35 YEARS OF PERFORMANCE MANAGEMENT

Introduction to Linux on z/VM Performance and Configuration Guidelines

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"If you can't Measure it,

I am Just Not Interested ™"

VELOCITY SOFTWARE

PROVEN PERFORMANCE

Configuration Objectives

The Objective:

- Configure a system to avoid performance problems
- Run well at higher utilization

If there are problems (and there will be problems):

- Understand the problem and correct

Overview

Configuring z/VM for Linux on zSeries

- z/VM defaults not optimum
- Linux must be configured for shared resource environment
- Many actions not intuitive
- “Best Practices”

Infrastructure unknowns for “new” installations

- How to manage performance / capacity planning?
- Is chargeback important?
- “Real” support for 1,000 servers?
- What are the limits of a configuration and how to measure
- How to share resources to INCREASE the ROI

Measurement and Tuning for z/VM IS Required

- Start with Proper Configurations

Configuration Options

General Storage Options:

Linux Options

- Storage Sizes
- Swapping for Linux
- Linux virtual processors
- Network

z/VM Configuration

- Network, I/O, FTP Topics
- MDC
- Paging and Spooling for z/VM
- DASD/Cache/Channels
- z/VM System parameters

Infrastructure

- Linux infrastructure – monitoring availability and performance

Performance Problem "Opportunities"

The user (Linux admin) says "Performance is bad, must be VM"

- From the "top" user who can't see anything

So is it z/VM? To start, must understand the metrics from:

1 - z/VM Subsystems (intro)

- Processor, Storage, Paging, DASD I/O

2 - Linux Subsystems (basics)

- Processor, RAM, file systems, network

3 - Network (advanced)

4 - Applications (more advanced)

- Java, WAS, Oracle, MQ, DB2, postgres, gpfs

Real Resources vs Virtual Resources

Real vs Virtual in SHARED resource environment:

- Capacity planning sees Real resources
- Users see Virtual resources (CPU threads, virtual storage)

Real Resources

- Real storage cost money
- IFLs cost money
- Lack of real resources delays work

Virtual Resources

- What end users see
- Need some amount of memory for workload
- Need some number of virtual CPUs for workload

Storage Considerations

z/VM LPAR is assigned storage, shares storage between servers

- Less storage per server allows more servers
- Over-allocating storage cause paging
- Knowing the sweet spot when over allocating impacts performance

Storage "overcommit" is a bogus metric

- Better managed servers have less idle storage
- Poor managed servers are over allocated, so high overcommit good
- Better managed servers results in lower overcommit

Storage requirements of Linux very high

- Linux designed for dedicated storage, references all storage
- Linux is LRU, competing with VM's reference pattern
- High percent of referenced pages – what can z/VM page out?

Page space required

Understand the Storage Map - ESASTR1

Storage Map to show storage (14GB) use

- User resident should be major use
- Control MDC, understand VDISK
- If you have an “event”, what changed?

Capture ratio shows accuracy

```
Report: ESASTR1      Main Storage Analysis                          Velocity Software Corporate   ZMAP 5.1.2 04/16/21   Pg   2
Monitor initialized: 04/15/21 at 00:00:00 on 8562 serial 040F78    First record analyzed: 04/15/21 00:00:00
-------------------------------------------------------------------------------------------------------------------------
         Users <----------------------------Pages-------------------------------------------------------------> Over
         Loggd System  Fixed Non-  Free Frame <Available> Systm  User  NSS/DCSS  <-AddSpace> VDISK <MDC> Diag Commit     Capt-
Time        On Storage Store Pgble Stor Table <2gb  >2gb  ExSpc Resdnt Resident  Systm User  Rsdnt Rsdnt  98  Ratio      Ratio
-------- ----- ------- ----- ----- ---- ----- ----- -----  ----- ------ --------  ----- -----  ----- ----- ---- -----      -----

04/15/21
17:30:00   111 3670016  2878 20883 1166 28672  3164  2669 52296  3383K    35077  75714     0  4307 19741  16K 3.653      0.988
17:45:00   111 3670016  2878 20872 1147 28672  3195  2389 52298  3381K    35074  75716     0  4270 21989  16K 3.653      0.988
18:00:00   111 3670016  2878 20889 1146 28672  3128  2851 52306  3383K    35079  75722     0  4103 19648  16K 3.653      0.988
18:15:00   113 3670016  2878 20876 1141 28672  3077  2508 52316  3384K    35099  75776     0  4028 19283  16K 4.609      0.988
18:30:00   116 3670016  2878 20880 1075 28672  3137  2544 52360  3349K    32071   122K     0  2118 12337  16K 7.354      0.988
18:45:00   116 3670016  2878 20808 1038 28672  3051  2234 52407  3293K    29914   196K     0     0    47  16K 8.227      0.988
19:00:00   116 3670016  2878 20765 1028 28672  3056  2245 52414  3293K    29082   196K     0     0   127  16K 8.227      0.988
19:15:00   115 3670016  2878 20797 1040 28672  3063  2232 52409  3297K    29522   192K     0    22    73  16K 8.754      0.988
19:30:00   116 3670016  2878 20809 1031 28672  3069  2235 52450  3293K    29065   196K     0     0     6  16K 9.363      0.988
```

Understanding Virtual Machine Storage

Virtual Machine Storage analysis – ESAUSP2 (percent/rate)

- Analyze by user – Large consumers?
- RHOS* users paging too much to get work done
- RHOS* is OpenShift installation

Report: **ESAUSP2** User Resource Rate Report Velocit

	<---CPU time-->			<----**Main Storage (pages)**----->						<-Paging (pages)-		
UserID	<(Percent)>		T:V	<Resident>		Lock	<-----WSS----->			Paged	**<Pgs/Second**	
/Class	Total	Virt	Rat	Totl	Activ	-ed	Totl	Activ	Avg	2Disk	Read	Write
18:30:00	145.3	133.9	1.1	**3.3M**	3348K	7048	3.9M	3909K	34K	9147K	27057	15496
***Key User Analysis ***												
TCPIP	0.15	0.05	3.0	1422	1422	601	817	817.3	817	7750	**43.4**	8.6
User Class Analysis												
Velocity	5.82	5.43	1.1	3763	3598	5	4593	4271	534	14472	137.4	57.0
SUSE	20.17	19.28	1.0	112K	112K	1534	193K	193K	32K	1048K	2754	828.5
ORACLE	4.66	3.84	1.2	195K	195K	734	381K	381K	190K	473K	2895	936.7
GPFS	12.51	11.68	1.1	195K	195K	975	439K	439K	146K	1332K	4008	1383
TheUsrs	95.37	89.07	1.1	**2.6M**	2615K	1145	2.5M	2472K	80K	5017K	12958	11022
Top User Analysis												
RHOSBOOT	39.91	38.51	1.0	727K	727K	30	99K	98642	99K	454K	**1175**	**2346**
RHOSCP2	8.92	8.20	1.1	250K	250K	19	116K	116K	174K	201K	**997.0**	**1965**
RHOSCP1	8.78	8.05	1.1	252K	252K	19	126K	126K	189K	205K	**967.6**	**2005**
RHOSCP3	7.83	7.04	1.1	161K	161K	28	48K	47842	80K	125K	**1230**	**1157**

Managing Real Paging in z/VM

Strategy / best practices in past if overcommit high

- Need high speed page recovery

~~Expanded Storage was used for "30 second test case"~~

- Pages migrated to disk after 30 seconds
- Minimum 20% of storage reconfigured to Expanded Storage
- Page-in from expanded storage was **synchronous,** FAST
- Pages migratable to disk after 30 seconds unreferenced

"New" strategy is IBR (z/VM 6.3)

- Invalid But Resident
- VERY LIMITED. 5% is the max
- 2% is the default, Go the max!

z/VM Storage Management Options

System Age List

- Maximum 5%,
- Recommend 5% always
- SET AGELIST SIZE 5% EARLYWRITES YES KEEPSLOT YES

```
-Set--AGELIST---.-SIZE--.-n.n--PERCent-.-.
                |       |-n.n%---------| |
                |       '-storsize-----' |
                |-EARLYWrites--.-Yes-.---|
                |              '-No--'   |
                '-KEEPSlot--.-Yes-.------'
                            '-No--'
```

- CP QUERY AGELIST (default)

```
Target size    =          280576K (274M)      2.0% of pageable storage
In use         =          271712K
Pending writes =          120296K
Early writes   = Yes
Sizing         = Variable
```

ESAUCD2: Linux RAM Overview

- Real storage
- Swap storage – some should be used
- "Read" cache
- "Write" buffer
- Anonymous "overhead"
- Available storage is the problem

```
Report: ESAUCD2       LINUX UCD Memory Analysis   Velocity Software Corpo
Monitor initialized: 10/03/14 at 07:22:27 on 2   First record analyzed:
-------------------------------------------------------------------------
Node/    <--------------------Storage Size (MB)-------------------------->
Time/    <--Real Storage--> <-----SWAP Storage--Storage in Use--------->
Date     Total  Avail Used  Total Avail Used   Buffer Cache Ovrhd Shared
-------- ------ ----- ----- ----- ----- -----  ------ ----- ----- ------
07:24:00
ORAap042 8041.5 475.9  7566  1130  1130   0.1   183.5  1512  5870      0
ORAap044  13069  7131  5939  6888  6888     0   233.0  3913  1793      0
```

Linux IDLE Storage

Linux Idle Storage costs money

- How much does Linux need? Only enough
- All Linux Idle storage is “touched”
- All Linux Idle storage is backed by z/VM
- Linux “round robins” through storage, VM MUST back it
- Linux Idle storage is NOT FREE

More idle storage, the more paged out,

- Linux storage requests take longer

What Linux Servers over configured Storage

Report: **ESAUCD2** LINUX UCD Memory Analysis Velocity Software Corpo
Monitor initialized: 10/03/14 at 07:22:27 on 2 First record analyzed:

Node/	<-------------------Storage Size (MB)------------------------->										
Time/	<--Real Storage-->			<-----SWAP Storage--Storage in Use--------->							
Date	Total	Avail	Used	Total	Avail	Used		Buffer	Cache	Ovrhd	Shared
07:24:00											
ORAap042	8041.5	475.9	7566	1130	1130	0.1		183.5	1512	5870	0
ORAap044	13069	**7131**	5939	6888	6888	**0**		233.0	3913	1793	0
ORAap046	8041.5	2091	5951	1130	1130	0.1		260.9	3423	2267	0
ORAap048	8041.5	2291	5751	1130	1130	0		224.8	3347	2179	0
ORAap050	8041.5	529.3	7512	1130	1130	0.1		186.9	1577	5749	0
ORAap052	10046	642.8	9403	8172	8172	0		226.5	3958	5218	0
ORAap054	8041.5	1235	6807	3036	2878	158.3		139.9	319.3	6348	0
ORAap056	8041.5	818.5	7223	5604	5592	12.2		156.4	968.3	6098	0
ORA1101b	12062	64.0	11997	4942	4758	183.6		727.5	10024	1246	0
ORA1201a	12062	218.9	11843	4942	4438	503.7		152.4	7170	4520	0
ORA1202a	12062	1668	10394	4942	4399	543.3		137.3	6435	3822	0
ORA1203a	12062	94.0	11968	4942	4443	498.5		168.6	7582	4216	0
ORA1204a	12062	90.9	11971	4942	3754	**1188**		70.9	8088	3811	0
ORA1205a	12062	81.8	11980	4942	4562	380.1		162.6	8115	3702	0
ORA1301b	12062	79.0	11983	4942	4760	181.7		731.4	9952	1299	0
ORA1401a	12062	334.7	11727	4942	4454	487.7		181.5	7234	4312	0
ORA1402a	12062	528.2	11533	4942	3777	1165		133.3	6976	4424	0
ORA1403a	12062	462.1	11599	4942	4420	521.8		180.6	6783	4636	0
ORA1404a	12062	439.3	11622	4942	4442	499.9		103.4	6853	4666	0
ORA1405a	12062	442.5	11619	4942	4471	471.1		127.0	6593	4899	0
WAS2a016	2502.6	89.6	2413	1130	1106	24.2		203.0	243.0	1967	48.0
WAS2a020	2502.6	29.9	2473	1130	1106	24.1		254.3	238.8	1980	47.9
WAS2a024	5520.4	**2635**	2885	1130	1130	**0**		776.4	613.3	1496	50.3
WAS2a054	2502.6	22.0	2481	1130	1106	23.4		247.9	274.1	1959	48.5
WAS2a058	2502.6	22.4	2480	1130	1106	23.5		244.5	254.9	1981	48.5
WAS2a062	6528.3	**3687**	2841	1130	1130	**0**		762.0	591.8	1487	50.3
WAS2a114	2502.6	17.7	2485	1130	1106	23.6		219.6	267.6	1998	48.4
WAS2a118	2502.6	17.6	2485	1130	1106	23.6		260.5	264.1	1960	48.2
WAS2a124	2502.6	14.1	2488	1130	1106	24.0		271.0	264.8	1953	48.0
WAS2a128	2502.6	17.8	2485	1130	1106	23.4		263.1	251.9	1970	48.4
WAS2a402	5016.4	37.7	4979	1130	907.0	222.9		15.8	418.3	4545	0.0

Linux data shows:

- Real storage
- Swap storage
- “Cache”

Some Swapping is “good”

- If not swapping -
  - Reduce VM size
  - Use CMM to reduce

Watch for opportunities

- HIGH available
- No swap

Linux Storage (RAM)

z/VM Paging

- Over commitment of storage causes paging
- **Over commitment of storage reduces cost**
- Paging is common **(manageable)** performance problem

Linux Swapping

- Swapping result of over commitment of Linux storage
- Swapping to vdisk very fast, uses storage when it happens
- Swapping to dasd very slow, always noticeable

Understanding Linux ram (real storage) will save gigabytes real storage

Linux Swapping Guidelines

Reducing virtual storage size may cause swap

- Linux does not swap until out of storage

Swapping to disk

- VERY VERY SLOW
- Other platforms increase storage size because disk is slow
- **Swap to disk if you want to penalize a server**
- Max swap rate maybe 200 on a very good day

Linux Swapping to Vdisk

- Not a performance degradation
- 40,000 / second is FAST

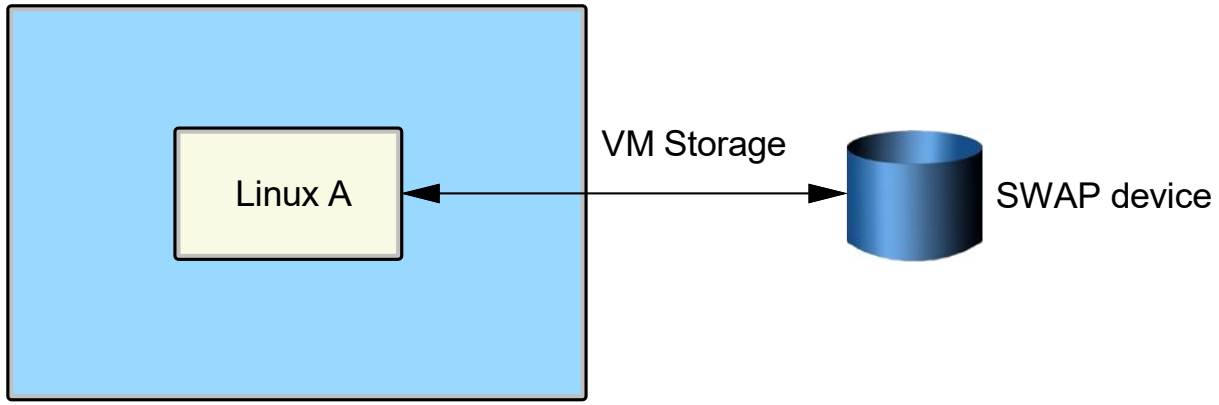
Swap Guideline:

- **Define 2 virtual disks, prioritized swap**
- **First one "smaller", 2nd on 2gb (Insurance)**
- More swap devices for SAP as needed (they are essentially free)
- Use DIAG driver instead of FBA - Reduces I/O by factor of 8

VM Storage Overview - Paging Hierarchy

Linux traditional perspective:

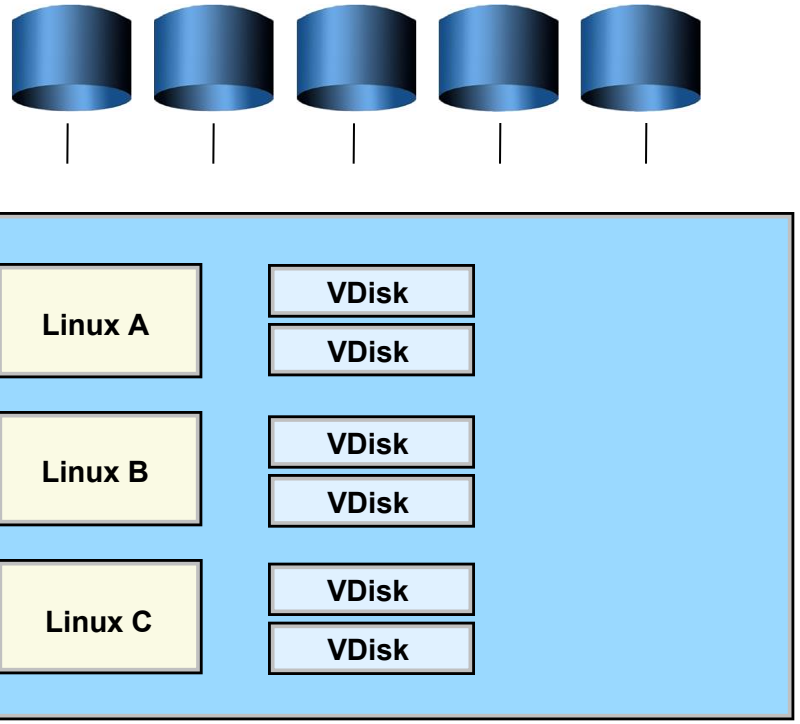
Linux storage/SWAP



z/VM Paging Hierarchy

Utilize features of z/VM – Virtual Disk

- Linux not limited in swap rate
- z/VM supports high paging band width over many exposures



Page volumes

z/VM Paging bandwidth VERY HIGH

Central processor storage

Linux Swap bandwidth VERY HIGH

VDISK Case Study

VDISK for swap rules:

- Two virtual disks for swap, one small, one large, prioritized to small

Breaking the rules increases storage:

- Typically, vdisk is a very small component of storage
- **Note case study, vdisk large? WHY???**

```
Report: ESASTR1
Monitor initialized: 032094 serial 9E14C     First record analyzed: 03/05/08
-------------------------------------------------------------------------
         Users <-------Pages-------------------------------------------
         Loggd System   <Available> Systm  User  NSS/DCSS  <-AddSpace> VDISK
Time        On Storage  <2gb  >2gb  ExSpc Resdnt Resident  Systm User  Rsdnt
-------- ----- -------  ----- ----- ----- ------ --------  ----- -----  -----
03/05/08
02:15:00    28 1310719    802  4377  1124 967698     2950   230K 10866  229K
02:30:00    28 1310719    784  4635  1123 967458     2952   230K 10866  229K
02:45:00    28 1310719    806  3129  1124 967570     2950   230K 10867  229K
```

VDISK Case Study

VDISK for swap best practice: Two disks, prioritized – DOUBLE CHECK

- Two disks per server, goodness
- Should be 1 small swap disk, plus 2nd large disks, goodness
- Prioritized backward though, badness….

```
*************************************************************************
                                 <--Size--->  <--pages--> -----> DASD    X-
                                 AddSpc VDSK  Resi- Lock-  Stg-> Page Store
Owner    Space Name              Pages  Blks   dent    ed T Migr Slots  Blks
-------- ----------------------- ----- -----  ----- ----- - ---- ----- -----
Average:
LINUX1   VDISK$LINUX1$$$0101$0041 65791  8738   3.0     0      0   568     0
LINUX1   VDISK$LINUX1$$$0112$0042  524K 69905   170     0    0.0 61212    11
LINUX2   VDISK$LINUX2$$$0101$0043 65791  8738   3.0     0      0   571     0
LINUX2   VDISK$LINUX2$$$0112$0044  524K 69905   85K     0    0.4  346K  2047
LINUX3   VDISK$LINUX3$$$0101$0045 65791  8738   3.0     0      0   571     0
LINUX3   VDISK$LINUX3$$$0112$0046  524K 69905   2.0     0      0  5767     0
LINUX4   VDISK$LINUX4$$$0101$0047 65791  8738   3.0     0      0   571     0
LINUX4   VDISK$LINUX4$$$0112$0048  524K 69905  147K     0    0.3  223K 35967
LINUX5   VDISK$LINUX5$$$0101$0049 65791  8738   3.0     0      0   568     0
LINUX5   VDISK$LINUX5$$$0112$004A  524K 69905   2.0     0      0  4321     0
. . . . . .
                                 ----- -----  ----- ----- - ---- ----- -----
System Totals:                   5901K 39321  233K     0    0.7  669K 38631
```

Using CMM: Overview

CMM Overview:

- Requires CMM driver, included since SLES9
- Make sure the virtual machine is enabled for IUCV

  #CP SET SMSG IUCV

CMM must be loaded prior to use:

```
modprobe cmm sender=ZVRM
```

- Or line in /etc/zipl.conf with (followed by doing a mkinitrd,ZIPL):

```
cmm.sender=ZVRM
```

NOTE: MAKE SURE USERID IS IN CAPITALS

Check to see if loaded:

```
linux9:~ # lsmod
Module                  Size  Used by
cmm                    20108  0
smsgiucv               13836  1 cmm
iucv                   31032  1 smsgiucv
```

Using CMM: Setting Balloon Size

Command to take away storage from Linux:

```
smsg suselnx2 CMM SHRINK 10000
```

Verify it:

```
linux9s:~ # cat  /proc/sys/vm/cmm_pages
10000
```

Give all the pages back (pop the balloon):

```
smsg suselnx2 CMM SHRINK 0000
```

Verify it:

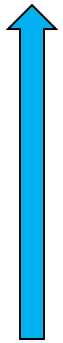
```
linux9s:~ # cat  /proc/sys/vm/cmm_pages
0
```

Using CMM: Setting Balloon Size

11:39, cmm loaded,
11:43, take away 20,240 pages (80mb)
12:38, take away 20,240 pages (80mb)
12:45, give them back
12:46, start up memory stresser

Using CMM: Setting Balloon Size

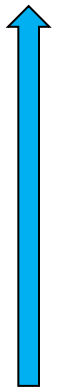
Set CMM balloon to 20000, 40000 pages
Set CMM balloon to zero pages
Note to release page, Linux must page it in



```
Screen: ESAUSR2  Velocity Software, Inc.
3 of 3  User Resource Utilization
                  <------Paging (pages)------->
          UserID  <---Allocated---> <---I/O--->
Time      /Class   Total ExStg  Disk  Read Write
-------- -------- ----- ----- ----- ----- -----
13:15:00 SUSELNX2  2517  2517     0     0     0
13:00:00 SUSELNX2  2617  2617     0     0     0   (set to zero)
12:45:00 SUSELNX2  1929  1929     0     0     0   (-20000 pages)
12:30:00 SUSELNX2 22845  4160 18685 35937 14443
12:15:00 SUSELNX2 28969  2640 26329   129     0
12:00:00 SUSELNX2 28969  2640 26329     0     0
11:45:00 SUSELNX2 30205  2640 27565     0     0
11:30:00 SUSELNX2 50452  1975 48477 21379   427   (-20000 pages)
```

Using CMM: Setting Balloon Size

Set CMM balloon to 10000 pages
Ramp up workload
Set CMM balloon to zero pages



```
Screen: ESAUSR2  Velocity Software, Inc.
1 of 3  User Resource Utilization
                   <---CPU time--> <---Main
         UserID    <(seconds)> T:V <Resident>
Time     /Class    Total  Virt Rat Total Activ
-------- -------- ----- ----- --- ----- -----
13:15:00 SUSELNX2 44.22 36.73 1.2 77161 77161
13:00:00 SUSELNX2   276   265 1.0 68721 68721   (zero pages)
12:45:00 SUSELNX2   357   343 1.0 45664 45664   (-40000 pages)
12:30:00 SUSELNX2   250   233 1.1 44758 44758
12:15:00 SUSELNX2 43.94 36.94 1.2 34877 34877
12:00:00 SUSELNX2 32.44 25.82 1.3 34791 34791
11:45:00 SUSELNX2 30.49 23.98 1.3 34774 34774
11:30:00 SUSELNX2   125   116 1.1 37992 35716   (-20000 pages)
```

MDC Pains

CP algorithms VERY poor at sizing MDC Storage - Control the size of MDC!

```
Report: ESAMDC       Minidisk Cache Analysis                    .     ESAMAP 3.6.1 02/08/07  Pg  2660
Monitor initialized: 02/07/07 at 00:00:05 on 2084 serial 447AA     First record analyzed: 02/07/07 00:00:05
```

	<----Load---->				<IO per>	<Insertions>	<-----Main Storage MDC-->								<-Expanded Storage MDC------>				<External>	
	<-Users->		Tran	Hit	<second>	Usr	Per	Not	<-Sizes (MB)-->				</Second>	<-Sizes (MB)-->				<Per Second >			<I/O rate>	
Time	Actv	In Q	/sec	Pct	rds	hits	Max	Min	Ald	Avg	MIN	MAX	Obj	Stls	Delt	Avg	MIN	MAX	Obj	Rds	Wrts	Stls	Pages	DASD
12:20:00	26	18.7	2.2	63	33	20.4	8K	7.5	0	2K	0	8K	2K	0.1	180	1K	0	3K	1K	55	0	0.1	253	261
12:35:00	26	19.1	2.1	63	8.5	5.4	10K	5.8	0	2K	0	8K	2K	0.0	69.9	1K	0	3K	1K	10	0	0.0	53	185
12:50:00	26	18.3	2.0	69	6.0	4.2	11K	4.7	0	1K	0	8K	2K	0.0	43.6	1K	0	3K	1K	12	0	0.0	33	167
13:05:00	27	19.5	2.2	38	29	11.0	12K	5.2	0.4	2K	0	8K	2K	1.2	1062	1K	0	3K	2K	63	0.0	1.3	571	406
13:26:00	**31**	**17.4**	**1.7**	**28**	**28**	**8.0**	**14K**	**12**	**0.7**	**4K**	**0**	**8K**	**4K**	**2.8**	**1324**	**272**	**0**	**3K**	**2K**	**3.7**	**0.0**	**4.5**	**1090**	**356**
13:41:00	25	19.9	2.9	69	60	41.5	14K	7.5	0	3K	0	8K	3K	0.5	483	727	0	3K	2K	2.0	0	0.2	742	422

Guideline - SET MDC STORAGE 128M 128M

z/VM Storage and Paging Architecture Moving Target

z/VM shared storage / Overcommit

- Objective: Page unused pages out to allow re-use
- Need optimal test before paging to slow disk
- Optimize page-in when needed (block paging)

The problem? Which servers, which pages are truly idle

Architectures to choose from:

- Excessive Storage – enough so no paging (expensive)
- Solid State paging device – sort of fast (SSD, Flash)
- Disk paging devices – not fast

z/VM Page Space

Overcommitting real storage is good - reduces cost

- Back up is Paging storage

If 40GB main storage

- Overcommit factor of 2 - How much paging storage needed?
- VM installations often very under-configured
- **Guideline: Paging storage should still be 2 times requirement**

Number of paging devices? Number of channels?

- ROT not valid, model-27 often used for page space
- Hyperpav now valid for page devices - value?

Lack of page space planning is top reason for first installation z/VM outage

"Pre-write" option can fill up page space. ALERT!

Strategy / best practices in past if overcommit high

- Need high speed page recovery

~~Expanded Storage was used for "30 second test case"~~

- Pages migrated to disk after 30 seconds
- Minimum 20% of storage reconfigured to Expanded Storage
- Page-in from expanded storage was **synchronous,** FAST
- Pages migratable to disk after 30 seconds unreferenced

"New" strategy is IBR (z/VM 6.3)

- Invalid But Resident
- VERY LIMITED. 5% is the max
- 2% is the default, Go the max!

z/VM Storage Management Options

System Age List

- Maximum 5%,
- Recommend 5% always
- SET AGELIST SIZE 5% EARLYWRITES YES KEEPSLOT YES

```
-Set--AGELIST---.-SIZE--.-n.n--PERCent-.-.
                |       |-n.n%---------| |
                |       '-storsize-----' |
                |-EARLYWrites--.-Yes-.---|
                |              '-No--'   |
                '-KEEPSlot--.-Yes-.------'
                            '-No--'
```

- CP QUERY AGELIST (default)

```
Target size    =          280576K (274M)      2.0% of pageable storage
In use         =          271712K
Pending writes =          120296K
Early writes   = Yes
Sizing         = Variable
```

Real vs Virtual: CPU

Real CPUs

- Capacity planning sees Real resources
- Users see Virtual resources

Virtual CPUs

- Historically, one thread = one core
- SMT says two threads on one core
- Linux sees thread, limited by thread(s)
- Users see thread

Virtual Resources

- What end users see
- Lack of virtual memory causes problems
- Lack of virtual CPUs causes problems

How many Virtual Processors?

Linux is multiprocessor capable

Global lock is large issue on older Linux

- One processor acquires lock
- Other processors attempt to spin
- On 390 – spin converted to Diagnose 44 (now 9C)

Problem easily detected

- High Diagnose -> Instruction Simulation -> SIE
- High TV ratio
- Guideline: Minimize virtual processors

CASE STUDIES>>>>

How many Virtual Processors

CPU Performance typical of many Linux Apps:

- High Diagnose 44 -> Instruction Simulation -> SIE
- z/VM 5.2 modified logic –Linux mostly now to use Diagnose 9C
- **VALIDATE YOUR LINUX SERVERS**

Report: **ESACPUA** CPU Utilization Analysis

		<CPU percents>			**<--Internal (per second)-->**					SIGP
		Totl	Ovrhead		**Diag**	**Inst**	**SIE**	Fast	Page	Rate
Time	CPU	Util	Usr	Sys	**nose**	**Sim**	**intrcp**	path	fault	/sec
16:01:00	0	66.6	12	25	80K	82K	83275	2108	0.1	350
	1	67.6	12	25	89K	91K	91879	1051	0	332
	2	62.3	12	24	83K	85K	85768	1219	0.1	383
	3	62.7	11	25	77K	78K	79354	776	0	293
	4	63.6	12	24	84K	85K	86175	1047	0.0	329
	5	63.1	11	26	82K	84K	85064	1188	0.0	297
	6	64.1	11	22	83K	84K	84874	1079	0.0	304
	7	57.3	10	22	73K	75K	75481	1044	0.0	323
	8	62.7	10	26	53K	57K	58761	1421	0.1	267
System:		570	101	218	**704K**	**723K**	**730630**	11K	0.2	2879

How many Virtual Processors

CPU Performance typical of many Linux Apps:

- High Diagnose 9C -> Instruction Simulation -> SIE
- Still a problem if too many vCPU

```
Report: ESADIAG      Diagnose Rate Report
-------------------------------------------------------------------
Date      CPU <--Total-->   <-------------------------------Diagnose Count
/Time         <Diags/Sec>   DIAG: Rate DIAG:Rate DIAG: Rate DIAG: Rate
              User  IBM
-------- --- ----- -----    ----- ---- ----- ---- ----- ---- ----- ----
10:45:00   0     0  1954    0000:  0.0 0008:  0.9 000C:  0.1 0024:  0.0
                             0068:  0.0 007C:    0 0098:    0 009C: 1733
           1     0  2593    0000:  0.0 0008:  0.9 000C:  0.1 0024:  0.0
                             0068:  0.0 007C:  0.0 0098:    0 009C: 2403
           2     0  1891    0000:  0.0 0008:  2.4 000C:  0.2 0024:  0.0
                             0068:  0.0 007C:    0 0098:    0 009C: 1654
           3     0  2174    0000:  0.0 0008:  0.6 000C:  0.0 0024:  0.0
                             0068:  0.0 007C:    0 0098:    0 009C: 1977
          14     0  1473    0000:  0.0 0008:  0.5 000C:  0.1 0024:  0.0
                             0068:  0.0 007C:    0 0098:    0 009C: 1351
           ----- ----- ----- ---- ----- ---- ----- ---- ----- ---- -
System:        0 26540    0000:  0.1 0008: 11.5 000C:  1.1 0024:  0.1
                             0068:  0.2 007C:  0.0 0098:  0.0 009C:  24K
```

How many Virtual Processors

CPU overhead much better with DIAG9C

- High Diagnose 9C -> Instruction Simulation -> SIE
- Still a (smaller) problem if vCPU is over configured

Report: **ESACPUA** CPU Utilization Analysis

	<----Load---->				<CPU percents>			<--Internal (per		
	<-Usrs-->		Tran		Totl	Ovrhead		Diag	Inst	SIE
Time	Actv	In Q	/sec	CPU	Util	Usr	Sys	nose	Sim	intrcp
10:45:00	65	132	1.7	0	90.7	1.8	2.3	1954	3124	9134.7
				1	91.7	1.7	2.2	2593	3787	9724.0
				2	91.4	1.7	2.3	1891	3059	8805.9
				3	91.9	1.7	1.9	2174	3380	8843.5
				4	91.9	1.6	1.9	2156	3245	8627.6
				12	79.5	1.8	2.4	1375	2430	7065.5
				13	78.9	1.7	2.1	1851	2857	7179.6
				14	75.1	1.6	2.0	1473	2402	6483.7
System:					1285	**25**	**31**	27K	43K	116734

New Linux MIB: Diagnose table

The Velocity MIB exposes the Linux data

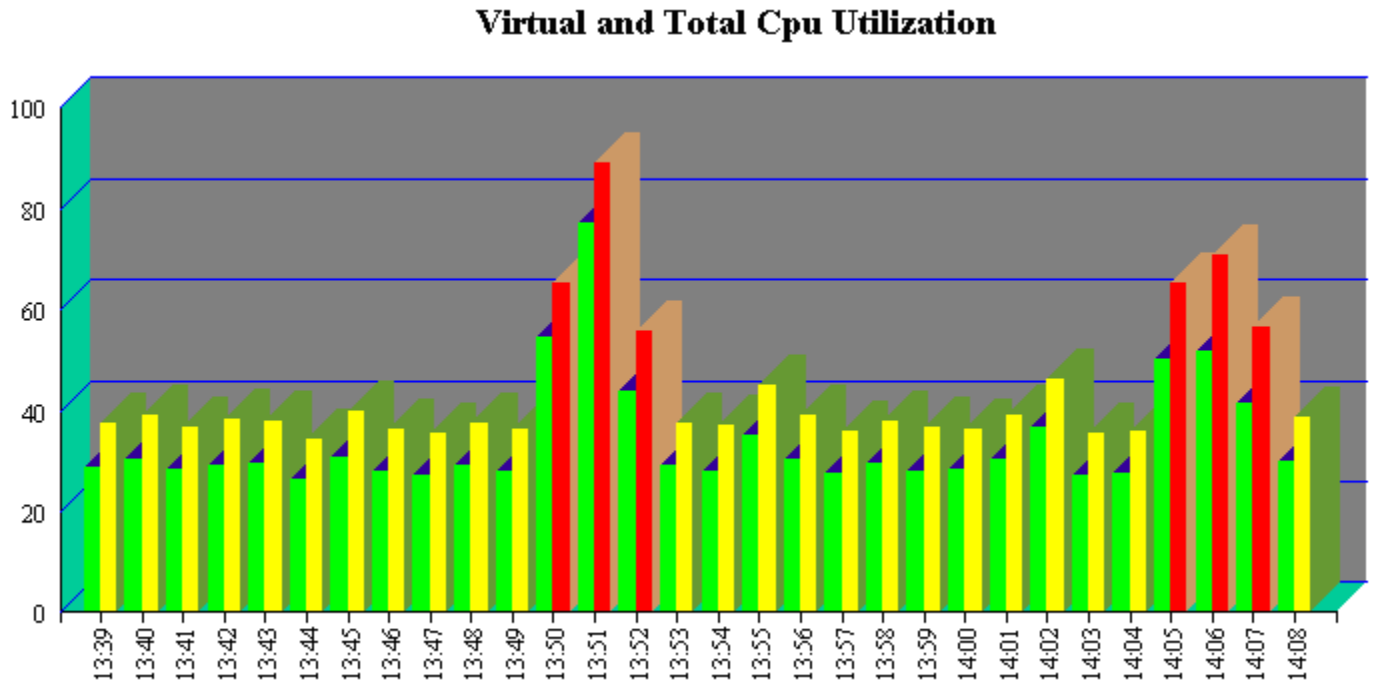
- Our SLES12 server does DIAG44

```
Report: ESALNXG       LINUX VSI System Analysis Report                Velo
Monitor initialized: 01/23/18 at 16:03:59 on 2828 serial 0314C7       Firs
-------------------------------------------------------------------------
Node/     <cpu> <------------Diagnose Rates Per Second-----------------
Time      nbr    008  00C  010  014  044  064  09C  0DC  204  210  224
-------- ---   ---- ---- ---- ---- ---- ---- ---- ---- ---- ---- ---- -
16:05:00
sles12     1       0    0    0    0  283    0  0.0    0    0    0    0
           2       0    0    0    0  0.1    0  0.2    0    0    0    0
-------------------------------------------------------------------------
16:06:00
sles12     1       0    0    0    0 14.6    0  0.0    0    0    0    0
           2       0    0    0    0  269    0  0.0    0    0    0    0
-------------------------------------------------------------------------
16:07:00
sles12     1       0    0    0    0  306    0    0    0    0    0    0
           2       0    0    0    0  0.0    0  0.1    0    0    0    0
```

Infrastructure: SOP Valid?

Question:

- Why always hit every 15 minutes?



SOP: Standard Operating Procedures need to be evaluated

Infrastructure: Operational Alerts are REQUIRED

Detect and alert looping processes:

```
Report: ESAHST1       LINUX HOST Software Analysis Report
Monitor initialized:                        on 2066 serial 71CE3
-------------------------------------------------------------------
Node/     <-----Software Program-------> <CPU Seconds> CPU  StgSize
Time      Name       ID    Type   Status  Total Intrval Pct  (Bytes)
--------  --------  ----  ------ ------- ----- ------- ---- -------
08:32:00
LINUXA
          init          1  Applic ResWait   0.9     0.0  0.0   61440
          kjournal     95  Applic ResWait   2.5     0.0  0.0       0
          db2fmd      596  Applic ResWait   0.3     0.0  0.0  573440
          sshd       1081  Applic ResWait   0.4     0.0  0.0  204800
          event     10787  Applic ResWait  19.5     0.0  0.0  11188K
          snmpd     10861  Applic Running 193.4     4.2  7.1   1492K
          adminp    11452  Applic ResWait  58.5     0.0  0.1  13848K
          server    11525  Applic ResWait   1.0     0.1  0.1  35720K
          server    11533  Applic ResWait   4.3     0.0  0.0  35720K
          server    11537  Applic Running 44697    58.3 99.2  35720K
          java      13024  Applic ResWait   0.0     0.0  0.0   6632K
          java      24016  Applic ResWait   1.9     0.0  0.0   6632K
          java      24024  Applic ResWait   4.9     0.0  0.0   6632K
          server    24192  Applic ResWait  19.0     0.1  0.1  35720K
          java      26352  Applic ResWait   0.4     0.0  0.0   7320K
          sshd      26477  Applic ResWait   0.2     0.0  0.1   2028K
```

Shows process by ID:

- Status
- Total CPU
- Percent CPU
- Storage

(Non-Velocity MIB)

Linux Configuration Summary

Virtual machine size

- Minimize until some swap

Swapping

- Swap to virtual disk
- Define 2 virtual disks,
- One to meet the average requirement
- Second one for overflow - Insurance
- Use DIAG driver instead of FBA
- Reduces I/O by factor of 8

Virtual processors

- Minimize to meet the workload/application requirement
- Ensure DIAG9C, not DIAG44

Infrastructure costs

- Minimize – shared resource architecture

z/VM Subsystem Configuration

DASD Channels

- ECKD “Measurable” by channel hardware
- FCP/SCSI measurable from inside each Linux

Paging

- How much paging is required to support 2 times over commitment of 40GB z/VM system?
- At least 80 GB

MDC

- Caches data – read-ahead, often used data
- Default too high
- SET MDC STORAGE 128M 128M

Linux Process Analysis

Many ways to look at Linux process data:

- By process (ESALNXP)
- By process name, show combined by process name (ESAHSTA)
- By Application – Parent/child relationship (ESALNXA)
- By Application across node groups (ESALNXA)

- By container (application, ESAK8S2)
- By pod (combine containers, ESAK8S2)

- By user (ESALNXU)

Analyzing Linux CPU

```
Report: ESALNXP       LINUX HOST Process Statistics Report
Monitor initialized: 02/05/07 at 10:41:41 on 2084 serial 5
-------------------------------------------------------------
node/      <-Process Ident-> Nice <------CPU Percents---->
 Name      ID    PPID   GRP  Valu  Tot  sys user syst usrt
--------- ----- ----- ----- ---- ---- ---- ---- ---- ----
10:43:00
dominoz1      0     0     0    0  9.9 3.20 6.69    0    0
 ksoftirq     5     1     0   19 0.03 0.03    0    0    0
 ksoftirq     7     1     0   19 0.05 0.05    0    0    0
 kswapd0    134     1     1    0 0.05 0.05    0    0    0
 kjournal  1140     1     1    0 0.08 0.08    0    0    0
 snmpd     1775     1  1774  -10 0.27 0.16 0.11    0    0
 scontrol 24521 24445 24414    0 0.03    0 0.03    0    0
 server   24539 24521 24414    0 1.46 0.41 1.06    0    0
 logasio  24553 24539 24414    0 0.14 0.11 0.03    0    0
 event    28636 24539 24414    0 0.16 0.03 0.14    0    0
 replica  28663 24539 24414    0 1.76 0.27 1.49    0    0
 update   28665 24539 24414    0 5.36 1.92 3.44    0    0
 amgr     28667 24539 24414    0 0.03    0 0.03    0    0
 adminp   28670 24539 24414    0 0.19 0.08 0.11    0    0
 sched    28676 24539 24414    0 0.03    0 0.03    0    0
 rnrmgr   28686 24539 24414    0 0.03    0 0.03    0    0
 clrepl   28920 24539 24414    0 0.22    0 0.22    0    0
```

Velocity MIB data:

- Provides process data
- Parent/Child relationship

Note ALL application processes are owned by “24445”

Analyzing Linux CPU by Application

```
Report: ESALNXA       LINUX HOST Application Report
Monitor initialized: 02/05/07 at 10:41:41 on 2084 ser
-------------------------------------------------------
Node/     Process/    ID    <---Processor Percent--->
Date      Application             <Process><Children>
Time      name              Total sys  user syst usrt
--------  ----------- ----- ----- ---- ---- ---- ----
10:43:00
dominoz1 *Totals*         0   9.9  3.2  6.7    0    0
         bash         24445   9.4  2.8  6.6    0    0
         kernel           1   0.2  0.2    0    0    0
         snmpd         1775   0.3  0.2  0.1    0    0
```

Velocity MIB data:

- Provides process data
- Parent/Child relationship
- Allows combining into “applications”
- Note the “bash/24445” “application”

Define alerts based on application

Analyzing Linux CPU by Userid

```
Report: ESALNXU       LINUX USER Analysis Report        Linux Te
Monitor initialized: 02/05/07 at 10:41:41 on 2084 serial 55BAF
-------------------------------------------------------------------------------
Node/                                                 <---Processor Percent--->
Date      <---------User and Group Identity------>      <Process><Children>
Time      Userid       GroupID      usrpid grppid Total sys  user syst usrt
--------- ------------ ------------ ------ ------ ----- ---- ---- ---- ----
10:43:00

dominoz1 bin          root            1      0     0    0    0    0    0
         daemon       daemon          2      2     0    0    0    0    0
         lp           lp              4      7     0    0    0    0    0
         notes        notes        1001   1001   9.4  2.8  6.6    0    0
         root         root            0      0   0.5  0.4  0.1    0    0
```

Velocity MIB data:

- Provides process data
- Parent/Child relationship
- Reporting by Linux userid
- Allows alerts by userid

Analyzing Linux CPU by Userid

Velocity MIB data: Process by user, by node, by node group

```
Report: ESALNXU      LINUX Process by User Analysis Report          Velocit
-------------------------------------------------------------------------
Node/                                                <---Processor Percent--->
Date      <---------User and Group Identity------>      <Process><Children>
Time      Userid       GroupID      usrpid grppid Total sys  user syst usrt
--------  -----------  -----------  ------ ------ ----- ---- ---- ---- ----
11/06/23
17:01:00
***Node Groups***
RHEL      postgres     postgres          0      0   0.2  0.0  0.1    0  0.0
          root         root              0      0  13.4  3.2  8.0  1.1  1.1
          scalemgmt    scalemgmt         0      0   2.1  0.1  0.9  0.4  0.7
          splunk       splunk            0      0   0.3  0.1  0.2    0    0
COREOS    nobody       nobody            0      0  37.0  3.1 33.9    0    0
          root         root              0      0 271.3 31.0  114 57.7 68.2
          unknown      root              0      0 147.9 18.6 49.2 19.3 60.8
          unknown      systemd-oom       0      0   0.4    0    0  0.2  0.2
          unknown      unknown           0      0   6.1  2.2  3.9  0.0  0.0
```

Analyzing Linux Disks

```
Report: ESAHST2       LINUX HOST Storage Analysis Report
Monitor initialized: 02/05/07 at 10:41:41 on 2084 serial 55BAF
-------------------------------------------------------------------
NODE/            <-Utilization->          <------Storage------>
Time/            <MegaByte>  Pct          Alloc
Date      Index  Size  Used Full  Errors  Units  Description
--------  -----  ----  ---- ----  ------  -----  ---------------
10:43:00
acme
              1   495  14.2  2.9       0   1024  Memory Buffers
              2   495   487 98.4       0   1024  Real Memory
              3  2031  12.8  0.6       0   1024  Swap Space
              4  2310   775 33.6       0   4096  /
              6  2310  1293 56.0       0   4096  /usr
dominoz1
              1  2002  38.5  1.9       0   1024  Memory Buffers
              2  2002  1994  100       0   1024  Real Memory
              3  2031  97.4  4.8       0   1024  Swap Space
              4  2310  1556 67.4       0   4096  /
              6  2310  1398 60.5       0   4096  /usr
              7  984K  238K 24.2       0   4096  /notesdata
ebiz1
              1   997   9.0  0.9       0   1024  Memory Buffers
              2   997   992 99.5       0   1024  Real Memory
              3  2031   514 25.3       0   1024  Swap Space
              4  2310  1607 69.6       0   4096  /
              6  2310  1451 62.8       0   4096  /usr
              7  101K   10K 10.3       0   4096  /notesdata
```

HOST MIB data:

- Provides disk data
- Percent full
- Supports WinNT,Unix
- Alerts by disk full

Analyzing Linux Disks

HOST MIB data:

- Provides disk data, by disk, by server, by node group

```
Report: ESAHST2       LINUX HOST Storage Analysis Report              Veloc
-------------------------------------------------------------------------
NODE/            <-Utilization->                    <------Storage------>
Time/            <MegaByte>  Pct           R/W  Boot Alloc
Date      Index  Size  Used Full  Errors  R/W  Flag Units  Description
-------- -----  ----  ---- ----  ------  ---  ---- -----  -------------
11/06/23
17:01:00
***Node Groups***
RHEL
              0  390K   97K 24.8       0  No   No    1024  Totals
COREOS
              0   27M  5.7M 21.5       0  No   No    1024  Totals
```

Summary

Real storage needs to be managed

Virtual CPUs need to be managed

Default parameters should be reviewed

Measurements and understanding are available