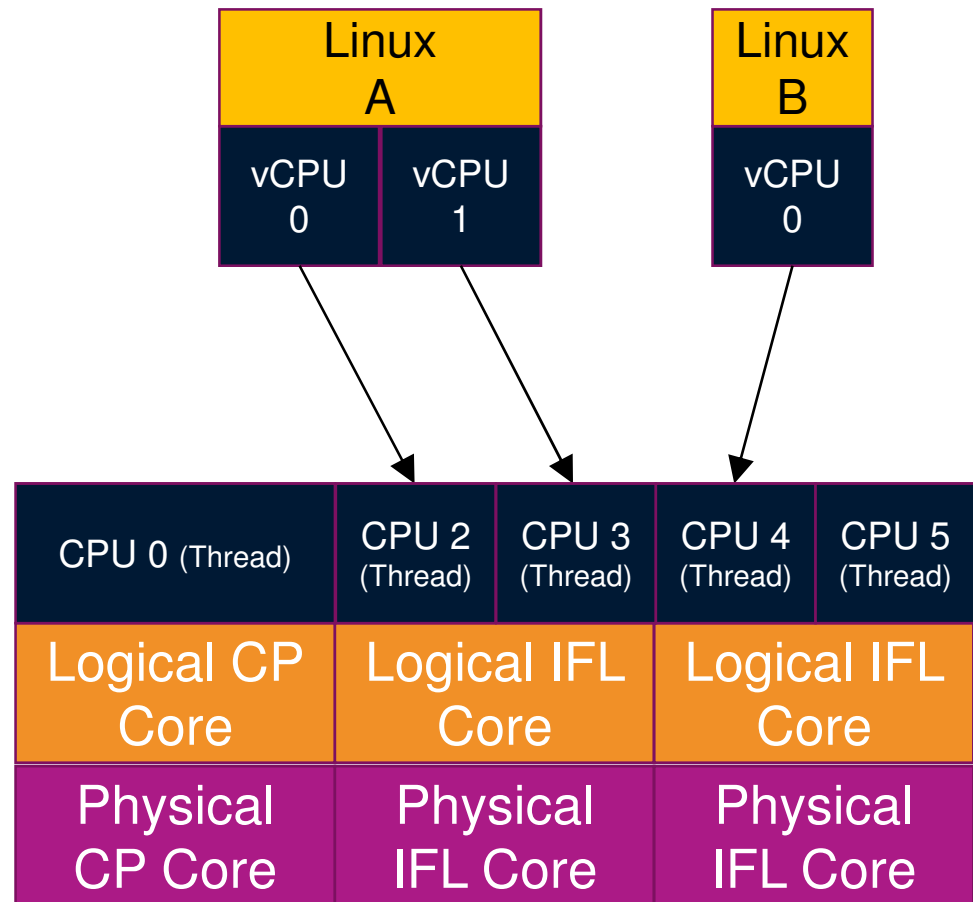


Which approach is designed for the higher volume of traffic? Which road is faster?

** Illustrative numbers only*

SMT Dispatching

- Physical IFLs (or Cores) with SMT allow up to two threads to be used.
- Logical IFLs are presented to z/VM as in the past, defined in LPAR definition..
- z/VM creates a CPU associated with each thread for it to use.
- The virtual CPUs of guests can then be dispatched on different threads intelligently, based on topology information.
- In a mixed-engine environment, general purpose processors can not do threading, but a second CPU address is consumed (CPU 1 in example)



Monitor Changes

New Monitor

Domain 5 Record 20

Record Name

MT CPUMF counters

Change Monitor

Domain 0 Record 2

Domain 0 Record 15

Domain 0 Record 16

Domain 0 Record 17

Domain 0 Record 19

Domain 0 Record 23

Domain 1 Record 4

Domain 1 Record 5

Domain 1 Record 16

Domain 1 Record 18

Domain 2 Record 4

Domain 2 Record 5

Domain 2 Record 7

Domain 2 Record 13

Domain 2 Record 14

Domain 4 Record 2

Domain 4 Record 3

Domain 4 Record 9

Domain 5 Record 1

Domain 5 Record 2

Domain 5 Record 11

Domain 5 Record 13

Domain 5 Record 16

Domain 5 Record 17

Domain 5 Record 19

Records Name

Processor data (per processor)

Logical CPU utilization (global)

CPU utilization in a logical partition)

Physical CPU utilization data for LPAR management

System data (global)

Formal spin lock data (global)

System configuration data

Processor configuration data (per processor)

Scheduler settings

CPU capability change

Add user to dispatch list

Drop user from dispatch list

Set SRM changes

Add VMDBK to limit list

Drop VMDBK from limit list

User logoff data

User activity data

User activity data at transaction end

Vary on processor

Vary off processor

Instruction counts per processor

CPU-measurement facility counters

Park/unpark decision

Real CPU data

CPU pool utilization

Perfkit Screen SYSCONF (FCX180) – SMT Disable

```

FCX180  Run 2015/02/15 08:52:14      SYSCONF
                                           System Configuration, Initial and Changed
From 2015/02/14 16:04:29
To   2015/02/14 16:14:59
For   630 Secs 00:10:30
                                           "This is a performance report for SYSTEM XYZ"
                                           SYSTEMID
                                           CPU 2964-704
                                           z/VM  V.6.3.0
    
```

Multithreading Disabled, No MULTITHREADING statement

Disabled as Config file does not contain a 'multithreaded enabled' statement.

```

Server Time Protocol (STP) facility configuration
XRC_TEST enabled          No          XRC_OPTIONAL enabled
STP H/W feature installed No          STP H/W feature enabled
STP Timestamping enabled  No          STP Timezone usage enabled
STP is active             No          STP is suspended
STP susp. message issued  No
STP TOD clock offset      +00:00:00.0000000000
    
```

```

Initial Status on 2015/02/14 at 16:04, Processor 2964-704
          Total Conf Stby Resvd Ded Shrd
Real Proc: Cap 492.0000  103   4   0   99
Sec. Proc: Cap 492.0000   99  99   0   4
Log. IFL : CAF    41    8   4   0   4   0
    
```

```

<----- Processor -----> Core/
Num Serial-Nr Type Status Thread
  0  012F17 IFL Master   00/0
  1  012F17 IFL Alternate 01/0
  2  012F17 IFL Alternate 02/0
  3  012F17 IFL Alternate 03/0
Processor Configuration Mode: LINUX
    
```

Total of 4 cores and each core has a thread 0 associated with it.

Perfkit Screen SYSCONF (FCX180) – SMT Enabled

```

FCX180 Run 2015/02/15 08:52:10 SYSCONF
                                System Configuration, Initial and Changed
From 2015/02/14 16:31:32
To   2015/02/14 16:42:02
For   630 Secs 00:10:30
                                "This is a performance report for SYSTEM XYZ"
                                CPU 2964-704
                                z/VM V.6.3.0
    
```

Multithreading Enabled

The z/VM system is enabled for SMT.

Initial Status on 2015/02/14 at 16:31, Processor 2964-704

	Total	Conf	Stby	Resvd	Ded	Shrd
Real Proc: Cap 492.0000	103	4	0	99		
Sec. Proc: Cap 492.0000	99	99	0	4		
Log. IFL : CAF	41	8	4	0	4	0

```

<----- Processor -----> Core/
Num Serial-Nr Type Status Thread
0 012F17 IFL Master 00/0
1 012F17 IFL Alternate 00/1
2 012F17 IFL Alternate 01/0
3 012F17 IFL Alternate 01/1
4 012F17 IFL Alternate 02/0
5 012F17 IFL Alternate 02/1
6 012F17 IFL Alternate 03/0
7 012F17 IFL Alternate 03/1
Processor Configuration Mode: LINUX
    
```

Total of 4 cores and each core has both a thread 0 and a thread 1 associated with it.

Perfkit Screen SYSSET (FCX154) – SMT Enabled

```

FCX154  Run 2015/02/15 08:52:10      SYSSET
                                           System Scheduler Settings, Initial and Changed
From 2015/02/14 16:31:32                SYSTEMID
To   2015/02/14 16:42:02                CPU 2964-704
For   630 Secs 00:10:30                 "This is a performance report for SYSTEM XYZ" z/VM  V.6.3.0
    
```

Initial scheduler Settings: 2015/02/14 at 16:31:32

```

LIMITHARD algorithm      Consumption
DSPWD method            Reshuffle
Polarization            Vertical
Global Perf. Data      ON
EXCESSUSE: CP .....  CPUPAD: CP      6400%
                   ZAAP .....  ZAAP      0%
                   IFL .....  IFL      0%
                   ICF .....  ICF      0%
                   ZIIP .....  ZIIP     0%
    
```

```

Multithreading          Enabled
<----- Threads ----->
H/W Requested System Activated
Max Threads            Max      2
CP core                1      Max      1      1
IFL core               2      Max      2      2
ICF core               2      Max      1      1
ZIIP core              2      Max      1      1
    
```

```

Changed Scheduler Settings
Date Time      Changed
..... No changes processed
    
```

For SMT to be enabled:

1. z/VM Dispatch Workload Algorithm must be at default of Reshuffle.
2. HiperDispatch polarization must be vertical.

Maximum number of threads activated on this z/VM. Activated column = minimum(H/W, Requested, System)

Perfkit Screen PRCLOG (FCX304) – SMT Disabled

```

FCX304 Run 2015/02/15 08:52:14 PRCLOG Page 56
Processor Activity, by Time
From 2015/02/14 16:04:29 SYSTEMID
To 2015/02/14 16:14:59 CPU 2964-704 SN 12F17
For 630 Secs 00:10:30 "This is a performance report for SYSTEM XYZ" z/VM V.6.3.0 SLU 0000
    
```

Interval	C P	U	Type	PPD	Ent.	DVID	Pct		Rates per Sec.							Paging			<Co> <mm>	<Di> <ag>	Core/ Thread	
							Time	Park	Total	User	Syst	Emul	Siml	DIAG	SIGP	SSCH	<2GB </s	PGIN </s				Fast Path %	Page Read </s	Msgs </s	X'9C' </s
>>Mean>>	0	IFL	Vhd	100	0000	0	0	95.7	95.5	.2	88.2	38153	551.3	22.8	37.1	.0	.0	....	.0	.2	.0	00/0
>>Mean>>	1	IFL	Vhd	100	0001	0	0	95.7	95.5	.2	88.2	37536	492.2	10.3	2.7	.0	.0	....	.0	.0	.0	01/0
>>Mean>>	2	IFL	Vhd	100	0002	0	0	95.6	95.4	.2	88.0	38178	509.8	74.0	2.9	.0	.0	....	.1	.0	.0	02/0
>>Mean>>	3	IFL	Vhd	100	0003	0	0	95.5	95.3	.2	87.8	38532	508.4	8.8	4.8	.0	.0	....	.1	.1	.0	03/0
>>Total>	4	IFL	Vhd	400	MIX	0	0	382.5	381.6	.9	352.1	152k	2062	115.9	47.5	.0	.0	....	.2	.3	.0	MIX

Report remains similar to the past, especially with SMT disabled. You will again see the Core/Thread nomenclature.

Core/
Thread
00/0
01/0
02/0
03/0
MIX

Perfkit Screen PRCLOG (FCX304) – SMT Enabled

```

04 Run 2015/02/15 08:52:10          PRCLOG                      Page 56
                                Processor Activity, by Time

m 2015/02/14 16:31:32                SYSTEMID
2015/02/14 16:42:02                CPU 2964-704  SN 12F17
630 Secs 00:10:30                  "This is a performance report for SYSTEM XYZ"          z/VM V.6.3.0 SLU 0000
    
```

Interval	C P	U	Type	PPD	Ent.	DVID	Pct		Rates per Sec.							Paging			<Co> <mm>	<Di> <ag>	Core/ Thread
							Time	Park	Total	User	Syst	Emul	Siml	DIAG	SIGP	SSCH	<2GB </s	PGIN </s			
Mean>>	0	IFL	VhD	100	0000	0	84.7	84.5	.2	77.0	30035	416.7	1124	34.6	.0	.0	....	.2	.2	.0	00/0
Mean>>	1	IFL	VhD	100	0000	0	84.3	84.1	.2	76.8	29845	447.8	1054	2.0	.0	.0	....	.0	.0	.0	00/1
Mean>>	2	IFL	VhD	100	0001	0	84.5	84.4	.2	76.8	31053	439.6	1098	1.4	.0	.0	....	.0	.0	.0	01/0
Mean>>	3	IFL	VhD	100	0001	0	84.6	84.4	.2	77.0	30648	491.9	1028	1.2	.0	.0	....	.0	.0	.0	01/1
Mean>>	4	IFL	VhD	100	0002	0	84.5	84.3	.2	77.0	29912	535.7	1106	1.7	.0	.0	....	.0	.0	.0	02/0
Mean>>	5	IFL	VhD	100	0002	0	84.9	84.7	.2	77.5	29667	526.1	1029	1.3	.0	.0	....	.0	.0	.0	02/1
Mean>>	6	IFL	VhD	100	0003	0	84.8	84.6	.2	77.3	29368	450.1	1062	2.1	.0	.0	....	.1	.0	.0	03/0
Mean>>	7	IFL	VhD	100	0003	0	84.7	84.5	.2	77.3	29026	566.8	1027	2.0	.0	.0	....	.0	.0	.0	03/1
Total>	8	IFL	VhD	800	MIX	0	677.0	675.5	1.5	616.6	240k	3875	8527	46.2	.0	.0	....	.2	.3	.0	MIX

With SMT enabled, you see each thread is shown as a "Logical CPU" on this report. The utilizations are of the thread, no longer the "core".

Other Changes

Monitor Record Changes

- All the HiperDispatch changes
- All the Large Memory changes
- For FCP Data Router: D1 R19, D6 R25
- HiperSockets changes: D1 R19, D6 R25, D6 R26, D6 R27
- For Large Memory Dump: D1 R7, D3 R1
- VSWITCH Edge Port Aggregator: D6 R21, D6 R35
- VSWITCH Recovery Stall Prevention: D6 R22
- Additional debug: D0 R17, D0 R20, D3 R4, D3 R11, D5 R8, D5 R10, D6 R3, D6 R4, D6 R7, D6 R8, D6 R14, D6 R31, D9 R3

z/VM Performance Toolkit

- High Performance FICON changes
 - SYSLOG, SYSTEM, DEVICE HPF, HPFLOG, SYSCONF, IOCHANGE, LCHANNEL all updated
- VSWITCH HiperSockets Bridge changes
 - GVNIC, VNIC, GVSWITCH, VSWITCH, QDIO, IOCHANGE all updated
- LGR changes
 - New reports LGRELOG and LGRDATA
- Large Memory Changes
 - 6 changed, 2 deleted, 8 new
- HiperDispatch Changes
 - 7 changed, 1 obsolete, 8 new

Please remember to fill out an evaluation. Thanks!



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