SHARE in San Jose, August 10-15, 2008

9279 – Problem Determination with Linux on System z

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Wednesday 11:00 AM

Agenda

- **Trouble shooting First aid-kit**
- **Remarks about customer incidents**
- **Customer reported incidents 2H2006 and 1H2007**
  - Storage Controller caching strategies
  - TSM - Network connectivity breaks
  - Disk I/O bottlenecks
  - SCSI disk configuration issues
  - More customer problems: in a nutshell

Trouble Shooting First Aid kit

- **Install packages required for debugging**
  - s390-tools/s390-utils
  - sysstat
  - lkcdutils
- **Collect dbginfo.sh output**
  - Various files from /etc, /proc, /sys, /var directories.
  - Proactively in healthy system
  - When problems occur – then compare with healthy system
- **Collect system data**
  - Always archive syslog (/var/log/messages)
  - Start sadc (System Activity Data Collection) service when appropriate
  - Collect z/VM Monitor Data if running under z/VM when appropriate
  - Enable /proc/dasd/statistics (see Device Drivers book)

Trouble Shooting First Aid kit (cont'd)

- **When System hangs**
  - Take a dump (see backup chart)
    - Include System.map and (if available) Kerntypes file from /boot
  - See “Using the dump tools” book on http://www-128.ibm.com/developerworks/linux/linux390/index.html
- **In case of a performance problem**
  - Enable sadc (System Activity Data Collection) service
  - Collect z/VM Monitor Data if running under z/VM
  - Enable DASD statistics:
    See /proc/dasd/statistics on how to enable
- **Function does not work as expected**
  - Enable extended tracing in /proc/s390dbf or /sys/s390dbf for subsystem

Trouble Shooting First Aid kit (cont'd)

- **Attach comprehensive documentation to problem report:**
  - Output file of dbginfo.sh (/tmp/DBGINFO-*date*.tgz)
  - z/VM monitor data
    - Binary format, make sure, record size settings are correct.
    - For details see http://www.vm.ibm.com/perf/tips/collect.html
  - When opening a PMR upload documentation to directory associated to your PMR at
    - ftp://ecurep.mainz.ibm.com/, or
    - ftp://testcase.boulder.ibm.com/
- **When opening a Bugzilla at Distribution partner attach documentation to Bugzilla** (Bug-Tracker-Webapplication)

Introductory Remarks

- **The incidents reported here are real customer incidents**
  - Out of years 2006 and 2007
  - Red Hat Enterprise Linux, and Novell Linux Enterprise Server distributions
  - Linux running in LPAR and z/VM of different versions
- **While problem analysis look rather straight forward on the charts, it might have taken weeks to get it done.**
- **The more information is available, the sooner the problem can be solved, because gathering and submitting additional information again and again usually introduces delays.**
  - See First Aid Kit at the beginning of this presentation.
- **This presentation focuses on how the tools have been used, comprehensive documentation on their capabilities is in the docs of the corresponding tool.**

Performance: ‘disk cache bits settings’

- Configuration:
  - This customer was running database workloads on FICON attached storage
  - The problem applies to any Linux distribution and any runtime environment (z/VM and LPAR)
  - The problem also applies to other workloads with inhomogeneous I/O workload profile (sequential and random access)
- Problem Description:
  - Transaction database performance is within expectation
  - Warm-up basically consisting of database index scans, takes longer than expected.

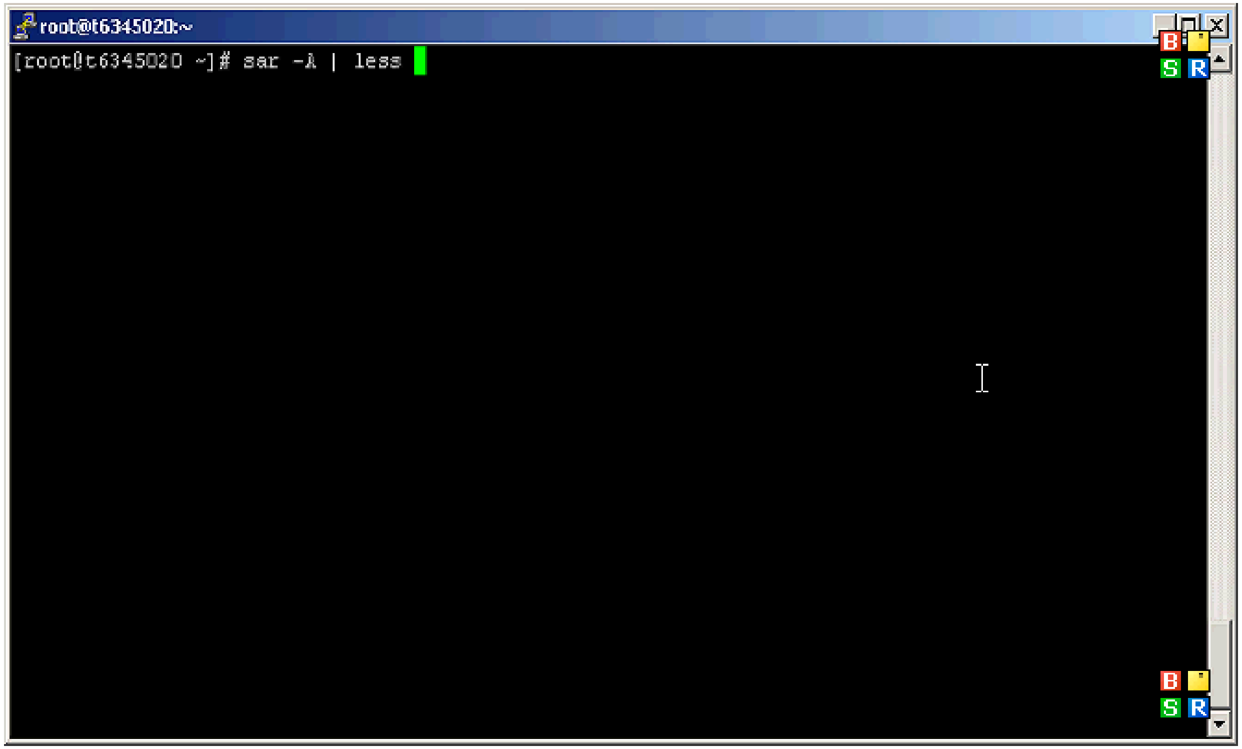
Performance: ‘disk cache bits settings’

- Tools used for problem determination:
  - Linux **SADC/SAR** and **IOSTAT**
  - Linux **DASD statistics**
  - **Storage Controller DASD statistics**
  - Scripted testcase
- Problem Indicators:
  - Random Access I/O rates and throughput are as expected
  - Sequential I/O throughput shows variable behaviour
    - always lower than expected
    - As expected for small files, lower than expected for large files
  - Test case showed even stronger performance degradation, when storage controller cache size was exceeded

Use and configure SADC/SAR and iostat:

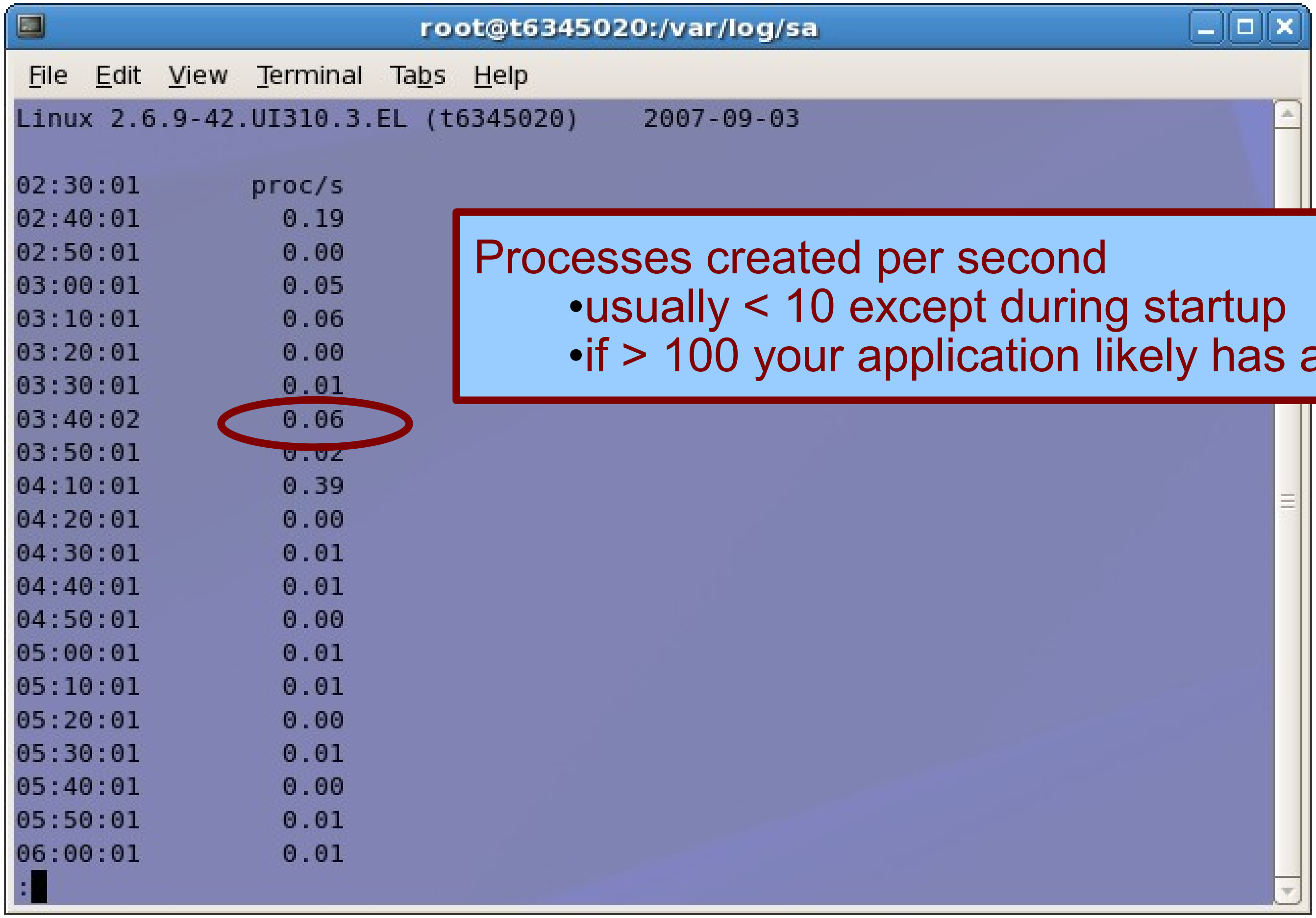
- **Capture Linux performance data with sysstat package**
  - **S**ystem **A**ctivity **D**ata **C**ollector (sadc)
  - **S**ystem **A**ctivity **R**eport (sar) command
  - **iostat** command
- **SADC example (for more see man sadc)**
  - /usr/lib/sa/sadc <interval> <count> **<binary outfile>**
  - /usr/lib/sa/sadc 5 10 sadc_outfile
  - Should be started as a service during system start
- **SAR example (for more see man sar)**
  - sar -A **-->** Analyse data from current sadc data collection
- **IOSTAT example (for more see man iostat)**
  - iostat -dkx **-->** Analyse io related performance data for all disks
- **Please include the binary sadc data and sar -A output when submitting SADC information to IBM support**

Sysstat Demo



```
[root@t6345020 ~]# sar -A | less
```

Processes created

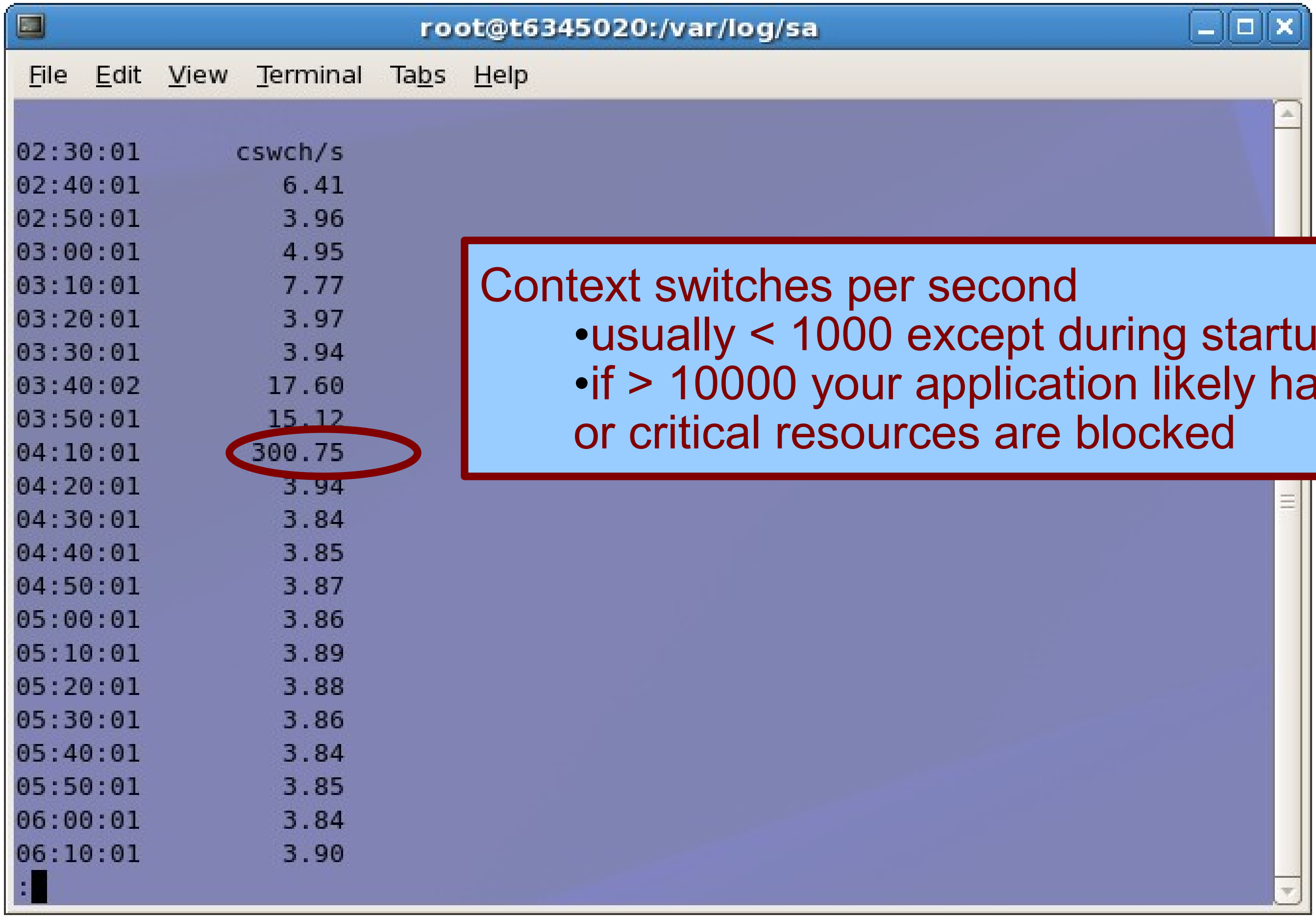


```
Linux 2.6.9-42.UI310.3.EL (t6345020)     2007-09-03

02:30:01        proc/s
02:40:01          0.19
02:50:01          0.00
03:00:01          0.05
03:10:01          0.06
03:20:01          0.00
03:30:01          0.01
03:40:02          0.06
03:50:01          0.02
04:10:01          0.39
04:20:01          0.00
04:30:01          0.01
04:40:01          0.01
04:50:01          0.00
05:00:01          0.01
05:10:01          0.01
05:20:01          0.00
05:30:01          0.01
05:40:01          0.00
05:50:01          0.01
06:00:01          0.01
:
```

Processes created per second

- usually < 10 except during startup
- if > 100 your application likely has an issue

Context Switch Rate



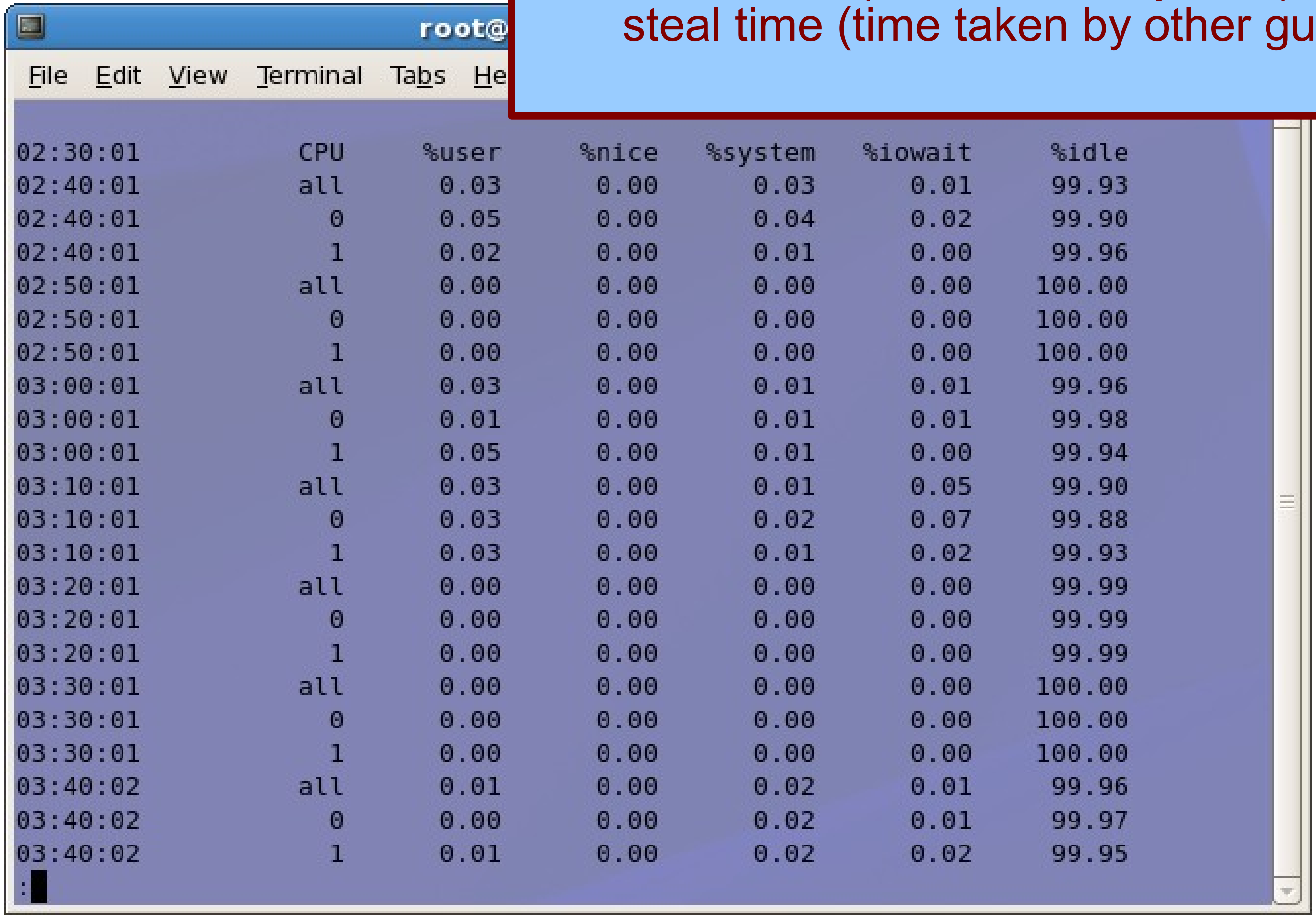
```
02:30:01       cswch/s
02:40:01          6.41
02:50:01          3.96
03:00:01          4.95
03:10:01          7.77
03:20:01          3.97
03:30:01          3.94
03:40:02         17.60
03:50:01         15.12
04:10:01        300.75
04:20:01          3.94
04:30:01          3.84
04:40:01          3.85
04:50:01          3.87
05:00:01          3.86
05:10:01          3.89
05:20:01          3.88
05:30:01          3.86
05:40:01          3.84
05:50:01          3.85
06:00:01          3.84
06:10:01          3.90
:
```

Context switches per second

- usually < 1000 except during startup
- if > 10000 your application likely has an issue or critical resources are blocked

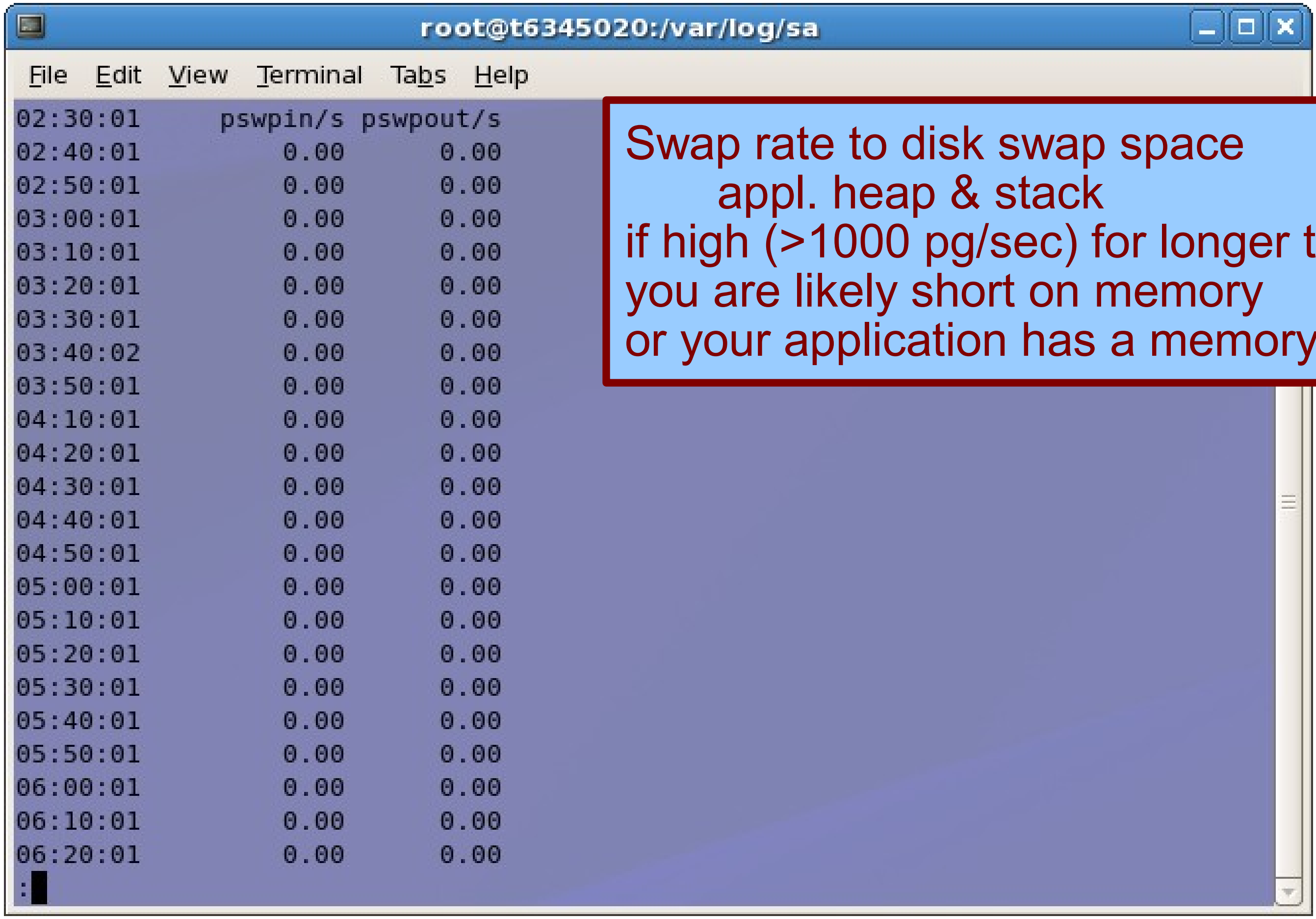
CPU utilization

Per CPU values:
watch out for
system time (kernel time)
iowait time (slow I/O subsystem)
steal time (time taken by other guests)



```
02:30:01          CPU     %user     %nice   %system   %iowait     %idle
02:40:01          all      0.03      0.00      0.03      0.01     99.93
02:40:01            0      0.05      0.00      0.04      0.02     99.90
02:40:01            1      0.02      0.00      0.01      0.00     99.96
02:50:01          all      0.00      0.00      0.00      0.00    100.00
02:50:01            0      0.00      0.00      0.00      0.00    100.00
02:50:01            1      0.00      0.00      0.00      0.00    100.00
03:00:01          all      0.03      0.00      0.01      0.01     99.96
03:00:01            0      0.01      0.00      0.01      0.01     99.98
03:00:01            1      0.05      0.00      0.01      0.00     99.94
03:10:01          all      0.03      0.00      0.01      0.05     99.90
03:10:01            0      0.03      0.00      0.02      0.07     99.88
03:10:01            1      0.03      0.00      0.01      0.02     99.93
03:20:01          all      0.00      0.00      0.00      0.00     99.99
03:20:01            0      0.00      0.00      0.00      0.00     99.99
03:20:01            1      0.00      0.00      0.00      0.00     99.99
03:30:01          all      0.00      0.00      0.00      0.00    100.00
03:30:01            0      0.00      0.00      0.00      0.00    100.00
03:30:01            1      0.00      0.00      0.00      0.00    100.00
03:40:02          all      0.01      0.00      0.02      0.01     99.96
03:40:02            0      0.00      0.00      0.02      0.01     99.97
03:40:02            1      0.01      0.00      0.02      0.02     99.95
:
```

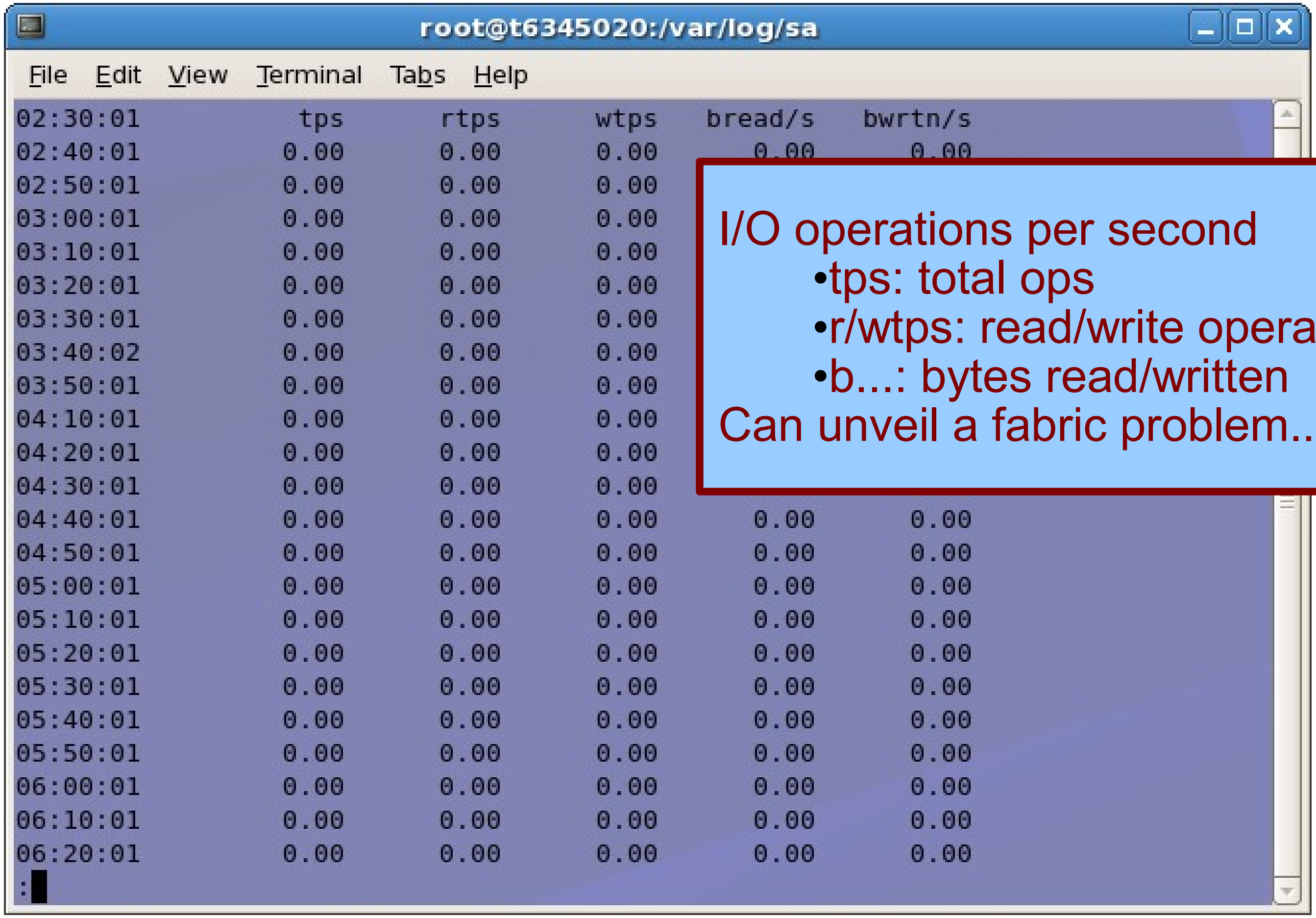
Swap rate



```
02:30:01      pswpin/s pswpout/s
02:40:01          0.00      0.00
02:50:01          0.00      0.00
03:00:01          0.00      0.00
03:10:01          0.00      0.00
03:20:01          0.00      0.00
03:30:01          0.00      0.00
03:40:02          0.00      0.00
03:50:01          0.00      0.00
04:10:01          0.00      0.00
04:20:01          0.00      0.00
04:30:01          0.00      0.00
04:40:01          0.00      0.00
04:50:01          0.00      0.00
05:00:01          0.00      0.00
05:10:01          0.00      0.00
05:20:01          0.00      0.00
05:30:01          0.00      0.00
05:40:01          0.00      0.00
05:50:01          0.00      0.00
06:00:01          0.00      0.00
06:10:01          0.00      0.00
06:20:01          0.00      0.00
:
```

Swap rate to disk swap space
appl. heap & stack
if high (>1000 pg/sec) for longer time
you are likely short on memory
or your application has a memory leak

I/O rates



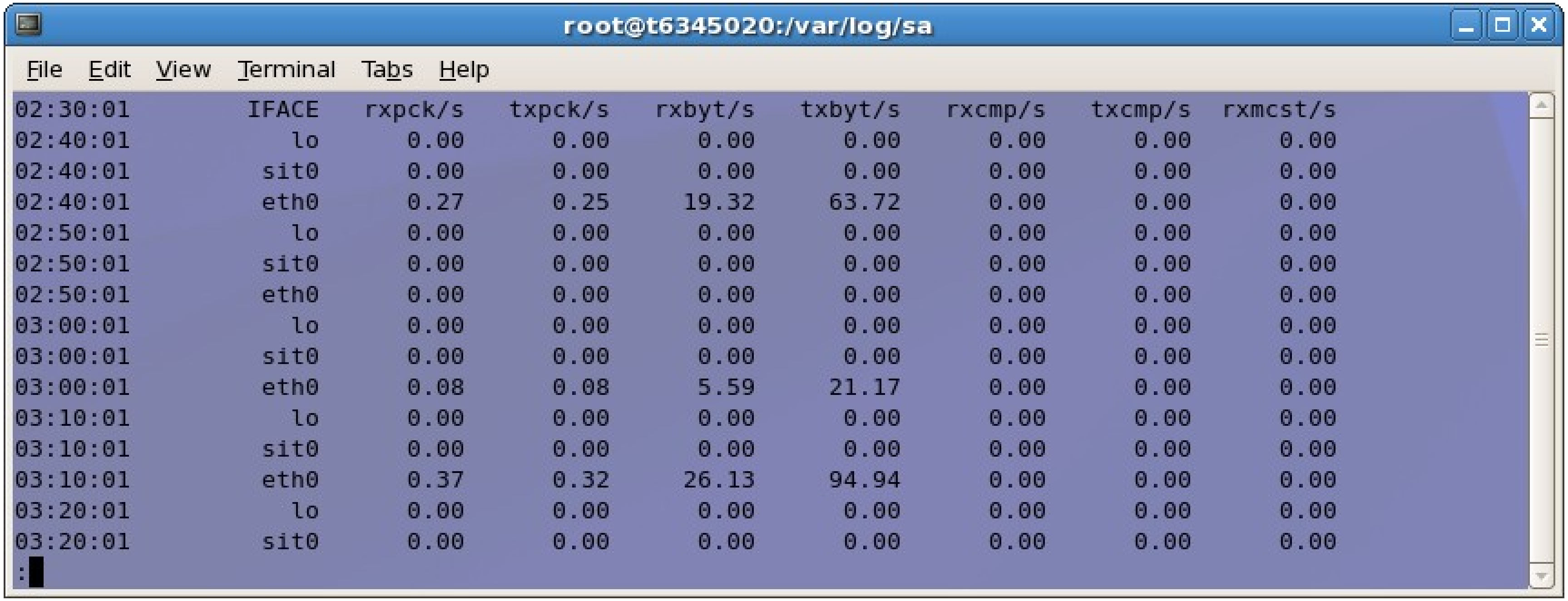
```
02:30:01          tps      rtps      wtps   bread/s   bwrtn/s
02:40:01         0.00      0.00      0.00      0.00      0.00
02:50:01         0.00      0.00      0.00
03:00:01         0.00      0.00      0.00
03:10:01         0.00      0.00      0.00
03:20:01         0.00      0.00      0.00
03:30:01         0.00      0.00      0.00
03:40:02         0.00      0.00      0.00
03:50:01         0.00      0.00      0.00
04:10:01         0.00      0.00      0.00
04:20:01         0.00      0.00      0.00
04:30:01         0.00      0.00      0.00
04:40:01         0.00      0.00      0.00      0.00      0.00
04:50:01         0.00      0.00      0.00      0.00      0.00
05:00:01         0.00      0.00      0.00      0.00      0.00
05:10:01         0.00      0.00      0.00      0.00      0.00
05:20:01         0.00      0.00      0.00      0.00      0.00
05:30:01         0.00      0.00      0.00      0.00      0.00
05:40:01         0.00      0.00      0.00      0.00      0.00
05:50:01         0.00      0.00      0.00      0.00      0.00
06:00:01         0.00      0.00      0.00      0.00      0.00
06:10:01         0.00      0.00      0.00      0.00      0.00
06:20:01         0.00      0.00      0.00      0.00      0.00
:
```

I/O operations per second

- tps: total ops
- r/wtps: read/write operations
- b...: bytes read/written

Can unveil a fabric problem...

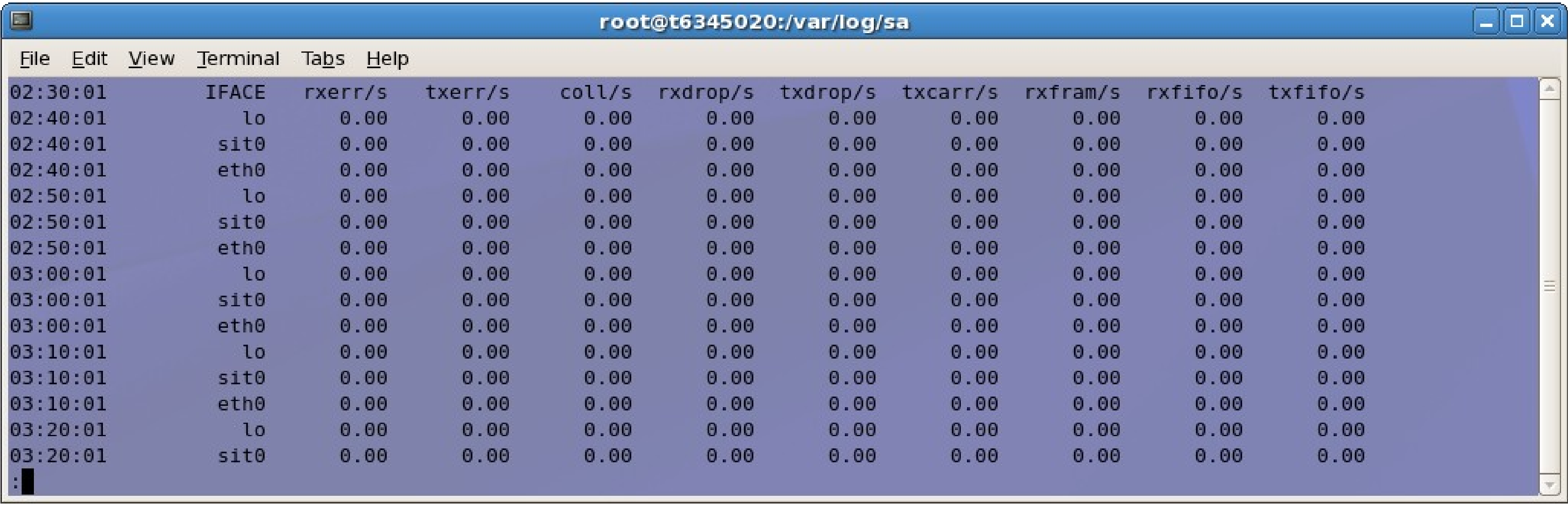
Networking data (1)



```
02:30:01        IFACE   rxpck/s   txpck/s   rxbyt/s   txbyt/s   rxcmp/s   txcmp/s  rxmcst/s
02:40:01           lo      0.00      0.00      0.00      0.00      0.00      0.00      0.00
02:40:01         sit0      0.00      0.00      0.00      0.00      0.00      0.00      0.00
02:40:01         eth0      0.27      0.25     19.32     63.72      0.00      0.00      0.00
02:50:01           lo      0.00      0.00      0.00      0.00      0.00      0.00      0.00
02:50:01         sit0      0.00      0.00      0.00      0.00      0.00      0.00      0.00
02:50:01         eth0      0.00      0.00      0.00      0.00      0.00      0.00      0.00
03:00:01           lo      0.00      0.00      0.00      0.00      0.00      0.00      0.00
03:00:01         sit0      0.00      0.00      0.00      0.00      0.00      0.00      0.00
03:00:01         eth0      0.08      0.08      5.59     21.17      0.00      0.00      0.00
03:10:01           lo      0.00      0.00      0.00      0.00      0.00      0.00      0.00
03:10:01         sit0      0.00      0.00      0.00      0.00      0.00      0.00      0.00
03:10:01         eth0      0.37      0.32     26.13     94.94      0.00      0.00      0.00
03:20:01           lo      0.00      0.00      0.00      0.00      0.00      0.00      0.00
03:20:01         sit0      0.00      0.00      0.00      0.00      0.00      0.00      0.00
:
```

- **Rates of successful transmits/receives**
  - Per interface
  - Packets and bytes

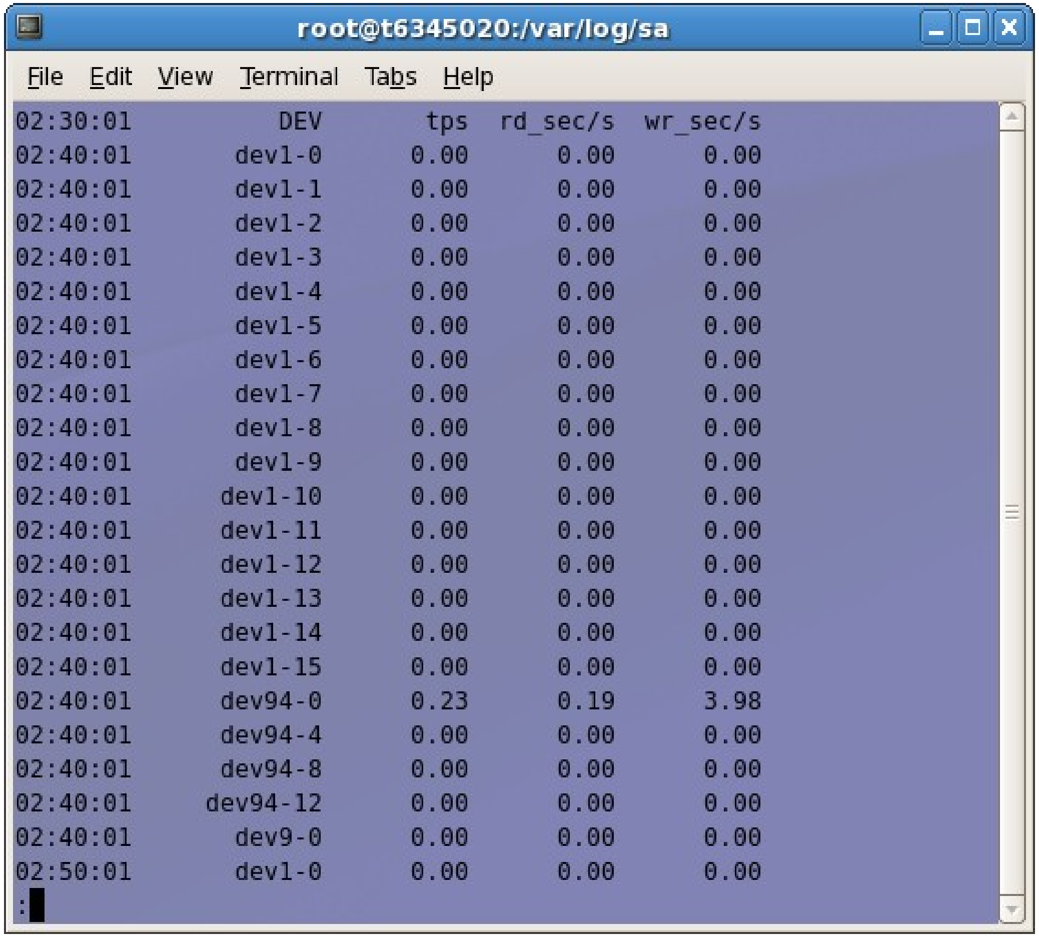
Networking data (2)



```
02:30:01        IFACE   rxerr/s   txerr/s    coll/s  rxdrop/s  txdrop/s  txcarr/s  rxfram/s  rxfifo/s  txfifo/s
02:40:01           lo      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00
02:40:01         sit0      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00
02:40:01         eth0      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00
02:50:01           lo      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00
02:50:01         sit0      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00
02:50:01         eth0      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00
03:00:01           lo      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00
03:00:01         sit0      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00
03:00:01         eth0      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00
03:10:01           lo      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00
03:10:01         sit0      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00
03:10:01         eth0      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00
03:20:01           lo      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00
03:20:01         sit0      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00
:
```

- **Rates of unsuccessful transmits/receives**
  - Per interface
  - rx/tx Errors
  - Dropped packets
    - Inbound: potential memory shortage

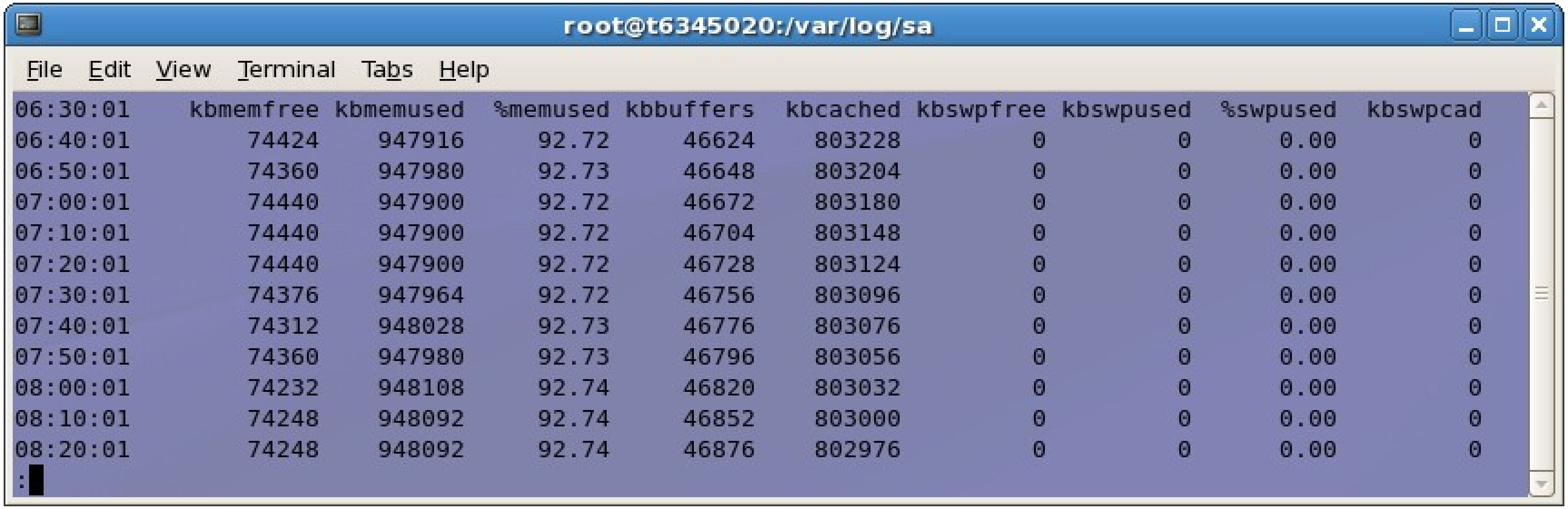
I/O rates



```
02:30:01          DEV       tps  rd_sec/s  wr_sec/s
02:40:01       dev1-0      0.00      0.00      0.00
02:40:01       dev1-1      0.00      0.00      0.00
02:40:01       dev1-2      0.00      0.00      0.00
02:40:01       dev1-3      0.00      0.00      0.00
02:40:01       dev1-4      0.00      0.00      0.00
02:40:01       dev1-5      0.00      0.00      0.00
02:40:01       dev1-6      0.00      0.00      0.00
02:40:01       dev1-7      0.00      0.00      0.00
02:40:01       dev1-8      0.00      0.00      0.00
02:40:01       dev1-9      0.00      0.00      0.00
02:40:01      dev1-10      0.00      0.00      0.00
02:40:01      dev1-11      0.00      0.00      0.00
02:40:01      dev1-12      0.00      0.00      0.00
02:40:01      dev1-13      0.00      0.00      0.00
02:40:01      dev1-14      0.00      0.00      0.00
02:40:01      dev1-15      0.00      0.00      0.00
02:40:01      dev94-0      0.23      0.19      3.98
02:40:01      dev94-4      0.00      0.00      0.00
02:40:01      dev94-8      0.00      0.00      0.00
02:40:01     dev94-12      0.00      0.00      0.00
02:40:01       dev9-0      0.00      0.00      0.00
02:50:01       dev1-0      0.00      0.00      0.00
:
```

- **read/write operations**
  - Per I/O device
  - tps: transactions
  - rd/wr_secs: sectors
- **Is your I/O balanced?**
  - Maybe you should stripe your LVs!

Memory statistics



```
06:30:01     kbmemfree kbmemused  %memused kbbuffers  kbcached kbswpfree kbswpused  %swpused  kbswpcad
06:40:01         74424    947916     92.72     46624    803228         0         0      0.00         0
06:50:01         74360    947980     92.73     46648    803204         0         0      0.00         0
07:00:01         74440    947900     92.72     46672    803180         0         0      0.00         0
07:10:01         74440    947900     92.72     46704    803148         0         0      0.00         0
07:20:01         74440    947900     92.72     46728    803124         0         0      0.00         0
07:30:01         74376    947964     92.72     46756    803096         0         0      0.00         0
07:40:01         74312    948028     92.73     46776    803076         0         0      0.00         0
07:50:01         74360    947980     92.73     46796    803056         0         0      0.00         0
08:00:01         74232    948108     92.74     46820    803032         0         0      0.00         0
08:10:01         74248    948092     92.74     46852    803000         0         0      0.00         0
08:20:01         74248    948092     92.74     46876    802976         0         0      0.00         0
:
```

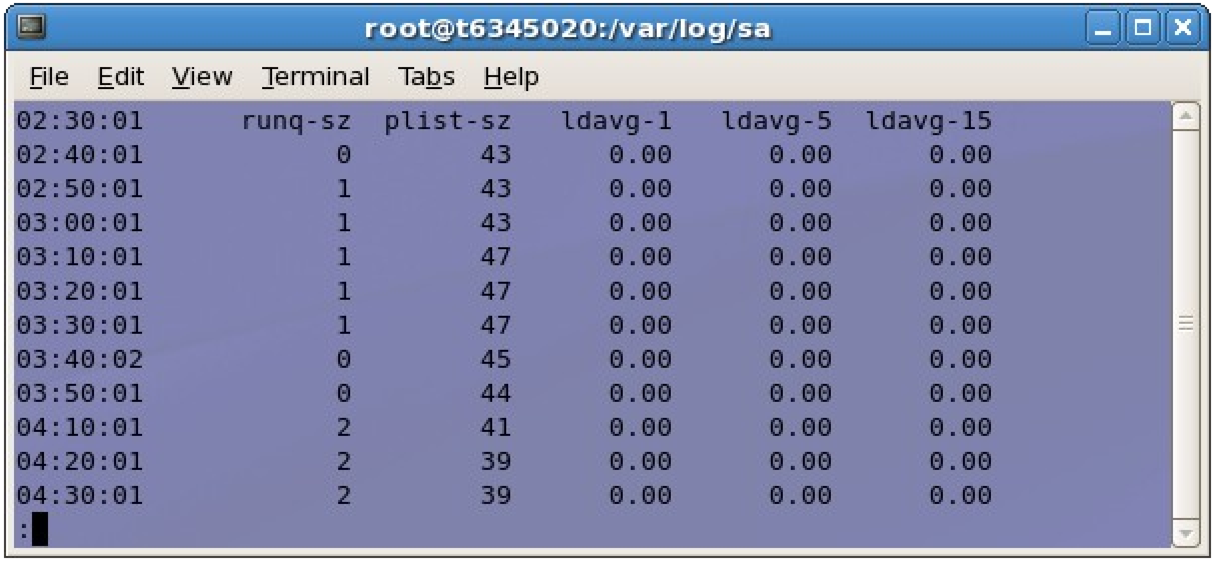
Watch

%memused and kbmemfree: short on available memory

kbswapfree: if not swapped but short on memory

the problem is not heap & stack but I/O buffers

System Load

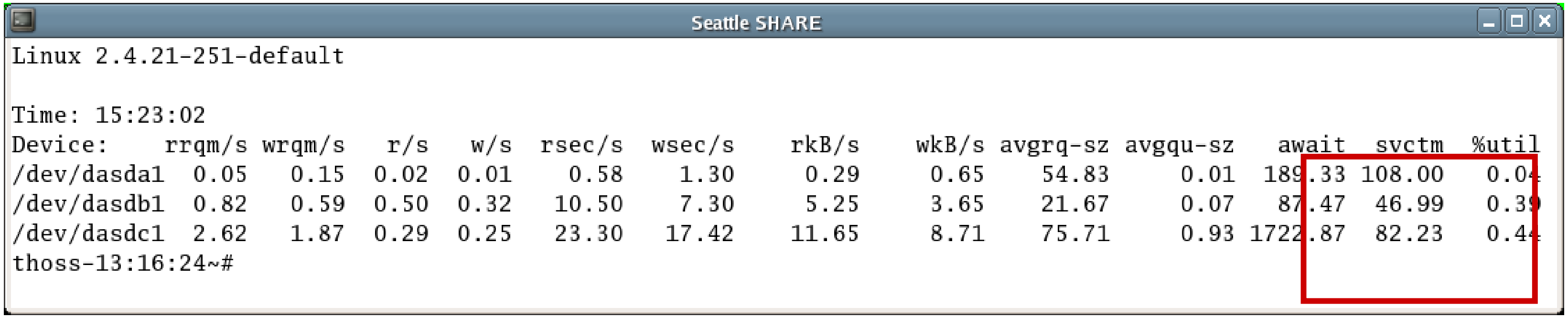


```
02:30:01        runq-sz  plist-sz   ldavg-1   ldavg-5  ldavg-15
02:40:01              0        43      0.00      0.00      0.00
02:50:01              1        43      0.00      0.00      0.00
03:00:01              1        43      0.00      0.00      0.00
03:10:01              1        47      0.00      0.00      0.00
03:20:01              1        47      0.00      0.00      0.00
03:30:01              1        47      0.00      0.00      0.00
03:40:02              0        45      0.00      0.00      0.00
03:50:01              0        44      0.00      0.00      0.00
04:10:01              2        41      0.00      0.00      0.00
04:20:01              2        39      0.00      0.00      0.00
04:30:01              2        39      0.00      0.00      0.00
:
```

- **Watch runqueue size snapshots**
  - Many (>5) processes on runqueue are critical
    - Blocked by shortage on available CPUs
    - Being bound in IOWAIT state
- **Loadaverage is runqeue length average in 1/5/15 mins**

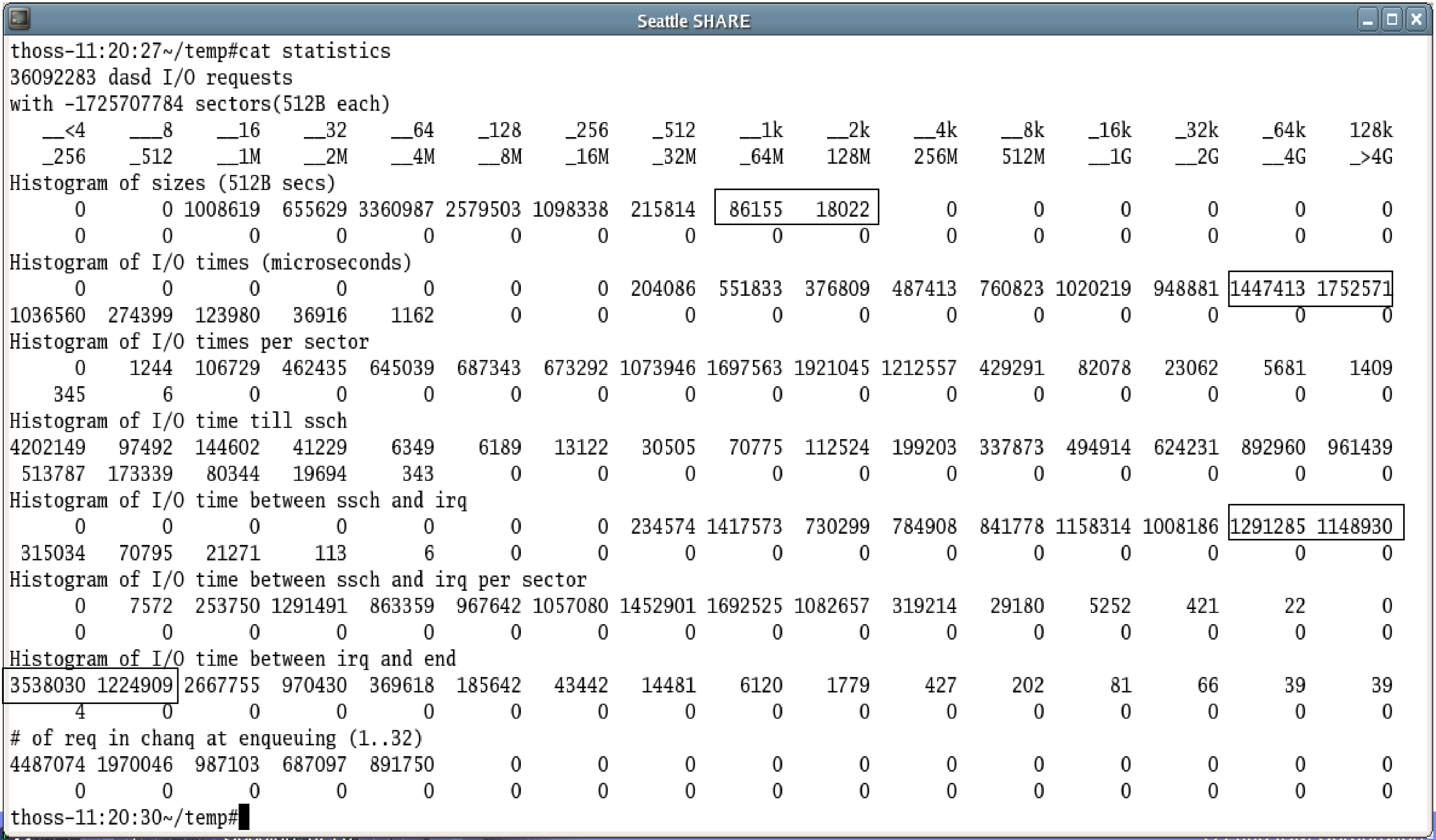
Iostat

- **Iostat: shows averaged performance data per device**
  - More detailed decomposition than achieved with sadc
  - Especially watch queue size and await/svctm



```
Linux 2.4.21-251-default

Time: 15:23:02
Device:     rrqm/s wrqm/s   r/s   w/s  rsec/s  wsec/s    rkB/s    wkB/s avgrq-sz avgqu-sz   await  svctm  %util
/dev/dasda1   0.05   0.15  0.02  0.01    0.58    1.30     0.29     0.65    54.83     0.01  189.33 108.00   0.04
/dev/dasdb1   0.82   0.59  0.50  0.32   10.50    7.30     5.25     3.65    21.67     0.07   87.47  46.99   0.39
/dev/dasdc1   2.62   1.87  0.29  0.25   23.30   17.42    11.65     8.71    75.71     0.93 1722.87  82.23   0.44
thoss-13:16:24~#
```

Linux DASD statistics



```
thoss-11:20:27~/temp#cat statistics
36092283 dasd I/O requests
with -1725707784 sectors(512B each)
   __<4    ___8    __16    __32    __64    _128    _256    _512    __1k    __2k    __4k    __8k    _16k    _32k    _64k    128k
   _256    _512    __1M    __2M    __4M    __8M    _16M    _32M    _64M    128M    256M    512M    __1G    __2G    __4G    _>4G
Histogram of sizes (512B secs)
      0       0 1008619  655629 3360987 2579503 1098338  215814   86155   18022       0       0       0       0       0       0
      0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0
Histogram of I/O times (microseconds)
      0       0       0       0       0       0       0  204086  551833  376809  487413  760823 1020219  948881 1447413 1752571
1036560  274399  123980   36916    1162       0       0       0       0       0       0       0       0       0       0       0
Histogram of I/O times per sector
      0    1244  106729  462435  645039  687343  673292 1073946 1697563 1921045 1212557  429291   82078   23062    5681    1409
    345       6       0       0       0       0       0       0       0       0       0       0       0       0       0       0
Histogram of I/O time till ssch
4202149   97492  144602   41229    6349    6189   13122   30505   70775  112524  199203  337873  494914  624231  892960  961439
 513787  173339   80344   19694     343       0       0       0       0       0       0       0       0       0       0       0
Histogram of I/O time between ssch and irq
      0       0       0       0       0       0       0  234574 1417573  730299  784908  841778 1158314 1008186 1291285 1148930
 315034   70795   21271     113       6       0       0       0       0       0       0       0       0       0       0       0
Histogram of I/O time between ssch and irq per sector
      0    7572  253750 1291491  863359  967642 1057080 1452901 1692525 1082657  319214   29180    5252     421      22       0
      0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0
Histogram of I/O time between irq and end
3538030 1224909 2667755  970430  369618  185642   43442   14481    6120    1779     427     202      81      66      39      39
      4       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0
# of req in chanq at enqueuing (1..32)
4487074 1970046  987103  687097  891750       0       0       0       0       0       0       0       0       0       0       0
      0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0
thoss-11:20:30~/temp#
```

DASD statistics (cont‘d)

- **DASD statistics decomposition**
  - Summarized histogram information available in /proc/dasd/statistics
  - 'tunedasd' to get performance statistics profile of a device
  - Also accessible per device via `BIODASDPRRD` and `BIODASDPRRST` ioctls

```
typedef struct dasd_profile_info_t {
        unsigned int dasd_io_reqs;       /* number of requests processed at all */
        unsigned int dasd_io_sects;      /* number of sectors processed at all */
        unsigned int dasd_io_secs[32];   /* histogram of request's sizes */
        unsigned int dasd_io_times[32];  /* histogram of requests's times */
        unsigned int dasd_io_timps[32];  /* histogram of requests's times per sector
*/
        unsigned int dasd_io_time1[32];  /* histogram of time from build to start */
        unsigned int dasd_io_time2[32];  /* histogram of time from start to irq */
        unsigned int dasd_io_time2ps[32]; /* histogram of time from start to irq */
        unsigned int dasd_io_time3[32];  /* histogram of time from irq to end */
        unsigned int dasd_io_nr_req[32]; /* histogram of # of requests in chanq */
} dasd_profile_info_t;
```

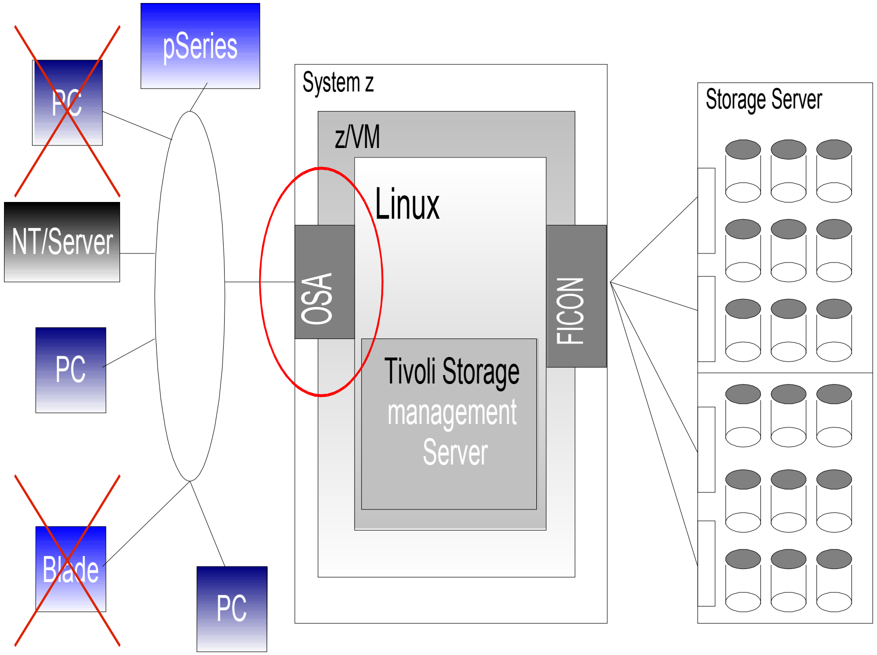
  - Storage Controller Cache statistics show cache utilization. Available in Controller HMC or via ioctl = `BIODASDPSRD`

Performance: ‘disk cache bits settings’

- Problem origin:
  - Storage controller cache is utilized inefficiently
    - Sequential data not prestaged
    - Used data not discarded from cache
- Solution:
  - Configure volumes for sequential I/O different from ones for random I/O
  - Use the tunedasd tool to set appropriate cache management algorithm (Sequential Prestage)
    - See; http://www.ibm.com/developerworks/linux/linux390/perf/tuning_rec_das

Networking:
'TSM - breaking TCP connections'

- Configuration:
  - Customer is running TSM backup over LAN with storage pool on minidisks provided by vendor supplied storage controller
- Problem Description:
  - During overnight backup runs the TSM clients report backup failure due to TCP/IP disconnect

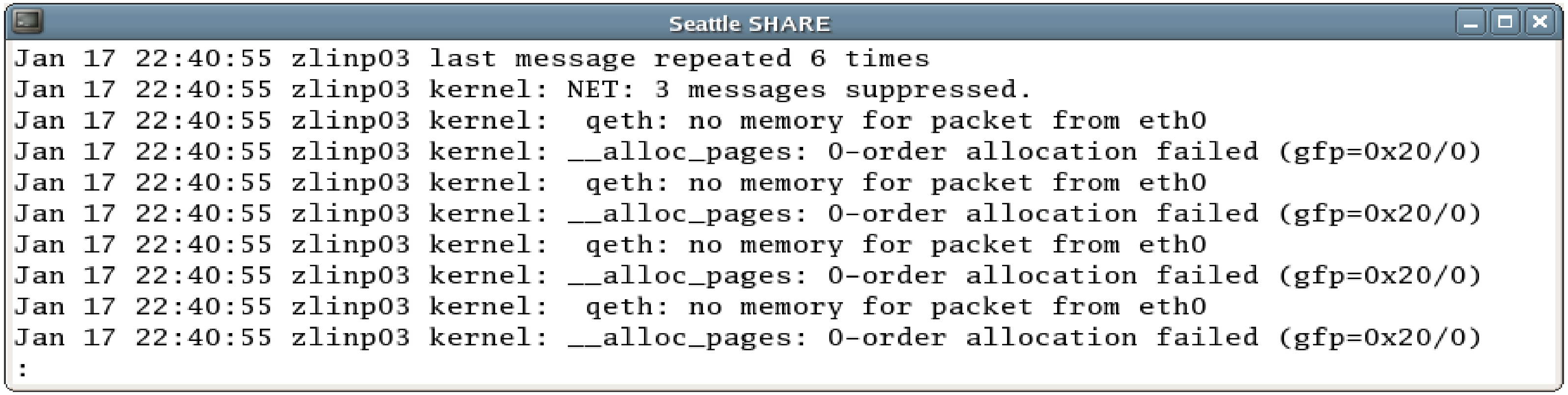


Networking:
‘TSM - breaking TCP connections'

- Tools used for problem determination:
  - dbginfo.sh
  - Linux for System z Debug Feature
  - Linux SADC/SAR and IOSTAT
  - Linux DASD statistics
  - Storage Controller DASD statistics

Networking:
‘TSM - breaking TCP connections'

- **dbginfo.sh collects /var/log/messages**
  - At the time of the outages



```
Jan 17 22:40:55 zlinp03 last message repeated 6 times
Jan 17 22:40:55 zlinp03 kernel: NET: 3 messages suppressed.
Jan 17 22:40:55 zlinp03 kernel:  qeth: no memory for packet from eth0
Jan 17 22:40:55 zlinp03 kernel: __alloc_pages: 0-order allocation failed (gfp=0x20/0)
Jan 17 22:40:55 zlinp03 kernel:  qeth: no memory for packet from eth0
Jan 17 22:40:55 zlinp03 kernel: __alloc_pages: 0-order allocation failed (gfp=0x20/0)
Jan 17 22:40:55 zlinp03 kernel:  qeth: no memory for packet from eth0
Jan 17 22:40:55 zlinp03 kernel: __alloc_pages: 0-order allocation failed (gfp=0x20/0)
Jan 17 22:40:55 zlinp03 kernel:  qeth: no memory for packet from eth0
Jan 17 22:40:55 zlinp03 kernel: __alloc_pages: 0-order allocation failed (gfp=0x20/0)
:
```

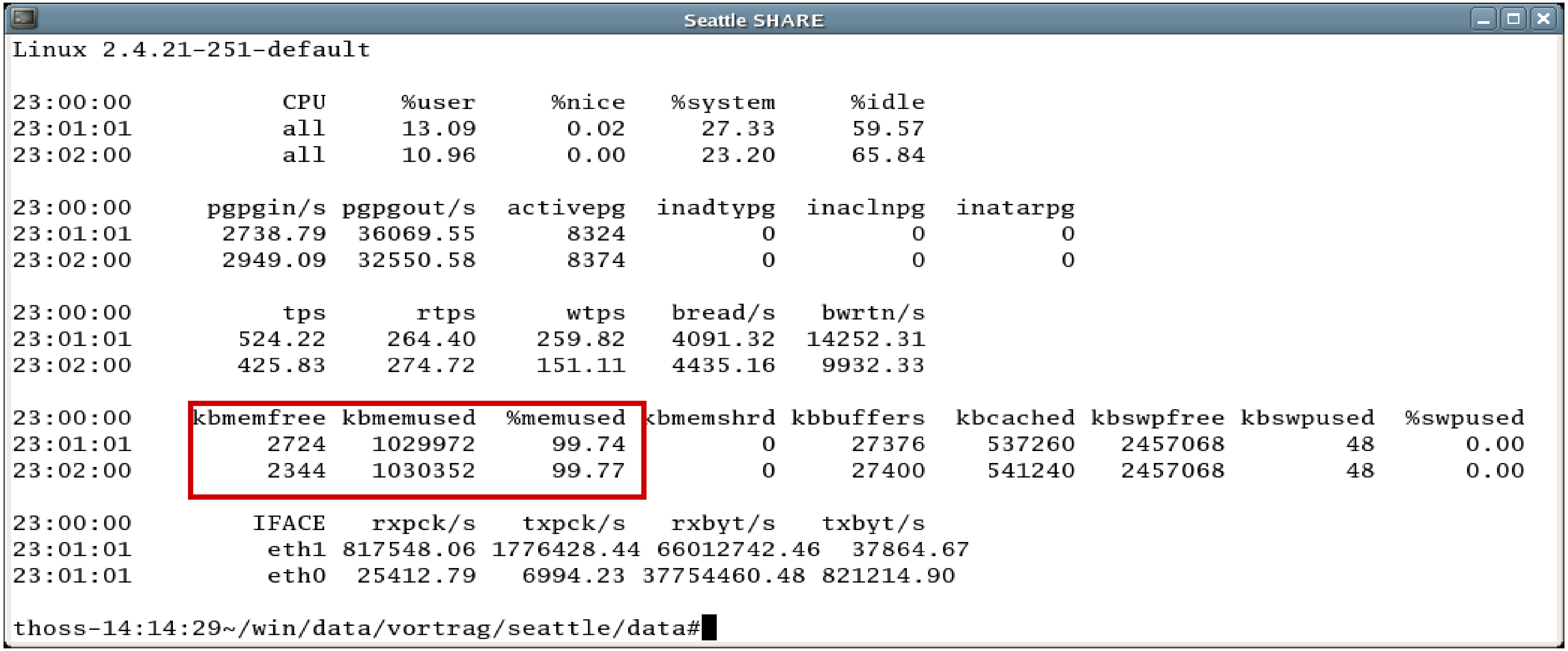
Networking:
‘TSM - breaking TCP connections'

- **dbginfo.sh also collects contents of Debug Feature for Linux on System z**

```
==> /proc/s390dbf/qeth_trace/hex_ascii <==
01132180673:456679 0 - 00 788606ba  4e 4f 4d 4d 20 20 20 38 | NOMM   8
01132180673:456810 0 - 00 788606ba  4e 4f 4d 4d 20 20 20 38 | NOMM   8
01132180673:456936 0 - 00 788606ba  4e 4f 4d 4d 20 20 20 38 | NOMM   8
```

Networking:
‘TSM - breaking TCP connections'

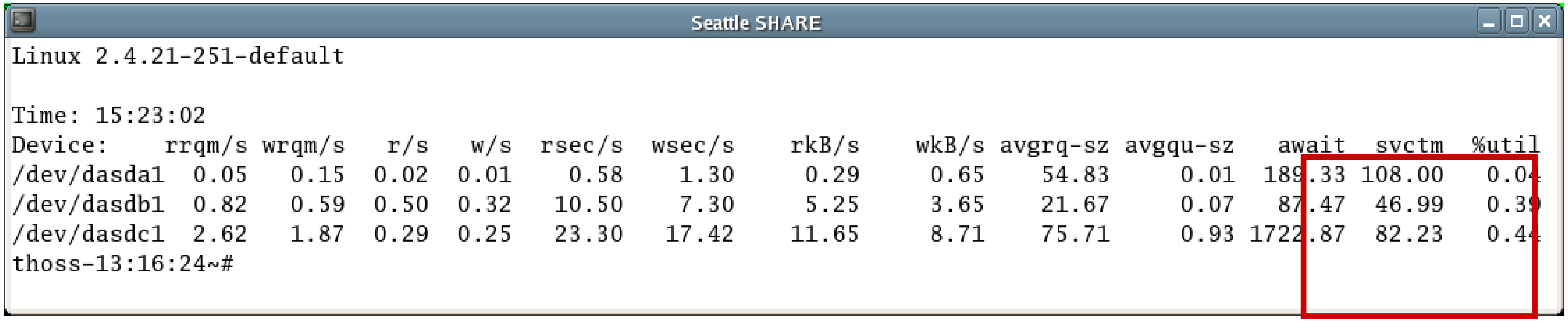
- **SADC data collection shows system low on memory at the time of the outages**



```
Linux 2.4.21-251-default

23:00:00          CPU     %user     %nice   %system     %idle
23:01:01          all     13.09      0.02     27.33     59.57
23:02:00          all     10.96      0.00     23.20     65.84

23:00:00     pgpgin/s pgpgout/s  activepg  inadtypg  inaclnpg  inatarpg
23:01:01      2738.79  36069.55      8324         0         0         0
23:02:00      2949.09  32550.58      8374         0         0         0

23:00:00          tps      rtps      wtps   bread/s   bwrtn/s
23:01:01       524.22    264.40    259.82   4091.32  14252.31
23:02:00       425.83    274.72    151.11   4435.16   9932.33

23:00:00    kbmemfree kbmemused  %memused kbmemshrd kbbuffers  kbcached kbswpfree kbswpused  %swpused
23:01:01         2724   1029972     99.74         0     27376    537260   2457068        48      0.00
23:02:00         2344   1030352     99.77         0     27400    541240   2457068        48      0.00

23:00:00        IFACE   rxpck/s   txpck/s   rxbyt/s   txbyt/s
23:01:01         eth1 817548.06 1776428.44 66012742.46   37864.67
23:01:01         eth0  25412.79   6994.23 37754460.48 821214.90

thoss-14:14:29~/win/data/vortrag/seattle/data#
```

Networking:
‘TSM - breaking TCP connections'

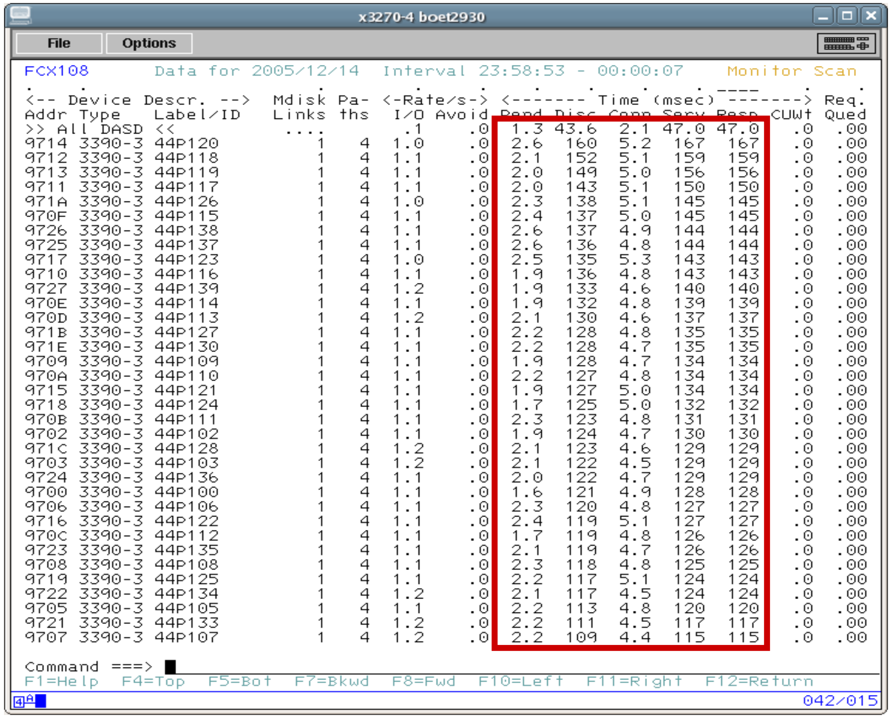
- **iostat shows long response times for disk I/O requests on certain devices**
  - Good values would be between 8-15ms



```
Linux 2.4.21-251-default

Time: 15:23:02
Device:    rrqm/s wrqm/s   r/s   w/s  rsec/s  wsec/s    rkB/s    wkB/s avgrq-sz avgqu-sz   await  svctm  %util
/dev/dasda1  0.05   0.15  0.02  0.01    0.58    1.30     0.29     0.65    54.83     0.01  189.33 108.00   0.04
/dev/dasdb1  0.82   0.59  0.50  0.32   10.50    7.30     5.25     3.65    21.67     0.07   87.47  46.99   0.39
/dev/dasdc1  2.62   1.87  0.29  0.25   23.30   17.42    11.65     8.71    75.71     0.93 1722.87  82.23   0.44
thoss-13:16:24~#
```

Networking:
‘TSM - breaking TCP connections'

- **z/VM Monitor data shows high service times in disconnected state while FICON channel utilization is rather low**



```
FCX108      Data for 2005/12/14  Interval 23:58:53 - 00:00:07    Monitor Scan
.   .                  .                  .         .     .     .     .     .  ____   .     .
<-- 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
>> All DASD <<           ....        .1    .0  1.3 43.6  2.1 47.0 47.0   .0  .00
9714 3390-3 44P120           1   4  1.0    .0  2.6  160  5.2  167  167   .0  .00
9712 3390-3 44P118           1   4  1.1    .0  2.1  152  5.1  159  159   .0  .00
9713 3390-3 44P119           1   4  1.1    .0  2.0  149  5.0  156  156   .0  .00
9711 3390-3 44P117           1   4  1.1    .0  2.0  143  5.1  150  150   .0  .00
971A 3390-3 44P126           1   4  1.0    .0  2.3  138  5.1  145  145   .0  .00
970F 3390-3 44P115           1   4  1.1    .0  2.4  137  5.0  145  145   .0  .00
9726 3390-3 44P138           1   4  1.1    .0  2.6  137  4.9  144  144   .0  .00
9725 3390-3 44P137           1   4  1.1    .0  2.6  136  4.8  144  144   .0  .00
9717 3390-3 44P123           1   4  1.0    .0  2.5  135  5.3  143  143   .0  .00
9710 3390-3 44P116           1   4  1.1    .0  1.9  136  4.8  143  143   .0  .00
9727 3390-3 44P139           1   4  1.2    .0  1.9  133  4.6  140  140   .0  .00
970E 3390-3 44P114           1   4  1.1    .0  1.9  132  4.8  139  139   .0  .00
970D 3390-3 44P113           1   4  1.2    .0  2.1  130  4.6  137  137   .0  .00
971B 3390-3 44P127           1   4  1.1    .0  2.2  128  4.8  135  135   .0  .00
971E 3390-3 44P130           1   4  1.1    .0  2.2  128  4.7  135  135   .0  .00
9709 3390-3 44P109           1   4  1.1    .0  1.9  128  4.7  134  134   .0  .00
970A 3390-3 44P110           1   4  1.1    .0  2.2  127  4.8  134  134   .0  .00
9715 3390-3 44P121           1   4  1.1    .0  1.9  127  5.0  134  134   .0  .00
9718 3390-3 44P124           1   4  1.1    .0  1.7  125  5.0  132  132   .0  .00
970B 3390-3 44P111           1   4  1.1    .0  2.3  123  4.8  131  131   .0  .00
9702 3390-3 44P102           1   4  1.1    .0  1.9  124  4.7  130  130   .0  .00
971C 3390-3 44P128           1   4  1.2    .0  2.1  123  4.6  129  129   .0  .00
9703 3390-3 44P103           1   4  1.2    .0  2.1  122  4.5  129  129   .0  .00
9724 3390-3 44P136           1   4  1.1    .0  2.0  122  4.7  129  129   .0  .00
9700 3390-3 44P100           1   4  1.1    .0  1.6  121  4.9  128  128   .0  .00
9706 3390-3 44P106           1   4  1.1    .0  2.3  120  4.8  127  127   .0  .00
9716 3390-3 44P122           1   4  1.1    .0  2.4  119  5.1  127  127   .0  .00
970C 3390-3 44P112           1   4  1.1    .0  1.7  119  4.8  126  126   .0  .00
9723 3390-3 44P135           1   4  1.1    .0  2.1  119  4.7  126  126   .0  .00
9708 3390-3 44P108           1   4  1.1    .0  2.3  118  4.8  125  125   .0  .00
9719 3390-3 44P125           1   4  1.1    .0  2.2  117  5.1  124  124   .0  .00
9722 3390-3 44P134           1   4  1.2    .0  2.1  117  4.5  124  124   .0  .00
9705 3390-3 44P105           1   4  1.1    .0  2.2  113  4.8  120  120   .0  .00
9721 3390-3 44P133           1   4  1.2    .0  2.2  111  4.5  117  117   .0  .00
9707 3390-3 44P107           1   4  1.2    .0  2.2  109  4.4  115  115   .0  .00

Command ===>
F1=Help  F4=Top  F5=Bot  F7=Bkwd  F8=Fwd  F10=Left  F11=Right  F12=Return
4A                                                                 042/015
```

Networking:
‘TSM - breaking TCP connections'

- Problem Indicators:
  - Network connections break, because buffers for inbound packets cannot be allocated due to insufficient memory
  - Disk I/O shows high service time on the storage controller
  - z/VM monitor data show long disconnect times while FICON channels still have capacity.
  - Disks with poor performance are configured as non-full-pack z/VM minidisks
  - Storage Controller statistics data shows large number of cache misses for write operations
  - Observed here, but not relevant: Paging space almost unused, because all memory is used for TSM I/O buffers, which are not pageable.

Networking: 'TSM - breaking TCP connections'

- Problem origin:
  - Disk Storage Controller (this one was provided by an independent storage vendor) treated write requests to non-full-pack z/VM minidisks as cache miss and performed a write through operation instead of fast write to NVS cache.
- Solution:
  - Use fullpack minidisk or dedicated disk as storage pool
  - For optimal disk configuration see http://www.ibm.com/developerworks/linux/linux390/perf/tuning_rec_dasd_

Performance: 'disk I/O bottlenecks'

- Configuration:
  - Customer has distributed I/O workload to multiple volumes using VM minidisk and Logical Volume Mgmnt. (LVM) striping
  - This problem also applies to non-LVM and non minidisk configurations
- Problem Description:
  - I/O performance is worse than expected by projecting single disk benchmark to more complex solution

Performance: 'disk I/O bottlenecks'

- Tools used for problem determination:
  - dbginfo.sh
  - Linux for System z Debug Feature
  - Linux SADC/SAR and IOSTAT
  - Linux DASD statistics
  - z/VM monitor data
  - Storage Controller DASD statistics
- Problem Indicators:
  - Multi-disk performance is worse than projected single-disk performance.

Performance: 'disk I/O bottlenecks'

- Problem origin:
  - bottleneck other than the device – e.g.:
    - z/VM minidisks are associated to same physical disk
    - SAN bandwidth not sufficient
    - Storage controller Host Bus Adapter (HBA) bandwidth not sufficient
    - Multiple disks used are in the same rank of storage controller
- Solution:
  - Check your disk configuration and configure for best performance
    - Make sure, minidisks used in parallel are not on the same physical disk (e.g. for swapspace!)
    - For optimal disk performance configurations read and take into account http://www.ibm.com/developerworks/linux/linux390/perf/tuning_rec_dasd_optim

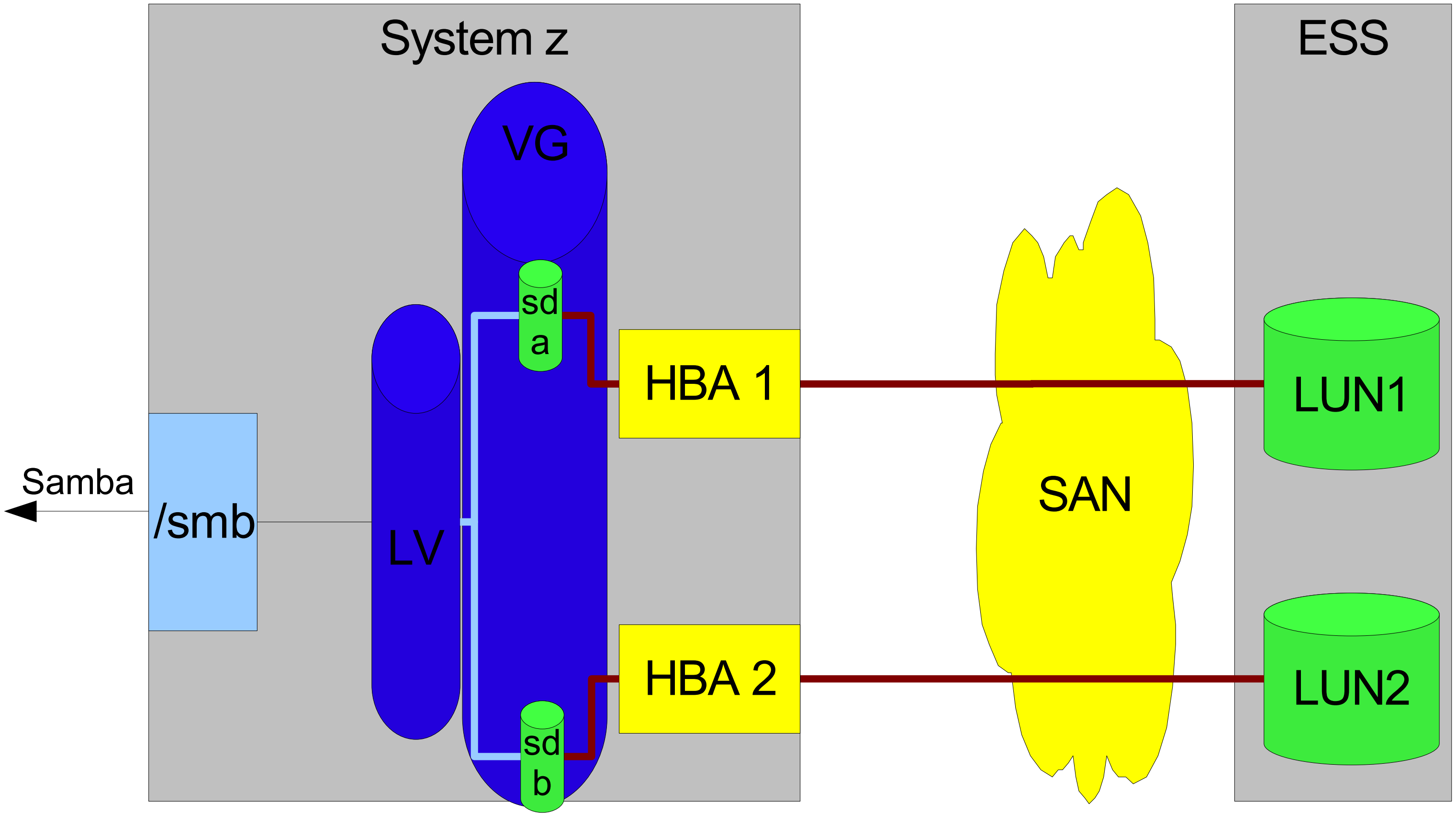
SCSI disk: 'multipath configuration'

- Configuration:
  - Customer is running Samba server (*Samba* = file and printer sharing e.g. with Windows clients) on Linux with FCP attached disk managed by Linux LVM.
  - This problem also applies to any configuration with FCP attached disk storage
- Problem Description:
  - Accessing *some files* through samba causes the system to hang while accessing other files works fine
  - Local access to the same file cause a hanging shell as well
    - Indicates: this is not a network problem!

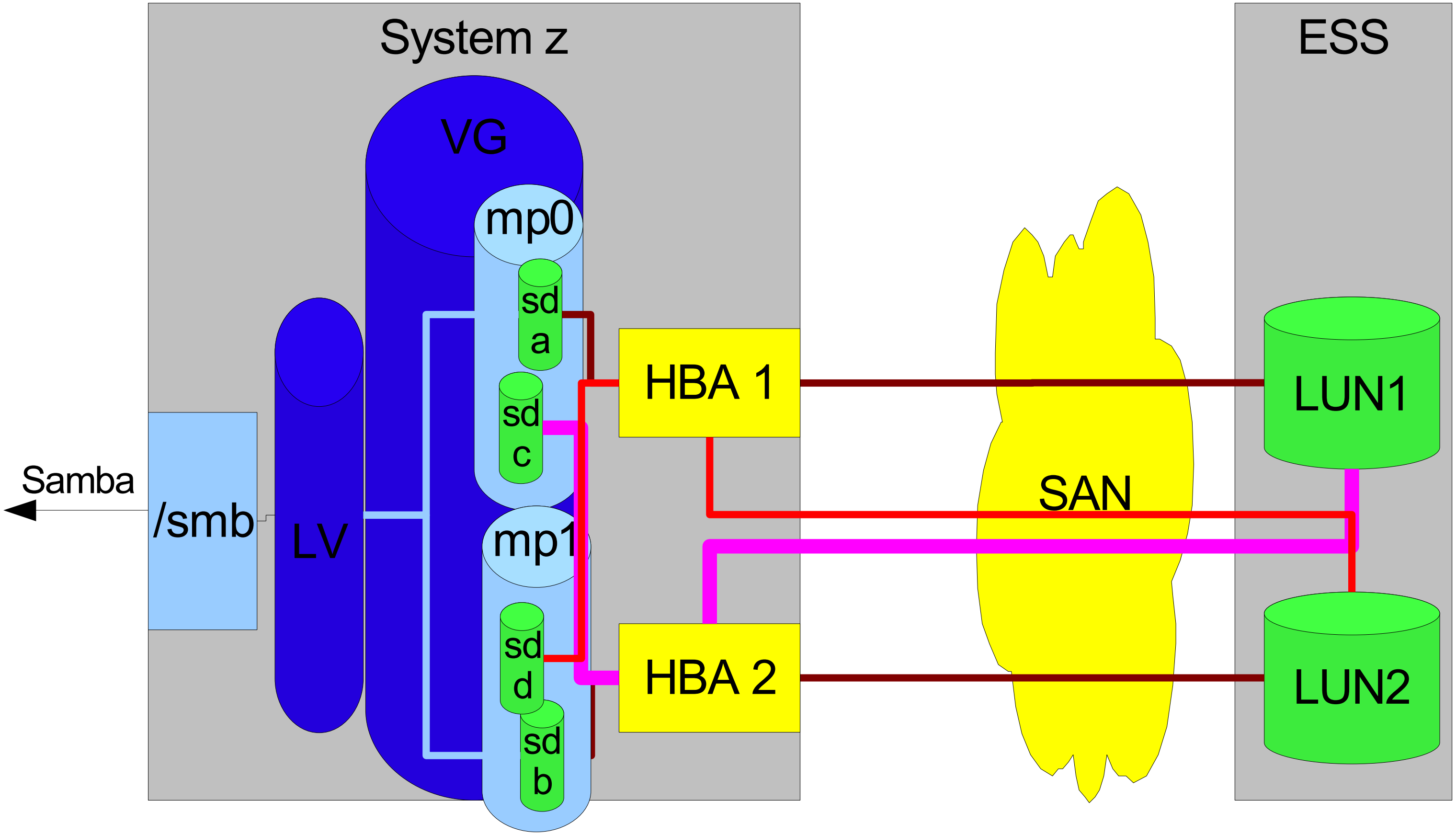
SCSI disk: 'multipath configuration'

- Tools used for problem determination:
  - dbginfo.sh
- Problem Indicators:
  - Intermittent outages of disk connectivity

SCSI disk:
‘multipath configuration’



SCSI disk:
‘multipath configuration’



SCSI disk: ‘multipath configuration’

- Solutions
  - Configure multipathing correctly:
    - Establish independent paths to each volume
    - Group the paths using the device-mapper-multipath package
    - Base LVM configuration on top of mpath devices instead of sd<#>
  - For a more detailed description how to use FCP attached storage appropriately with Linux on System z see http://download.boulder.ibm.com/ibmdl/pub/software/dw/linux390/

More customer problems:
In a nutshell

Performance:
'aio (POSIX asynchronous I/O) not used'

- Configuration:
  - Customer is running DB2 on Linux
- Problem Description:
  - Bad write performance is observed, while read performance is okay
- Tools used for problem determination:
  - DB2 internal tracing
- Problem Origin:
  - libaio is not installed on the system
- Solution:
  - Install libaio package on the system to allow DB2 using it.

Memory: ‘higher order allocation failure’

- Configuration:
  - Customer is running CICS transaction gateway in 31 bit emulation mode
- Problem Description:
  - After several days of uptime, the system runs out of memory
- Tools used for problem determination:
  - dbginfo.sh
- Problem Indicators:
  - Syslog contains messages about failing 4th-order allocations
    - Caused by compat_ipc calls in 31bit emulation, which request 4th-order memory chunks
- Problem Origin:
  - compat_ipc code makes order-4 memory allocations
- Solution:
  - Switch to 31 bit system to avoid compat_ipc
  - Upgrade to SLES10
  - Request a fix from distributor or IBM

Memory: '31bit address space exhausted'

- Configuration:
  - Customer is migrating database contents to different host in a 31bit system.
- Problem Description:
  - Database reports system caused out-of-memory condition: 'SQL1225N The request failed because an operating system process, thread, or swap space limit was reached.' indicating that a sycall returned -1 and set errno to ENOMEM
- Tools used for problem determination:
  - DB2 internal tracing
- Problem Origin:
  - System out of resources due to 31bit kernel address space
- Solution:

System stalls: 'PFAULT loop'

- Configuration:
  - Customer is running 35 Linux guests (SLES 8) in z/VM with significant memory overcommit ratio.
- Problem Description:
  - After a couple of days of uptime, the systems hang.
- Tools used for problem determination:
  - System dump
- Problem Origin:
  - CPU loop in the pfault handler caused by
    - Linux acquiring a lock in pfault handler although not needed
- Solution:
  - Request a fix for Linux from SUSE and/or IBM

System stalls: 'reboot hangs'

- Configuration:
  - Customer is running Linux and issuing 'reboot'-command to re-IPL
- Problem Description:
  - 'reboot' shuts down the system but hangs.
- Tools used for problem determination:
  - System dump
- Problem Indicators:
  - 'reboot' hangs, but LOAD-IPL works
- Problem Origin:
  - Root cause: CHPIDs are not reset properly during 'reboot'
- Solution:
  - Apply Service to Linux, ask SUSE/IBM for appropriate kernel level.

Cryptography: 'HW not used for AES-256'

- Configuration:
  - Customer wants to use Crypto card acceleraton for Advanced Encryption Standard (AES)
- Problem Description:
  - HW acceleration is not used – system falls back to SW implementation
- Tools used for problem determination:
  - SADC/SAR
- Problem Indicators:
  - CPU load higher than expected for AES-256 encryption
- Problem Origin:
  - System z Hardware does not support AES-256 for acceleration.
- Solution:
  - Switch to AES 128 to deploy HW acceleration
  - Expect IBM provided Whitepapers on how to use cryptography appropriately

Cryptography:
'glibc error in openssl'

- Configuration:
  - Customer is performing openssl speed test to check whether crypto HW functions are used in SLES10
- Problem Description:
  - Openssl speed test fails with an error in glibc:
    "glibc detected openssl: free(): invalid next size (normal)"
    (*glibc* = free implementation of Standard C Library)
- Solution:
  - Upgrade Linux to SLES10 SP1 or above

Storage: 'zipl fails in EAL4 environment'

- Configuration:
  - Customer installs an Evaluation Assurance Level 4 (EAL4) compliant environment with Reiser File System
- Problem Description:
  - Zipl (*zipl* = Bootmanager for Linux on System z) refuses to write boot records due to an ioctl blocked by the auditing SW
- Problem Indicators:
  - Zipl on ext3-FS works well
- Solution:
  - Use ext3-FS at least for /boot

Storage: 'non-persistent tape device nodes'

- Configuration:
  - Customer uses many FCP attached tapes
- Problem Description:
  - Device nodes for tape drives are named differently after reboot
- Solution:
  - Create UDEV-rule to establish persistent naming
  - Wait for IBMtape device driver to support persistent naming

Storage: 'tape device unaccessible'

- Configuration:
  - Customer has FCP attached tape
- Problem Description:
  - Device becomes unaccessible
- Problem Indicators:
  - ELS messages in syslog, or
  - Device can be enabled manually, but using hwup-script it fails
- Solution:
  - Apply service to get fixed version of hwup scripts
  - Apply service to Linux and µCode and disable QIOASSIST if appropriate
    - See: http://www.vm.ibm.com/perf/aip.html for required levels.
  - If tape devices remain reserved by SCSI 3rd party reserve use the ibmtape_util tool from the IBMTape device driver package to break the reservation

Storage: 'QIOASSIST'

- Configuration:
  - Customer is running SLES10 or RHEL 5 under z/VM with QIOASSIST enabled
- Problem Description:
  - System hangs
- Problem Indicators:
  - System stops operation because all tasks are in I/O wait state
  - System runs out of memory, because I/O stalls
  - When switching QIOASIST OFF, the problems vanish
- Solution:
  - **Apply service to Linux, z/VM and System z µCode**
    - See: http://www.vm.ibm.com/perf/aip.html for required levels.

Networking: 'firewall cuts TCP connections'

- Configuration:
  - Customer is running eRMM in a firewalled environment
- Problem Description:
  - After certain period of inactivity Enterprise Removable Media Mgr. (eRMM) server loses connectivity to clients
- Problem Indicators:
  - Disconnect occurs after fixed period of inactivity
  - Period counter appears to be reset when activity occurs
- Solution:
  - Tune TCP_KEEPALIVE timeout to be shorter than firewall setting, which cuts inactive connections

Networking:
'Channel Bonding'

- Configuration:
  - Customer is trying to configure channel bonding on SLES 10 system (*channel bonding* = combine two or more network interfaces for redundancy or increased thruput)
- Problem Description (various problems):
  - Interfaces refuse to get enslaved
  - Failover/failback does not work
  - Kernel Panic when issuing 'ifenslave -d' command
- Solution:
  - Apply Service to Linux, System z HW and z/VM
    - ask SUSE/IBM for appropriate kernel and µCode levels.

Networking: 'tcpdump fails'

- Configuration:
  - Customer is trying to sniff the network using tcpdump
- Problem Description (Various problems):
  - tcpdump does not interpret contents of packets or frames
  - tcpdump does not see network traffic for other guests on GuestLAN/HiperSockets network
- Problem Indicators:
  - OSA card is running in Layer 3 mode
  - HiperSocket/Guest LAN do not support promiscuous mode
- Solution:
  - Use the layer-2 mode of your OSA card to add Link Level header
  - Use the tcpdump-wrap.pl script to add fake LL-headers to frames
  - Use the fake-ll feature of the qeth device driver
  - Wait for Linux distribution containing support for promiscuous mode

Networking: 'Dynamic Host Configuration Protocol (DHCP) fails'

- Configuration:
  - Customer is configuring Linux guests with dhcp and using Virtual LAN (VLAN)
- Problem Description (Various problems):
  - DHCP configuration does not work on VLAN because
    - DHCP user space tools do not support VLAN packets
- Problem Indicators:
  - When VLAN is off, dhcp configuration works fine.
- Workaround:
  - Apply service to Linux to hide VLAN information from dhcp tools
    - Ask Distributor/IBM for appropriate kernel levels
- Solution:
  - Request VLAN aware dhcp tools from your distributor

NFS: NFS write to z/OS server is slow

- Configuration:
  - Customer is configuring Linux guests with Network File System (NFS) mount to VSAM datasets on z/OS NFS server
- Problem Description:
  - NFS write of large file takes hours
- Problem Indicators:
  - NFS server writes VSAM datasets
  - Sync mount is faster
- Workaround:
  - Switch to HFS/zFS
  - Use Sync-NFS mount
- Solution:
  - Currently none

Some acronyms explained

- AES = Advanced Encryption Standard. Symmetric encrypt/-decrypt system.
- DHCP = Dynamic Host Configuration Prot. Prot. to get network config data from a central server (e.g. IP address, net mask, default gateway).
- FCP = Fibre Channel Protocol. Prot. to access devices on fibre-channel networks.
- FICON = Fibre Channel Connection.
- LUN = Logical Unit Number. Unique identifier to differentiate devices (Lus).
- LVM = Logical Volume Mgr. Create logical volumes out of physical storage resources, for flexible data management operations.
- NFS = Network File System. Prot. to allow computers to access files over a network.
- OSA = Open System Adapter. Network interface card for fast LAN access.
- SCSI = Small Computer System Interface. ANSI-Standard interface that allows computers to communicate with peripheral hardware.
- TSM = Tivoli Storage Mgr. Automate data backup and restore functions and centralize storage management functions.

Your feedback and questions:

- **Raise it right now!**
- **Write it on the feedback sheets!**
- **Submit it by email to**
  - Steffen Thoss (thoss@de.ibm.com)
  - Klaus-Dieter Wacker (kdwacker@de.ibm.com)
  - linux390@de.ibm.com
  - Please refer to this presentation

Backup

Links

- Linux on System z project at IBM DeveloperWorks: http://www.ibm.com/developerworks/linux/linux390/
- HW and SW level requirements for QIOASSIST: http://www.vm.ibm.com/perf/aip.html
- Fixed I/O buffers with z/VM 5.1:

  http://www.ibm.com/developerworks/linux/linux390/perf/tuning_rec_fixed_io_buffers.html
- Optimize disk configuration for performance: http://www.ibm.com/developerworks/linux/linux390/perf/tuning_rec_dasd_optimizedisk.html
- DASD cache bit tuning:

  http://www.ibm.com/developerworks/linux/linux390/perf/tuning_rec_dasd_cachemode.html

Dump Tools Summary

Tool	Stand alone tools			VMDUMP
	DASD	Tape	SCSI	
Environment	VM&LPAR		LPAR	VM
Preparation	Zipl -d /dev/<dump_dev>		Mkdir /dumps/mydumps zipl -D /dev/sda1 …	---
Creation	Stop CPU & Store status ipl <dump_dev_CUU>			Vmdump
Dump medium	ECKD or FBA	Tape cartridges	LINUX file system on a SCSI disk	VM reader
Copy to filesystem	Zgetdump /dev/<dump_dev> > dump_file		---	Dumpload ftp … vmconvert …
Viewing	Lcrash or crash			

See “Using the dump tools” book on
http://www-128.ibm.com/developerworks/linux/linux390/index.html