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Agenda

- **Objectives**
- **Tools**
  - System
    - vmstat
    - sadc/sar
  - Disk
    - iostat
    - DASD statistics
    - SCSI statistics
  - Network
    - netstat
  - Processes
    - top
    - ps
- **Assuming we have a problem …**
  - .. somewhen
  - .. now
- **Summary**

Objectives

- **There are really many tools available on Linux to monitor the system!**
- **Describe tools available on Linux on System z, which are**
  - available via the Distribution (SUSE, RedHat)
  - specific for Linux on System z (the most are of general use)
  - in use and proven by the Linux Performance team for Linux on System z
- **Help to decide depending on what should be monitored**
  - which is the right tool
  - how should it be used
- **If you are aware of other tools giving more/better information, let me know!**

How and when to use the tools

- **Basic considerations**
  - Monitoring could impact the system
  - Each data gathering averages over a certain period of time
    ==> this flattens peaks
  - Start with defining the problem!
    - which parameter(s) from the application indicates the problem (mostly response or execution times)
    - which range is considered as bad, what is considered as good
    - monitor the good case and save the results for comparison when a problem occurs
  - Use meaningful names for the output files (e.g. tool_test_case_date_and_time)

- **The next slides describe the tools we use**

- **We need a strategy how to use the tools**
  - When we have a problem somewhen
  - To analyze a problem occurring now

- **Disclaimer:**
  - The following advices are no guarantee that each problem can be identified in all cases!

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- Objectives
- **Tools**
  - **System**
    - **vmstat**
    - **sadc/sar**
  - Disk
    - iostat
    - DASD statistics
    - SCSI statistics
  - Network
    - netstat
  - Processes
    - top
    - ps
- Assuming we have a problem …
  - .. somewhen
  - .. now
- Summary

vmstat

- **Characteristics:** **Easy to use, high-level information**
- **Objective:** **First and fast impression of the current state**
- **Usage:** vmstat [interval in sec]

- **Output sample:**

```
vmstat 1
procs -----------memory---------- ---swap-- -----io---- -system-- -----cpu------
 r  b   swpd   free   buff  cache   si   so    bi    bo   in   cs us sy id wa st
 2  2      0 4415152  64068 554100    0    0     4 63144  350   55 29 64  0  3  4
 3  0      0 4417632  64832 551272    0    0     0   988  125   60 32 67  0  0  1
 3  1      0 4415524  68100 550068    0    0     0  5484  212   66 31 64  0  4  1
 3  0      0 4412672  68856 552408    0    0     0    40  109   48 32 68  0  0  0
 3  0      0 4414408  69656 549544    0    0     0     0  103   36 32 68  0  0  0
 3  0      0 4411184  70500 552312    0    0     0     0  104   37 33 67  0  0  0
 3  0      0 4411804  72188 549592    0    0     0  8984  230   42 32 67  0  0  1
 3  0      0 4405232  72896 555592    0    0     0    16  105   52 32 68  0  0  0
```

- **Shows**
  - Data per time interval
  - CPU utilization
  - Disk I/O
  - Memory usage/Swapping

- **Hints**
  - Shared memory usage is listed under 'cache'

sadc/sar

- **Characteristics: Very comprehensive, statistics data on device level**
- **Objective: Suitable for permanent system monitoring and detailed analysis**
- **Usage (recommended):**
  - monitor /usr/lib64/sa/sadc -d [interval in sec] [outfile]
  - view sar -A -f [outfile]

- **Shows**
  - CPU utilization
  - Disk I/O overview and on device level
  - Network I/O and errors on device level
  - Memory usage/Swapping
  - … and much more
  - Reports statistics data over time and creates average values for each item

- **Hints**
  - Specify -d parameter to sadc to include disk device statistics (increase size of outfile)
  - Shared memory is listed under 'cache'
  - [outfile] is a binary file, which contains all values. It is formatted using sar
    - enables the creation of item specific reports, e.g. network only
    - enables the specification of a start and end time → averages are created for the time of interest

sadc/sar (cont.)

- **Some output samples:**
  - CPU load

```
14:19:29        CPU     %user     %nice   %system   %iowait    %steal     %idle
14:20:29        all      2.61      0.00      0.24      0.26      0.09     96.80
14:20:29          0     13.09      0.00      0.88      0.62      0.45     84.96
14:20:29          1      0.63      0.00      0.12      0.03      0.02     99.20
...
Average:        all     88.13      0.00      1.75      0.05      1.29      8.78
Average:          0     85.61      0.00      5.20      0.03      3.19      5.97
Average:          1     88.98      0.00      1.08      0.04      0.93      8.97
```

  - Network load

```
14:19:29        IFACE   rxpck/s   txpck/s    rxkB/s    txkB/s   rxcmp/s   txcmp/s  rxmcst/s
...
Average:           lo      0.00      0.00      0.00      0.00      0.00      0.00      0.00
Average:         sit0      0.00      0.00      0.00      0.00      0.00      0.00      0.00
Average:         eth3   3587.47   3604.13   2002.09   5381.80      0.00      0.00      0.00
Average:         eth1      0.04      0.00      0.01      0.00      0.00      0.00      0.04
```

  - Memory usage

```
14:19:29    kbmemfree kbmemused  %memused kbbuffers  kbcached kbswpfree kbswpused  %swpused  kbswpcad
...
Average:        46312   8176012     99.44     13142   1906865    319172    729764     69.57    387029
```

sadc/sar (cont.)

- **Some output samples:**
  - Disk I/O – paging statistics

```
14:19:29     pgpgin/s pgpgout/s   fault/s  majflt/s  pgfree/s pgscank/s pgscand/s pgsteal/s    %vmeff
14:20:29       493.62    117.47   1039.55      0.00    413.26    253.97      0.00    246.28     96.97
14:21:29      1148.91    148.14   3757.45      0.00    734.55    553.94      0.00    536.69     96.89
14:22:29       357.95    183.74   7039.62      0.00    508.28    338.69      0.00    328.42     96.97
14:23:29       286.27    552.20   8352.07      0.00    499.92    327.25      0.00    317.33     96.97
14:24:29       255.05    276.37   9260.43      0.02    486.67    323.29      0.00    313.50     96.97
...
Average:       117.22    503.81   3647.43      0.03    312.71    385.32     67.19    127.55     28.19
```

  - Disk I/O – device level

```
04:46:59        DEV       tps  rd_sec/s  wr_sec/s  avgrq-sz  avgqu-sz     await     svctm     %util
04:47:29    dev94-0      0.83      0.00     80.83     96.96      0.00      1.20      0.80      0.07
04:47:29    dev94-4      0.00      0.00      0.00      0.00      0.00      0.00      0.00      0.00
```

  - Identify the devices via cat /proc/partitions

```
major minor  #blocks  name

  94      0    7212240 dasda
  94      1    7212144 dasda1
  94      4    7212240 dasdb
  94      5         96 dasdb1
  94      6    7212048 dasdb2
```

Agenda

- **Objectives**
- **Tools**
  - System
    - vmstat
    - sadc/sar
  - **Disk**
    - **iostat**
    - **DASD statistics**
    - **SCSI statistics**
  - Network
    - netstat
  - Processes
    - top
    - ps
- **Assuming we have a problem …**
  - .. somewhen
  - .. now
- **Summary**

iostat

- **Characteristics:** **Easy to use, information on disk device level**
- **Objective:** **Detailed input/output disk statistics**
- **Usage:** iostat -xtdk [interval in sec]

- **Shows**
  - Throughput
  - Request merging
  - Device queue information
  - Service times

- **Hints**
  - Most critical parameter is *await*
    - average time (in milliseconds) for I/O requests issued to the device to be served.
    - includes the time spent by the requests in queue and the time spent servicing them.
  - Also suitable for network file systems

iostat

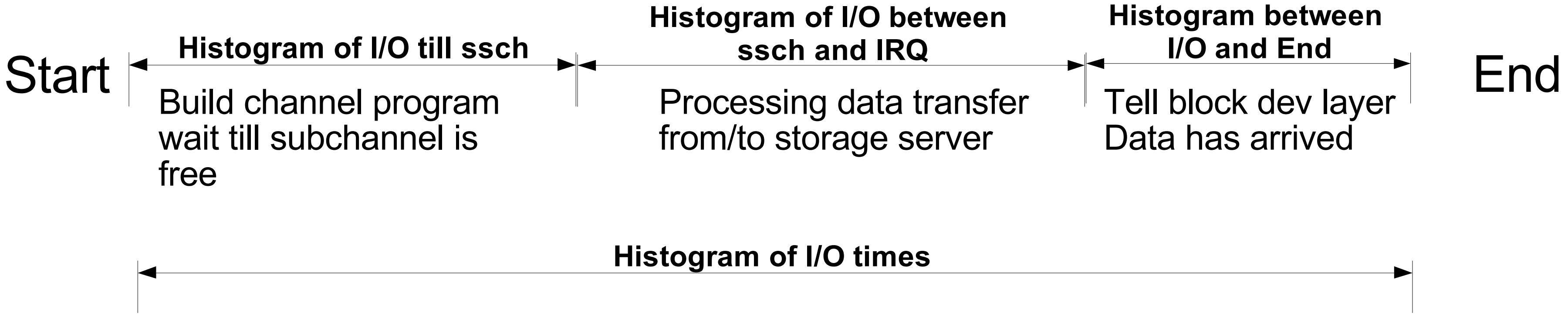
- **Output sample:**

```
Time: 10:56:35 AM
Device:         rrqm/s   wrqm/s     r/s     w/s    rkB/s    wkB/s avgrq-sz avgqu-sz   await  svctm  %util
dasda             0.19     1.45    1.23    0.74    64.43     9.29    74.88     0.01    2.65   0.80   0.16
dasdb             0.02   232.93    0.03    9.83     0.18   975.17   197.84     0.98   99.80   1.34   1.33

Time: 10:56:36 AM
Device:         rrqm/s   wrqm/s     r/s     w/s    rkB/s    wkB/s avgrq-sz avgqu-sz   await  svctm  %util
dasda             0.00     0.00    0.00    0.00     0.00     0.00     0.00     0.00    0.00   0.00   0.00
dasdb             0.00  1981.55    0.00  339.81     0.00  9495.15    55.89     0.91    2.69   1.14  38.83

Time: 10:56:37 AM
Device:         rrqm/s   wrqm/s     r/s     w/s    rkB/s    wkB/s avgrq-sz avgqu-sz   await  svctm  %util
dasda             0.00     0.00    0.00    0.00     0.00     0.00     0.00     0.00    0.00   0.00   0.00
dasdb             0.00  2055.00    0.00  344.00     0.00  9628.00    55.98     1.01    2.88   1.19  41.00
```

DASD statistics

- **Characteristics:** **Easy to use, very detailed**
- **Objective:** **Collects statistics of I/O operations on DASD devices**
- **Usage:**
  - enable: echo on > /proc/dasd/statistics
  - show:
    - overall cat /proc/dasd/statistics
    - for individual DASDs tunedasd -P /dev/dasda

- **Shows:**
  - various processing times:


Start
Histogram of I/O till ssch
Build channel program wait till subchannel is free
Histogram of I/O between ssch and IRQ
Processing data transfer from/to storage server
Histogram between I/O and End
Tell block dev layer Data has arrived
End
Histogram of I/O times

DASD statistics - report

- **Sample:**

4KB <= request size < 8 KB

1ms <= response time < 2 ms

```
29432 dasd I/O requests
with 6227424 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    9925    3605    1866    4050    4102     933    2700    2251       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    1283    1249    6351    7496    3658    8583     805       7       0
      0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0

Histogram of I/O time till ssch
   2314     283      98      34      13       5      16     275     497    8917    5567    4232    7117      60       4       0
      0       0       0       0       0       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   14018    7189    2402    1031    4758      27       4       3       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
   2733       6    5702    9376    5781     940    1113    3781       0       0       0       0       0       0       0       0
      0       0       0       0       0       0       0       0       0       0       0       0       0       0       0       0

# of req in chanq at enqueuing (1..32)
      0    2740     628    1711    1328   23024       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
```

- **Hints**
  - Also shows data per sector

FCP statistics

- **Characteristics:** **Detailed latency information (SLES9 and SLES10)**
- **Objective:** **Collects statistics of I/O operations on FCP devices on request base, separate for read/write**

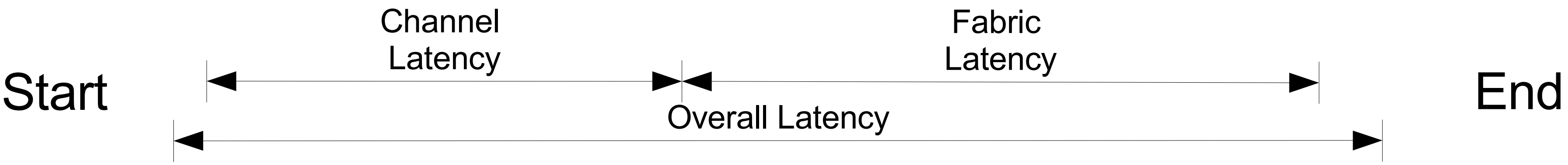
- **Usage:**
  - enable
    - CONFIG_STATISTICS=y must be set in the kernel config file
    - debugfs is mounted at /sys/kernel/debug/
    - For a certain LUN in directory `/sys/kernel/debug/statistics/zfcp-<device-bus-id>-<WWPN>-<LUN>`
      - issue `echo on=1 > definition` (turn off with on=0, reset with data=reset)
  - view
    - `cat /sys/kernel/debug/statistics/zfcp-<device-bus-id>-<WWPN>-<LUN>/data`

- **Hint**
  - FCP and DASD statistics are not directly comparable, because in the FCP case many I/O requests can be sent to the same LUN before the first response is given. There is a queue at FCP driver entry and in the storage server

FCP statistics

- **Shows:**
  - Request sizes in bytes (hexadecimal)
  - Channel latency Time spent in the FCP channel in nanoseconds
  - Fabric latency processing data transfer from/to storage server incl. SAN in nanoseconds
  - (Overall) latencies whole time spent in the FCP layer in milliseconds

  - Calculate the pass through time for the FCP layer as
    `pass through time = overall latency – (channel latency + fabric latency)`
    → Time spent between the Linux device driver and FCP channel adapter inclusive in Hypervisor



FCP statistics example

```
cat /sys/kernel/debug/statistics/zfcp-0.0.1700-0x5005076303010482-0x4014400500000000/data
...
request_sizes_scsi_read 0x1000 1163
request_sizes_scsi_read 0x80000 805
request_sizes_scsi_read 0x54000 47
request_sizes_scsi_read 0x2d000 44
request_sizes_scsi_read 0x2a000 26
request_sizes_scsi_read 0x57000 25
request_sizes_scsi_read 0x1e000 25
request_sizes_scsi_read 0x63000 24
request_sizes_scsi_read 0x6f000 19
request_sizes_scsi_read 0x12000 19
...
latencies_scsi_read <=1 1076
latencies_scsi_read <=2 205
latencies_scsi_read <=4 575
latencies_scsi_read <=8 368
latencies_scsi_read <=16 0
...
channel_latency_read <=16000 0
channel_latency_read <=32000 983
channel_latency_read <=64000 99
channel_latency_read <=128000 115
channel_latency_read <=256000 753
channel_latency_read <=512000 106
channel_latency_read <=1024000 141
channel_latency_read <=2048000 27
channel_latency_read <=4096000 0
...
fabric_latency_read <=1000000 1238
fabric_latency_read <=2000000 328
fabric_latency_read <=4000000 522
fabric_latency_read <=8000000 136
fabric_latency_read <=16000000 0
...
```

request size 4KB, 1163 occurrences

response time <= 1ms

response time <= 32µs

response time <= 1ms

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    - top
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- Assuming we have a problem …
  - .. somewhen
  - .. now
- Summary

netstat -s

- **Characteristics:** **Easy to use, very detailed information**
- **Objective:** **Display summary statistics for each protocol**
- **Usage:** netstat -s

- **Shows**
  - Information to each protocol
  - Amount of incoming and outgoing packages
  - Various error states, for example TCP segments retransmitted!

- **Hints**
  - Shows accumulated values since system start, therefore mostly the differences between two snapshots are needed
  - There is always a low amount of packets in error or resets
  - Retransmits occurring only when the system is sending data
    When the system is not able to receive, then the sender shows retransmits
  - Use sadc/sar to identify the device

netstat -s

- **Output sample:**

```
Tcp:
  15813 active connections openings
  35547 passive connection openings
  305 failed connection attempts
  0 connection resets received
  6117 connections established
  81606342 segments received
  127803327 segments send out
  288729 segments retransmitted
  0 bad segments received.
  6 resets sent
```

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top

- **Characteristics:** **Easy to use**
- **Objective:** **Shows resource usage on process level**
- **Usage:** top -b -d [interval in sec] > [outfile]

- **Shows**
  - CPU utilization
  - Detailed memory usage

- **Hints**
  - Parameter -b enables to write the output for each interval into a file
  - Use -p [pid1, pid2,...] to reduce the output to the processes of interest
  - Configure displayed columns using 'f' key on the running top program
  - Use the 'W' key to write current configuration to ~/.toprc
    → becomes the default

top (cont.)

- **See ~/.toprc file in backup**

- **Output sample:**

```
top - 11:12:52 up  1:11,  3 users,  load average: 1.21, 1.61, 2.03
Tasks:  53 total,   5 running,  48 sleeping,   0 stopped,   0 zombie
Cpu(s):  3.0%us,  5.9%sy,  0.0%ni, 79.2%id,  9.9%wa,  0.0%hi,  1.0%si,  1.0%st
Mem:   5138052k total,   801100k used,  4336952k free,   447868k buffers
Swap:       88k total,        0k used,       88k free,   271436k cached

  PID USER      PR  NI  VIRT  RES  SHR S %CPU %MEM    TIME+  P SWAP DATA WCHAN     COMMAND
 3224 root      18   0  1820  604  444 R  2.0  0.0   0:00.56 0 1216  252 -         dbench
 3226 root      18   0  1820  604  444 R  2.0  0.0   0:00.56 0 1216  252 -         dbench
 2737 root      16   0  9512 3228 2540 R  1.0  0.1   0:00.46 0 6284  868 -         sshd
 3225 root      18   0  1820  604  444 R  1.0  0.0   0:00.56 0 1216  252 -         dbench
 3230 root      16   0  2652 1264  980 R  1.0  0.0   0:00.01 0 1388  344 -         top
    1 root      16   0   848  304  256 S  0.0  0.0   0:00.54 0  544  232 select    init
    2 root      RT   0     0    0    0 S  0.0  0.0   0:00.00 0    0    0 migration migration/0
    3 root      34  19     0    0    0 S  0.0  0.0   0:00.00 0    0    0 ksoftirqd ksoftirqd/0
    4 root      10  -5     0    0    0 S  0.0  0.0   0:00.13 0    0    0 worker_th events/0
    5 root      20  -5     0    0    0 S  0.0  0.0   0:00.00 0    0    0 worker_th khelper
```

- **Hints**

▶ virtual memory:	VIRT = SWAP + RES	unit KB
▶ physical memory used:	RES = CODE + DATA	unit KB
▶ shared memory	SHR	unit KB

Linux ps command

- **Characteristics:** **very comprehensive, statistics data on process level**
- **Objective:** **reports a snapshot of the current processes**
- **Usage (recommended):**
  ps -eo pid,tid,nlwp,policy,user,tname,ni,pri,psr,sgi_p,stat,wchan:12,start_time,time, pcpu,pmem,vsize,size, rss,share,command

```
 PID   TID NLWP POL USER     TTY       NI PRI PSR P STAT WCHAN        START     TIME %CPU %MEM   VSZ    SZ   RSS - COMMAND
...
 871   871    1 TS  root     ?         -5  29   0 * S<   kauditd_thre 10:01 00:00:00  0.0  0.0     0     0     0 - [kauditd]
2319  2319    1 TS  root     ?          0  23   0 * Ss   poll         10:01 00:00:00  0.0  0.0  2332   264   756 - /sbin/syslog-ng
2322  2322    1 TS  root     ?          0  23   0 * Ss   syslog       10:01 00:00:00  0.0  0.0  1940   376   588 - /sbin/klogd -c 7 -x -x
2324  2324    1 TS  daemon   ?          0  23   0 * Ss   poll         10:01 00:00:00  0.0  0.0  4524   288  1168 - /usr/sbin/slpd
2350  2350    2 TS  root     ?         -3  26   0 * S<sl select       10:01 00:00:00  0.0  0.0 10188  8452   696 - /sbin/auditd -n
2352  2352    1 TS  nobody   ?          0  23   0 * Ss   poll         10:01 00:00:00  0.0  0.0  1856   244   572 - /sbin/portmap
2675  2675    1 TS  root     ?          0  23   0 * Ss   select       10:02 00:00:00  0.0  0.0  5772   520  1532 - /usr/sbin/sshd -o PidFile=/var/
run/sshd.init.pid
2680  2680    1 TS  root     ttyS0      0  21   0 * Ss+  read_chan    10:02 00:00:00  0.0  0.0  2008   244   656 - /sbin/mingetty --noclear
/dev/ttyS0 dumb
2737  2737    1 TS  root     ?          0  24   0 * Ss   select       10:30 00:00:00  0.0  0.0  9512   868  3228 - sshd: root@pts/0
2739  2739    1 TS  root     pts/0      0  24   0 * Ss   wait4        10:30 00:00:00  0.0  0.0  5140   824  2668 - -bash
2766  2766    1 TS  root     ?          0  23   0 * Ss   select       10:35 00:00:00  0.0  0.0  9364   720  3136 - sshd: root@pts/1
2768  2768    1 TS  root     pts/1      0  23   0 * Ss   wait4        10:35 00:00:00  0.0  0.0  5140   824  2680 - -bash
2833  2833    1 TS  root     ?          0  23   0 * Ss   select       10:38 00:00:00  0.0  0.0  9512   868  3152 - sshd: root@pts/2
2835  2835    1 TS  root     pts/2      0  23   0 * Ss+  read_chan    10:38 00:00:00  0.0  0.0  5140   824  2644 - -bash
3437  3437    1 TS  root     pts/1      0  23   0 * S+   wait4        11:39 00:00:00  0.0  0.0  1816   248   644 - dbench 3
3438  3438    1 TS  root     pts/1      0  20   0 0 R+   -            11:39 00:00:24 33.1  0.0  1820   252   604 - dbench 3
3439  3439    1 TS  root     pts/1      0  20   0 0 R+   -            11:39 00:00:23 32.8  0.0  1820   252   604 - dbench 3
3440  3440    1 TS  root     pts/1      0  20   0 0 R+   -            11:39 00:00:23 31.8  0.0  1820   252   604 - dbench 3
3461  3461    1 TS  root     pts/0      0  22   0 0 R+   -            11:40 00:00:00  0.0  0.0  2688   588   976 - ps -eo
pid,tid,nlwp,policy,user,tname,ni,pri,psr,sgi_p,stat,wchan:12,start_time,time,pcpu,pmem,vsize,size,rss,shar
```

- **Hints**
  - Do not specify blanks inside the -o format string
  - Many more options available

Agenda

- **Objectives**
- **Tools**
  - System
    - vmstat
    - sadc/sar
  - Disk
    - iostat
    - DASD statistics
    - SCSI statistics
  - Network
    - netstat
  - Processes
    - top
    - ps
- **Assuming we have a problem …**
  - **.. somewhen**
  - **.. now**
- **Summary**

We have the problem somewhen - Strategy

- **Requires permanent monitoring**
  - Use sadc with a suitable interval, e.g. 1 – 5 minutes
  - Because of the flattening effects of averaging, limits for critical ranges are much lower!
  - Try to identify time patterns
→ use the 'at' command and
→ the 'counts' parameter from the monitoring tool (sadc, iostat) limits the amount of samples gathered, reduces the impact and the amount of data
  - Allows to gather data with a much higher granularity during a certain period
  - Follow the advices on page 'We have the problem now'

We have the problem now - Analysis

- **Check CPU utilization**
  - Start with vmstat 1 for a fast view or sadc/sar for a comprehensive data gathering (especially if the problem is only temporary)
  - user + system + nice >95%?
    - Is the system doing the right things? Continue with top
      → Do the right processes use the CPU?
    - Is kswapd using significant amount of CPU? Continue with top or ps
      → memory is constrained
    - Does the system use Hipersockets? Continue with netstat -s on sender and receiver (or sadc/sar)
      → Hipersockets are CPU-driven
    - Add CPUs! Or analyze the application used.
  - High steal times?
    - Under z/VM:
      - monitor z/VM using the z/VM performance tool kit
      - high steal times on one CPU might be caused by VM activity for virtual interfaces from the guest, e.g. VSWITCH
    - In LPAR: monitor LPAR activity with the SE

We have the problem now - Analysis

- **Check CPU utilization (cont)**
  - I/O wait times
    - counts as idle!
    - indicates disk I/O contention. Continue with 'check disk utilization'
  - Significant idle times?
    - system is waiting. Continue with 'system is waiting'

- **Check disk utilization**
  - sadc/sar or iostat → identify concerned disks
  - Contention on DASD devices → continue with DASD statistics
  - Contention on FCP devices → continue with FCP statistics

- **System is waiting**
  - If no contention on disk devices,
  - Check for errors/retransmits using netstat -s or sadc/sar
  - Analyze application for locking scenarios

Agenda

- Objectives
- Tools
  - System
    - vmstat
    - sadc/sar
  - Disk
    - iostat
    - DASD statistics
    - SCSI statistics
  - Network
    - netstat
  - Processes
    - top
    - ps
- Assuming we have a problem …
  - .. somewhen
  - .. now
- **Summary**

Summary

- **I showed various tools providing performance data for**
  - The overall system
  - Disk I/O
  - Network I/O
  - Processes
- **The recommended tool for general purpose is sadc/sar!**
  - Suitable for permanent system monitoring.
  - The other tools are for a detailed analysis of specific problems
- **Stay current with updates on your preferred monitoring tool.**
  - Might provide more accurate values or more information.

Related Topics at 2009 System z Expo

- **Problem Determination with Linux on System z**

zLG05	Thursday	1:00 PM

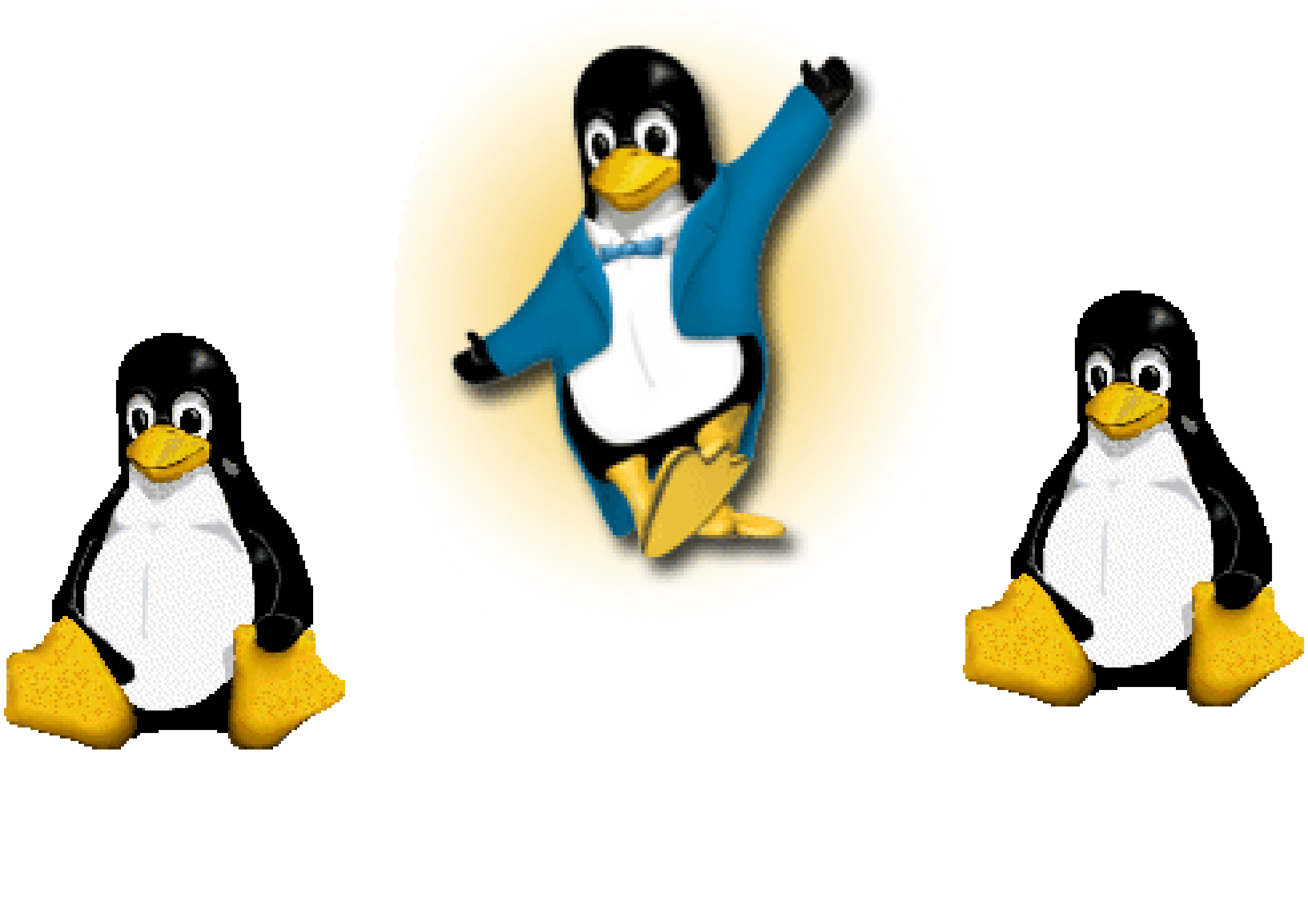
- **Performance Tuning and Monitoring: DB2 for Linux, Unix and Windows (LUW) for Linux**

zLA08	Monday	4:10 PM
zLA08	Wednesday	4:10 PM

Visit us !

- **Linux on System z: Tuning Hints & Tips**
  - http://www.ibm.com/developerworks/linux/linux390/perf/
- **Linux-VM Performance Website:**
  - http://www.vm.ibm.com/perf/tips/linuxper.html
- **IBM Redbooks**
  - http://www.redbooks.ibm.com/
- **IBM Techdocs**
  - http://www.ibm.com/support/techdocs/atsmastr.nsf/Web/Techdocs

Questions



Backup

top (config file)

- **Sample .toprc**
  - used for the output on the next slide

```
RCfile for "top with windows"           # shameless braggin'
Id:a, Mode_altscr=0, Mode_irixps=1, Delay_time=1.000, Curwin=0
Def     fieldscur=AEHIOQTWKNMbcdfgJPlrSuvYzX
        winflags=64825, sortindx=10, maxtasks=0
        summclr=1, msgsclr=1, headclr=3, taskclr=1
Job     fieldscur=ABcefgjlrstuvyzMKNHIWOPQDX
        winflags=62777, sortindx=0, maxtasks=0
        summclr=6, msgsclr=6, headclr=7, taskclr=6
Mem     fieldscur=ANOPQRSTUVbcdefgjlmyzWHIKX
        winflags=62777, sortindx=13, maxtasks=0
        summclr=5, msgsclr=5, headclr=4, taskclr=5
Usr     fieldscur=ABDECGfhijlopqrstuvyzMKNWX
        winflags=62777, sortindx=4, maxtasks=0
        summclr=3, msgsclr=3, headclr=2, taskclr=3
```

sysstat tools

- **provides a bunch of tools:**
  - /usr/bin/iostat
  - /usr/bin/mpstat
  - /usr/bin/pidstat
  - /usr/bin/sadf
  - /usr/bin/sar
  - /usr/lib64/sa
  - /usr/lib64/sa/sa1
  - /usr/lib64/sa/sa2
  - /usr/lib64/sa/sadc
  - /usr/sbin/rcsysstat