Linux Storage Understanding and Analysis

http://velocitysoftware.com/lnxstg.pdf

www.VelocitySoftware.com
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PROVEN PERFORMANCE

Metrics Process

- Determine available metrics
- Exploit available metrics
- Understand metrics
- Evaluate value, accuracy
  - (Performance research)

Topics

- **Storage opportunities**
- **Performance measurement and tuning**
  - Swapping to VDISK analysis
  - Storage Analysis and Tuning (XIP, CMM)
- **Linux Storage**
- **XIP**
- **CMM**
- **z/VM 6.3 Topics**
- **zVPS 4.2**

Linux Storage: Performance

- **Storage is always an issue.**
  - Other platforms increase storage to fix performance problems
  - "z" objective is to share storage effectively (overcommit)
  - Smaller (virtual) servers run faster
  - Oracle was Virtual Friendly
- **Current research:**
  - CMM
  - **Metrics**
  - **z/VM 6.3 ("virtual friendly" has changed)**

Linux Storage Tuning Summary

- **Minimize the virtual machine size Until it starts to swap**
- **Use VDISK for swap**
  - Allocate 2 vdisks for swap disks
  - Prioritize the disks!
  - Change any “real” swap disks to VM paging packs
- **Use XIP to reduce storage**
- **Use CMM to temporarily reduce storage and other games**

VMRM, CMMA, CMM1

- **VMRM Does not have feed back or Linux data**
  - Often crashes Linux servers
  - Does not differentiate between Oracle or WAS servers
  - Recent experiment: Started database load, VMRM took more storage away from server
- **CMMA – discontinued**
  - Project involving kernel, z/VM, microcode
  - No validated positive experience (reported crashes/lpars)
  - Driver withdrawn by Novell in SLES11,
    - (replaced by CMMA-lite)
- **CMM1**
  - Very positive results (but can crash a server if used with no feedback)
  - Requires intelligence, knowledge and feedback

Tuning Objectives

- **Maximize SYSTEM Throughput**
  - Storage is always a challenge
  - Must trade off Linux storage size and VM System Paging
  - (or buy LOTS more storage)
- **Storage (ram) Opportunities**
  - Minimize server size **(CMM)**
  - Swap to VDISK
  - Shared NSS, DCSS (XIP)
- **Available Metrics:**
  - ucd snmpd – standard with Linux

Tailoring Linux Storage

Linux data shows
- Real storage
- Swap storage
- "cache"

Some Swapping "good"

If not swapping,
- reduce vm size
- Use CMM to reduce

Report: ESAUCD2 LINUX UCD Memory Analysis Report TEST MAP

Node/	<-Storage Sizes (in MegaBytes)->										
Time/	<--Real Storage-->			<-----SWAP Storage---->				Total	<--Storage in Use->		
Date	Total	**Avail**	Used	Total	Avail	**Used**	MIN	Avail	Shared	Buffer	**Cache**
20:58:35											
LNXldap	122.4	4.6	117.8	511.4	501.2	10.2	15.6	505.8	0	17.1	49.6
LNXnfs	193.1	4.6	188.5	511.4	511.0	0.4	15.6	515.6	0	29.6	55.7
LNXzero	122.8	3.4	119.3	444.2	436.1	8.1	15.6	439.5	0	19.6	43.2
LNXdna2	499.6	**182.9**	316.8	317.3	317.3	0	15.6	500.1	0	25.7	164.5
LNXdna3	499.6	25.0	474.6	511.4	511.4	0	15.6	536.4	0	38.7	315.0
LNXtux	502.2	6.7	495.5	571.1	571.1	0	15.6	577.8	0	108.9	180.8
LNXPRbt0	499.6	22.9	476.7	511.4	511.4	0	15.6	534.3	0	94.6	241.5
LNXPRbt1	499.6	27.6	472.0	511.4	511.4	0	15.6	539.0	0	25.2	299.9
LNXPRbt2	287.4	18.5	268.9	511.4	511.4	0	15.6	529.9	0	30.7	106.3
LNXPRci1	499.6	10.1	489.5	511.4	358.6	**152.9**	15.6	368.7	0	20.6	269.4
LNXPRci2	499.6	21.3	478.4	511.4	449.8	61.7	15.6	471.0	0	17.7	164.5
LNXPRot1	499.6	8.5	491.1	511.4	394.6	116.8	15.6	403.1	0	39.0	164.5
LNXPRot3	704.0	12.1	691.8	511.4	511.4	0	15.6	523.6	0	28.9	239.9
LNXPRot5	499.6	4.0	495.6	511.4	451.3	60.1	15.6	455.3	0	4.4	426.5
LNXPRic1	499.6	31.6	468.0	511.4	462.5	48.9	15.6	494.1	0	20.6	184.6
LNXPRic5	248.1	5.6	242.5	511.4	437.8	73.6	15.6	443.4	0	2.4	201.0
LNXPRic6	248.1	5.7	242.4	511.4	467.7	43.7	15.6	473.5	0	2.3	194.8
LNXPRic2	499.6	27.6	472.0	511.4	511.4	0	15.6	539.0	0	38.7	213.9
LNXPRiv1	499.6	16.0	483.6	511.4	316.7	**194.7**	15.6	332.7	0	2.8	281.7
LNXPRmx1	499.6	29.7	470.0	511.4	511.4	0	15.6	541.1	0	15.3	151.6
LNXPRmx2	499.6	27.8	471.8	511.4	459.2	52.3	15.6	487.0	0	14.6	143.1
LNXPRbq1	499.6	11.6	488.1	511.4	453.2	58.2	15.6	464.8	0	16.3	92.5
LNXPRsd1	499.6	23.7	475.9	1023	1023	0	15.6	1047	0	3.9	411.0
LNXPRkf1	499.6	**161.8**	337.8	511.4	511.4	0	15.6	673.2	0	22.7	178.9
LNXPRot2	751.1	13.5	737.6	511.4	511.4	0	15.6	524.9	0	47.3	235.8
LNXPRa8	502.3	21.5	480.8	507.7	507.7	0	15.6	529.2	0	18.9	292.3

Tailoring Linux Storage

Node Groups -Group by ESX

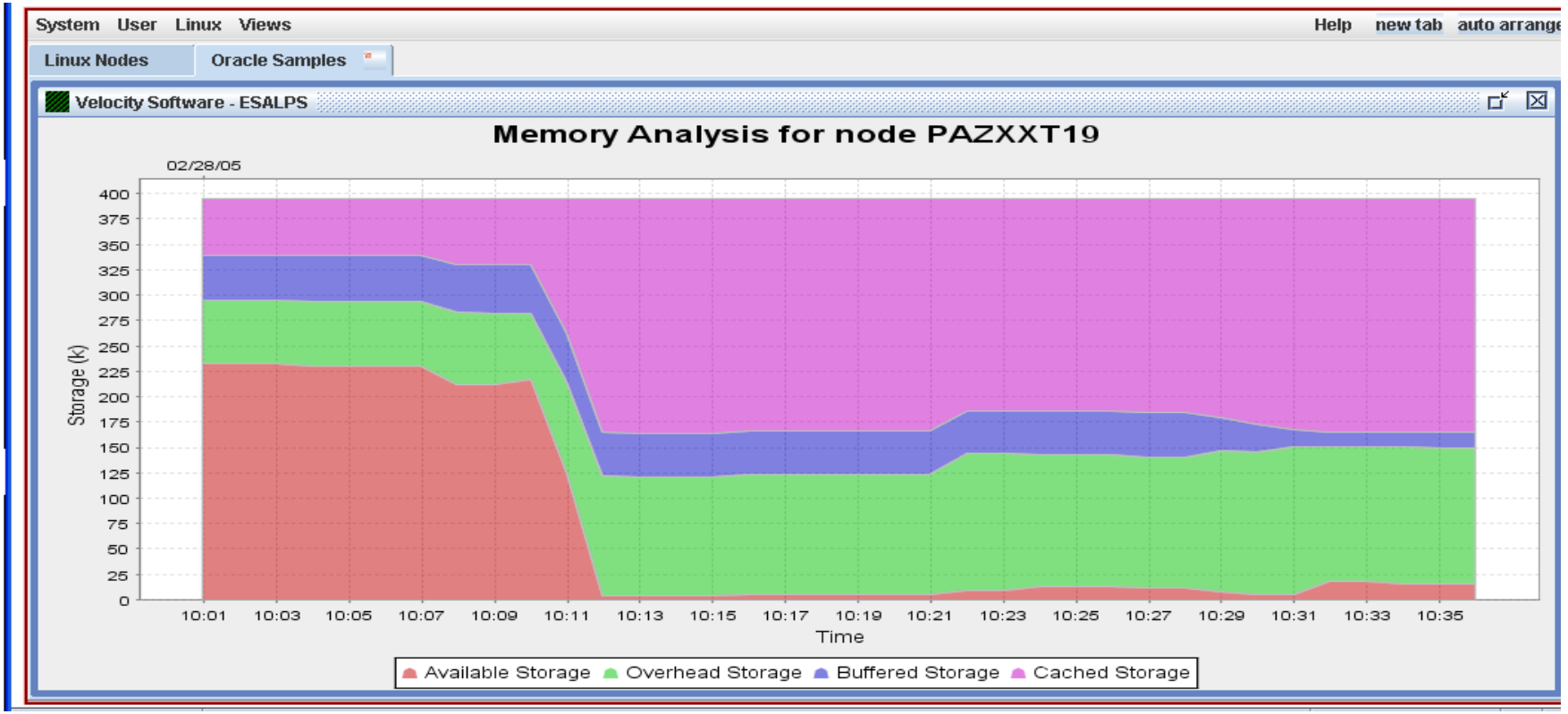
```
Report: ESAUCD2      LINUX UCD Memory Analysis Report  Velocity Software Corporate
Monitor initialized: 06/20/13 at 00:00:00 on 2096 serial 44B42     First record
-------------------------------------------------------------------------------
Node/    <-------------------------Storage Sizes (in MegaBytes)------------------->
Time/    <--Real Storage--> <-----SWAP Storage----> Total <----Storage in Use----->
Date     Total  Avail Used  Total Avail Used  MIN   Avail CMM    Buffer Cache Ovrhd
-------- ----- ----- ----- ----- ----- ----- ----- ------ ------ ----- ----- ------
00:15:00
***Node Groups***
REDHAT   3477.6 104.4  3373 14609 13490  1119  93.7 13595      0  644.8  1272  1456
SUSE      11098 873.8 10224 25733 24337  1395 193.7 25211      0 1867.6  4367  3989
SOLARIS  2535.1 215.6  2320  1792 888.4 903.6  31.2 720.3      0      0     0  2320
VMWARE   1985.9 135.8  1850  5636  5454 182.7  46.9  5589      0  448.7 779.2 622.1
*TheUsrs  10084  2602  7482  1250 883.4 366.4 187.5  3485   73.2  745.7  5289  1447
*** Nodes *******
redhat01  496.9  12.5 484.3  1024  1024   0.1  15.6  1036      0   56.4 338.1  89.8
redhat5   499.2  17.5 481.7  4095  3561 533.2  15.6  3579      0   63.8  24.9 393.0
redhat5x  497.1  18.2 478.9  4095  3874 220.5  15.6  3892      0   96.9  55.7 326.3
linux93  1011.4  21.5 989.9  1914  1336 578.2  15.6  1357      0   61.2  91.4 837.3
redhat56  497.0  17.4 479.7  1176 820.1 355.9  15.6 837.5      0   71.3  40.7 367.6
linux64  2013.1  15.8  1997     0     0     0  15.6  15.8      0   71.4  1819 107.0
rhel55v   498.5  22.5 476.1  2047  2047   0.1  15.6  2070      0  133.0 139.3 203.8
rhel64v   996.4  82.8 913.7  2047  2047     0  15.6  2130      0  194.7 536.2 182.7
roblx2    996.5 466.8 529.8 256.0 256.0     0  15.6 722.7      0  145.0 249.8 135.0
solarisa 1535.6 166.1  1369 768.0 768.0     0  15.6 700.2      0      0     0  1369
solarisb  999.6  49.5 950.1  1024 120.4 903.6  15.6  20.2      0      0     0 950.1
```

Linux Storage

- **Linux**
  - Kernel – Fixed at boot, includes Page management structures **(not reported)**
  - Available - small
  - Buffer – write buffer, small
  - Cache – includes programs, Oracle SGA, data
  - Overhead / anonymous – page tables, working storage
- **Linux Swap**
  - Disk
  - Virtual disk
- **Opportunities**
  - XIP/DCSS
  - NSS
  - Collaborative Memory Management (CMM 1)

Linux Storage

Following picture shows available storage as oracle starts



Understanding Linux Storage

- **Linux Storage management effective**
  - Programs loaded once, read/only
  - Modified pages become owned by process
  - Shared storage (overlap) difficult to analyze
  - For oracle processes, difficult to know how much storage is shared

```
Report: ESALNXC      LINUX Process Configuration Report
-------------------------------------------------------------------
Node/        <-Process Ident-> <-----Process---> <Storage(k)> Proc
 Name        ID    PPID   GRP  Path     parms     Size  RSS   TYPE
------------ ----- ----- ----- -------- -------- -----  ----- ----
PAZXXT19
 init           1     0     0 init [3] "          696   288    4
 snmpd       2574     1  2573 snmpd    -a        9788  5652    4
 nscd        2867     1  2867 /usr/sbi "        42928   916    4
 oracle      9729     1  9729 ora_dbw0 "         284K 28364    4
 oracle      9731     1  9731 ora_lgwr "         296K  7112    4
 oracle      9755     1  9755 ora_j000 "         283K 55964    4 -→ largest process
 oracle      9761     1  9761 ora_j003 "         282K 17880    4
 oracle     13956     1 13956 oracleor (DESCRIP  282K 22004    4
 oracle     13960     1 13960 oracle   "         282K 22072    4
```

XIP in DCSS

- **Costs (Two xip experiments had higher costs)**
  - Addressability – Page management structures
    - Use “mem=“ to increase addressability
  - DCSS Storage
    - Evaluate resident storage
- **Benefits**
  - Reduced Linux Storage
  - Impacts the “page cache” requirement
- **Some measurements showed costs can outweigh benefits!**
  - Increase in kernel size, VM working set size
  - Increase in overhead

Testing Linux Storage “mem=”

- **Measure Linux overhead (SLES9/2.6 Kernel)**
  - Assumption is DCSS in high storage somewhere
  - Kernel size (page structure tables)
  - Linux reported “total storage” excludes kernel
- **SUSELNX1 (256mb, 31-bit)**
  - mem=1gb
- **SUSELNX2 (256mb, 31-bit)**
  - mem=256mb

```
Report: ESAUCD2      LINUX EXAMPLE      Linux Test
-------------------------------------------------
Node/    <------------------Mega Bytes---------->
Time/    <--Real Storage--> . <----Storage in Use-
Date     Total  Avail Used  . Shared Buffer Cache
-------- ------ ----- ----- . ------ ------ -----
10:26:00                    .
SUSELNX1  239.3 175.8  63.5 .      0   18.6  26.1
SUSELNX2  247.3 182.8  64.5 .      0   18.5  26.2
```

Testing VM's working set "mem=256M"

- **Force storage contention,**
  - only referenced pages resident (low point 1150 pages)

```
Report: ESAUSR2      User Resource     Linux Test
-------------------------------------------------------------
        <---CPU time--> <-Pages-->  <------Paging (pages)------->
UserID  <(seconds)> T:V <Resident>  <---Allocated---> <---I/O--->
/Class  Total  Virt Rat Totl Activ  Total ExStg  Disk  Read Write
-------- ----- ----- --- ---- -----  ----- -----  ----- ----- -----
14:47:00
SUSELNX1  2.48  2.03 1.2  16K 16222      0     0     0     0     0  ==➔ All storage resident
14:48:00
SUSELNX1  2.47  2.03 1.2  16K 16222      0     0     0     0     0
14:49:00
SUSELNX1  3.05  2.28 1.3 5584  5584  11037   907 10130  1021 10145  ==➔ contention starts
14:50:00
SUSELNX1  4.98  4.15 1.2 1879  1879  14937    21 14916  2916  5033  ==➔ Page stealing
14:51:00
SUSELNX1  2.68  1.92 1.4 1189  1189  15658   197 15461  2974  2028
14:52:00
SUSELNX1  5.63  5.01 1.1 1196  1196  15754   366 15388  3082  2271
14:53:00
SUSELNX1  3.89  3.13 1.2 1160  1160  15819   410 15409  2431  1907  ===➔ Minimum storage requirement (SNMP ONLY)
14:54:00
SUSELNX1  3.33  2.63 1.3 1461  1461  15498   195 15303   143    52  ===➔ init,kblockd,pdflush
14:55:00
SUSELNX1  3.33  2.67 1.2 1331  1331  15630   362 15268    37     0  ==➔ storage starts to drop
14:56:00
SUSELNX1  3.70  2.94 1.3 3910  3910  15405   144 15261  2361     0  ==➔ Start "top" – cost 10MB
14:57:00
SUSELNX1  5.04  4.40 1.1 4135  4135  15056   136 14920   217     0
```

Testing VM's working set "mem=256M"

Process activity during measurement

```
Report: ESALNXP      LINUX HOST Process Statistics Report
------------------------------------------------------------------------
node/     <-Process Ident-> <-----CPU Percents----------> <Stg (k)>
 Name     ID    PPID   GRP   Tot  sys user syst usrt nice  Size RSS
--------- ----- ----- ----- ---- ---- ---- ---- ---- ---- ---- ----
14:54:00
SUSELNX1      0     0     0 10.0  8.1  1.8    0    0    0 135K  53K
 init         1     0     0  0.5  0.4  0.0    0    0    0  628  100  ==➔ kernal processes
 kblockd/     6     4     0  0.1  0.1    0    0    0    0    0    0
 pdflush   1509     4     0  0.4  0.4    0    0    0    0    0    0
 snmpd     1817     1  1816  4.0  3.0  1.0    0    0    0 7060 4016
 slpd      1832     1  1832  0.2  0.2  0.0    0    0    0 3588 1244
------------------------------------------------------------------------
14:55:00
SUSELNX1      0     0     0  6.3  4.0  2.3    0    0    0 135K  53K  ==➔ storage requirements drop
 snmpd     1817     1  1816  2.6  1.6  1.0    0    0    0 7060 4016
------------------------------------------------------------------------
14:56:00
SUSELNX1      0     0     0  9.7  6.2  3.5    0    0    0 135K  53K
 snmpd     1817     1  1816  3.8  2.4  1.4    0    0    0 7060 4016
 sshd      2073  1868  2073  0.3  0.3  0.0    0    0    0 8392 2576
------------------------------------------------------------------------
14:57:00
SUSELNX1      0     0     0 13.3  8.8  4.5    0    0    0 137K  54K
 kjournal   277     1     1  0.2  0.2    0    0    0    0    0    0
 snmpd     1817     1  1816  2.4  1.7  0.8    0    0    0 7060 4016
 sshd      2073  1868  2073  0.6  0.4  0.2    0    0    0 8392 2580
 bash      2076  2073  2076  0.6  0.5  0.1    0    0    0 3204 1952
 top       2095  2076  2095  2.0  1.1  0.9    0    0    0 2132 1100   ==➔ top starts
```

Testing “mem=” impact on VM pages

Increasing “mem=“ from 256M to 1024M

- Increased kernal storage 8mb
- Increased VM working set 2000 pages (8mb)
- **NOTE, 64-bit Linux has DOUBLE COST**

If using XIP in DCSS

- Location of DCSS can create hidden cost
- If dcss is 1000M to 1024M instead of at 256M,
  - Added cost is 16mb REAL storage for 64-bit Linux
- If savings from DCSS is 8mb, then no savings using xip
- Page table requirement eliminated in 2.6.26 kernel

Implementing XIP

Choose processes for DCSS/XIP

Report: **ESALNXC** LINUX Process Conf Report

Node/ Name	<-Process Ident-> ID	PPID	GRP	<-----Pr Path	<Storage(k) Size	RSS	
SUSELNX1							
init	1	0	0	init [3]	628	99	
*	4	1	0		0	0	
khelper	5	4	0	khelper	0	0	
kblockd/	6	4	0	kblockd/	0	0	
pdflush	1516	4	0		0	0	
kjournal	277	1	1	pdflush	0	0	
rc	557	1	557	/sbin/sy	2616	144	
S14hwsca	1921	557	557	top	2616	256	
hwbootsc	1929	1921	557	sshd: ro	2612	208	
hwscan	1953	1929	557	-bash	2880	1064	
blogd	568	1	568	/sbin/kl	9824	76	
syslogd	1798	1	1798	/sbin/kl	1640	728	
snmpd	1817	1	1816	/sbin/re	7060	4016	-→ candidate
resmgrd	1830	1	1830	/sbin/po	1496	516	
portmap	1831	1	1831	/usr/sbi	1516	580	
syslogd	1841	1	1841	/sbin/re	1640	196	
klogd	1844	1	1844	/sbin/po	1596	224	
sshd	1868	1	1868	/sbin/mi	5304	1972	-→ candidate
sshd	2073	1868	2073	-bash	8392	2580	-→ candidate
bash	2076	2073	2076	top	3204	1952	-→ candidate
top	2095	2076	2095	sshd: ro	2132	1104	-→ candidate
sshd	6524	1868	6524	-bash	8392	2576	
bash	6527	6524	6527	pdflush	3208	1996	-→ candidate
bash	10430	6527	10430		3208	1996	-→ candidate
vi	10433	6527	10433		4100	2368	

Implementing XIP

Choose processes for DCSS/XIP

- Requires 13mb dcss, located at 64mb
- Measure the impact at process leveL
  - - saves about 5.3 MB virtual storage

```
Report: ESALNXP      LINUX HOST Process Statistics Report
-------------------------------------------------------------------
node/     <-Process Ident-> <-----CPU Percents----------> <Stg (k)>
 Name     ID    PPID   GRP   Tot  sys user syst usrt nice   Size RSS
--------- ----- ----- ----- ---- ---- ---- ---- ---- ----  ---- ----
SUSELNX1      0     0     0 10.6  6.2  4.4    0    0    0  131K  15K
 kjournal   279     1     1  0.1  0.1    0    0    0    0     0    0
 snmpd     1865     1  1864  1.3  0.7  0.6    0    0    0  7248 1948   → dropped 2.0 MB
 sshd      2125  1923  2125  0.6  0.5  0.2    0    0    0  8392  740   → dropped 1.2 MB
 bash      2128  2125  2128  0.2  0.2  0.0    0    0    0  3204  592   → dropped 1.4 MB
 top       3171  2128  3171  3.3  1.7  1.5    0    0    0  2132  288   → dropped .7 MB
```

Testing “xip” impact on VM pages

Comparable minimal storage: 1160 pages

- XIP reduces to 498 pages – 2.5mb Real saving

```
Report: ESAUSR2      User Resource U    Linux Test
-----------------------------------------------------------------------
         <---CPU time--> <--------Ma <------Paging (pages)-------->
UserID   <(seconds)> T:V <Resident>  <---Allocated---> <---I/O--->
/Class    Total  Virt Rat Totl Activ  Total ExStg  Disk  Read Write
SUSELNX1   4.21  3.63 1.2  16K 16186      0     0     0     0     0
16:29:00
SUSELNX1   5.04  4.46 1.1  16K 16186      0     0     0     0     0
16:30:00
SUSELNX1   2.90  2.31 1.3 1290  1290  15046 12465  2581   641  2759
16:31:00
SUSELNX1   5.59  5.04 1.1 1198  1198  15657  4912 10745  3548 10838
16:32:00
SUSELNX1   3.55  2.89 1.2  785   785  16417  1051 15366  2675  6475
16:33:00
SUSELNX1   5.90  5.35 1.1 1111  1111  16548  1206 15342  2547  1813
16:34:00
SUSELNX1   3.26  2.56 1.3  981   981  16667  1342 15325    35    15
16:35:00
SUSELNX1   4.64  3.96 1.2 1402  1402  16505  1232 15273   311     0
16:36:00
SUSELNX1   3.37  2.69 1.3  925   925  17015  1709 15306    89    89
16:37:00
SUSELNX1   4.68  3.99 1.2  738   738  17373  1993 15380   795   678
16:38:00
SUSELNX1   4.63  3.95 1.2  498   498  17639  2342 15297   155    48 --→ Minimum storage
requirement
```

Testing “xip” impact on Oracle pages

Two Oracle servers 400mb each (Unconstrained system)

- PAZXXT20 with dcss, dcss 420mb to 512M
- PAZXXT21 without dcss, savings 30MB virtual storage

```
Report: ESALNXP      LINUX HOST Process Statistics Report
-------------------------------------------------------------------
node/     <-Process Ident-> <-----CPU Percents----------> <Stg (k)>
 Name     ID    PPID   GRP   Tot  sys user syst usrt nice   Size RSS
--------- ----- ----- ----- ---- ---- ---- ---- ---- ----  ---- ----
14:42:00
PAZXXT21      0     0     0  5.1  0.6  0.1  1.2  3.2    0    6M 682K
 init         1     0     0  4.3    0    0  1.1  3.2    0   696  288
 kswapd0    232     1     1  0.2  0.2    0    0    0    0     0    0
 snmpd     2571     1  2570  0.4  0.3  0.1    0    0    0  9784 5644
 nscd      2859     1  2859  0.0  0.0    0    0    0    0   43K  912
 bash      3258  3257  3258  0.0  0.0    0  0.0    0    0  4788 2360
 oracle    3288     1  3288  0.1  0.1  0.0    0    0    0  296K  15K
 oracle    3290     1  3290  0.0  0.0    0    0    0    0  281K  15K
 oracle    3313     1  3313  0.0    0  0.0    0    0    0  283K  60K    --→ Largest Oracle Process

PAZXXT20      0     0     0 12.4  0.4  0.2  2.6  9.3    0   15M   1M
 init         1     0     0 11.9  0.0    0  2.6  9.3    0   696  288
 pdflush    231     4     0  0.0  0.0    0    0    0    0     0    0
 kswapd0    232     1     1  0.0  0.0    0    0    0    0     0    0
 snmpd     2575     1  2574  0.2  0.2  0.0    0    0    0  9788 5648
 bash      3265  3264  3265  0.0    0  0.0    0  0.0    0  4788 2360
 oracle    3295     1  3295  0.2  0.1  0.1    0    0    0  296K 7088
 oracle    3320     1  3320  0.0    0  0.0    0    0    0  282K  30K   --→ Largest Oracle process
```

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=VRM`

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

`cmm.sender=VRM`

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: Overview

CMM loaded as boot parameter:

[defaultboot]
default=linux
target=*/boot/* [linux]
image=/boot/vmlinuz-2.6.18-164.el5
ramdisk=/boot/initrd-2.6.18-164.el5.img
parameters="root=/dev/VolGroup00/root cmm.sender=VRM"

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:

```
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

```
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,
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)
```

Storage Metrics Version 2

Current, Available from UCD snmp mib (top, etc)

- RealSize (excludes Kernel, page structure tables)
- RealAvail (available list)
- Shared (not implemented)
- Buffer (write buffer)
- Cache (disk cache)
- “anonymous”, what was left (processes, slab)

Exploited: ESAUCD2

Accurate, capture ratio good

Deficiencies: **reduce storage until you swap**

System Storage Metrics Version 4.2

http://careers.directi.com/display/tu/Understanding+and+optimizing+Memory+utilization

VSI snmpd will expose new metrics

- 40 new System Storage Metrics
- 10 new process storage metrics

Process Storage Metrics zVPS Version 4.1

Current Storage system metrics

Available from Velocity Software snmp mib (top, etc)

- RSS
- SIZE

Exploited: ESALNXP, ESALNXC

Accurate, capture ratio not so good

- Shared storage missing

Deficiencies:

- How much storage is it using?
- ROT: reduce storage until you swap
- How much swapped?

Process Storage metrics (zVPS version 4.2)

New metrics

- RSS, Size - Same
- Locked: Locked memory size (mlock)
- Peak: peak RSS (high water mark)
- Data: size of data, stack
- Stack: size of stack
- EXEC: size of executable (text)
- Lib: shared library code size
- **PTBL**: page table entries (linux 2.6.10) - Use to evaluate LARGE PAGES
- **Swap:** Swapped out

```
Report: ESALNXP      LINUX HOST Process Statistics Report          Velocity Software Corporate   ESAMAP 4.2.0
Monitor initialized: 03/07/13 at 13:04:28 on 2096 serial 34B42     First record analyzed: 03/07/13 13:05:00
-------------------------------------------------------------------------------------------------------------
node/     <-Process Ident-> Nice PRTY <------CPU Percents----> <---------------Storage Metrics (MB)----------
 Name     ID    PPID   GRP  Valu Valu  Tot  sys user syst usrt  Size RSS Peak Swap Data Stk  EXEC Lib Lck PTbl
--------- ----- ----- ----- ---- ---- ---- ---- ---- ---- ---- ---- ---- ---- ---- ---- ---- ---- --- --- ---
13:06:00
sles11x2      0     0     0    0    0 0.58 0.37 0.22    0    0  508  109  589 1.73  170  6.2 10.3 159   0 0.70
 ksoftirq     3     2     0    0   20 0.02 0.02    0    0    0    0    0    0    0    0    0    0   0    0    0
 snmpd    15544     1 15544  -10   10 0.28 0.18 0.10    0    0   31   15 40.4    0 18.4  0.1  0.0  11   0 0.06
 kworker/ 30397     2     0    0   20 0.02 0.02    0    0    0    0    0    0    0    0    0    0   0    0    0
 top      35656     1     0    0   20 0.27 0.15 0.12    0    0    3    1  2.9    0 0.40  0.1  0.1 1.9   0 0.09
```

System Storage Metrics Version 4.1

Storage system metrics (4.1)

- MemTotal (same as UCD)
- MemFree
- Buffers
- Cached
- ANON (Overhead)

Process Storage metrics (zVPS version 4.2)

New metrics, New report ESALNXR (RAM)

- SwapCached Both in swap and ram
- Active Recently referenced
- **Inactive** Not recently referenced
- ActiveAnon Anonymous storage NOT file backed
- **InactiveAnon**
- ActiveFile page cache active
- VmallocTotal total allocated virtual address space
- VmallocUsed total used virtual address space
- VmallocChunk largest available chunk (virtual?)
- Slab - In-kernel data structure cache
- SReclaimable
- SUnreclaim
- KernelStack
- **PageTables**

```
Report: ESALNXR      LINUX RAM/Storage Analysis Report            Velocity Software Corporate   ESAMAP 4.2.0
Monitor initialized: 03/07/13 at 13:04:28 on 2096 serial 34B42    First record analyzed: 03/07/13 13:05:00
-------------------------------------------------------------------------------------------------------------------
Node/    <---Memory in megabytes--<---------> <-Kernel(MB)-> <-Buffers(MB)-->       Wrt  <---VMAlloc-->
                 <---Cache----><Anonymous> Stack<-Slab-->            Write <---VMAlloc-->           <------Huge page----->
Time     Total Free Size Actv Swap Actv Inact Size Size SRec  Size Dirty Back  Unre Back TOT Used Chunk Totl Fre Rsv Surp Size
-------- ----- ---- ---- ---- ---- ---- ----- ---- ----- ---- ---- ----- ----  ---- --- ---- ----- ---- --- --- ---- ----
13:06:00
sles11x2 996.5 43.1  519  399  0.2 51.1 12.2  39.1  1.6  117   106   242   0.0    0 .1M 13.1 131K 928.0   0   0   0
```

System Storage Metrics zVPS 4.2

Huge Page system metrics

- HUGE BENEFIT to using large pages in Linux for Oracle

Metrics:

- HugePgsTotal
- HugePgsFree
- HugePgsRsvd
- HugePgsSurp
- HugePgSize

System Storage Metrics zVPS 4.2

Other metrics not yet exposed

- InactiveFile
- Unevictable
- Mlocked
- Dirty Waiting to be written to disk
- Writeback data actively being written
- Mapped
- Shmem
- NFS_Unstable
- Bounce
- WritebackTmp
- CommitLimit Over committ storage maximum if enabled (usually not)
- Committed_AS Storage committed to processes with page tables

System Storage Metrics zVPS 4.2

Storage overview

Reserved – kernel, 3-5 mb

the kernel tries to defer allocating dynamic memory to User Mode processes

Dynamic memory request “malloc” builds page tables

- new process
- memory mapping of file

Pages mapped when “page faulted”

System Storage Metrics zVPS 4.2

Page faults and swapping are two independent processes.

- Page faults take place when a process requests for an address that has been allocated to it but has not yet been assigned to it.
- Swapping is when memory unavailable for processes (vs disk cache)

Swappiness:

- Prefer pages of a user mode process over disk cache pages when reclaiming memory
- 100: prefers disk cache to process storage
- 60: default,

Swapping:.

- Drop disk cache not dirty
- Flush dirty pages
- Move process page to disk

System Storage Metrics zVPS 4.2

Syncable

- Usermode address space mapped pages
- Pages in page cache (also on disk)
- Block device buffer pages (write buffer)
- Disk caches

Minor page faults:

- shared page already in storage, just point

Major page fault:

- Page allocation required, page read required

System Storage Metrics zVPS 4.2

Disk cache

- Used for process read/write data
- Data maintained in cache “in case”
- Deferred writes done from cache
- Page reclaim LRU
- Swappable
- Inactive storage is “extra”
- Active storage is “required”

System Storage Metrics zVPS 4.2

Anonymous

- Pages in the User Mode heap
- No named file system source
- Process stack
- Swappable
- Once modified must be maintained
- Source of “swap size ROT”
  - must be enough swap to hold anonymous pages

System Storage Metrics zVPS 4.2

buffer:

- memory used for filesystem meta data
- Relatively temporary storage for raw disk blocks

Slab (kernel slab)

- memory being used for kernel mallocs

6.3 Thoughts

Page space will be less fragmented

- ReWrite to same page location instead of new "fragment"

Page space utilization WILL be higher than previous

- Many pages duplicated in real storage AND on disk
- FULLY FUNCTIONAL ALERTS NEEDED

Customers with Expanded Storage can reconfigure

- Most large customers have found that 20% **(really)** of Storage configured as expanded works best
- LRU requirement because Linux (java) apps poll and don't drop from queue
- NEW 6.3 storage algorithm is much closer to LRU than previous "steal" algorithm
- Correct VDISK allocation much more important

6.3 Thoughts

VDISK Allocation:

- Vdisks are not backed until “touched”
- Define many vdisks, and no overhead until “touched”
- Multiple vdisks for swap, small to large, prioritized!

Paging Devices

- There will be some vendor hardware differences
- One installation going to SSD because 6.3 died….