z/VM Performance Case Studies
Session 9166

Please consider sitting near the front.

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Agenda

- **Brief review of collecting performance data.**
- **Brief review of IBM Performance Support**
- **Case Studies**

Acknowledgments

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Collecting Raw Monitor Data

- **What is raw monitor data?**
- **How do I set up to collect it?**
- **When do I collect it?**
- **What tools are available to help me collect it?**
- **How do I package it for transmission?**
- **How do I study it myself?**
- **Summary**

What is Raw Monitor Data?

- **It is unformatted binary data describing system configuration or activity**
- **Logically, it is a sequence of *monitor records***
  - Each record comments on some specific aspect of system activity or performance
  - In aggregate they constitute a comprehensive, time-indexed record of system activity
- **There are three large classes of monitor records**
  - *Configuration records:* emitted when monitor starts, these describe system configuration
  - *Sample records:* emitted every so often, these comment on the accumulated activity of an entity (device, user, …)
  - *Event records:* emitted as needed, these comment on some specific phenomenon that just now occurred
- **Some records come from the Control Program and comment on its experience in running the system**
- **Other records come from guests and comment on their experiences in doing whatever it is they do**
- **We collect this data using an IBM-supplied utility program called MONWRITE**
- **During the rest of this presentation, we will call this data *MONWRITE data***

How Do I Collect MONWRITE Data?

- **By Default the z/VM system is set up with DCSS and user ID named MONWRITE**
- **If somehow skipped, then:**
  - You set up a DCSS where CP will buffer the monitor records it emits
    - CP DEFSEG and SAVESEG commands
  - You tell CP which kinds of records to emit, and how often to emit them, and in fact to begin emitting them
    - CP MONITOR command
  - You set up a guest that drains the DCSS to a disk or a tape via the MONWRITE utility
- **On some occasions, the default DCSS (named MONDCSS) is too small.**
  - See http://www.vm.ibm.com/perf/tips/mondcss.html
- **You run the guest**
- **You archive the resultant files or tapes, so that you have a long-term historical record of system activity and performance**

When Do I Collect MONWRITE Data?

- **Periodically, collect and archive some data during your peak periods, so that you have a historical record**
  - Every Tuesday at 10 AM for an hour
  - Month-end processing
  - Whenever you do that really big thing you do
- **When directed by IBM**
  - Health check, PMR, crit sit, ESP, whatever

Tool: Running MONWRITE By Hand

- **A great idea, assuming you are not running some other performance product**
  - If you know what you are doing, you can do both simultaneously
- **Create the DCSS to hold the buffered records**
- **Set up a guest to run our MONWRITE MODULE (collector)**
- **Issue some CP MONITOR commands to start CP emitting records**
  - Enable all samples
  - Enable all events except seeks and scheduler
  - Use a 1-minute sample interval and a 5-second HFS rate
- **In your guest, start MONWRITE to collect the data CP's emitting**
- **To stop collecting, type this: MONWSTOP**
- **You will end up with one MONWRITE file that you can:**
  - Archive for the historical record
  - Analyze yourself with z/VM Performance Toolkit
  - Send to IBM so we can look at it
- **There is an option for MONWRITE to close the file at regular times of day and a user exit to process the just-closed file.**
- **Good references:**
  - http://www.vm.ibm.com/perf/tips/collect.html - a good cheat sheet
  - z/VM Performance, chapter 9, "Monitoring Performance Using CP Monitor" – an excellent writeup of every last detail

Tool: Brian Wade's LINMON Collector

- **At http://www.vm.ibm.com/devpages/bkw/monitor.html**
- **Based on a modified MONWRITE**
- **Sets up the DCSS, etc. on its own, using certain assumptions that are probably safe for many systems**
- **Can be configured to:**
  – Account for presence of another performance product
  – Collect for a while then log off
  – Start a new file every so often
  – Keep only the last N files

Packaging MONWRITE Data For Transmission

- **MONWRITE files are binary CMS files, F 4096.**
- **Just attaching them to an e-mail is NOT recommended.**
- **The standard z/VM Level 2 process for FTPing files calls for COPYFILE (PACK**
  - This is unnecessary for MONWRITE and VMARC files.
- **Always, always, always:**
  - Move the files in binary (ASCII is a sure showstopper)
  - Do not use FTP's SITE FIXREC, QUOTE SITE FIXREC, or LOCSITE FIXREC features (error-prone)
- **You will probably FTP your data to IBM's receiving server in Boulder, CO**
  - Testcase.boulder.ibm.com, cd /toibm/vm
  - Name your file mnemonically and send us a note about it
  - See http://techsupport.services.ibm.com/390/tcprocs.html for additional info on the Testcase process
  - In PMR and/or note be clear as to what is sent and how packaged
- **We suggest you use the VMARC file archiver that runs on CMS for very large files or when several files are being sent.**
  - Kind of like "zipping" on a PC (compresses, combines)
    - MONWRITE data is very compressible
    - Sometimes you also want to send us a console spool, or some QUERY outputs, or whatever
    - You can package everything into one VMARC archive and just send us that
- **There are VMARC instructions near the bottom of http://www.vm.ibm.com/devpages/bkw/monitor.html**

Studying MONWRITE Data

- **z/VM Performance Toolkit**
- **Interactively – possible, but not so useful**
- **PERFKIT BATCH command – pretty useful**
  – Control files tell Perfkit which reports to produce
  – You can then inspect the reports by hand or programmatically
- **See <u>z/VM Performance Toolkit Reference</u> for information on how to use PERFKIT BATCH**

Other Types of Data Confused with MONWRITE Data

- **Asking for "raw VM monitor" data can be confusing.**
  - Velocity has their own form of raw monitor data and history files, and even a form that mimics MONWRITE.
  - "VM Monitor" sounds like the "VM:product" often associated with CA products.
  - Performance Toolkit's history, trend, and summary files do not have the same detail.
- **Be specific when asking for data.**

Monwrite Summary

- **MONWRITE data is a comprehensive record of system activity**
- **It is invaluable in diagnosing performance concerns**
- **If you ask IBM for performance help, IBM will very likely ask you for MONWRITE data**
- **Practice collecting and transmitting MONWRITE data when you are not under duress**
- **Archive your MONWRITE data routinely so that you have a good record of your system's usual behavior**
- **Learn to use PERFKIT BATCH to generate reports, and get familiar with a few of the basic reports**

Performance Support

The typical lines of support:

1. Your FTSS (Field Technical Sales Support)
2. If FTSS he needs help, he will contact Region Designated Support (RDS)
3. If RDS needs help, they will contact Advanced Technical Support (ATS)
4. If ATS needs help, they will contact z/VM Development Lab

– **You may also have contract for Q&A help**

1. **z/VM is Doing Fine:** This study shows how to recognize a healthy z/VM system.
2. **Logical to Physical CPUs:** We'll look at measures of processor time in an LPAR environment and how the over commitment of logical to real can affect both LPAR and z/VM.
3. **Emergency Scan:** We get asked about "emergency scan" from time to time. This case study explains it and tells why seeing it is not always an "emergency" in the literal sense.
4. **Why Doesn't My System Page Faster?:** This system isn't broken, but the customer didn't understand its behavior. The case study illustrates why it's important to know the big picture when trying to discern meaning in measurement data.
5. **Undersized LPAR:** This system is generally short on storage, CPU, and paging. The case study illustrates how to detect it and how to fix it.
6. **PAV and MDC:** This customer called in with a performance PMR and we ended up taking an APAR. See how we put the finger on a CP bug using CP monitor data.
7. **Paging Difficulties:** This system was grossly under configured for paging. The case study illustrates what we examined and what changes we recommended. It also illustrates what happens when one relieves a constraint: namely, one usually bumps into another one.
8. **HiperSockets Performance:** HiperSockets is thought of as a super high speed connectivity feature. This case study looks at some aspects of that performance and a scenario where it might not be as fast as expected.
9. **The Grinch that Stole Performance:** This case study illustrates how system performance can change when hardware fails. CP Monitor showed where the problem was and pointed the way for a hardware fix.

Case Study: z/VM is Running Fine

Question from Customer

- **Linux on z/VM on 2086**
- **Java core and heap dumps**
- **Linux transaction rollback exceptions**
- **Linux slow response time**
- **Can you please take a look**
- **I have MONWRITE data for you**
  - … that's always tempting, so we looked

Basic Things to Check

- **Do we have enough CPU**
  - FCX225 SYSSUMLG
  - FCX126 LPAR
  - FCX114 USTAT, %CPU
- **Do we have enough storage**
  - FCX114 USTAT, %PGW
  - FCX113 UPAGE, XSTORE and DASD paging
- **Do we have enough SXS storage**
  - FCX264 SXSUTIL
- **Are we spending too much time in the Control Program**
  - FCX225 SYSSUMLG
- **Are we paging OK**
  - FCX109 DEVICE CPOWNED, paging I/O performance
  - FCX103 STORAGE, page blocking factors
  - FCX113 UPAGE, is XSTORE more active than DASD
- **Is I/O performance OK**
  - FCX108 DEVICE
  - FCX177 CACHEXT
- **Is networking performance OK**
  - Find OSD chpids via FCX161
  - FCX215 FCHANNEL
  - FCX240 VSWITCH

Do We Have Enough CPU: FCX126 and FCX225

```
FCX126  Run 2008/07/24 12:46:56         LPAR
                                        Logical Partition Activity

 Partition Nr.  Upid #Proc Weight Wait-C Cap %Load CPU %Busy %Ovhd %Susp %VMld %Logld Type
 LMRHA       1    ..     0            NO          0 ...   ...   ...   ...   ...    ... ..
 LMRPROD     2    01     2    500     NO  NO    ...   0  41.9  41.9    .2  41.7   41.8 ICF
                              500         NO          1  52.2  52.2    .2  52.0   52.1 ICF
```

<- This is us

Only one LPAR is using these two engines.

```
FCX225  Run 2008/07/24 12:46:56         SYSSUMLG
                                        System Performance Summary by Time

           <------- CPU --------> <Vec> <--Users--> <---I/O---> <Stg> <-Paging--> <Spl>
                 <--Ratio-->                         SSCH  DASD Users <-Rate/s-->
 Interval    Pct        Cap-  On-   Pct  Log-        +RSCH Resp    in PGIN+ Read+ Pages
 End Time   Busy   T/V  ture line  Busy   ged Activ    /s  msec Elist PGOUT Write    /s
 >>Mean>>   46.9  1.02 .9945  2.0  ....    22    12  30.1   3.7    .0  14.0    .2    .0
 12:55:38   31.0  1.02 .9946  2.0  ....    22    12  23.9   2.9    .0    .0    .0    .0
 12:56:38   41.3  1.02 .9961  2.0  ....    22    11  27.8   3.3    .0    .0    .0    .0
 12:57:38   47.9  1.01 .9966  2.0  ....    22    11  20.2   3.1    .0    .0    .0    .0
 12:58:38   51.7  1.01 .9968  2.0  ....    22    11  27.6   3.0    .0    .0    .0    .0
 12:59:38   61.5  1.01 .9968  2.0  ....    22    11  25.9   3.0    .0   1.5    .0    .0
 13:00:38   44.7  1.03 .9944  2.0  ....    22    11  26.8   3.0    .0    .0    .0    .0
 13:01:38   51.1  1.02 .9961  2.0  ....    22    11  38.9   2.5    .0    .0    .0    .0
 13:02:38   40.2  1.02 .9956  2.0  ....    22    11  27.7   2.4    .0    .0    .0    .0
 13:03:38   44.9  1.02 .9955  2.0  ....    22    13  32.9   3.2    .0    .0    .0    .0
```

We don’t see any particularly high percentages.

Also note T/V is nearly perfect.

CPU and Storage: FCX114 USTAT

```
FCX114  Run 2008/07/24 12:46:56         USTAT
                                        Wait State Analysis by User
From 2008/07/24 12:54:38                                                                          12
To   2008/07/24 14:04:38                                                                          CP
For   4200 Secs 01:10:00                Result of 12345 Run                                       z/
```

										<-SVM and->							<--%Time spent in-->				
Userid	%ACT	%RUN	%CPU	%LDG	%PGW	%IOW	%SIM	%TIW	%CFW	%TI	%EL	%DM	%IOA	%PGA	%LIM	%OTH	Q0	Q1	Q2	Q3	E0-3
>System<	22	21	4	0	0	0	0	71	0	0	0	2	1	0	0	0	98	0	0	0	0
LMRDB2P	99	29	4	0	0	0	0	65	0	0	0	0	2	0	0	0	100	0	0	0	0
LMRLN2P	99	8	4	0	0	0	0	86	0	0	0	0	1	0	0	0	100	0	0	0	0
LMRWASP	99	64	3	0	0	0	0	32	0	0	0	0	1	0	0	0	100	0	0	0	0
DTCVSW2	91	0	9	0	0	0	0	91	0	0	0	0	0	0	0	0	100	0	0	0	0
LMRLN1P	87	5	3	0	0	0	0	92	0	0	0	0	0	0	0	0	100	0	0	0	0
PERFSVM	13	0	0	0	0	0	0	11	0	5	0	60	23	0	0	0	40	0	0	0	0
TCPIP	4	0	1	0	0	0	0	99	0	0	0	0	0	0	0	0	100	0	0	0	0

Do We Have Enough Storage: FCX113 UPAGE

```
FCX113   Run 2008/07/24 12:46:56         UPAGE
                                         User Paging Activity and Storage Utilization
From 2008/07/24 12:54:38                                                                      12345
To   2008/07/24 14:04:38                                                                      CPU 2
For    4200 Secs 01:10:00                Result of 12345 Run                                  z/VM
```

	Data	<--------- Paging Activity/s ---------->							<----------------- Number of Pages ----------------->							
	Spaces	<Page Rate>		Page	<--Page Migration-->						<-Resident->		<--Locked-->			
Userid	Owned	Reads	Write	Steals	>2GB>	X>MS	MS>X	X>DS	WSS	Resrvd	R<2GB	R>2GB	L<2GB	L>2GB	XSTOR	DASD
>System<	.0	.0	.0	.5	.0	.2	.5	.0	117135	0	22167	94880	4	27	9374	39
BKRBKUP	.0	.0	.0	.0	.0	.0	.0	.0	83	0	0	65	0	0	399	0
BKRCATLG	.0	.0	.0	.0	.0	.0	.0	.0	85	0	0	66	0	0	412	0
DISKACNT	.0	.0	.0	.0	.0	.0	.0	.0	1227	0	0	0	0	0	1227	0
DTCVSW1	.0	.0	.0	.0	.0	.1	.1	.0	49	0	1	45	0	1	2614	0
DTCVSW2	.0	.0	.0	.0	.0	.0	.0	.0	273	0	10	297	8	26	2385	0
EREP	.0	.0	.0	.0	.0	.0	.0	.0	78	0	0	0	0	0	1231	0
LMRDB2P	.0	.0	.0	.0	.0	.4	4.7	.0	1027k	0	269342	758161	4	68	17870	0
LMRLN1P	.0	.0	.0	.0	.0	.0	3.0	.0	449333	0	116199	333205	0	71	73948	0
LMRLN2P	.0	.0	.2	.0	.0	.2	.8	.2	501237	0	73352	427956	4	68	20735	847
LMRWASP	.0	.0	.0	.0	.0	2.0	.2	.0	593939	0	28710	565308	48	27	74281	0

Is SXS OK: FCX264 SXSUTIL

```
FCX264  Run 2008/07/24 12:46:56         SXSUTIL
                                        System Execution Space Utilization
From 2008/07/24 12:54:38
To   2008/07/24 14:04:38
For    4200 Secs 01:10:00               Result of 12345 Run
```

<------------------------- System Execution Space Utilization (Pages) ------------------------->

			<--- Used							--->				
				<--- CP		--->	<--- Aliases			--->			Poten-	
		Avail-											tial	Conti-
Interval	Total	able		ID				<--Locked-->		No-	<Pages	Backed>	Steal	guous
End Time	Pages	Queues	Total	Mapped	Free	Other	Total	Total	CPLock	Owned	<2GB	>2GB	Queue	Pages
>>Mean>>	524287	513742	10545	3063	812	6485	185	28	0	0	7873	2714	186	1851
12:55:38	524287	513750	10537	3063	813	6477	184	29	0	0	7859	2719	185	1851
12:56:38	524287	513756	10531	3063	806	6478	184	29	0	0	7860	2719	185	1851
12:57:38	524287	513754	10533	3063	807	6479	184	29	0	0	7860	2719	185	1851
12:58:38	524287	513754	10533	3063	806	6480	184	29	0	0	7862	2719	185	1851

Are We Paging OK: FCX109 DEVICE CPOWNED

FCX109 Run 2008/07/24 12:46:56 DEVICE CPOWNED
Load and Performance of CP Owned Disks

Page / SPOOL Allocation Summary

PAGE slots available	6609240	SPOOL slots available	600840
PAGE slot utilization	0%	SPOOL slot utilization	15%
T-Disk cylinders avail.	....	DUMP slots available	0
T-Disk space utilization	...%	DUMP slot utilization	..%

< Device Descr. ->						<------------- Rate/s					------------->	User		Serv	MLOAD	Block	%Used
		Volume	Area	Area	Used	<--Page--->		<--Spool-->			SSCH	Inter	Queue	Time	Resp	Page	for
Addr	Devtyp	Serial	Type	Extent	%	P-Rds	P-Wrt	S-Rds	S-Wrt	Total	+RSCH	feres	Lngth	/Page	Time	Size	Alloc
0D15	3390	LPVPM7	PAGE	1-3338	0	.0	.0	...	...	.0	.0	0	0	13.3	13.3	...	0
0D16	3390	LPVPM8	PAGE	1-3338	0	.0	.0	...	...	.0	.0	0	0	13.3	13.3	...	0
0D17	3390	LPVPM9	PAGE	1-3338	0	.0	.0	...	...	.0	.0	0	0	.8	.8	15	100
0D18	3390	LPVPMA	PAGE	1-3338	0	.0	.0	...	...	.0	.0	0	0	11.9	11.9	14	25
0D19	3390	LPVPMB	PAGE	1-3338	0	.0	.0	...	...	.0	.0	0	0	5.9	5.9	12	100
0E05	3390	LPVPM1	PAGE	1-3338	0	.0	.0	...	...	.0	.0	0	0	5.3	5.3	16	100
0E06	3390	LPVPM2	PAGE	1-3338	0	.0	.0	...	...	.0	.0	0	0	2.1	2.1	19	100
0E07	3390	LPVPM3	PAGE	1-3338	0	.0	.0	...	...	.0	.0	0	0	8.3	8.3	12	50
0E08	3390	LPVPM4	PAGE	1-3338	0	.0	.0	...	...	.0	.0	0	0	4.9	4.9	16	100
0E09	3390	LPVPM5	PAGE	1-3338	0	.0	.0	...	...	.0	.0	0	0	13.3	13.3	...	0
0E0A	3390	LPVPM6	PAGE	1-3338	0	.0	.0	...	...	.0	.0	0	0	5.2	5.2	14	100

Time In The Control Program: FCX225 SYSSUMLG

- **We saw this report already**
- **T/V ~ 1.02**
- **T/V = (CP time + guest time) / guest time**
- **1.0 is a perfect T/V (CP=0)**

I/O Performance: FCX108 DEVICE

FCX108 Run 2008/07/24 12:46:56 DEVICE
General I/O Device Load and Performance

<-- Device Descr. -->			Mdisk	Pa-	<-Rate/s->		<------- Time (msec) ------->						Req.	<Percent>		SEEK	Recov	<-Throttle->	
Addr	Type	Label/ID	Links	ths	I/O	Avoid	Pend	Disc	Conn	Serv	Resp	CUWt	Qued	Busy	READ	Cyls	SSCH	Set/s	Dly/s
>> All	DASD	<<	....		.2	.0	.2	2.1	1.4	3.7	3.7	.0	.0	0	23	737	0	...	.0
0E21	3390	LPLAM1	1	2	4.6	.0	.2	4.8	5.7	10.7	10.7	.0	.0	5	0	1372	0	...	...
0E00	3390	LPVRM1 CP	50	2	.4	.0	.2	5.1	1.0	6.3	6.3	.0	.0	0	0	7	0	...	...
0E02	3390	LPVWM2 CP	43	2	.1	.2	.2	3.7	.8	4.7	4.7	.0	.0	0	0	46	0	...	...
0E22	3390	LPLQM1	1	2	1.5	.0	.2	3.2	1.0	4.4	4.4	.0	.0	1	0	1910	0	...	...
0E20	3390	LPLDM1	1	2	3.0	.6	.2	2.4	.9	3.5	3.5	.0	.0	1	0	884	0	...	...
0D13	3390	>LMRDB2P	0	2	.7	.0	.2	2.6	.5	3.3	3.3	.0	.0	0	83	393	0	...	...
0E23	3390	LPLQM2	1	2	2.7	.1	.2	2.3	.8	3.3	3.3	.0	.0	1	0	870	0	...	...
0E19	3390	LPLZM2	1	2	.0	.0	.2	2.5	.4	3.1	3.1	.0	.0	0	50	52	0	...	...
0F2C	3390	>LMRDB2P	0	2	.5	.0	.2	2.0	.8	3.0	3.0	.0	.0	0	3	803	0	...	...
0D12	3390	>LMRDB2P	0	2	.8	.0	.2	2.3	.4	2.9	2.9	.0	.0	0	61	490	0	...	...
0D0F	3390	>LMRDB2P	0	2	2.8	.0	.2	2.0	.6	2.8	2.8	.0	.0	1	63	108	0	...	...
0D11	3390	>LMRDB2P	0	2	1.2	.0	.2	2.1	.4	2.7	2.7	.0	.0	0	46	399	0	...	...
0D14	3390	>LMRDB2P	0	2	.5	.0	.2	2.0	.5	2.7	2.7	.0	.0	0	81	283	0	...	...
0E26	3390	>LMRDB2P	0	2	.5	.0	.2	1.6	.8	2.6	2.6	.0	.0	0	21	415	0	...	...
0D2D	3390	>LMRDB2P	0	2	1.3	.0	.2	.0	2.2	2.4	2.4	.0	.0	0	9	17	0	...	...
0E28	3390	>LMRDB2P	0	2	.2	.0	.2	1.4	.8	2.4	2.4	.0	.0	0	71	697	0	...	...
0D00	3390	RM1LPV	0	2	.0	.0	.2	.0	2.1	2.3	2.3	.0	.0	0	..	...	0	...	...
0D10	3390	>LMRDB2P	0	2	2.2	.0	.2	1.6	.5	2.3	2.3	.0	.0	1	17	420	0	...	...

0E21 LPLAM1 and 0E00 LPVRM1 a little slow, but I/O rates are so low… worth studying the workload.

Networking Performance: FCX161 and FCX215

```
FCX161  Run 2008/07/24 12:46:56         LCHANNEL
                                        Channel Load and Channel Busy Distribution
From 2008/07/24 12:54:38
To   2008/07/24 14:04:38
For   4200 Secs 01:10:00                Result of 12345 Run
________________________________________________________________________________________

 CHPID Chan-Group       <%Busy>  <----- Channel %Busy Distribution 12:54:38-14:04:38 ------>
 (Hex) Descr Qual Shrd  Cur Ave  0-10 11-20 21-30 31-40 41-50 51-60 61-70 71-80 81-90 91-100
  11   OSD    00 Yes     15  10   77    23     0     0     0     0     0     0     0     0
  00   OSD    00 Yes      0   0  100     0     0     0     0     0     0     0     0     0
  01   OSD    00 Yes      0   0  100     0     0     0     0     0     0     0     0     0
  10   OSD    00 Yes      0   0  100     0     0     0     0     0     0     0     0     0
```

```
FCX215  Run 2008/07/24 12:46:56         FCHANNEL
                                        FICON Channel Load

              <------ FICON Channel Utilization % ------->
              <-- Total for System --> <-Own Partition--> <--Total Data-->
 Channel        Bus  Work <Data Units>   Work <Data Units> <Transfer Rate->
 Path         Cycle Units Write    Read Units Write    Read <- (Bytes/s) -->
 ID       Shrd T_BCy T_WUn T_DUW   T_DUR L_WUn L_DUW   L_DUR Write/s    Read/s
 11       Yes      0    10     0       0    10     0       0  513697    127155     < 1 MB/sec altogether
 50       Yes      0     0     0       0     0     0       0  259435     25383
 40       Yes      0     0     0       0     0     0       0  250804     25338
```

Networking Performance: FCX240 VSWITCH

```
FCX240  Run 2008/07/24 12:46:56         VSWITCH
                                        VSWITCH Activity
From 2008/07/24 12:54:38
To   2008/07/24 14:04:38
For   4200 Secs 01:10:00                Result of 12345 Run
______________________________________________________________________________________________________________

 ____ .         .              .       .      .      .      .      .      .      .      .     .      .     .
                         Q Time  <--- Outbound/s ---> <--- Inbound/s ----> <--- Signals ---> < Intrpts >
                         S  Out   Bytes <--Packets--> Bytes <--Packets--> <-- issued/s --->
 Addr      Name  Controlr V  Sec  T_Byte T_Pack T_Disc R_Byte R_Pack R_Disc Write  Read  Sync  Rcv/s Pro/s
 >>       System       << 8  300  502784  463.6     .0 116135  351.0     .0 165.0    .0    .0  244.4 238.8
 02F2 ........  DTCVSW2   8  300  502784  463.6     .0 116135  351.0     .0 165.0    .0    .0  244.4 238.8
```

Summary

- There doesn’t seem to be anything wrong with this z/VM
- It’s worth looking inside the Linux guests
- The questioner directed to Linux support

Case Study: Logical to Physical

Logical to Physical Processor Ratios

- **As the number of partitions and their size increases, questions continue to arise as to how to configure z/VM systems**
- **This case study illustrates some of the factors and information that can be examined**
- **More complex scenarios would include mixed engine environments**

Configuration

- **2097-401**
- **18 Physical Processors**
  - 1 CP
  - 17 IFLs
    - 3 Dedicated
- **11 Partitions**
  - 5 Active Shared: 3+3+13+13+2 = 34 logicals IFLs
- **Ratio of Non-dedicated Logical to Physical CPUs: 2.4**

Partition Configs

<Partition->

Name	Nr.	Upid	#Proc	Weight	Wait-C	Cap
DRLPAR	1	..	0	0	NO	NO
A5Q1	2	..	0	0	NO	NO
A5Q2	3	..	0	0	NO	NO
A5Q3	4	..	0	0	NO	NO
A5Q4	5	..	0	0	NO	NO
A5T	6	15	2	4	NO	NO
A5X	7	14	3	DED	YES	NO
LPAR1	8	01	3	2	NO	NO
LPAR2	9	02	13	46	NO	NO
LPAR3	10	03	3	2	NO	NO
LPAR4	11	04	13	46	NO	NO

- 14 undedicated IFLs
- LPAR2 weight equates to 6.44 IFLs
  - 6.44 << 13

Looking at Processor Time – CPU FCX100

PROC	TYPE	%CPU	%CP	%EMU	%WT	%SYS	%SP	%SIC	%LOGLD
P00	IFL	46	6	40	54	4	2	77	65
P12	IFL	46	5	41	54	3	3	76	65
P11	IFL	46	5	41	54	3	3	76	65
P01	IFL	46	5	41	54	3	3	76	65
P02	IFL	46	5	41	54	3	2	77	65
P03	IFL	46	5	40	54	4	2	76	65
P04	IFL	46	5	41	54	3	3	76	65
P05	IFL	46	5	41	54	3	2	76	65
P06	IFL	46	5	40	54	4	2	76	65
P07	IFL	46	5	41	54	3	3	77	65
P08	IFL	46	5	41	54	3	3	76	65
P09	IFL	46	5	41	54	3	3	76	65
P10	IFL	46	5	41	54	3	3	77	65

%CPU: total cycles consumed in z/VM.

%CP: total cycles in z/VM control program

%EMU: total cycles inside z/VM guests

%SYS: total cycles in CP not associated with a guest (subset of %CP)

%SP: wall clock time in formal spin locks

%LOGLD: pct busy time of time z/VM timers are running

Looking at Processor Time – LPAR FCX126

%Load	CPU	%Busy	%Ovhd	%Susp	%VMld	%Logld	Type
34.0	0	47.2	1.4	29.8	45.6	64.9	IFL
	1	47.1	1.3	29.8	45.6	64.9	IFL
	2	47.1	1.3	29.8	45.5	64.8	IFL
	3	47.2	1.4	29.9	45.6	64.9	IFL
	4	47.1	1.3	29.8	45.5	64.9	IFL
	5	47.1	1.4	29.9	45.5	64.8	IFL
	6	47.1	1.3	29.8	45.5	64.8	IFL
	7	47.1	1.2	29.8	45.6	64.9	IFL
	8	47.1	1.2	29.8	45.7	65.0	IFL
	9	47.1	1.3	29.8	45.6	65.0	IFL
	10	47.1	1.2	29.8	45.7	65.0	IFL
	11	47.0	1.2	29.7	45.6	64.8	IFL
	12	47.1	1.2	29.8	45.6	65.0	IFL

%Busy: Total CPU

%Ovhd: LPAR Mgmt Time for LCPU

%VMld: %CPU from FCX100

%Susp: 100% - total of z/VM Timers

%Logld: %Logld from FCX100

LPAR Mgmt Time (Overhead)

- **%Ovhd on FCX126 is LPAR management time associated with a given partition's LCPU**
- **General LPAR overhead also reported, not associated with a given partition.**
- **Mgmt time can be influenced by activity and requests from within the partitions**

LPAR Suspend Time

- **An approximation of when z/VM partition is removed from running for either:**
  - Being capped
  - Running other partitions
  - z/VM giving up time via diagnoses while waiting on locks
- **Another side effect of high suspend time**
  - z/VM User State Sampling could be skewed

Reconfigure the Logical Processor Counts

Phys	Ded.	LCPUs	Log:Phy	%LPBUSY	%LPOVHD	%NCOVHD	%BUSY	%SUSP
17	3	34	2.4	1249	41	26	1316	29.8%
17	3	24	1.7	851	18	18	887	3.5%

FCX265 LOCKLOG

Interval End Time	LockName	Before Locks /sec	Before Average usec	Before Pct Spin	After Locks /sec	After Average usec	After Pct Spin
>>Mean>>	SRMATDLK	563.8	71.78	.311	474.8	29.76	.157
>>Mean>>	RSAAVCLK	.0	458.6	.000	.0	1.306	.000
>>Mean>>	RSA2GCLK	.0	187.3	.000	.1	6.128	.000
>>Mean>>	BUTDLKEY	.0	145.0	.000	.0	.243	.000
>>Mean>>	HCPTMFLK	.0	.000	.000	.0	.000	.000
>>Mean>>	RSA2GLCK	6.6	63.55	.003	16.8	8.880	.002
>>Mean>>	HCPRCCSL	.0	.000	.000	.0	.000	.000
>>Mean>>	RSASXQLK	2.9	61.99	.001	3.1	11.17	.000
>>Mean>>	HCPPGDML	.5	174.9	.001	.7	26.71	.000
>>Mean>>	NSUIMGLK	.0	.000	.000	.0	.000	.000
>>Mean>>	FSDVMLK	4.3	39.73	.001	6.8	14.62	.001
>>Mean>>	HCPPGDPL	1.5	190.9	.002	1.7	81.73	.002
>>Mean>>	SRMALOCK	.0	.000	.000	.0	.000	.000
>>Mean>>	HCPTRQLK	434.5	51.29	.171	306.0	3.439	.012
>>Mean>>	SRMSLOCK	3062	89.98	2.119	2193	20.15	.491

Summary

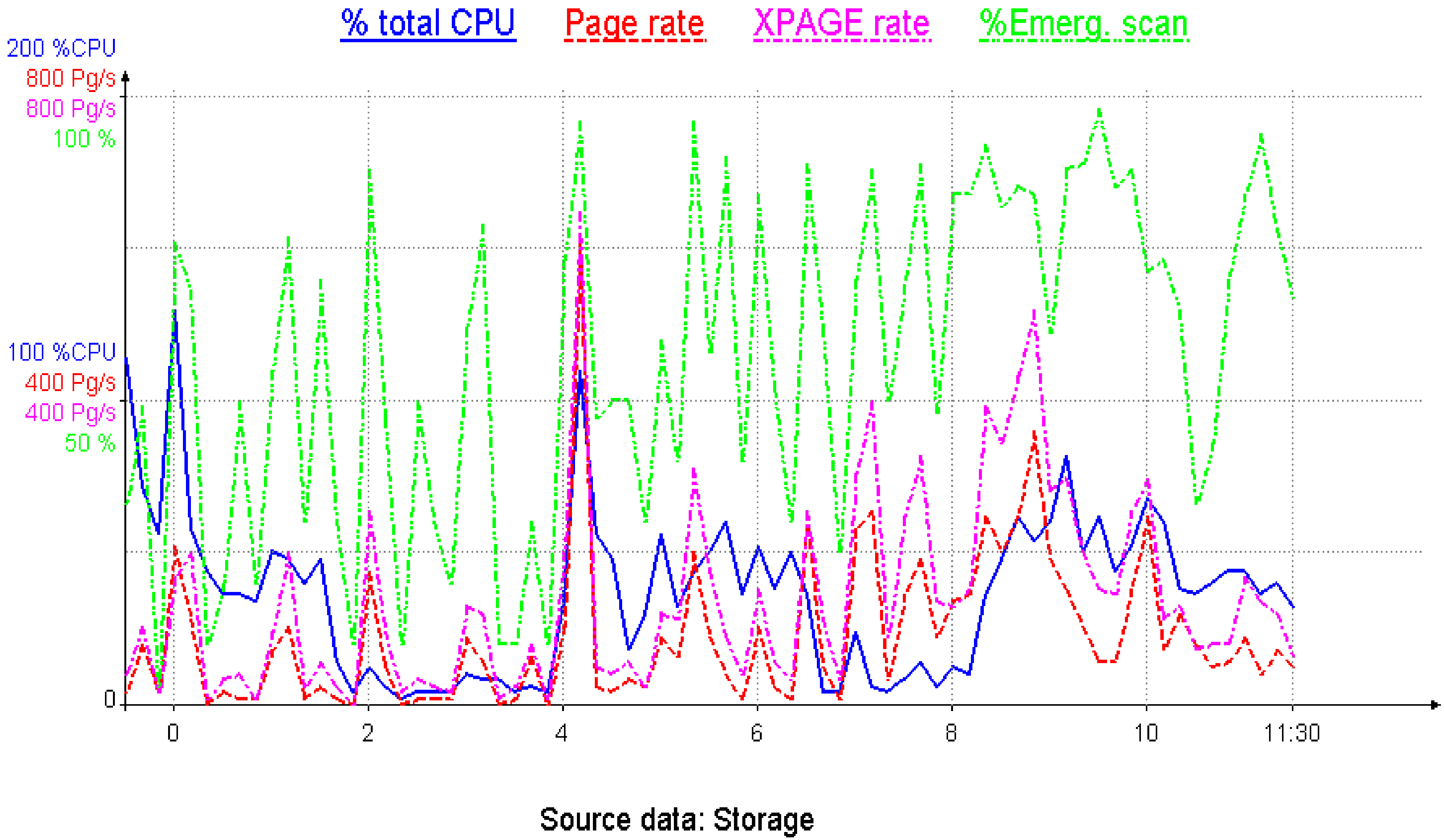
- **Various rules of thumbs for Logical to Physical**
- **Starting points**
- **Look at data**
- **Suspend time is helpful but has multiple causes**

Case Study: Emergency Scan

Question from Customer

- **My system seems to have a high percentage of emergency scan**
- **Application performance doesn't seem bothered**
- **Should I be worried?**

Graph from Customer



Finding a Memory Frame

- **Pass 1: tries 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:**
  - Avoids shared address spaces
  - Will take from dispatch-list users down to their SET RESERVE
- **Emergency scan: anything we can find**
- **Bit of a misnomer**
- **Want to know more? Read the prologue of HCPALD**

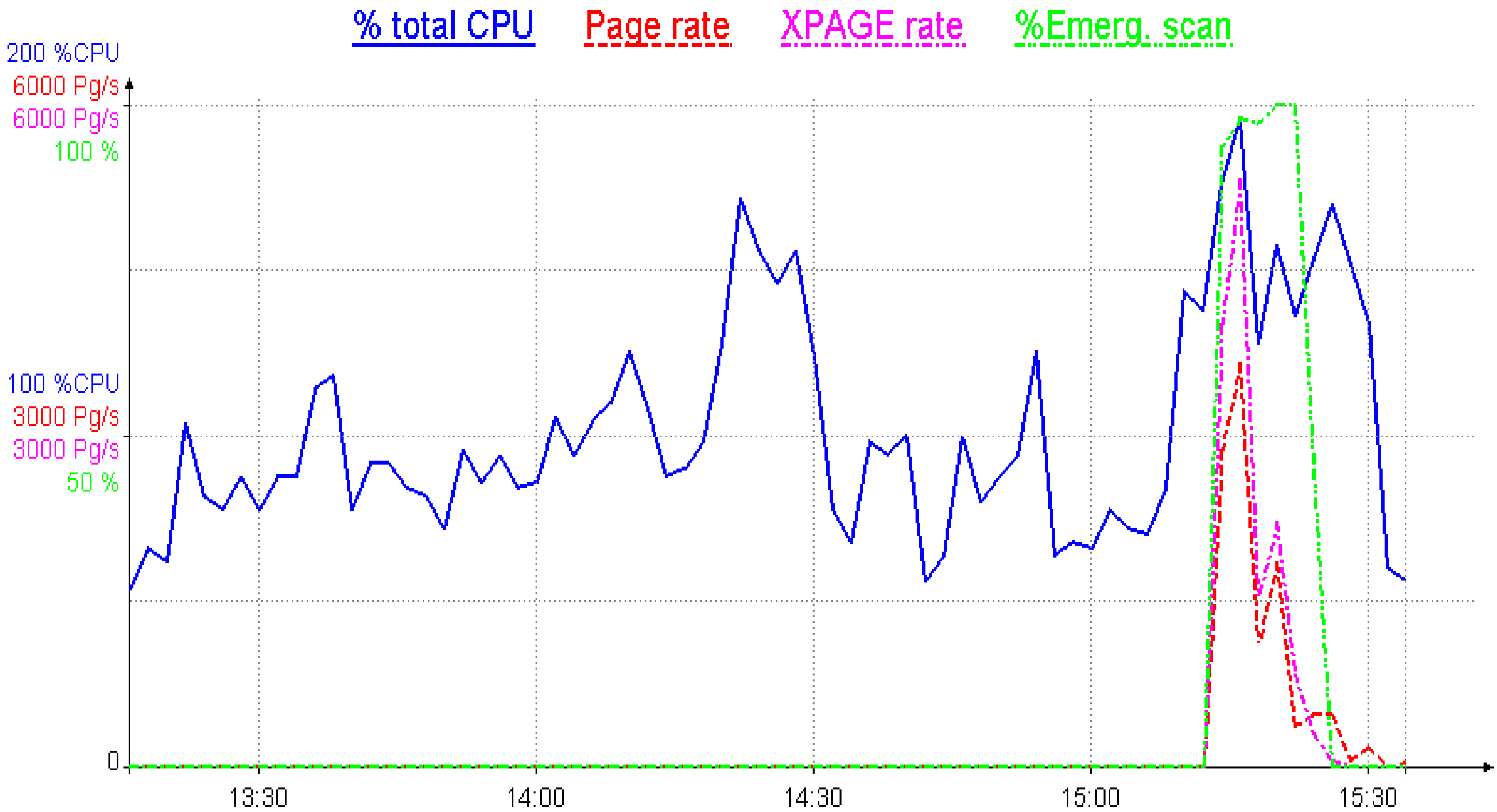
Is Emergency Scan A Sign of Duress?

- **Not alone, no.**
- **Evaluate some other things too.**
  - Are free frame lists routinely zero? (FCX254 AVAILLOG)
  - Is system T/V high? (FCX225 SYSSUMLG)
  - Are we spinning significantly on any locks? (FCX265 LOCKLOG)
  - Does USTAT show users in page wait? (FCX114 USTAT)
  - Is an eligible list forming? (FCX100 CPU)
  - Are MDC hits satisfactory? (FCX103 STORAGE, FCX108 DEVICE)
  - Do you have plenty of SXS space? (FCX264 SXSUTIL)
  - Is DASD page rate > XSTORE page rate? (FCX143 PAGELOG)
  - Are there queues at paging DASD? (FCX109 DEVICE CPOWNED)
  - Is paging MLOAD OK? (FCX109 DEVICE CPOWNED)
  - Is paging blocking factor OK? (FCX103 STORAGE)
  - Is paging space too full? (FCX109 DEVICE CPOWNED)
  - Does application performance seem OK? (you tell me)

Storage Management and VDISKs

- **Referenced VDISK pages are avoided in Pass 1**
- **This customer realized he had a lot of VDISK for Linux swap space**
- **If those VDISK pages are used often, they will tend to stick and be ejectable by only emergency scan**
- **Hmm, customer tried an experiment…**

Customer Removed His VDISKs



Source data: Storage

Summary

- **Try to look at system as a whole**
- **Whether applications seem debilitated is the best indicator of whether the system is suffering**

Case Study: Why Doesn't My System Page Faster

Question from Customer

- **“z/VM pages extremely slowly”**
- **Inactive Linux guest is paged in at only about 1000 pages per second**
- **12 3390-9 paging packs, 2 LCUs, with 6 FICON chpids**
- **During busy periods of running 30 guests, he sees 6000 pages per second**
- **Customer thinks this single guest should page in much faster**
- **He devised a 300 MB thrasher that reproduced the behavior**
- **He sent us lots of charts and graphs**
- **We asked for MONWRITE data**

Customer Sent MONWRITE Data

- **User LIN102 is running the 300 MB thrasher**
- **It touched 64,000 pages in 61 seconds (1049/sec)**
- **The interesting time period is 15:12:30 to 15:13:20**
- **He used MONITOR SAMPLE 10 SEC (brilliant!)**
- **Ran his data through PERFKIT BATCH**
- **Looked at some interesting reports for that period**

User Configuration

```
FCX226 UCONF – user configuration report
                              <-------- Share -------->                    No    Stor
             Virt  Mach Stor                      %     Max. Max.   Max.    QUICK MDC   Size Reserved
Userid   SVM  CPUs  Mode Mode  Relative Absolute Value/% Share Limit  DSP   Fair  (MB)     Pages

LIN102   No      1  EME  V=V       100      ...     ... ..    ..     No    No    768M         0
```

Virtual uniprocessor with one process (thread) running the memory initializer.

Implications:

1. Memory initializer will touch pages serially.
2. Page faults will happen serially.

Activity on Paging DASD

```
FCX108 INTERIM DEVICE 15:12:40 to 15:12:51
<-- Device Descr. -->  Mdisk Pa- <-Rate/s-> <------- Time (msec) -------> Req. <Percent>  SEEK
Addr Type   Label/ID   Links ths  I/O Avoid Pend Disc Conn Serv Resp CUWt Qued Busy READ  Cyls
9F11 3390   VSPPG8 CP      0   6 25.5    .0   .2   .0  3.9  4.1  4.1   .0   .0   10    0   131
A062 3390   VSPPG5 CP      0   6 25.0    .0   .2   .0  3.3  3.5  3.5   .0   .0    9  100  2580
A02D 3390   VSPPG3 CP      0   6 27.4    .0   .2   .1  3.1  3.4  3.4   .0   .0    9  100   505
9F41 3390   VSPPGB CP      0   6 29.8    .0   .2   .0  3.0  3.2  3.2   .0   .0   10  100   753
A03D 3390   VSPPG2 CP      0   6 35.4    .0   .2   .0  2.9  3.1  3.1   .0   .0   11  100   832
9F01 3390   VSPPG7 CP      0   6 38.0    .0   .2   .0  2.8  3.0  3.0   .0   .0   11    0  1174
9F5A 3390   VSAPAG CP      0   6 40.9    .0   .2   .0  2.7  2.9  2.9   .0   .0   12  100    33
A05D 3390   VSPPG6 CP      0   6 38.9    .0   .2   .0  2.7  2.9  2.9   .0   .0   11  100  1446
A01B 3390   VSPPG4 CP      0   6 32.3    .0   .2   .0  2.5  2.7  2.7   .0   .0    9  100  2670
9F21 3390   VSPPG9 CP      0   6 45.6    .0   .2   .0  2.2  2.4  2.4   .0   .0   11    0     0
9F51 3390   VSPPGC CP      0   6 48.5    .0   .2   .0  2.2  2.4  2.4   .0   .0   12  100  2971
                        TOTAL   387.3                                              115
```

Eleven paging devices:

1. Each in the neighborhood of 10% busy, all reads
2. Each showing response time of about 3.1 msec

Who Else is Doing Paging Activity?

```
FCX113 UPAGE
           Data  <--------- Paging Activity/s ---------->
         Spaces  <Page Rate>   Page  <--Page Migration-->  Nr of
Userid    Owned  Reads Write Steals  >2GB> X>MS MS>X X>DS  Users
>System<     .0    2.3   1.6    7.2     .0  4.6  6.3  1.7     44

User Data:
LIN102       .0   75.8    .0     .0     .0 35.2  4.5   .0
```

```
44 * 2.3 = 101 pages read/sec altogether.
LIN102 accounts for 76% of this, 76 pages read/sec.
```

What We Know So Far

- **Each paging I/O takes about 3.1 msec**
- **One single-threaded application in one guest is responsible for most of the paging I/Os**
- **This means we should see about (1000/3.1) = 323 SSCH ops for paging per second**
- **We actually saw 387/sec, but remember other guests are paging slightly**
- **Because one single-threaded guest is responsible for most of the paging I/O, the paging device utilizations should add to about 100%**
- **They actually add to 115%, but remember other guests are paging slightly**

What Did We Tell The Customer?

- **LIN102's page reading speed is limited by its single-threaded nature and the speed of the paging DASD.**
- **Your system pages at higher rates when 30 guests are running because with multiple guests you can generate concurrent page reads. You have multiple paging exposures too and so you can parallelize paging I/O.**
- **Your 11 paging exposures look like they could support (1100%/115%) = 9.5 such thrashers concurrently.**
- **But from FCX109 DEVICE CPOWNED, we see your page space is about 15% full so I wouldn't try more than four of them at once.**

Something Interesting About LIN102

```
FCX163  Run 2008/05/19 12:18:57         UPAGELOG LIN102
                                        User Paging Activit

From 2008/05/15 15:10:10
To   2008/05/15 15:15:50
For    340 Secs 00:05:40
```

```
 Page Data Log for User LIN102

            Data  <--------- Paging Activity/s ---------->
 Interval Spaces  <Page Rate>   Page  <--Page Migration-->
 End Time  Owned  Reads Write Steals  >2GB> X>MS MS>X X>DS
 15:12:40      0    437    .0     .0     .0  116  4.2   .0
 15:12:50      0    534    .0     .0     .0  167   .6   .0
 15:13:00      0    440    .0     .0     .0  342 37.7   .0
 15:13:10      0    313    .0     .0     .0  288   .2   .0
 15:13:20      0    473    .0     .0     .0  246  3.4   .0
 Avg                439                      232
```

Thrasher touched 1049/sec altogether.

1. 439/sec read from disk
2. 232/sec read from XSTORE
3. 378/sec resident

A Note on User States

```
FCX164  Run 2008/05/19 12:18:57         USTATLOG LIN102
                                        User Wait States
From 2008/05/15 15:10:10
To   2008/05/15 15:15:50
For    340 Secs 00:05:40
________________________________________________________

 Wait State Data Log for User LIN102

 Interval
 End Time   %ACT  %RUN %CPU %LDG %PGW %IOW %SIM %TIW %CF
 15:12:30    100     0    0    0  100    0    0    0
 15:12:40    100     0    0    0  100    0    0    0
 15:12:50    100     0    0    0  100    0    0    0
 15:13:00    100     0    0    0  100    0    0    0
 15:13:10    100     0    0    0  100    0    0    0
 15:13:20    100     0    0    0  100    0    0    0
```

Customer said this means LIN102 “is in page wait 100% of the time”.
This is not correct.
It means 100% of the times we looked, LIN102 was in a page wait.
We looked only once every two seconds (FCX149 MONSET).
After all, LIN102 was also *touching* pages.

Summary

- **Customer became absorbed with z/VM measurements but forgot what his workload does**
- **Knowledge of the workload's behavior is crucial in understanding why the system performs the way it does**
- **Customer was very good at collecting raw monitor data appropriate for the diagnosis task at hand**
- **Fun question that was not too difficult to answer**

Case Study: Undersized LPAR

Question from Customer

- **Why do my workloads run so slowly?**

Customer's Configuration

System model	2094-606
Processors	2 IFL
SYSGEN storage	19968 (19.5 GB)
XSTORE	4096 (4 GB)
Page slots	24641k (94 GB)
Paging devices	25
Logged-on virtual	68 GB

What We Saw in Customer's Data

- **Long queues and long response times for paging devices**
- **Possibility for processor contention during peak hours**

BEFORE: Customer's FCX109 DEVICE CPOWNED

```
FCX109   Run 2008/05/02 12:13:56         DEVICE   CPOWNED
                                         Load and Performance of CP Owned Disks
From 2008/04/30 09:50:08                                                                     ……
To   2008/04/30 23:53:33                                                                     CPU 209
For  50604 Secs 14:03:24                                                                     z/VM
```

Page / SPOOL Allocation Summary

PAGE slots available	24641k	SPOOL slots available	600840
PAGE slot utilization	37%	SPOOL slot utilization	31%
T-Disk cylinders avail.	....	DUMP slots available	0
T-Disk space utilization	...%	DUMP slot utilization	..%

< Device Descr. ->						<------------- Rate/s				------------>		User		Serv	MLOAD	Block	%Used
		Volume	Area	Area	Used	<--Page--->		<--Spool-->			SSCH	Inter	Queue	Time	Resp	Page	for
Addr	Devtyp	Serial	Type	Extent	%	P-Rds	P-Wrt	S-Rds	S-Wrt	Total	+RSCH	feres	Lngth	/Page	Time	Size	Alloc
7904	3390	520PG7	PAGE	0-3338	57	21.7	16.9	...	...	38.6	17.7	1	3.24	6.4	29.0	3	78
790D	3390	520SPL	?????	....-....		...	...	...	...	...	...	...	...	...	...	...	...
			SPOOL	1-3338	31	.0	.0	.0	.0	.0	.0	1	0	3.7	3.7	...	100
791B	3390	520PG4	PAGE	0-3338	59	23.0	18.0	...	...	41.0	19.8	1	2.10	5.7	12.9	2	83
7921	3390	52PG14	PAGE	0-3338	59	22.7	17.7	...	...	40.4	19.3	1	3.03	6.0	28.4	2	82
7922	3390	52PG15	PAGE	0-3338	60	23.1	18.0	...	...	41.1	19.8	1	3.77	5.8	27.6	2	84
792C	3390	520PGA	PAGE	803060	22	25.7	19.6	...	...	45.4	18.6	1	2.93	5.2	15.7	3	90
792D	3390	520PGC	PAGE	803060	22	25.5	19.7	...	...	45.2	18.4	1	2.38	4.9	15.5	3	90
7934	3390	520PG8	PAGE	803060	22	25.5	19.6	...	...	45.1	18.4	1	2.78	5.0	17.1	3	89
79FC	3390	52PG10	PAGE	0-3338	56	21.5	16.8	...	...	38.3	17.6	1	3.29	6.6	26.5	3	78

BEFORE: Customer's FCX225 SYSSUMLG

FCX225 Run 2008/05/02 12:13:56 SYSSUMLG

System Performance Summary by Time

From 2008/04/30 09:50:08 VMLNX1

To 2008/04/30 23:53:33 CPU 2094-

For 50604 Secs 14:03:24 z/VM V.

	<------- CPU	-------->			<Vec>	<--Users-->		<---I/O--->		<Stg>	<-Paging-->		<Spl>	<------- UP+MP Transactions --				
		<--Ratio-->						SSCH	DASD	Users	<-Rate/s-->			<-Response Time->			<-Transactio	
Interval End Time	Pct Busy	T/V	Cap- ture	On- line	Pct Busy	Log- ged	Activ	+RSCH /s	Resp msec	in Elist	PGIN+ PGOUT	Read+ Write	Pages /s	Triv	Non- Triv	Quick Disp	Triv	Non- Triv
>>Mean>>	46.7	1.25	.8177	2.0	....	31	26	566.8	11.8	.0	1680	1046	.0	.947	47.16	1.302	1.15	.45
10:00:08	71.3	1.45	.7064	2.0	....	34	30	1071	14.0	.0	3215	2094	.0	1.057	50.79	1.558	.91	.51
10:10:08	68.0	1.38	.7363	2.0	....	34	30	968.9	13.4	.0	2531	1888	.2	.754	48.21	1.647	1.27	.56
10:20:08	71.6	1.25	.8138	2.0	....	30	26	1034	14.3	.0	2235	1919	.1	.966	25.24	1.382	1.09	.44
10:30:08	37.4	1.17	.8732	2.0	....	30	25	418.9	7.7	.0	957.7	420.8	.1	.902	3.662	1.379	1.09	.49
10:40:08	28.6	1.28	.7995	2.0	....	30	25	332.1	7.8	.0	1186	504.1	.0	.824	11.15	.996	1.28	.41
10:50:08	28.0	1.25	.8183	2.0	....	30	25	328.1	8.1	.0	1023	548.3	.0	.982	3.409	1.261	1.31	.35
11:00:08	32.6	1.21	.8433	2.0	....	30	27	439.1	9.3	.0	1381	794.2	.0	.931	19.85	1.360	1.28	.34
11:10:08	31.6	1.22	.8385	2.0	....	30	24	400.4	8.8	.0	1473	716.6	.1	.856	5.452	1.460	1.37	.40
11:20:08	39.4	1.26	.8079	2.0	....	30	25	571.9	11.2	.0	1761	1092	.0	.710	9.936	1.313	1.33	.38
11:30:08	37.0	1.18	.8603	2.0	....	30	24	405.5	9.2	.0	1324	687.0	.1	.766	113.9	1.084	1.34	.54
11:40:08	54.7	1.16	.8757	2.0	....	30	25	430.4	9.5	.0	1395	774.0	.0	.849	6.610	.907	1.19	.46
11:50:08	57.1	1.22	.8318	2.0	....	30	24	626.6	11.5	.0	2343	1202	.0	.868	13.42	1.311	1.23	.45
12:00:08	47.7	1.37	.7433	2.0	....	30	26	662.0	12.2	.0	2185	1238	.0	.836	481.5	.948	1.28	.39

BEFORE: Customer's FCX126 LPAR

```
FCX126  Run 2008/05/02 12:13:56         LPAR
                                        Logical Partition Activity
From 2008/04/30 09:50:08
To   2008/04/30 23:53:33
For  50604 Secs 14:03:24
```

LPAR Data, Collected in Partition VMLNX1

```
Processor type and model    : 2094-606
Nr. of configured partitions:       7
Nr. of physical processors  :       9
Dispatch interval (msec)    : dynamic
```

Partition	Nr.	Upid	#Proc	Weight	Wait-C	Cap	%Load	CPU	%Busy	%Ovhd	%Susp	%VMld	%Logld	Type
CF01A	1	01	1	900	NO	NO	...	0	98.7	98.7	...	...	...	ICF
CF01B	2	02	1	100	NO	NO	...	0	.7	.7	...	...	...	ICF
… CPs removed for readability …														
VMLNX1	6	13	2	500	NO	NO	...	0	47.2	47.2	1.9	46.7	47.6	IFL
				500		NO		1	47.0	47.0	1.9	46.6	47.5	IFL
VMLNX3	7	14	2	500	NO	NO	...	0	1.4	1.4	...	...	...	IFL
				500		NO		1	2.0	2.0	...	...	...	IFL

```
General LPAR mgmt overhead                   .3
Overall physical load                      51.5
```

If VMLNX3 ever gets hungry, there is going to be a CPU constraint.

What We Recommended The Customer Change

- **More central storage**
  - Calculated new amount based on:
    - User pages resident on DASD (“before” FCX113 UPAGE report)
    - Understanding that memory comes in 32 GB increments

- **More and faster paging devices**
  - One would think if we were adding storage to reduce paging, we wouldn’t have to tinker with the paging configuration too
  - However, we knew the customer wanted to grow his logged-on virtual
  - Also, customer reconfigured his [non-IBM] DASD to improve I/O response time

- **1 additional processor**
  - Seems sufficient based on old FCX225 SYSSUMLG report

Customer's New Configuration

	Old	New	Change
System model	2094-606	2094-705	-
Processors	2	3	+50%
SYSGEN storage	19968 (19.5 GB)	52736 (52 GB)	+267%
XSTORE	4096 (4 GB)	4096 (4 GB)	0
Page slots	24641k (94 GB)	72121k (275 GB)	+293%
Paging devices	25	40	+160%
Logged-on virtual	68 GB	87 GB	+28%

Measurement After The Change

- **60% reduction in user pages on DASD (FCX113 UPAGE)**
- **No queuing for paging devices (FCX109 DEVICE CPOWNED)**
- **No more user page waits (FCX114 USTAT)**
- **No processor constraint during the peak hour (FCX225 SYSSUMLG)**

AFTER: Customer's FCX109 DEVICE CPOWNED

```
FCX109  Run 2008/06/16 13:51:28         DEVICE   CPOWNED
                                        Load and Performance of CP Owned Disks
From 2008/06/13 11:35:25                                                                       SYSTEM
To   2008/06/13 15:35:25                                                                       CPU 20
For  14400 Secs 04:00:00                "This is a performance report for SYSTEM XYZ"          z/VM
______________________________________________________________________________________________________

 Page / SPOOL Allocation Summary
 PAGE slots available       72121k          SPOOL slots available       600840
 PAGE slot utilization          4%          SPOOL slot utilization         54%
 T-Disk cylinders avail.   .......          DUMP slots available             0
 T-Disk space utilization      ...%         DUMP slot utilization          ..%


 ____ .             .                         .     .     .     .     .      .     .     .     .     .     .     .
 < Device Descr. ->                         <------------- Rate/s -------------> User        Serv MLOAD Block %Used
             Volume Area    Area      Used  <--Page---> <--Spool-->       SSCH Inter Queue  Time  Resp  Page   for
 Addr Devtyp Serial Type    Extent       %  P-Rds P-Wrt S-Rds S-Wrt Total +RSCH feres Lngth /Page  Time  Size Alloc
 790D 3390   520SPL SPOOL      1-3338   54     .0    .0   1.5   1.6   3.0    3.1     1     0   2.1   2.1   ...   100
 7957 3390   520PAG PAGE       803060    4     .1    .0   ...   ...    .1     .1     1     0   3.0   3.0   ...   ...
 7958 3390   520PG3 PAGE       803060    4     .1    .0   ...   ...    .1     .0     1     0   3.2   3.2   ...   ...
 7959 3390   520PG5 PAGE       803060    4     .1    .0   ...   ...    .1     .0     1     0   4.2   4.2   ...   ...
 795A 3390   520PG7 PAGE       803060    4     .1    .0   ...   ...    .1     .0     1     0   3.1   3.1   ...   ...
 795B 3390   520PG9 PAGE       803060    4     .1    .0   ...   ...    .1     .0     1     0   3.4   3.4   ...   ...
 795C 3390   520PGB PAGE       803060    4     .1    .0   ...   ...    .1     .0     1     0   3.5   3.5   ...   ...
 795D 3390   520PGD PAGE       803060    4     .1    .0   ...   ...    .1     .0     1     0   4.1   4.1   ...   ...
 795E 3390   520PGF PAGE       803060    4     .1    .0   ...   ...    .1     .0     1     0   4.3   4.3   ...   ...
 795F 3390   52PG11 PAGE       803060    4     .1    .0   ...   ...    .1     .0     1     0   3.7   3.7   ...   ...
 7960 3390   52PG13 PAGE       803060    4     .1    .0   ...   ...    .1     .1     1     0   3.3   3.3   ...   ...
```

AFTER: Customer's FCX225 SYSSUMLG

```
FCX225   Run 2008/06/16 13:51:28         SYSSUMLG
                                         System Performance Summary by Time
From 2008/06/13 11:35:25                                                                      SYSTEMID
To   2008/06/13 15:35:25                                                                      CPU 2094-7
For  14400 Secs 04:00:00                 "This is a performance report for SYSTEM XYZ"        z/VM   V.5
_____________________________________________________________________________________________________

           <------- CPU --------> <Vec> <--Users--> <---I/O---> <Stg> <-Paging--> <Spl> <------- UP+MP Transactions ---
                <--Ratio-->                              SSCH  DASD Users <-Rate/s-->       <-Response Time-> <-Transaction
 Interval   Pct        Cap-  On-   Pct  Log-            +RSCH  Resp    in PGIN+ Read+ Pages        Non- Quick          Non-
 End Time  Busy   T/V  ture line  Busy   ged Activ         /s  msec Elist PGOUT Write    /s  Triv  Triv  Disp  Triv    Triv
 >>Mean>>  14.1  1.06 .9817  3.0  ....    37    31 113.6    1.2    .0    5.7   4.2   3.0  .781 2.788  .959  3.84    1.80
 11:45:25  14.0  1.05 .9836  3.0  ....    37    31 112.0    1.2    .0    1.8   2.3    .0  .837 2.980  .963  3.78    1.71
 11:55:25  14.5  1.05 .9838  3.0  ....    37    31 104.5    1.3    .0    1.2   3.7    .0  .821 2.878 1.018  3.88    1.71
 12:05:25  16.1  1.05 .9853  3.0  ....    37    31 114.9    1.5    .0    2.6  12.9    .0  .782 2.807 1.040  3.91    1.76
 12:15:25  14.2  1.05 .9835  3.0  ....    37    31 106.7    1.3    .0    1.8   4.3    .0  .789 2.867  .975  3.71    1.80
 12:25:25  13.2  1.06 .9822  3.0  ....    37    31 112.1    1.2    .0    1.9   4.9    .0  .852 3.054  .953  3.71    1.64
 12:35:25  13.6  1.05 .9830  3.0  ....    37    31 105.7    1.3    .0    3.1   7.8    .0  .817 2.687  .887  3.99    1.77
 12:45:25  14.1  1.05 .9832  3.0  ....    37    31 122.0    1.6    .0    2.0  14.8    .0  .776 2.996  .967  3.79    1.71
 12:55:25  13.3  1.05 .9825  3.0  ....    37    30 102.6    1.3    .0    1.1   3.3    .0  .783 2.895  .990  3.76    1.76
 13:05:25  13.7  1.05 .9828  3.0  ....    37    31 114.9    1.2    .0    1.1   5.2    .0  .787 2.536  .923  4.10    1.81
 13:15:25  14.0  1.05 .9832  3.0  ....    37    30 104.5    1.2    .0     .6   1.1    .0  .783 2.779  .943  3.83    1.79
 13:25:25  13.7  1.06 .9826  3.0  ....    37    30 114.1    1.2    .0     .9   4.0    .0  .756 2.832  .997  3.88    1.78
 13:35:25  13.6  1.06 .9786  3.0  ....    37    30 103.0    1.3    .0    1.0   3.5    .0  .771 2.676  .990  3.77    1.88
 13:45:25  13.7  1.05 .9829  3.0  ....    37    30 116.1    1.1    .0     .9   2.0    .0  .793 2.975  .929  3.79    1.71
 13:55:25  14.6  1.05 .9838  3.0  ....    37    30 102.2    1.2    .0     .8   4.2    .0  .749 2.733  .964  3.63    1.85
 14:05:25  13.8  1.06 .9830  3.0  ....    37    31 115.2    1.1    .0     .6   2.7    .0  .766 2.921  .887  3.87    1.78
```

AFTER: Customer's FCX126 LPAR

```
FCX126  Run 2008/06/16 13:51:28         LPAR
                                        Logical Partition Activity
From 2008/06/13 11:35:25
To   2008/06/13 15:35:25
For  14400 Secs 04:00:00                "This is a performance report for SYSTEM XYZ"
_____________________________________________________________________________________________

 LPAR Data, Collected in Partition VMLNX1

 Processor type and model    : 2094-705
 Nr. of configured partitions:       7
 Nr. of physical processors  :       9
 Dispatch interval (msec)    : dynamic

 Partition Nr.  Upid #Proc Weight Wait-C Cap %Load CPU %Busy %Ovhd %Susp %VMld %Logld Type
 CF01A       1    01     1    900     NO  NO   ...   0  98.2  98.2   ...   ...    ... ICF
 CF01B       2    02     1    100     NO  NO   ...   0   1.1   1.1   ...   ...    ... ICF
 … CPs deleted for readability …
 VMLNX1      6    13     3    500     NO  NO   ...   0  14.3  14.3    .4  14.0   14.1 IFL
                              500         NO         1  14.3  14.3    .4  14.1   14.1 IFL
                              500         NO         2  14.3  14.3    .4  14.1   14.2 IFL
 VMLNX3      7    14     3    500     NO  NO   ...   0   2.9   2.9   ...   ...    ... IFL
                              500         NO         1   2.9   2.9   ...   ...    ... IFL
                              500         NO         2   2.9   2.9   ...   ...    ... IFL

 General LPAR mgmt overhead                  .4
 Overall physical load                     41.0
```

Summary

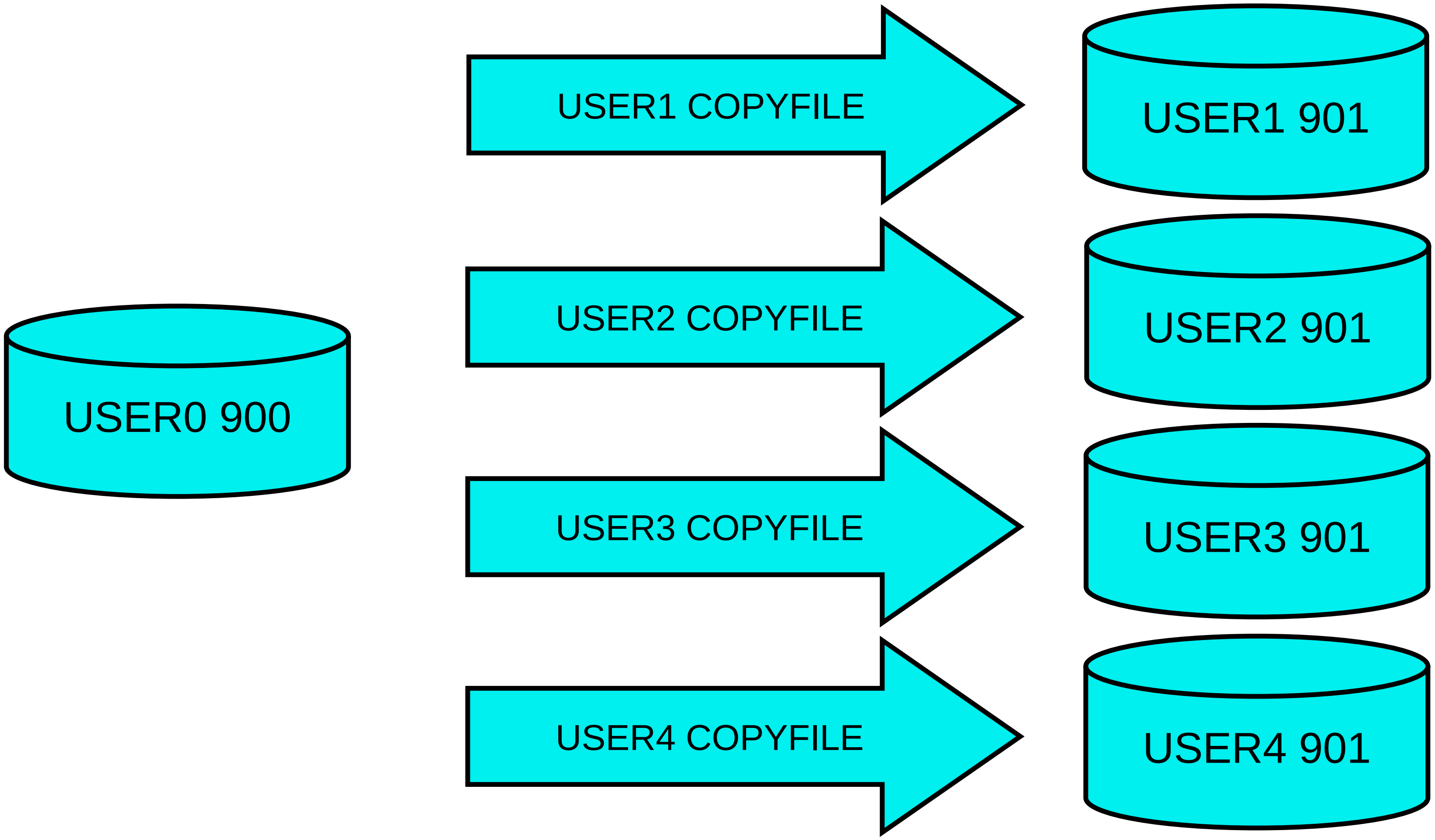
- **System was running "as it was designed to run" before the changes**
- **Workloads ran as expected after the changes**

Case Study: PAV and MDC

Customer Called IBM

- I have disk I/O problems on z/VM 5.2
- When I turn on MDC, my system slows down
- OK, nobody panic or speculate
- Send us some raw monitor data...
  - For MDC off, when things are good
  - For MDC on, when things are not so good
- Customer sent two very descriptive sets of data
- So good, in fact, that we easily replicated the customer's problem on GDLSPRF3

Customer's Workload



All five minidisks are on the same RDEV.

Without MDC

```
z/VM 5.2, MDC OFF, without the fix, excerpt from typical FCX108 (DEVICE)
report

<-- Device Descr. -->  Mdisk Pa- <-Rate/s-> <------- Time (msec) -------> Req.
Addr Type   Label/ID   Links ths  I/O Avoid Pend Disc Conn Serv Resp CUWt Qued
E700 3390   LDB307        15   4  564    .0   .3   .2  1.2  1.7  1.7   .0   .0
E7FC ->E700 LDB307        15   4  543    .0   .3   .2  1.2  1.7  1.7   .0   .0
E7FD ->E700 LDB307        15   4  541    .0   .4   .2  1.2  1.8  1.8   .0   .0
E7FE ->E700 LDB307        15   4  539    .0   .4   .2  1.2  1.8  1.8   .0   .0
```

Things to notice:
- E700 with three PAV aliases
- Four users doing I/O to the volume
- Aggregate volume I/O rate is (564+543+541+539) = 2187 IOs/sec

From this report, how do we know...
- PAV is correctly configured for the volume?
- PAV is functioning correctly?
- MDC is turned off for this volume?

But With MDC...

```
z/VM 5.2, MDC ON, without the fix

<-- Device Descr. -->  Mdisk Pa- <-Rate/s-> <------- Time (msec) -------> Req.
Addr Type   Label/ID   Links ths  I/O Avoid Pend Disc Conn Serv Resp CUWt Qued
E700 3390   LDB307        15    4  564  90.6   .3   .1  1.3  1.7  1.9   .0  2.9
E7FC ->E700 LDB307        15    4   .5    .0   .3   .3  1.5  2.1  2.3   .0   .0
E7FD ->E700 LDB307        15    4   .3    .0   .3   .3  1.4  2.0  2.2   .0   .0
E7FE ->E700 LDB307        15    4   .3    .0   .3   .6  1.3  2.2  2.4   .0   .0
```

Things to ask ourselves:

- Is MDC really on for this volume?
- What is the MDC-on volume I/O rate? (564+90.6+.5+.3+.3) = 655.7 IOs/sec
- Is it correct that the volume I/O rate should go down with MDC on?
- Is the CP I/O subsystem functioning correctly? Why or why not?

Things That Look Suspicious

- The volume I/O rate should not go down substantially when MDC comes online.
  - If some other limit is holding the applications back, the volume I/O rate should stay about the same
  - If nothing else is holding the applications back, the volume I/O rate should increase

- The CP I/O subsystem appears not to be functioning correctly
  - I/Os are happening almost exclusively on the base RDEV
  - The aliases appear to be doing almost no work
  - There is queueing at the base RDEV

A Visit to Development

- I went to see Bill Stephens (virtual I/O and MDC expert)
- He felt MDC's I/Os should be PAV-able
- But investigation revealed...
  - There are bits CP sets for its own I/Os to tell the real I/O layer whether to try to PAV the I/O...
  - but MDC was forgetting to set these bits...
  - (in fact, nowhere did CP ever set those bits!)...
  - thus all I/Os originating in MDC were being forced to the base...
  - thus MDC was failing to exploit the volume's PAV capability
- VM64199 repaired CP MDC so that its I/Os are PAV-able

MDC ON, With The Fix

```
z/VM 5.2, MDC ON, with the fix

<-- Device Descr. -->  Mdisk Pa- <-Rate/s-> <------- Time (msec) -------> Req.
Addr Type   Label/ID   Links ths  I/O Avoid Pend Disc Conn Serv Resp CUWt Qued
E700 3390   LDB307        15   4  442 402.3   .3   .4  1.4  2.1  2.1   .0   .0
E7FC ->E700 LDB307        15   4  421    .0   .4   .3  1.5  2.2  2.2   .0   .0
E7FD ->E700 LDB307        15   4  415    .0   .4   .3  1.5  2.2  2.2   .0   .0
E7FE ->E700 LDB307        15   4  410    .0   .4   .3  1.5  2.2  2.2   .0   .0
```

Things to notice:

- MDC is functioning (there are avoided I/Os)
- Aggregate I/O rate is (442+402+421+415+410) = 2090 IOs/sec
- About one-fifth of the I/Os are being avoided... makes sense
- Connect time is up compared to MDC off (1.2 to 1.5) -- IOs are bigger
- I/Os are spreading across base and aliases
- No queueing at the base device

It Turns Out...

- Our System Test group saw this behavior too, during z/VM 5.2 test
- They thought it was expected that the I/O rate would go down when MDC was ON, and we can't entirely blame them
- The only clue anything is wrong is that there is a queue at the base RDEV -- I doubt System Test would see that
- All of our PAV measurements were done with MDC OFF, of course

Status

- APAR VM64199, UM32047 (z/VM 5.2), UM32048 (z/VM 5.3)
- Is on the GA RSU for z/VM 5.3
- In the base of z/VM 5.4

Case Study: Paging Difficulties

Customer Calls In

- My system isn't running fast, but it isn't paging either
- My application formats lots of VDISKs... aren't they in memory? Shouldn't this be fast?
- I have raw monitor data... will you take a look?
- Customer sent raw monitor file 20070501 MD111606
- He says his workload uses disk volumes 1240-59 and 16C0-E3
- We took a look-see

Basic System Summary

```
FCX225  Run 2007/05/02 12:56:34         SYSSUMLG
                                        System Performance Summary by Time
From 2007/05/01 11:16:08
To   2007/05/01 12:37:10
For   4861 Secs 01:21:01                Result of 20070501 Run
```

```
           <------- CPU --------> <Vec> <--Users--> <---I/O---> <Stg> <-Paging-->
                 <--Ratio-->                          SSCH  DASD Users <-Rate/s-->
 Interval   Pct         Cap-  On-   Pct  Log-         +RSCH  Resp    in PGIN+ Read+
 End Time  Busy   T/V   ture line  Busy   ged Activ     /s  msec Elist PGOUT Write
 >>Mean>>  10.3 106.3 .7577 27.0  ....   280   263 122.7  11.1    .0  5418  1445
 11:23:41   9.9 180.7 .8232 27.0  ....   280   263  25.8    .8    .0  2645    .0
 11:24:40  10.3 193.5 .8051 27.0  ....   280   263  23.8    .7    .0  2707    .0
 11:25:39  10.5 196.8 .8218 27.0  ....   280   262  23.6    .8    .0  2825    .0
 11:27:10   9.7 159.5 .8232 27.0  ....   280   262  29.9    .7    .0  3714    .0
 11:28:09   9.8 108.2 .8015 27.0  ....   280   266  48.4    .8    .0  8942    .1
 11:29:40   9.8 119.2 .8134 27.0  ....   280   264  33.2    .9    .0  8602   2.8
 11:36:10  10.3 119.6 .8048 27.0  ....   280   263  45.7    .6    .0  9327    .0
 11:37:40  10.5 136.8 .8028 27.0  ....   280   262  30.3    .6    .0  9213    .0
 11:39:10  10.8 144.2 .8158 27.0  ....   280   264  30.7    .7    .0  9189    .0
 11:40:40  10.5 135.6 .8093 27.0  ....   280   264  32.5    .7    .0 10083    .0
 11:41:39  10.7 166.5 .8124 27.0  ....   280   262  25.2    .8    .0  8942    .0
 11:                                                                           .0
```

Look at those T/V ratios! What is CP doing?

Think About the Application

- Customer says he is formatting VDISKs
- VDISKs are address spaces
- We page them when storage gets tight
- We do seem to be spending a lot of time in CP
- Let's see if DEVICE CPOWNED shows us anything

DEVICE CPOWNED

```
FCX109  Run 2007/05/02 12:56:34         DEVICE   CPOWNED
                                        Load and Performance of CP Owned Disks
From 2007/05/01 11:16:08                                                                20070501
To   2007/05/01 12:37:10                                                                CPU 2094
For   4861 Secs 01:21:01                Result of 20070501 Run                          z/VM   V
_____________________________________________________________________________________________________

 Page / SPOOL Allocation Summary
 PAGE slots available       34745k        SPOOL slots available      3656598
 PAGE slot utilization          3%        SPOOL slot utilization          9%
 T-Disk cylinders avail.   .......        DUMP slots available            0
 T-Disk space utilization      ...%       DUMP slot utilization          ..%

 ____ .             .                          .     .     .     .     .      .     .     .     .     .     .     .
 < Device Descr. ->                      <------------- Rate/s ------------->  User        Serv MLOAD Block %Used
           Volume Area    Area      Used <--Page---> <--Spool-->         SSCH Inter Queue  Time  Resp  Page   for
 Addr Devtyp Serial Type  Extent       % P-Rds P-Wrt S-Rds S-Wrt Total  +RSCH feres Lngth /Page  Time  Size Alloc
 1240 3390   XXPG20 PAGE     0-3338    3   1.2  17.6   ...   ...  18.8    1.4     1     0   3.8   3.8    14    44
 1241 3390   XXPG21 PAGE     0-3338    3   1.3  16.8   ...   ...  18.1    1.3     1     0   7.8   7.8    14    42
 1242 3390   XXPG22 PAGE     0-3338    3   1.3  17.4   ...   ...  18.6    1.3     1   .57   6.7   9.0    14    43
 1243 3390   XXPG23 PAGE     0-3338    2   1.3  16.2   ...   ...  17.5    1.3     1  1.08   5.2  11.0    14    40
 1244 3390   XXPG24 PAGE     0-3338    2   1.3  16.4   ...   ...  17.7    1.3     1  1.16   5.0  11.5    14    41
 1245 3390   XXPG25 PAGE     0-3338    2   1.2  15.9   ...   ...  17.1    1.3     1   .57   5.6   8.6    14    40
 1246 3390   XXPG26 PAGE     0-3338    2   1.3  15.7   ...   ...  17.0    1.2     1     0  12.5  12.5    14    39
 …
```

From 11:16 to 12:37 the paging devices have queues on average?

Let's look at some INTERIM reports and see what we see...

INTERIM DEVICE, 11:47

```
1FCX108  Run 2007/05/02 12:56:29         INTERIM DEVICE
                                         General I/O Device Load and Performance
 From 2007/05/01 11:45:39
 To   2007/05/01 11:47:37
 For     118 Secs 00:01:58               Result of 20070501 Run
```

<-- Device	Descr. -->		Mdisk	Pa-	<-Rate/s->		<-------	Time	(msec)	------->			Req.	<Percent>	
Addr	Type	Label/ID	Links	ths	I/O	Avoid	Pend	Disc	Conn	Serv	Resp	CUWt	Qued	Busy	READ
1240	3390	XXPG20 CP	0	2	1.3	.0	47.3	.9	5.4	53.6	53.6	.0	.0	14	0
16DE	3390	XXPG0E CP	0	2	1.3	.0	48.9	.1	6.5	55.5	55.5	.0	.0	12	100
16E0	3390	XXPG0F CP	0	2	1.3	.0	53.8	.6	7.0	61.4	61.4	.0	.0	12	0
16D9	3390	XXPG0D CP	0	2	1.3	.0	53.3	.9	6.1	60.3	60.3	.0	.0	14	100
16DF	3390	XXPG09 CP	0	2	1.3	.0	49.9	.0	7.1	57.0	57.0	.0	.0	11	100
16DC	3390	XXPG07 CP	0	2	1.2	.0	50.7	.0	6.5	57.2	57.2	.0	.0	12	100
1247	3390	XXPG27 CP	0	2	1.2	.0	52.2	.7	6.4	59.3	75.0	.0	.0	15	0
16DB	3390	XXPG06 CP	0	2	1.2	.0	51.6	.0	7.0	58.6	58.6	.0	.0	12	0
16DD	3390	XXPG08 CP	0	2	1.2	.0	54.6	.4	7.2	62.2	62.2	.0	.0	13	0
16D8	3390	XXPG0C CP	0	2	1.2	.0	54.7	.0	6.6	61.3	61.3	.0	.0	13	100
1241	3390	XXPG21 CP	0	2	1.2	.0	48.9	.8	7.0	56.7	56.7	.0	.0	13	0
16D6	3390	XXPG0B CP	0	2	1.1	.0	55.7	.5	6.9	63.1	63.1	.0	.0	13	0
1242	3390	XXPG22 CP	0	2	1.1	.0	45.5	.0	7.3	52.8	52.8	.0	.0	12	0

…

Look at that pending time on the paging volumes!

High pending time usually means channel contention...

Configuration

From FCX131 DEVCONF:

```
1240-1259  0008-0021   3390-3 (E)  67 69  .  .  .  .  .  .   2105-E8   Online
16C0-16E3  0050-0073   3390-3 (E)  67 69  .  .  .  .  .  .   2105-E8   Online
```

From FCX161 LCHANNEL:

```
   67    ESCON    00 Yes    15    6    93     7
   69    ESCON    00 Yes    16   10    73    27
```

Two ESCON chpids for all this paging DASD?!

Recommendation

- Customer added four ESCON chpids
- (Why didn't he add FICON?
- He was quiet for a while, and then...

He's Baa-aaack

```
FCX109  Run 2007/08/15 09:58:19         INTERIM DEVICE   CPOWNED
                                        Load and Performance of CP Owned Disks
From 2007/08/14 07:15:03                                                                AB815
To   2007/08/14 07:20:02                                                                CPU 209
For     299 Secs 00:04:59               Result of AB815 Run                             z/VM
```

< Device Descr. ->						<------------- Rate/s ------------>					User		Serv	MLOAD	Block	%Used
		Volume	Area	Area	Used	<--Page--->		<--Spool-->			SSCH	Inter	Queue	Time	Resp	Page	for
Addr	Devtyp	Serial	Type	Extent	%	P-Rds	P-Wrt	S-Rds	S-Wrt	Total	+RSCH	feres	Lngth	/Page	Time	Size	Alloc
16D5	3390	XXPG0A	PAGE	0-3338	88	21.7	19.1	...	...	40.8	15.5	1	33.00	1.0	2.9	4	49
16D6	3390	XXPG0B	PAGE	0-3338	88	20.5	17.2	...	...	37.7	15.1	1	19.00	2.2	42.5	4	44
16D8	3390	XXPG0C	PAGE	0-3338	88	22.7	18.1	...	...	40.7	15.8	1	22.00	1.2	28.7	4	45
16D9	3390	XXPG0D	PAGE	0-3338	87	21.1	18.5	...	...	39.6	15.2	1	29.00	.8	25.0	4	48
16DB	3390	XXPG06	PAGE	0-3338	87	22.3	20.0	...	...	42.3	15.6	1	20.00	.8	17.1	4	51
16DC	3390	XXPG07	PAGE	0-3338	86	21.9	17.7	...	...	39.6	15.7	1	10.00	.9	10.4	3	45
16DD	3390	XXPG08	PAGE	0-3338	86	22.0	18.2	...	...	40.3	15.5	1	106.0	.8	5.9	4	47
16DE	3390	XXPG0E	PAGE	0-3338	86	21.4	19.6	...	...	41.0	15.0	1	0	.6	.6	4	48
16DF	3390	XXPG09	PAGE	0-3338	84	22.1	19.6	...	...	41.7	14.2	1	17.00	1.0	18.4	5	50
16E0	3390	XXPG0F	PAGE	0-3338	83	20.4	17.6	...	...	38.1	12.4	1	63.00	2.2	139.3	5	44
5805	3390	CF5805	PAGE	810000	12	46.5	41.9	...	...	88.4	21.3	10	0	.1	.1	11	100
9F23	3390	XPG2	PAGE	0-3338	99	18.6	18.1	...	...	36.7	25.9	1	23.00	.7	16.9	2	47
9F24	3390	XPG3	PAGE	0-3338	99	19.2	17.5	...	...	36.6	25.8	1	29.00	.6	19.2	2	46
9F25	3390	XPG4	PAGE	0-3338	99	18.6	17.4	...	...	36.0	26.9	1	0	.6	.6	1	46
9F2F	3390	XPG6	PAGE	0-3338	99	20.9	17.9	...	...	38.8	27.1	1	35.00	.6	20.6	2	47
C09E	3390	PC09B	PAGE	0-3338	100	22.4	19.2	...	...	41.6	30.2	1	0	.6	.6	1	98
D007	3390	CFD007	PAGE	896800	17	46.1	40.7	...	...	86.8	19.9	1	30.00	.1	.1	11	99
D008	3390	CFD008	PAGE	896800	17	42.2	39.7	...	...	81.9	18.1	1	32.00	.2	.2	11	99
D00D	3390	JSPG04	PAGE	896800	20	42.9	39.0	...	...	81.9	18.5	1	0	.3	.3	12	100

Removed 25 100% full 3990-3's from this excerpt.

So What's The Problem

- 40 3390-3 paging volumes nearly full
- 4 3390-9 paging volumes have the free space
- We can do only one I/O at a time to those gigantic model 9's
- Get rid of those mod 9's and add a lot of mod 3's
- He's working on it

Case Study: HiperSockets

Question from Customer

- **My system seems to have:**
  – Long ping times from my z/VM partition to my z/OS partition
  – Long transaction times from my z/VM partition to my z/OS partition
- **Seems related to my use of HiperSockets to connect z/VM to z/OS**
  – When I use a real OSA to connect the partitions, I don't have these problems
  – When I drive the z/OS server from external AIX boxes, I don't have the long transaction times
- **Customer sent MONWRITE data**

CEC and LPAR Configuration, from MONWRITE Data

- **2094 with:**
  - 6 CPs
  - 4 ICFs
  - 12 IFLs
  - 4 zIIPs
- **Several z/VM partitions, all shared IFL 12-ways, but only one of these partitions is active**
- **Several z/OS partitions, all shared, with varying logical PU configurations, that use the CPs and zIIPs**
- **Two coupling partitions that use the ICFs, dedicated**

Workload Configuration, from Customer

- **Linux on z/VM is the origin**
- **Over to z/OS database server via real HiperSocket**
- **Back to Linux on z/VM via real HiperSocket**
- **Transaction ends**

Long Response Time? Let's Hunt z/VM Constraints

- **FCX126 LPAR and FCX225 SYSSUMLG – no IFL constraints found**
- **FCX225 SYSSUMLG and FCX109 INTERIM DEVICE CPOWNED – no paging found – everything fits in central**
- **FCX108 DEVICE DASD revealed the active user volumes, and FCX168 DEVLOG showed good service time and small to no queues**
- **FCX215 INTERIM FCHANNEL – no FICON adapter CPU problems; FCX108 DEVICE DASD – no pending time concerns**
- **FCX112 USER revealed the big CPU users, and FCX162 USERLOG showed very low T/V and no CPU peaks**
- **FCX231 INTERIM HIPSOCK showed <10 msgs/sec and 600 data units/message – seems small**
- **Couldn't find a z/VM constraint**

FCX126 LPAR: General View of CPU Busy (z/VM)

Partition	Nr.	Upid	#Proc	Weight	Wait-C	Cap	%Load	CPU	%Busy	%Ovhd	%Susp	%VMld	%Logld	Type
XXX1	11	14	12	200	NO	NO	...	0	20.5	.1	.3	20.3	20.4	IFL
				200		NO		1	21.9	.2	.3	21.7	21.7	IFL
				200		NO		2	21.5	.2	.3	21.3	21.3	IFL
				200		NO		3	22.0	.2	.3	21.7	21.8	IFL
				200		NO		4	22.1	.2	.3	21.9	21.9	IFL
				200		NO		5	22.2	.2	.3	22.0	22.0	IFL
				200		NO		6	22.0	.2	.3	21.8	21.8	IFL
				200		NO		7	22.1	.2	.3	21.8	21.9	IFL
				200		NO		8	21.9	.1	.3	21.7	21.8	IFL
				200		NO		9	22.2	.2	.3	22.0	22.0	IFL
				200		NO		10	22.1	.2	.3	21.8	21.9	IFL
				200		NO		11	21.9	.2	.3	21.6	21.7	IFL

The other partitions using IFLs are not running.

We don’t see a problem here.

FCX126 LPAR: CPU Busy, z/OS Partitions

Partition	Nr.	Upid	#Proc	Weight	Wait-C	Cap	%Load	CPU	%Busy	%Ovhd	%Susp	%VMld	%Logld	Type
XXXA	8	03	8	190	NO	NO	5.9	0	28.2	.2	...	...	...	CP
				190		NO		1	28.2	.2	...	...	...	CP
				190		NO		2	28.1	.2	...	...	...	CP
				190		NO		3	28.0	.2	...	...	...	CP
				190		NO		6	10.6	.1	...	...	...	ZIIP
				190		NO		7	10.5	.0	...	...	...	ZIIP
				190		NO		22	10.5	.0	...	...	...	ZIIP
				190		NO		23	10.6	.1	...	...	...	ZIIP
XXXB	9	04	8	190	NO	NO	5.8	0	26.5	.1	...	...	...	CP
				190		NO		1	26.5	.2	...	...	...	CP
				190		NO		2	26.4	.1	...	...	...	CP
				190		NO		3	26.4	.1	...	...	...	CP
				190		NO		6	11.5	.1	...	...	...	ZIIP
				190		NO		7	11.5	.0	...	...	...	ZIIP
				190		NO		22	11.5	.0	...	...	...	ZIIP
				190		NO		23	11.5	.0	...	...	...	ZIIP
XXX0	10	05	2	20	NO	NO	...	0	.0	.0	...	...	...	CP
				20		NO		1	.0	.0	...	...	...	ZIIP
YYYA	13	11	9	600	NO	NO	23.5	0	70.5	.1	...	...	...	CP
				600		NO		1	70.5	.1	...	...	...	CP
				600		NO		2	70.4	.1	...	...	...	CP
				600		NO		3	70.2	.1	...	...	...	CP
				600		NO		4	64.9	.0	...	...	...	ZIIP
				600		NO		5	64.9	.0	...	...	...	ZIIP
				600		NO		6	69.3	.1	...	...	...	CP
				600		NO		22	64.9	.0	...	...	...	ZIIP
				600		NO		23	65.0	.1	...	...	...	ZIIP

None of these partitions look real busy.

But we will see shortly that there is in fact a problem.

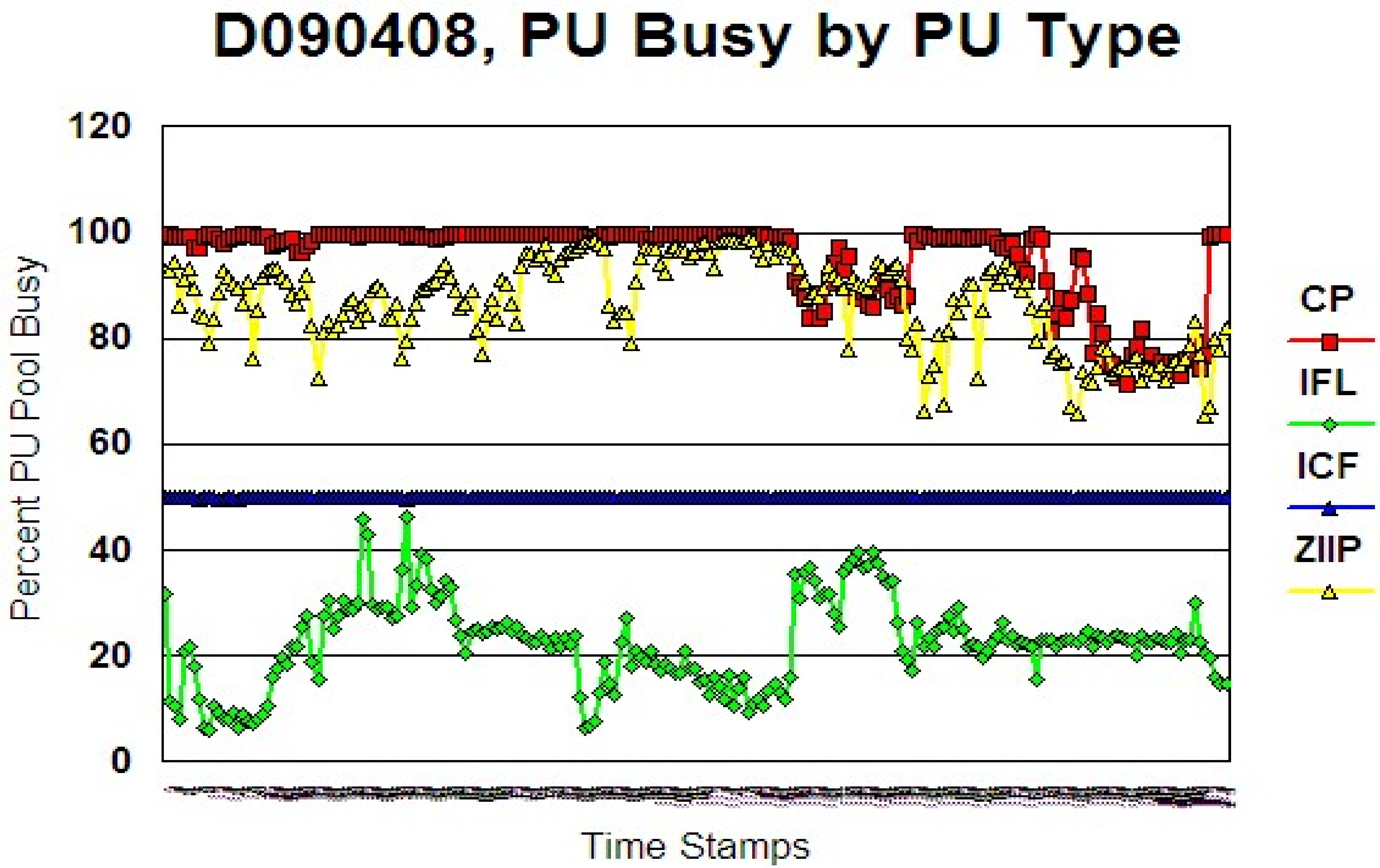
How Do HiperSockets work?

- **Synchronous data transfer between partitions**
- **Firmware copies data from one PU's buffers to the other PU's buffers**
- **Firmware runs on the PUs that did the calls**
- **Works fine in CPU-rich environments**
- **Not so well in CPU-constrained environments**

How Are The z/OS CPUs Doing?

- **6 real standard CPs**
- **4 z/OS partitions have 14 logical standard CPs altogether**
- **Good thing MONWRITE data captures LPAR's view of the partitions' consumptions**
- **For each sample interval, add up those 14 logical standard CPs' utilizations to see how much of the 6 real CPs they're using altogether**
  - Post-process the FCX126 INTERIM LPAR reports
  - Requires a little Rexx
- **While we're at it, do this for every engine type**

CEC View, PU Utilization by Type



Findings

- **Real standard CPs are saturated**
- **Real HiperSockets require readily accessible cycles to work well**
- **This is a CPU-constrained environment**
- **Explains why real OSA was better**
- **Recommended either:**
  - Adding more standard CPs, or
  - Tuning z/OS partitions to reduce CP resource they need
- **Also recommended a z/OS expert look at RMF reports to see how else the CP constraint was impacting z/OS function**

Case Study: Grinch that Stole Performance

The Grinch That Stole Performance

From Performance Toolkit USTAT FCX114 Report January 5:

							<-SVM	and->		
%CPU	%LDG	%PGW	%IOW	%SIM	%TIW	%CFW	%TI	%EL	%DM	%IOA
0	0	0	**19**	2	10	0	3	0	51	8

From Performance Toolkit DEVICE FCX108 Report January 5:

	<-Rate/s->		<--------		Time (msec)		-------->		Req.	<Pct>
Addr	I/O	Avoid	Pend	Disc	Conn	Serv	Resp	CUWt	Qued	Busy
1742	26.7	.0	1.3	**18.4**	4.7	24.5	**69.0**	.0	1.2	65.4

Went to check Toolkit CACHEXT FCX177 Report for control unit cache stats, but it didn't exist!

It is a good thing I keep historical data -- let's go back and see what's going on...

When Did We Last See Cache?

From Performance Toolkit DEVICE FCX108 Report:

	<-Rate/s->		<--------	Time (msec)		-------->			Req.	<Pct>
Addr	I/O	Avoid	Pend	Disc	Conn	Serv	Resp	CUWt	Qued	Busy
Dec8	41.0	.0	0.3	0.2	2.0	2.6	2.9	.0	.0	10.5
Jan5	26.7	.0	1.3	**18.4**	4.7	24.5	**69.0**	.0	1.2	65.4

From Performance Toolkit CACHEXT FCX177 Dec. 8th Report:

<----------	Rate/s	---------->			<-------Percent	---------->				
Total	Total	Read	Read	Write		<-------	Hits	------>		
Cache	SCMBK	N-Seq	Seq	FW	Read	Tot	RdHt	Wrt	DFW	CFW
53.0	41.0	52.3	0	0.6	99	99	99	96	96	..

Down for the 3-Count

```
q dasd details 1742
1742 CUTYPE = 3990-EC, DEVTYPE = 3390-06, VOLSER=USE001
      CACHE DETAILS:  CACHE NVS CFW DFW PINNED CONCOPY
           -SUBSYSTEM    F     Y   Y   -     Y       N
           -DEVICE       Y     -   -   Y     N       N
      DEVICE DETAILS: CCA = 02, DDC = 02
      DUPLEX DETAILS: SIMPLEX
```

Pinned data! Yikes! I had never seen that before!

Performance Toolkit Device Details

```
FCX110    CPU 2003   GDLVM7    Interval INITIAL. - 13:08:47   Remote Data

Detailed Analysis for Device 1742 ( SYSTEM )
Device type :  3390-2    Function pend.:      .8ms   Device busy    :   27%
VOLSER      :  USE001    Disconnected  :    20.3ms   I/O contention:     0%
Nr. of LINKs:     404    Connected     :     5.4ms   Reserved       :    0%
Last SEEK   :    1726    Service time  :    26.5ms   SENSE SSCH     :  ...
SSCH rate/s :    10.5    Response time :    26.5ms   Recovery SSCH :  ...
Avoided/s   :    ....    CU queue time :      .0ms   Throttle del/s:  ...
Status: SHARABLE

Path(s) to device 1742:    0A     2A     4A
Channel path status   :    ON     ON     ON

Device              Overall CU-Cache Performance            Split
DIR ADDR VOLSER   IO/S %READ %RDHIT %WRHIT ICL/S BYP/S    IO/S %READ %RDHIT
08   1742 USE001     .0     0      0      0     .0    .0    'NORMAL' I/O only
```

Performance Toolkit Device Details

```
MDISK Extent Userid   Addr  Status LINK MDIO/s
----------------------------------------------
 101 -  200  EDLSFS   0310   WR       1      .0
 201 -  500  EDLSFS   0300   WR       1      .0
 501 -  600  EDLSFS   0420   WR       1      .0
 601 - 1200  EDLSFS   0486   WR       1      .0
1206 - 1210  RAID     0199   owner
             BRIANKT  0199   RR       5      .0
1226 - 1525  DATABASE 0465   owner
             K007641  03A0   RR       3      .0
1526 - 1625  DATABASE 0269   owner
             BASILEMM 0124   RR      25      .0
1626 - 1725  DATABASE 0475   owner
             SUSANF7  0475   RR       1      .0
1726 - 2225  DATABASE 0233   owner  366    10.5
```

Solution

- Use **Q PINNED** CP command to check for what data is pinned.
- Discussion with Storage Management team.
- Moved data off string until corrected.

Pinned data is <u>very</u> rare, but when it happens it is serious.